GREEN DIAMOND
RESOURCE COMPANY

Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances

FINAL

October 2006 • Volume 1

Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances

Prepared for:

National Marine Fisheries Service
U.S. Fish and Wildlife Service

Prepared by:

GREEN DIAMOND RESOURCE COMPANY

FINAL

October 2006

Volume 1

Contents

Appendices (Volume 2)

Figures

Tables

Addendum

PURPOSE OF THE ADDENDUM

Since public review of the Aquatic Habitat Conservation Plan/Candidate Conservation Agreement with Assurances (AHCP/CCAA) dated July 2002, Green Diamond Resources Company (Green Diamond) has worked with staff of the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) to respond to comments on and revise sections of the AHCP/CCAA. This process occurred primarily in 2005 and yielded the documents identified as the Final AHCP/CCAA. The changes to the July 2002 AHCP/CCAA were made with the concurrence of NMFS, USFWS, and Green Diamond and include corrections, revised and new language regarding the measures in the Operating Conservation Program, and updated information about Green Diamond's ownership as of April 2005. This addendum identifies completed and pending changes in Green Diamond's ownership since April 2005. Upon issuance of the incidental take permit by NMFS and the enhancement of survival permit by USFWS, Green Diamond will prepare a map that shows Green Diamond's current ownership. The current ownership will comprise the Initial Plan Area as defined in the AHCP/CCAA. After permit issuance, Green Diamond may continue to acquire or sell property in accordance with the terms of the AHCP/CCAA.

OWNERSHIP CHANGES SINCE APRIL 2005 AND PROBABLE OWNERSHIP CHANGES BEFORE PERMIT ISSUANCE

Sale of Goose Creek Tract

The Western Rivers Conservancy has exercised a legally binding option to purchase all of Green Diamond's 9,478-acre Goose Creek tract located in the Smith River HPA. The sale of this tract is proceeding in three phases. Western Rivers has closed on the purchase of Phase I (3,858 acres) and Phase IIA (1,844 acres) and these lands have been conveyed to Western Rivers. Western Rivers is expected to complete the acquisition of the Goose Creek tract and close on the purchase of Phase IIB (3,776 acres) before or soon after the approval of the AHCP/CCAA and issuance of permits. The Goose Creek land acquired from Green Diamond by Western Rivers has been conveyed or will be conveyed to the United States for management as part of the Six Rivers National Forest and subject to the Northwest Forest Plan Amendments and PACFISH biological opinion.

Property Under Threat of Condemnation

Green Diamond has recently received notice that the California Department of Transportation intends to take two small parcels of Green Diamond land for public use as highway right of way. Green Diamond has agreed to sell a parcel of 1.88 acres abutting State Route 299 to the State. Another parcel of 0.15 acre abutting State Route 197 is likely to be acquired by the State.

This page intentionally blank.

Summary

PURPOSE AND SCOPE

This *Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances* (AHCP/CCAA, the Plan) was prepared for the California timberlands of Green Diamond Resource Company (Green Diamond) to conserve habitat for and mitigate impacts on six aquatic species:

- *Oncorhynchus tshawytscha* (chinook salmon)
- *Oncorhynchus kisutch* (coho salmon)
- *Oncorhynchus mykiss* (steelhead and resident rainbow trout)
- *Oncorhynchus clarki clarki* (coastal cutthroat trout)
- *Ascaphus truei* (tailed frog)
- *Rhyacotriton variegatus* (southern torrent salamander)

The Plan is part of Green Diamond's applications to the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for permits authorizing incidental take of listed species in accordance with the federal Endangered Species Act (ESA) and federal policies regarding conservation of unlisted species. NMFS is being asked to approve a habitat conservation plan (HCP) and incidental take permit (ITP) for listed and unlisted populations of three fish under its jurisdiction: chinook salmon, coho salmon, and steelhead. USFWS is being asked to approve a CCAA and enhancement of survival permit (ESP) for two unlisted fish and two unlisted amphibians under its jurisdiction: resident rainbow trout, coastal cutthroat trout, tailed frog, and southern torrent salamander. Table S-1 identifies the species covered by each of the Permits and indicates their current listing status. The ITP and ESP collectively are cited in this Plan as the “Permits.” NMFS and USFWS collectively are cited as “the Services.” The species identified in Table S-1 are cited as the “Covered Species.”

The Plan provides the information and analysis required in the applications for the Permits and identifies the measures that Green Diamond will implement to:

- Minimize and mitigate the potential adverse effects of any authorized taking of listed Covered Species that may occur incidental to Green Diamond’s activities in the area covered by the Plan and Permits;

- Ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of any Covered Species; and

- Contribute to efforts to reduce the need to list currently unlisted Covered Species under the ESA in the future by providing early conservation benefits to those species.

An Implementation Agreement (IA) also has been prepared to accompany the applications to NMFS and USFWS. The IA defines the roles and responsibilities of the parties regarding the Plan and Permits, ensures implementation of the Operating Conservation Program identified in the Plan, describes procedures for modifications, and provides assurances to Green Diamond and the Services.

Table S-1. The Covered Species

Species Common Name, *Scientific Name*	Listing Status in HPAs	
	Federal	State
Species Covered by the AHCP/ITP		
Chinook salmon, *Oncorhynchus tshawytscha*		
California Coastal ESU	FT	None
Southern Oregon and Northern California Coastal ESU	None	None
Upper Klamath/Trinity Rivers ESU	None	None
Coho salmon, *Oncorhynchus kisutch*		
Southern Oregon/Northern California Coast ESU	FT	ST
Steelhead, *Oncorhynchus mykiss*		
Northern California DPS	FT	None
Klamath Mountains Province ESU	None	None
Species Covered by the CCAA/ESP		
Resident rainbow trout, *Oncorhynchus mykiss*	None	None
Coastal cutthroat trout, *Oncorhynchus clarki clarki*	None	CSC
Tailed frog, *Ascaphus truei*	None	CSC
Southern torrent salamander, *Rhyacotriton variegatus*	None	CSC

Codes
CSC California Department of Fish and Game Species of Special Concern
DPS Distinct Population Segment
ESU Evolutionarily Significant Unit
FT Federal threatened species
None Currently not listed, proposed for listing, a candidate for listing, or a CSC.
ST State threatened species

Both the Plan and the Permits have a term of 50 years. The geographic area in which the Plan will be implemented and where incidental take may occur is defined as Green Diamond's ownership within eleven Hydrographic Planning Areas (11 HPAs) on the west slopes of the Klamath Mountains and the Coast Range of California. 'Ownership' means fee-owned lands and lands where Green Diamond own harversting rights. The Plan also covers up to 100 miles of road where Green Diamond owns and exercises road access rights within approved Timber Harvesting Plan (THP) areas. ***Figure S-1*** shows Green Diamond's ownership (Initial Plan Area) as of April 2005 and the boundaries of the HPAs. As indicated in Table S-1, the Initial Plan Area includes approximately 416,533 acres. As with other commercial timber operations, Green Diamond's ownership in the HPAs is expected to change over time. To address such changes, the Plan and IA allow for the Initial Plan Area to expand or contract within certain limits. As depicted in ***Figure S-1***, the Plan identifies an Eligible Plan Area that includes both the Initial Plan Area and commercial timberlands that potentially could become part of Green Diamond's ownership. These other lands are identified as the Adjustment Area and include approximately 291,377 acres.

Table S-2. Estimated acreage of the Initial Plan Area, Adjustment Area, and Hydrographic Planning Areas (HPAs).

HPA Name (Type[1])	Hydrographic Planning Areas (HPAs)				
	Eligible Plan Area (EPA)			Non-EPA[5] (acres)	Total HPA (acres)
	Initial Plan Area [2] (acres)	Adjustment Area[3] (acres)	Total EPA[4] (acres)		
Smith River HPA (Hydrographic Area)	44,177	8,140	52,318	129,681	181,999
Coastal Klamath HPA (Hydrographic Area)	88,760	5,300	94,060	14,090	108,150
Blue Creek HPA (Hydrologic Unit)	15,393	35	15,428	64,875	80,303
Interior Klamath HPA (Hydrographic Area)	66,139	43,217	109,357	18,649	128,006
Redwood Creek HPA (Hydrologic Unit)	33,038	67,693	100,731	87,604	188,335
Coastal Lagoons HPA (Hydrographic Area)	39,981	4,678	44,659	8,932	53,592
Little River HPA (Hydrologic Unit)	26,041	1,908	27,949	1,753	29,703
Mad River HPA (Hydrographic Area)	49,376	49,787	99,163	20,523	119,686
North Fork Mad River HPA (Hydrologic Unit)	28,209	3,207	31,416	0	31,416
Humboldt Bay HPA (Hydrographic Area)	17,484	21,386	38,870	99,849	138,719
Eel River HPA (Hydrographic Area)	7,933	86,026	93,958	111,202	205,160
TOTAL	416,533	291,377	707,909	557,158	1,265,069

Notes

1 HPAs that encompass the entire drainage are referred to as hydrologic units. HPAs that encompass multiple watersheds or a fraction of one watershed are referred to as hydrographic areas.

2 The Initial Plan Area includes 413,064 acres of fee owned land and 3,469 acres of harvesting rights..

3 Estimated acreage of the Adjustment Area as of the effective dates of the Permits; includes other commercial timberlands potentially available for addition to the Plan Area as of the effective date of the Permits; estimate excludes non-forested commercial timberlands, a large tract of land proposed for conservation commitments, and commercial timberlands covered by an approved HCP.

4 Estimated acreage based on configuration of Initial Plan Area and Adjustment Area as shown in ***Figure 1-2***.

5 Estimated acreage includes developed and undeveloped privately owned lands, all public lands, Native American lands, and commercial timberlands excluded from the estimated acreage of the initial Adjustment Area (see note 3 above).

The activities covered by the Plan and Permits (Covered Activities) include timber operations and related management activities on Green Diamond's ownership in the HPAs and the activities needed to carry out all measures identified in the Plan. Timber operations and related management activities include but are not limited to: felling and bucking timber, yarding timber, loading and other landing operations, salvaging timber products, transporting timber and rock products, road construction and maintenance, rock pit construction and use, water drafting, equipment maintenance, regeneration harvest, site preparation, prescribed burning, slash treatment, planting, pre-commercial thinning and pruning, commercial thinning, and the collection and transport of minor forest products such as burls, stumps, boughs, and greenery. All Covered Activities will be implemented in accordance with the impact avoidance, minimization, and mitigation measures identified in Section 6.2 of the Plan, California Forest Practice Rules (FPRs), Green Diamond's Northern Spotted Owl HCP, and other applicable federal and state regulations.

THE COVERED SPECIES AND THEIR HABITAT

Each Covered Species is a cold-water adapted species whose habitat requirements make it sensitive to the potential impacts of timber management. Within the Plan Area, the Covered Species occupy a wide range of stream reaches based on their specific habitat requirements and biological adaptations. The larger streams tend to be used by the fish species, while smaller tributaries are primarily used by the amphibians.

The four fish Covered Species are members of the Salmonid family and exhibit varying levels of anadromy. Within the Plan Area, chinook and coho salmon are exclusively anadromous; rainbow trout exhibit both anadromous (steelhead) and resident forms; and cutthroat trout mostly exist as resident populations, but limited anadromy does occur. Chinook and coho salmon die after spawning, while rainbow trout (including steelhead) and coastal cutthroat trout can survive to spawn more than once. All four of the salmonids are potentially responsive to changes in five variables: water supply, temperature, nutrients, large woody debris (LWD), and sediment. In this regard, their habitat is largely a function of the interaction of flowing water, sediment, and structures in stream channels and the adjacent riparian area. Stream channels encompass the area where water flows most of the time and the floodplain above the bankfull channel margin that are sporadically inundated at higher flows.

Stream habitat for the two amphibian Covered Species (southern torrent salamander and tailed frog) generally occurs upstream from salmonid habitat in the smaller headwater portions of streams with cold water and clean gravels and in seeps or springs. Compared to lower stream reaches, headwater streams tend to have higher gradients and more confined channels. Larval stages of both amphibians are aquatic obligates and prefer riffle habitats that have clean cobble and gravel with minimal fine sediment accumulation. However, under certain circumstances, both can persist in streams with temporary periods of subsurface flow during the late summer and early fall. Adults of both species have limited dispersal abilities and are seldom found outside the stream or riparian strip. Tailed frogs appear to have somewhat greater tolerances for increases in water temperature than southern torrent salamanders; and springs and seeps that are vital habitat for torrent salamanders are of limited value to tailed frogs.

CURRENT STATUS OF AQUATIC HABITAT AND COVERED SPECIES IN THE ELIGIBLE PLAN AREA AND HPAs

As part of the development of the Plan, Green Diamond compiled and analyzed information about the HPAs as a whole and the Eligible Plan Area within each HPA. The information and analysis regarding the Eligible Plan Area is based primarily on studies conducted on Green Diamond's ownership in the HPAs. The premise of this approach is that the watercourses and watersheds which were studied encompass the range of conditions found on Green Diamond's entire ownership in the HPAs and also are representative of conditions on other commercial timberlands in the same area (i.e., in the Adjustment Area). This premise is supported by the location of the Adjustment Area lands in the same watersheds as the Initial Plan Area and their common history and characteristics as commercial timberlands.

The information compiled for the assessment of current conditions includes:

- A description of the geology and geomorphology of the entire area encompassed by the 11 HPAs and the features within each HPA;
- Water temperature profiles collected in all 11 HPAs from a total of 109 Class I and 66 Class II watercourses;
- Monitoring data for "treatment" and "control" sites on eight Class II watercourses in three HPAs (Smith River, Little River, and Mad River);
- Channel and habitat typing assessments for 58 streams (230 miles of stream channel) in nine HPAs (Smith River, Coastal Klamath, Blue Creek, Interior Klamath, Little River, Mad River, North Fork Mad River, Humboldt Bay, and Eel River);
- LWD inventories of 20 streams in seven HPAs (Smith River, Coastal Klamath, Blue Creek, Interior Klamath, Little River, Mad River, North Fork Mad River, and Humboldt Bay);
- LWD inventory for Prairie Creek in Redwood National Park, conducted by NMFS and Redwood National Park (Redwood Creek HPA);
- Channel monitoring data for five Class I watercourses in five HPAs (Smith River, Coastal Klamath, Mad River, North Fork Mad River, and Humboldt Bay);
- A retrospective study of sediment delivery from Class III watercourses based on 100 sites in THPs completed between 1992 and 1998, including sites in all 11 HPAs;
- Data from fish presence/absence surveys conducted in Plan Area streams in all 11 HPAs;
- Juvenile salmonid population estimates based on sampling surveys conducted in eight streams in five HPAs (Smith River, Coastal Klamath, Little River, Mad River, and North Fork Mad River);
- Results of out-migrant smolt trapping in four streams in the Little River HPA;

- Results of spawning surveys in 16 streams in six HPAs (Smith River, Coastal Lagoons, Little River, Mad River, North Fork Mad River, and Humboldt Bay); and
- Results of surveys for tailed frogs and southern torrent salamanders in 68 and 67 streams respectively in nine HPAs (Smith River, Coastal Klamath, Blue Creek, Interior Klamath, Redwood Creek, Mad River, North Fork Mad River, Humboldt Bay, and Eel River) and in additional sites outside the HPAs.

Results of the assessment indicate the following:

<u>Geologic and geomorphic factors</u>. The lands in the 11 HPAs are characteristic of the steep and rugged terrain of the Coast Ranges and Klamath Mountains. The underlying geologic formations are marked by extensive folds, fault lines, and several types of unstable soils. The entire area is subject to high hazard from potential earthquakes occurring on several onshore faults. Deep-seated and shallow landslides are common throughout the area. The Redwood Creek, Mad River, Humboldt Bay, and Eel River HPAs have weakly consolidated geologic composition; the other HPAs have relatively stable and/or mixed geologic composition. The Coastal Klamath and Interior Klamath HPAs are less subject to deep-seated landslides than the other HPAs but are highly susceptible to shallow landslides.

<u>Overall habitat conditions.</u> Seven day moving average summer water temperatures in approximately 94% of all assessed streams were at or below 17.4 °C. Applying the monitoring thresholds developed for the Plan, water temperatures at five locations would have triggered adaptive management responses (see “Effectiveness Monitoring” and “Adaptive Management”). The five sites are Coyote Creek in the Redwood Creek HPA, lower and middle Cañon Creek in the Mad River HPA, Salmon Creek in the Humboldt Bay HPA, and Stevens Creek in the Eel River HPA. On the streams where channel and habitat typing was conducted mean canopy closure ranges from 36% to 99%; deciduous trees dominate the canopy along the riparian margin; the percentage of total stream length in pools varies from 4% to 81%; and average maximum residual pool depth is 2 feet. Relatively high levels of fine sediments were found in most assessed streams in the Redwood Creek, Humboldt Bay, and Eel River HPAs and in portions of the Coastal Klamath, Coastal Lagoons, Little River, Mad River, and North Fork Mad River HPAs. Class I watercourses are generally deficient in larger classes of LWD, which limits the amount and quality of pool habitat. Assessed streams in the Little River HPA had the highest amount and quality of LWD and pool habitat. All of the assessed Plan Area streams had fewer pieces of in-stream LWD per 100 feet of channel than Prairie Creek in Redwood National Forest; the average LWD count was 4 to 5 pieces per 100 feet for the Plan Area streams and 7 pieces for Prairie Creek.

<u>Habitat conditions for Covered Species.</u> Water temperatures generally are suitable for all Covered Species in the assessed streams but potentially limiting in the watercourses where the highest average temperatures were recorded and in the Eel River HPA overall because of its southern and inland warmer climate. Access to spawning habitat by the anadromous salmonids is limited in the Interior Klamath, Redwood Creek, Mad River, and North Fork Mad River HPAs due to stream gradient or falls and cascades and in the Coastal Lagoon HPA dependent on lagoon breeching. Summer and winter rearing habitat generally is limited in all HPAs due to the deficit of large size-class LWD and pools. Ample habitat for the amphibian Covered Species is available in headwater streams in most HPAs, except in the streams with high levels of fine sediment in the

Coastal Lagoons, Little River, Mad River, and Humboldt Bay HPAs and in the Eel River HPA which has limited potential habitat.

Occurrence of Covered Species. Chinook, coho salmon, and steelhead occur in all HPAs, but are limited in or precluded from streams where access to spawning habitat is limited by steep gradients or other barriers and where water temperatures are limiting. In the Interior Klamath HPA only resident rainbow trout and coastal cutthroat trout occur in many of the Class I watercourses. Cutthroat trout are particularly abundant in the Coastal Lagoons HPA, likely due to reduced competition with the anadromous salmonids. Streams in the Little River HPA support the highest population levels of all four salmonids, especially coho salmon. The salmonids generally are scarce throughout the Eel River HPA. Green Diamond has documented tailed frogs and southern torrent salamanders in all HPAs except the Eel River HPA. Where found, the amphibians are generally widespread and abundant, except in the Interior Klamath and Humboldt Bay HPAs.

POTENTIAL IMPACTS TO COVERED SPECIES AND THEIR HABITATS THAT MAY RESULT IN TAKE

In addition to assessing current conditions, Green Diamond evaluated the potential for Covered Activities to have direct, indirect, and cumulative effects that could result in take of Covered Species. This evaluation focused on the potential for Covered Activities to:

- Alter hydrology,
- Increase sediment delivery from surface erosion or mass wasting,
- Adversely affect LWD recruitment,
- Alter water temperature and nutrient inputs,
- Create barriers to fish and amphibian passage, or
- Entail the use of equipment that could cause localized instances of direct harm.

The evaluation also took into account factors that may influence the responses of Covered Species to the effects of Covered Activities, including species' diversity and adaptability, physical and vegetative conditions, harvest methods, biotic interactions, and wide-ranging migratory behaviors. These other factors were considered because their effects on one or more life stages of a species that were considered their effects on one or more life stages of a species ultimately can limit the growth of a population. A factor that acts on a single life stage can be viewed as the limiting factor or "bottleneck" for the population or species. Green Diamond assessed the HPAs to determine which factors have a greater probability of being limiting and then assessed the Covered Activities to determine how they might cause or contribute to population "bottlenecks."

Summary results of the assessment are as follows:

1. For the salmonids, available summer and winter rearing habitat is most likely to be limiting in most HPAs. If this is true, the interaction of excess coarse sediment input and a lack of LWD will have the greatest potential to negatively impact the local and regional population of these species. Fine sediment inputs are less likely to be limiting, because it tends to have the greatest impact on spawning success. However, given the high potential for fine sediments to be transported downstream, the cumulative effect of multiple sources of fine sediment inputs throughout a sub-basin over extended periods could impair the feeding efficiency of juvenile salmonids and cause local or regional population declines.

2. For the two amphibians, excess sediment inputs, both coarse and fine, have the greatest potential to limit habitat and deter beneficial conservation efforts. However, rather than eliminating pool formation, the greatest impact will be the embedding of riffle habitat that eliminates the interstices in the substrate on which the larval phases of these species depend.

3. Altered hydrology has the potential to impact the Covered Species in both positive and negative ways. Green Diamond does not believe that altered hydrology by itself could be a limiting factor for any of the Covered Species. However, it has the potential to exacerbate a situation in which there is excess sediment inputs with too little LWD present. Because the effect is cumulative, the hydrology of a large portion of a sub-basin or watershed would need to be altered before the magnitude of the response would be large enough to impact the Covered Species.

4. Water temperature, as a single factor, has the potential to be limiting for all of the Covered Species. All of the Covered Species are considered “cold water adapted,” and each has relatively discrete upper thermal limits above which harm or death occurs. However, streams throughout the HPAs generally do not have temperatures that are at or near these upper thresholds. A few isolated streams or stream reaches have water temperatures that could cause local declines in populations of Covered Species but are not likely to be potentially responsible for regional declines.

5. Barriers, both partial and complete, can limit local populations when all other habitat factors are good. As a result, the cumulative impact of barriers has the potential to limit populations over both a local and regional scale. However, within the HPAs, anthropogenic barriers are relatively isolated so the impact of these barriers tends to only have localized impacts.

6. Use of equipment with the potential for direct take will affect individuals but, because of the localized and stochastic nature of the events, will not likely result in even local impacts on populations of Covered Species.

The complicated nature of the potential limiting factors makes it impossible to definitively assess the extent of the potential impact of take on the Covered Activities associated with any given factor. To account for this concern, Green Diamond formulated a conservation program that addresses all factors as if they are limiting for Covered Species in each HPA and provides for significant improvements in each factor over baseline conditions in all HPAs. With a few exceptions where HPA-specific measures are proposed, the measures designed to address each limiting factor will be applied throughout all 11 HPAs as if that factor were in fact limiting throughout the Plan Area. Under these conditions, the Plan will not result in negative cumulative effects. The incremental effect of Plan implementation will be positive compared with existing baseline conditions and will result in generally improving habitat conditions for the Covered Species over the term of the Permits in all HPAs. Therefore, Plan implementation will not result in negative cumulative effects.

CONSERVATION PROGRAM

The conservation program that Green Diamond will implement is based on biological goals and objectives and includes measures to minimize and mitigate the impacts of incidental take, maintain and improve habitat conditions for the Covered Species, monitor implementation and effectiveness of the Plan, institute adaptive management, and respond to changed and unforeseen circumstances. The measures collectively are identified in the Plan as “Green Diamond’s Operating Conservation Program.”

Biological Goals and Objectives

The biological goals and objectives of the Plan are based on the habitat requirements and life cycles of the Covered Species and reflect in biological terms the intended result of the Operating Conservation Program. Five goals have been established for the Plan:

1. Maintain cool water temperature regimes that are consistent with the requirements of the individual species,

2. Minimize and mitigate human-caused sediment inputs,

3. Provide for the recruitment of LWD into all stream classifications so as to maintain and allow the development of functional stream habitat conditions,

4. Allow for the maintenance or increase of populations of the amphibian Covered Species in the Plan Area through minimization of timber harvest-related impacts on the species, and

5. Monitor and adapt the Plan as new information becomes available, to provide those habitat conditions needed to meet the general goals that benefit the Covered Species.

Objectives that identify measurable parameters for each goal also have been set and are identified in the Effectiveness Monitoring and Adaptive Management Measures of the Operating Conservation Program.

Green Diamond’s Operating Conservation Program

Development of the specific conservation measures that comprise Green Diamond’s Operating Conservation Program was guided by the biological goals and objectives stated above. The measures are grouped into ten categories:

1. Riparian Management
2. Slope Stability
3. Road Management
4. Harvest-related Ground Disturbance
5. Effectiveness Monitoring
6. Adaptive Management
7. Implementation Monitoring
8. Special Project
9. Changed Circumstances
10. Unforeseen Circumstances

A summary description of each group of measures is provided below, with an emphasis on the overall purpose and focus of the measures. The complete list and exact wording of all measures are stated in Section 6.2 of the Plan.

Riparian Management

The riparian zone adjacent to streams is a vital component of salmonid and amphibian habitat, providing temperature control, nutrient inputs, channel stability, sediment control, and LWD recruitment. Following the distinctions used in California's Forest Practice Rules (FPRs), the Riparian Management Measures are directed at three broad classes of watercourses (Class I, Class II, and Class III). The purpose of the measures is to maintain and enhance the key riparian functions of such watercourses. Measures include but are not limited to:

1. Establishing Riparian Management Zones (RMZs) of specified widths and each with an inner and outer zone along all Class I and II watercourses, as summarized in Table S-3;

2. Requiring the outer zone of Class I RMZs to be extended, where necessary, to cover the entire floodplain and, depending on slope, an additional 30-50 feet beyond the outer edge of the floodplain;

Table S-3. Watercourse classes and minimum buffer widths.

Watercourse Class	Further Subdivisions	Total Width[2]	Inner Zone Width	Outer Zone Width
Class I	None	150 ft RMZ	50-70 ft	80-100 ft
Class II	2nd order or larger	100 ft RMZ	30 ft	75 ft
	1st order[1]	75 ft RMZ	30 ft	45 ft
Class IIIA	Depends on terrains	30 ft EEZ	NA	NA
Class IIIB	Depends on terrains	50 ft EEZ plus tree retention	NA	NA

Notes
1 Some Class II-1 watercourses will receive the protections of Class II-2 watercourses.
2 one side.

3. Establishing Equipment Exclusion Zones (EEZs) of specified widths along Class III watercourses (see Table S-3), and designating Class I and II RMZs as EEZs except for the limited circumstances identified in the Plan;

4. Allowing only a single harvest entry into Class I and II RMZs over the term of the Permits;

5. In Class I and II RMZs, requiring at least 85% overstory canopy closure in the inner zone and 70% in the outer zone, prohibiting the harvest of trees that contribute to maintaining bank stability, requiring the retention of all safe snags, limiting salvage activities, and requiring mulching and seeding of ground disturbances larger that 100 square feet; and

6. In Class I RMZs and within the first 200 feet of Class II RMZs adjacent to Class I RMZs, prohibiting harvest of trees that are judged likely to recruit to the watercourse.

Slope Stability

The purpose of the Slope Stability measures is to: 1) reduce management-related sediment delivery to the aquatic system from landslides, and 2) reduce landslide-related erosion that might occur in specific portions of the landscape. Slope stability and erosion problems associated with Plan Area roads are addressed separately under "Road Management."

The Slope Stability measures focus on THP-level identification of areas prone to mass wasting and the application of specific prescriptions to those areas. Initial default prescriptions are identified for Plan Area lands within each HPA, with HPAs that share common geologic and geomorphic characteristics grouped together. Implementation of the measures will occur on a plan-by-plan basis concurrently with slope stability and mass wasting assessments described under "Effectiveness Monitoring". The initial default prescriptions will be revised based on the results of the monitoring projects. Initial default slope stability prescriptions may also be modified on a plan-by-plan basis through an onsite review by a qualified geologist. Covered Activities that involve geologic issues and require the expertise of a professional geologist (PG) will be carried out by, or occur under the supervision of, a PG as required by California law.

Initial slope stability measures include but are not limited to:

1. Training all Registered Professional Foresters (RPFs) who write THPs for Green Diamond to identify and more fully understand the Slope Stability Measures as well as the possible implications of various timber management scenarios for landslide and other unstable areas.

2. Identifying in THPs: a) all steep streamside slopes (SSS) leading to Class I or II watercourses based on initial slope gradients specified for each HPA (Table S-4); b) all headwall swales; c) all active deep-seated landslides; and d) in certain circumstances, shallow rapid landslides;

3. In THP areas with identified SSS, establishing an SSS zone of specified widths (see Table S-4), each comprised of an inner Riparian Slope-stability Management Zone (RSMZ), an outer RSMZ, and a Slope-stability Management Zone (SMZ);

4. In the Coastal Klamath and Blue Creek HPAs, prohibiting harvesting in the inner and outer RSMZs on all Plan Area lands;

5. In all HPAs except Coastal Klamath and Blue Creek, prohibiting harvesting in inner RSMZs and requiring 85% overstory canopy retention in outer RSMZs on Plan Area lands with Class I or II-2 watercourses; and requiring 85% overstory canopy retention in inner RSMZs and 75% in outer RSMZs on Plan Area lands with Class II-1 watercourses;

6. In all HPAs, limiting harvesting in an SMZ or headwall swale to one entry during the term of the Permits and prohibiting harvesting 25 feet upslope from an active deep-seated landslide; and identifying single tree selection as the initial silvicultural prescription in SMZs and headwall swales;

7. In all HPAs, prohibiting harvesting 25 feet upslope of shallow landslides without a geologic review; and

8. In all HPAs, requiring Green Diamond to avoid road construction in SSS zones and field verified headwall swales, where feasible, and across active deep-seated landslide toes or scarps or on steep (greater than 50% gradient) areas of dormant slides except as approved by a PG and a RPF with experience in road construction in steep forested terrain.

Table S-4. Slope gradient for determining steep streamside slopes (SSS) and SSS zone widths for Class I and II watercourses, by HPA.

HPA	Slope Gradient	SSS Zone Slope Distance from Watercourse Transition Line (feet)		
		Class I[1]	**Class II-2**[2]	**Class II-1**[2]
Smith River	65%	150[3]	100[3,4]	75[3]
Coastal Klamath and Blue Creek	70%	475	200	100
Interior Klamath, Redwood Creek, Coastal Lagoons, Little River, Mad River, and North Fork Mad River	65%	200	200	75[3]
Humboldt Bay and Eel River	60%	200	200	75[3]

<u>Notes</u>
1 The inner RSMZ on all Class I watercourses will be 70 feet, except where a qualifying slope break exists within that distance. In that case, the inner RSMZ may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.
2 The inner RSMZ on all Class II watercourses will be 30 feet, except where a qualifying slope break exists within that distance. In that case, the inner RSMZ may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.
3 Maximum SSS zone is equal to the RMZ width, but the RSMZ prescriptions will apply.
4 There are no data available for Class II-2 watercourses in the Smith River HPA; values presented here are based on Class I watercourses.

Road Management

The purpose of the Road Management Measures is to reduce sediment delivery into watercourses from road sources, including surface erosion from roads, road-related landslides, and watercourse crossing failures (washouts and diversions). In general, chronic surface erosion delivers sediment every winter, whether or not there are any large storms. Sediment delivery from chronic road erosion is generally greatest on roads that are used during the winter, and where ditches are connected to watercourses. Newly constructed roads also exhibit increased risk of surface erosion for the first several years following construction. Sediment delivery from road-related landslides and watercourse crossing failures are episodic in nature, are linked to large storm events, and deliver relatively large quantities of sediment to watercourse channels. The risk is typically greatest on old or abandoned roads with undersized culverts that are not properly maintained.

The Road Management Measures address sediment delivery in two primary ways: 1) through an accelerated schedule of road decommissioning and upgrading; and 2) through the systematic application of standards for the construction, management, and use of roads and related facilities. The measures will be implemented concurrent with the road-related sediment delivery assessments described under "Effectiveness Monitoring" and will be revised as appropriate based on monitoring results. Measures include but are not limited to:

1. Conducting a detailed assessment of road-related sediment sources in each of 58 sub-watershed road work units (RWUs) that encompass the existing road network on Green Diamond's fee owned lands in the Plan Area, with the order in which the RWUs are assessed based on a ranking of their biological, geomorphic, and road-related features.

2. Prescribing and implementing erosion control and erosion prevention measures in connection with the decommissioning or upgrading of roads at each site where treatable sources of erosion are identified, including but not limited to measures such as road surfacing, dispersing runoff into stable vegetated filter areas, armoring with rock rip-rap, end hauling waste material to stable locations, constructing dips and waterbars, mulching, and revegetating disturbed surfaces.

3. Prioritizing sites for treatment as "high," "moderate" or "low" based on (a) projected volume of future sediment delivery; (b) treatment immediacy; and (c) treatment cost-effectiveness;

4. Providing approximately $2.5 million per year during the first 15 years of the Permits' term for the specific purpose of accelerating the treatment of "high" and "moderate" sites;

5. Implementing the prescribed treatments at all "high" and "moderate" sites within the term of the Permits;

6. Adhering to the time-of-year restrictions identified in Table S-5 for road work and use of roads and related facilities in the Plan Area;

Table S-5. Time periods when road work, road use, and harvest-related ground disturbances may/may not occur within the Plan Area.

Activity	Nov. 16 –April 30	May 1-May 14	May 15-Oct. 15	Oct. 16-Nov. 15
Road Decommissioning	None	None	Yes	Yes if (1, 3)
Road Upgrades	None	Yes if (2)	Yes	Yes if (1, 3)
New Road Construction	None	None	Yes	None
New Landing Construction	None	None	Yes	None
Hauling and Loading On rocked surfaces On unsurfaced roads	 Yes None	 Yes Yes if (2)	 Yes Yes	 Yes Yes if (1)
Helicopter Landing Areas	Same as for road use	Same as for road use	Same as for road use	Same as for road use
Vehicle Use of Unsurfaced Seasonal Roads	ATVs only	Yes if (2)	Yes	Yes if (1)
Use of Landings and Roadside Deckings within RMZs(4)	None	None	Yes if (5)	None
Mechanized Site Preparation	None	None	Yes	None
Ground-Based Yarding – Tractor, Skidder, and Forwarder	None	Yes if (6)	Yes	Yes if (6)
Ground-Based Yarding – Feller-Buncher and Shovel Logging	Yes if (6)	Yes	Yes	Yes
Skyline and Helicopter Yarding	Yes	Yes	Yes	Yes
Skid Trail Construction and Reconstruction	None	None	Yes	None

Notes

1 Cumulative rainfall from September 1st through October 15th is less than 4" and activity will cease when cumulative rainfall reaches 4".

2 No measurable rainfall has occurred within the last 5 days and no rain is forecast by the National Weather Service for the next 5 days.

3 A project can be completed in one day and erosion control structures can be installed. If a site requires multiple days for completion, a long-range National Weather Service forecast of no rain for the next 5 days is required.

4 Any proposed use of existing landings and alternatives to roadside decking will be discussed and mapped in THPs and also included on the THP map submitted to the Services.

5 Ditchlines and drainage facilities associated with existing roads within RMZs that are used for landings or roadside decking (May 15th through October 15th) will be repaired immediately following completion of operations and prior to October 16th

6 Conditioned on use of procedures and limitations specified in Plan.

7. Requiring that log hauling, road decommissioning, road upgrading, road construction, and use of landings cease, regardless of the time of year, if any portion of a road or landing would result in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II, or III watercourse.

8. On fee-owned lands and harvesting-rights areas where Green Diamond has exclusive road-use rights, conducting inspections and implementing repairs and maintenance of mainline roads, roads appurtenant to THPs, secondary roads, and roads not yet decommissioned in accordance with the schedules and standards identified in the Plan;

9. Requiring that maintenance and repairs be prioritized based on treatment immediacy, with the goal being to complete all priority tasks prior to the winter period.

10. Requiring that, where feasible, new roads be located on or close to ridge tops or on benches where the road prism can be built with the least soil displacement and be constructed in accordance with the standards identified in the Plan;

11. Classifying new roads that are designed for a single-use in a THP as temporary and decommissioning such roads upon completion of operations;

12. Limiting width of new roads to 16 to 18 feet of running surface for mainline roads and 14 to 16 feet for secondary and temporary roads, with a combination of outsloped and crowned roads plus inside ditches where appropriate and occasional turnouts.

13. Limiting the final grade of new roads to no more than 15%, except to avoid unstable slopes, steep slopes, inner gorges, inner gorge crossings, or to access a suitable watercourse crossing location, as measured in minimum 100-foot increments.

14. Designing all new permanent watercourse crossing culverts to handle a 100-year return interval flow event without overtopping;

15. Conducting emergency inspections of all accessible rocked roads in the affected area if a storm occurs that produces three inches of precipitation or more in a 24-hour period, and prioritizing and scheduling repairs so they are accomplished as soon as possible.

16. Requiring that water drafting from Class I or II watercourses, impoundments, and gravity-fed water storage systems conform to the pumping rates and screen design specifications in the Plan;

17. Prohibiting the use of herbicide mix trucks in direct drafting of water from any watercourse;

18. Prohibiting the establishment of new rock quarries and borrow pits within Class I or II RMZs or the use of an existing rock quarry or borrow pit within 150 feet of a Class I, 100 feet of a Class II-2, or 70 feet of a Class II-1 watercourse;

19. Requiring that rock quarrying, rock extraction from borrow pits, and hauling not result in a visible increase in turbidity in watercourses or hydrologically connected facilities that discharge into watercourses; and

20. Training foresters, field supervisors, and equipment operators to conduct road decommissioning, road location and design, road construction, road upgrading, and road maintenance in accordance with the measures of the Plan.

Harvest-related Ground Disturbance

The purpose of the Harvest-related Ground Disturbance Measures is to reduce sediment delivery to watercourses from activities conducted as part of timber harvesting operations. Measures include but are not limited to:

1. Adhering to the time-of-year restrictions identified in Table S-5 for mechanized site preparation, ground-based yarding, skyline and helicopter yarding, and skid trail construction and reconstruction;

2. Requiring that all site preparation operations be designed to limit the amount of ground and forest floor disturbance to that which is required for fuel reduction and reforestation operations;

3. Designing prescribed fire operations to produce low intensity burns; limiting fireline construction, reconstruction, and use within RMZs and EEZs; and requiring that firelines not in an RMZ or EEZ have drainage facilities adequate to prevent the delivery of sediments to RMZs or EEZs;

4. Implementing erosion control measures in RMZs or EEZs in areas disturbed by felling, bucking, and yarding activities;

5. Prohibiting the use of ground-based yarding systems that require constructed skid trails on slopes over 45%, unless greater soil or riparian zone disturbance would be expected from cable yarding;

6. Prohibiting the use of ground-based yarding or skidding equipment in RMZs or EEZs adjacent to Class I, II and III watercourses, except for the limited circumstances identified in the Plan; and

7. Requiring that field trials of mechanized equipment for silvicultural operations not be conducted unless the Services are provided with documentation that the equipment will not cause compaction or soil displacement measurably greater than the equipment or methods previously used.

Effectiveness Monitoring

The purpose of the Effectiveness Monitoring Measures is to track the success of the Operating Conservation Program in relation to the Plan's biological goals and objectives and provide the basis for the Adaptive Management Measures. Four categories of projects will be implemented: Rapid Response Monitoring, Response Monitoring, Long-term Trend Monitoring/Research, and Experimental Watersheds Program.

Rapid Response Monitoring. Rapid Response Monitoring projects include: (1) annual property-wide water temperature monitoring in Class I and Class II watercourses; (2) before-after-control-impact (BACI) water temperature monitoring in paired sites on Class II watercourses; (3) monitoring of spawning gravel permeability in selected Class I watercourses; (4) monitoring of road-related delivery of fine sediments into Plan Area streams and evaluation of the effectiveness of the Road Management Measures in reducing those inputs; (5) BACI monitoring of changes in larval populations of tailed frogs; and (6) BACI monitoring of changes in the persistence of sub-populations of southern torrent salamanders.

Response Monitoring. Response Monitoring measures include: (1) measuring changes in reaches of Class I watercourse at least every other year for the duration of the Permits; and (2) BACI monitoring of sediment delivery from Class III watercourses.

Long-term Trend Monitoring/Research. Long-term Trend Monitoring/Research projects include: (1) monitoring the effectiveness of the road decommissioning and upgrading measures in reducing road-related mass wasting; (2) delineation of minimum slope gradients and maximum slopes distances for Plan Area lands in each HPA, with the results used to modify the corresponding Slope Stability Measures; (3) evaluation of the effectiveness of the SSS prescriptions based on landslide-relevant data collected in the Plan Area over the first 15 years of Plan implementation; (4) a two-stage assessment of the relationship between mass wasting processes and timber management processes; (5) channel and habitat typing assessments of selected Plan Area streams; (6) LWD surveys on the stream reaches selected for channel and habitat typing; (7) annual summer sampling surveys to estimate young of the year coho and age 1+ steelhead and coastal cutthroat trout; and (8) annual out-migrant trapping in the Little River HPA to monitor smolt abundance, size, and out-migration timing.

Experimental Watersheds Program. Green Diamond will designate the Little River HPA, South Fork Winchuck River in the Smith River HPA, Ryan Creek in the Humboldt Bay HPA, and Ah Pah Creek in the Coastal Klamath HPA as experimental watersheds for additional monitoring and research. Projects in the four watersheds will include: (1) Effectiveness Monitoring that due its complexity and expense of implementation can only be applied in limited regions (i.e., turbidity monitoring, Class III sediment monitoring, and road-related mass wasting); (2) BACI studies of harvest and non-harvest areas; (3) BACI studies of conservation and management measures; and (4) development and implementation of new or refined monitoring and research protocols. In addition, Green Diamond may expand out-migrant trapping in the Little River HPA to one or more of the other experimental watersheds. No monitoring or research which involves the application of measures other than those prescribed in this Plan will occur without the concurrence of the Services.

Monitoring thresholds. Measurable thresholds that will trigger management responses when exceeded will be established for all Rapid Response and Response Monitoring projects. Each project will have a “yellow light” and “red light” threshold that triggers different levels of review and response. Based on studies already completed, the thresholds identified in Table S-6 have been determined for the property-wide water temperature, Class II BACI, tailed frog, and southern torrent salamander monitoring projects. Thresholds for the other projects will be established based on data collected from reference sites and appropriate statistical analysis in the time-frame identified in Table S-6.

Table S-6. Yellow and red light thresholds for Rapid Response and Response Monitoring projects.

Monitoring Project/Program	Yellow Light Threshold	Red Light Threshold
Annual Property-wide Water Temperature Monitoring of Class I and II Watercourses	• A 7DMAVG above the upper 95% PI described by the regression equation: *Water Temperature (°C) = 14.35141 + 0.03066461x square root Watershed Area (acres)*, or • Any statistically significant increase in the 7DMAVG of a stream where recent timber harvest has occurred, which cannot be attributed to annual climatic effects.	• A 7DMAVG above the upper 95% PI plus one °C as described by the regression equation: *Water Temperature* (°C) *=15.35141+ 0.03066461x square root Watershed Area (acres)*, • An absolute value of 17.4 °C (relevant for fish), or • A 7DMAVG value that triggers a yellow light for three successive years.
Class II BACI Water Temperature Monitoring	• A statistically significant treatment (harvesting) effect in at least 3 of 8 BACI experiments.	• Significant treatment effects continuing for 3 successive years following treatment in at least 3 of 8 BACI experiments.
Tailed Frog Monitoring	• Any statistically significant decrease in the larval populations of treatment streams relative to control streams, or • A statistically significant downward trend in both treatment and control streams.	• A statistically significant decline in larval populations in treatment streams relative to control streams in >50% of the monitored sub-basins in a single year; • A statistically significant decline in treatment vs. control sites continuing over a three year period within a single sub-basin; or • A statistically significant downward trend in both treatment and control streams that continues for 3 years or more.
Southern Torrent Salamander Monitoring	• Any extinction of a sub-population, or • An apparent decline in the average index of sub-population size in treatment sites compared to control sites.	• A statistically significant increase in the extinction of treatment sub-populations relative to control streams, or • A significant increase in the net rate of extinctions over the landscapes.
Spawning Substrate Permeability Monitoring and Road-related Sediment Delivery (Turbidity) Monitoring	Will be established after five years of data collection for each project.	
Class I Channel Monitoring and Class III Sediment Monitoring	Will be established after 10 years of data collection for each project.	
Codes BACI = Before-After-Control-Impact PI = prediction interval 7DMAVG = highest 7-day moving mean of water temperature		

Adaptive Management

The purpose of the Adaptive Management Measures is to incorporate the results of the Effectiveness Monitoring projects into Plan implementation and provide the basis for necessary modifications to Plan measures over the term of the Permits. Measures include but are not limited to:

1. Initiating internal review by Green Diamond, review by the Services, and/or review by a scientific panel as specified in the Plan when yellow or red light thresholds of Rapid Response or Response Monitoring projects are exceeded and in response to results of the SSS Delineation Study, SSS Assessment, or Experimental Watersheds Programs.

2. Limiting the modifications that can be made under the adaptive management process to:

   - Changes to RMZ widths and prescriptions that are within the range of options either under state forestry regulations applicable at the time the change is made or the interim Northwest Forest Plan riparian measures;

   - Changes to SSS default widths and slope gradients after they have been set based on results of the SSS Delineation;

   - Changes to SMZ default prescriptions based on results of the SSS Assessment, with the prescriptions ranging from no cut to even-age management;

   - Changes that would increase the rate at which high and moderate priority sites are treated during the first 15 years of the road decommissioning and upgrading program; and

   - Changes to the drainage structure and erosion control prescriptions in the Road Management Measures.

3. Establishing an Adaptive Management Reserve Account (AMRA) to fund implementation of adaptive management measures over the Permits' term, in which:

   - The AMRA and the costs of implementing adaptive management measures will be expressed in terms of fully stocked acres (FSA);

   - The opening balance of the AMRA will be 1,550 FSA;

   - Credits and debits will be calculated in terms of acres harvested or retained as a result of a proposed change;

   - Debits for road-related adaptive management measures will be limited to 2% per year of the opening AMRA balance (i.e., the equivalent of 31 FSA);

   - No limits will apply to the annual use of the AMRA for RMZ or SMZ modifications; and

- No adaptive management change will be made unless there is a sufficient balance in the AMRA to make the change.

Implementation Monitoring

The purpose of the Implementation Monitoring Measures is to track and facilitate compliance with the provisions of the Plan. Measures include but are not limited to:

1. Designating a Plan Coordinator to work in conjunction with Green Diamond RPFs, fisheries, wildlife, and geologic staff to identify the provisions of the Plan applicable to individual THPs and document compliance with the Operating Conservation Program on the THP level;

2. Providing the Services with biennial reports that summarize compliance with the Operating Conservation Program, results to date of the Effectiveness Monitoring Measures, and any field reviews conducted in the period since the last report.

3. Scheduling annual meetings with the Services for the first five years of the Plan, with the annual meeting in the second and fourth years followed with a field review of implemented conservation measures.

In addition, the Services may audit the efficacy of the RMZ measures annually, by selecting three to five harvest units and requiring Green Diamond to gather before/after data and calculate an estimate of relative change in 'full tree equivalents' (FTE). The protocol used in the potential recruitment of LWD report (Appendix B of the AHCP/CCAA) will be used in any future audits. If the results of the audit indicate that the FTE values were reduced by more than 3.2% post-harvest, then the Services may call a meeting with Green Diamond to recalibrate the interpretation of the likelihood to recruit judgment in the field. The 3.2% post-harvest FTE value reduction is a trigger for recalibration of the interpretation. If an agreement cannot be reached in the recalibration among the Services and Green Diamond, then the dispute resolution provisions of the Plan will be initiated.

Special Project

The purpose of the Special Project is to examine the potential conservation benefits of transporting coho salmon and possibly other salmonids around barriers to spawning and rearing habitat. Green Diamond proposes to undertake a 10-year project that will entail trapping coho salmon in a stream with a barrier to spawning and rearing habitat, transporting them around the barrier during spawning season, and monitoring subsequent spawning, rearing, and out-migration. Prior to undertaking the project, Green Diamond will evaluate the selected stream based on criteria specified in the Plan to determine that salmonids residing in the basin above the barrier will not be adversely affected by the project.

Changed Circumstances

The purpose of the Changed Circumstances Measures is to address reasonably foreseeable changes in habitat conditions and the status of Covered Species in the Plan Area. Five types of changes are identified in the Plan as potential "changed circumstances" as defined in applicable federal regulations and policies:

- Fire covering more than 1,000 acres within the Plan Area or more than 500 acres within a single watershed within the Plan Area, but covering 10,000 acres or less;

- Complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream; but less than 900 feet of trees within an RMZ, due to a windstorm;

- Loss of 51% or more of the total basal area within any SSS, headwall swale or Tier B Class III watercourses as a result of Sudden Oak Death or stand treatment to control Sudden Oak Death;

- Landslides that deliver more than 20,000 and less than 100,000 cubic yards of sediment to a channel; and

- Listing of a species that is not a Covered Species but is affected by the Covered Activities.

If such circumstances occur, Green Diamond will implement the applicable supplemental prescriptions specified in the Plan.

Unforeseen Circumstances

Unforeseen circumstances are substantial adverse changes in the circumstances affecting Covered Species in the Plan Area that cannot be reasonably anticipated in the Plan. Should unforeseen circumstances occur, modifications to the Plan will be made only in accordance with the procedures set forth in the IA.

ASSESSMENT OF CONSERVATION STRATEGY'S LIKELY EFFECTIVENESS

To assess the likely success of the proposed conservation strategy in fulfilling the Plan's purposes, Green Diamond evaluated the potential effectiveness of the identified measures in avoiding take of listed Covered Species, minimizing and mitigating the effects of authorized take, including cumulative impacts, and providing conservation benefits to listed and unlisted Covered Species.

Impact Avoidance, Minimization, and Mitigation

Although the take avoidance and "minimize and mitigate" standards are legally applicable only to the species covered by the ITP, the Plan applies both to the ESP Species as well. Application of these standards to the ESP Species helps to ensure that jeopardy is avoided. Moreover, the minimization and mitigation measures are themselves "conservation" measures that help to provide the early benefits for ESP Species as called for in the CCAA policy. Likewise, the ITP Species benefit from the measures applied for the conservation benefit of ESP Species; and such conservation benefits go beyond those required to minimize and mitigate the impacts of taking and avoid jeopardy to the ITP Species.

The impact of the different factors that can potentially cause take of the Covered Species is highly variable. As previously noted, populations of animals have one or more limiting factors that act on different life history stages to ultimately limit the growth of the population. The factors can interact in complex ways spatially and temporally, which make it difficult to know with certainty which factor or factors are actually limiting. As a result, the Plan is designed to address each of the potential impacts that might cause and result from take of the Covered Species. However, it is important to put the greatest effort into those factors that have the greatest probability to be limiting for the Covered Species. The primary limiting factor within each HPA, the Covered Species most affected by that limiting factor and Covered Activities, and the primary measures in the Operating Conservation Program that address such impacts are identified in Table S-7. In Green Diamond's view, the conservation strategy, as designed to address these limiting factors that could be associated with or exacerbated by Covered Activities, will more than minimize and mitigate the impacts of taking (including cumulative impacts) and avoid jeopardy to the Covered Species.

Conservation Benefits

In addition to the measures to avoid or address specific impacts, the Plan includes measures to improve conditions for the Covered Species and/or their habitats. These additional measures provide a level of mitigation that exceeds the anticipated impacts of taking. Examples include the road decommissioning and upgrading measures (and the accelerated implementation of the measures) and the LWD recruitment measures. Green Diamond also believes that the Plan as designed provides for a significant improvement in the habitat conditions for all Covered Species within the Plan Area in all HPAs. In particular, the Road Management Measures will significantly accelerate the recovery of stream conditions negatively impacted by sediment, and other measures will provide similar improvements of habitat conditions.

The conservation benefits provided by the additional measures also provide extra confidence that the Plan meets and in some cases exceeds the ITP and ESP standards that apply to each identified impact. Stated another way, the extra measures supply added assurance that a sufficient level of conservation is being provided to address any concern about the sufficiency of any particular measure to address the extent of a particular type of impact. Furthermore, the improvement in conditions that will result from these measures exceeds that needed to meet the ITP "minimize and mitigate" standard and will contribute both to the recovery of the ITP Species and to efforts to preclude the need to list the ESP Species.

ALTERNATIVES CONSIDERED

Green Diamond considered alternatives to the taking of listed Covered Species and alternative conservation strategies for listed and unlisted aquatic species. The alternatives and the reasons they were not selected are summarized below.

Table S-7. Summary of limiting habitat factors for the Covered Species and the relative benefits of the conservation measures for each HPA.

HPA	Primary Limiting Factor(s)	Covered Species Most Affected	Most Relevant Conservation Measures
Smith River	Lack of LWD resulting in limited rearing habitat (summer and winter) for most salmonids	Primarily the anadromous salmonids	Riparian measures that promote LWD recruitment
Coastal Klamath	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat for salmonids and embedded substrates for amphibians	All of the salmonids and to a lesser extent the amphibians	Riparian management, slope stability, and road management measures
Blue Creek	Lack of LWD resulting in limited rearing habitat for most salmonids	Primarily the anadromous salmonids	Riparian management measures that promote LWD recruitment
Interior Klamath	Excess sediment resulting in embedded substrates and aggraded channels	Primarily tailed frogs and resident salmonids	Road management and slope stability measures
Redwood Creek	Excess sediment resulting in embedded substrates and aggraded channels	Primarily resident salmonids and the amphibians	Road management and slope stability measures
Coastal Lagoons	Excess sediment (mostly fines) resulting in embedded substrates	Primarily cutthroat trout and the amphibians	Primarily road management measures that reduce fine sediment inputs to watercourses
Little River	Excess sediment resulting in embedded substrates and aggraded channels	Primarily the amphibians and the anadromous salmonids	Primarily road management measures
Mad River	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat for salmonids and embedded substrates for amphibians	All	Riparian management, slope stability, and road management measures
North Fork Mad River	Excess sediment resulting in embedded substrates	Primarily the amphibians	Primarily road management measures
Humboldt Bay	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates	Primarily the anadromous salmonids	Slope stability and road management measures
Eel River	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates	Primarily the anadromous salmonids – there are few salmonids and no known amphibian populations in this HPA	Road management and slope stability measures, but the limited numbers of covered species in the HPA would put it at the lowest priority

No Permits/No Plan. Green Diamond would not seek authorization for take of the Covered Species; and timber operations and related activities would occur in accordance with existing state and federal regulations, Green Diamond's ITP for northern spotted owls, and Green Diamond's timber management policies and practices. Green Diamond considered but rejected this alternative because it does not offer a long-term solution for reconciling Green Diamond's operations with ESA requirements. Further, Green Diamond believes that the Plan will have significant beneficial effects for Covered Species not possible under this alternative.

Listed ITP Species Only. The Plan and Permits would cover only currently listed Covered Species. Green Diamond considered and rejected this alternative as counter to sound planning principles. The alternative would not provide adequate long-term assurances to Green Diamond that operations could continue in watersheds covered by the Plan if one or more of the unlisted Covered Species were listed.

Simplified Prescriptions Strategy. The Services would issue the Permits as proposed in this Plan, and Green Diamond would implement a simplified conservation strategy of fixed, no-cut riparian buffers. Green Diamond considered but rejected this alternative because the permanent commitment of land and resources represented by the fixed buffers would be disproportionate mitigation for minimal impacts under a take avoidance strategy. Green Diamond also believes that the Plan is a superior conservation strategy because it would avoid take to the maximum extent practical in riparian zones while enacting additional measures to improve, not just avoid impacts to, habitat conditions.

Expanded Plan Area/Species List. The Initial Plan Area would be expanded to include an additional 26,116 acres of "rain-on-snow" areas owned by Green Diamond; the ITP from NMFS would cover the same salmonids as in the Plan; and Green Diamond would seek an ITP from USFWS for 9 species. Green Diamond considered but rejected this alternative in favor of limiting the Plan and Permit applications to the six cold-water adapted aquatic species. This decision does not preclude future amendments to the Plan to include other species or the development of separate plans and permit applications for other species. Further, Green Diamond proposes to use the AHCP/CCAA as the framework for other conservation efforts that will provide significant protection and benefits to a broad range of aquatic and terrestrial species in the Plan Area.

Section 1. Purpose, Scope, and Context

1.1 INTRODUCTION

This *Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances* (AHCP/CCAA, the Plan) was prepared for the California timberlands of Green Diamond Resource Company (Green Diamond) to conserve habitat for and mitigate impacts on six aquatic species (Covered Species):

- *Oncorhynchus tshawytscha* (chinook salmon)
- *Oncorhynchus kisutch* (coho salmon)
- *Oncorhynchus mykiss* (steelhead and resident rainbow trout)
- *Oncorhynchus clarki clarki* (coastal cutthroat trout)
- *Ascaphus truei* (tailed frog)
- *Rhyacotriton variegatus* (southern torrent salamander)

The Plan is part of Green Diamond's applications to the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for permits authorizing incidental take of listed species in accordance with the federal Endangered Species Act (ESA) and federal policies regarding conservation of unlisted species. NMFS is being asked to approve a habitat conservation plan (HCP) and incidental take permit (ITP) for listed and unlisted populations of three fish under its jurisdiction: chinook salmon, coho salmon, and steelhead. The ITP would be issued by NMFS pursuant to Section 10(a)(1)(B) of the ESA. USFWS is being asked to approve a CCAA and enhancement of survival permit (ESP) for two unlisted fish and two unlisted amphibians under its jurisdiction: resident rainbow trout, coastal cutthroat trout, tailed frog, and southern torrent salamander. The ESP would be issued by USFWS pursuant to Section 10(a)(1)(A) of the ESA. The ITP and ESP collectively are cited in this Plan as the "Permits." NMFS and USFWS collectively are cited as "the Services."

The information, analysis, and conservation program that comprise the Plan are organized as follows:

Sections 1-8 present:

- The purposes of the Plan; the term, area, species, and activities covered by the Plan and Permits; the requirements and approval criteria for the Plan and Permits; and other conservation efforts involving Green Diamond (Section 1);

- A description of Green Diamond's timber operations and other forest management activities (Section 2);

- A description of the Covered Species and their habitats (Section 3);

- A description and assessment of habitat conditions and occurrence of Covered Species in the area where the Plan will be implemented (Section 4);

- An assessment of the potential for timber operations and other activities to directly or indirectly impact Covered Species and potentially result in take of listed species (Section 5);

- A statement of the biological goals and objectives of the Plan; a listing of the specific measures that Green Diamond will implement under the Plan (i.e., the Operating Conservation Program); and a discussion of the intent, rationale, and analysis underlying the Operating Conservation Program (Section 6);

- An analysis of the effectiveness of the conservation strategy in fulfilling the purposes of the Plan (Section 7); and

- A description of alternatives to the taking of Covered Species that Green Diamond considered, and a discussion of the reasons why those why those options were not pursued (Section 8).

Oversize (11" x 17") maps are bound separately to facilitate viewing and are identified in the text in bold italic font (e.g., ***Figure 1-1***).

Seven appendices provide additional information, analysis, and details about components of the Plan:

- Appendix A provides additional information about the biology, habitat requirements, and sensitivity to impacts of each Covered Species.

- Appendix B presents an evaluation of the timber harvest impacts on future potential recruitment of large woody debris.

- Appendix C includes summaries of the physical habitat assessments, fish population studies, amphibian surveys, and analyses of habitat conditions conducted by Green Diamond.

- Appendix D describes the effectiveness monitoring protocols that will be followed during Plan implementation.

- Appendix E supplements the assessment of timber management impacts on the Covered Species with a review of literature on the subject.

- Appendix F presents sediment studies and modeling efforts, including an assessment of long-term sediment production with and without the AHCP/CCAA.

- Appendix G provides additional detail and analysis regarding a project that will be implemented under the Plan to enhance coho salmon productivity by utilizing habitats upstream of a barrier.

In addition to the above components, an Implementation Agreement (IA) has been prepared to accompany the applications to NMFS and USFWS. The IA defines the roles and responsibilities of the parties regarding the Plan and Permits, ensures implementation of the Operating Conservation Program identified in the Plan, describes procedures for modifications, and provides assurances to Green Diamond and the agencies. An Environmental Impact Statement (EIS) also has been prepared for the actions of the Services on the Plan and Permits in accordance with the National Environmental Policy Act (NEPA).

1.2 PURPOSE

The primary purposes of this AHCP/CCAA are to:

- Coordinate and facilitate Green Diamond's compliance with the federal ESA; and
- By providing for the conservation of individual species and their habitats, provide the NMFS and USFWS as appropriate with the bases for authorizing Green Diamond to take Covered Species pursuant to an ITP and an ESP.

The Plan describes the conservation measures that Green Diamond will implement to:

- Minimize and mitigate the potential adverse effects of any authorized taking of listed Covered Species in the Plan Area that may occur incidental to Green Diamond’s timber operations in California;
- Ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of any Covered Species; and
- Contribute to efforts to reduce the need to list currently unlisted Covered Species under the ESA in the future by providing early conservation benefits to those species.

The measures in the Plan focus on assessing, conserving, and monitoring the populations and habitats of the Covered Species and are designed to be a comprehensive conservation program for the species in the Plan Area. The measures, supporting analysis, and related authorizations also provide the basis for Green Diamond to comply with any requirements of the Forest Practice Rules (FPRs) relating to the ESA and the Covered Species. These requirements and other aspects of the multiple uses proposed for the Plan are discussed in more detail in Section 1.4.5.

1.3 SCOPE

The term, area, species, and activities covered by the requested authorizations for incidental take and this Plan are as follows.

1.3.1 Term of the AHCP/ITP and CCAA/ESP

The term of the AHCP/ITP and CCAA/ESP will be 50 years. Provisions for extending or terminating this term are presented in the IA consistent with the requirements of applicable regulations.

1.3.2 Area Where Take Will Be Authorized and the Plan Will Be Implemented

Green Diamond buys and sells timberlands in the general area covered by the Plan on a regular basis and expects to continue this practice in the normal course of business during the 50-year term of the Plan. To reflect this aspect of Green Diamond's business practices, the Plan is designed to allow some flexibility in the application of the Plan and Permits to the ownership as it adjusts over time. The Plan uses a number of defined terms to describe the extent to which adjustments may occur to the area in which the Permits may be exercised and the Plan will be implemented. Those terms and their definitions are set forth in this section, and the Plan provides the rationale based upon Green Diamond's assessment of information compiled about Green Diamond's ownership and other lands in the general area.

1.3.2.1 Definitions

In this Plan, the following definitions apply:

- "**Plan Area**" means all commercial timberland acreage within eleven Hydrographic Planning Areas (HPAs) on the west slopes of the Klamath Mountains and the Coast Range of California where Green Diamond owns fee lands and Harvesting Rights (Green Diamond's ownership), during the period of such ownership within the term of the Permits, subject to the limitations described in Section 1.3.2.3 and in the IA, and up to 100 miles of roads on lands where Green Diamond owns and exercises Road Access Rights within its approved Timber Harvesting Plan (THP) areas in the Eligible Plan Area during the term of the Plan and Permits. This is the geographic area where incidental take will be authorized, the Covered Activities will occur, and the Operating Conservation Program will be implemented. Except where stated otherwise in the Plan, references to lands, commercial timberlands, and Green Diamond's ownership in the context of the Plan Area include lands owned in fee and lands subject to harvesting rights.

- "**11 HPAs**" means the area encompassed by the eleven Hydrographic Planning Areas (HPAs) as identified in ***Figure 1-1*** and described in Section 1.3.2.4.

- "**Eligible Plan Area**" means all privately owned commercial timberlands within the 11 HPAs that, over the life of the Plan, are either included within the Plan Area or are eligible for inclusion in the Plan Area as provided in the IA. This is the entire commercial timberland acreage analyzed in the Plan and the EIS prepared pursuant to NEPA to support the Plan's provisions allowing for additions and deletions of lands from the Plan Area over the term of the Plan and Permits.

- "**Initial Plan Area**" means Green Diamond's ownership within the 11 HPAs as of the effective date of the Permits. ***Figures 1-1*** and ***1-2*** depict the Initial Plan Area based on the ownership as of April 2005.

- "**Adjustment Area**" means commercial timberland acreage within the 11 HPAs that is not within Green Diamond's ownership or the Plan Area on any given date during the term of the Plan. This includes lands that are eligible for addition to the Plan Area through acquisition or that may be or have been removed from the Plan Area through sale, subject to the limitations imposed by the Plan and IA.

1.3.2.2 Eligible Plan Area: Initial Plan Area and Adjustment Area

Figure 1-2 shows the Eligible Plan Area and its components (the Initial Plan Area and Adjustment Area) as of the effective date of the Permits. Table 1-1 indicates the approximate acreage of the Eligible Plan Area and its components, other lands in the HPAs, and total area of the 11 HPAs. As depicted in ***Figure 1-2***, the Eligible Plan Area includes approximately 707,909 acres: 416,533 acres of Initial Plan Area and 291,377 acres of Adjustment Area.

The Initial Plan Area is flanked by National Forests and Wilderness Areas on the north and east and abuts Redwood National Park and various State Parks on the west. Other adjacent ownerships include industrial timberlands managed by Sierra Pacific Industries, Soper-Wheeler Company, Pacific Lumber Company, and other private holdings. The Hoopa Valley Indian Reservation is located east of the Initial Plan Area; lands administered by the Yurok Tribe or Bureau of Indian Affairs occur along the lower Klamath River. Adjacent land uses vary by location but generally follow land ownership patterns. The federal and state lands are managed for multiple uses, including preservation and recreation; various levels of timber harvesting also are allowed in designated areas. On adjacent private lands, commercial timber operations and ranching predominate; other uses include gravel mining and residential development. The Adjustment Area shown on ***Figure 1-2*** includes adjacent commercial timberlands but excludes non-forested commercial timberlands, a large tract of land proposed for conservation commitments, and commercial timberlands covered by an approved HCP.

1.3.2.3 Plan Area Adjustments Over Time

During the term of the Plan and Permits, Green Diamond may elect to add commercial timberlands to the Plan Area within any of the 11 HPAs by submitting to the Services a description of the lands within the Adjustment Area that it intends to add, along with a summary of relevant biological and physical characteristics that they share with existing Plan Area lands in that HPA. As discussed above, Green Diamond estimates that there are approximately 291,377 acres of other commercial timberlands in the 11 HPAs that could be added to the Plan Area if acquired by Green Diamond in the future. However, the IA limits expansions of the Plan Area under this process to 15% of the Initial Plan Area (approximately 62,480 acres). This estimate is based on the acreage of the Adjustment Area within the HPAs as of the effective date of the Permits (see Table 1-1). Further, through a notification to the Services, the Plan Area would contract automatically with sales or disposals of commercial timberlands in the 11 HPAs unless the contraction of the Initial Plan Area exceeds 15%.

Table 1-1. Estimated acreage of the Eligible Plan Area and Hydrographic Planning Areas (HPAs) by component, and Initial Plan Area as percentage of HPAs.

HPA Name (Type[1])	Hydrographic Planning Areas (HPAs)					IPA as % of its HPA
	Eligible Plan Area (EPA)			Non-EPA[5] (acres)	Total HPA (acres)	
	Initial Plan Area (IPA)[2] (acres)	Adjustment Area[3] (acres)	Total EPA[4] (acres)			
Smith River HPA (Hydrographic Area)	44,177	8,140	52,318	129,681	181,999	24%
Coastal Klamath HPA (Hydrographic Area)	88,760	5,300	94,060	14,090	108,150	82%
Blue Creek HPA (Hydrologic Unit)	15,393	35	15,428	64,875	80,303	19%
Interior Klamath HPA (Hydrographic Area)	66,139	43,217	109,357	18,649	128,006	52%
Redwood Creek HPA (Hydrologic Unit)	33,038	67,693	100,731	87,604	188,335	18%
Coastal Lagoons HPA (Hydrographic Area)	39,981	4,678	44,659	8,932	53,592	75%
Little River HPA (Hydrologic Unit)	26,041	1,908	27,949	1,753	29,703	88%
Mad River HPA (Hydrographic Area)	49,376	49,787	99,163	20,523	119,686	41%
North Fork Mad River HPA (Hydrologic Unit)	28,209	3,207	31,416	0	31,416	90%
Humboldt Bay HPA (Hydrographic Area)	17,484	21,386	38,870	99,849	138,719	13%
Eel River HPA (Hydrographic Area)	7,933	86,026	93,958	111,202	205,160	4%
TOTAL	416,533	291,377	707,909	557,158	1,265,069	33%

Notes

1 HPAs that encompass the entire drainage are referred to as hydrologic units. HPAs that encompass multiple watersheds or a fraction of one watershed are referred to as hydrographic areas.

2 The Initial Plan Area includes 413,064 acres of fee owned land and 3,469 acres of harvesting rights..

3 Estimated acreage of the Adjustment Area as of the effective dates of the Permits; includes other commercial timberlands potentially available for addition to the Plan Area as of the effective date of the Permits; estimate excludes non-forested commercial timberlands, a large tract of land proposed for conservation commitments, and commercial timberlands covered by an approved HCP.

4 Estimated acreage based on configuration of Initial Plan Area and Adjustment Area as shown in ***Figure 1-2***.

5 Estimated acreage includes developed and undeveloped privately owned lands, all public lands, Native American lands, and commercial timberlands excluded from the estimated acreage of the initial Adjustment Area (see note 3 above).

All expansions and contractions of the Plan Area are subject to provisions described in the IA. As discussed in greater detail in Sections 5 and 7 of this Plan, the adjustment mechanisms are based on analysis in the Plan concluding that, in general, habitat and relevant environmental conditions, as well as the potential impacts to the Covered Species, are sufficiently similar across the 11 HPAs to support the application of the conservation strategy on any lands on which Green Diamond operates within the 11 HPAs during the term of the Plan.

1.3.2.4 Hydrographic Planning Areas

As indicated in Table 1-1 and depicted in ***Figure 1-1***, the HPAs encompass approximately 1,265,000 acres and range in size from approximately 30,000 to 205,000 acres. They were delineated to encompass Plan Area and other lands in the same watersheds and provide an appropriate scale for analyzing habitat conditions and potential effects on Covered Species. The commercial timberlands in the HPAs (including the Initial Plan Area) have common characteristics directly related to habitat conditions for Covered Species. As described in detail in Section 4, these characteristics include:

- Steep and rugged terrain;
- Extensive geologic folds and fault lines;
- Several highly unstable bedrock types;
- Seasonally intense precipitation; and
- More than a century of logging, mining, road building, and grazing.

1.3.2.4.1 Rationale

The 11 HPAs are a subset of nine contiguous coastal drainages that encompass 13.7 million acres in northwestern California and southern Oregon (Table 1-2). Within these coastal drainages, the Initial Plan Area constitutes as little as 0.3% and as much 88% of the total area. These percentages are important because the size of Green Diamond's ownership relative to the size of the drainages directly affects the potential influence of Green Diamond’s timber operations on the basins. Green Diamond’s ownership in the largest drainages (Klamath, Smith, and Eel Rivers) is concentrated near the coast and very small relative to total basin size, limiting the influence of Green Diamond’s operations on these watersheds. It is possible however, to have a proportionally larger impact on a coastal species. Upstream factors including dams, water diversions, development, and commercial land uses such as agriculture and other (non-Green Diamond) timber management activities further reduce the relative impact of Green Diamond’s operations on these drainages. Some of the smaller watersheds, in contrast, are largely owned by Green Diamond, and Green Diamond’s operations may be the main anthropogenic disturbance to these drainages. The 11 HPAs were delineated to address the differences in scale mentioned above and allow Green Diamond to examine and address habitat conditions and the status of Covered Species on a finer scale.

Table 1-2. Initial Plan Area as proportion of nine major coastal drainages.

Major Coastal Drainages		Initial Plan Area (IPA)	
Drainage	**Total Acres**	**IPA Acres in Drainage**	**IPA as % of Drainage**
Winchuck River	49,434	8,473	17%
Smith River	510,263	36,028	7%
Klamath River	10,042,645	169,968	2%
Redwood Creek	188,335	33,038	18%
Coastal Lagoons	53,592	38,982	75%
Little River	29,703	26,041	88%
Mad River	325,030	77,585	24%
Humboldt Bay	138,719	17,484	13%
Eel River	2,357,273	7,933	0.3%
TOTAL	13,694,995	416,533	3%

1.3.2.4.2 <u>HPA Types</u>

HPAs that encompass an entire drainage are identified in this Plan as “hydrologic units.” HPAs that encompass multiple watersheds or a fraction of one watershed are identified as “hydrographic areas.” As indicated in Table 1-1, four HPAs are hydrologic units (Blue Creek, Redwood Creek, Little River, and North Fork Mad River); seven HPAs are hydrographic areas (Smith River, Coastal Klamath, Interior Klamath, Coastal Lagoons, Mad River, Humboldt Bay, and Eel River).

1.3.2.4.3 <u>HPA Groups</u>

For purposes of applying slope stability measures identified in the Operating Conservation Program (see Section 6), the 11 HPAs are divided into four HPA Groups (Table 1-3). A brief description of each group is provided below; additional information about the HPA Groups is provided in Section 4.2.

Table 1-3. HPA Groups.

HPA Group	Individual HPAs in Group
Smith River	Smith River
Coastal Klamath	Coastal Klamath Blue Creek
Korbel	Redwood Creek Coastal Lagoons Little River North Fork Mad River Mad River Interior Klamath
Humboldt Bay	Humboldt Bay Eel River

- <u>Smith River HPA Group</u>

The Smith River HPA Group includes approximately 182,000 acres and consists only of the Smith River HPA. Because it does not have the same topographic characteristics as the Coastal Klamath HPA Group and is too far geographically from the Korbel HPA Group, the Smith River HPA was not included in these other HPA Groups. Approximately 44,177 acres of the Initial Plan Area are in the Smith River HPA Group.

- <u>Coastal Klamath HPA Group</u>

The Coastal Klamath HPA Group includes approximately 188,500 acres and consists of the Coastal Klamath and Blue Creek HPAs. Approximately 104,153 acres of the Initial Plan Area are in this group.

- <u>Korbel HPA Group</u>

The Korbel HPA Group includes approximately 551,000 acres and encompasses the Interior Klamath, Redwood Creek, Coastal Lagoons, Little River, Mad River, and North Fork Mad River HPAs. Approximately 242,784 acres of the Initial Plan Area are in this HPA Group.

- <u>Humboldt Bay HPA Group</u>

The Humboldt Bay HPA Group includes approximately 344,000 acres and consists of the Humboldt Bay and Eel River HPAs. This group includes all of the Jacoby Creek, Freshwater Creek, Elk River, Salmon Creek, and Yager Creek drainage basins and portions of the lower reaches of the Eel and Van Duzen Rivers. Approximately 25,417 acres of the Initial Plan Area are in this group.

1.3.3 Covered Species

The Covered Species include populations of four fish species and two amphibian species as identified in Table 1-4. Each is a cold-water adapted taxonomic species whose habitat requirements make it sensitive to the impacts of timber management.

Three of the species are under NMFS' jurisdiction and include five "evolutionarily significant units" (ESUs) and one "distinct population segment" (DPS) of those species. Two of the ESUs currently are listed under the ESA; three are not. The one DPS currently is not listed under the ESA. This Plan is a HCP for the fish populations in all six ESUs/DPSs (see Section 1.4.1), and the six ESUs/DPSs will be named on the ITP. The species and ESUs are identified on Table 1-4 as the "ITP Species."

The resident form of the rainbow trout, coastal cutthroat trout, southern torrent salamander, and tailed frog are under USFWS jurisdiction; and none of them is currently listed under the ESA. Under these circumstances, USFWS takes the view that the Covered Species under its jurisdiction are most appropriately addressed in a CCAA (rather than an HCP) and that incidental take coverage should be provided through issuance of an ESP rather than an ITP. Accordingly, with respect to these species, the Plan includes the conservation planning elements of a CCAA as described in Section 1.4.1. The species under the jurisdiction of the USFWS are identified in Table 1-4 as the "ESP Species."

Table 1-4. The Covered Species.

Species Common Name, *Scientific Name*	Listing Status in HPAs	
	Federal	**State**
ITP Species		
Chinook salmon, *Oncorhynchus tshawytscha*		
California Coastal ESU	FT	None
Southern Oregon and Northern California Coastal ESU	None	None
Upper Klamath/Trinity Rivers ESU	None	None
Coho salmon, *Oncorhynchus kisutch*		
Southern Oregon/Northern California Coast ESU	FT	ST[1]
Steelhead, *Oncorhynchus mykiss*[2]		
Northern California DPS	FT	None
Klamath Mountains Province ESU	None	None
ESP Species		
Resident rainbow trout, *Oncorhynchus mykiss*	None	None
Coastal cutthroat trout, *Oncorhynchus clarki clarki*	None	CSC
Tailed frog, *Ascaphus truei*	None[3]	CSC
Southern torrent salamander, *Rhyacotriton variegatus*	None[3]	CSC

Codes

CSC California Department of Fish and Game Species of Special Concern
DPS Distinct Population Segment
ESU Evolutionarily Significant Unit
FT Federal threatened species
None Currently not listed, proposed for listing, a candidate for listing, or a CSC
ST State threatened species

Notes

1 In March 2005, the California Fish and Game Commission listed coho as threatened from Punta Gorda to the Oregon border. The coho population covered by the State listing includes the San Francisco portion of the federal Central California Coast ESU and the northern California portion of the federal So. Oregon/No. California ESU.
2 Steelhead are the anadromous form of the rainbow trout.
3 Previously identified by USFWS as a "federal species of concern" and a "category 2 candidate"; currently (July 2006), USFWS does not use these categories.

The characteristics and general habitat requirements for the Covered Species are described in Section 3 and Appendix A. Current habitat conditions and the status of the Covered Species in the area where the Plan will be implemented are described in Sections 4 and 5 and in Appendix C.

1.3.3.1 ITP Species

The ITP Species include five ESUs and one DPS of coho salmon, chinook salmon, and steelhead. Three of the ESUs/DPSs are listed as threatened by NMFS (the Southern Oregon/Northern California Coast ESU of coho salmon, California Coastal ESU of chinook salmon, and Northern California DPS of steelhead). The other three ESUs currently have no federal listing status (Southern Oregon and Northern California Coastal ESU and Upper Klamath/Trinity Rivers ESU of chinook and the Klamath Mountains Province ESU of steelhead).

1.3.3.2 ESP Species

The ESP Species include two fish species (resident rainbow trout and coastal cutthroat trout) and two amphibians (southern torrent salamander and tailed frog). None of the populations of these species within the Plan Area currently are federally listed or proposed for federal listing. Prior to the USFWS taking sole responsibility for the coastal cutthroat trout, NMFS considered listing the species in 1999 but determined that listing was not warranted at that time. USFWS considered listing southern torrent salamander in 2000 but determined that listing was not warranted at that time.

USFWS recently asserted jurisdiction over the resident form of the rainbow trout, which is unlisted. The anadromous form of the rainbow trout (the steelhead) is under NMFS's jurisdiction and covered under the Plan as an ITP Species within the Northern California DPS and Klamath Mountains Province ESU. The anadromous and resident forms are genetically indistinguishable, and the life history and habitat requirements of resident rainbow trout are similar to those of steelhead while in the freshwater phase (with the possible exception of estuary and some mainstem habitats).

1.3.4 Covered Activities

The activities covered by the Plan and Permits (Covered Activities) include many aspects of Green Diamond's timber operations and other forest management activities that have the potential to adversely affect the Covered Species and/or their habitats in the Plan Area. Covered Activities are specifically described in Section 2 and include those activities needed to carry out all the measures identified in Section 6. This includes surveying watercourses for the presence or absence of fish to make Class I/Class II determinations, which could constitute take. The AHCP/CCAA is designed to meet the approval criteria for a CCAA/ESP and an HCP/ITP that covers the take of Covered Species incidental to the Covered Activities. All Covered Activities will be conducted in accordance with the measures identified in this Plan, the California FPRs, and all other applicable laws and regulations.

1.4 CONTEXT

This Plan has been prepared in the overlapping contexts of:

- ITP and ESP requirements;
- California FPRs and other regulations;
- Green Diamond's Northern Spotted Owl Habitat Conservation Plan (NSO HCP);
- Other conservation efforts; and
- The multiple uses of the Plan.

1.4.1 ITP and ESP Requirements

The information, analysis, and conservation measures in this Plan, together with the assurances and procedures identified in the accompanying IA, are designed to meet the application requirements and approval criteria for an ITP and an ESP.

1.4.1.1 ITP Requirements

Under Section 10(a)(1)(B) of the ESA, NMFS and USFWS are authorized to approve ITPs. As described in the Code of Federal Regulations (CFR), applications for such permits must be submitted on a specific form and must be accompanied by an HCP that contains the following information:

1. The names of the species that will be taken;
2. The impacts that will likely result from the proposed taking;
3. Steps the applicant will take to monitor, minimize, and mitigate such impacts;
4. The funding available to implement such steps;
5. Procedures that will be used to respond to unforeseen circumstances;
6. The names of the responsible party or parties;
7. Alternatives to the taking and the reasons why they were not pursued; and
8. Other measures that may be required by the approving agency as necessary or appropriate.

Guidance on the contents of HCPs also is provided in the "Endangered Species Habitat Conservation Planning Handbook" (HCP Handbook) prepared by the agencies, particularly as addressed in the Addendum to the HCP Handbook published by the agencies in June 2000. The Handbook Addendum focuses on the expanded use and integration of five components in HCPs: biological goals and objectives, adaptive management as a method for addressing uncertainty, monitoring measures to ensure compliance and gauge the effects of effectiveness of HCPs, permit duration in relation to effects and mitigation, and expanded public participation in the review process.

ITP applications are submitted to USFWS and/or NMFS as appropriate. Upon receiving a completed application, the appropriate Director will decide whether or not to issue a permit. The permit is required to be issued if it is found that:

1. The taking will be incidental to an otherwise lawful activity;
2. The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;
3. The applicant will ensure that adequate funding for the HCP and procedures to deal with unforeseen circumstances will be provided;
4. The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and
5. The applicant will ensure that other assurances and measures as required by the Director of the approving agency will be provided and implemented.

Consistent with applicable regulations, unlisted Covered Species must be addressed in the AHCP as if already listed and will be named on the ITP. If approved, the ITP will take effect for listed Covered Species at the time the permit is issued. For unlisted covered species, the ITP will take effect upon the listing of such species (50 CFR 17.22(d)(1), 17.32(d)(1), 222.102, and 222.307). Prior to making the decision whether to issue an ITP, the agency will comply with the consultation requirements of Section 7 of the ESA, the public review provisions of the ESA, and the environmental analysis and public review requirements of NEPA.

1.4.1.2 ESP Requirements

Under Section 10(a)(1)(A) of the ESA, USFWS and NMFS are authorized to approve ESPs. As described in the CFR, applications for such permits must be submitted on a specific form and be accompanied by a CCAA that complies with the requirements of the CCAA policy (64 FR 32726-36). The CCAA regulations and policy are intended to facilitate the conservation of proposed or candidate species, or species likely to become proposed or candidate species in the near future, by giving incentives to non-Federal property owners who commit in a CCAA to implement mutually agreed upon conservation measures. Sections 2 and 10 of the ESA (as well as 4 and 7) allow implementation of the CCAA policy. Section 2 of the ESA states that “the purposes of this Act are to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of...treaties and conventions….” Section 2 goes on to state that “all Federal departments and agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of this Act.” Section 10 (a)(1) of the ESA provides for the issuance of permits for any act that enhances the propagation or survival of the affected species that would otherwise be prohibited by Section 9. The application of the CCAA policy in the Plan Area will provide benefits to the covered CCAA species through the voluntary conservation measures agreed to and implemented by Green Diamond.

As stated in the CCAA policy, CCAAs are required to identify or include:

1. The population levels (if available or determinable) of the covered species existing at the time the parties negotiate the CCAA; the existing habitat characteristics that sustain any current, permanent, or seasonal use by the covered species on lands or water owned by the participating non-Federal property owner; and/or the existing characteristics of the property owner's lands or water included in the CCAA that support populations of covered species on land or water not on the participating property owner's property;

2. The conservation measures the participating non-Federal property owner is willing to undertake to conserve the species included in the CCAA;

3. The benefits expected to result from the conservation measures described in 2 above (e.g., increase in population numbers; enhancement, restoration, or preservation of habitat; removal of threat) and the conditions that the participating non-Federal property owner agrees to maintain.

4. Assurances provided by USFWS that no additional conservation measures will be required and no additional land, water, or resource use restrictions will be imposed beyond those described in 2 above should the covered species be listed in the future. Assurances related to take of the covered species will be authorized through a Section 10(a)(1)(A) ESP.

5. A monitoring provision that may include measuring and reporting progress in implementation of the conservation measures described in 2 above and changes in habitat conditions and the species status resulting from these measures; and

6. A notification requirement to provide USFWS with a reasonable opportunity to rescue individuals of the covered species before any authorized incidental take occurs.

Items 1-3 and 5 are similar in nature to the elements of an HCP and, therefore, are included in this document. Items 4 and 6 are addressed in the IA and ESP itself.

The Director of USFWS must publish notice in the Federal Register of each application made for an ESP. Each notice must invite the submission from interested parties, within 30 days after the date of the notice, of written data, views, or arguments with respect to the application. The procedures included in 50 CFR 17.22(e) for objections to permit issuance apply to the published notice. Upon receiving a completed application, the Director of USFWS will decide whether or not to issue a permit. A permit may be issued if it is found that:

1. The taking will be incidental to an otherwise lawful activity and will be in accordance with the terms of the CCAA;

2. The CCAA complies with the CCAA policy issuance criteria of the CCAA policy, including the requirement that the benefits of the conservation measures implemented by a property owner under a CCAA, when combined with those benefits that would be achieved if it is assumed that the conservation measures were also implemented on other necessary properties, would preclude or remove any need to list the covered species. Under the CCAA policy “other necessary properties” are those “properties in addition to the property that is the subject of a Candidate Conservation Agreement with assurances on which conservation measures would have to be implemented in order to preclude or remove any need to list the covered species" (64 FR at 32734);

3. The probable direct and indirect effects of any authorized take will not appreciably reduce the likelihood of survival and recovery in the wild of any species;

4. Implementation of the terms of the CCAA is consistent with applicable Federal, State, and Tribal laws and regulations;

5. Implementation of the terms of the CCAA will not be in conflict with any ongoing conservation programs for species covered by the permit; and

6. The applicant has shown capability for and commitment to implementing all terms of the CCAA.

The agency, in this case USFWS, will issue an ESP at the time of entering into a CCAA. The permit will have a delayed effective date tied to the date of any future listing of a Covered Species (50 CFR 17.22(a), 17.32(d)(1); 64 FR 32735).

1.4.2 California's FPRs and Other Regulations

California's FPRs include a number of standard prescriptions that must be applied in every THP approved by the California Department of Forestry and Fire Protection (CDF). Prescriptions include: protection measures for watercourse zones (minimum buffer sizes, canopy closure requirements, and equipment exclusion); restrictions on construction, use, and maintenance of roads, trails, landings, and watercourse crossings; and snag retention requirements and measures providing for large woody debris (LWD) recruitment.

The FPRs also require a site-specific and area-specific assessment of potential individual and cumulative impacts of timber harvesting on the environment, including aquatic resources. Any significant impacts remaining after application of the standard prescriptions must be addressed through the adoption of other measures to mitigate or avoid such impacts.

The FPRs incorporate a significant requirement of the state water quality protection law, prohibiting the unreasonable degradation of the "quality and beneficial uses of water" by timber operations. Beneficial uses of water include protection of fish, wildlife, and other aquatic resources. All THPs must be judged against this prohibition, and all commercial timber operations must comply with it.

Other regulations that provide a level of resource protection and conservation in the Plan Area include the federal ESA, federal Clean Water Act, and California Fish and Game Code (including the State ESA).

1.4.3 Green Diamond's NSO HCP

This AHCP/CCAA is the second HCP that covers Green Diamond operations in the Plan Area. The first is the NSO HCP, which was approved by USFWS in 1992 (the first such plan approved for commercial timberlands in the Pacific Northwest) and covers the Green Diamond's operations in most of the same area as this AHCP/CCAA.

The AHCP/CCAA builds on conservation provided under the NSO HCP, which provides significant protection to the AHCP/CCAA species through resource management measures such as enhanced watercourse protection zones and wildlife habitat retention areas. In addition, although Green Diamond sought authorization only for incidental take of spotted owls, the NSO HCP also considers the needs of 39 other terrestrial species thought to be the most sensitive to timber operations in the area. For planning and management purposes, the NSO HCP is the terrestrial species equivalent to the AHCP/CCAA. Green Diamond considered simply amending the NSO HCP rather than having two separate operating conservation plans on its ownership. However, although the conservation plans have significant overlap, they address different elements of the ecosystem: the aquatic and the terrestrial. They have different terms; the NSO HCP has a 30-year term, whereas the AHCP/CCAA has a 50-year term. There are differences in the plan areas. The AHCP/CCAA Plan Area consists of Green Diamond's ownership within the 11 HPAs during the term of the Permits. The NSO HCP Plan Area consists of Green Diamond's California ownership within Humboldt, Mendocino and Del Norte Counties during the term of that permit (as well as lands Green Diamond owned in Trinity County at the time the NSO HCP was approved). In addition, the need to prepare a CCAA for the ESP Species, and the participation of NMFS in the conservation planning for the aquatic species under its jurisdiction, added complexity to the conservation planning. Finally, Green Diamond anticipates that the AHCP/CCAA will be used as the basis to satisfy other water quality and aquatic regulatory requirements in the future. For these and other reasons, Green Diamond chose to leave the NSO HCP/ITP intact and seek separate approvals of the aquatic conservation plan.

Provisions of Green Diamond's NSO HCP, principally through the retention of wildlife trees that are left within marked tree clumps or designated habitat retention areas, provide residual vertical structure. These retained trees, in conjunction with those left in Riparian Management Zones (RMZs), will result in a significant portion of the area within even-aged harvesting units supporting post-harvest vertical structure to provide various habitat attributes for terrestrial and aquatic wildlife. The following are the approved live tree retention guidelines from the NSO HCP:

1. Live trees retained for wildlife habitat pursuant to these guidelines are to be in addition to those trees left in Watercourse and Lake Protection Zones.

2. Except as noted below, at least one live tree per clearcut acre will be retained. At least two trees per clearcut acre will be retained in tracts where Green Diamond's biologists have determined that past intensive harvesting activity has resulted in a landscape deficient in residual vertical structure, and in all THPs where hardwood is the principal species harvested.

3. In a cable or helicopter yarding unit the requisite number of trees shall be retained in a habitat retention area (HRA) at least ½ acre in size. For optimal protection of HRAs from windthrow and damage resulting from yarding or site preparation activities, HRAs will usually be retained low on the slope and adjacent to RMZs.

4. If 15% or more of the total area in a harvesting unit (including any ground skidding area) is designated as uneven-aged management (selection or group selection silvicultural system), then an HRA will not normally be required.

5. In ground skidding areas trees will be retained in "tree clumps" of ten or more trees. The requisite number trees per ground skidding clearcut acre will be retained regardless of the percentage of the total harvesting unit area (including any portion that is to be cable or helicopter yarded) that may be specified as uneven-aged management. Protection from windthrow and site preparation burning should be considered when designating the location of tree clumps.

6. Candidate Trees for retention will be selected as follows:

    a. The average diameter at breast height (dbh) of retained trees should be equal to or greater than the average dbh of trees in the THP area.

    b. Large defective or poorly formed trees are preferred for retention (e.g., forked top, broken top, mistletoe broom, etc.). Because these particular habitat structural elements are not common and have high wildlife value, they should be retained wherever feasible.

c. A mix of conifers and hardwoods should be retained (approximately 50/50 mix where possible). Conifer species preference: Douglas-fir, hemlock, white fir, cedar, spruce, redwood. Hardwood species preference: tanoak, Pacific madrone, California laurel, chinquapin.

1.4.4 Other Conservation Efforts

Other conservation efforts that provide a foundation for this Plan include:

1. The long-term channel monitoring program initiated in 1995,

2. Stream assessments and studies of aquatic species conducted on Green Diamond property since 1993, (see Section 4 and Appendix C),

3. The Salmon Creek Management Plan, prepared in 1993 in coordination with CDF, CDFG, and the North Coast Regional Water Quality Control Board (RWQCB),

4. The Management Strategies for the Little River Watershed, prepared in 1999 after Green Diamond acquired the Little River timberlands formally owned by Louisiana-Pacific Corporation,

5. A cooperative effort with the Yurok Tribe fisheries staff and the Coastal Conservancy on a long-term program to restore anadromous fish habitat in 24 tributaries of the lower Klamath River,

6. A cooperative effort with Redwood National Park (RNP) in the upper Redwood Creek watershed to inventory roads and hillslopes and prioritize treatment areas to reduce the risk of future erosion,

7. Habitat restoration and enhancement projects completed in cooperation with restoration groups on 33 streams,

8. Standardized field methods to assess salmonid populations and habitat, developed through the cooperative efforts of the Fish, Farms, and Forests Communities (FFFC) Coalition,

9. Habitat conservation on a landscape scale through resource protection and balanced forest growth and timber harvest (Maximum Sustained Production [MSP]) under a CDF-approved sustained yield strategy for Green Diamond's timberlands,

10. Green Diamond's voluntary ownership-wide road maintenance program; and

11. The Redwood Creek TMDL Implementation Plan proposed by the Redwood Creek Landowners Association.

1.4.5 Multiple Uses of the Plan

In addition to satisfying ESA requirements regarding authorization for incidental take, the Operating Conservation Program presented in Section 6.2 of this AHCP/CCAA is designed to address other significant, closely related issues such as water quality and cumulative wildlife impacts. These multiple uses of the Plan are important to note because some of the specific measures and level of mitigation provided under the Operating Conservation Program would not necessarily be required to satisfy federal or state requirements if Green Diamond were only seeking authorization for take. Individual components of the Operating Conservation Program and, in some instances, the program as a whole, also provide the basis for satisfying non-ESA legal requirements related to aquatic resources and moving forward on voluntary issues. For example, a number of other statutes address water quality protection and govern activities within streams. In many cases, particularly with regard to the potential impacts of timber operations, the principal target of protection and the indicator of the protection's success is the health of the aquatic ecosystem. By targeting fish populations and habitat components representative of that aquatic ecosystem, the AHCP/CCAA provides the framework for assessing and addressing multiple issues regarding the same resource.

Section 2. Description of Green Diamond's Timber Operations and Forest Management Activities

2.1 INTRODUCTION

This Section describes Green Diamond's timber operations and related land management activities in the Initial Plan Area under four headings:

- Timber-Product Harvest
- Silvicultural Regimes and Methods
- Timber Stand Regeneration and Improvement
- Minor Forest-Product Harvest

The activities described in this section (as well as those activities need to carry out all the measures identified in Section 6) will be covered by the authorizations for incidental take of Covered Species and be subject to the applicable provisions of the Operating Conservation Program in this Plan.

2.2 TIMBER-PRODUCT HARVEST

Timber-product harvest includes activities necessary to the logging (i.e. felling, yarding, and loading), salvage, and transport of timber products. Such activities are described below under the following headings:

- Felling and bucking timber
- Yarding timber
- Loading and other landing operations
- Salvaging timber products
- Transporting timber and rock products
- Road construction and maintenance
- Rock pit construction and use
- Water drafting
- Equipment maintenance

Green Diamond is not seeking coverage under the Permits for the harvest of trees, as described in Sections 2.2.1, 2.2.2, and 2.2.3, in any portion of the Eligible Plan Area that has been designated as critical habitat for the marbled murrelet under 50 C.F.R. 17.95 when the harvested trees constitute a “primary constituent element” of critical habitat for the marbled murrelet, as defined in 50 C.F.R. 17.95 (adopted May, 24, 1996, 61 FR 26256).

Methods used to harvest timber products are described in Section 2.3.

2.2.1 Felling and Bucking Timber

Timber felling is the necessary first step in any logging operation, and usually includes "bucking", or cutting of the felled tree into predetermined log lengths that are specified by the timber owner to maximize the value of the tree. Felling and bucking are generally done with chain saws by independent contractors who work in pairs ("sets"). On terrain that is not too steep, mechanical felling machines (feller-bunchers) can be used. These machines are structurally similar to tracked excavators and have an articulated attachment that grabs the tree, cuts it, and then places it in a pile with other trees to facilitate subsequent skidding of "bunched" stems to the log landing. More complex feller-bunchers have "processor heads" that will delimb the tree and buck it into logs. Tracked undercarriages and the self-leveling mechanisms configured on some of these machines allow them to operate on moderate slopes. Feller-bunchers have no blade or other attachment capable of moving soil.

2.2.2 Yarding Timber

Yarding, also referred to as skidding, is the movement of logs from the stump to the log landing. There are three major classifications of yarding systems; ground based, cable, and aerial logging

2.2.2.1 Ground-Based Yarding

Ground based logging usually involves the use of tractors, either tracked or rubber tired (rubber tired skidders) to skid logs to the landing. These machines use either powered grapple attachments or winch lines to grasp of the log, and require constructed "skid trails" for their operation on all but the mildest terrain. A related system used only with small logs and on the mildest terrain is forwarder logging, where a specialized tractor equipped with a small hydraulic boom loader travels into the logging unit and loads logs onto bunks that are mounted on a rearward extension of the tractor's frame - in essence a small self-loading truck designed with tires, gearing, and ground clearance that allow it to operate off-road.

Another variant on ground skidding is shovel logging. A shovel, or hydraulic boom log loader, is an excavator that has been equipped with a log loading boom and grapple instead of an excavator boom and bucket. Most shovels are mounted on tracked undercarriages with generous ground clearance, providing some degree of off-road mobility. This capability is used in shovel logging, where a shovel walks off the truck road, picks up logs in a unit that has been felled, and passes them back towards the truck road using its upper structure rotation or "swing" function. This system is very efficient over short distances, since the same machine that does the yarding can load the logs on trucks. However, it is not used over long distances because of the amount of repeated log handling that becomes necessary as distance from the truck road increases. As with feller-bunchers, shovels have no blade or other attachment capable of moving soil and do not require the construction of roads or trails to operate.

2.2.2.2 Cable Yarding

Cable yarding involves the use of steel cables, or wire ropes, to skid logs to a truck road or log landing using a yarder that is set up on the truck road or landing. A yarder has a number of powered drums filled with wire rope, and a vertical tower or leaning boom that is necessary to elevate or provide lift to the cables as they leave the machine. The tower ("pole") or boom that provides this lift is held in position by three to eight wire rope guylines that are also stored on powered drums on the machine. With rare exception, logs are yarded uphill with cable systems.

Cable yarding is usually described as either "high lead" or "skyline", depending on how much lift is applied to logs as they are yarded. High lead logging essentially attaches logs directly to the end of the "mainline" that exits the top of the yarder tower. The only lift provided is that resulting from the difference in elevation between the location of the log and the top of the tower. This system is quick to set up and is effective over short distances (generally less than 500') where, depending on terrain and tower height, the resulting lift will be sufficient to prevent the logs from digging into the soil surface during yarding.

Over longer reaches some form of skyline logging is preferred to provide lift sufficient to increase productivity (reduced drag over long distances significantly increases yarding speed) and minimize ground disturbance. Skyline logging involves use of a skyline cable that extends from the top of the tower to an anchor located at some elevated point beyond the edge of the logging area. This anchor is usually a stump on an opposing hill slope, but can be a suitable tree at the perimeter of the logging unit that has been climbed and rigged to provide the necessary elevation for the skyline. Logs are attached to a carriage that rides on the skyline, and the carriage is pulled to the landing with the yarder's mainline (also referred to as the skidding line in this application). Depending on which variant of skyline logging is used, the skyline can be lowered to attach the logs and then raised to provide lift, or the carriage can spool out its own skidding line through one of various mechanisms and then lift the logs towards the skyline. Either way, enough lift is provided to suspend the uphill end of logs above the ground surface unless an unusually large log is encountered or the only available skyline anchor point cannot provide enough lift.

2.2.2.3 Aerial Yarding

Aerial yarding (e.g., by helicopter or balloons) is used where roads cannot be constructed to provide access to a harvesting unit for conventional (ground based or cable) yarding systems. Steep and/or unstable terrain is usually the reasons for the decision to use aerial methods, although lack of a road right-of-way may also trigger its use. Aerial logging uses cables or grapples suspended from long cables to pick up logs and hold them for transport to the landing. The logs are lowered to the log loading area and released without the aerial equipment landing. This type of yarding generates virtually no soil disturbance. However, a large landing is required to safely accommodate concurrent landing of logs, truck loading operations, and decking of logs generated during peak production hours. A separate service landing is also needed to provide a clean, rocked, debris and dust-free surface to protect the helicopter’s engines from damage. The disadvantages of helicopter logging are its expense (roughly three times more expensive than cable yarding) and the fact that lack of vehicular access to the area compromises the landowner's ability to accomplish site preparation, reforestation, and other forest management activities in the future. Helicopter service landing areas are appurtenant to the THP area.

2.2.2.4 Loading and Other Landing Operations

After logs are yarded to a landing or roadside they may need some additional saw work to remove limbs, to buck overly long pieces into shorter segments, or to remove breakage. These tasks are either accomplished with hand labor or with a mechanical delimber, a tracked machine similar to an excavator that has a long boom and moving cutting head that delimbs logs, and that can also accurately measure and buck a tree-length piece into logs. Logs are next loaded onto log trucks using a shovel or front-end loader (a wheeled bucket loader equipped with log loading forks instead of a bucket). Shovels (or heel-boom loaders) can operate on small landings or, if sideslopes are suitable, they can deck logs on the roadside and load trucks without leaving the road grade. In contrast, front-end loaders have a longer turning radius and require larger landings.

2.2.3 Salvaging Timber Products

Dead, dying, and windthrown trees are periodically salvaged. . This salvage is primarily related to road maintenance or fire damage resulting from prescribed burns. Dead or dying trees are removed from along roads if they can be easily salvaged and yarded onto an adjacent road. Salvage of timber products is conducted through the annual filing of a property wide Exempt Notice (i.e. subject to the FPRs but exempt from THP requirements) and THP processes. Removal of these products requires a licensed timber operator. If the volume to be salvaged exceeds 10% of the average existing timber volume per acre, a THP is required.

2.2.4 Transporting Timber and Rock Products

Timber and rock materials are most commonly transported along roads via truck and trailer. Helicopters may occasionally but infrequently be used to transport logs directly to the sawmills.

2.2.5 Road Construction and Maintenance

Roads on lands owned in fee by Green Diamond are constructed most commonly by felling and yarding timber along a predetermined road alignment that has been designated on the ground. This activity is followed by excavating or filling hillslope areas, using tractors or excavators. Road construction also commonly involves construction of watercourse crossings which use culverts, bridges, and occasionally fords. Roads also include vehicle turnouts and log landings, which are wide spots capable of being used as destinations of yarded logs as well as locations for loading logs onto trucks. Road construction may also involve the surfacing of soil roads with rock, lignin, pavement, or other surface treatments approved by NMFS and USFWS.

Road maintenance commonly includes surface grading, clearing bank slumps, repairing slumping or sliding fills, clearing ditches, repairing or replacing culverts and bridges, adding surface material, dust abatement, and installing or replacing of surface drainage structures. Road maintenance for fire prevention, public access, and timber management may include mechanical control of roadside vegetation. Mechanical control may include grading, hand cutting or pulling, use of a "brush buster"-type mechanical device, burning, steaming, other experimental methods, etc.

2.2.6 Rock Pit Construction and Use

Rock pits, also referred to as borrow pits, are locations where rock is excavated, crushed, blasted, or otherwise produced for eventual use as a road surface, road fill, or rock bank stabilization materials. Activities associated with the use of rock pits also include loading rock into trucks for hauling, hauling of mined rock, and the construction and maintenance of rock pit access roads (see above).

2.2.7 Water Drafting

Water drafting involves the direct drafting of stream flow into a water truck which is then periodically sprinkled or otherwise applied for dust abatement, road maintenance, road construction, surfacing, and prescribed fuel reduction burning. Water may also be obtained by the use of gravity fed systems that provide water directly to storage reservoirs or tanks for similar use. Occasionally, existing drafting locations within or adjacent to watercourses are excavated and cleaned of debris to increase their in-channel storage area for drafting purposes.

2.2.8 Equipment Maintenance

The use of falling, yarding, loading, trucking, and road maintenance equipment requires equipment fueling and maintenance. This maintenance generally occurs on or adjacent to roads and landings.

2.3 SILVICULTURAL REGIMES AND METHODS

Green Diamond's silvicultural practices are designed to enhance the productivity of its timberlands by ensuring both prompt regeneration of harvested areas and rapid forest growth. Treatments vary by stand age, stand condition, site class, and species composition, and not all treatments are applied to every site. Table 2-1 summarizes the treatments, in approximate chronological order, that are considered as part of Green Diamond's forest management regime.

Table 2-1. Green Diamond's forest management regime.

Treatment	Stand Age
Regeneration Harvest	50 and older
Site preparation	0 – 1
Planting	1
Vegetation Management	0 – 10
Pre-commercial thinning	10 – 20
Commercial Thinning	35 – 45

Silvicultural activity involves the specific methods by which a forest stand or area is harvested and regenerated over time to achieve the desired management objectives. Typical management objectives include achieving maximum sustained yield, and the maintenance, alteration, or creation of habitat. Specific examples of silvicultural activity include silvicultural methods such as individual (single) tree selection, group selection, seed tree, shelterwood, and clearcut.

2.4 TIMBER STAND REGENERATION AND IMPROVEMENT

Timber stand regeneration and improvement includes activities necessary to establish, grow, and achieve the desired species composition, spacing, and rate of growth of young forest stands. Such activities include:

- Site preparation, prescribed burning, and slash treatment
- Tree planting
- Control of competing vegetation
- Precommercial thinning and pruning

Green Diamond manages timber in the Initial Plan Area under a Maximum Sustained Production (MSP) plan prepared and approved in accordance with state law. Under the MSP plan, annual harvest levels are carefully scheduled to balance forest growth and timber harvest over a 100-year period and to achieve maximum sustained production of high quality timber products while protecting resource values such as water quality and wildlife. Stands are considered ready for harvest once they enter the 50-year age class. However, state laws that constrain both the size of even-aged management units and the timing of adjacent even-age harvesting operations can delay the harvest of many stands until they reach the 70 year age class. The estimated average age of stands harvested is expected to be around 55 years as the property approaches full regulation.

With the exceptions noted below, Green Diamond plans to practice even-aged management in the Plan Area, using clear-cutting as the harvest/regeneration method. Clearcutting provides for prompt regeneration of redwood and Douglas-fir, the principal commercial tree species in these forests, and maintains these trees in a "free-to-grow" state that is not compromised by competition with a residual overstory of older trees or by the possibility of damage from the repeated site disturbance that is implicit in the application of other silvicultural systems. The growth potential inherent in the use of clearcutting in these forest types was assumed in the calculation of yields for Green Diamond's sustained yield (Option A document).

The primary exceptions to clearcutting will occur in the following situations:

- Areas where past use of selection or seed tree logging has left residual mature timber that will be harvested in "seed tree removal" or "overstory removal" operations.

- Areas where buffers along public roads or near urban development are harvested using the shelterwood or selection systems so that the visual impact of timber harvesting is ameliorated.

- Overly steepened or unstable slopes where slope stability concerns take precedence over forest productivity.

- Riparian Management Zones (RMZs), Habitat Retention Areas (HRAs), or other areas managed principally for fish and wildlife habitat.

Clearcut management units will continue to reflect the provisions of Green Diamond's NSO HCP, principally through the retention of wildlife trees that are left within marked tree clumps or designated habitat retention areas to provide residual vertical structure. These retained trees, in conjunction with those left in RMZs, will result in a significant portion of the area within even-aged harvesting units supporting post-harvest vertical structure to provide various habitat attributes for terrestrial and aquatic wildlife.

Since essentially all of Green Diamond's property has been harvested at some time in the past, the progress of timber harvesting across the ownership will always reflect to some extent the pattern of age classes imprinted on the landscape by the timing of prior logging activity. In areas where large ownership blocks were initially harvested in more or less continuous logging operations during the railroad logging era (pre-WWII), ensuing harvesting operations will be more concentrated, although FPR constraints will result in dispersal of activities within these blocks during subsequent rotation periods.

This pattern of timber harvesting was changed by decades of selective logging throughout the redwood region during the middle of the past century, and by the eventual acquisition by Green Diamond of a patchwork of properties that reflected differing harvest schedules and treatments by prior owners. Future harvesting cycles in these areas will see timber operations that are more dispersed due to their varied management histories.

The effects of the timing of past harvesting activity are reflected in Table 2-2, which shows the age classes of forests in the Initial Plan Area. As indicated in Table 2-2, this acreage is dominated by forests between 0 and 60 years old; 85% of the forested land in the Initial Plan Area is in these age classes. Approximately 12% of the forested land in the Initial Plan Area is 61 years or older, and the proportion of the area in these older age classes is expected to remain at this level or increase over the life of the Plan for two reasons:

1. FPR adjacency constraints that are applied to even-aged harvesting units result in retention of many stands far past planned rotation age. If harvesting of a tract of mature timber is initiated around age 50, the harvesting of much of that tract will be constrained into the following decade, and the harvest of a few stands will be constrained past 70 years of age. This effect has been demonstrated in Green Diamond’s long term operating plan.

2. Current rules and regulations, interacting with provisions of the NSO HCP, result in harvesting restraints or prohibitions on approximately 12% of the Initial Plan Area. Provisions of the AHCP/CCAA will add to the area subject to such restrictions. Trees in these areas will be retained at least through Plan period and will thus add to the total acreage in older age classes.

2.4.1 Site Preparation, Prescribed Burning, and Slash Treatment

Site preparation may be required where accumulations of slash following timber harvesting constitute a physical barrier to effective planting, or where weed species (brush or non-merchantable trees) remaining on the site would comprise severe competition for planted seedlings. In either situation, prescribed burning, machine piling, mechanical scarification, or a combination of these methods may be used to prepare the site for hand planting.

Table 2-2. Initial Plan Area acreage per age class.

HPA	Forested Land by Age Class (acres)						Non-Forest (acres)	Total
	0-20 yrs	21-40 yrs	41-60 yrs	61-80 yrs	81-100 yrs	>100 yrs		
Smith River	9,524	16,852	12,266	1,105	794	1,418	2,220	44,177
Coastal Klamath	19,638	46,283	15,496	530	504	3,842	2,468	88,760
Blue Creek	3,496	8,962	1,108	162	221	624	820	15,393
Interior Klamath	8,491	31,989	15,165	2,370	3,946	2,012	2,168	66,139
Redwood Creek	4,728	15,266	8,746	2,620	703	154	822	33,038
Coastal Lagoons	7,662	6,008	20,456	4,985	180	136	553	39,981
Little River	14,564	3,391	1,156	5,541	1,294	0	96	26,041
Mad River	16,771	4,253	14,435	4,436	3,267	533	5,680	49,376
North Fork Mad River	8,205	5,120	11,270	2,496	260	150	708	28,209
Humboldt Bay	7,640	3,029	3,396	2,230	871	141	176	17,484
Eel River	4,465	695	1,633	1,015	24	0	100	7,933
Total	105,183	141,849	105,126	27,490	12,064	9,012	15,810	416,533

Site preparation is done as soon as possible after completion of logging so that planting will not be delayed. Mechanical site preparation may be done concurrently with logging operations. If prescribed burning is required, it is scheduled during the first spring or fall following completion of timber harvesting. Timing of such burns is predicated upon temperature, wind, humidity, and fuel moisture conditions that will result in low intensity burns. Such conditions minimize the probability of escape and allow retention of large woody debris and the finer organic matter concentrated at the soil/litter interface. Ignition patterns are used that are designed to keep fire from intruding into RMZs.

Prescribed burning is used to reduce slash concentrations or to reduce vegetative levels or control species composition. This practice involves the introduction of fire under controlled conditions to remove specified forest elements with little risk of catastrophic fire damage. Fire may be broadcast across large areas, or may be used in specific sites. Prescribed burning is also used for slash control and to reduce fuel concentrations in established stands for fire prevention.

In general, slash created by logging activity is retained on site without treatment. The California FPRs require that accidental deposits of slash within Class I and Class II watercourses be removed. Slash deposited into Class III watercourses must be removed unless it is stable within the channel. When timber harvest is accompanied by restocking (planting of young conifers) after the harvest is complete, slash is either retained untreated, mechanically cleared from small circular planting spots, or broadcast burned. In all logging areas, slash developed on log landings as a result of yarding and truck loading activities may be piled and burned on the landing.

2.4.2 Tree Planting

Tree planting generally involves hand planting nursery-grown tree seedlings directly into the soil, ensuring good contact between the soil and roots. Tree seedlings will be hand planted in even-aged management areas including landings during the first winter following completion of a THP. Planting will be postponed only if site preparation is necessary but cannot be completed prior to the planting season. The summer after initial planting, Green Diamond surveys planted areas to determine seedling survival rates and, where necessary to achieve desired stocking, will plant additional seedlings during the following winter. At age 2, a more detailed stocking survey will be done and, if necessary, additional trees are planted.

2.4.3 Control of Competing Vegetation

To provide successful establishment and continuing, rapid growth of desired tree species, it is often necessary to control species that compete with desired species for water and sunlight. Control methods are mechanical cutting and chipping. Green Diamond is not seeking coverage of herbicide use for control of competing vegetation as a part of the Permits.

2.4.4 Precommercial Thinning and Pruning

Precommercial thinning involves thinning dense young forest trees by mechanical means, including cutting individual trees or mechanically sawing or chipping rows or groups of trees. Pruning removes the lower limbs of desirable tree species to increase the eventual product value of the pruned trees. Between age 10 and 20, pre-commercial thinning may be prescribed to remedy overstocked conditions in planted stands so that crop trees will achieve optimum diameter growth. Currently, pre-commercial stems are not removed from the site because they are too small to meet current merchantable standards. This operation is performed only once in the life of a stand, and only on those stands with an excess number of trees per acre. Although chainsaws are used to cut the non-crop trees, progress in the development of feller-bunchers may eventually lead to machines that are capable of carrying out this operation more efficiently and with less risk of injury to workers. Alternatively, improvements in markets for small wood and in the machinery used to harvest small stems may allow economic harvesting of the excess trees, thus converting pre-commercial thinning to commercial thinning, as described below.

2.5 MINOR FOREST-PRODUCT HARVEST

Minor forest products include burls, stumps, boughs, and greenery. Such products are collected, harvested, and transported on Green Diamond timberlands. These activities will comply with the measures in Section 6.2. Permits are issued to ensure these activities are conducted in a way that protects sensitive habitats and minimizes the risks of any incidental take of Covered Species.

This page intentionally blank.

Section 3. Description of the Covered Species and their Habitats

3.1 SUMMARY

The six Covered Species occupy a wide range of stream reaches based on their specific habitat requirements and biological adaptations (Figure 3-1). In this regard, the Covered Species are dependent on a variety of stream habitats in the Initial Plan Area. Some larger streams may be used by all six species, while smaller tributaries may be used by all, some, one, or none of the Covered Species. A general description of the Covered Species and their habitats follows; a more detailed description of each of these species is provided in Appendix A.

3.2 SPECIES CHARACTERISTICS

3.2.1 Fish Species Characteristics

The four fish Covered Species are members of the Salmonid family. All four species exhibit varying levels of anadromy. Within the Initial Plan Area, chinook and coho salmon are exclusively anadromous, rainbow trout exhibit both anadromous (steelhead) and resident forms, and cutthroat trout mostly exist as resident populations, but limited anadromy does occur. Coho and chinook salmon are semelparous (individuals die after spawning), while rainbow trout (including steelhead) and coastal cutthroat trout are iteroparous (can survive to spawn more than once). Table 3-1 summarizes the key characteristics of the four covered salmonid species. A detailed description of each Covered Species is provided in Appendix A.

3.2.2 Amphibian Species Characteristics

The southern torrent salamander and tailed frog are alike in that:

- Both are found primarily in perennial watercourses and colder water relative to the salmonid species;
- Larval stages of both prefer riffle habitats that have clean cobble and gravel with minimal sediment accumulation;
- Both have limited dispersal abilities and are seldom found outside the stream or riparian strip; and
- Under certain circumstances, both can persist in streams with temporary periods of no flow or segments of subsurface flow during the late summer and early fall.

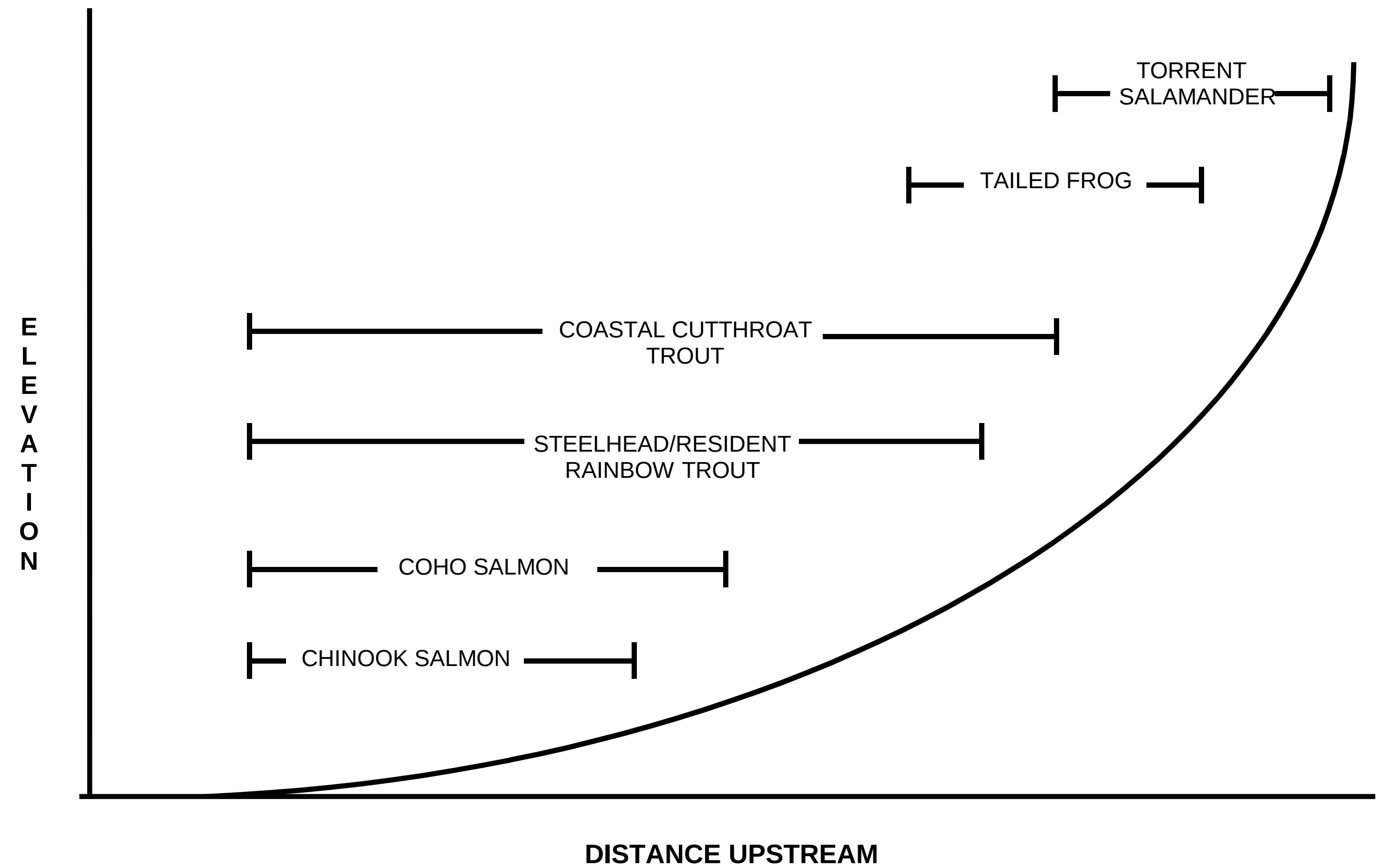


Figure 3-1. Schematic profile of the Covered Species distribution along a hypothetical stream channel.

Figure 3-1 is a generalized view of the distribution of the Covered Species within a hypothetical sub-basin in a coastal California watershed. The limits of each species' distribution in regard to channel gradient and distance upstream are not to scale, and smaller tributaries are not accounted for.

Table 3-1. Key characteristics of the fish Covered Species.[1]

Characteristic	Chinook Salmon	Coho Salmon	Steelhead/Resident Rainbow Trout	Coastal Cutthroat Trout
Spawning Period (anadromous populations)	September to January, concentrated in Nov-Jan, depending on rainfall and stream discharge	• September to March, concentrated in Jan-Feb, depending on rainfall and stream discharge	• September to April depending on time of entry	• December to May depending on time of entry
Spawning Habitat **Redd Sites** **Water Depth** **Water Velocity** **Substrate Size** **Temperature**	 • Pool tails or slightly upstream • 0.5 to 7 m • 0.2 to 1.9 m/sec • 1.2 to 10.2 cm • 5.6°C to 13.9°C	 • Pool tails or slightly upstream • 0.2 to 0.5 m • 0.3 To 0.5 m/sec • 1.3 to 15 cm • 5.6°C to 13.3°C	 • Pool tails, upper sections of watershed • 0.1 to 1.5 m • 0.2 to 1.6 m/sec • 0.6 to 12.7 cm • 5°C to 15°C	 • Pools tails with protective cover nearby • 0.1 to 1 m • 0.1 to 1 m/sec • 0.6 to 10.2 cm • 5°C to 15°C
Incubation Period	• 30 to 159 days depending on water temperature	• 36 to 100 days depending on water temperature	• 19 to 80 days depending on water temperature	• 40 to 50 days depending on water temperature
Rearing Habitat	• Fry seek cover in shallow water along channel margins or in low velocity channel bottoms • Overwintering juveniles seek shelter under large boulders and woody debris, and in side channels or other low-velocity refugia • Fry young-of-the-year and yearling smolts also use estuarine habitat • Summer weekly average temperatures (MWAT) below 17.4°C (NMFS recommendation for coho)	• Mix of pools and riffles with abundant in-stream and overhead cover • Fry seek out shallow water along stream margins, backwaters, and side channels • Summer parr found mainly in pools. • Overwintering juveniles seek shelter from high flows in side channels, backwaters, under large boulders and woody debris • Summer weekly average temperatures (MWAT) below 17.4°C	• Fry tend to school and seek out shallow water along stream margins • Larger fry and juveniles maintain territories in pool and run habitat • Summer weekly average temperatures (MWAT) below 17.4°C (NMFS recommendation for coho)	• Fry seek out low velocity shallow water in stream margins, backwater pools, and side channels • Large coho fry can force cutthroat fry into riffles • Summer weekly average temperatures (MWAT) below 17.4°C (NMFS recommendation for coho)
Out-Migration (for anadromous populations)	• Downstream migration begins immediately after emergence (Late Feb –June) • Estuarine residence varies, probably 1-6 weeks depending on conditions.	• Juveniles usually remain in freshwater for one year • Smolts out-migrate in late March to mid- June	• Freshwater residence varies from 1-4 years, but 1-2 years is predominant in the Initial Plan Area.	• Anadromous cutthroat smolt out-migrate at one to six years old depending on estuarine conditions.
Other Factors	• Chinook spawn at two to seven years old; in California, three to four year olds are most common. • Some males (Jacks) spawn at age 1-2. • All chinook die after spawning	• Coho spawn after spending one to two years at sea; in California, most coho spawn at three years of age, with some males spawning at age 2 (jacks). • All coho die after spawning	• Steelhead spawn after one to four years at sea • Adult steelhead may spawn more than once • Summer run steelhead are able to use habitat not accessible to fall/winter run salmonids • Resident rainbow trout and steelhead populations occur in the Initial Plan Area	• Potamodromous and anadromous cutthroat use similar spawning habitat • Non-migratory cutthroat live in isolated headwater tributaries • Spawning tends to occur in 1st and 2nd order streams and isolated headwaters • Cutthroat trout may spawn more than once

Note
1 For additional life history discussion and references see Appendix A, Section A-1.

They differ from one another primarily in that:

- Tailed frogs appear to have somewhat greater tolerances for increases in water temperature; and

- Springs and seeps are vital habitat for torrent salamanders but of limited value to tailed frogs.

Key characteristics of the two amphibian Covered Species Area are summarized in Table 3-2. A detailed description of both amphibians is provided in Appendix A.

3.3 HABITAT CHARACTERISTICS

3.3.1 Fish Habitat Characteristics

As described by Steele and Stacy (1994) and others, salmonids are highly responsive to changes in five variables: water supply, temperature, nutrients, LWD, and sediment. In this regard, the habitat is largely a function of the interaction of flowing water, sediment, and structures in stream channels and the adjacent riparian area. Stream channels encompass the area where water flows most of the time and the floodplain and former terraces above the bankfull channel margin that are sporadically inundated at higher flows. Along the river continuum from headwaters to lowland reaches, the terrestrial influences on the channel lessen as flow and sediment load increase and physical structures become less common (Murphy and Meehan 1991).

- Steep, headwater channels are tightly confined by valley walls and shaped by bedrock, boulders, LWD, coarse sediments, and riparian vegetation.

- Moderate to low gradient mid-reach channels are less confined and are shaped by bedrock, boulders, LWD, sediments, and riparian vegetation. At this point along the river continuum, the degree to which LWD forms and maintains channel features is often a function of gradient, with LWD-formed features more common in lower than steeper gradient reaches.

- Lowland reaches have channels which commonly meander freely across floodplains of fine sediments and are shaped by scour and deposition at meander bends. Pools are seldom strongly influenced by bedrock, boulders, or LWD.

Key interactions and variables of salmonid habitat are described below in terms of stream and channel features, riparian zone contributions, and other habitat factors.

3.3.1.1 Stream and Channel Features

3.3.1.1.1 _Pools_

Pools are formed either by local scouring or impoundment of the flowing water by structures such as bedrock, boulders, or LWD in or adjacent to the channel. During lower velocity flows, they are deposit areas for fine sediments, becoming shallower and wider as sediment inflow increases.

Table 3-2. Key characteristics of the tailed frog and southern torrent salamander.[1]

Characteristic	Tailed Frog	Southern Torrent Salamander
Habitat Requirements		
General	• Cold clear streams with a boulder, cobble, or gravel substrate • Upper portions of streams but overlapping upper extent of fish-bearing reaches	• Cold clear streams with a loose gravel substrate • Areas with water seeping through moss-covered gravel • Splash zones of waterfalls • Uppermost portions of streams and headwater seeps
Adults	• Streams and upland habitats along streambanks.	• Interstices within gravel in streams and under objects along stream edges and in splash zone • Usually remain within 1 m of flowing water.
Larvae	• Attach selves to rocky substrates, primarily in riffles	• Interstices within gravel in streams
Breeding Period	• Spring and fall	• Spring or early summer
Metamorphosis of Young	• 1 to 2 years (data specific to Plan Area)	• Probably 2 to 3 years
Forage	• Terrestrial and aquatic invertebrates • Tadpoles feed on diatoms	• Terrestrial and aquatic invertebrates
Other Factors	• Predation by fish may limit distribution within lower sections of stream.	• Can persist in streams with subsurface flow during the dry summer season • Generally are believed to have low dispersal capabilities

Note
1 For additional life history discussion and references see Appendix A, Section A-1.

Complexity of pool habitat (e.g., amount, size, and configuration of in-stream structures, water depth, sediment levels, and water velocity) affects the retention and cycling of nutrients within stream channels and the ability of some pools to sort and store the size of gravels required for salmonid spawning.

All salmonid species utilize pools at various life history stages. Pool abundance and depth has been positively correlated with salmon and trout abundance and density (Bisson et al. 1982; Murphy et al. 1986). For anadromous adult salmonids, pools provide protection from predators during spawning migrations and spawning activities. Protective cover for adult salmonids is provided by pools with depth and complexity, including undercut banks, LWD pieces, and LWD debris jams. Pools also are essential for juvenile salmonids such as coho salmon, steelhead, and coastal cutthroat trout that rear in fresh water for extended time periods. For such juveniles, pool habitats act as cool water temperature refugia in the summer and as cover from high flows in the winter (Steele and Stacy 1994). Pools with complex LWD jams provide juveniles year-round protection from predators and seasonal protection from high winter flows. Salmonid species with resident life histories such as resident rainbow trout and coastal cutthroat trout also require year-round pool habitat.

The following habitat type descriptions follow the descriptive language of the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998) unless otherwise noted.

3.3.1.1.2 <u>Riffles</u>

Riffles are swift flowing water with surface agitation with bars of deposited sediments that typically occur in areas of increased channel gradient. The upstream section of riffles (the riffle crest) forms a transitional zone between pools and riffles and is the area where hydraulic conditions initially sort transported sediments (gravel, cobble, and boulders). Riffles are important to salmonids because:

- Riffle areas produce a majority of the aquatic invertebrates consumed by juvenile and resident salmonids; and

- The substrates deposited at riffle crests are generally in the size range preferred by spawning salmonids, allowing them to use the upstream sections of riffles for redd construction.

3.3.1.1.3 <u>Runs</u>

Runs are typically areas of swift flowing water with little surface agitation and no major flow obstructions. The substrate composition of runs usually consists of gravel, cobbles, and boulders. The margins of runs are often utilized by young-of-the-year salmonids displaced by more dominant fish from pool habitats.

3.3.1.1.4 <u>Side Channels</u>

Side channels occur along stream margins or where water at elevated flows leaves the main channel and spreads over the floodplain. Secondary channel pools often form in side channels and extend beyond the average wetted channel. During low flows, side channels and pools are usually of little value to salmonids. However, in higher order river channels (greater than fourth order), side channels and associated pools often provide thermal refugia for juvenile salmonids when main channel temperatures are high. Thermal refugia are formed when water from the main channel percolates subsurface through point bar formations and emerges as cooler water in side channel pools.

Side channels also provide vital habitat during elevated winter flows. For example, side channels formed by tree root systems and/or LWD offer protection from high flows that render the main channel inhospitable. The low velocity of secondary channel pools offers similar protection to over-wintering juveniles. In some instances, adult salmonids spawn in the tails of secondary channel pools that may remain more stable during flows at or above bankfull.

3.3.1.1.5 Channel Migration Zones

Channel migration zones are located in low gradient stream reaches with banks composed primarily of unconsolidated alluvial material whose form is controlled by a balance between flow regime and sediment supply. Within these channels, bank stability is maintained by the roots of riparian vegetation and by LWD that is large enough to remain stable during winter storms. In alluvial channels, the removal of riparian vegetation and excess sediment supply increases bank erosion and causes channels to become wider and shallower with decreased pool habitat.

Side channels often form in channel migration zones and provide quality fish habitat during high flows. Because these stream channels may migrate laterally in either direction during high flows, functional riparian zones should extend out to the valley walls to ensure proper riparian function for all potential channel locations.

3.3.1.1.6 Hyporehic Zone

The hyporehic zone is the interstitial habitat beneath the streambed that is the interface between surface water and the adjoining groundwater (Naiman 1992). In an alluvial channel or depositional reach this hyporehic zone can be relatively wide extending under point bars and into the adjacent bank as well as being several meters deep. In steeper transport reaches this zone would be proportionally less wide and much shallower, if not completely absent, due to bedrock control points. This zone provides interstitial habitat for numerous aquatically dependent species. Additionally, this zone acts as a regulator of nutrients to and from the surface water system depending on the flow conditions in-channel. Higher stream flows will recharge the ground water system as well as the hyporheic zone.

3.3.1.2 Riparian Zone Contributions

The riparian zone adjacent to streams (i.e., the corridor of distinctive soils and vegetation between a stream channel and the adjacent upland) is a vital component of salmonid habitat, providing temperature control, nutrients, channel stability, sediment control, and LWD.

3.3.1.2.1 Riparian Vegetation

In the coastal watersheds of the Pacific Northwest, riparian zone vegetation includes tree and shrub species such as alders (*Alnus* spp.), willows (*Salix* spp.), western red cedar (*Thuja plicata*), coastal redwood (*Sequoia sempervirens*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), big leaf maple (*Acer macrophylum*), and salmonberry (*Rubus spectabilis*). Their leaves, needles, stems, and branches provide shade that helps maintain summer water temperatures within the range required by salmonids. Leaves and other organic litter also are important energy sources to the aquatic ecosystem. In first and second order watersheds, for example, they provide more food for aquatic invertebrates than the organic matter in streams resulting from photosynthesis of aquatic plants (Murphy and Meehan 1991).

Riparian vegetation also aids in channel stability and in channel-forming processes. The root systems within the riparian zone stabilize channel banks and aid in the formation of undercut banks when the channel moves laterally and scours underneath the root systems. This undercutting often results in the recruitment of LWD to the stream channel. Riparian vegetation also may reduce amounts of sediment entering a watershed by intercepting the products of hillslope erosion.

3.3.1.2.2 LWD

Probably the most important function of the riparian zone is the production of large trees for recruitment as LWD to the stream channel. LWD is recognized as a vital component of salmonid-bearing coastal watersheds. The physical processes of LWD in watersheds include the formation of pools and other important rearing habitats, sediment control and storage, retention of organic debris, and modification of water quality (Bisson et al. 1987). The biological processes associated with LWD structures include barriers to fish migration, protective cover from predators and elevated stream flow, retention of gravels for salmonid redds, and regulation of organic material for the in-stream community of aquatic invertebrates (Bisson et al. 1987).

In coastal watersheds, LWD is responsible for the formation and location of many pools (Keller and Swanson 1979). For example, Keller and Tally (1979) and Keller et al. (1995) reported that 50% to 90% of the pools in the Prairie Creek watershed were formed by LWD. They also reported that some LWD had been in the stream channel for 200 years.

Depending on the size and location of the debris pieces, pools formed by LWD may be plunge pools, dammed pools, or lateral scour pools associated with a root wad or a log parallel to the stream channel. In first to third order streams, LWD often forms pools by a single piece fully spanning the stream channel. The single piece may entrain additional pieces of wood to form a stepped longitudinal profile (Bisson et al. 1987). In the smaller order channels, LWD that has spanned the channel as a whole tree will often be a stable fixture because even elevated discharges are unable to transport the debris downstream. As stream order increases, the magnitude and spacing of LWD clumps increases too (Bisson et al. 1987). In third to fifth order streams woody debris is often transported downstream during storms and is deposited on channel obstructions and on the outside of channel bends near the highwater mark.

Deposited LWD also has been shown to increase channel width, produce mid-channel bars and aid the formation of meander cutoffs and secondary channels (Keller and Swanson 1979). These debris deposits often result in short braided reaches and secondary channels that are important rearing habitat for juvenile salmonids in coastal watersheds (Sedell et al. 1984).

3.3.1.3 Other Habitat Factors

Other factors associated with salmonid habitat include water temperature, barriers to anadromy, and the importance of smaller watersheds.

3.3.1.3.1 Water Temperature

Water temperature can affect the survival, behavior, and metabolism of juvenile and adult salmonids (Bell 1973, Moyle 1976, Bjornn and Reiser 1991). Factors influencing water temperatures include stream flow and riparian cover. Low temperatures may inhibit growth by slowing fish metabolism (Chapman and Knudsen 1980), while high temperatures can cause direct mortality at temperatures of 23-25°C (Bjornn and Reiser 1991). The effects of elevated water temperatures on fish may be influenced by the range of daily temperature fluctuations, the duration of peak temperatures, acclimation, and the availability of lower temperature refugia (deep pools, undercut banks, and other in-stream cover) (Bjornn and Reiser 1991). In Mattole River coho were absent in streams with an MWAT (Mean Weakly Average Temperature) greater than 16.7°C (Welsh et al. 2001).

The reported upper limits of temperatures tolerable to the four covered salmonids vary depending on the measuring technique, species, and acclimation regime. Most published upper tolerance levels are based on laboratory experiments with fish acclimated to a constant temperature. Konecki et al. (1995) showed that juvenile coho acclimated to streams with summer temperature fluctuations had higher critical thermal maximums (CTMs) than fish from the same streams that had been acclimated to a constant temperature in the lab. This work suggests that fish in HPA streams (which have natural diurnal temperature fluctuations) may have higher critical thermal maximums than most published values.

Using one or several sets of water temperature values to establish biological objectives or thresholds is problematic because of the relationship between water temperature at a site and the drainage area above that site. Green Diamond has found that water temperatures are positively associated with drainage area and relatively predictable up to a size of approximately 10,000 acres. In drainages with greater watershed area, water temperatures tend to have increasingly greater variation probably in response to a variety of complex interacting physical factors (Beschta et al. 1987). To account for the relationship between water temperature and drainage area, 7-day highest mean water temperature (7DMAVG) was regressed on the square root of drainage area at locations known to support populations of southern torrent salamanders, tailed frogs or coho salmon. These three species were selected for the analysis because they are the most sensitive of the Covered Species to water temperature increases. The square root transformation was used to create a linear relationship between the two variables. Then, to establish a temperature threshold value, the upper 95% prediction interval (PI) of individual sample sites was used for drainages up to approximately 10,000 (100 square) acres. A prediction interval is based on the probability that a sample point will occur within a specified interval. It should be noted that using the regression of water temperature versus drainage area to establish threshold values was only intended to apply to 4th order or smaller streams that generally occur in drainages less than 10,000 acres. As noted above, this is because the relationship gets weaker for increasingly larger watersheds. The temperature threshold is described as: water temperature = 14.35141 + 0.03066461 x square root watershed area.

A summary of each summer temperature profile which includes some of this information is presented in Appendix C5, along with a review of the literature on appropriate salmonid temperature thresholds (also see Section 4.3 and the HPA profiles in Sections 4.4).

3.3.1.3.2 Barriers

Barriers are channel features that have the effect of partially or completely impeding fish passage. They form as the result of natural occurrences and as a by-product of land uses in the watershed. Natural barriers, such as falls and gorges, are often the result of a watershed's geologic conditions; woody debris jams also occur naturally. Barriers result in separating resident populations and controlling the distribution of anadromous species over a broad range.

Barriers resulting from land uses typically occur when debris from logging related activities enters the stream channel (often triggered by a road or hillslope failure) or when culverts are placed in the channel at road crossings. Depending on where and when such debris accumulates, the barrier can compound the restrictions on fish passage that occur naturally, precluding access to or exit from stream niches.

Depending on placement and stream flow, culverts may act as partial or total barriers to fish migration. Improperly designed and installed culverts restrict the movement of juvenile salmonids as well as adults, thus potentially affecting the access to potential spawning habitat and overwintering survival of juvenile coho salmon, steelhead, and cutthroat trout that commonly seek refuge from winter flows in smaller streams. There are five common conditions at culverts that create barriers (Bates 1992):

- Excess drop at culvert outlet;
- High velocity within culvert barrel;
- Inadequate depth within culvert barrel;
- High velocity and/or turbulence at culvert inlet; and
- Debris accumulation at culvert inlet.

3.3.1.3.3 Smaller Watersheds

Along the Pacific Northwest coast, watersheds occupied by salmonids vary in size from tiny intermittent streams to the mainstem Columbia River. However, smaller watersheds (first to fourth order) are where the majority of spawning and rearing occurs in forested watersheds (Chamberlain et al. 1991). Coho salmon, steelhead, and coastal cutthroat trout in particular often seek out the smallest tributaries available for spawning.

Smaller watersheds also are important because of their influence on the quality of the habitat downstream. Sediments, woody debris, nutrients, and thermal radiation that enter the upper sections of a watershed can be transported downstream and directly affect the water quality and channel formation of downstream areas. In addition, smaller watersheds may be acutely responsive to alterations of their riparian zone vegetation and adjacent hillslopes. In this regard, a small watershed can serve as an important bellwether of habitat conditions for salmonids in a larger area.

3.3.2 Amphibian Habitat Characteristics

3.3.2.1 Stream and Channel Features

Stream habitat for the southern torrent salamander and tailed frog generally occurs upstream from salmonid habitat in the smaller headwater portions of streams with cold water and clean gravels and in seeps or springs. Compared to lower stream reaches, headwater streams tend to have higher gradients and more confined channels. In addition, immediate geological conditions tend to dictate channel morphology more than hydrological processes. Some of the habitat elements in headwater streams are not directly comparable to the lower fish-bearing reaches, but there are many similarities relevant to understanding the habitat requirements of the covered amphibians.

3.3.2.1.1 Pools

Pools, which are so important to many of the fish species, are of limited use to tailed frogs and are avoided by torrent salamanders. Pools are extensively used by the Pacific giant salamander which preys on all smaller amphibians and whose presence may preclude use of pool habitat by other amphibian species.

3.3.2.1.2 Riffles

Riffle habitats generally are the most important to torrent salamanders and the tadpoles (larvae) of tailed frogs. To be high quality habitat, the riffles must be composed of unembedded cobble and gravel with minimal amounts of sand and silt. The cobble and gravel provide interstices through which these amphibians can move to forage and escape predation. Tailed frog tadpoles are more likely to be found in lower gradient riffles in areas of greater stream flow (lower in the stream course), while torrent salamanders are more often found in riffles with higher gradient and lesser flow (uppermost portions of the stream channel). Low gradient riffles with minimal flow are good habitat for torrent salamanders if the substrate is not highly embedded. However, this condition is less likely to exist in disturbed areas or where there are naturally high background levels of sediment.

3.3.2.1.3 Seeps, Cascades, and Splash Zones

Seeps, which are probably the best habitat for the torrent salamander, are a special type of habitat in which there is minimal but rather constant flow of water through the substrate. Many seeps are occupied only by the torrent salamander, without the potential competing and predatory interactions of the Pacific giant salamander. This circumstance is the reason that the highest densities of torrent salamanders are commonly found in this habitat type. Tailed frog tadpoles are not found in seeps, but the juvenile and adult frogs presumably forage and, in higher elevation areas, possibly overwinter in such habitat.

Cascade and splash zone habitats are also used by covered amphibians. Cascades of small headwater streams are likely used for foraging by adult tailed frogs and torrent salamanders; and both larvae and adults of both species are commonly found in splash zones where the streamside substrate stays constantly moist and cool.

3.3.2.1.4 Perennial and Intermittent Stream Flows

Streams with torrent salamanders and tailed frogs generally have perennial flow, but the flow may be intermittent with subsurface flow in some reaches. For example, in some of the low elevation coastal streams, tailed frog tadpoles that first emerge in October or November complete metamorphosis the following summer in late July or August. Tailed frog eggs are laid in summer, deep in the stream bed beneath logs, boulders or other coarse substrate and can be maintained by subsurface flow. Therefore, portions of the stream can appear dry with only subsurface flow during late summer and early fall, and support a viable population of tailed frogs. Torrent salamander larvae respire through gills and require more than one year to metamorphose, so they cannot persist in a stream that goes completely dry. However, similar to the eggs of tailed frogs, the larvae can survive in minimal amounts of subsurface water. As a result, a stream can give the appearance of being dry but still support a viable population of these salamanders.

3.3.2.2 Riparian Zone Contributions

The two covered amphibians have an additional dependency on the riparian zone relative to the covered anadromous fish species, because the adults of both amphibian species spend most of their time in this area. Both tailed frogs and southern torrent salamanders have limited dispersal abilities, and the juveniles and adults of both species spend most of their time in close proximity to the stream. Riparian vegetation provides the cover and maintains the cool moist microclimate that is essential to adults of both species. In addition, the riparian vegetation is necessary to maintain cold water temperatures required by the larvae of both species.

As with the fish Covered Species, the riparian zone is important to the covered amphibians as a source of large woody debris. Useful LWD can be smaller in headwater streams than in fish-bearing reaches because the stream channel is smaller and the energy of the water is less. However, its function is similar in both stream types in that LWD serves to store gravel and other sediments that create vital habitat. When clean cobble and gravel are sorted and stored in headwater streams by LWD, they allow water to percolate down through the coarse sediment, providing excellent amphibian habitat for escape cover, foraging, and egg laying.

3.3.2.2.1 Water Temperature

Brown (1975) found that the upper limiting temperature for tailed frog eggs was 18.5°C. The lethal thermal maximum for adult tailed frogs was reported to be 23-24°C (Claussen 1973). The preferred thermal range of tailed frogs in the Initial Plan Area is likely to be lower than either of these values, as Bury (1968), surveying in Northern California, found tailed frogs in streams with temperatures ranging from approximately 2 to 15.5° C, and Green Diamond personnel have observed a similar range (4-15° C).

Welsh and Lind (1996) determined that 17.2°C was the thermal stress threshold for southern torrent salamanders. Green Diamond personnel have observed southern torrent salamanders in streams with a mean water temperature of 12.5°C (SE = 0.25) and a range from 10°C to a maximum of 16°C, indicating that their preferred thermal range is substantially lower than their thermal stress threshold.

This page intentionally blank.

Section 4. Description and Assessment of the Current Status of Aquatic Habitat and Covered Species in the Area Where the Plan Will Be Implemented

4.1 INTRODUCTION

This Section summarizes what is known about the current status of aquatic habitat and Covered Species in the area where the Plan will be implemented (including the area where incidental take will be authorized). It presents information about the HPAs as a whole, the Eligible Plan Area within the HPAs (i.e., Initial Plan Area and Adjustment Area), and assessments conducted on Green Diamond's ownership. (The area where assessments were conducted is cited as the "Original Assessed Ownership"; this area excludes lands that, as anticipated in the draft Plan, were acquired by Green Diamond prior to the effective date of the Permits). Factors and conditions relevant to the planning and implementation of conservation measures for the Covered Species are identified and examined in three subsections.

- Geologic and Geomorphic Factors (Section 4.2) presents the underlying physical characteristics of the watersheds and watercourses in the 11 HPAs and identifies the contribution of those characteristics to habitat conditions. Characteristics unique to an HPA or Green Diamond's ownership also are noted.

- Methods and Results of Studies in the Original Assessed Ownership (Section 4.3) summarizes the data collection and assessments that were conducted to determine habitat conditions and the status of Covered Species on the Original Assessed Ownership and provide a basis for analyzing other commercial timberlands in the Eligible Plan Area.

- Assessment of Habitat Conditions and Status of Covered Species by HPA (Section 4.4) describes the characteristics of each HPA; identifies similarities and differences in habitat conditions and occurrence of Covered Species within and among HPAs; and identifies specific conservation concerns for Covered Species in each HPA.

4.2 GEOLOGIC AND GEOMORPHIC FACTORS

North coastal California includes some of the most rapidly eroding areas in the United States. Streams draining the area, such as the Eel River, have some of the highest suspended sediment loads per unit area recorded in the world (Judson and Ritter 1964). One fundamental reason for this occurrence is the unstable geology of the Coast Range (CA DWR 1992). A basic knowledge of the geology and geomorphology of the region is essential to understanding the environmental condition of the area. The following text provides a description of the geology and geomorphology in the HPAs. The information provides a broad overview of how geologic characteristics such as bedrock composition, bedrock structure, and tectonic uplift relate to topography, mass wasting, and erosion in the region.

4.2.1 Geologic Composition, Structure, and Activity

As shown in ***Figure 4-1 (A-D)***, the HPAs are located mostly within California's Coast Ranges geologic province. At their northeastern margin, they are within the Klamath Mountains geologic province. Both provinces include a complex of terranes that collectively are within the convergent margin of the North American plate. Within the individual provinces and terranes, geomorphic conditions vary widely. On a regional scale, the bedrock in the HPAs is a composite of accreted oceanic rocks and pre- and post-accretionary plutonic rocks that are overlain in places by younger depositional strata. Locally, the bedrock can vary greatly, ranging from deeply weathered sandstone and mudstone to metasedimentary rock, greenstone, and ultramafic bedrock.

The geologic structure of the HPAs generally is dominated by a series of north to northwest trending faults. The faults correspond to topographic highs (such as the South Fork Mountain Fault) and lows (such as the Grogan Fault). Numerous northwest-trending anticlines and synclines are associated with the faulting and also contribute to the shape of the landscape. The extensive uplift of the region is well known. The height of the mountains and the high elevation of bedrock composed of marine sediments and ultramafic ophiolite sequences are the most obvious indicators of this uplift. Accretion, deformation, and uplift of the region are ongoing today, as interactions continue between the Gorda, Pacific, and North American tectonic plates along the continental margin. Slip rates along the major thrust faults in the area is on the order of several millimeters per year (California Department of Conservation, Division of Mines and Geology (DMG)).

4.2.1.1 Klamath Mountain Province

At present, five major terranes of the Klamath Mountains are recognized, and several of these are subdivided into two or more geologic units. Each terrane is bordered by major faults that represent lines or sutures where plate fragments are joined (Harden 1998).

4.2.1.1.1 <u>Western Jurassic Belt</u>

The rocks of the Western Jurassic Belt underlie the eastern margin of the HPAs. This belt represents the youngest accreted terranes within the Klamath province. This belt includes the rock units of the Smith River subterrane (Galice Formation) as well as rocks that may be correlative with the Josephine Ophiolite.

The Galice Formation represents a long belt of metasedimentary rocks formed during the Jurassic period approximately 150 million years ago. The rocks of the Galice formation include marine slate (mildly slatey to phyllitic argillite), partially serpentinized peridotite, metagraywacke, stretched pebble conglomerate, greenstone, and metavolcanic Western Jurassic Belt breccia.

The Josephine Ophiolite represents a remnant of oceanic basement rocks that originated from a fragment of oceanic plate that was thrust onto the North American continent during the Jurassic period. The rocks of the Josephine Ophiolite include gabbro, pyroxinite, pillow basalt, serpentinite, and sequences of ultramafic rocks.

The Western Jurassic Belt also contains small pockets of intruded dioritic rocks that may occur in the Original Assessed Ownership and elsewhere in the HPAs. To the west, the rocks of the western Jurassic belt are separated from the rocks of the Coast Ranges by a major fault (the South Fork Mountain Thrust fault).

4.2.1.1.2 Western Paleozoic and Triassic Belt

This belt is located to the east of the Western Jurassic belt and has been subdivided into at least three separate geologic terranes. Only one terrane (Rattlesnake Creek) occurs within the HPAs.

The Rattlesnake Creek terrane includes oceanic ultramafic rocks (i.e., gabbro), metasedimentary rocks (i.e., argillite, phylitte, conglomerate and metachert), vocaniclastic sediments, and mixed volcanic and metasedimentary rocks. In addition, the Western Paleozoic and Triassic belt contains extensive intrusions of post-accretionary dioritic and pre-accretionary ultramafic-gabbroic plutonic rocks. However, it is uncertain if any of these materials occur within the Original Assessed Ownership or elsewhere in the HPAs. The Western Paleozoic and Triassic belt is primarily located along the eastern margin of the Smith River HPA and is separated from the Western Jurassic Belt by a complex network of thrust faults.

4.2.1.2 Coast Range Province

As noted, the HPAs are located mostly within the Coast Range Province (see ***Figure 4.1***). The rocks of the Coast Range represent oceanic crust that was accreted to the continent beginning in the mid-Jurassic period (approximately 140 million years ago). Similar to the Klamath Province, the assemblages of the Coast Range terranes are fault bounded and exhibit a sequential east to west accretionary pattern.

4.2.1.2.1 Franciscan Complex

The Franciscan Complex includes three major belts: the Eastern, Central, and Coastal belts. Cashman et al. 1995 and McLaughlin et al. 2000 describe the rocks of these belts and the geologic terranes in further detail. In general, the most abundant types of rock units found within these terranes consist of layered and interlayered sequences of marine sandstone (i.e., greywacke sandstone), mudstone, and other common rock types such as schist, melange, serpentinite, chert, and conglomerate, basalt, and Coast Range ophiolitic rocks. Because the Franciscan Complex rock units vary greatly in lithology, structural style, and degree of metamorphism, the rocks in the complex are also described as belonging to a specific textural zone (Blake et al. 1967). It should be noted that some of the older geologic maps used to compile ***Figure 4-1*** did not differentiate the various units and textural zones. Thus, unless a unit is specifically called out on the map, the textural zones listed below may be included in the areas mapped as Franciscan Complex (KJf) and Franciscan Complex Sandstone (KJfss). The textural zones of the Franciscan Complex include the following:

- Franciscan Melange. The Franciscan Melange consists of discontinuous, resistant blocks of graywacke sandstone, chert, greenstone, and high-grade metamorphic rock in an intensely sheared, blue-gray shaley matrix. The texture of the unit may be related to mixing by either tectonic or sedimentary (mudslide) processes (Jordan 1978).

- Unmetamorphosed Franciscan Complex - Textural Zone 1. Textural Zone 1 consists of fine- to coarse-grained graywacke sandstone with interbeds of siltstone, shale and minor conglomerate. The rocks are olive to gray-green when fresh and weather to tan or gray-brown. Exposures are well-lithified and massive to thickly bedded. Subordinate rock types include chert, pillow basalt, and greenstone.

- Semi-Metamorphosed Franciscan Complex - Textural Zone 2. Textural Zone 2 consists of semi-schistose, lawsonite bearing graywacke sandstone and siltstone, similar to the rocks in Textural Zone 1. Platy foliation, visible in hand specimen, has developed, but original bedding is still present.

- Undifferentiated Franciscan Complex. Undifferentiated Franciscan Complex is mapped where the Franciscan has not been subdivided. It consists predominantly of fine- to coarse-grained dark gray to green graywacke sandstone and dark-gray shale. Subordinate amounts of red or green chert, conglomerate, pillow basalt, greenstone, and pods of serpentinized ultramafic rocks also occur within this unit.

- South Fork Mountain Schist - Textural Zone 3. The South Fork Mountain Schist is metamorphosed and sheared to the point where original bedding is no longer evident. The unit forms a sinuous belt of schistose metasedimentary and metavolcanic rocks next to the South Fork Fault, the unit’s eastern boundary.

4.2.1.2.2 Overlap Assemblage

Sedimentary deposits that formed in a variety of marine to non-marine environments overlie the late Cenozoic to late Mesozoic accreted terranes of the Franciscan Complex. These deposits (the Late Cenozoic post-accretionary Overlap Assemblage) are partly similar in age to the Franciscan basement rocks. However, the rocks are considerably less deformed, unmetamorphosed, and less lithified than the rocks of the Franciscan Complex (McLaughlin et al. 2000). The primary rock units that occur in the overlap assemblage are represented by the formations of the Wildcat Group and to a lesser extent the Bear River beds. In general, the Wildcat Group consists predominantly of a sequence of weakly to moderately well lithified marine sandstone, siltstone, mudstone, and non-marine sandstones and conglomerates. The Wildcat Group overlies older basement rocks of the Franciscan Complex and middle rocks that have been assigned to the Bear River beds (interbedded siltstone, sandstone) (McLaughlin et al. 2000).

4.2.1.3 Other Quaternary and Tertiary Overlap Deposits

Some rocks may occur within both the Klamath and Coast Range provinces. These rocks include units of unconsolidated or weakly consolidated materials such as terrace deposits, alluvial and colluvial materials, coastal sediments, and unusual occurrences of post-accretionary intrusive rocks (e.g., Coyote Peak diatreme).

4.2.1.3.1 Weathered Bedrock, Colluvium, and Soils

An overlying mantle of weathered bedrock and colluvial deposits is ubiquitous in the HPAs. Typically, the deposits are poorly consolidated, loose and moderately to well drained. The material is usually thickest toward the axes of swales and drainages and thinnest on the steeper side slopes where it has been shed off by erosion and shallow landsliding. The composition and thickness of the colluvial deposits and associated soils is variable and is related to the makeup and slope gradient of the underlying bedrock.

Thicker colluvium and soils typically reside in areas with gentle slopes where the bedrock is usually less indurated. Steeper slopes are generally covered by only a thin mantle (typically less than three feet thick) of colluvium. These slopes are usually underlain by hard, well-cemented materials (e.g., sandstone, siltstone), and the contact between the bedrock and colluvium is often sharp. The sharp contact is often accompanied by a permeability contrast between the two units that allows a seasonal perched water table to develop. The thin soil cover is a product of the inherent low rate of bedrock weathering and the steepness of the slope (which facilitates the shedding off of the unconsolidated surface material). The thin nature of the colluvial deposits overlying hard bedrock on the steeper slopes plays an important role in the style and distribution of shallow landslides and the potential effects of timber management.

4.2.1.3.2 Modern Alluvium

Scattered concentrations of modern alluvium occur along stream beds and inner and upper floodplains. The alluvial materials include boulders in creek bottoms, sand, pebbles, and cobbly gravel in inner floodplains and fine sand and silt loam in overbank deposits.

4.2.1.3.3 Stream Terrace Deposits

Deposits of moderately to intensely weathered alluvium are scattered throughout the HPAs. Mapable units have been noted in prominent terrace surfaces adjacent to Redwood Creek, and remnants of former terrace deposits have been mapped on gently sloping hillslopes near Redwood Creek (Harden et al. 1982). Late Quaternary fluvial terraces are found along well developed major rivers such as the Mad, Eel, and Van Duzen rivers.

4.2.1.3.4 Coastal Plain Sediments

Unconsolidated to weakly consolidated silts, sands, and gravels associated with minor amounts of organic-rich mud are located along the coastal plain.

4.2.1.3.5 Landslide Deposits

A number of landslide deposits and scars have been mapped within the Original Assessed Ownership and elsewhere in the HPAs (Harden et al. 1982). Many of the more prominent landslides may be correlated to terranes underlain by fault zones and specific rock units (e.g., the Incoherent Unit of Coyote Creek in the Franciscan Complex).

4.2.1.3.6 Tertiary Intrusive Rocks

The Central belt of the Franciscan Complex contains limited occurrences of (alkalic) intrusive volcanic rocks of unusual mineralogical composition. These intrusive bodies correspond in age to the Oligocene epoch (approximately 35 million years before) and occur at two localities northeast of Arcata. One of these localities, known as the Coyote Peak diatreme, is located within the Redwood Creek HPA.

4.2.1.4 Seismic Hazards, Faults, and Structural Relationships

Northern coastal California and the adjacent offshore area constitute one of the most seismically active areas in the State (Cashman et al. 1995). This entire area of northwest coastal California is subject to high hazard from potential earthquakes on several onshore faults and the region falls within the Cascadia subduction zone, an area thought to be capable of great (magnitude 8 to 9) earthquakes (CA DMG 1996). The high level of tectonic activity in the region is also attributed to the proximity of the Mendocino triple junction (McKenzie and Morgan 1969), located south of the planning area which separates three major crustal plates and is the northern terminus of the San Andreas Fault (see ***Figure 4-1***).

Several moderately active crustal faults (e.g., the Little Salmon, Mad River, Trinidad, and Fickle Hill faults) are located near or within sections of the Original Assessed Ownership. Faults that show evidence of recent (Quaternary) movement and faults that form the boundaries separating the major belts, terranes, and sub-terranes of the Klamath Mountains and Coast Range provinces are described below. Although most of these faults strike northwest, they exhibit a range of orientations from shallowly dipping to vertical and also represent different deformational episodes (Monsen, Alto, Cashman et al. 1980, 1982). In addition, the orientations of the region's faults and geologic terranes often mark contacts between distinctly different rock units that in-turn, strongly influence area topography and drainage patterns. The faults that exhibit evidence of recent activity may also delineate potential geologic hazard zones (i.e., the occurrence of high ground accelerations resulting from earthquakes on nearby faults may directly or indirectly result in slope failures).

The following faults exhibit evidence of recent movement and may be active:

- Patricks Point Fault. The Patricks Point fault is a northeast-dipping thrust fault located below the prominent raised marine terrace cut into the Falor and Franciscan rocks at Patricks Point. The terraces are interpreted to record fault bend folding of the hanging wall of a deeply buried, thrust above the fault. The length of the inclined segment of the Patricks Point terrace is about 2 kilometers (km). The fault bend fold model predicts this length should correspond with the total accrued slip on the buried fault, i.e., about 2.4 centimeters per year (Carver and Burke 1989).

- Mad River Fault Zone. The Mad River fault zone is a major zone of complex southwest verging thrust faults located in the vicinity of the Mad River northeast of Arcata Bay. There are five principle faults in the Mad River Fault zone including the Trinidad, Blue Lake, McKinleyville, Mad River, Fickle Hill, and numerous minor thrustfaults (e.g., Korbel and Falor faults). The faults of this zone have been shown to displace strata in the late Pleistocene to Holocene age (< 2 million years) and are thus active (McLaughlin et al. 2000).

- Freshwater Fault. The Freshwater fault is an east dipping, high angle reverse fault, which decreases in dip to the north. Movement on this fault was thought to have preceded Wildcat deposition (Ogle 1953), but recent studies show it to offset the Wildcat, suggesting late Cenozoic reactivation (Woodward-Clyde Consultants 1980).

- Little Salmon Creek and Yager Faults. The Little Salmon Creek fault a moderately low dipping southwest thrust fault zone located in the central Eel River basin south of Eureka. The fault zone cuts the surface and displaces Holocene (recent) age strata. The nearby Yager fault is interpreted to root in the same zone of thrusting as the Little Salmon Creek fault (McLaughlin et al. 2000). Data on slip rate and estimates on earthquake recurrence intervals indicate that the Little Salmon fault is active and capable of generating very large earthquakes.

- Russ and False Cape Fault Zones. The Russ fault zone juxtaposes Miocene and younger strata (<24 million years) of the Eel River forearc basin (i.e., overlap assemblage) with coeval and older strata of the underlying accretionary complex. The distribution of surface and subsurface earthquakes strongly suggest that the Russ Fault is active at shallow depths (McLaughlin et al. 2000).

The following faults show no evidence of movement during the Quaternary period:

- South Fork Fault. The South Fork Fault (Irwin 1974) a major east dipping fault, separates and thrusts the rocks of the Klamath Mountains over the rocks of the Eastern Franciscan belt of the Coast Range Province. Serpentinite and a zone of tectonically mixed rocks have been mapped in areas (e.g., in the Redwood Creek basin) immediately above the South Fork Fault (Young 1978).

- Indian Field Ridge Fault. The surface trace of the Indian Field Ridge fault is found to the west of the South Fork fault and is marked in places by narrow zone of unmetamorphosed pervasively sheared rocks (Cashman et al. 1995).

- Grogan Mountain Fault Zone. The steep northeast dipping Grogan Mountain Fault Zone delineates the channel of Redwood Creek. The zone is defined by an area of metamorphosed and pervasively sheared rocks and separates units of sandstone that mark distinct contrasts in surface topography (e.g., incoherent unit of Coyote Creek and coherent unit of Lacks Creek).

- Bald Mountain Fault. The Bald Mountain fault lies to the west of the Grogan fault and separates unmetamorphosed sandstone and melange units to the west from the metamorphosed units (schists) of the Grogan Fault zone to the east (Strand 1963).

- Snow Camp Creek Fault. The Snow Camp Creek fault is the only major east-west trending fault in the HPAs. The fault is located just south of Pardee Creek in the Redwood basin and it separates (Redwood Creek) schist units on the south from Franciscan sandstone and melange units to the north (Harden et al. 1982).

4.2.1.5 Geologic Profile of the HPA Groups

As noted in Section 1, the 11 HPAs are divided into four HPA Groups for purposes of the applying the initial default slope stability conservation measures (see Section 6). Table 4-1 lists the groups, the HPAs in each group and the dominant bedrock types in each HPA Group. A brief description of each HPA Group follows the table. The geologic features and conditions of the individual HPAs are described in Section 4.4.

Table 4-1. Bedrock types within HPA Groups.

HPA Group	HPAs Included in Group	Bedrock Types in HPA Group
Smith River	Smith River	Central Belt Franciscan and minor amounts of Western Jurassic Belt of the Klamath Mountains Province.
Coastal Klamath	Coastal Klamath Blue Creek	Central Belt Franciscan, Western Jurassic Belt (Klamath Mountains province), and minor amounts of Eastern Belt Franciscan Complex and Western Paleozoic and Triassic Belt of the Klamath Mountains Province.
Korbel	Redwood Creek Coastal Lagoons Little River North Fork Mad River Mad River Interior Klamath	Central Belt Franciscan Complex and limited amounts of Eastern Belt Franciscan, Wildcat Group (equivalent), and Western Jurassic Belt of the Klamath Mountains Province
Humboldt Bay	Humboldt Bay Eel River	Wildcat Group, Yager Terrane, and minor amounts of Central Belt Franciscan Complex.

4.2.1.5.1 <u>Smith River HPA Group</u>

The Smith River HPA Group is bisected by the South Fork Mountain Thrust (The Coast Ranges Thrust), which separates Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. Both of these geologic terranes underlie Green Diamond's ownership in the Smith River HPA. The Franciscan Bedrock is composed of a mixture of sandstone and mudstone and the Klamath Mountains Bedrock is composed of volcanics and ultramafic intrusive rocks.

4.2.1.5.2 <u>Coastal Klamath HPA Group</u>

The Coastal Klamath HPA Group is bisected by the South Fork Mountain Thrust (The Coast Ranges Thrust), which separates Franciscan Central Belt from the Klamath Mountains and Eastern Franciscan Belt bedrock. Most of the Original Assessed Ownership within the Coastal Klamath HPA Group is underlain by undifferentiated Central Belt Franciscan Complex sandstone and mudstone. The South Fork Mountain Schist of the Eastern Belt Franciscan Complex and volcanic and ultramafic rocks of the Western Jurassic Belt of the Klamath Mountains province underlie smaller portions of the Original Assessed Ownership. The steep topography of the two HPAs is a distinguishing landscape characteristic and a primary reason for their grouping.

4.2.1.5.3 Korbel HPA Group

The Korbel HPA Group is located entirely within the Coast Ranges province and is transected by numerous faults, including the Mad River Fault Zone (MRFZ), the Bald Mountain Fault, the Grogan Fault, and the South Fork Fault, which separates the Coast Range province from the Klamath Mountains province. Franciscan Central Belt and Eastern Belt Bedrock comprised of sandstone, mudstone, mélange, and schist underlies most of the Korbel HPA Group. Limited occurrences of Wildcat Group equivalent and younger bedrock is found within the MRFZ and along the coast of the Korbel HPA Group. Limited occurrences of volcanic and ultramafic rocks of the Western Jurassic Belt of the Klamath Mountains province are found at the eastern margin of the Interior Klamath HPA.

4.2.1.5.4 Humboldt Bay HPA Group

The Humboldt Bay HPA Group is located entirely within the Coast Ranges province and is transected by numerous fault zones, including the Freshwater Fault, Little Salmon Fault, and Russ/False Cape faults. The eastern portion of the region is underlain by sandstone and melange associated with the Central belt of the Franciscan Complex. The Freshwater fault delineates the western boundary of the Central belt and separates it from the rocks of the Wildcat formation (Overlap Assemblage), and the Yager Terrane (argillite, shale, sandstone and conglomerate associated with the Coastal belt of the Franciscan Complex). The Russ/False Cape fault zone roughly delineates the southern boundary of the region, and also separates the Pliocene/Pleistocene materials from a strip of Coastal belt (Yager terrane) rock located just within the southern margin of the region. Most of Original Assessed Ownership in this HPA Group is underlain by the Wildcat Group geologic units.

4.2.2 Landform Development

The topography of the HPAs is highly variable and consists of landforms ranging from steep terrain with deeply incised narrow drainages to rolling landscape with less deeply incised drainage networks. As noted, the region has experienced high rates of Neogene uplift, deformation, and accompanying channel down cutting. Parallel to these processes, the area has experienced relatively high denudation rates, and the upper reaches of many drainages have been sculpted over geologic time by repeated shallow landslides. At present, landslides are common throughout the area and continue to be a major force shaping the modern landscape.

In addition to mass wasting and erosional processes, a dominant factor controlling the variation in topography is the underlying rock mass and associated geologic structure. According to McLaughlin et al. 2000, rock masses larger than a few hundred meters in diameter tend to develop topographic forms related to the erosional and slope-stability properties of the constituent materials. These properties may be controlled by many factors, such as the structural state of the rock mass and orientation of layering. Rates of tectonic uplift may also play a role in the development of topographic form. However, geodetic work indicates that these rates tend to vary gradually and impact broad regional areas rather than more localized areas (e.g., subunits of specific rock terranes located within individual hydrographic planning areas) (McLaughlin et al. 2000).

The spatial variation in dominant rock units or geologic groups in the HPAs is evident in the expression of the local topography. In addition, the contact between the rock units and overlying soil is gradational and varies according to rock unit and topography. The major rock types and associated soils and landforms are as follows:

- Well indurated sandstone rock masses weather to granular (sandy and silty) soil that is stable enough to form steep slopes. The stability and homogeneity of such soils and rock masses tend to result in steep, sharp-crested topography dissected by a regularly spaced array of straight, well-incised sidehill drainages (McLaughlin et al. 2000).

- Units containing unconsolidated and poorly indurated sandstone rock masses rapidly weather when disturbed and are highly unstable. These units tend to form a thick cover of sandy and silty soils, support only gentle hillslopes and poorly incised sidehill drainages, and crests tend to be rounded (Bond, pers. comm.).

- Highly folded broken formations that also include zones of clayey sheared argillitic rock generally correspond to steep topography with generally sharp crests and well-incised but irregular sidehill drainages (McLaughlin et al. 2000).

- Units containing melange with subequal amounts of sandstone and argillite or units that are predominantly made up of argillitic sequences that are highly folded and variably sheared generally have irregular, gently to moderately sloping topography that lacks a well-incised system of sidehill drainages (McLaughlin et al. 2000). Melange areas typically support grassland prairie zones, which are susceptible to gully erosion, especially where overgrazing has increased runoff and road construction has disturbed the natural drainage channels. Although commercial timber grows on land underlain by melange, many such areas were converted to grassland, after harvest and have not produced new timber growth (CA DWR 1982).

- Clayey rock masses, especially where sheared, weather to clayey soil materials. These clayey soils and bedrock are so weak that they can support only gentle hillslopes and poorly incised sidehill drainages, and crests tend to be rounded (Kelsey et al. 1995; McLaughlin et al. 2000).

- Well-indurated rock masses associated with the terranes of the Klamath Mountains province result in very steep, sharp-crested topography. These units typically are overlain by thin soils and are dissected by straight, well-incised sidehill drainages.

4.2.3 Landslide Classifications

Many types of mass movement occur within the Coast Range and Klamath Mountain provinces. As noted, landslides are common throughout the area. Intense and prolonged rainfall events, combined with area geology, geomorphology, and timber harvesting activities often result in conditions that are highly susceptible to excessive erosion and landslides, especially when high antecedent groundwater conditions exist. Types of landslides in the Original Assessed Ownership and elsewhere in the HPAs are described below based on the classifications in Crudden and Varnes (1996) and DMG Note 50 (CDMG 1997) with modifications to suit the conditions present.

4.2.3.1 Shallow-Seated Landslides

Shallow-seated landslides are generally confined to the overlying mantle of colluvium and weathered bedrock but in some instances also may involve competent bedrock. Most shallow landslides are rapid events and commonly leave a bare unvegetated scar after failure.

4.2.3.1.1 Debris Slides

Debris slides are characterized by a process whereby unconsolidated rock, colluvium, and soil have failed rapidly along a relatively shallow failure plane. In most instances the depth of failure is less than 10 feet. In some instances, however, a debris slide may extend deeper and incorporate some of the underlying competent bedrock. Debris slides often form steep, unvegetated scars in the head region and irregular, hummocky deposits in the toe region. Slide debris often overrides the ground surface near the toe. Debris slides may exist individually or coalesce to form a larger landslide complex. Slides often continue to move for several years following initial failure. Most natural debris slides are triggered by elevated pore water pressures resulting from high intensity and/or long duration rainfall or from being undercut by stream erosion. The occurrence of high ground accelerations resulting from earthquakes on nearby faults may also result in shallow slope failures either directly or indirectly by reducing soil strength and altering the groundwater regime. In many managed watersheds, a common cause of debris slides is thick, over-steepened road fill associated with old roads, skid trails, and landings that generally predate current FPRs.

4.2.3.1.2 Debris Flows/Torrents

Debris flows and debris torrents are characterized by long stretches of bare soil and generally unstable channel banks that have been scoured by the rapid movement of debris. Failure typically begins as a debris slide but quickly mobilizes into a flow or torrent as material liquefies, traveling rapidly downslope. These landslides occur most commonly on very steep slopes at or near the axis of small swales or stream channels. As a debris flow/torrent moves through first and second order channels, the volume of material may increase to a much greater size than the initial failure. It is not unheard of for a large debris torrent to deliver over ten thousand cubic yards of sediment to a stream channel.

4.2.3.1.3 Channel Bank Failures

Channel bank failures are defined as small shallow debris slides that occur along the banks of stream channels. Such failures are a result of undercutting of the stream bank by stream incision or stream widening. Large channel bank failures that extend far up an adjacent hillslope may become difficult to distinguish from debris slides. Because such failures are relatively common along streams they have been classified separately from the other failures.

4.2.3.1.4

Rock Falls

Rock falls are characterized by catastrophic failure of relatively steep rock slopes or cliff along a surface where little or no shear displacement takes place. Generally rock debris accumulates at the toe of the slope. Rock falls are relatively uncommon in the planning area.

4.2.3.2 ***Deep-Seated Landslides***

Deep-seated landslides typically have a basal slip plane that extends into bedrock. Most deep-seated failures move incrementally; catastrophic failure is relatively rare. Active slides are typically vegetated with trees and/or grass.

4.2.3.2.1 Translational/Rotational Rockslides

Translational/rotational rockslides are characterized by movement of a relatively intact slide mass with a failure plane that is relatively deep when compared to that of a debris slide. The slide plane typically extends below the colluvial layer into the underlying and more competent bedrock. The slides often have a distinct toe at the base of the hillside and undercutting of the toe of the slope by streams plays a key role in their long term stability. Translational/rotational rock slides are identified by a broad arcuate headscarp and a series of mid-slope benches on what is otherwise moderately to steeply sloping terrain. Sag ponds, hummocky topography and springs and patches of wet ground may be present. Commonly the landslide consists of several smaller slide blocks that coalesced together to form the larger landslide complex. Lateral scarps between the individual landslide blocks are often poorly defined, in part due to the low rate and/or infrequent movement of the slide mass. Differential movement between individual slide blocks is common. Where slide movement is most active, drainage networks and stream channels are shallow and generally poorly to moderately defined. Movement is most apparent in the upper portion of the hillside and less apparent near the toe. Steep main scarps, secondary internal slide scarps, and toe slopes may be subject to debris sliding.

4.2.3.2.2 Earthflows

Earthflows are characterized by a relatively large semi-viscous and highly plastic mass resulting in a slow flowage of saturated earth. Most earthflows are comprised of a heterogeneous mixture of fine-grained soils and rock. Earthflows may range from less than one acre to hundreds of acres. The depth of failure is varied but typically greater than 15 feet and the degree of activity is varied: many earthflows are dormant while others exhibit seasonal creep in response to high rainfall. Rapid movement of such failures is rare. Ground displacement is generally slight, and catastrophic failure of the slope is unlikely. Slide materials erode relatively easily, result in gullying and irregular drainage patterns, and may be reactivated in response to removal of toe support, high rainfall events, and possibly by large seismic events. Because of the seasonal movement associated with some of these slides, earthflow areas often are unable to support forest stands. Small earthflows may be influenced by poor road drainage across the toe of the slide.

4.2.4 Landslide-Prone Terrains

Both deep and shallow landslides occur within the Original Assessed Ownership and elsewhere in the HPAs, with shallow landslides most common on slopes steeper than 60% to 70%. In general, steep streamside slopes, inner gorge slopes, steep headwall swales, and breaks-in-slopes have been identified as being potentially higher risk areas for producing shallow landslides compared to adjacent slopes. Landslides are also more frequent in areas of convergent slope form where surface and ground waters tend to concentrate and where colluvial soils tend to be thickest. The most prevalent landslide-prone terrains are described below.

4.2.4.1 Steep Streamside Slopes

Steep streamside slopes are defined as steep slopes located immediately adjacent to a stream channel, and generally formed, over time, by coalescing scars from shallow landsliding and stream erosion. These slopes typically exceed 65% gradient where stream incision has undercut the toe of the slope, and descend directly to streams without intervening topographic benches. Preliminary landslide inventories in the planning area indicate that roughly 60% to 90% of all shallow landslides initiate on steep streamside slopes. All steep streamside slopes show evidence of modern landslide processes (less than 50 years old) when slopes are examined on a sub-basin level.

4.2.4.2 Inner Gorge

An Inner Gorge is a subset of steep streamside slopes where a more-or-less distinct break-in-slope separates steeper “Inner Gorge” slopes below the break-in-slope from lower gradient slopes above the break. The steep streamside slopes classification includes Inner Gorge slopes as well as those steep slopes where a distinct break-in-slope is absent.

4.2.4.3 Headwall Swales

Many shallow landslides occur within headwall swales upstream of Class III watercourses, where convergent topography forces both the accumulation of thick soils and the concentration of shallow subsurface runoff along the axis of the valleys. Headwall swales are characterized by areas of narrow, steep, convergent topography (swales or hollows) located at the heads of Class III watercourses (i.e. an unchanneled swale extending upstream of a watercourse) that have been sculpted over geologic time by repeated debris slide and debris flow events. The sideslopes leading into the swale are typically greater than 70%. Slopes are often smooth to slightly irregular, unbroken by benches. Swales often have an inverted teardrop or spoon shaped appearance. Seasonal seeps, springs and wet areas may exist within the axis of the swale toward the base. The soil and colluvium depth is often much deeper within the axis of the swale than on the adjoining side slopes. The surface expression of the swale may be distinct to subdued. The width of headwall swales is highly variable ranging between 30 and 100 feet.

4.3 METHODS AND RESULTS OF STUDIES IN THE ORIGINAL ASSESSED OWNERSHIP

This Section summarizes the methods and results of various studies conducted by Green Diamond and others to collect and analyze information about the condition of aquatic habitats and the occurrence of Covered Species in the Original Assessed Ownership and provide a basis for analyzing other commercial timberlands in the Eligible Plan Area. The Original Assessed Ownership in the 11 HPAs is depicted in ***Figure 1-1*** and constitutes approximately 99% of the Initial Plan Area as estimated in Section 1 (see Table 1-1). Additional details regarding the objectives, methods, results, discussions, and conclusions of the studies are presented in Appendix C.

Except as noted, all studies summarized in this subsection were conducted on the Original Assessed Ownership in the 11 HPAs. Some of these studies also extended into areas outside the 11 HPAs, but only data and analysis for lands in the HPAs are presented here.

4.3.1 Water Temperature Monitoring

Stream water temperature monitoring has been conducted in the Original Assessed Ownership since 1994. Presently there are two water temperature-monitoring programs: general water temperature monitoring in Class I and II watercourses, and a modified before-after-control-impact (BACI) study of water temperatures Class II watercourses (see Appendix C5.1 and C5.2 for details).

4.3.1.1 General Water Temperature Monitoring

The general water temperature monitoring program is designed to:

- Determine the seasonal temperature fluctuations for each monitored site; :
- Document the highest 7-day moving average (7DMAVG) of all recorded water temperatures;
- Document the highest 7-day moving average of the maximum daily (7DMMX) water temperatures; and
- Identify watercourse reaches with temperatures that have the potential to exceed the MWAT temperature monitoring thresholds relative to the drainage area above the monitoring site.

By the end of 2000, Green Diamond had recorded and/or collected 400 temperature profiles in approximately 108 Class I watercourses and 210 temperature profiles in approximately 70 Class II watercourses. The data from these profiles were used to calculate the 7DMAVG, 7DMMX, absolute maximum, the minimum temperature following the maximum temperatures, as well as the associated dates of occurrence. Various attributes have been collected for many of these monitoring stations, specifically watershed area. The summary of the 7DMAVG water temperature for each stream monitoring site in relation to the square root of its watershed area above the monitoring site is shown in Figure 4-2.

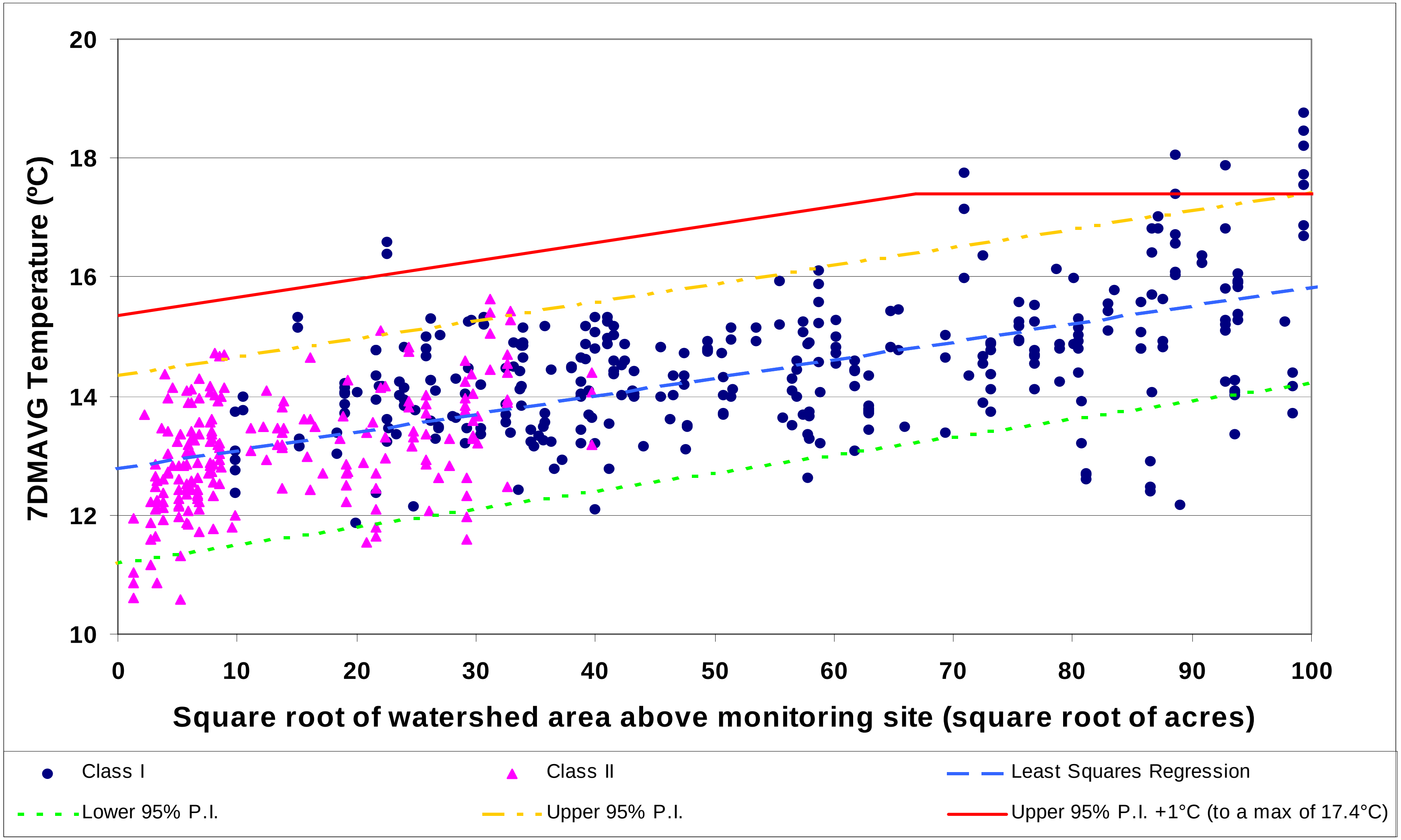


Figure 4-2. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the 11 HPAs monitored between 1994 and 2000.**

Of the 400 Class I temperature profiles, 375 (93.8%) were at or below the suggested MWAT threshold of 17.4 °C in the Aquatic Properly Functioning Condition Matrix (NMFS 1997). Green Diamond believes that the single MWAT threshold value of 17.4 ºC fails to account for natural variations in water temperature due to geographic location, climatic factors and drainage area of the monitored sub-basin. For this reason, future water temperatures will be evaluated based on the yellow and red light thresholds that were developed for this Plan (see below for brief description of the thresholds; see Section 6 for detailed description and discussion). Exceeding a yellow light temperature threshold would result in an internal review by Green Diamond to determine causes and management actions that may be necessary to rectify elevated water temperatures if practicable. Similarly, exceeding a red light threshold would result in a review by NMFS, USFWS, and Green Diamond to determine causes and management actions that may be implemented to rectify excessive water temperatures. As discussed below, the expected temperature threshold for a monitoring site will be based on its watershed size rather than a generic threshold value applied equally to all streams.

To develop a relationship between water temperature and watershed drainage area, Green Diamond regressed water temperature on the square root of drainage area at locations known to support populations of southern torrent salamanders, tailed frogs, or coho salmon. The relationship of water temperature and watershed area was examined to help account for the observed natural variation in water temperature. Furthermore, and to establish biological objectives and threshold values, Green Diamond used the upper 95% prediction interval (PI) of individual sample sites as the yellow light threshold for drainages up to approximately 10,000 acres (=100 acres squared). (A prediction interval is based on the probability that a sample point will occur within a specified interval.) One degree above the upper 95% PI was set as the red light threshold until a maximum of 17.4 °C was reached. These monitoring thresholds are shown on Figure 4-2. It should be noted that using the regression of water temperature versus drainage area to establish biological objectives and threshold values was only intended to apply to 4th order or smaller streams that generally occur in drainages less than 10,000 acres. As indicated in Figure 4-2, the red light threshold was exceeded 11 times in 5 different locations over the monitoring period (1994-2000). The streams, years, and size of watershed where the red light threshold was exceeded are as follows:

- Coyote Creek (Redwood Creek HPA); Year: 2000; Watershed area: 5,025 acres.
- Lower Cañon Creek (Mad River HPA); 1996 through 2000; 9,869 acres.
- Middle Cañon Creek (Mad River HPA); 2000; 8,620 acres.
- Salmon Creek (Humboldt Bay HPA); 1997 and 1998; 7,858 acres.
- Stevens Creek (Eel River HPA); 1999 and 2000; 506 acres.

As part of the implementation of this Plan, Green Diamond will continue to evaluate these monitoring sites as outlined in Section 6.2.5.

4.3.1.2 Class II BACI Study

The Class II BACI study was initiated in the summer of 1996 to examine the adequacy of riparian buffers in maintaining water temperatures following timber harvest. Streams in five areas where timber harvest was planned were identified and paired with separate streams in close proximity that have similar size, streamflow, aspect, elevation, stand type, stand age, and streambed geology. The stream running through a harvested area was designated as the “treatment” site. The other stream of each pair was designated as the “control” site. The five pairs selected in 1996 include:

- One pair in the headwaters of Dominie Creek (D1120) in the Smith River HPA ;
- One pair of tributaries to the South Fork Winchuck River (D1120 in the Smith River HPA ;
- One pair in the headwater tributaries of the Little River (Mitsui) in the Little River HPA;
- One pair off the mainstem Mad River in the Mad River HPA; and
- One pair in the headwater tributaries of Dominie Creek in the Mad River HPA.

In 1999, three pairs were added to the study:

- Two pairs of tributaries to Maple Creek (Windy Point and M1) in the Mad River HPA; and
- One pair of tributaries to the Lower South Fork Little River (M155) in the Little River HPA.

At least one year prior to timber harvest, paired temperature-recording devices (HOBO’s® or TitBiTs®) were placed in the treatment stream at the upstream and downstream edges of the harvest unit. At the same time, another pair of temperature recording devices were placed in the control stream at locations which are the same (stream) distance apart as the recording locations in the treatment stream. The paired thermographs were deployed to all streams in middle and late spring each year and collected after 15 September each year. The upstream and downstream placement of temperature recording devices allowed measurement of temperature differential across the treatment area and an assessment of the extent to which water temperature changed as it flowed through the treatment area. Interest is primarily in the amount of warming water experiences as it flows through the treatment area. Ground water inputs, climate, and microclimatic factors can all affect water temperature and consequently the paired stream design was adopted. Data collection from each pair began when the thermographs were placed (at least one year prior to timber harvest) and will continue for at least three years after harvest or until the temperature profile of each pair returns to the pre-treatment pattern.

Following data collection, a modified BACI analysis will be used to assess harvest impacts. BACI analyses assess the lack of parallelness in response profiles through time. This lack of parallelness is measured by the treatment by time (year) interaction from an ANOVA with time as one factor and treatment as the other. The BACI analysis allows the level of responses to be different between control and treated sites both before and after treatment, but requires the after treatment difference in control and treated responses to be the same as the before treatment difference in control and treated responses. If the after treatment difference in responses is different from the before treatment difference in responses, the BACI analysis will conclude that there was significant change in treatment areas after application. Inference as to the cause of treatment differences will be a professional judgment based on a preponderance of evidence. Each site also will be analyzed separately so no statistical inference to other sites is possible.

The study is still in its data collection phase on pairs where the treatment site was harvested after 1999 or have yet to be harvested. However, as described in more detail in Appendix C5.2, a preliminary analysis has been conducted of data from four pairs harvested before 1999 (Mitsui, D2010, 6001, and 5410). In general, the analysis indicates that all of the treatment streams showed a significant change in water temperature relative to the controls streams following timber harvest. However, the treatment streams were warmer in two pairs and colder in the other two. There are no other data to help provide clues as to why these sites responded in opposite directions to timber harvest, but Green Diamond speculates that it may be due to altered hydrology. Clearcutting adjacent to a stream should increase the amount of water that is retained in the soil for a few years following harvest primarily due to a reduction of evapotranspiration water losses. If some treatment streams had groundwater inputs while others did not, it would be possible that the increased groundwater could result in relatively cooler water temperatures following harvest in those treatment streams with groundwater inputs. Those treatment streams without significant groundwater inputs would have the greater potential to experience increases in water temperature following harvest. If this pattern persists in additional monitored sites, one would conclude that the cumulative effect of timber harvest on water temperature in small Class II watercourses within a watershed should net to zero.

The Class II BACI study will continue under the Plan, as described in Section 6.2.5.

4.3.2 Channel and Habitat Typing Assessments

A total of 58 streams were assessed between 1994 and 1998. Channel and habitat typing assessments were conducted using the CDFG methods described by Flosi and Reynolds (1994). Green Diamond assessed sixteen streams for a total of over 94 miles of stream channel (see Appendix C1). An additional 42 streams (135 miles of channel) were assessed by the following organizations:

- Yurok Tribal Fisheries Program (1996-1998) - 31 streams
- California Conservation Corp (1995) - 3 streams
- Louisiana Pacific Corporation (1994) - 4 streams
- California Department of Fish and Game (1991 and 1998) - 4 streams

Tables C1-1 through C1-8 in Appendix C1 identify the assessed streams; also see the HPA assessments in Section 4.4.

To summarize, compare, and assess stream channel and habitat parameters, channel and habitat typing variables were plotted against stream watershed area. The watershed area was determined at the midpoint of the surveyed reach of each stream. The dry sections of channel in the lower portion of the watershed were not included in the overall stream length. The midpoint of the wetted channel length normalizes the stream size based on the relative position in the watershed where the survey occurred and the mean values of interest.

To allow for a comparison of pool tail-out embeddedness between streams, a stream gradient was determined from the channel types. Each channel type has a delineation criteria based on a range of channel gradients (see Appendix C1). To derive an average stream gradient, the mean gradient of each channel type criteria was weighted according to the length of each channel type. The least squares regression for variables also was calculated (for comparison purposes only, not for statistical analysis). The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs. The R^2 and p values are also shown on the figures in Appendix C1.

The results of these assessments are summarized below and depicted in Figure 4-3 (A-F).

- Mean canopy closure for the assessed streams ranged from 36-99% with an inverse relationship between water temperature and watershed area. Of the assessed streams, 69% had a mean canopy closure greater than or equal to 80% (Figure 4-3 [A]).

- Percentage of conifer canopy cover for the assessed streams ranges from 2% to 77% (Figure 4-3 [B]). Deciduous trees dominate the riparian canopy along the assessed streams, with 67% containing less than 20% conifers along the riparian margin. The percentage of conifer canopy increases slightly with increased stream watershed area.

- Percentage of total stream length in pools varies from 4% to 81% in the assessed pools and is particularly variable in streams with watershed areas less than 5,000 acres (Figure 4-3[C]).

- Percentage of LWD as structural shelter in pools ranges from 0% to 55% in the assessed streams (Figure 4-3 [D]). In streams with watershed areas less than 5,000 acres, the percentage varies greatly (0% to over 50%). In streams with watershed areas greater than 5,000 acres, the percentage is much lower on average than in streams with smaller watershed areas.

- Maximum residual pool depth, which is used to classify primary pools, is shown for the assessed streams in Figure 4-3[E]. The average for all 58 streams is approximately 2 feet. The streams with larger watershed areas have deeper pools than those with smaller watershed areas.

- Most of the assessed streams are 3rd order or less and in small drainages. A primary pool in a 3rd order or larger stream would be expected to have a depth of 3 feet or greater. However, pools with residual depths greater than 2 feet also may act as primary pools (i.e., provide temperature refugia and function as summer habitat for juvenile salmonids during low flow conditions).

- In 41 (71%) of the assessed streams, more than 40% of the pools have residual depths greater than 2 feet. In 14 (24%) of the assessed streams, more than 40% of the pools have residual depths greater than 3 feet. The estimated embeddedness index values for the assessed streams generally is within a range of 2 to 3 (>26% < 75% embedded), regardless of stream gradient (Figure 4-3 [F]). On the average, the embeddedness index rating diminishes slightly for streams with larger watersheds.

In summary, the assessed streams with greater watershed areas tend to have less canopy closure but a greater percentage of conifer canopy than those with smaller watershed areas. Pools within streams with smaller watersheds have a greater percentage of LWD as structural shelter than streams with larger watershed areas. The average maximum pool depth increases and pool tail-out embeddedness decreases as the watershed area increases.

4.3.3 LWD Assessments

LWD assessments were conducted on 20 streams: 16 streams were assessed by Green Diamond, and 4 were assessed by Louisiana Pacific (LP). In addition, a cooperative effort by Redwood National Park and NMFS inventoried in-channel LWD in 4.3 miles of Prairie Creek in Prairie Creek State Park (Redwood Creek HPA). Prairie Creek is considered to be the best remaining example of a relatively undisturbed watershed dominated by old growth redwood forest.

Green Diamond's LWD surveys were conducted in 1994 and 1995 using CDFG methods (Flosi and Reynolds 1994) The surveys applied a 20% sampling approach and covered two zones: the bank-full discharge area of the stream channel and the "recruitment" zone. LP's LWD inventory for Little River and three of its tributaries was conducted in 1994 and used a 100% approach. This inventory tallied all in-channel pieces of LWD within the bank-full margins; no riparian or recruitment zone inventories were conducted. To address potential differences in methodologies used for the assessed streams, Green Diamond conducted a 100% inventory on all of the streams surveyed in 1995 while simultaneously using CDFG 20% sampling approach. This allowed for a direct comparison of the CDFG methodology to a known inventory and allowed for a determination of the accuracy of a 20% sample. The Prairie Creek inventory was conducted in 1999 using a 100% approach. It is considered a true piece count and can be directly compared to both the CDFG 20% samples and the 100% inventories. The details of the investigations are presented in Appendix C2, with the names of the assessed streams identified in Tables C2-1 through C2-14. The results of are summarized below and shown in Figure 4-4 (A-C) in terms of mean values for the length of stream surveyed.

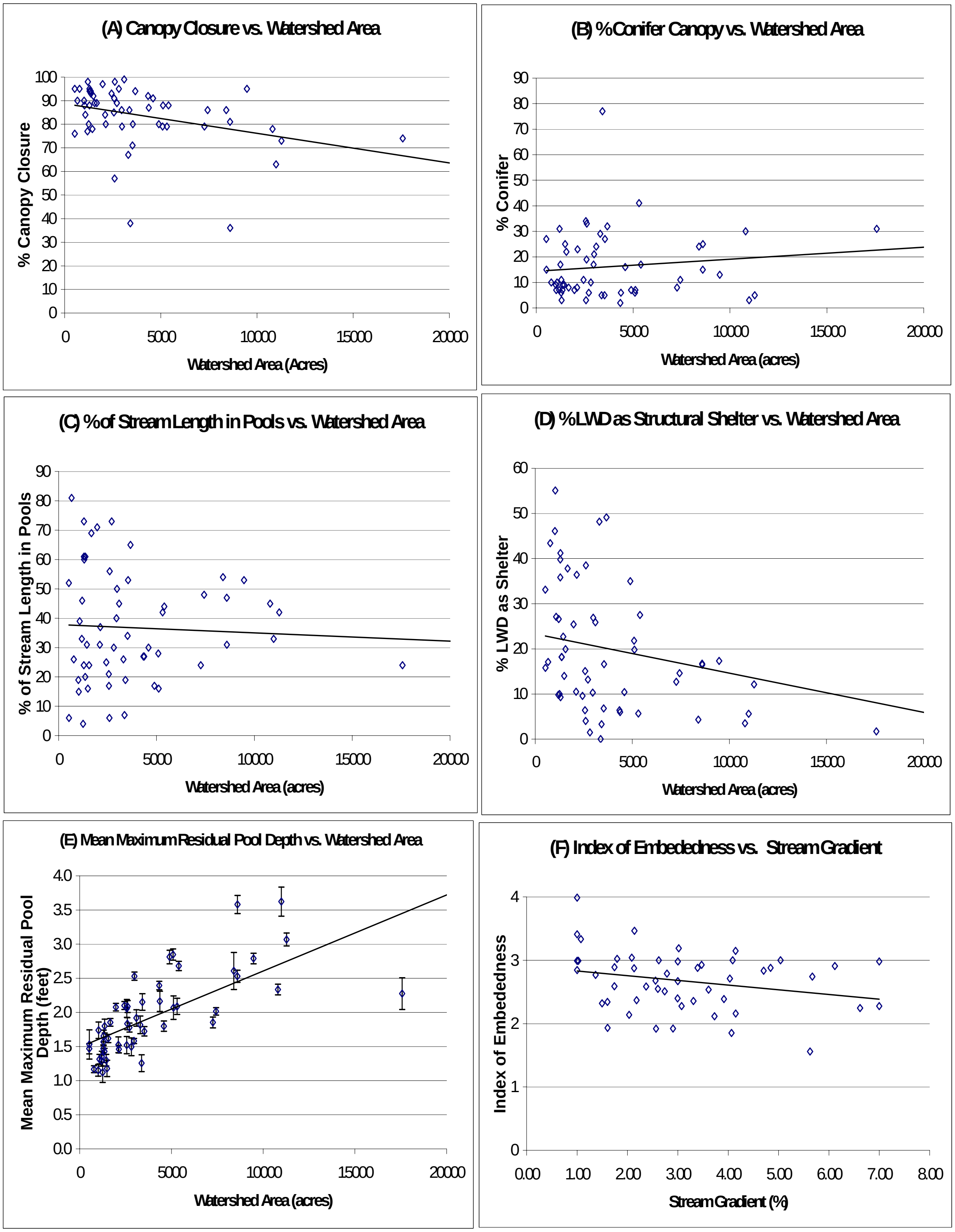


Figure 4-3. Channel and habitat types in 58 streams in the 11 HPAs assessed between 1994 and 1998. (Watershed area measured at the midpoint of the surveyed reach. Bars represent plus or minus one standard error. Stream gradient determined based on channel type and length.)

Figure 4-4 (A) and (B) show in-stream LWD pieces per 100 feet of channel and LWD volume index versus watershed area of the surveyed streams. The watershed area was determined at the midpoint of the surveyed reach of each stream. The dry sections of channel in the lower portion of the watershed were not included in the overall stream length. The midpoint of the wetted channel length normalizes the stream size based on the relative position in the watershed where the survey occurred and the mean values of interest.

- As seen in Figure 4-4(A), the number of in-stream pieces of LWD per 100 feet of channel in the assessed streams diminishes as watershed area increases. The streams with watershed areas similar to Prairie Creek have on average 4-5 pieces of LWD per 100 feet of channel (approximately 30% less than the nearly 7 pieces per 100 feet for Prairie Creek).

- As seen in Figure 4-4 (B), the LWD volume index for the assessed streams diminishes as watershed area increases and, for streams with comparable watershed areas, is approximately two-thirds of that for Prairie Creek.

- For the 16 streams where recruitment zone surveys were conducted, s the number of LWD pieces in the riparian zone ranged from less than 4 to greater than 12 pieces per 100 feet of channel (Figure 4-4(C)).

In summary, the occurrence of larger in-channel pieces of LWD is lower in the 20 assessed streams than in Prairie Creek. Several of the assessed streams had average overall piece counts per 100 feet within specific size categories that approached or exceeded the values seen in Prairie Creek. However, the piece lengths in the 20 streams were shorter than the piece lengths in Prairie Creek, especially in similar channel types.

In the 20 assessed streams, most of the larger diameter LWD was either: 1) old-growth root wads with little or no bole attached to them, or 2) in-stream restoration projects consisting of short, stubby pieces of cull logs anchored to bedrock, boulders, or riparian trees. Both of these types of LWD often provide marginal habitat compared to intact trees recruited from the riparian zone. Old-growth redwood rootwads contain fairly large volumes of wood, yet their short length provides minimal surface area for capturing and retaining additional LWD to form complex salmonid habitat. The short length of these rootwads also increases their likelihood of mobilizing during moderate storm events (as occurred during the winters of 1995-96 and 1996-97).

LWD within Plan Area streams will be reassessed periodically during the 50-year life of the Plan with the objective of documenting changes in conifer piece frequency, size, and functionality. Conditions can be expected to gradually improve as a result of current FPRs and the increased riparian standards implemented under the Plan. The hardwood dominated riparian zones now prevalent in the Original Assessed Ownership in the 11 HPAs will eventually be succeeded by redwoods and other conifers, resulting in increasing recruitment of large diameter LWD for Plan Area streams.

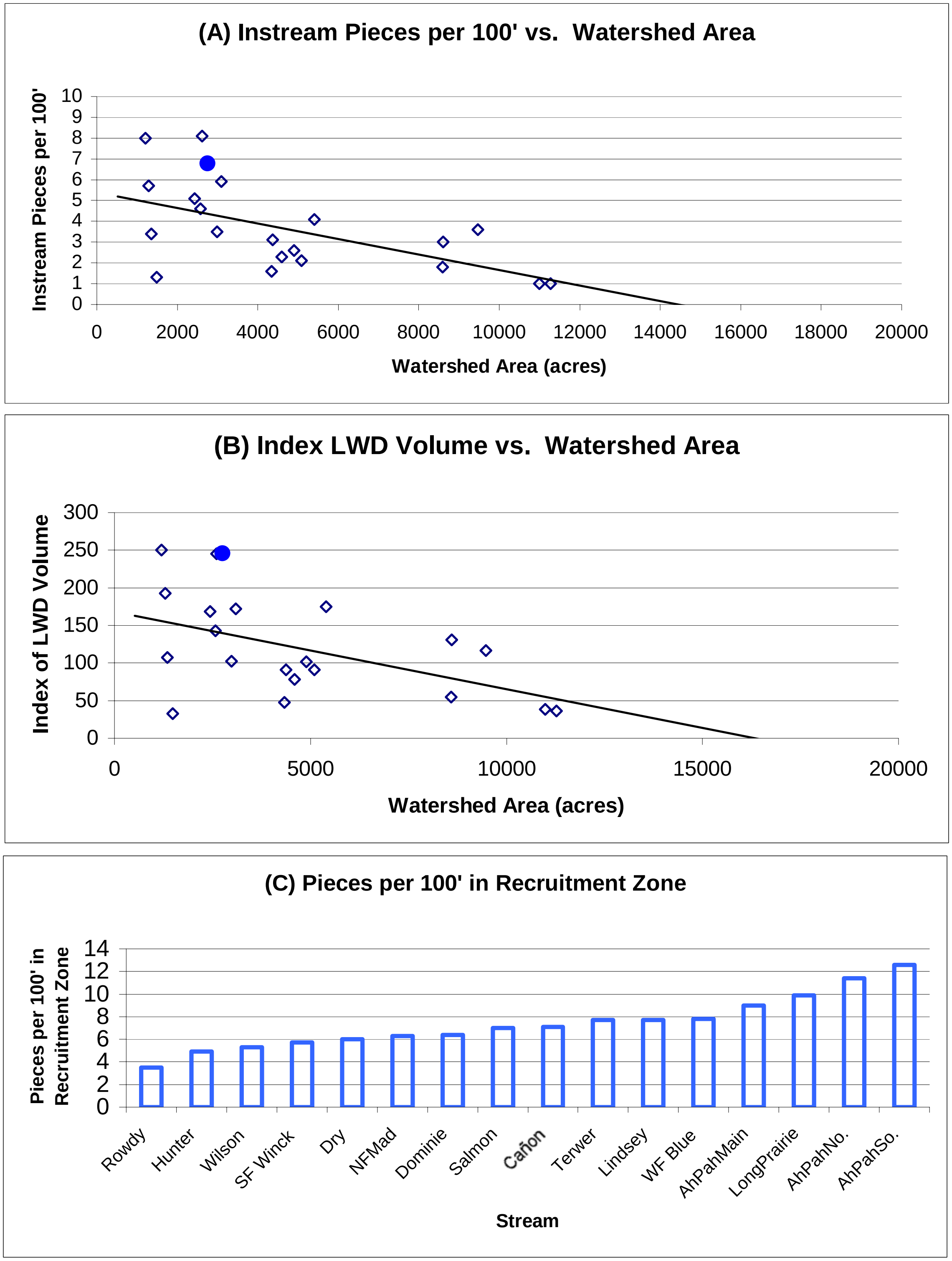


Figure 4-4. **LWD survey results for 20 streams in the 11 HPAs assessed between 1994 and 1999. (Watershed area measured at mid-point of surveyed reach. Open diamonds are the assessed streams. Large circle indicates comparable data for Prairie Creek.)**

4.3.4 Class I Channel Monitoring

Green Diamond is monitoring representative stream reaches on its ownership in the HPAs to capture specific channel responses to significant hydrologic events (and possibly management activities). Only variables that are independent of flow are measured. The protocol was implemented first on Cañon Creek (a tributary in the Mad River HPA) in 1995. During 1996, the Cañon Creek site was monitored again, and additional channel monitoring reaches were established on Canyon Creek (a tributary in the North Fork Mad River HPA), South Fork Winchuck River (a tributary in the Smith River HPA), Hunter Creek (Coastal Klamath HPA), and Salmon Creek (Humboldt Bay HPA). The surveys have continued since 1996, with scheduled re-surveys every two years or after a five year flood event. Details of the channel monitoring projects analyzed to date are presented in Appendix C3.

The purpose of the monitoring protocol is to document the recovery of Plan Area watersheds from past timber harvesting practices and to evaluate the effects of current and future harvesting practices on watershed condition and recovery. The long-term channel monitoring protocol also has potential to evaluate the effectiveness of "storm-proofing" techniques, currently in vogue, in reducing road-related erosion sources. The monitoring objective of the Class I channel monitoring project is to track long term trends in the sediment budget of Class I watercourses as evidenced by changes in channel dimensions. These dimensions include thalwag profile, thalwag elevation (defined as the height of the deepest part of the channel), bankfull width, active channel width, and substrate (pebble) size.

Data collected on all of the monitoring sites since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and updated biennially to coincide with the biennial report to the Services (see Section 6 regarding report). This is a long term monitoring study, and therefore Green Diamond does not expect to be able to determine trends in the sediment budget of Class I watercourses for possibly 10-15 years. Threshold values for monitoring can not be established until lag times and the ranges of natural variability for individual watersheds or sub-basins are understood. In the interim period, Green Diamond expects to gain useful insights concerning the relationship between channel dynamics and hillslope processes within the Plan Area. By integrating data from different monitoring approaches, Green Diamond believes that channel monitoring will ultimately be a powerful tool for better understanding of the relationship between management activities and stream habitat conditions for the Covered Species in the Plan Area.

4.3.5 Assessment of Sediment Delivery from Class III Watercourses: A Retrospective Study

Concerns have been raised that complete removal of trees from Class III watercourses will result in destabilizing these headwater areas resulting in an upslope extension of the channel and increased risk of shallow rapid landslides. The net effect is that there could be significant increases in sediment production from watercourses even though Class I and II watercourses may have ample buffer retention. A retrospective study was used to provide a description of key variables of Class III watercourses sampled and quantify gross changes that might have occurred following clearcut timber harvesting (see Appendix C4 for details). Since this was a retrospective study and it was not possible to utilize controls, it was expected that subtle changes in Class III watercourses following timber harvest could not be quantified. The objective was to assess the extent to which major changes occurred in Class IIIs that were responsible for substantial increases in management related sediment production.

A stratified random sampling approach was used to select THPs throughout Green Diamond's ownership that had been completed between 1992 and 1998. THPs were not selected before 1992, because of a property-wide shift in the designation of Class II versus III watercourses. Prior to that year, many small intermittent channels were classified as Class IIIs that would have been designated Class IIs after 1992. THPs were not selected after 1998 to insure that Class IIIs had experienced at least one winter of storms. Of all THPs reviewed, 47 "run-through" and 53 "within" channels were selected for the study. A "run-through" is a Class III watercourse where the beginning of the channel is outside the harvest unit. If the channel begins within the boundaries of the harvest unit, it was designated as "within." Table 4-2 summarizes the characteristics of the watercourses of the study (also see Appendix C4).

Table 4-2. Characteristics of Class III watercourses examined in retrospective study of 100 sites from THPs completed between 1992 and 1998.[1]

Variables	Run-through		Within		Total	
	N	Mean (SE)	N	Mean (SE)	N	Mean (SE)
Drainage area (acres)	47	10.5 (2.48)	53	5.6 (0.66)	100	7.9 (1.24)
Channel length (ft)	47	451.5 (31.62)	53	346.1 (34.46)	100	395.6 (24.02)
Channel width (ft)	47	2.55 (0.147)	53	2.69 (0.234)	100	2.62 (0.140)
Channel depth (ft)	47	0.33 (0.029)	53	0.25 (0.002)	100	0.29 (0.019)
X-section area (ft^2)	47	0.96 (0.146)	53	0.67 (0.083)	100	0.81 (0.083)
Channel gradient (%)	47	31.5 (1.79)	53	35.2 (1.81)	100	33.4 (1.28)
Bank slope (%)	47	47.4 (2.481)	53	43.0 (2.61)	100	45.1 (1.81)
Exposed bank (%)	47	0.66 (0.113)	53	1.00 (0.343)	100	0.84 (0.189)

Note
1 Cross-sectional area of the channel represents the product of the active channel depth and width measurement.

This study suggested that there were no catastrophic short-term effects (1-7 years) of timber harvest on erosion in and near Class III channels for the period 1992-1998. There were few sites that experienced extensive bank erosion and less than 25% of 10-foot channel segments/intervals contained an exposed active channel. Furthermore, of the 100 sites examined, there were no debris flows. This is significant in that there were several potential triggering storms in this period 1996 and 1998 and there was above average total rainfall in all years except 1992 and 1994. It may therefore be concluded that under the recent regime of harvest practices, Class III channels were not responding to harvest in the short-term by unraveling and causing major increases in sedimentation downstream. However, these results do not rule out the possibility that there were increases in sediment production from more subtle and chronic sources, or that a longer period of study might reveal changes not recognized in this investigation. Most of the sediment production from Class IIIs were limited to a relatively few streams, particularly in regions with unconsolidated geology. This suggests that effective mitigation can be provided by site specific geologic review where conditions warrant.

This retrospective study also showed that there were few landslides associated with Class III watercourses. Those landslides that did occur were associated with steeper stream gradients and steeper bank slopes. These two variables explained over 40% of the variation in landslides among streams and accounted for over two-thirds of the variation explained by the full regression model.

Since there were no controls, this study design was not capable of assessing whether the observed erosion indicators differed significantly from either virgin old growth or advanced second growth forest stand conditions. In particular, it provided no clear evidence regarding whether predicted increases in peak runoff have induced significant increases in rates of fluvial erosion. As a result, a before-after-control-impact (BACI) experiment has recently been initiated for evaluating more subtle changes in sediment production from Class III watercourses. The initial BACI data set collected for the Little River HPA suggests that control-treatment comparisons may not show significant harvesting effects in that region.

4.3.6 Section 303(d) Impaired Watersheds

As part of the examination of habitat conditions, the status of watersheds in the HPAs under the federal Clean Water Act (CWA) was considered. Section 303(d) (33 USC §1313) of the CWA established the Total Maximum Daily Load (TMDL) process which is a three step methodology to assess, prioritize, and develop action plans required to attain water quality standards within watersheds identified as having impaired water quality. These impairments can be as a result of point source, nonpoint source, and naturally occurring sources of pollution. The listed northcoast rivers (Table 4-3) were identified by the State Water Resources Control Board (SWRCB) in 1998 and approved by the United States Environmental Protection Agency (USEPA) on May 12,1999 as water bodies with impaired or threatened water quality stemming, in part, from silvicultural and rangeland activities.

Table 4-3. CWA Section 303(d) Impaired Watersheds in the HPAs as determined by the SWRCB and USEPA.

Watershed	Pollutants	Targeted TMDL Completion Date
Klamath River	Temperature, Nutrients	2004
Redwood Creek	Sediment	1998[(1)]
Mad River	Sediment, Turbidity	2007
Eel River	Temperature, Sediment	2006
Van Duzen River	Sediment	1999[(1)]

Notes
(1) Technical portion of TMDL adopted by EPA.

4.3.7 Fish Presence/Absence Surveys

Fish presence/absence surveys are conducted continually on Green Diamond's ownership in the HPAs. The purpose of these surveys is to identify a stream reach of interest as a Class I (fish bearing) or Class II (non-fish bearing) watercourse. A key assumption of these surveys is that only the presence of fish species can be absolutely proven. Absence of fish can only be inferred from a lack of presence. For a further discussion of objectives and methods, see Appendix C6.

All information from the presence/absence surveys is entered into Green Diamond's Forest Resources Information System (FRIS), and the results are incorporated into THPs as they are being prepared. A series of FRIS maps are continuously updated with information obtained from the presence/absence surveys. The maps and database provide current information on the distribution of fish on a property-wide basis.

A presence/absence survey is a valuable technique to establish Class I watercourse determinations and fish species distributions on a site-specific basis. The extent of anadromy for streams on the ownership is generally known, with the exception of the actual extent for each individual species. The presence/absence surveys are primarily used to delineate the extent of resident populations of rainbow and coastal cutthroat trout in low order Class I watercourses.

4.3.8 Summer Juvenile Salmonid Population Estimates

Surveys to estimate and monitor summer populations of juvenile salmonids have been conducted in eight streams. Data collection on summer populations of juvenile coho salmon and 1+ and older steelhead was initiated in 1995 in three streams: South Fork Winchuck River (Smith River HPA), Wilson Creek (Smith River HPA), and Cañon Creek (Mad River HPA). Since 1995, data collection has occurred annually in these three streams for chinook salmon and coastal cutthroat trout as well as coho salmon and steelhead. Sampling surveys were initiated in 1998 in four additional creeks: Hunter Creek (Coastal Klamath HPA); Lower South Fork Little River, Railroad Creek, and Upper South Fork Little River (all Little River HPA). Sullivan Gulch (North Fork Mad River HPA) was added to the program in 1999.

A modified Hankin and Reeves (1988) juvenile sampling protocol is used to estimate the juvenile populations (Hankin 1999). The estimated population during summer low flow periods (August-September) represents juvenile salmonids that will be shortly out-migrating or over-wintering in streams on the ownership. Details of the population surveys are provided in Appendix C7.

In summary, the summer population estimates for the surveyed streams indicate the following:

- Juvenile coho salmon population estimates vary from stream to stream and year to year. In data sets that span a period of five years, juvenile coho population estimates vary widely, increasing in some streams and decreasing in others. Overall, the surveyed streams north of Redwood Creek show a downward progression in coho populations; the streams south of Redwood Creek show relatively stable or increasing populations (see Appendix C7). Studies within these streams have not occurred long enough to infer trends; however, factors such as low winter flows and poor ocean conditions can contribute to poor adult escapement and thus low juvenile recruitment. Steelhead population estimates indicate stable or increasing populations both north and south of Redwood Creek (see Appendix C7; also see Appendix C10 for Mad River steelhead population estimates). Juvenile populations within streams north of Redwood Creek tend to show the highest population estimates. Within these streams, habitat conditions may be more suited for this species that has behaviors adapted for swift flowing, higher gradient watercourses, with reduced velocity refuge. Distinguishing coastal cutthroat from steelhead while snorkeling is often difficult. Population estimates are calculated for both of these species; however, the estimates may not reflect the actual populations for each species individually. Juvenile coastal cutthroat populations tend to show very limited numbers in the sampled streams, except for the South Fork Winchuck (see Appendix C7). However, presence/absence surveys indicate that coastal cutthroat trout are widely dispersed across streams on the ownership. Coastal cutthroat trout populations tend to decrease south of Redwood Creek and are absent south of the Eel River (Gerstung 1997).

- Juvenile chinook salmon are also observed during the summer population estimates. However, juvenile chinook salmon tend to out-migrate from streams on the ownership prior to June. The juvenile dive counts take place in the months of August and September during summer low flow after the majority of chinook salmon smolts out-migrate. Therefore residual populations of chinook salmon counted during the summer dives demonstrate species presence, but cannot be used for population estimates due to their pattern of early season out-migration.

4.3.9 Out-migrant Smolt Trapping

Trapping for juvenile salmonid out-migrants has been conducted annually on Little River tributary streams since 1999. This project is designed to monitor smolt abundance, size, and out-migration timing, and to examine long term trends in these variables (see Appendix C8 for details). The trapping results are used in conjunction with the summer juvenile population monitoring to estimate over-wintering survival in the streams monitored. The program also assists in identifying factors affecting the timing of smolt emigration and in establishing baseline and long-term abundance trend data for juvenile populations. The results and discussion of population estimates from coho salmon out-migrant trapping during 1999 and 2000 and corresponding previous summers' population estimates (1998 and 1999) are shown in Appendix C8. Overall, the smolt trapping program results indicates that there is a great deal of variability in the number of smolts between Little River tributaries within a single trapping year as well as between years.

4.3.10 Salmonid Spawning Surveys

No attempts are made by Green Diamond to estimate adult salmonid populations or spawner escapements. However, periodic spawning surveys have been conducted in several streams on Green Diamond's ownership since 1995-6. They are conducted to determine habitat use and relative numbers of spawners of all species as well as watershed conditions during the winter months (see Appendix C9 for details). Due to the limitations of time, water conditions, and weather, spawner surveys tend to be opportunistic rather than at fixed time intervals or fixed reaches. In general, the entire anadromous reach accessible to coho salmon is surveyed. In long anadromous reaches within one stream, the survey may be broken up into sub-reaches that tend to be based on accessibility and/or time available for the survey. Because of these constraints the surveys are somewhat inconsistent from year to year. Sub-reaches within one watershed may or may not be surveyed on the same day or by the same crew. A general description of the sub-reaches for each stream for which spawner surveys have been conducted is provided in Appendix C9.

The spawning surveys conducted in a small number of streams to date provide an indication of habitat use and relative abundance of spawners in those streams surveyed. Salmonid escapement surveys have helped to show that returning adult populations are using the majority of anadromous habitat available in the surveyed streams. Opportunistic surveys looking at chinook and coho escapement may be helpful in examining age structure, sex ratios, migration timing, and hatchery infiltration. However, the number of HPA streams, high flows, and water visibility limit the utility of such surveys in estimating adult escapement.

4.3.11 Headwaters Amphibian Studies and Monitoring

Green Diamond has conducted distribution and habitat association studies and has initiated a monitoring program for tailed frogs and southern torrent salamanders. A thorough discussion of the specific objectives, methods and results to date is found in Appendix C11.

4.3.11.1 Tailed Frogs

As described in detail in Diller and Wallace (1999), the distribution and habitat of larval tailed frogs was studied in first and second order watercourses from 1993-1996 (see Appendix C11.1). Seventy-two watercourses were studied to relate habitat variables to the presence of tailed frogs. From this study, tailed frogs were found to be present and widespread throughout most of the study area. Tailed frogs were found in 75% of the surveyed headwater streams. However, their presence was closely tied to the geological formation of the stream drainage. Data are not available to make direct comparisons of the presence data for tailed frogs within headwater streams to other studies because different sampling procedures were employed. However, estimates of the proportion of streams with tailed frogs varied from 35% in young forests to 96% in old growth areas (Corn and Bury 1989; Welsh 1990; Bull and Carter 1996).

Monitoring of tailed frog populations was initiated in 1997 and will continue under the Plan. The primary approach is a paired sub-basin design. The primary purpose is to compare changes in larval populations of tailed frogs in streams with watersheds where timber harvest occurs (treatment sites) and where it does not (control sites). In instances where control sites are not available, changes in larval populations will be compared to the amount of timber harvest. In either case, the objective will be to determine if timber harvest activities have a measurable impact on larval populations. Different levels of change in larval tailed frog populations will be used to trigger reviews of management activities (see Section 6). The monitoring reaches within each sub-basin will be sampled at least one year prior to operations that could influence the treatment sites and every year thereafter. New sub-basins will be added across the ownership until there are 12-15 paired sites well distributed across the Plan Area. Depending on the schedule of harvesting in the treatment sub-basins, it will likely be necessary to monitor a site for more than 10 years to determine if a treatment effect has occurred. (See Appendix D for full details of the field protocol.) A secondary monitoring objective will be to document long-term changes in tailed frog populations across Green Diamond's ownership.

Eight paired sub-basins have already been selected. Monitoring began at five paired sub-basin in 1997, at one in 1998, at two more in 1999, and at one more in 2000. Only one treatment monitoring reach has had any significant timber harvest to date. The results to date indicate that there is considerable annual variation within monitoring stream reaches for both control and treatment streams. It also appears that the different sites were somewhat in synchrony such that there were generally good and bad years for tailed frog reproduction. This may be the result of differential annual reproductive effort by the adult population or differences in larval survival among years. Currently, there are many unknowns regarding the adult population in terms of its size or life history characteristics. Therefore it is not possible to determine the cause of these annual fluctuations. In spite of the annual fluctuations in the larval populations, the BACI experimental design that was incorporated in this monitoring program will still allow for the detection of treatment effects since the analysis will be based on a treatment by time interaction. However, these fluctuations will increase the variance in the analysis and therefore decrease the statistically power. As a result, Green Diamond intends to implement additional studies of the adult population to determine if the effects of annual variation can be removed from the analysis through the inclusion of one or more additional covariates.

In conclusion, this study is in its preliminary stages and there has been very little harvesting in any of the treatment sub-basins to date. Therefore, it would be premature to attempt to analyze the data to determine if there were any effects of timber harvest on larval tailed frog populations. However, the data do suggest that there was substantial annual variation in both control and treatment sites which if not explained through future studies of the adult population, may reduce the statistical power of this monitoring approach.

4.3.11.2 Southern Torrent Salamanders

As described in detail in Diller and Wallace (1996), the distribution and habitat of southern torrent salamanders in streams of managed forests was studied from 1990-1994 (see Appendix C11.1). The salamanders were located through surveys of first and second order watercourses and incidental searches. Seventy-one headwater streams were studied to relate landscape variables to the presence/absence of southern torrent salamanders. Southern torrent salamanders were found to be present and widespread throughout most of the study area, occurring in 57(80.3%) of the sampled streams. However, southern torrent salamander presence was closely tied to the geological formation of the stream drainage. Data are not available to make direct comparisons of the presence data for torrent salamanders within headwater streams to other studies because different sampling procedures were employed. However, estimates of the proportion of streams with torrent salamanders have varied from 28.5% in young forests to 86.4% in old growth areas (Carey 1989; Corn and Bury 1989; Welsh et al. 1992).

Monitoring of southern torrent salamander populations was initiated in 1998 and will continue under the Plan. The primary approach is a paired sub-basin design. The primary purpose is to compare changes in sub-populations of southern torrent salamanders in streams with watersheds where timber harvest occurs (treatment sites) and where it does not (control sites). In instances where control sites are not available, changes in sub-populations will be compared to the amount of timber harvest. In either case, the objective will be to determine if timber harvest activities have a measurable impact on the persistence of sub-populations. The objectives of the monitoring program are to determine if there is a difference in the persistence rate for treatment and control sub-populations, and to document any apparent changes in the habitat conditions or index of sub-population size at each site. Different levels of change will be used to trigger reviews of management activities (see Section 6). The monitoring reaches within each sub-basin will be sampled at least one year prior to operations that could influence the treatment sites and every year thereafter. New sub-basins will be added across the ownership until there are 12-15 paired sites well distributed across the Plan Area. Depending on the schedule of harvesting in the treatment sub-basins, it will likely be necessary to monitor a site for more than 10 years to determine if a treatment effect has occurred. (See Appendix D for full details of the field protocol.) A secondary monitoring objective will be to document long-term changes in southern torrent salamander populations across Green Diamond's ownership.

A total of 18 sites in 8 paired sub-basins have already been selected for monitoring southern torrent salamanders. Monitoring began in five of the paired sub-basins in 1998, at two in 1999, and at one more in 2000. As of 2001, there has been no timber harvest immediately adjacent to any of the torrent salamander monitoring sites. The torrent salamander population monitoring protocol is based on the persistence of sites as the primary response variable and not on estimates of abundance of individuals in monitoring reaches. However, the protocol does specify consistent collecting effort over the same sample reach each year so that comparisons of relative abundance of individuals at each site can be made. In spite of the less precise estimate of abundance relative to tailed frogs, there has been little annual variation in the number of torrent salamanders collected at monitoring reaches to date. The mean number of individuals captured per year from 1998-2000 for the 18 sites that were monitored over the entire three years was 11.6, 13.6, and 12.6, respectively. If this pattern persists, it could lend support for using relative abundance as the primary response variable, which would provide much greater sensitivity to the treatment effects for this monitoring approach. In conclusion, this monitoring study is in its preliminary stages and it is too early to determine if there will be any effects of timber harvest on the persistence of the sites by torrent salamanders. Most sites seemed to have relatively constant numbers among years and there is no evidence of any local extinction.

4.4 ASSESSMENT OF HABITAT CONDITIONS AND STATUS OF COVERED SPECIES BY HPA

This section provides an assessment of current habitat conditions and the status of Covered Species on an HPA-by-HPA basis. The assessment identifies similarities and differences in habitat conditions and species occurrence within and among HPAs.

4.4.1 Smith River HPA

4.4.1.1 HPA Type, Size, and Group

The Smith River HPA is a hydrographic area as defined in this Plan and includes approximately 181,999 acres. It comprises the entire Smith River HPA Group.

4.4.1.2 Eligible Plan Area

The Eligible Plan Area in the Smith River HPA includes approximately 52,318 acres: 44,177 acres of Initial Plan Area and 8,140 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). Approximately 3,000 acres of the Initial Plan Area were acquired during preparation of the Plan; approximately 41,000 acres are part of the Original Assessment Ownership.

The Initial Plan Area is divided into four areas: 1) the Smith River tract, 2) the Fort Dick and Peacock Creek tracts, 3) the Goose Creek tract, and 4) the Wilson Creek watershed.

- The Smith River tract is in the northern portion of the HPA. It is bounded on the north, for the most part, by the California/Oregon state line. It includes portions of the Winchuck River, which flows into the Pacific Ocean less than a mile north of the state line, and most of the Rowdy and Dominie Creek drainages, which are tributary to the Smith River. Green Diamond's ownership in this area extends across the State border, but the Oregon portion of the Smith River tract is not part of the HPA and is not covered by this Plan.

- The Fort Dick and Peacock Creek tracts are in the northern portion of the HPA and are separated from the Smith River tract. They straddle the Smith River approximately 8 to 10 miles from its mouth. The Fort Dick tract is on the west side of the river, and the Peacock Creek tract is on the east bank. Much of the Fort Dick tract is on the coastal plain and does not drain into the Smith River.

- The Goose Creek tract is in the southeastern portion of the HPA. It is entirely within the Goose Creek drainage, which is tributary to the South Fork of the Smith River. This property is located eight to twelve miles from the coast.

- The Wilson Creek drainage is located in the southwestern portion of the HPA.

4.4.1.3 Geology

The Smith River HPA includes portions of both the Coast Ranges and Klamath Mountains Geologic Provinces (see ***Figure 4-1***). The underlying bedrock of this HPA predominantly consists of Central Belt Franciscan Complex rock, with areas of Klamath Mountains bedrock along the eastern margin of the region. Faults in region include the inactive South Fork Fault, which separates the Franciscan bedrock from the Klamath Mountains bedrock, and a complex network of thrust faults within the Klamath Mountains geology. Scattered, poorly consolidated remnants of Miocene marine sandstone, siltstone and conglomerate deposits (Wimer Formation) overlie the Franciscan bedrock on ridges approximately five miles inland and at elevations of 1200 to 1600 feet above sea level. There are also remnants of continental deposits of sandstone and conglomerate, of similar age, on ridges at slightly higher elevations, near the Wimer Formation deposits. The coastal section of the HPA is dominated by the Smith River Plain, an elevated marine terrace where an abrasion platform of Franciscan rocks is almost entirely covered with a blanket of marine siltstone, shale and unconsolidated sands of Pliocene and Pleistocene age (Battery Formation). Pleistocene to Holocene river terrace deposits, flood plain deposits and dune sands also cover large portions of the Smith River Plain. Unconsolidated Pleistocene to Holocene river terrace and flood plain deposits can also be found at various locations along stream and river channels (Ristau 1979; Davenport 1982-84; Wagner and Saucedo 1987) within the HPA.

Within the HPA, Central Belt Franciscan bedrock composed of Undifferentiated Franciscan Sandstone underlies Green Diamond's northern and southwestern ownership; and Klamath Mountains bedrock composed of serpentinite, gabbro, metavolcanics, and metasedimentary rocks underlies the southeastern ownership.

The topography of the Smith River HPA is highly variable, but in general is relatively steep and sharp-featured compared to other HPAs. Pleistocene and Holocene landslide deposits cover portions of the Franciscan bedrock at numerous locations. Published landslide maps indicate that both shallow and deep-seated landslides exist throughout this HPA with debris slides and disrupted ground present on many slopes (CA DMG 1999). The inherently weak serpentinite of the Klamath Mountains bedrock is also particularly prone to landslide processes, but no known published landslide maps of this area were available for review.

4.4.1.4 Climate

This HPA is one of the wettest areas of California. Average annual rainfall varies from about 60 inches at Point St. George to over 125 inches at higher inland areas. The precipitation is orographic in nature, increases with elevation, and is usually greater on the windward (southwest) slopes. About 75% of the precipitation occurs between November 1 and March 31 (90% between October 1 and April 30). Average annual snowfall in the unit ranges from 28 inches at elevations of 1700 feet (Elk Valley) to 126 inches at 2420 feet (Monumental). Marine air masses and cold air drainage from higher elevations primarily influence the climate in this area. Occasionally, the climate is influenced by drier air masses associated with east winds.

4.4.1.5 Vegetation

The Smith River HPA is heavily forested, except for areas on the coastal plain that support agricultural and urban development.

Vegetation in the Initial Plan Area of this HPA is as follows:

- On the Smith River tract and in Wilson Creek, redwood is the dominant component of most cover types. Sitka spruce is a major stand component on coastal aspects, and Douglas-fir is the principal constituent of many stands in the more inland portions of these properties. Western hemlock, western red cedar, and grand fir occur as minor stand components on lower slopes near the coast. Red alder dominates most riparian zones and many lower slopes on north to east aspects throughout this area. Tan oak and madrone are common on drier sites toward the interior, particularly upper slopes with south to west aspects. Stand ages vary from recently planted harvest units to 60 year-old second-growth forests.

- On the Fort Dick and Peacock Creek tracts, the vegetation types are not markedly different from those in the Smith River block, although their more inland location results in less spruce. Younger age-classes also dominate, with few stands over 40 years old in these areas.

- On the Goose Creek tract, the principal forest type is Douglas-fir/tan-oak, with some redwood and Port Orford cedar on lower slopes and along watercourses. It has a cover of interior forest types that reflects far less coastal influence than the other tracts within this HPA. Stands in this area are 30 to 45 years of age, with some scattered older trees throughout the tract that are remnants of the original forest.

4.4.1.6 Current Habitat Conditions

4.4.1.6.1 <u>Water Temperature</u>

Water temperature monitoring in the Smith River HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 61 summer temperature profiles were recorded at 25 sites within 16 Class I watercourses. An additional 52 summer temperature profiles were recorded at 20 headwater sites in 22 Class II watercourses. (See Table C5-2 in Appendix C5 for names of watercourses and sites.) Figure 4-5 shows the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the yellow and red light thresholds of this Plan. Results for the period (1994-2000) indicate that none of Class I sites exceeded the red or yellow light threshold; one Class II site (D1120 TD, a watershed of approximately 71.5 acres) exceeded the yellow light threshold in 2000 with a 7DMAVG of 14.7°C; none of the Class II sites exceeded the red light threshold.

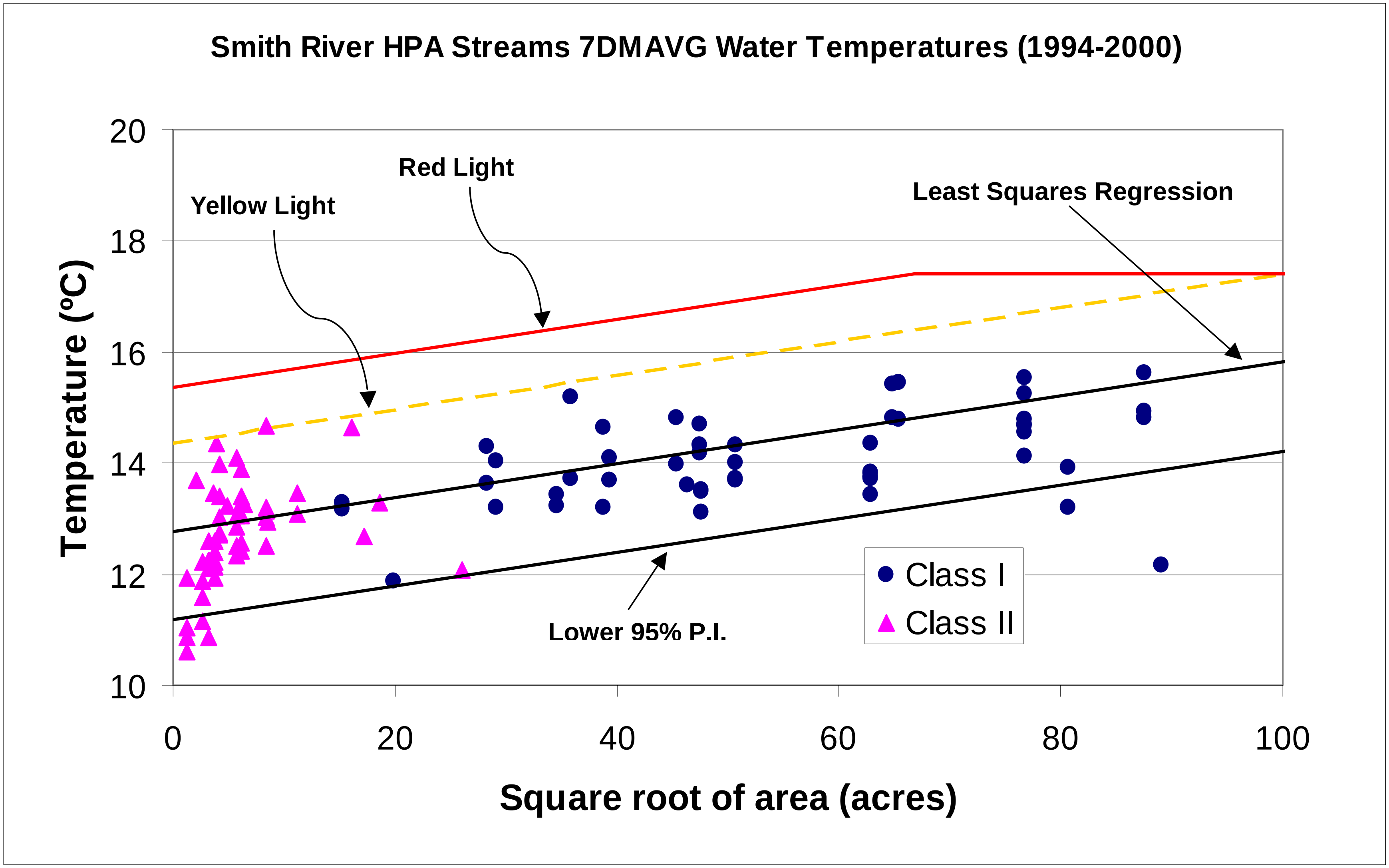


Figure 4-5. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Smith River HPA monitored between 1994 and 2000.**

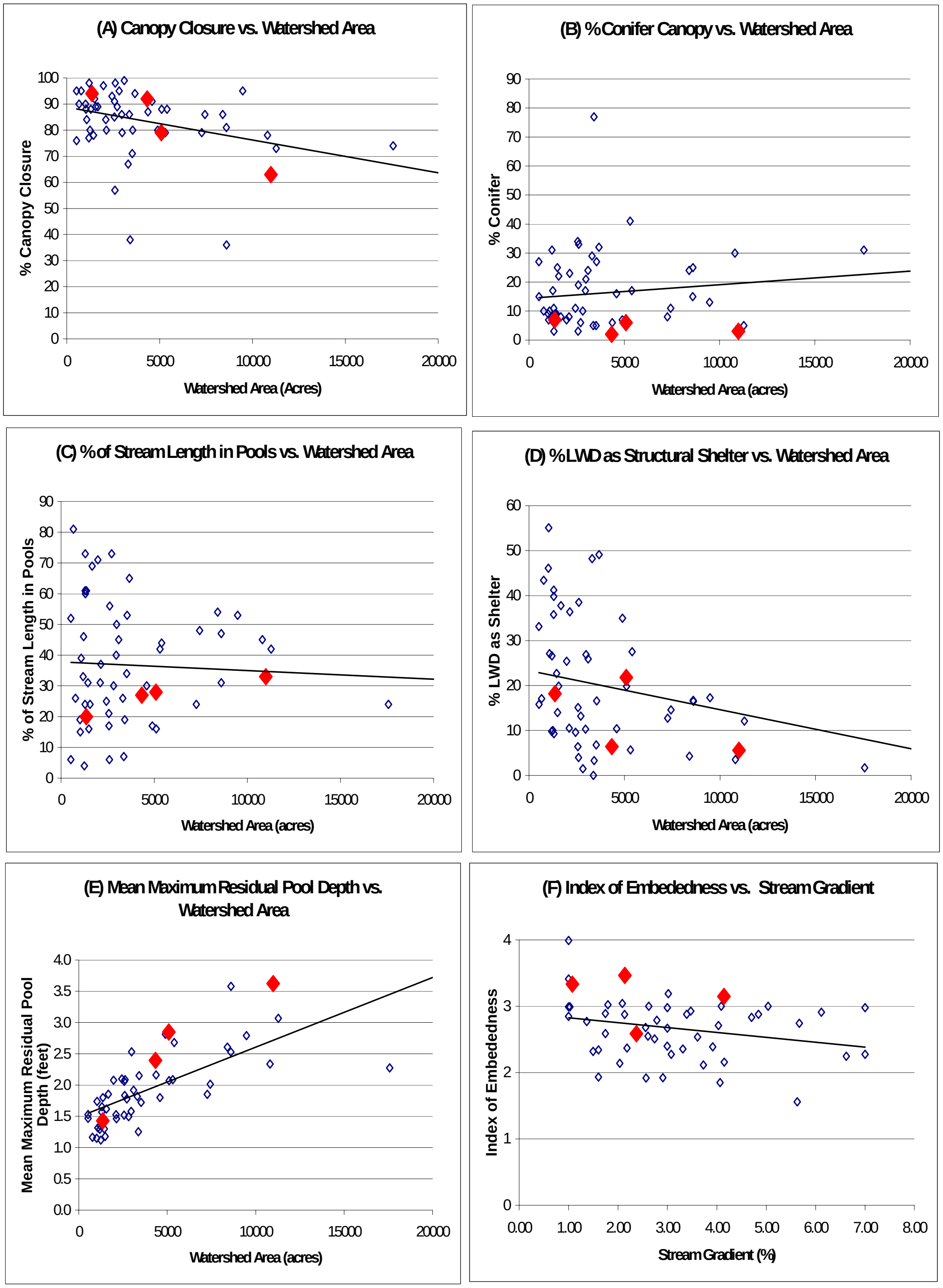


Figure 4-6. **Channel and habitat types in four streams assessed in the Smith River HPA. (Solid diamonds are assessed streams in Smith River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)**

4.4.1.6.2 Channel and Habitat Typing

Channel and habitat types were assessed in four streams within the Smith River HPA. The four streams (in descending order of mid-point watershed area), their mid-point watershed area, and their mid-point gradient are as follows:

Stream	Mid-point Watershed Area	Mid-point Gradient
Dominie Creek	1,356 acres	4.2%
South Fork Winchuck River	4,336 acres	2.1%
Wilson Creek	5,092 acres	1.1%
Rowdy Creek	10,990 acres	2.4%

The results of the assessment surveys are summarized in Figure 4-6 (A-F). See Table C1-2 in Appendix C1 for database, and Section 4.3.1 for summary of methods and assumptions. The least squares regression displayed on the figure was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in this HPA compare with those in other HPAs. The results indicate the following regarding the assessed streams:

- Percentages of canopy closure (63-94%) are somewhat typical compared with all other assessed streams (Figure 4-6 [A]).

- Percentages of conifer canopy (2-7%) are somewhat lower than those for other assessed streams of similar watershed area (Figure 4-6 [B]). Percentage of stream length in pools for three of the streams (20-28%) is considerably lower than that for other assessed streams of comparable watershed area. In the fourth stream (Rowdy Creek), stream length in pools was 33% (Figure 4-6 [C]).

- Percentage of LWD as structural cover in pools for South Fork Winchuck River and Rowdy Creek (6-4%-5.6% respectively) is much less than that for other assessed of streams of comparable watershed area (Figure 4-6 [D]).

- Residual pool depths in three of the streams (2.4 feet to 3.6 feet) are deeper on average than those in other assessed streams of comparable watershed area. In the fourth stream (Dominie Creek), average residual pool depth was 1.4 feet.

- Based on index values for pool embeddedness, all of these streams except Wilson Creek had greater pool tail-out substrate embeddedness than other assessed streams with similar gradients (Figure 4-6 [F]).

In summary, the habitat in the four streams is similar in many instances to that in other assessed streams of similar watershed area. There are, however, some habitat differences. Compared with streams of similar watershed area, the four streams on average have less total linear pool length as a percentage of total stream, are somewhat deeper, have pool tail-outs that are somewhat more embedded, have less LWD as a percentage of structural cover, and their adjacent riparian forest canopy is dominated to a greater extent by deciduous trees.

4.4.1.6.3 LWD Inventory

LWD survey/inventories were conducted in 1994 and 1995 in the same four streams where channel and habitat typing assessments were conducted: Dominie Creek, South Fork Winchuck River, Wilson Creek, and Rowdy Creek (see Appendix C2 for details).Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment in-stream and riparian LWD.

Results of these investigations are summarized below and depicted in Figure 4-7 (A-C) (see Tables C2-1 and C2-8, C2-15 in Appendix C2 for data). LWD data for Prairie Creek (which is not in this HPA) also are included to provide an additional point of comparison.

- Except for Rowdy Creek, the average number of in-stream LWD pieces per 100 feet of channel was somewhat lower (1.6-3.4 pieces) than that for other assessed streams of similar watershed area (Figure 4-7 [A]). South Fork Winchuck River and Wilson Creek had an average of 1.6 and 2.1 LWD pieces, respectively, per 100 feet of channel, compared with the average of 3-4 pieces per 100 feet for streams with comparable watershed areas (4,000-5,000 acres). In Prairie Creek, the LWD count was approximately 6.8 pieces per 100 feet of channel.

- The LWD volume indices for these streams are shown in Figure 4-7 (B). For Wilson Creek, the LWD volume index is similar to that for all other assessed streams. This is in contrast to the LWD piece count for Wilson Creek and indicates that, although there are fewer pieces per 100 feet of channel, the average size is greater and therefore the volume index is greater. Dominie Creek and South Fork Winchuck had volume indices somewhat lower than the average for streams of comparable watershed area. As a point of comparison, Prairie Creek had a volume index more than twice that for assessed streams of similar watershed area.

- The four assessed streams tended to be on the lower end of the 16 streams where LWD counts were conducted in the riparian recruitment zone (Figure 4-7 [C]). Rowdy Creek had the lowest count of the 16 assessed streams, with an average of 3.5 per 100 feet of recruitment zone.

4.4.1.6.4 Long Term Channel Monitoring

Long term channel monitoring is ongoing in two locations within the Smith River HPA: the South Fork Winchuck River and Wilson Creek. Monitoring began on the South Fork Winchuck in 1996 and on Wilson Creek in 1998. Detailed monitoring objectives and methods are found in Appendix C3. Detailed data analysis has not been completed for streams within this HPA to date. No conclusions can be drawn at this point in the monitoring.

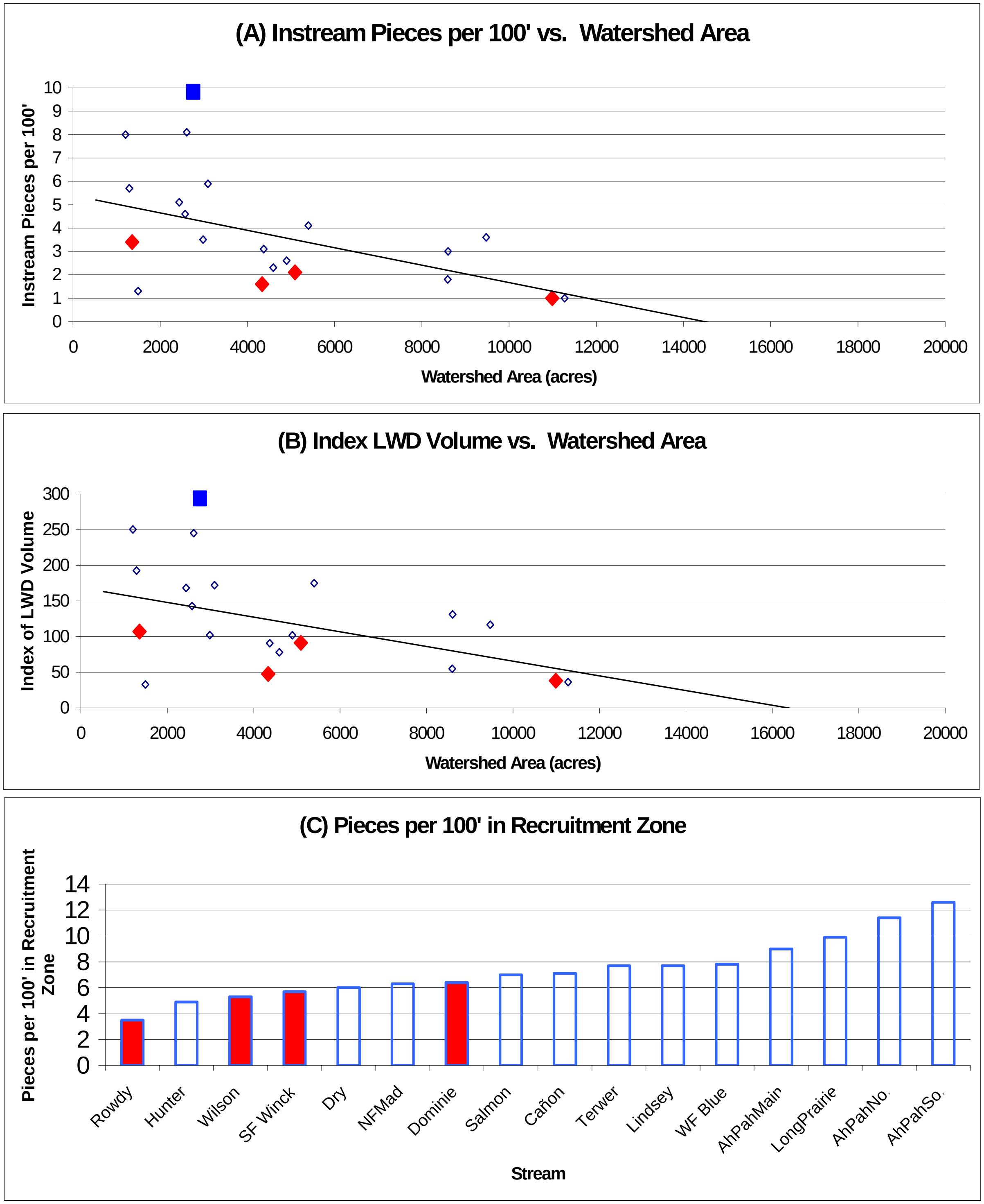


Figure 4-7. **LWD survey results for four streams assessed in the Smith River HPA. (Solid diamonds are assessed streams in Smith River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

4.4.1.6.5 Estuarine Conditions

The estuaries of the rivers within the Smith River HPA have all been altered to some degree by human activity. The extent and impacts of these alterations are unknown.

Winchuck River. The Winchuck River estuary has been impacted by a reduction of habitat through channelization for livestock grazing. The mouth of the Winchuck River regularly bars over during the summer to form an enclosed estuary. This estuary is occupied by juvenile chinook salmon and coastal cutthroat trout during the summer months. The estuary habitat for rearing salmonids is limited due to both a lack of depth and large woody debris for protective cover and avian predator avoidance. Efforts are currently underway by the Oregon Department of Fish and Wildlife (ODFW) to enhance the rearing habitat in the Winchuck River estuary.

Smith River. The lower channel and estuary of the Smith River has been altered and simplified by agriculture, livestock grazing, gravel mining, and urban development. The loss of secondary channels, sloughs, backwaters and large woody debris has reduced the amount and complexity of salmonid rearing habitat. The Smith River mouth generally remains open and does not bar over to form an enclosed estuary.

Wilson Creek. The lower section of this coastal watershed lacks an estuary. The creek runs directly into a semi-protected section of coastline where wave action at the creek's entrance is cushioned by exposed rocks. The lower channel is intermittent during the summer, thus out-migrating smolts have a discrete window in which to leave the watershed.

4.4.1.7 Salmonid Population Estimates

Population and adult spawner surveys have been conducted in five streams of this HPA (see Appendices C7, C9, and C10 for details). South Fork Winchuck River and Rowdy, Savoy, South Fork Rowdy and Wilson creeks have been monitored for adult returns since 1998. Spawner surveys within these streams are sporadic and often only conducted once in a season. Based on observed returns, no coho have been seen during surveys conducted within the five streams. Chinook salmon have been fairly common and easily distinguished during surveys. Based on late season results, it appears that the available spawning habitat is used by chinook annually in this HPA. Although adult coho have not been observed during spawning surveys, coho juveniles/smolts are found frequently in juvenile dive counts and electrofishing within these streams. Their numbers, however, are very low, which may factor into low observed adult escapement numbers. Steelhead are often seen during late winter surveys in small numbers, however juvenile population estimates within this HPA indicate that adult escapement may be much higher than that indicated from spawner surveys.

4.4.1.7.1 Juvenile Summer Population Estimates

Figure 4-8 (A-C) summarizes summer population estimates for juvenile coho salmon, steelhead, and coastal cutthroat trout in South Fork Winchuck River and Wilson Creek in 1995 through 2000 (see Appendix C7).

- As shown in Figure 4-8 (A), the annual estimate of juvenile coho salmon in Wilson Creek has varied widely from less than 20 to nearly 1,400 juveniles during the years 1995-2000. The annual coho estimates for South Fork Winchuck also have been variable, with no juvenile coho observed in this stream during the 1999 and 2000 surveys. Overall, coho estimates in South Fork Winchuck River have been much lower than those for Wilson Creek during 1995-2000.

- Annual juvenile steelhead population estimates for Wilson Creek and South Fork Winchuck are highly variable, ranging from a few hundred to over 3,000 during the monitoring period (Figure 4-8 [B]). No pattern in population variation is apparent from the Wilson Creek estimates.

- Coastal cutthroat trout population estimates in the South Fork Winchuck during the years 1996 through 2000 have remained somewhat stable at approximately 400 to 500 juveniles (Figure 4-8 [C]). Population estimates in Wilson Creek have indicated that coastal cutthroat trout populations may not be as stable as those in the South Fork Winchuck. In Wilson Creek, no coastal cutthroat trout were observed in 1997 and 1999, and estimates have ranged from less than 20 to approximately 160 in other years.

In summary, there is significant variability in annual population estimates for all salmonids monitored in the two Smith River HPA streams. The exceptions were that the cutthroat trout populations in South Fork Winchuck seem to be stable. In addition, there has been an apparent increase of juvenile steelhead in the South Fork Winchuck River and a decrease in juvenile coho populations in Wilson Creek during the survey period.

4.4.1.7.2 Adult Spawner Surveys

Spawning surveys have been conducted on five streams within the Smith River HPA during the period of 1998 through 2000 (see Appendix C9 for details). The streams and years surveyed are:

- South Fork Winchuck River: 1998-9
- Rowdy Creek: 1998-9
- Savoy Creek: 1999-2000 and 1998-9
- South Fork Rowdy Creek: 1999-2000 and 1998-9
- Wilson Creek: 1999-2000

The results to date confirm that chinook salmon are using all of these streams surveyed with the possible exception of Wilson Creek. No live chinook salmon, redds, or carcasses were observed in Wilson Creek during the 1999-2000 spawner surveys. Steelhead were confirmed in only the South Fork of the Winchuck River during thee surveys. However, steelhead redds may have been among the many unknown redds observed in the surveyed streams.

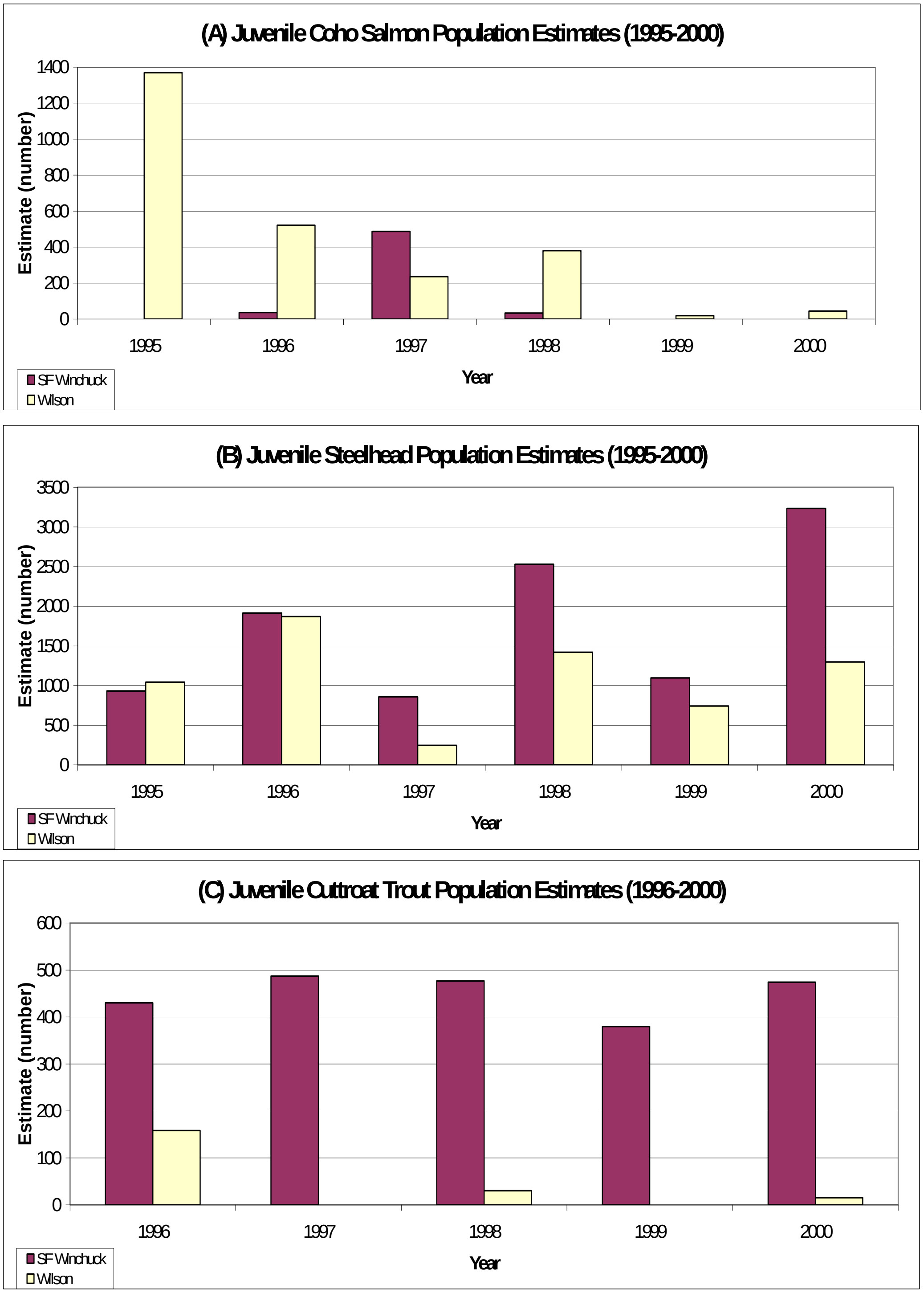


Figure 4-8. **Summary of the summer juvenile salmonid population estimates for the years 1995 through 2000 for South Fork Winchuck River and Wilson Creek in the Smith River HPA.**

4.4.1.8 Covered Species Occurrence and Status

Information regarding the presence or absence of Covered Species in the Smith River HPA is summarized by drainage in Table 4-4. ***Figure 4-9*** shows the recorded distribution of species in the HPA.

4.4.1.8.1 Chinook Salmon

The Smith River HPA includes the Southern Oregon and Northern California Coastal Chinook ESU, which was determined to not warrant listing by NMFS as of September 1999 (64 FR 50394). Juvenile chinook salmon production is thought to be increasing in the Winchuck River. The Smith River has the only known spring-run chinook population in coastal California. Chinook are well distributed in smaller coastal streams in this ESU, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5).

4.4.1.8.2 Coho Salmon

The Smith River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al*.* 1995).

4.4.1.8.3 Steelhead and Resident Rainbow Trout

The Smith River HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 4, 2001 (66 FR 17845). Steelhead populations in the Winchuck River were assessed as "healthy" by ODFW/CDFG (Nickelson et al. 1992), and the USFS (1993 a, b). Smith River fall run steelhead were considered "healthy" by ODFW/CDFG but summer run fish were considered at high risk of extinction by Nehlsen et al. (1991) and as depressed by the USFS (from Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

Table 4-4. Covered Species distribution in the Smith River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT[1]	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Winchuck River	3	3	3	3	3	3
South Fork Winchuck River	2,3	1,2,3	2,3	2,3	3	3
Salmon Creek	U	U	U	U	U	U
Bear Creek	U	U	U	U	3	3
Gilbert Creek	A	A	2,3	2	3	3
Lopez Creek	A	A	2	2	P	P
Smith River	2	1,2	2	2	P	P
Ritmer Creek	U	U	U	2	3	3
Tryon Creek	P	2	2	2	U	3
Rowdy Creek	2,3	1,2,3	2,3	2,3	3	3
Dominie Creek	3	1,2,3	2,3	2	3	3
Savoy Creek	3	1	2,3	2	3	P
Ravine Creek	A	A	P	P	3	3
Copper Creek	2	1	2,3	3	P	P
Hutsinpillar Creek	U	U	P	P	3	3
Little Mill Creek	2	1,2	2	2	P	P
Sultan Creek	2	2	2	2	P	P
Camp Six Creek	A	A	A	2	U	U
Peacock Creek	2	2	2	2	P	P
South Fork Smith River	2	1,2	2	2	P	P
Goose Creek	2	P	2,3	2,3	3	3
Wilson Creek	2	1,2,3	2,3	2	3	3

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT=resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur.
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.1.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations, with the exception of the Rogue and Smith Rivers, which support large and healthy populations (Johnson et al. 1999). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The populations in this HPA are part of that ESU.

The Smith River is considered California's most important producer of coastal cutthroat trout. Cutthroat trout abundance trends in the Smith River increased 1-5% annually from 1982-1998 (Johnson et al. 1999). In addition, smolt abundance in Mill Creek (tributary to the Smith River) has increased from 1994-1997 (Howard and Albro 1997). Habitat in the

Smith River estuary has been substantially degraded, and populations of coastal cutthroat trout in the estuary are very low compared to historical estimates (Gerstung 1997). Smolt counts in the Winchuck River from 1996-1998 show high variation, but the numbers of trapped smolts (1400 to 2800) are encouraging (Johnson et al. 1999).

4.4.1.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in eight streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Smith River HPA, 8 of 8 (100%) of the sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 27 other streams throughout the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the Smith River HPA appear to be in excellent condition.

4.4.1.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in seven streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Smith River HPA, 7 of 7 (100%) of the sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 68 other streams throughout the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Smith River HPA appear to be in excellent condition.

4.4.1.9 Assessment Summary

Due to the coastal influence and high canopy closure on most streams, water temperatures are good in streams on the Original Assessed Ownership in the Smith River HPA. The HPA is geologically stable relative to many of the other HPAs with competent (consolidated) geologic parent material. As a result, stream substrates remain relatively coarse in most streams even if there are greater than optimum levels of sediment inputs. Most Class I watercourses on the Original Assessed Ownership are generally deficient in the larger classes of LWD due to past timber management and active removal programs. This limits both the amount and quality of pool habitat. Because the current canopy on these watercourses is predominately made up of red alder, the potential for future LWD within the timeframe of this Plan is limited.

All of the Covered Species are common on the Original Assessed Ownership in the Smith River HPA, indicating that conditions are at least adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in some streams. There is ample spawning habitat for the salmonid species due to coarse sediment inputs. However, the general lack of pools and LWD suggests that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered

Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area in this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats.

4.4.2 Coastal Klamath HPA

4.4.2.1 HPA Type, Size, and Group

The Coastal Klamath River HPA is a hydrographic area as defined in this Plan and includes 108,150 acres. It is part of the Coastal Klamath HPA Group.

4.4.2.2 Eligible Plan Area

The Eligible Plan Area in the Coastal Klamath HPA includes approximately 94,060 acres: 88,760 acres of Initial Plan Area and 5,300 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). Approximately 1,600 acres in the Initial Plan Area were acquired by Green Diamond during preparation of the Plan; approximately 87,100 acres are part of the Original Assessed Ownership.

4.4.2.3 Geology

The Coastal Klamath HPA is mostly within the Coast Ranges Province, with a sliver of Klamath Mountains Province underlying its northeastern margin (see ***Figure 4-1***).

The HPA is predominantly underlain by Central Belt Franciscan Complex bedrock, with Klamath Mountains bedrock underlying the narrow strip along the northeastern margin. The Central Belt Franciscan Complex is generally described as a complex mixture of meta-sandstone and mudstone, with inclusions of other rock types. Klamath Mountains bedrock in the HPA is composed of Josephine Ophiolite intrusive and extrusive volcanics, which includes partially to completely serpentinized ultramafic rocks, gabbro, diorite, pillow lava and breccia. The inactive South Fork Fault separates the Franciscan rocks from the older rocks of the Klamath Mountains geologic province.

The topography of this HPA is highly variable, but in general it is steep and relatively sharp featured. Landslide processes in the HPA are dominated by shallow debris slides and debris flows, based on Green Diamond's preliminary landslide inventory data from this area. These landslides tend to be prevalent on steep slopes along Class I and Class II watercourses and to a lesser extent in the headwall areas of Class III watercourses. Sediment delivered to watercourses from shallow landslides is considered a significant portion of the sediment budget for this hydrologic unit. Deep-seated landslides are relatively uncommon within this HPA, but do exist, as indicated by Green Diamond's preliminary landslide inventory data.

4.4.2.4 Climate

The large size of the Klamath basin and its geographic differences results in a wide range of climatic conditions. For the entire basin, the weather can be generalized as having dry summers with hot daytime temperatures and wet winters with low to moderate temperatures. Peak air temperatures occur during July with a monthly average maximum of 65°F for the coast and 95°F inland. Precipitation is quite seasonal, with approximately 90% falling between October and March. Annual amounts vary from 20 inches to over 80 inches, depending on location. High intensity rainfall occurs during December-February and may cause flooding at times.

Snow occurs at higher elevations and some areas receive up to 80 inches annually. The highest instantaneous discharge ever recorded in the Klamath River was during the 1964 flood. At the town of Klamath the flow peaked at 650,000 cubic feet per second (cfs) and caused considerable damage. Numerous Klamath River tributaries are still recovering from sediment inputs from this storm event.

4.4.2.5 Vegetation

The Coastal Klamath HPA is dominated by redwood and redwood/Douglas-fir forests, with Sitka spruce occupying a narrow strip of westerly aspects along the coast and some lower slopes for a short distance inland. The redwood/Douglas-fir forests also include grand fir, western red cedar, and western hemlock on lower slopes and in riparian zones. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood, with pacific madrone occurring as a minor stand component on drier sites. As distance from the coast increases, the proportion of redwood in stands decreases and Douglas-fir and tanoak become more prevalent. Ridge tops and upper south to west slopes in the most inland reaches can support nearly pure Douglas-fir or tanoak/madrone stands. A distinct ecotone occurs around 2500 to 3000 feet elevation where redwood and Douglas-fir forest rapidly gives way to a non-forest landscape dominated by manzanita, with knobcone pine, ponderosa pine, and Port Orford cedar at the transition and persisting upslope in the bottom of many watercourses. The ecotone is due to a band of serpentinaceous soils on the Red Mountain/Rattlesnake Mountain ridge that divides Terwer Creek and Goose Creek in the Smith River HPA. A few isolated small stands of old growth exist on the Original Assessed Ownership in this HPA, in addition to those in state and federal parks situated within a few miles of the coast. Most of the forests in this HPA were harvested between the 1930s and the 1970s, and stand ages reflect that history.

4.4.2.6 Current Habitat Conditions

4.4.2.6.1 <u>Water Temperature</u>

Water temperature monitoring in Original Assessed Ownership in the Coastal Klamath HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 67 summer temperature profiles were recorded at 28 sites within 18 Class I watercourses. An additional 8 summer temperature profiles were recorded at 6 sites within 5 Class II watercourses. Figure 4-10 displays the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow thresholds of this Plan. The results for the period

(1994-2000) indicate that none of Class I or Class II sites exceeded the red or yellow light threshold.

4.4.2.6.2 Channel and Habitat Typing

Channel and habitat types were assessed in 22 streams within the Coastal Klamath HPA. The assessed streams (in descending order of mid-point watershed area, their mid-point watershed area, and their mid-point gradient (%) are as follows:

Stream	Mid-point Watershed Area	Mid-point Gradient
Terwer Creek	8,602 acres	1.5%
Tectah Creek	7,424 acres	Not Available
Bear Creek	5,112 acres	3.4%
Hunter Creek	4,896 acres	1.6%
East Fork Terwer Creek	3,523 acres	Not Available
Surpur Creek	2,712 acres	Not Available
Mainstem Ah Pah Creek	2,573 acres	1.7%
North Fork Ah Pah Creek	2,437 acres	2.1%
High Prairie Creek	2,134 acres	3.6%
Tarup Creek	1,971 acres	5.6%
McGarvey Creek	1,672 acres	1.8%
Tributary 2 to Bear Creek	1,442 acres	Not Available
Little Surpur Creek	1,363 acres	4.0%
West Fork McGarvey Creek	1,296 acres	2.7%
South Fork Ah Pah Creek	1,290 acres	4.5%
Tributary 1 to Bear Creek	1,186 acres	4.2%
Tributary to Mainstem Ah Pah Creek	1,076 acres	5.6%
East Fork Hunter Creek	1,031 acres	Not Available
Hoppaw Creek	1,012 acres	1.7%
Omagar Creek	773 acres	3.9%
Mynot Creek	526 acres	Not Available
North Fork Hoppaw Creek	522 acres	3.0%

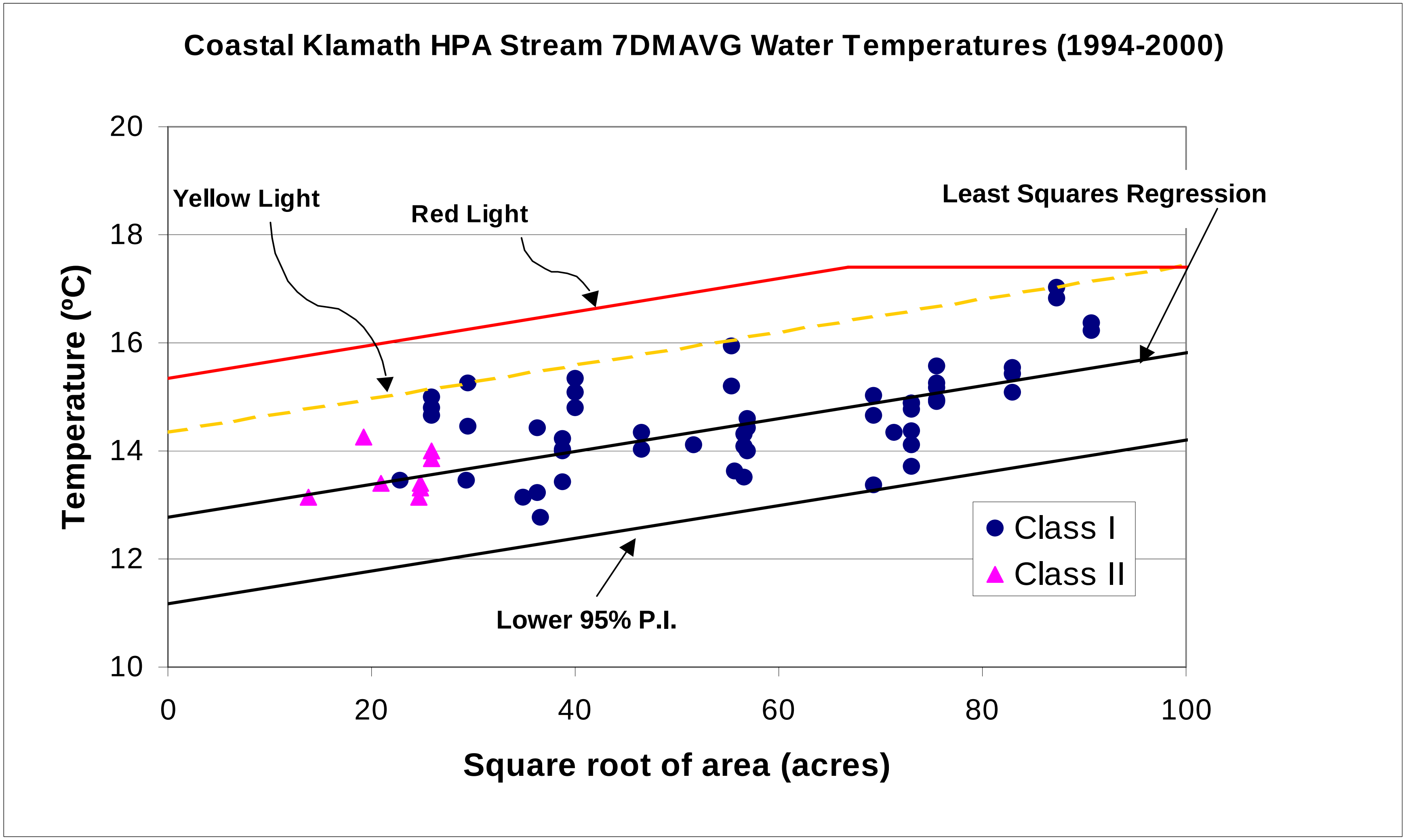


Figure 4-10. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Coastal Klamath HPA monitored between 1994 and 2000.

Six assessments were conducted by Green Diamond, and 16 were conducted by the Yurok Tribal Fisheries Program (see Appendix C1 for details). The results are summarized below and depicted in Figure 4-11(A-F) (see Table C1-3 in Appendix C1 for data). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in this HPA compare with those in other HPAs.

The results indicate the following regarding channel and habitat types in the 22 streams assessed in the Coastal Klamath HPA:

- Except for Terwer Creek, the percentage of canopy closure for these streams (range 71-97%) is somewhat typical of all other assessed streams. (Figure 4-11[A]). Terwer Creek had 36% canopy cover.
- With three exceptions, the 22 assessed streams in this HPA have somewhat lower percentages of conifer canopy (range 3-27%) than assessed streams of similar watershed area in other HPAs (Figure 4-11[B]). North Fork Hoppaw, High Prairie, and Terwer creeks had >20% conifer canopy.
- The percentage of stream length in pools varies widely for the 22 streams, and percentages generally are similar to those for assessed streams in the other HPAs (Figure 4-11[C]).
- The percentage of LWD as structural cover in pools for the 22 streams varies widely, and the percentages are somewhat typical of assessed streams of comparable watershed area in other HPAs (Figure 4-11[D]).
- The residual pool depths measured in the 22 streams vary greatly, and this variation appears similar to that for assessed streams in other HPAs (Figure 4-11 [E]).
- Based on index values for pool tail-out embeddedness, pool tail-out substrate embeddedness for these streams is comparable to that for other assessed streams with similar gradients in other HPAs (Figure 4-11 [F]).

In summary, the habitat in the 22 assessed streams of the Coastal Klamath HPA is in many instances similar to other assessed streams of similar watershed size. However, many of these streams have on average a lower percentage of conifers within adjacent riparian areas and therefore have canopies more dominated by deciduous trees than do other assessed streams of similar watershed area.

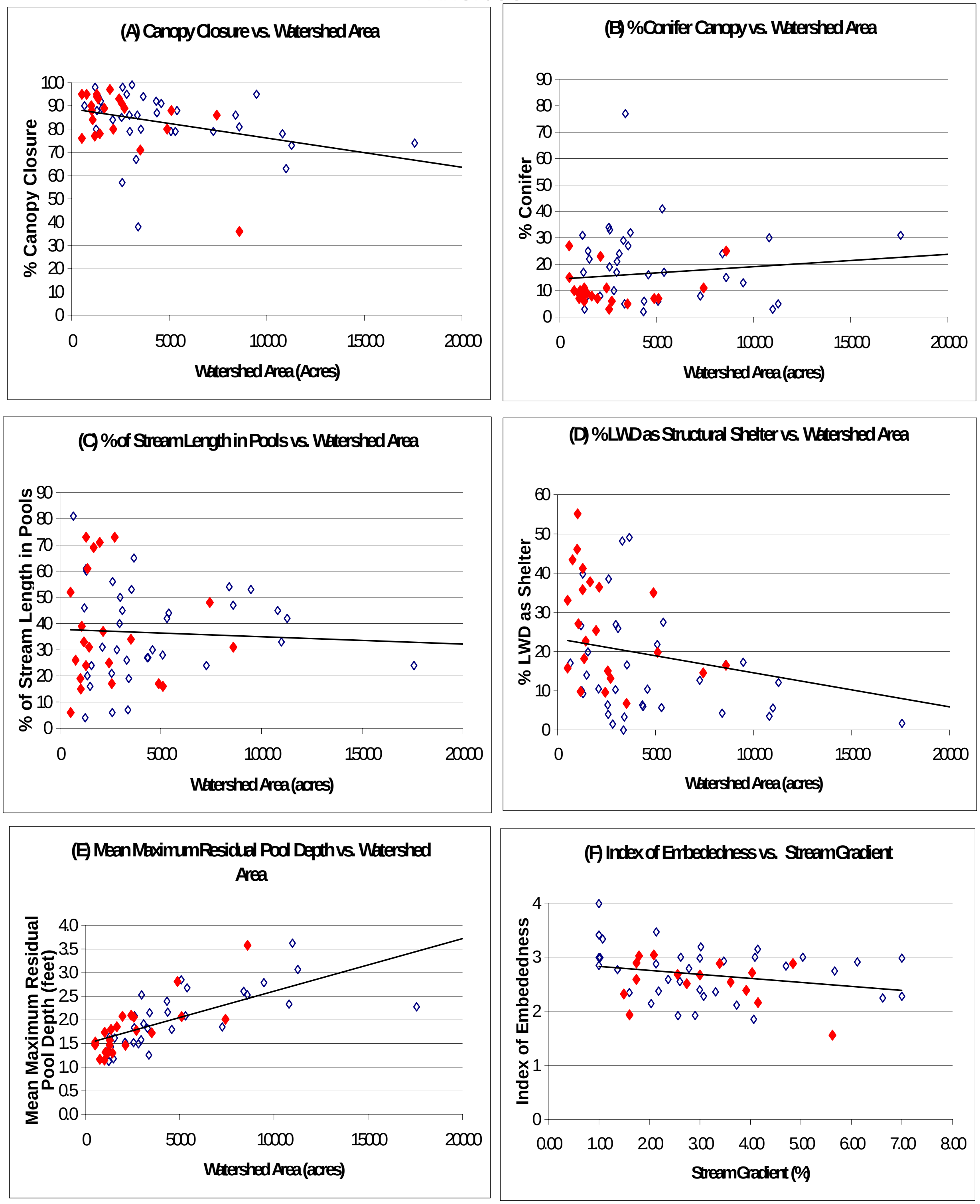


Figure 4-11. Channel and habitat types in five streams assessed in the Coastal Klamath HPA, (Solid diamonds are assessed streams in Coastal Klamath HPA. Open diamonds are assessed streams in other HPAs. Solid line represents the trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

4.4.2.6.3 LWD Inventory

LWD surveys/inventories were conducted in 1994 and 1995 in five streams within the Coastal Klamath HPA: Hunter, Terwer, North Fork Ah Pah, South Fork Ah Pah, and Ah Pah creeks (see Appendix C2 for details). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The summary of the results of these investigations are presented in Figure 4-12 (A-C) (see Tables C2-2 and C2-8 for data). Data for LWD in Prairie Creek also are included to provide an additional point of comparison.

Results indicate the following regarding the LWD inventories for the five assessed streams in the Coastal Klamath HPA:

- As shown in Figure 4-12 (A), the average number of in-stream LWD pieces per 100 feet of channel for the five assessed streams (2.6 to 5.7 pieces) is similar to that assessed streams of similar watershed size in other HPAs and lower than the LWD count for Prairie Creek (6.8 pieces per 100 feet of channel).

- As shown in Figure 4-12 (B), the LWD volume indices for these assessed streams are similar to those for other assessed streams of similar watershed area, with the exception of Terwer Creek. Terwer Creek has a greater LWD volume index for its watershed size than the two other assessed streams of comparable watershed area. This indicates that LWD in Terwer Creek has a greater average piece size and therefore the volume index is greater. Prairie Creek had a volume index approximately twice that of assessed streams of similar watershed area.

- The five assessed streams tend to be on the upper end of the 16 streams where LWD counts were conducted in the riparian recruitment zone (Figure 4-12 [C]). South Fork and North Fork Ah Pah and mainstem Ah Pah creeks had three of the four highest average LWD piece counts per 100 feet of recruitment zone of all streams assessed in the 11 HPAs.

4.4.2.6.4 Long Term Channel Monitoring

Channel monitoring is ongoing in four locations within the Coastal Klamath HPA: two sites on Hunter Creek, one on Hoppaw Creek, and one on Tectah Creek. Monitoring began in 1996 on one site in Hunter Creek and in 1997 at the other three sites. (See Appendix C3 for details and data collected.) No conclusions can be drawn at this point in the monitoring.

4.4.2.6.5 Estuarine Conditions

The Klamath River estuary has been impacted by human activities like most north coast watersheds. The lower channel has lost some its wetland habitat to residential development. The estuary has been degraded by excessive sedimentation from the upper basin. The lower channel was also extensively cleared of snags and large woody debris at the turn of the century for commercial gillnetting and navigational purposes.

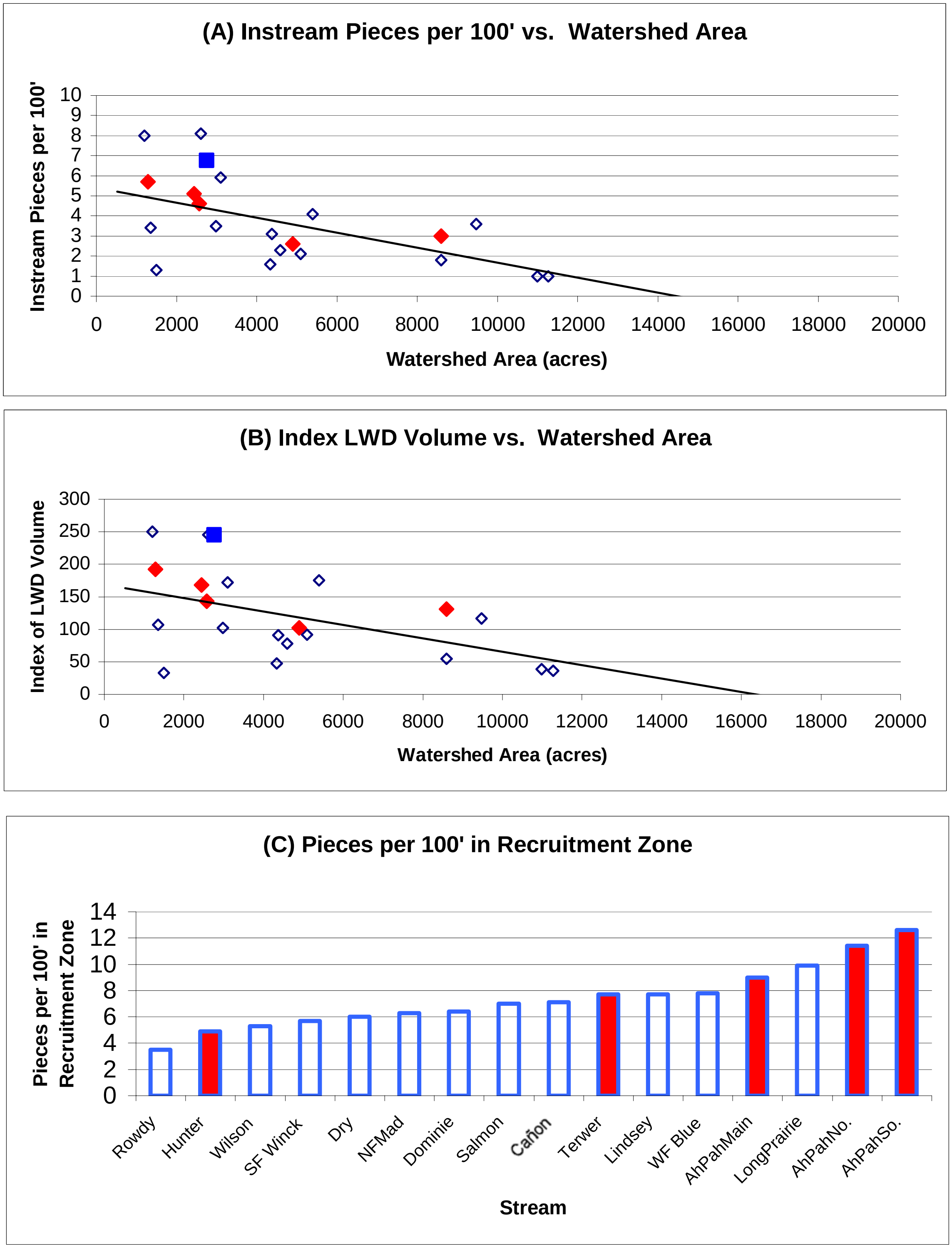


Figure 4-12. **LWD survey results for five assessed streams in the Coastal Klamath HPA. (Solid diamonds are the assessed streams in Coastal Klamath HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

Water diversions from the upper Klamath and Trinity River basins affects the water quality of the estuary during summer months and probably contributes to the occasionally high water temperatures. Even with a large volume of flow, the Klamath River mouth periodically bars over and back floods the lower river for several miles.

4.4.2.7 Salmonid Population Estimates

Salmon, steelhead, and coastal cutthroat trout population estimate surveys have been conducted only for Hunter Creek in this HPA; direct observation surveys have been conducted on a number of streams within the Coastal Klamath HPA (see Appendices C7 and C9 for details).

4.4.2.7.1 Juvenile Summer Population Estimates

Figure 4-13 (A-C) summarizes summer population estimates for Hunter Creek conducted in 1998-2000 for juvenile coho salmon, steelhead, and coastal cutthroat trout. As seen in Figure 4-13 (A), the number of juvenile coho salmon in Hunter Creek in 1998 was estimated to be 400 juveniles. Surveys in 1999 and 2000 found no juvenile coho present in the reaches surveyed, and therefore no population estimates could be made for those years. Steelhead population estimates for Hunter Creek ranged from nearly 900 juveniles in 1999 to greater than 2,000 juveniles in 2000 (Figure 4-13 [B]). The number of juvenile coastal cutthroat trout estimated in Hunter Creek in 2000 was 50 (Figure 4-13 [C]). There were no cutthroat present during surveys conducted in 1998 and 1999. In summary, there is variability in annual estimated juvenile steelhead populations in Hunter Creek. However, the juvenile steelhead population appears to be relatively robust and stable. Summer population estimates for coho and cutthroat indicated there are small numbers of juveniles of these species present with some variability in these populations in Hunter Creek.

4.4.2.8 Covered Species Occurrence and Status

Presence/absence of the six Covered Species in the Coastal Klamath HPA is presented by drainage in Table 4-5, and the recorded distribution of species is displayed in ***Figure 4-14***.

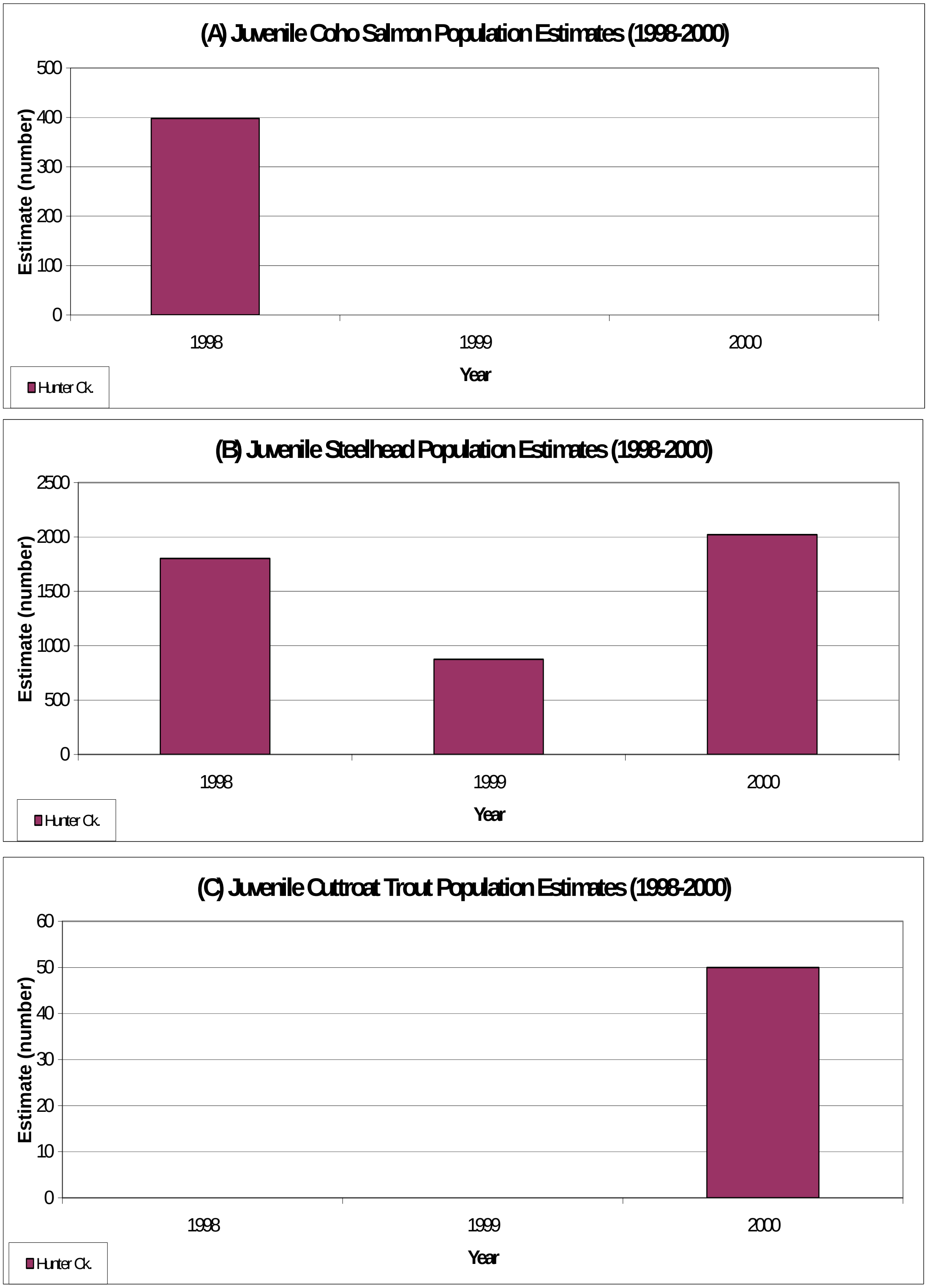


Figure 4-13. Summary of the summer juvenile salmonid population estimates for the years 1998 through 2000 for Hunter Creek in the Coastal Klamath HPA.

4.4.2.8.1 Chinook Salmon

The Coastal Klamath HPA includes the Southern Oregon/Northern California and Upper Klamath/Trinity Rivers Chinook ESUs. The Southern Oregon/Northern California Chinook ESU was determined to not warrant listing as of September 1999 (64 FR 50394). Within this ESU as a whole, juvenile production is thought to be increasing in the Winchuck River, and the Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5). Chinook escapement in the Klamath Basin is greatly reduced from historic estimates, and current escapement levels are dependent on hatchery production (Voight and Gale 1998) (Busby et al. 1996). The Upper Klamath-Trinity Rivers Chinook ESU was determined to not warrant listing in March 1998. These chinook migrate through the Klamath HPA as adults or as out-migrant smolts.

Table 4-5. Covered Species distribution in the Coastal Klamath HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Klamath River	3,4	1,3,4	3,4	3,4	3	3
Hunter Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
High Prairie Creek	2	1	2	2	U	U
Salt Creek	P	1,2	2	2	A	A
Mynot Creek	3,4	1	2,3,4	2,3,4	3	3
Saugep Creek	3,4	1,2,3,4	2,3,4	2,3,4	P	P
Hoppaw Creek	A	1,2,3,4	2,3,4	3,4	3	3
Waukell Creek	U	1,2	2	2	U	U
Terwer Creek	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Dandy Creek	U	U	P	P	3	P
South Fork Terwer Creek	U	U	P	P	P	3
McGarvey Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
Tarup Creek	2,3,4	1,3,4	2,3,4	2,3,4	3	3
Omagar Creek	2	1,3,4	2,3,4	2,3,4	3	3
Ah Pah Creek	2	1,2,3,4	2,3,4	2,3,4	3	3
North Fork Ah Pah Creek	A	A	2,3	2	3	3
South Fork Ah Pah Creek	P	1,2,3,4	2,3	2,3	3	3
Bear Creek	P	1,3,4	2,3,4	3,4	3	3
Surpur Creek	2	1,2	2,3,4	2,3,4	3	3
Little Surpur Creek	A	A	2,3,4	P	P	3
Tectah Creek	2,3	1,2,3,4	2,3	2,3,4	3	3

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records in 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records
4= Present based on Yurok Tribal Fisheries Program

4.4.2.8.2 Coho Salmon

Coho salmon populations are depressed throughout the Southern Oregon/Northern California Coasts Coho ESU, which encompasses the Coastal Klamath HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995). This ESU was listed as threatened in May 1997 (62 FR 24588). Coho salmon runs in the Klamath Basin are greatly diminished from historical estimates and are largely hatchery supported today, although small wild runs exist in some tributaries (Weitkamp et al. 1995). Juvenile coho were present in 8 of 12 tributaries sampled by the Yurok Tribal Fisheries Program within the Coastal Klamath HPA in 1996 (see Table 4-5), but were generally scarce and narrowly distributed within these tributaries (Voight and Gale 1998). The ratio of wild fish to hatchery fish spawning naturally in these tributaries is unknown.

4.4.2.8.3 Steelhead and Resident Rainbow Trout

The Coastal Klamath HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 2001 (66 FR 17845). Attempts to assess the status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally spawning fish with hatchery fish and downward trends in abundance in most populations (Busby et al. 1994). Specific information on steelhead in the Coastal Klamath HPA is limited. The Yurok Tribal Fisheries Program sampling found juvenile steelhead to be well distributed in Coastal Klamath tributaries (100% presence, n=12 tributaries sampled), but no estimates of abundance were made (Voight and Gale 1998). Steelhead populations in the Klamath River as a whole are significant, (summer/fall-run size of 110,000, winter-run size 20,000) but believed to be largely hatchery supported (Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.2.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999).

The Yurok Tribal Fisheries Program found juvenile coastal cutthroat trout to be well distributed and relatively abundant in Coastal Klamath HPA tributaries (present in 10 of 12 tributaries sampled). However, the dominance and abundance of (presumably) resident cutthroat in areas above barriers to anadromy could mask declines in anadromous sea-run coastal cutthroat trout populations (Voight and Gale 1998). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.2.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in 17 streams within this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Coastal Klamath HPA, 16 of 17 (94.1%) of the sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 26 other streams in the HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the Coastal Klamath HPA seem to be in excellent condition.

4.4.2.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in 16 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Coastal Klamath HPA, 15 of 16 (93.8%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 81 other streams in this HPA either through other types of amphibian surveys or incidental observations. Given this high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Coastal Klamath HPA appear to be in excellent condition.

4.4.2.9 Assessment Summary

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good throughout the Original Assessed Ownership in the Coastal Klamath HPA. Although the HPA is less subject to deep-seated instability compared with many of the other HPAs, it is highly susceptible to shallow landslides, and some streams have relatively high levels of sediment inputs. In most of the HPA, the steep slopes are composed of relatively competent (consolidated) geologic parent material, so that stream substrates remain coarse in most streams---even those with high sediment inputs. Exceptions are found in some of the more extreme coastal sub-basins, such as Waukell and McGarvey Creeks, where unconsolidated material results in a fining of the bed. The amount and quality of pool habitat in streams on the Original Assessed Ownership in this HPA are generally consistent with assessed streams in other HPAs, but this is probably less than optimum for salmonids. With a few exceptions, most Class I watercourses on the Original Assessed Ownership in this HPA also are generally deficient in the larger classes of LWD due to past timber management and active removal programs. Because the current canopy on these watercourses is predominately made up of red alder, the potential for future LWD within the timeframe of this Plan is limited.

All of the Covered Species are common throughout the Original Assessed Ownership in the Coastal Klamath HPA, indicating that conditions are adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership in this HPA limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in at least some streams. There is ample spawning habitat for the salmonid species in most streams due to coarse sediment inputs. However, the general lack of pools and LWD suggest that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area in this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats. In addition, the Plan Area in this HPA should have a high priority for addressing road-related sediment inputs.

4.4.3 Blue Creek HPA

4.4.3.1 HPA Type, Size, and Group

The Blue Creek HPA is a hydrologic unit as defined in this Plan and includes 80,303 acres. It is part of the Coastal Klamath HPA Group.

4.4.3.2 Eligible Plan Area

The Eligible Plan Area in the Blue Creek HPA includes approximately 15,428 acres: 15,393 acres of Initial Plan Area and 35 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.3.3 Geology

The Blue Creek HPA is predominantly within the Klamath Mountain Geologic Province, and its western quarter is underlain by Coast Ranges geology (see ***Figure 4-1***). The majority of the Blue Creek HPA (i.e., the central and eastern areas of the unit) is underlain by Klamath Mountains bedrock. The bedrock in the remaining portion of the HPA is composed of Franciscan Complex rocks. The inactive South Fork Fault separates the Coast Ranges Province from the Klamath Mountains Province.

This HPA is primarily underlain by Franciscan Complex rocks. From east to west, the bedrock consists of small patches of partially to completely serpentinized ultramafic bedrock of the Josephine Ophiolite, the South Fork Mountain Schist unit of the Franciscan Eastern Belt, and meta-sandstone and mudstone of the Franciscan Central Belt.

The topography of the Blue Creek HPA generally is characterized by steep terrain and is similar to the steep topography within the Coastal Klamath HPA. Elevations and slope gradients increase toward the east of the HPA in the bedrock of the Klamath Mountains province. Specific data on landslides in this HPA were unavailable for review, but it is thought that landslide processes in this hydrologic unit are dominated by shallow debris slides and debris flows in the Klamath terranes, and there is also considerable potential for deep-seated landslides within this HPA.

4.4.3.4 Climate

Precipitation in the Blue Creek headwaters averages 100 inches annually, 75% of which falls between November and March (Helley and LaMarche 1973, as cited in YTF Tech. Rep. #4 1998). The seasonal nature of the precipitation leads to large seasonal variations in stream flow, ranging from a low of 43 cfs to a high of 33,000 cfs over the period 1965 to 1978. (USGS, unpublished data, as cited in YTF Tech. Re. #4 1998). Air temperatures in the region are mainly affected by the coastal marine climate, with daily high temperatures ranging from 40-70^{o}F annually. During the summer, the climate is moderated by coastal fog which reduces solar radiation and contributes moisture by fog drip.

4.4.3.5 Vegetation

Blue Creek's elevation range (50 to 5700 feet) and its location at the inland edge of summer fog intrusion provide for a diverse association of forest types. At the mouth of Blue Creek, coastal redwood/Douglas-fir forest predominates, and redwood persists nearly to Green Diamond's property line, approximately 7 miles upstream. Six Rivers National Forest owns the entire HPA above Green Diamond's property, and the forest there progresses from Douglas-fir/tanoak at lower elevations to a montane conifer forest more typical of the Klamath Mountains at higher elevations, with Douglas-fir and white fir the primary overstory species. As in the Coastal Klamath HPA, serpentinaceous soils on South Red Mountain generate a vegetative cover type above 2500 to 3000 feet that is dominated by manzanita, with knobcone pine, ponderosa pine, and Port-Orford-cedar at the transition and persisting upslope in the bottom of many watercourses. This same soil-vegetation complex occupies over much of the Slide Creek subwatershed that is mostly within the National Forest on the south slope of Blue Creek.

Timber harvesting operations began around 1960 in this HPA and by 1990 all but scattered remnants of the original forest on Green Diamond's property had been harvested. Very little timber harvesting has occurred within the 80% of this watershed owned by the National Forest and roughly 40% of that ownership is in the Siskiyou Wilderness Area.

4.4.3.6 Current Habitat Conditions

4.4.3.6.1 <u>Water Temperature</u>

Water temperature monitoring in the Blue Creek HPA 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 23 summer temperature profiles were recorded at 7 sites within 7 Class I watercourses. An additional 5 summer temperature profiles were recorded at 3 headwater sites within 2 Class II watercourses.

Figure 4-15 displays the 7DMAVG water temperature for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow thresholds of this Plan. The results for the period (1994-2000) indicate that none of the Class I sites exceeded the red or yellow light thresholds and two of the Class II sites exceeded the yellow light threshold (lower Potato Patch Creek in 1996 and upper Potato Patch in 1997).

4.4.3.6.2 Channel and Habitat Typing

Channel and habitat typing assessments have been conducted in four streams in the Blue Creek HPA. The assessments were conducted by the Yurok Tribal Fisheries Program. The four assessed streams (in descending order of mid-point watershed area), their mid-point watershed area, and their gradient are as follows:

Stream	Mid-point Watershed Area	Mid-point Gradient
Blue Creek	38,563 acres	2.0%
West Fork Blue Creek	4,372 acres	6.1%
Slide Creek	3,414 acres	6.6%
Potato Patch Creek	2,820 acres	5.7%

The results of the assessments for West Fork Blue Creek, Slide Creek, and Potato Patch Creek are summarized below and in Figure 4-16 (A-F) (see Table C1-4 in Appendix C1 for data). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs. Assessment results for Blue Creek are not presented in Figure 4-16 (A-E) because the watershed area for this stream is greater than 38,000 acres but are included in the analysis of gradients in Figure 4-16 (F). The results for the assessed streams in this HPA indicate the following:

- Compared with other assessed streams in the 11 HPAs, Slide Creek has a much lower percentage canopy closure (38%) than did all but one other stream regardless of watershed area (Figure 4-16 [A]). However, the canopy cover in Slide Creek consists of 77% conifer, a much greater percentage than in other assessed streams (Figure 4-16 [B]).

- West Fork Blue, Slide, and Potato Patch creeks has a somewhat lower percentage of stream length in pools than other assessed streams with similar watershed area (Figure 4-16 [C]). Also, the percentage of LWD as structural cover in pools in these streams is lower than in almost all other assessed streams of comparable watershed area (Figure 4-16 [D]). The average residual pool depths in these three streams are shallow (1.5 feet to 2.2 feet) but appear to be similar to other assessed streams of similar watershed area (Figure 4-16 [E]).

- Substrate embeddedness indices for the all four assessed streams in this HPA are somewhat variable, and three of the streams had a much greater gradient that most other assessed streams in the HPAs (Figure 4-16 [F]). Blue Creek was included in the analysis of embeddedness in relation to stream gradient, and the results indicate that this stream has a rather low index of substrate embeddedness (see Figure 4-16 [F]).

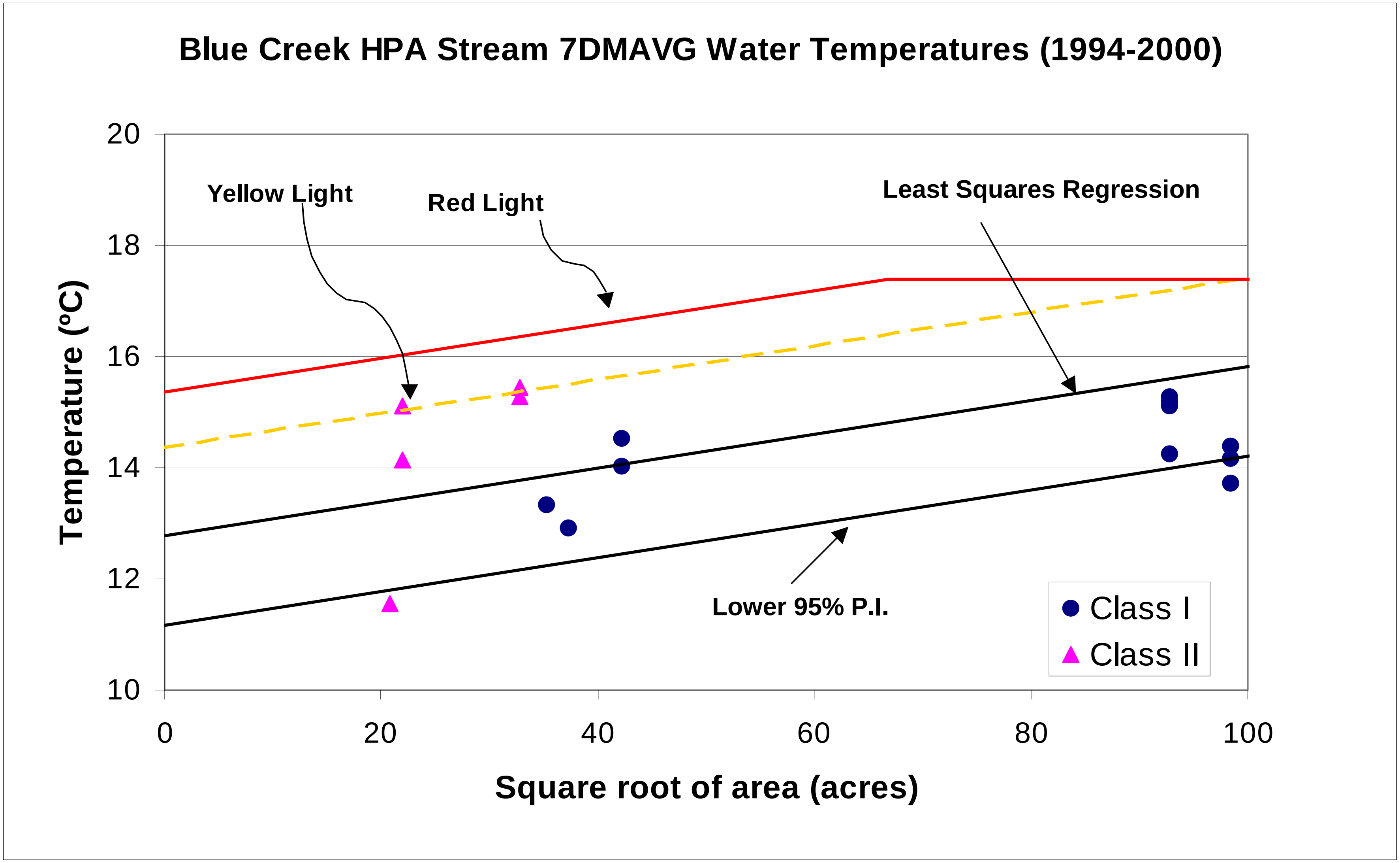


Figure 4-15. 7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Blue Creek HPA monitored between 1994 and 2000.

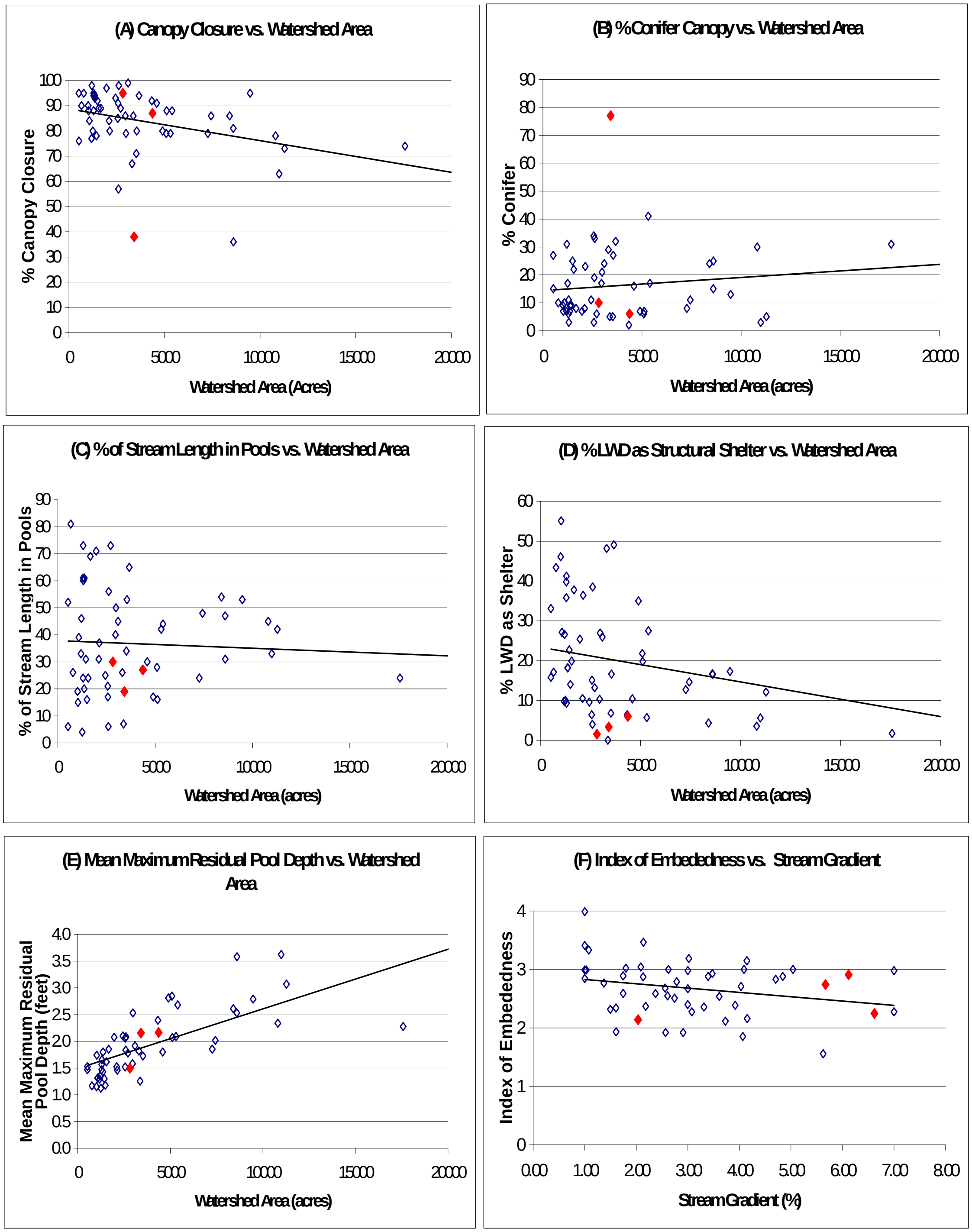


Figure 4-16. **Channel and habitat types in streams assessed in the Blue Creek HPA. (Solid diamonds are assessed streams in Blue Creek HPA; Blue Creek not included in A-E. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)**

In summary, these results suggest that the habitat in the assessed streams in this HPA in many instances is similar to that in other assessed streams of similar watershed area. There are, however, some habitat differences. West Fork Blue, Slide, and Potato Patch creeks on average had a lower percentage of stream length in pools, and their pools contained lower percentages of LWD as cover structure than most of the other assessed streams. All four assessed streams also had greater stream gradients than most other assessed streams on the Original Assessed Ownership.

4.4.3.6.3 <u>LWD Inventory</u>

LWD survey/inventories were conducted in 1994 and 1995 in 1 stream (West Fork Blue Creek) within the Blue Creek HPA (see Appendix C2). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of in-stream and riparian LWD.

Results of the assessment are summarized below and displayed in Figure 4-17(A-C) (see Tables C2-3 and C2-9 in Appendix C2 for data).

- As shown in Figure 4-17 (A) the average number of in-stream LWD pieces per 100 feet of channel for West Fork Blue Creek is somewhat greater than in other assessed streams with similar watershed area. The average number of LWD pieces per 100 feet of channel for West Fork Blue Creek was approximately 3.1 pieces. However, this is less than one-half of the LWD count in Prairie Creek (6.8 pieces per 100 feet of channel).

- The index volume of LWD for West Fork Blue Creek is shown in Figure 4-17 (B). The index is similar but somewhat greater than that for other assessed streams of similar watershed area. Prairie Creek had a volume index approximately twice that for all assessed streams of similar watershed size and almost 3 times that for West Fork Blue Creek.

- As shown in Figure 4-17 (C), West Fork Blue Creek is on the upper end of the set of the 16 streams assessed for LWD in the riparian recruitment zone. The average number of LWD pieces per 100 feet of recruitment zone in West Fork Blue Creek is determined to be 7.7 (see Figure 4-17 [C]). This piece count is similar to that for Terwer Creek in the Coastal Klamath HPA and Lindsey Creek in the Mad River HPA.

4.4.3.7 Salmonid Population Estimates

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.

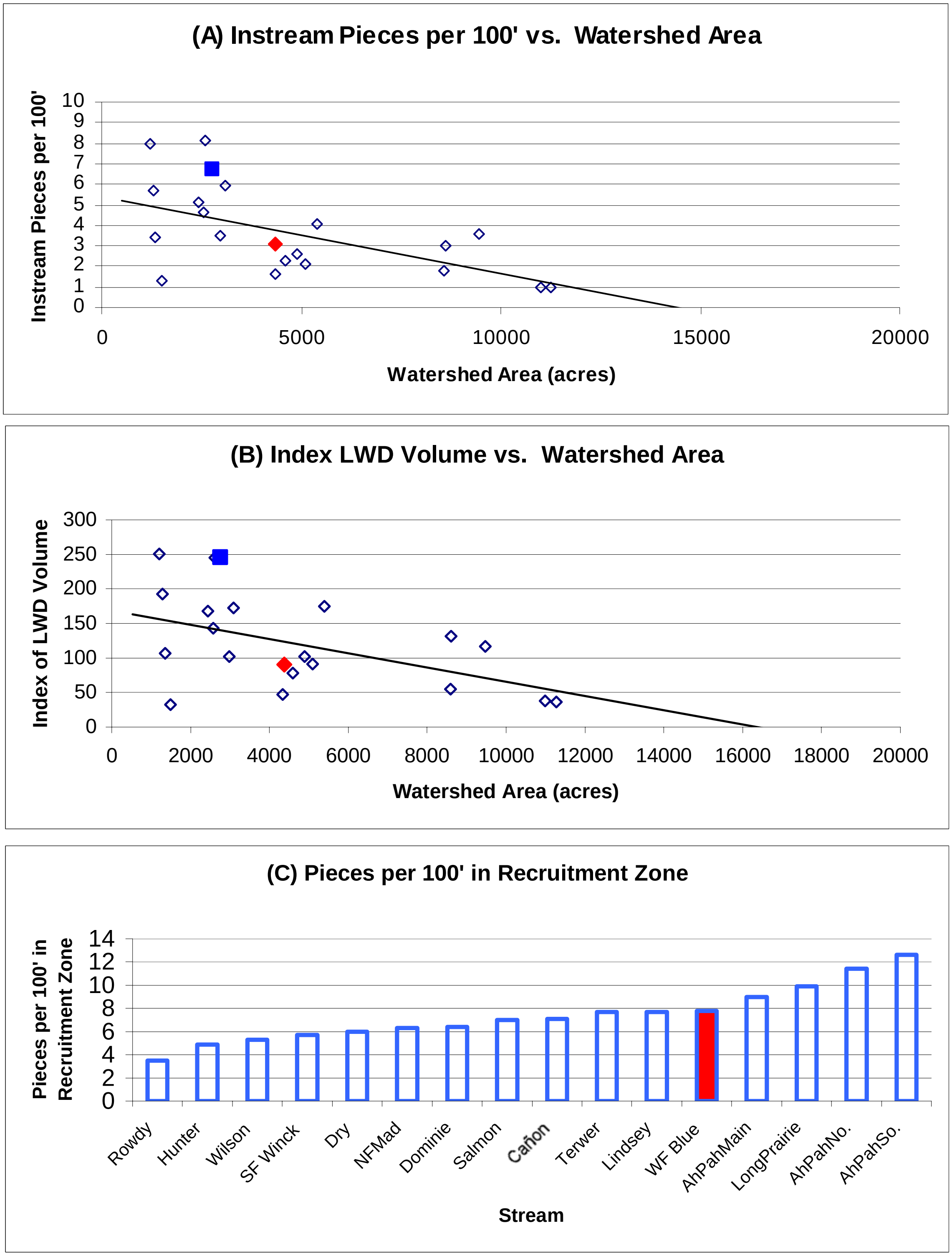


Figure 4-17. **LWD survey results for one stream assessed in the Blue Creek HPA. (Solid diamond is West Fork Blue Creek. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

4.4.3.8 Covered Species Occurrence and Status

Presence/absence of the six Covered Species in the Blue Creek HPA is presented by drainage in Table 4-6; the recorded distribution of the species is shown in ***Figure 4-18***.

4.4.3.8.1 Chinook Salmon

The Blue Creek HPA is in the Southern Oregon and Northern California Chinook ESU, which was determined to not warrant listing as of September 1999 (64 FR 50394). In this ESU as a whole, juvenile production is thought to be increasing within the Winchuck River, and the Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in these smaller coastal streams (64 FR 50404-5).

Blue Creek chinook populations have been monitored by the USFWS (1988 to 1992) and are currently monitored by the Yurok Tribal Fisheries Program. Chinook escapement in the Klamath Basin is greatly reduced from historic estimates. Blue Creek has a significant but variable chinook salmon population which has shown an increasing trend of adult escapement and juvenile out-migrant abundance during the period from 1988 through 1996. (Gale et al. 1998) (Busby et al. 1996). Compared with other non-hatchery supported tributaries of the Klamath basin with similar drainage areas, Blue Creek is thought to contribute a significant component to the wild chinook run within the Klamath River (Gale et al. 1998).

Table 4-6. Covered Species distribution in the Blue Creek HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Klamath River	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Blue Creek	2,3,4	1,2,3,4	2,3,4	2,3,4	3	3
Pularvasar Creek	U	1,3,4	2,4	P	P	3
One Mile Creek*	3,4	1,3,4	3,4	3,4	4	P
West Fork Blue Creek	2,3	1,2	2,4	P	3	3
Potato Patch Creek	A	1	2	P	3	3
Coyote Creek	U	U	U	U	3	3
Indian Creek	U	U	U	U	3	3
Slide Creek	A	A	2,3,4	P	P	P
Nickowitz Creek	4	1	2,3,4	P	P	P

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records
4= Present based on Yurok Tribal Fisheries Program

4.4.3.8.2 Coho Salmon

The Blue Creek HPA includes Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU, and current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

The Blue Creek HPA is somewhat unusual in that it supports a significant population of native coho salmon with no evidence of hatchery produced fish in a river system characterized by heavy hatchery production and planting within many tributaries (Weitkamp et al. 1995, Gale et al. 1998). Estimates of and trends in spawner escapements are hampered by low numbers of spawners and the difficulty in enumerating adult coho salmon, especially during the high flow/poor visibility conditions. Qualitative snorkeling surveys indicate that portions of the Blue Creek HPA (especially the Crescent City Fork) have ideal spawning and rearing habitat for coho, and juvenile coho were observed utilizing this habitat in high densities (Gale et al. 1998).

4.4.3.8.3 Steelhead and Resident Rainbow Trout

The Blue Creek HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing in April 2001(66 FR 17845). Attempts to assess the status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally spawning fish with hatchery fish, and downward trends in abundance in most populations (Busby et al. 1994).

The Blue Creek HPA has ideal habitat for steelhead and is thought to contain a large population of winter-run steelhead as well as a small number of summer-run steelhead. Snorkel surveys found juvenile steelhead to be abundant and well distributed throughout Blue Creek (Gale et al. 1998).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.3.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not warrant listing (64 FR 16397). The population in this HPA is a part of that ESU.

Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999). The Yurok Tribal Fisheries Program reports that Blue Creek supports a small population of coastal cutthroat trout (Gale et al. 1998).

4.4.3.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in three streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Blue Creek HPA, 2 of 3 (66.7%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 7 other streams in the HPA either through other types of amphibian surveys or incidental observations.

A relatively small portion (19.2%) of the HPA is Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, this HPA appears very similar to the Coastal Klamath HPA, which appears to have excellent habitat for tailed frogs. The limited data collected are not inconsistent with this conclusion, and Green Diamond concludes that tailed frogs streams in the Blue Creek HPA are also likely to be in excellent condition.

4.4.3.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in four streams in this HPA. The surveys were part of a sampling of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Blue Creek HPA, 4 of 4 (100%) streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 32 other streams in this HPA either through other types of amphibian surveys or incidental observations.

A relatively small portion (19.2%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, this HPA appears very similar to the Coastal Klamath HPA, which appears to have excellent habitat for torrent salamanders. The limited data collected are consistent with this conclusion, and Green Diamond concludes that southern torrent salamander streams in the Blue Creek HPA are also likely to be in excellent condition.

4.4.3.9 Assessment Summary

Water temperatures are generally good throughout the Original Assessed Ownership in the Blue Creek HPA. The fact that some Class II watercourse reaches had water temperatures at the yellow light threshold is an indication of warmer summer temperatures in this interior region. The geologic parent material is apparently relatively well-consolidated, resulting in generally coarse stream substrates in the region. Within the Original Assessed Ownership in this HPA, Class I watercourses are generally deficient in LWD; but due to the small portion (19.1%) of the HPA in Green Diamond's ownership, it is not known if this is applies to the entire HPA.

All of the Covered Species are relatively common throughout the Original Assessed Ownership in the Blue Creek HPA, indicating that conditions are adequate for most species in most streams. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species even though two Class II watercourse reaches had temperatures that reached the yellow light threshold. This conclusion is based on the presence of both of the amphibian Covered

Species in the stream for which the yellow light threshold was recorded. There is ample spawning habitat for the salmonid species in most of the streams due to coarse sediment inputs. However, the general lack of pools and LWD suggest that salmonid numbers may be limited by the amount and/or quality of summer and winter rearing habitat. The abundance of the amphibian Covered Species in the Original Assessed Ownership in this HPA is consistent with this conclusion, because these amphibians are closely tied to streams with coarse substrate and do not appear to be dependent on pool habitat with LWD for cover.

Assuming these conclusions are correct, the primary management emphasis within the Plan Area of this HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses. Given the extended time necessary to recruit LWD through natural processes, the Plan Area of this HPA should be evaluated for restoration activities that have the potential to provide short-term increases in quality summer and winter rearing habitats.

4.4.4 Interior Klamath HPA

4.4.4.1 HPA Type, Size, and Group

The Interior Klamath HPA is a hydrographic area as defined in this Plan and includes 128,006 acres. It is part of the Korbel HPA Group.

4.4.4.2 Eligible Plan Area

The Eligible Plan Area in the Interior Klamath HPA includes approximately 109,357 acres: 66,130 acres of Initial Plan Area and 43,217 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.4.3 Geology

Bedrock in this HPA is primarily composed of the Coast Ranges Franciscan Complex, with Klamath Mountains bedrock present in limited areas at the eastern margin (see ***Figure 4-1***). The inactive South Fork Fault is the major structural feature in the HPA.

Most of the HPA is underlain by the Franciscan Complex bedrock. The bedrock is roughly divided between Central Belt sandstone and mudstone and the Eastern Belt South Fork Mountain Schist. Limited portions of the eastern margin of the area are underlain by Klamath Mountains volcanics and metavolcanics.

Specific landslide data for this HPA were unavailable for review. However, it is assumed that landslide processes in this HPA are dominated by shallow landslide types and that deep-seated landslides also likely exist.

4.4.4.4 Climate

The large size of the Klamath basin and its geographic differences result in a wide range of climatic conditions. For the entire basin, the weather can be generalized as having dry summers with hot daytime temperatures and wet winters with low to moderate temperatures. Peak air temperatures occur during July with a monthly average maximum of 65°F for the coast and 95°F inland. Precipitation is quite seasonal, with approximately 90% falling between October and March. Annual amounts vary from 20 inches to over 80 inches, depending on location. High intensity rainfall occurs during December-February and may cause flooding at times.

Snow occurs at higher elevations and some areas receive up to 80 inches annually. The highest instantaneous discharge ever recorded in the Klamath River was during the 1964 flood. At the town of Klamath the flow peaked at 650,000 cfs and caused considerable damage. Numerous Klamath River tributaries are still recovering from sediment inputs from this storm event.

In the South Fork Trinity sub-basin, the climate is generalized by hot, dry summers and cool, wet winters. The average annual precipitation for the South Fork basin is 30 to 60 inches, depending on altitude and distance from the Pacific Ocean. Most precipitation falls between November and March, with negligible amounts in localized areas between June and September. In higher elevations snow is a major component of the annual precipitation.

4.4.4.5 Vegetation

The Interior Klamath HPA spans the transition from coastal redwood/Douglas-fir forests to more mesic interior landscapes that are dominated by Douglas-fir/tanoak forests, with grasslands appearing on some drier ridge tops and south to west aspects.

On the east side of the Klamath River, redwood only occurs north of Cappell Creek and only on lower slopes along the river face. On the west side of the Klamath, redwood persists to the Redwood Creek divide in Roach Creek and throughout the area north and west of this tributary. Higher elevations at the eastern boundary of this HPA (4,000 - 4,500 feet) support montane conifer forests dominated by Douglas-fir and white fir. Red alder occurs in riparian zones along lower stream reaches throughout the HPA, and golden chinquapin can be found as a stand component on more xeric sites. Oregon white oak is common at the margins of grasslands, with California black oak also found on drier soils.

With the exception of the areas along the western margin of this HPA that are in Six Rivers National Forest, and some fragmented stands on the Hoopa Indian Reservation, most of the forest in this area is young growth originating from timber harvesting activities that occurred between the 1940s and the 1980s.

4.4.4.6 Current Habitat Conditions

4.4.4.6.1 <u>Water Temperature</u>

Water temperature monitoring on the Original Assessed Ownership in the Interior Klamath HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 24 summer temperature profiles were recorded at 13 sites in 10 Class I watercourses. An additional 6 summer temperature profiles were recorded at four headwater sites in 3 Class II watercourses.

Figure 4-19 displays the 7DMAVG (7 day maximum moving average) water temperatures for the each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for period (1994-2000) indicate that none of the Class I or Class II monitoring sites in this HPA exceeded the red or yellow light thresholds.

4.4.4.6.2 Channel and Habitat Typing

Channel and habitat typing assessments were conducted in 11 streams in the Interior Klamath HPA by the Yurok Tribal Fisheries Program in 1996-7 (see Appendix C1 for details). The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows:

Stream	Mid-point Watershed Area	Mid-point Gradient
Pecwan Creek	17,574 acres	3.5%
Roach Creek	10,808 acres	2.2%
East Fork Pecwan Creek	8,401 acres	4.1%
Tully Creek	7,264 acres	4.1%
Cappell Creek	5,312 acres	7.0%
Roach Creek Tributary	3,548 acres	2.6%
Mettah Creek	2,959 acres	2.8%
Morek Creek	2,562 acres	4.7%
Robbers Creek	2,106 acres	5.0%
South Fork Mettah Creek	1,558 acres	3.0%
Johnson Creek	1,307 acres	Not Available

The results of the assessments are summarized below and depicted in Figure 4-20 (A-F) (see Table C1-5 in Appendix C1 for data). The least squares regression displayed on the figure was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The assessments indicate the following regarding the 11 assessed streams:

- In general, the percentage of canopy closure for the 11 assessed streams (74-94%) is similar to the range for all assessed streams on the Original Assessed Ownership (Figure 4-20 [A]).

- For the most part, percentage conifer canopy cover for the 11 streams is typical (8-41%) of the range for other assessed streams of similar watershed area, with the exception of Johnson Creek (Figure 4-20 [B]). Johnson Creek has 3% conifer canopy cover, a much lower percentage that that in other assessed streams. Cappell Creek has one of the highest percentages of conifer canopy cover (41%) of all assessed streams on the Original Assessed Ownership.

- The 11 assessed streams in this HPA had typical percentages of stream length in pools (21-60% by length) compared with other assessed streams of similar watershed area (Figure 4-20 [C]). The percentage of LWD as structural cover in pools for the 11 streams was lower (1.7-19.9%) than that for most assessed streams with similar watershed area (Figure 4-20 [D]).

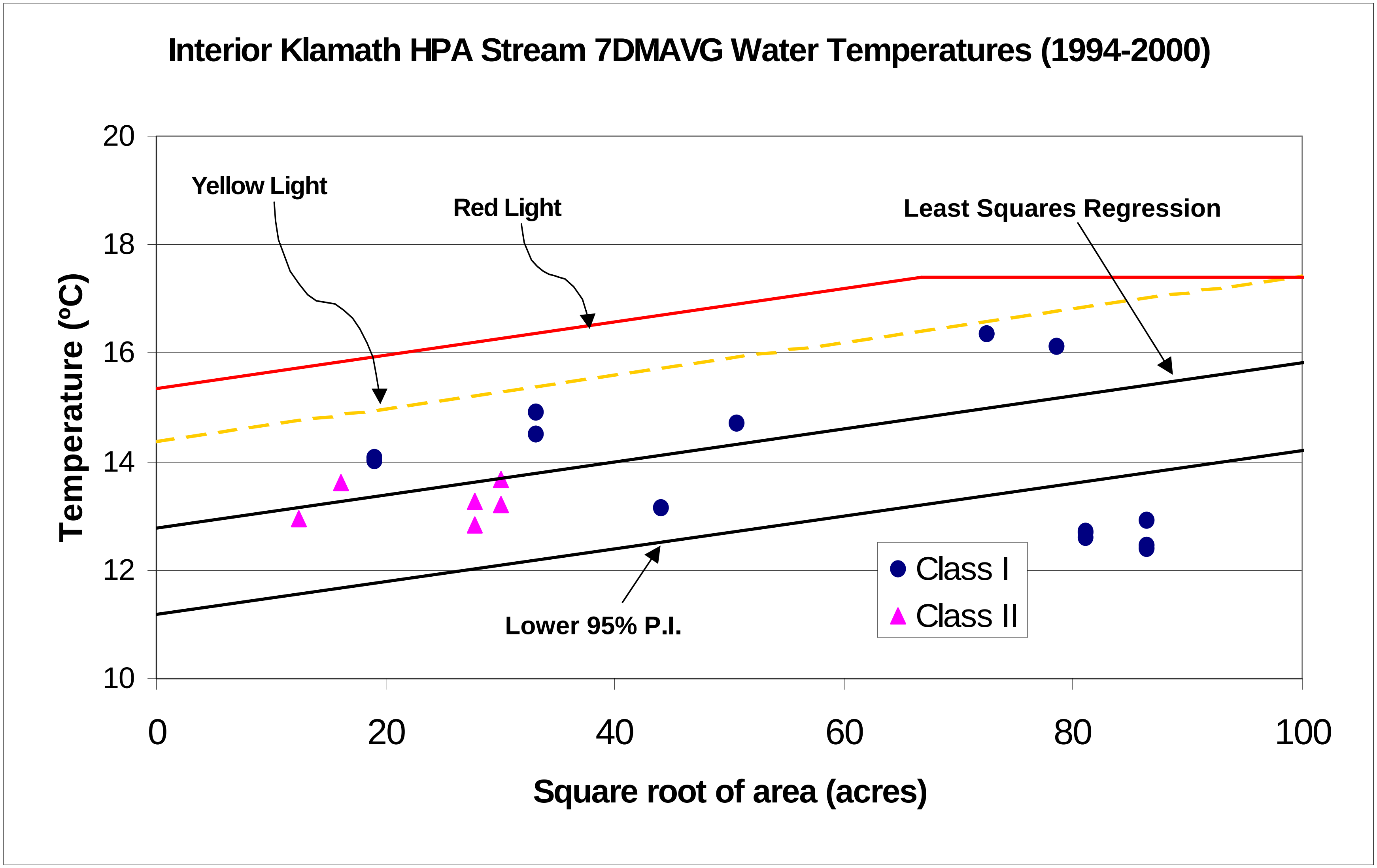


Figure 4-19. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Interior Klamath HPA monitored between 1994 and 2000.**

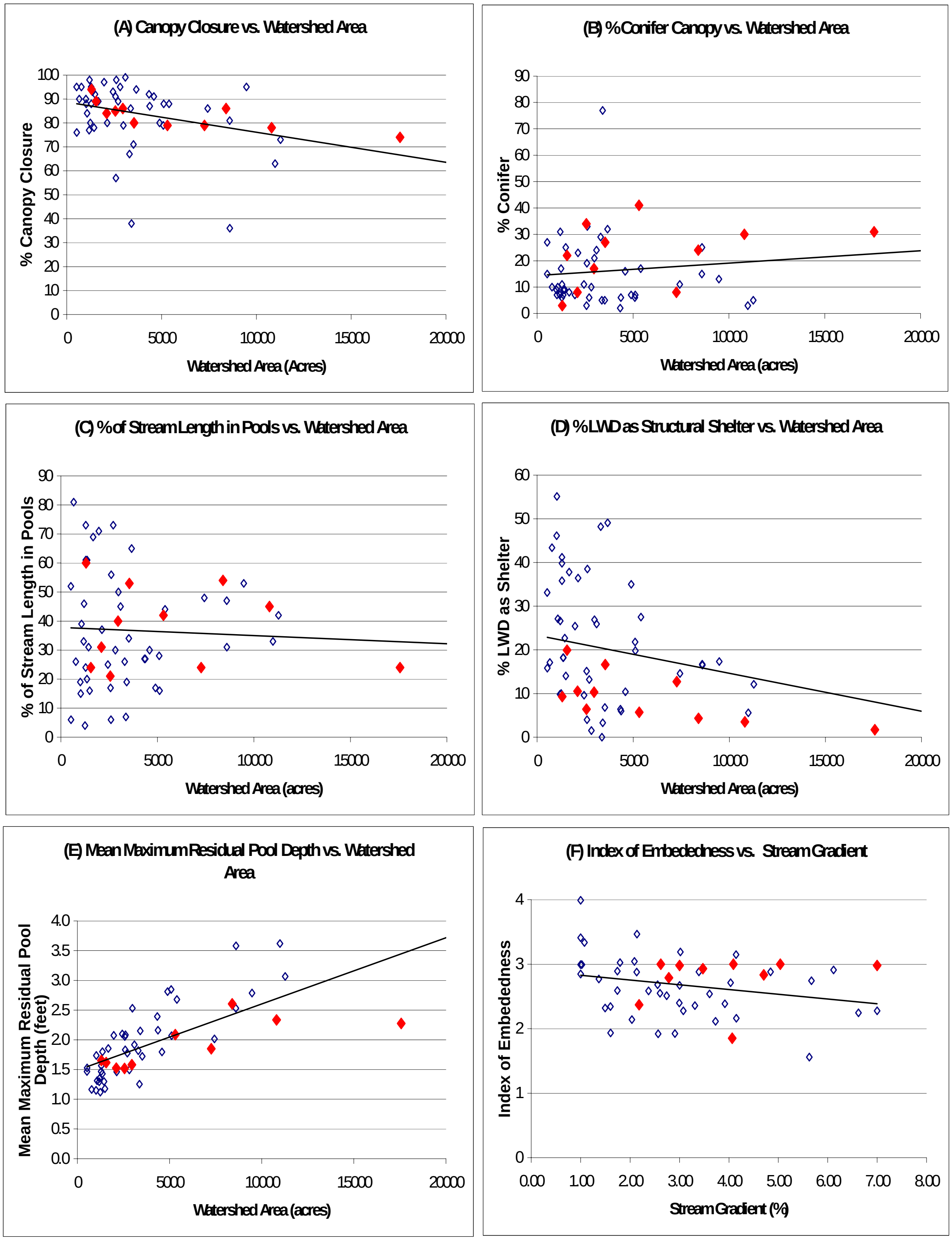


Figure 4-20. Channel and habitat types in 11 streams assessed in the Interior Klamath HPA. (Solid diamonds are assessed streams in the Interior Klamath HPA; Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

- The average residual pool depth in the 11 assessed streams varies somewhat but for the most part appears similar to all assessed streams on the Original Assessed Ownership (Figure 4-20 [E]). Pecwan Creek has lower than expected average residual pool depths (2.3 feet) for its watershed area. With the exception of Tully and Roach creeks, the assessed streams in this HPA have substrate embeddedness indices which are somewhat greater than other assessed streams in the HPAs, regardless of stream gradient (Figure 4-20[F]).

In summary, these results suggest that the habitat within the 11 assessed streams of the Interior Klamath HPA are, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The 11 streams in this HPA have on average a lower percentage of LWD as structural cover and many of the streams have greater embeddedness indices than other assessed streams.

4.4.4.7 Salmonid Population Estimates

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.

4.4.4.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in Interior Klamath HPA is presented by drainage in Table 4-7, and the recorded distribution of the species is displayed in ***Figure 4-21***.

4.4.4.8.1 <u>Chinook Salmon</u>

The Interior Klamath HPA includes the Southern Oregon/Northern California ESU and Upper Klamath-/Trinity Rivers Chinook ESUs.

The Southern Oregon/Northern California Chinook ESU was determined to not warrant listing as of September 1999 (64 FR 50394). In this ESU as a whole, juvenile production is thought to be increasing in the Winchuck River. The Smith River has the only known spring-run chinook population in coastal California. Chinook salmon are well distributed in smaller coastal streams, and recent increases in abundance have been noted in many of these (64 FR 50404-5).

The Upper Klamath-/Trinity Rivers Chinook ESU also was determined to not warrant listing. Specific information on chinook salmon escapements for streams within the Interior Klamath HPA is limited. Total chinook spawner escapement in the Klamath Basin is greatly reduced from historic estimates, and current escapement levels are supported by hatchery production (Voight and Gale 1998) (Busby et al. 1997).

Table 4-7. Covered Species distribution in the Interior Klamath HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Klamath River	2,3,4	1,2,3,4	2,3,4	2,3	3	3
Halagow Creek	A	A	2	U	P	3
Achelth Creek	A	A	U	U	3	P
Johnson Creek	2,3,4	1,3,4	2,3,4	3,4	P	3
Pecwan Creek	2	1	2	P	3	3
West Fork Pecwan Creek	A	A	2	P	P	3
Buzzard Creek	A	A	2	U	P	3
East Fork Pecwan Creek	A	A	2	P	3	3
Mettah Creek	2	1	2	P	3	3
Notchkoo Creek	A	A	A	A	P	P
Roach Creek	2	1,2,3,4	2,3,4	A	P	3
Morek Creek	A	A	2,3,4	A	3	3
Cappell Creek	2	A	U	A	P	P
Devil's Creek	A	A	U	A	P	P
Coon Creek	A	A	U	A	P	P
Tully Creek	P	1,2	2,3,4	A	3	3
Robbers Gulch	U	U	2	A	3	3
Pine Creek	P	1	2	A	U	U
Little Pine Creek	U	1	2	A	U	U
Bens Creek	U	A	U	A	U	U
Gist Creek	U	A	U	A	U	U
Cavanaugh Creek	U	A	U	A	P	3
Joe Marine Creek	U	A	U	A	U	U

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records
4= Present based on Yurok Tribal Fisheries Program

4.4.4.8.2 Coho Salmon

The Interior Klamath HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of the coho abundance in the 1940s (Weitkamp et al. 1995). Specific information on coho populations for streams within the Interior Klamath HPA is limited. Recent sampling (1996) by the Yurok Tribal Fisheries Program found juvenile coho in 2 of 3 tributaries which historically have been reported to have coho; observed numbers were low (Voight and Gale 1998).

4.4.4.8.3 Steelhead and Resident Rainbow Trout

The Interior Klamath HPA includes the Klamath Mountains Province Steelhead ESU, which was determined to not warrant listing as of April 2001 (66 FR 17845). Attempts to assess the population status of steelhead in this ESU are hampered by a lack of biological information. In general, there has been a replacement of naturally produced fish with hatchery fish, and downward trends in abundance in most populations (Busby et al. 1994).

Specific steelhead population abundance estimates for streams within the Interior Klamath HPA are generally non-existent. Yurok Tribal Fisheries Program sampling (1996) found juvenile steelhead are well-distributed in Interior Klamath tributaries (100% presence, n=4 tributaries sampled), but no estimates of abundance were made (Voight and Gale 1998). Steelhead populations in the Klamath River as a whole are significant (summer/fall-run size of 110,000, winter-run size 20,000) but thought to be largely hatchery-supported (Busby et al. 1994).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.4.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999). Short-term trends indicate increases in adult abundance in the lower Klamath River and its tributaries (Johnson et al. 1999).

Specific information on coastal cutthroat trout populations in the Interior Klamath HPA is almost non-existent. The Yurok Tribal Fisheries Program found coastal cutthroat in 1 of 4 tributaries in the HPA surveyed in 1996 (Gale et al. 1998). Gerstung (1997) suggests that coastal cutthroat typically do not occur above Mettah Creek. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.4.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in 11 streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Interior Klamath HPA, 7 of 11 (63.6%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 5 other streams in this HPA either through other types of amphibian surveys or incidental observations.

Given this moderate rate of occurrence and relatively small number of streams known to support the species, tailed frogs streams in the Interior Klamath HPA appear to be in only moderate condition.

4.4.4.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in 11 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Interior Klamath HPA, 10 of 11 (90.9%) streams sampled as part of this presence/absence survey had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 56 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given the high rate of occurrence and large number of streams known to support the species, southern torrent salamander streams in the Interior Klamath HPA appear to be in excellent condition.

4.4.4.9 Assessment Summary

Water temperatures are generally good throughout the Original Assessed Ownership in the Interior Klamath HPA, despite the warmer summer temperatures associated with this more interior region. Presumably this is due to the good canopy cover on streams in the Original Assessed Ownership this HPA. Like the Coastal Klamath HPA, the Interior Klamath is less subject to deep-seated instability than to shallow landslides and the relatively competent (consolidated) geologic parent material results in coarse stream substrates. Within the Original Assessed Ownership of this HPA, Class I watercourses are also generally deficient in LWD as cover in pools, but this is probably due to the abundance of steep confined channels that prevent LWD from being functional. In these streams, much of the pool formation is created by boulders and bedrock.

The Covered Species are relatively common throughout the Original Assessed Ownership in the Interior Klamath HPA; but in many of the Class I watercourses, only a small portion near the mouth is open to anadromy. Natural barriers associated with steep gradient reaches preclude coho and chinook salmon from the majority of many streams. Resident trout (rainbow and/or cutthroat) are the only salmonids that occur throughout much of the Class I watercourses. It is not likely that water temperature limits populations of any Covered Species in streams on the Original Assessed Ownership in this HPA. The steep gradients associated with many streams in this HPA limit the quantity and quality of the salmonid habitat, so that past management activities probably have had comparatively less impact on current habitat conditions relative to other HPAs. However, the relative lack of tailed frog populations in the Original Assessed Ownership in this HPA support the field observation that past management activities have substantially influenced many of the lower gradient headwater streams. These areas appear to have been impacted primarily by excessive sediment inputs. The abundance of southern torrent salamanders in the Original Assessed Ownership seems inconsistent with the relative lack of tailed frogs. However, Green Diamond's research on these two Covered Species indicates that torrent salamanders are primarily sensitive to direct impacts (harvesting activities that directly destroy a headwater seep or spring), whereas tailed frogs are more sensitive to indirect impacts from sediment inputs such as debris torrents initiated from legacy roads (Diller and Wallace 1999).

Based on these observations, the top conservation priority for the Plan Area in this HPA should be to address potential sediment inputs from legacy road sites.

4.4.5 Redwood Creek HPA

4.4.5.1 HPA Type, Size, and Group

The Redwood Creek HPA is a hydrographic unit as defined in this Plan and includes 188,335 acres. It is part of the Korbel HPA Group.

4.4.5.2 Eligible Plan Area

The Eligible Plan Area in the Redwood Creek HPA includes approximately 100,731 acres: 33,038 acres of Initial Plan Area and 67,693 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.5.3 Geology

The Redwood Creek HPA is within the Coast Ranges Geologic Province (see ***Figure 4-1***). Because substantial geologic mapping and research has been done in the Redwood Creek area, the geology, landform development, and mass wasting characteristics of this HPA are probably the best understood of all of the HPAs.

Over one-half of the HPA is composed of Redwood Creek Schist, Other major rock units in this HPA include the Incoherent Unit of Coyote Creek, the Coherent Unit of Lacks Creek, and the Sandstone and Melange of Snow Camp Mountain. Coastal plain and marine terrace sediments are located in the northern coastal portion of the HPA. These sediments are mainly composed of unconsolidated to slightly consolidated sands, silts, and gravels and may be as much as 300 feet thick.

Most of this HPA is underlain by the Redwood Creek Schist. Much smaller sections of the ownership, located to the east and southeast, are underlain by the Incoherent Unit of Coyote Creek and the Coherent Unit of Lacks Creek. A small section of the Plan Area, located at the southern tip of the HPA, is underlain by the Sandstone and Melange of Snow Camp Mountain.

The major bedrock units in the HPA are set apart from one another by a series of major northwest trending faults. The most notable of the faults found in this unit include the Grogan fault, which defines the channel of Redwood Creek and separates the Redwood Creek Schist from the Incoherent Unit of Coyote Creek. Other notable faults include Indian Field Ridge and Snow Camp Creek. The Indian Field Ridge fault separates the Incoherent Unit of Coyote Creek from the Coherent Unit of Lacks Creek. The Snow Camp Creek fault is located at the southern tip of the HPA and separates Redwood Creek Schist from the Sandstone and Melange of Snow Camp Mountain.

Many hillslopes in the Redwood Creek basin are unstable and highly susceptible to mass-movement failure because of the steepness of the terrain and the low shear strength of much of the underlying saprolite and residual soil. This is especially true in the Incoherent Unit of Coyote Creek, although shallow landslides also exist in the HPA. According to Colman (1973), at least 36% of the basin shows landforms that are the result of active mass movements or that are suggestive of former mass-movement failures. Complex associations of rotational slumping, translation, and earthflows are the most visually obvious forms of mass movement in the Redwood Creek basin. Some have clearly defined margins, but many gradually merge with less active areas of soil creep. On many earthflows, grass, grass-bracken-fern, and grass-oak prairie vegetation dominate in marked contrast to the mature coniferous forest or cutover land on more stable slopes.

Several lithologies occur within the Redwood Creek Schist, and the geomorphic expression of the different schist units is variable. Slopes underlain by the Redwood Creek Schist have gently convex profiles, and side-slope gradients commonly range from 20% to 40%. Both the Redwood Creek Schist and the South Fork Mountain Schist exhibit knobby topography in areas where greenstone units of tectonic blocks are included in the schist. Shallow, incised streams are a typical drainage feature of schist slopes (Cashman et al. 1995). In addition, some evidence of deep-seated, slow moving, landslide deposits have been identified in road cut exposures in the schist units (Cashman et al. 1995).

The sandstone and mudstone of the Coherent Unit of Lacks Creek have a distinct geomorphic expression. Sharp ridges, steep slopes and narrow V-shaped tributary canyons are characteristic of the landscape developed on these relatively resistant rocks. Slopes have straight to gently concave profiles, and slope gradients commonly range from 30% to 50%. In the Coherent Unit, streamside debris slides and debris avalanches are common in the inner gorges of tributaries (Cashman et al. 1995). In contrast to the steep terrain of the Coherent Unit, the bedrock of the Incoherent Unit of Coyote Creek forms a subdued rolling landscape having less deeply incised drainage networks and few high points and knobs formed by resistant rock types. Earthflows are preferentially developed in this unit, as are streamside debris slides along inner gorges.

Rocks in the Grogan Fault Zone are intermediate in texture and degree of metamorphism between the Redwood Creek Schist and the sandstone and mudstone units. The geomorphic expression of this area is similar to that of the Incoherent Unit of Coyote Creek, and streamside debris slides are concentrated along linear zones of sheared rocks parallel to the Grogan fault (Harden et al. 1981).

The landscape developed on the sandstone and melange unit of Snow Camp Mountain is generally more hummocky than other hillslopes in the HPA.. However, parts of the Snow Camp Mountain unit are underlain by massive sandstone and display steep slopes, prominent ridges, and V-shaped valleys, in contrast to the more rolling hummocky hillslopes underlain by melange. Tectonic blocks of greenstone and chert form prominent knobs and summits (Cashman et al. 1995). As in the Coherent Unit of Lacks Creek, streamside debris slides and debris avalanches are common in the inner gorges of tributaries and in steeper areas underlain by massive sandstone.

4.4.5.4 Climate

Precipitation in the Redwood Creek basin is highly seasonal, with 90% occurring between October and April. The annual average for the basin is almost 80 inches, with over 90 inches occurring in localized areas. December is usually the wettest month with about 17% of the annual total falling.

4.4.5.5 Vegetation

The Redwood Creek HPA supports cover types that range from Sitka spruce/Douglas-fir forest at the coast to Douglas-fir/white fir forest at the origin of Redwood Creek, 46 miles south-southeast of its mouth.

In the Redwood Creek watershed, the redwood/Douglas-fir type includes grand fir, western red cedar, and western hemlock on lower slopes near the coast and in riparian zones. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood. Aspect strongly affects the distribution of redwood within the watershed. Redwood persists roughly half way up the west side of the drainage, but only one-third of the way up the east side. The drier regime created by the west facing slope also leads, along with soil type differences, to the appearance of natural grasslands on the east side of the drainage approximately 10 miles from the mouth of redwood creek, while they do not appear on the west side until south of Highway 299, approximately two-thirds of the way up the drainage. These grasslands and associated true oak woodlands become more prominent in the upper portion of the watershed, leading to a history of agricultural use, principally livestock grazing, since white settlers arrived. The middle to upper reaches of Redwood Creek transition rapidly to Douglas-fir\tan-oak forest at the limits of the redwood type, and white fir becomes prevalent near the watershed's 5300-foot crest.

Agricultural development and the small town of Orick on the alluvial plain between Redwood Creek's estuary and the mouth of Prairie Creek constitute the only significant conversion of native forest to other uses within the drainage. Except for that area, roughly the lower third of the drainage is in Redwood National and Prairie Creek State parks. The parks support 25,000 acres of old growth uncut coniferous forest, principally redwood and redwood/Douglas-fir type, and another 1800 acres where logging has occurred but over 50% of the original stand remains. The remainder of the forested area within the watershed has been harvested since the 1930s, with very few sites that support any significant remnants of the original forest.

4.4.5.6 Current Habitat Conditions

4.4.5.6.1 Water Temperature

Water temperature monitoring on the Original Assessed Ownership in the Redwood Creek HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 15 summer temperature profiles were recorded at 7 sites within 6 Class I watercourses. An additional 22 summer temperature profiles have been recorded at 9 headwater sites within 7 Class II watercourses within the HPA. Figure 4-22 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that one Class I site (Coyote Creek) exceeded the yellow light threshold in 1999 and the red light threshold in 2000; one Class II site (Lake Prairie Creek) exceeded the yellow light threshold in 1999 and 2000.

4.4.5.6.2 Estuarine Conditions

After the flood of 1964, which inundated the town of Orick with five feet of water, the U.S. Army Corps of Engineers constructed a levee from Prairie Creek to the ocean. During low summer flows, the north and south sloughs of the estuary become isolated and anoxic. The lower three miles of Redwood Creek also are devoid of riparian vegetation and large woody debris because the Corps of Engineers requires that the levee's channel be clear of debris that may lessen its transport capacity.

4.4.5.7 Salmonid Population Estimates

Salmonid population surveys have not been conducted in the Initial Plan Area of this HPA.

4.4.5.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in the Redwood Creek HPA is presented by drainage in Table 4-8, and the recorded distribution of the species is displayed in ***Figure 4-23***.

4.4.5.8.1 Chinook Salmon

The Redwood Creek HPA is the northernmost boundary of the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance were cited in the decision to list this ESU as threatened (64 FR 50405).

Specific information on chinook in the Redwood Creek HPA is limited. Spawner escapement for fall chinook in Redwood Creek was estimated to be approximately 5,000 in the mid-1960s (Myers et al. 1998). Nehlsen et al. (1991) characterized fall-run chinook in Redwood Creek as at 'moderate risk of extinction', and a reanalysis by Higgins et al. (1992) resulted in an upgrade in status to 'stocks of special concern'.

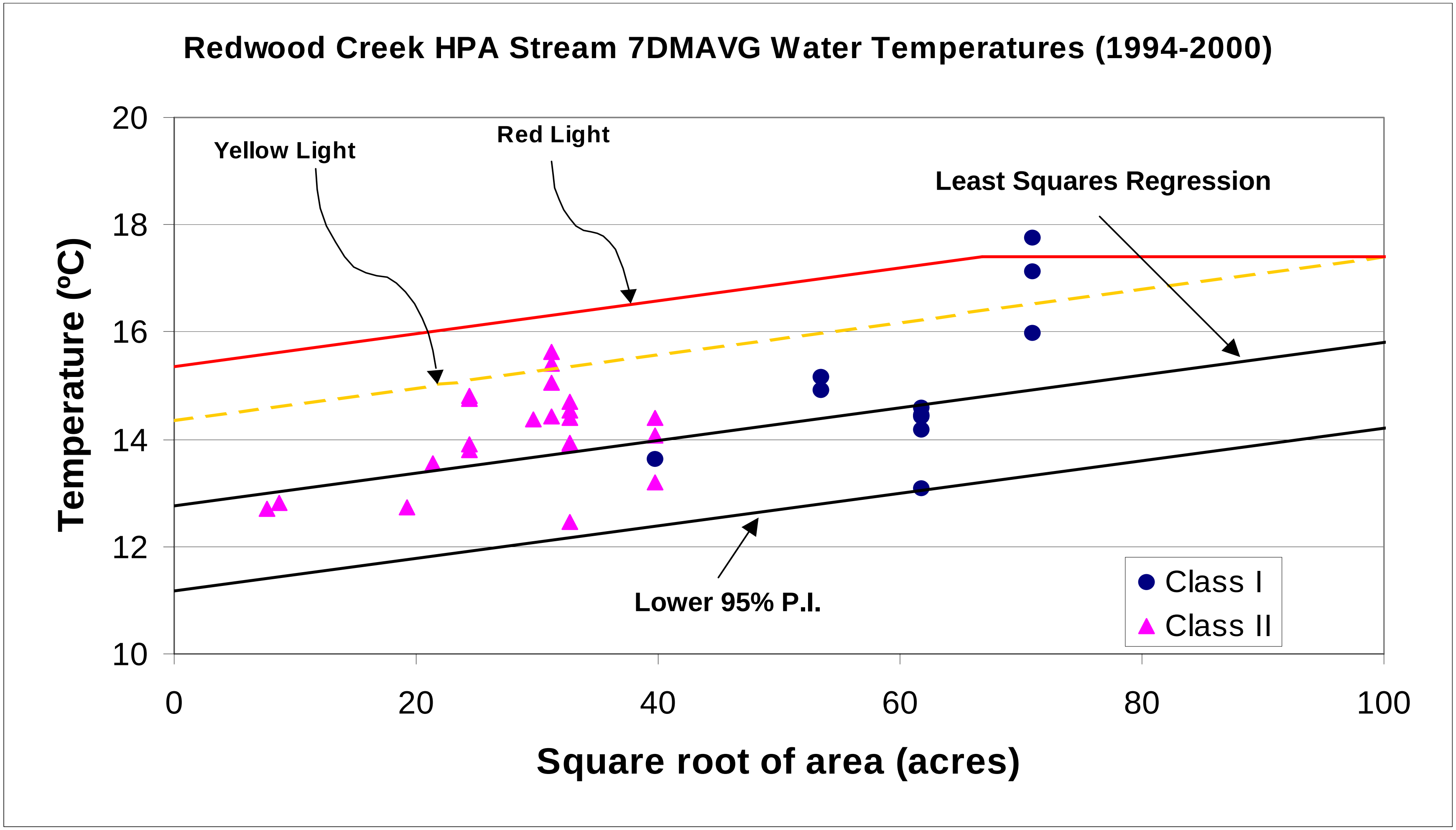


Figure 4-23. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Redwood Creek HPA monitored between 1994 and 2000.**

Table 4-8. Covered Species distribution in the Redwood Creek HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Cutthroat	Tailed Frog	Torrent Salamander
Redwood Creek	3	1	3	3	3	3
Coyote Creek	P	1,2,4	2,3,4	3	3	3
Panther Creek	P	1,2	2,3,4	3	3	3
Garrett Creek	A	A	4	U	P	P
Dolly Varden Creek*	A	4	4	U	3	3
Beaver Creek	A	A	2,4	U	P	3
Toss-Up Creek	A	U	4	U	P	3
Minor Creek	2	2	2,4	U	3	P
Lupton Creek	A	A	2,4	U	3	3
Noisy Creek	A	A	3,4	U	3	3
Cool Spring Creek	A	A	U	U	P	P
Miñon Creek	U	U	3,4	U	P	P
Lake Prairie Creek	A	A	2,4	U	3	3
Panther Creek	A	A	3,4	U	P	P
Bradford Creek	A	A	4	U	P	P
Pardee Creek	A	A	3,4	U	3	3
Twin Lakes Creek	A	A	3,4	U	P	P
Smokehouse Creek	A	A	4	U	P	P
Snow Camp Creek	A	A	4	U	P	P

Codes
U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS data files as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records
4= Present based on Brown 1988; Anderson 1988; RNSP 1994; and RNSP 1995-1996.

4.4.5.8.2 Coho Salmon

The Redwood Creek HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho salmon populations are depressed throughout this ESU. Current coho salmon abundance in the California portion of this ESU is thought to be less than 6% of their abundance in the 1940s (Weitkamp et al. 1995).

4.4.5.8.3 Steelhead and Resident Rainbow Trout

The Redwood Creek HPA is the northern boundary of the Northern California Steelhead DPS, which was listed as threatened in June 2001 (65 FR 36074). Steelhead abundance data is very limited for this ESU, but available data indicates that winter-run steelhead populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then. Nehlsen et al. (1991) identified summer steelhead in Redwood Creek as 'at risk of extinction'. NMFS found that for the seven populations of steelhead within this ESU only the small summer steelhead population within the Mad River, which has had large supplemental production from hatchery sources and Prairie Creek winter steelhead have shown recent trends of increasing abundance (65 FR 36082). Prairie Creek is a tributary to Redwood Creek and as such is within the Redwood Creek HPA

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.5.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Redwood Creek historically supported a large population of anadromous coastal cutthroat trout. The current population is thought to be very depressed compared to historical estimates but relatively stable (Gerstung 1997). Severe alteration of the estuary environment and habitat degradation from logging in the 50s and 60s, compounded by the 1964 flood, are believed to be largely responsible for the depressed state of the population (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.5.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in six streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Redwood Creek HPA, 6 of 6 (100%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 11 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Although a relatively small portion (18%) of the HPA is in Green Diamond's ownership, the high rate of occurrence and significant number of other streams known to support the species suggest that tailed frogs streams in the Redwood HPA are in good condition.

4.4.5.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in six streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams that supported populations of southern torrent salamanders (Diller and Wallace 1996). In the Redwood Creek HPA, 5 of 6 (83.3%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 61 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Although a relatively small portion (18%) of the HPA is in Green Diamond's ownership, the high rate of occurrence and large number of other streams known to support the species suggest that torrent salamander streams in the Redwood Creek HPA are in good condition.

4.4.5.9 Assessment Summary

Water temperatures are generally good throughout the Original Assessed Ownership in the Redwood Creek HPA despite the warmer summer temperatures associated with this more interior region. Presumably this is due to the good canopy cover on the streams in the Original Assessed Ownership in this HPA. There were two exceptions to this generalization. One was the lower mainstem of Coyote Creek, which has high canopy closure but much of its drainage area in prairies in Redwood National Park. Hand held temperature recordings from these prairie tributaries indicate that they are likely the source of the warm water in the mainstem of Coyote Creek. The other exception is a Class II watercourse (Lake Prairie Creek), which was impacted by a debris torrent in the winter of 1996/97 that removed all the streamside vegetation.

The soft and fractured natured of the sheared bedrock associated with the Grogan Fault, which controls the trace of Redwood Creek, as well as the inherently weak nature of some of the geologic parent material (Redwood Creek Schist) in the basin contribute to the relatively high amounts of fines in streams. There are no data available for a quantitative assessment of canopy closure, LWD, or other aspects of aquatic habitat in streams on the Original Assessed Ownership in the Redwood Creek HPA. However, most streams (not including the mainstem of Redwood Creek) are high gradient with limited access to anadromous salmonids. These streams are generally boulder dominated. LWD, whether or not it is in short supply, is probably not an important habitat element. In these streams, much of the pool formation is created by boulders and bedrock.

The salmonid Covered Species, especially coho and chinook salmon, are relatively uncommon in streams on the Original Assessed Ownership in this HPA. Many of the streams are sufficient in size and have good water quality to support populations of fish, but anadromous access is limited due to stream gradient. The primary anadromous habitat in this HPA is in the mainstem of Redwood Creek and some of the lower tributaries of the watershed, which support good populations of both coho and chinook salmon. Steelhead and resident populations of rainbow and coastal cutthroat trout persist throughout the watershed, although likely at reduced densities. Water temperature may limit some populations of the Covered Species in isolated locations of the Original Assessed Ownership within the HPA. The lower portion of Coyote Creek may have water temperatures that impair salmonid populations, but the maintenance of prairies in Redwood National Park would preclude corrective action. The high water temperatures following a debris flow in Lake Prairie Creek negatively impacted larval tailed frogs, but the regrowth of riparian vegetation allowed for substantial recovery after five years. Although similar debris flows have the potential to occur given the steep terrain in many of the headwater streams in this HPA, the rate of their occurrence relative to the rate of recovery would not likely result in widespread impacts on the amphibian Covered Species in the Original Assessed Ownership throughout this HPA. The high occurrence of tailed frogs on the Original Assessed Ownership in this HPA supports this conclusion.

The steep gradients associated with most of the streams on the Original Assessed Ownership in this HPA limit the quantity and quality of the salmonid habitat.

Consequently, conservation measures implemented under this Plan will likely have little direct impact on the future occurrence of salmonids in those streams. However, the streams have the potential to deliver large amounts of coarse and fine sediments to the mainstem of Redwood Creek, which supports all of the salmonid Covered Species. Therefore, the top conservation priority for the Plan Area in this HPA should be to address potential sediment inputs from legacy road sites or hillslopes that would trigger debris flows or result in other substantial sediment transport to the mainstem of Redwood Creek.

4.4.6 Coastal Lagoons HPA

4.4.6.1 HPA Type, Size, and Group

The Coastal Lagoons HPA is a hydrographic area as defined in this Plan and includes 53,592 acres. It is part of the Korbel HPA Group.

4.4.6.2 Eligible Plan Area

The Eligible Plan Area in the Coastal Lagoons HPA includes approximately 44,649 acres: 39,981 acres of Initial Plan Area and 4,678 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.6.3 Geology

The Coastal Lagoons HPA is within the Coast Ranges Province (see ***Figure 4-1***). From east to west, the bedrock in this HPA includes the Redwood Creek Schist, the Sandstone and Melange of Snow Camp Mountain, Undifferentiated Central Belt Franciscan Sandstone, the Patrick's Point meta-graywacke unit, and younger marine and non-marine terrace deposits near the coastline. These geologic units are generally structurally bounded by northwest trending thrust faults and high angle faults. Broad northwest trending anticlines and synclines are also mapped within the hydrographic region.

The topography of the HPA is moderately-steep, except in the younger terrace deposits and in the area of the lagoons near the coastline. A preliminary inventory of landslides on the Original Assessed Ownership indicate that both shallow and deep-seated landslides exist in this HPA.

4.4.6.4 Climate

The coastal weather pattern in this HPA is typical for the lagoons. Summers are mild in temperature with a marine fog layer commonly occurring. Winters are cooler with an average annual rainfall of 40 to 60 inches, heavier amounts falling in the more inland areas. Most of the precipitation falls between October and April.

4.4.6.5 Vegetation

The Coastal Lagoons HPA encompasses the coastal streams between Redwood Creek and Little River, and its inland extent is defined by the divide into those drainages. The HPA extends only 10 miles inland and crests at 2,800 feet elevation. It is entirely within the zone of summer fog intrusion, and all vegetative types therefore reflect a strong coastal influence.

Aside from coastal scrub and wetland vegetation around the lagoons, and residential development along U.S. Highway 101 (including the town of Trinidad), the entire HPA is forested. Sitka spruce and Douglas-fir/spruce forests along the coast rapidly give way to redwood and redwood/Douglas-fir forests that persist to the eastern boundaries of the HPA. Minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes near the coast and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood.

4.4.6.6 Current Habitat Conditions

4.4.6.6.1 Water Temperature

Water temperature monitoring in streams in the Original Assessed Ownership in the Coastal Lagoons HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 43 summer temperature profiles were recorded at 13 sites in 9 Class I watercourses. An additional 22 summer temperature profiles were recorded at 12 sites within 11 Class II watercourses. Figure 4-24 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that none of the Class I sites exceeded the red or yellow light threshold; two Class II sites (M1TD and M1TD2) exceeded the yellow light threshold during 2000.

4.4.6.6.2 Long Term Channel Monitoring

Channel monitoring is ongoing in two locations within the Coastal Lagoons HPA: Maple Creek and Beach Creek. Monitoring began on both reaches in 1998 (see Appendix C3 for details). Data has not been analyzed at the present time and no conclusions can be drawn at this point in the monitoring.

4.4.6.6.3 Estuarine Conditions

Stone Lagoon is approximately 500 acres in size, and it is where salmonids from McDonald Creek generally rear to maturity. Because the lagoon only opens to the ocean occasionally, salmonids have limited opportunities to pass between the two water bodies. However, the brackish lagoon is highly productive and supports a diverse aquatic ecosystem.

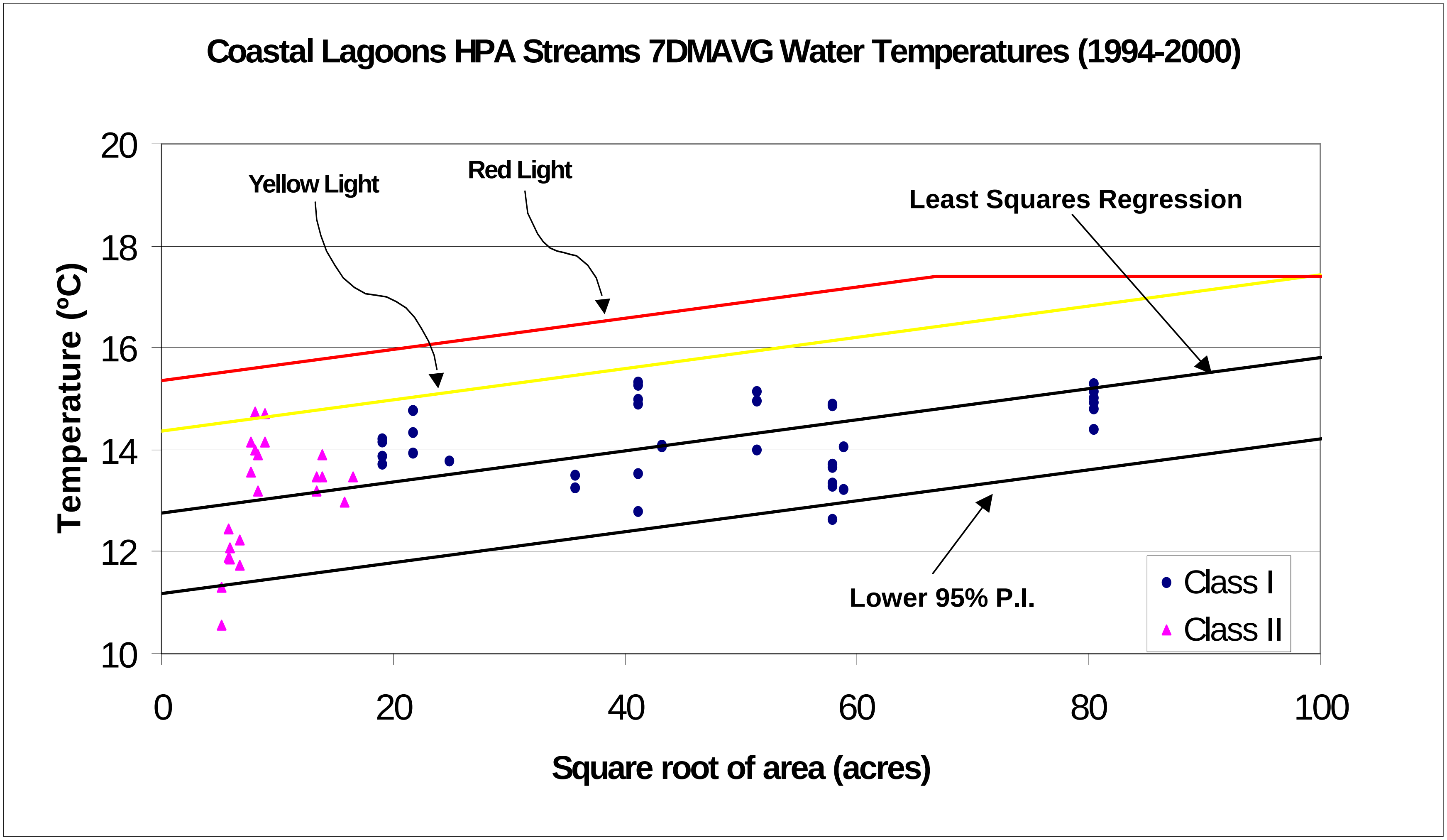


Figure 4-24. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Coastal Lagoons HPA monitored between 1994 and 2000.**

4.4.6.7 Salmonid Population Estimates

No salmonid population estimates have been made for streams within the Coastal Lagoons HPA. However spawning surveys have been conducted recently on some streams within this HPA (see Appendix C9).

4.4.6.7.1 Adult Spawner Surveys

Spawning surveys have been conducted on three streams within the Coastal Lagoons HPA during the period of 1998 through 2000. The streams and years surveyed are:

- Maple Creek: 1998-1999 and 1999-2000
- North Fork Maple Creek: 1998-1999 and 1999-2000
- Pitcher Creek: 1998-1999 and 1999-2000

The streams of the Coastal Lagoon HPA are subject to irregular entry by returning salmonids. These systems are regulated by high flow events that allow for the breaching of the sand spit, which would otherwise block the entry of salmonids into their natal streams. Based on spawning survey results since 1998, it is unclear whether adequate adult escapement is received in these streams due to the timing of when the lagoon breaches. Indications are that the timing of when the lagoon breaches plays an important role in determining if, when or what species enter the Maple Creek system. The absence of 0+ coho during the summer of 1999 indicates that Big Lagoon did not breach during the 1998/1999 coho run, but the presence of 1+ coho indicates that adults were able to enter during the 1997/1998 spawning season. During the formal spawning surveys only redds of unknown species have been found late in the survey season. It is likely these redds where created by anadromous or “lagoon run” cutthroat or by steelhead that were able to enter the lagoon during high winter flow. All four covered salmonid species have been observed in the Coastal Lagoon HPA; however coastal cutthroat trout is the only species that have been seen in the adult form.

4.4.6.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in the Coastal Lagoons HPA is presented by drainage in Table 4-9, and the recorded distribution of the species is displayed in ***Figure 4-25***.

4.4.6.8.1 Chinook Salmon

The Coastal Lagoons HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU are cited in the decision to list this ESU as threatened (64 FR 50405). Specific information on chinook in the Coastal Lagoons HPA is limited. Chinook populations, if present, are probably small and potentially absent in many years. Big and Stone Lagoons are only open to the ocean for short time periods in winter and early spring, limiting the ability of anadromous fishes particularly chinook salmon to migrate between the ocean and the lagoons.

Table 4-9. Covered Species distribution in the Coastal Lagoons HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Stone Lagoon						
McDonald Creek	U	1	3	3	3	3
North Fork McDonald	U	U	3	3	P	3
Big Lagoon	3	1,3	3	3	U	U
Maple Creek	3	1,3	3	3	3	3
Diamond	A	A	U	U	U	U
Pitcher Creek	3	3	3	3	3	3
NF Maple Creek	3	3	3	3	3	3
M-Line Creek	A	A	3	3	P	3
Beach Creek	A	A	3	3	P	3
Clear Creek	A	A	3	3	P	3
Gray Cr. (into mill pond)	A	A	U	3	U	U
Mill Cr.	A	A	U	3	U	U
Luffenholtz	A	A	3	3	U	3
North Fork Luffenholtz	A	A	3	3	U	U

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.6.8.2 Coho Salmon

The Coastal Lagoons HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA as of May 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

As many as approximately 1,200 coho salmon were estimated to occur in Maple Creek, a tributary to Big Lagoon, as late as the 1960s (USFWS 1967). Currently, specific information on coho salmon in the Coastal Lagoons HPA is limited. Coho populations are probably small, and possibly absent in some years. Big and Stone Lagoons are only open to the ocean for relatively short time periods (days to weeks) in winter and early spring, limiting the ability of anadromous fishes to migrate between the ocean and the lagoons.

4.4.6.8.3 Steelhead and Resident Rainbow Trout

The Coastal Lagoons HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 4, 2000 (65 FR 36074). Steelhead abundance data are very limited for this DPS, but available data indicate that winter-run steelhead populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Specific information on steelhead populations in the Coastal Lagoons HPA is limited. As many as 3,000 steelhead may have occurred in Maple Creek as late as the 1960s (USFWS 1967). Recent spawning surveys conducted by Green Diamond during 1998 and 1999 recorded only a small number of redds, indicating limited spawning by salmonids in Maple, North Fork Maple, and Pitcher Creeks. Big and Stone Lagoons are only open to the ocean for relatively short time periods (days to weeks) in winter and early spring. This is likely limiting the ability of anadromous fishes to migrate between the ocean and the lagoons. The lagoons do, however, provide rearing habitat for juveniles and holding and foraging habitat for adult steelhead trout.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.6.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Big Lagoon is believed to support a “fair” population of coastal cutthroat trout (Gerstung 1997). Green Diamond observed high numbers of large coastal cutthroat in lower Maple Creek in 1999. Stone Lagoon had low numbers of cutthroat prior to heavy stocking of yearling fish in 1990-1994. Spawning escapement in McDonald Creek increased dramatically in the years following the stocking, but conditions in McDonald Creek are degraded and limit natural production (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined not to warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.6.8.5 Tailed Frog

Green Diamond’s ownership in the Coastal Lagoon HPA was acquired in 1998 after the presence/absence surveys for tailed frogs were completed. Sampling was not conducted in the HPA as part of the study of 72 streams. However, populations of tailed frogs have been confirmed in 22 streams in the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, tailed frogs streams in the Coastal Lagoon HPA are likely to be in good condition.

4.4.6.8.6 Southern Torrent Salamander

Green Diamond’s ownership in the Coastal Lagoon HPA was acquired in 1998 after the presence/absence surveys for southern torrent salamanders were completed. Sampling was not conducted in the HPA as part of the study of 71 streams. However, populations of torrent salamanders have been confirmed in 47 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, torrent salamander streams in the Coastal Lagoon HPA are likely to be in good condition.

4.4.6.9 Assessment Summary

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good in streams throughout the Original Assessed Ownership in the Coastal Lagoons HPA. The geologic parent material is relatively competent (consolidated) in some areas, but less so in others. Stream substrates range from relatively coarse in many streams to being predominately composed of fines in others.

The Covered Species are relatively common throughout the Original Assessed Ownership in this HPA, except chinook and coho salmon. Since most of these streams drain into a lagoon, the infrequent and stochastic breaching of the lagoons restricts the presence of salmon. Steelhead and coastal cutthroat are probably less impacted by the breaching of the lagoons, because the adult fish are able to reside in the lagoons. Based on qualitative assessments, coastal cutthroat trout appear to be particularly abundant in this HPA, which is likely due to the reduced competition with anadromous salmonids. It is not likely that water temperature in streams on the Original Assessed Ownership limits populations of any Covered Species, and temperatures may be optimum for some Covered Species in most streams. There are no data to quantitatively assess canopy closure, LWD, or other aspects of aquatic habitat in the streams. However, spawning habitat for the salmonid Covered Species in most streams on the Original Assessed Ownership is probably good to adequate and is probably not limiting except for isolated reaches of some streams. Qualitative assessments indicate that LWD is probably relatively more abundant in streams on the Original Assessed Ownership in this HPA than in other HPAs. Therefore, the amount and/or quality of summer and winter rearing habitat is probably good for the populations of salmonids that utilize the streams in this HPA. The amphibian Covered Species are relatively common in the Original Assessed Ownership throughout this HPA. However, there are no data to determine the proportion of streams on the Original Assessed Ownership in the HPA supporting these species. The relative high number of sites with the amphibian Covered Species is consistent with the presence of cold water temperatures and competent geology and coarse stream substrates. However, based on anecdotal observations and recently initiated headwaters monitoring sites, many streams appear to have relatively high inputs of fines sediments from roads.

Given the limitations to anadromy caused by the lagoons, the highest conservation priority for the Plan Area in this HPA probably should be to address road-related sediment inputs that may impact the resident rainbow and coastal cutthroat trout and the amphibian Covered Species.

4.4.7 Little River HPA

4.4.7.1 HPA Type, Size, and Group

The Little River HPA is a hydrographic unit as defined in this Plan and is part of the Korbel HPA Group. It includes approximately 29,703 acres.

4.4.7.2 Eligible Plan Area

The Eligible Plan Area in the Little River HPA includes approximately 27,949 acres: 26,041 acres of Initial Plan Area and 1,908 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.7.3 Geology

The Little River HPA falls within the Coast Ranges Province (see ***Figure 4-1***). From east to west, the bedrock of the HPA is composed of Redwood Creek Schist (along the eastern margin), Sandstone and Melange of the Snow Camp Mountain, and Undifferentiated Central Belt Franciscan Bedrock. Quaternary deposits are found near the mouth of the watershed, which is several miles south of Trinidad, California. The Redwood Creek Schist is mostly composed of hard, fine-grained quartz-mica schist, which includes or grades locally into bodies of semi-schist, slate, meta-conglomerate, and meta-chert (Kilbourne 1983-85; Harden et al., 1981). The Snow Camp Mountain geologic unit is composed of hard, intensely folded greywacke sandstone and siltstone that grades into sheared melange. The Undifferentiated Central Belt is composed of sandstone and mudstone. The Quaternary deposits are composed of poorly consolidated interbedded clays, silts, sands, and gravels.

Marine terrace deposits of late Pleistocene and Holocene age cover bedrock surfaces on wave-cut benches, within about three miles of the coastline and up to 500 feet above sea level near the mouth of Little River. The terrace deposits are composed of unconsolidated to slightly consolidated silts, sands, and gravels, including old dune sands. Holocene alluvium and floodplain deposits cover the valley floor, nearly one mile wide, in the area downstream from Crannell (Ristau 1979; Kelley 1984).

The inactive Bald Mountain Fault is located between the Snow Camp Mountain and Redwood Creek Schist geologic units, and the active Trinidad Fault separates these relatively young strata from the adjacent Franciscan Mélange.

The HPA generally is characterized by moderate to high relief hillslopes, except for the area from the Crannell town site to the mouth of the river at Moonstone Beach. Green Diamond's preliminary landslide data indicate that both shallow and deep-seated landslides exist throughout this HPA.

4.4.7.4 Climate

Little River HPA has a similar weather pattern of most northern California coastal watersheds, typically wet winters and dry summers. At least 80% of the precipitation occurs between November and April. The coastal area receives about 50 inches annually, whereas interior parts of the watershed receive over 80 inches annually. Most of the precipitation falls as rain, although snow fall occurs at the higher elevations. Coastal marine fog is common during the summer months.

4.4.7.5 Vegetation

The Little River HPA extends inland from the coast approximately 12 miles and reaches an elevation of 3360 feet. Aside from residential and agricultural development along U.S. Highway 101, the entire HPA is forested, with no natural prairies or other non-forest openings.

Sitka spruce and Douglas-fir/spruce forests along the coastal face give way within a mile or two of the coast to redwood and redwood/Douglas-fir forests. Minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes near the coast and in riparian zones. All but the extreme eastern tip of the HPA (approximately the last mile or two of the main stem of Little River) is within the summer fog zone. This area supports redwood as a significant, if not dominant, stand component. Above that limit, Douglas-fir and tanoak dominate the landscape. Red alder is the most common hardwood found in riparian zones throughout the HPA.

4.4.7.6 Current Habitat Conditions

4.4.7.6.1 Water Temperature

Water temperature monitoring in streams on the Original Assessed Ownership in the Little River HPA began in 1994 and is ongoing today (see Appendix C5 for details). During 1994-2000, 44 summer temperature profiles were recorded at 14 sites in 11 Class I watercourses. An additional 28 summer temperature profiles were recorded at 8 headwater sites in 8 Class II watercourses. Figure 4-26 displays the 7DMAVG water temperatures for each of the monitored sites in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results indicate that none of the Class I or Class II monitoring sites exceeded the red or yellow light threshold.

4.4.7.6.2 Channel and Habitat Typing

Louisiana-Pacific (LP) conducted channel and habitat assessments in 1994 on four streams in this HPA. The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows (see Appendix C1 for details and Table C1-6 for summary of data collected).

Stream	Mid-point Watershed Area	Mid-point Gradient
Mainstem Little River	9,475 acres	3.0%
Upper South Fork Little River	3,095 acres	3.1%
Lower South Fork Little River	2,611 acres	1.6%
Railroad Creek	1,205 acres	2.9%

The results of the assessments are summarized below and depicted in Figure 4-27 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

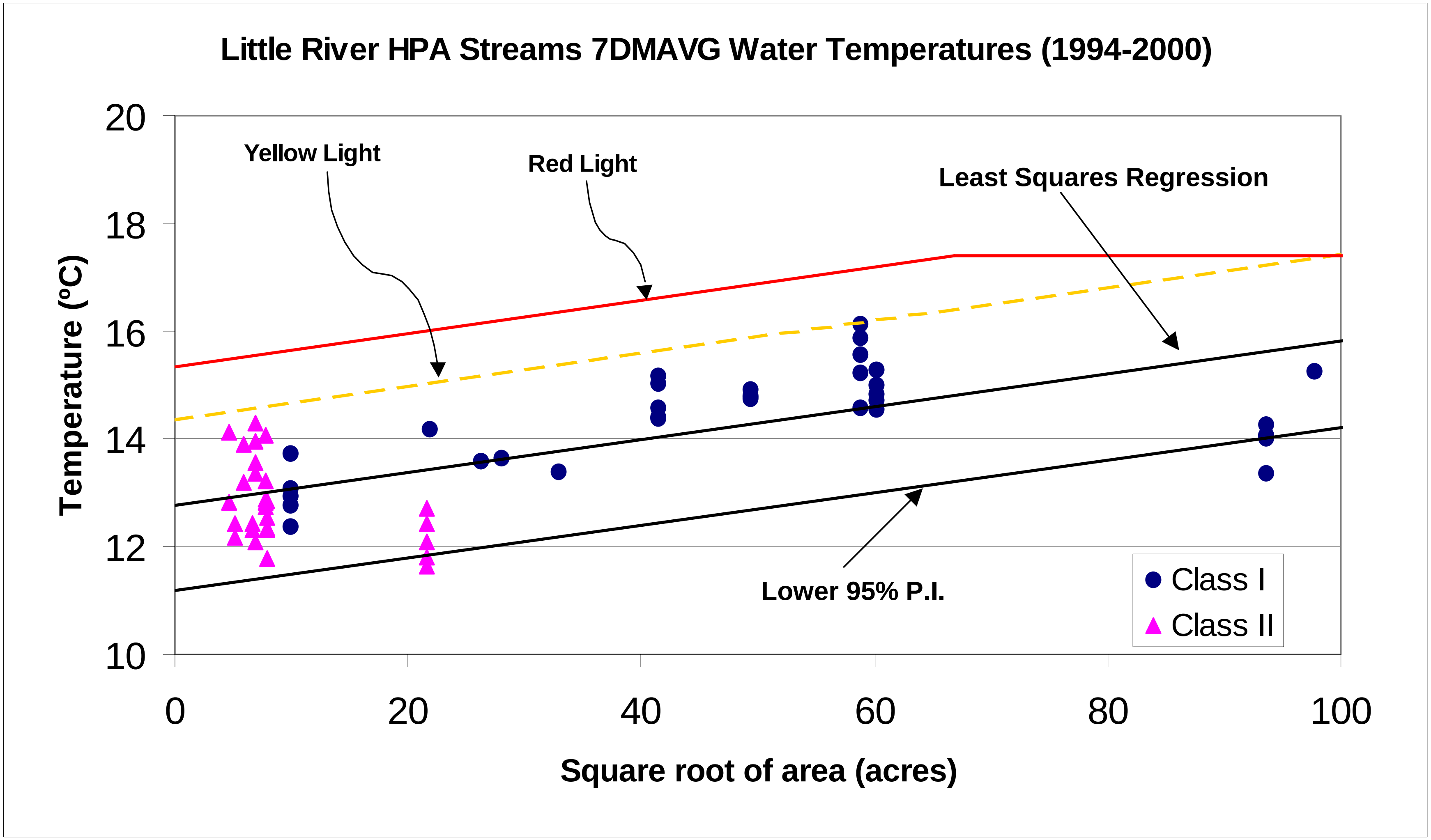


Figure 4-26. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Little River HPA monitored between 1994 and 2000.**

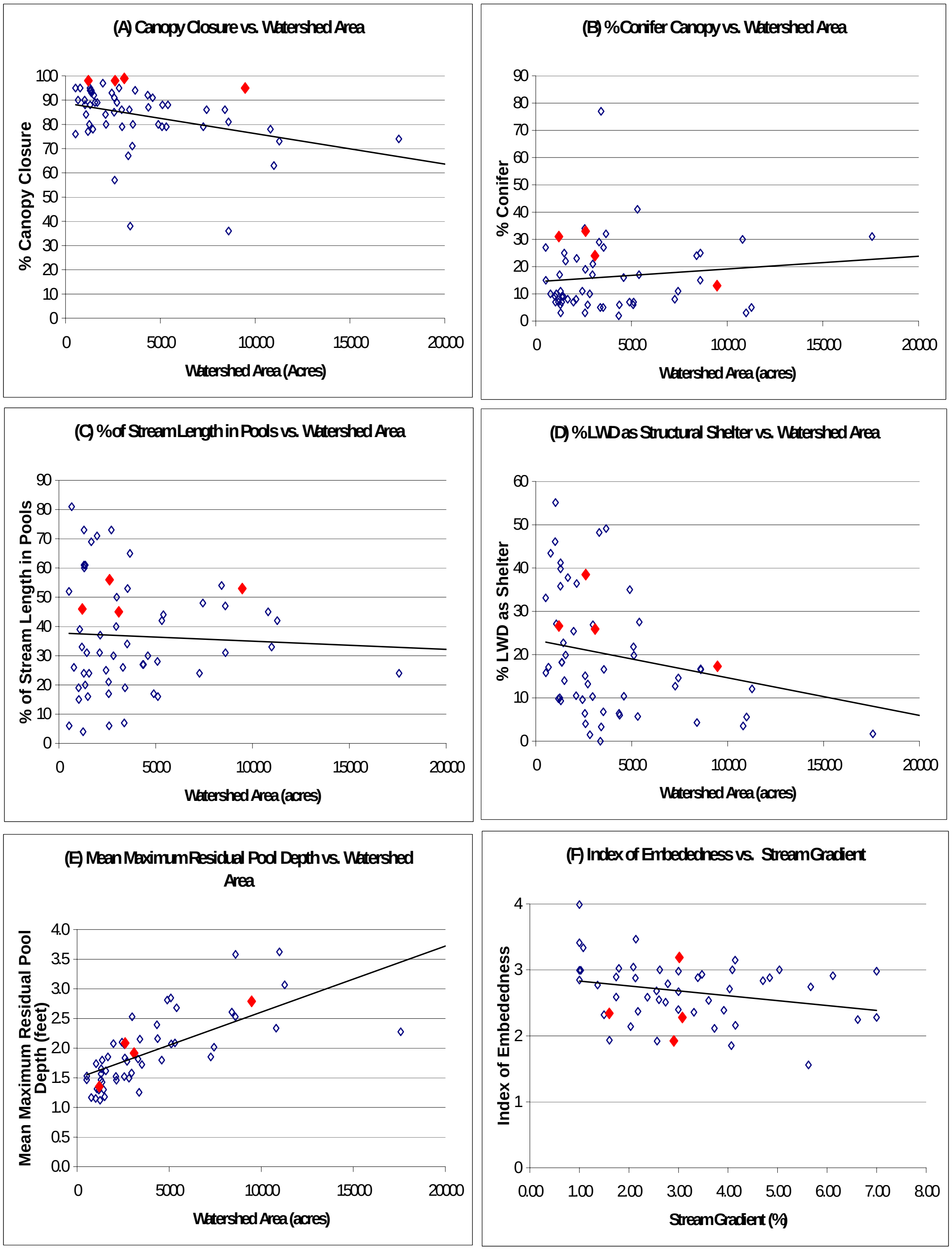


Figure 4-27. Channel and habitat types in four streams assessed in the Little River HPA. (Solid diamonds are assessed streams in Little River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

The results indicate the following regarding the four assessed streams in this HPA:

- Percentage canopy cover for the four assessed streams is very high (95-99%) and includes some of the highest percentages for all assessed streams regardless of watershed area (Figure 4-27 [A]).

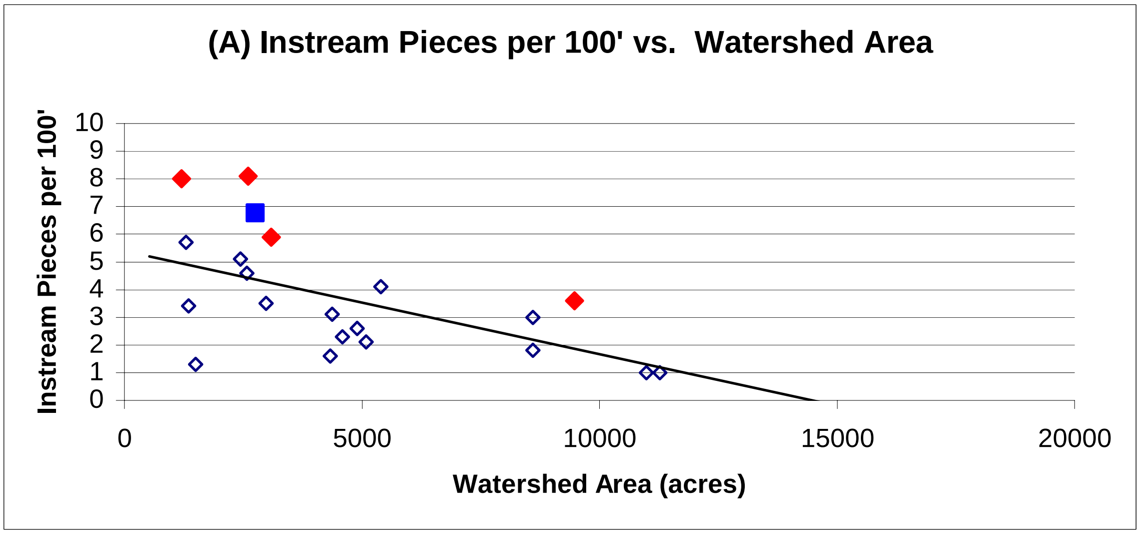
- Except for the mainstem Little River, the percentage of conifer canopy is greater for the assessed streams in this HPA (23%-33%) than for most other assessed streams with similar watershed area (Figure 4-27[B]). The conifer canopy for mainstem Little River (13%) is lower than that for many other assessed streams of similar watershed area (see Figure 4-27[B]). Compared with all assessed streams with similar watershed areas, the assessed streams in this HPA generally had greater percentages of stream length in pools (45%-56% by length) (Figure 4-27[C]). Except for Lower South Fork Little River, the percentage of LWD as structural cover in pools for the four streams is typical of that for most other assessed streams with comparable watershed size (Figure 4-27[D]).

- As shown in Figure 4-27[E]) the average residual pool depths in the four streams are variable but similar to other assessed streams. With the exception of mainstem Little River, the assessed streams in this HPA have somewhat lower substrate embeddedness indices than other assessed streams, regardless of stream gradient (Figure 4-27[F]). Little River has one of the greatest embeddedness indices for any of the Plan Area streams surveyed.

In summary, the results suggest that the habitat within the four assessed streams of the Little River HPA are, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The four streams have higher canopy cover percentages on average than other streams of similar watershed size, and 3 of the 4 have higher percentages of conifer cover along the riparian margins. The 4 assessed streams in this HPA also have somewhat less embedded substrates than many other assessed streams of similar watershed area.

4.4.7.6.3 <u>LWD Inventory</u>

LWD survey/inventories were conducted in 1994 and 1995 in four streams within the Little River HPA: mainstem Little River, Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek. (See Appendix C2 for details and Tables C2-4 and C2-11 for summary of data collected.) Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-28 (A-B).



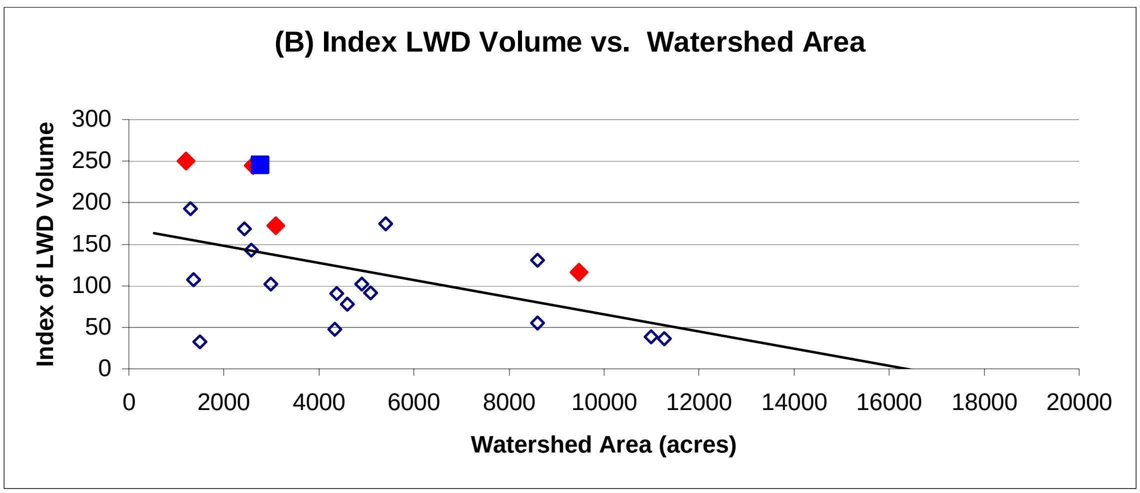


Figure 4-28. **LWD survey results for four streams assessed in the Little River HPA. (Solid diamonds are assessed streams in Little River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

- As shown in Figure 4-28 (A), the average in-stream LWD piece counts per 100 feet of channel for Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek are much greater than those for all other assessed streams. The LWD counts per 100 feet of channel for these streams ranged from 5.1 to 8.1 pieces, which is 80% to more than 100% of the average for Prairie Creek. Counts of LWD pieces per 100 feet of stream channel in Little River were also greater than other assessed streams with similar watershed areas, but to a lesser magnitude than the three other streams assessed in this HPA (see Figure 4-28 [A]).

- LWD volume indices for Upper South Fork Little River, Lower South Fork Little River, and Railroad Creek are greater than those for other assessed streams with similar watershed area (Figure 4-28 [B]). Little River also had a greater LWD volume index area than other streams with comparable watersheds within the Plan area but to a lesser extent than the three other assessed streams.

In summary, the four assessed streams in this HPA have the highest average LWD piece counts per 100 feet of channel and volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

4.4.7.6.4 <u>Estuarine Conditions</u>

The Little River estuary has been impacted to a certain degree by human activities. Livestock grazing has denuded some of the riparian zone along the lower channel, accelerating the erosion of streambanks. In spite of this, the Little River has more estuarine habitat than many local streams of its size, and surveys have indicated utilization of the estuary by juvenile chinook salmon (LP 1986, CDFG 1986). Although Little River is a relatively small watershed, its mouth rarely, if ever, bars over during the summer to form an enclosed lagoon.

4.4.7.7 Salmonid Population Estimates

The Little River HPA is currently the most actively surveyed HPA for adult spawning escapement. However, spawner surveys on these streams have only been conducted since 1998, since the acquisition of the LP holdings. The mainstem Little River has the highest totals of both redds, live fish, and carcasses. The second largest spawner counts have been observed on Lower South Fork Little River. The majority of spawning activity appears to be by chinook; however, coho and steelhead are occasionally observed during surveys. Although these surveys would indicate very little spawning activity by these species, juveniles of these species are extremely abundant during summer juvenile dive counts and out-migrant trapping, indicating a fair number of adults may not be observed during spawner escapement surveys. This is often a result of survey limitations due to high flows, which may reduce visibility and flush carcasses out of the system. Survey frequency and timing are important, but even with the increased surveys adult salmonids will be missed, making it very difficult to rely on adult counts as an intricate component of the monitoring program.

4.4.7.7.1 Summer Juvenile Population Estimates

A summary of juvenile coho salmon, steelhead, and cutthroat trout summer population estimates for Railroad Creek, Lower South Fork Little River, and Upper South Fork Little River for 1998-2000 are shown in Figure 4-29 (A-C respectively).

As seen in Figure 4-29 (A) the juvenile coho salmon population estimate in Railroad Creek ranged from 176 to 339 during these three years. Steelhead estimates ranged from 76 to 115 juveniles. Estimates of juvenile cutthroat trout populations in Railroad Creek could only be made in 1998. No coastal cutthroat trout were observed in 1999 and 2000 (see Figure 4-29[A]). The estimated numbers of juvenile coho salmon for Lower South Fork Little River were much greater than the other streams surveyed in this HPA for all three years. The coho estimates in Lower South Fork Little River ranged from greater than 3,600 to nearly 8,000 juveniles for the three years (Figure 4-29[B]). However the number of juvenile steelhead were similar to those estimated for Railroad Creek and ranged from 62 to 230 during the three years of estimates. Coastal cutthroat trout estimates for Lower South Fork Little River were slightly better than those for Railroad Creek and ranged from 0 to 230 (see Figure 4-29[B]).

Coho salmon also dominated the populations in Upper South Fork Little River based on estimates made during 1998 through 2000 (Figure 4-29 [C]). Population estimates for coho ranged from 343 to 1,230 during those years. Estimated populations of juvenile steelhead were somewhat stable and overall were greater in Upper South Fork Little River compared to other streams surveyed in this HPA. Steelhead population estimates ranged from approximately 250 to 350 juveniles (Figure 4-29 [C]). As was the case with the other streams surveyed, cutthroat trout juvenile estimates were low (range = 0 to 7) in Upper South Fork Little River during the three years estimates were made.

In summary, the summer juvenile population estimates indicate that coho populations are variable but their populations appear to be robust and stable in the three streams surveyed in this HPA. Steelhead populations, while less than those estimated for coho salmon, also appear to be somewhat stable between years and streams surveyed in this HPA. Summer population estimates for cutthroat indicated there are small numbers of juveniles of these species, and some variability from year to year in the streams surveyed.

4.4.7.7.2 Out-migrant Trapping

Juvenile salmonid outmigrant smolt trapping was conducted on Little River tributary streams during 1999 and 2000 (see Section 4.3 and Appendix C8 for details). Results are shown in Figure 4-30(A-C).

The results of population estimates from coho salmon outmigrant trapping during 1999 and 2000 and corresponding previous summers' population estimates (1998 and 1999) are shown in Figure 4-30 (A and B). These results indicate that there is a great deal of variability between Little River tributaries within a single trapping year as well as between years.

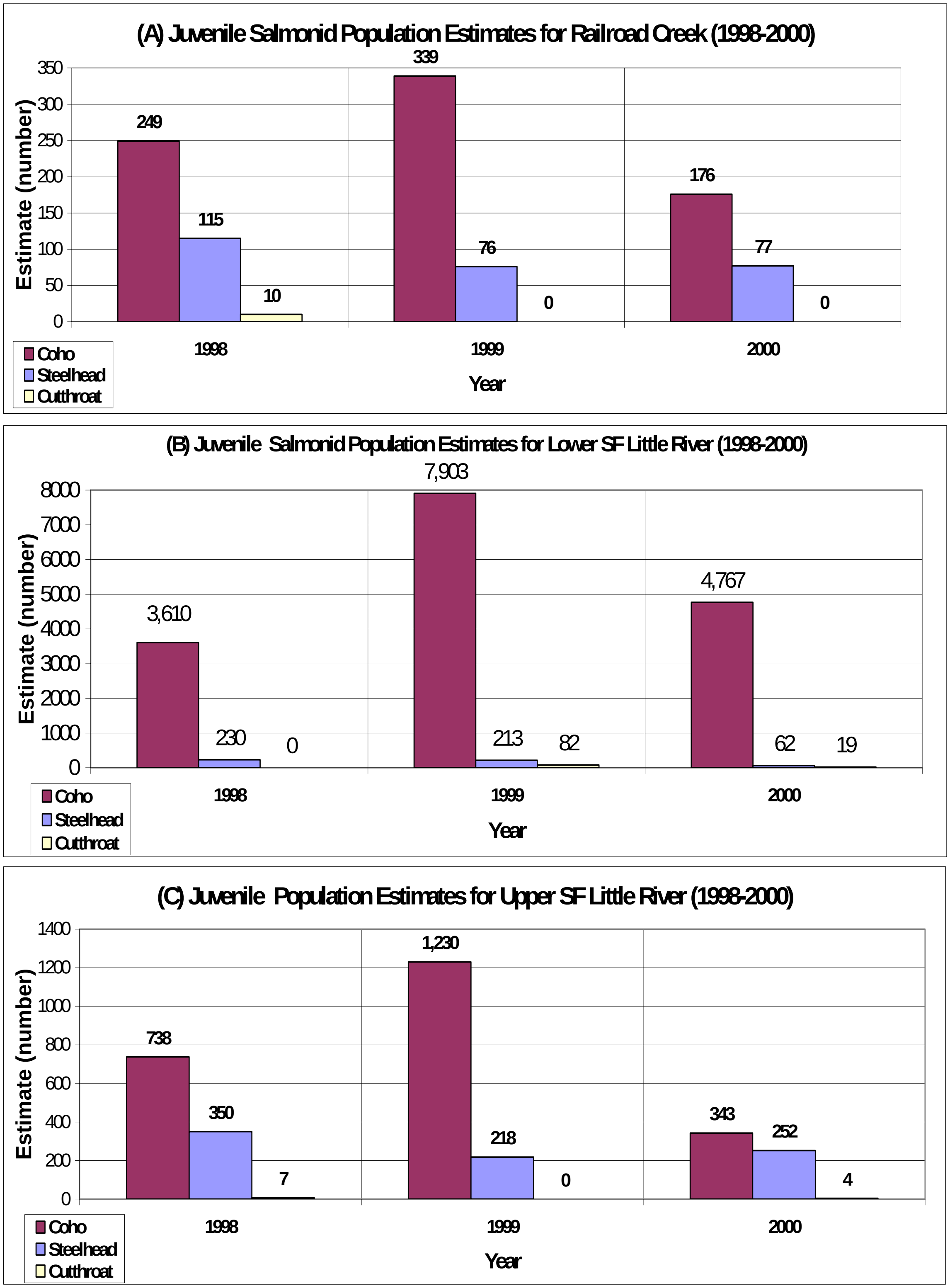


Figure 4-29. **Summary of the juvenile population estimates for coho salmon, steelhead, and cutthroat trout, in the 3 Little River HPA streams surveyed in 1998, 1999, and 2000.**

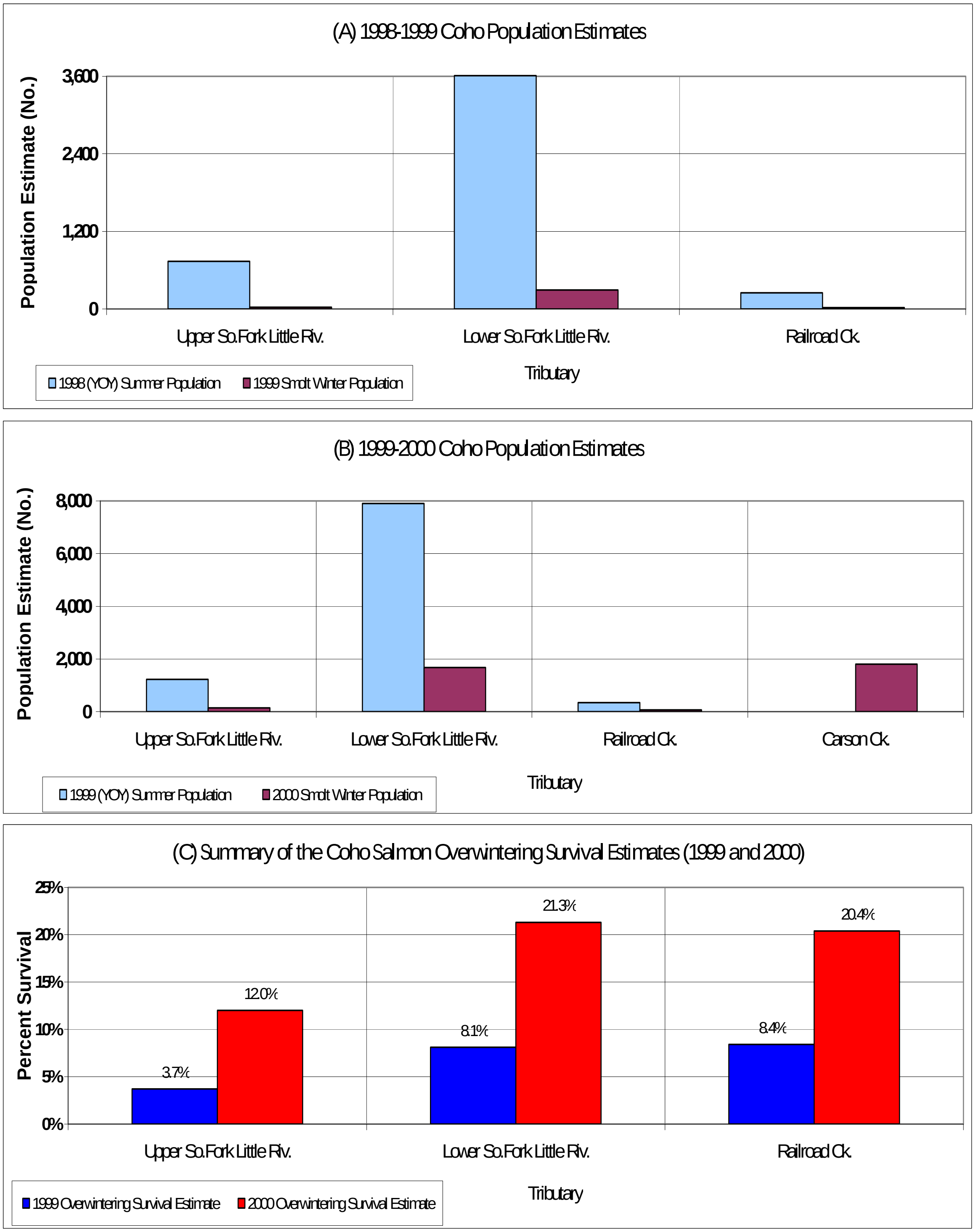


Figure 4-30. **Summary of the summer and winter juvenile coho salmon population estimates and over-wintering survival estimates for tributaries of Little River (1998-1999 and 1999-2000).**

In general, summer populations of coho salmon in Lower South Fork Little River were much greater that other tributaries during both 1998 and 1999. The over-wintering survival percentages for coho during 1999 for all 3 tributaries were from one-third to approximately one-half of those for 2000 (Figure 4-30 [C]). This may indicate that habitat conditions in Little River tributaries were more suitable for coho during 2000 as compared to 1999. Furthermore, when comparing the over-wintering survival to the other tributaries (Lower South Fork Little River and Railroad Creek) during both years, Upper South Fork Little River had approximately ½ the rate of over-wintering survival (see Figure 4-30[C]). This indicates that habitat conditions in Upper South Fork Little River may have been less suitable than those in the other tributaries during both years.

Outmigrant smolt population estimates for coho, steelhead and cutthroat trout for 1999 and 2000 are shown in Figure 4-31. Coho salmon dominated the outmigrant smolt estimates in Lower South Fork Little River and Carson Creek in 2000, exceeding 1,600 and 1,800 smolts respectively. Except for coho in Lower South Fork Little River during 1999, all other outmigrant smolt populations for other tributaries and species were less than 200 smolts for 1999 and 2000.

The use of outmigrant trapping appears to be an excellent tool for collecting information pertaining to coho production in the Little River drainage. The use of this trapping system efficiently samples streams during low and normal streams flows. The outmigrant trapping program is in preliminary stages however, and it is too early to determine population trends for the results of 2 trapping seasons.

4.4.7.7.3 Adult Spawner Escapement Surveys

Spawning surveys have been conducted on 6 streams within the Little River HPA during the period of 1998 through 2000 (see Appendix C9 for details). The streams and years surveyed are:

- Carson Creek: 1998-1999
- Danielle Creek: 1998-1999
- Mainstem Little River: 1998-1999 and 1999-2000
- Lower South Fork Little River: 1998-1999 and 1999-2000
- Upper South Fork Little River: 1998-1999 and 1999-2000
- Railroad Creek: 1998-1999 and 1999-2000

The results to date indicate that no salmonids were observed spawning in Danielle Creek during 1998-1999 and only a few un-identified redds and carcasses were observed in Carson Creek during those surveys. In addition, in Railroad Creek only a small number of unidentified redds that were observed during the 1999-2000 surveys and none observed during the 1998-1999 surveys.

A good number of live chinook, chinook carcasses, and redds (1998-1999 and 1999-2000), and to a lesser degree live adult steelhead and redds (1999-2000) were observed in the mainstem Little River. Live coho adults and carcasses and steelhead carcasses were infrequently observed during both years, but a large number of un-identified redds were observed during the 1998-1999 and 1999-2000 escapement surveys in Little River.

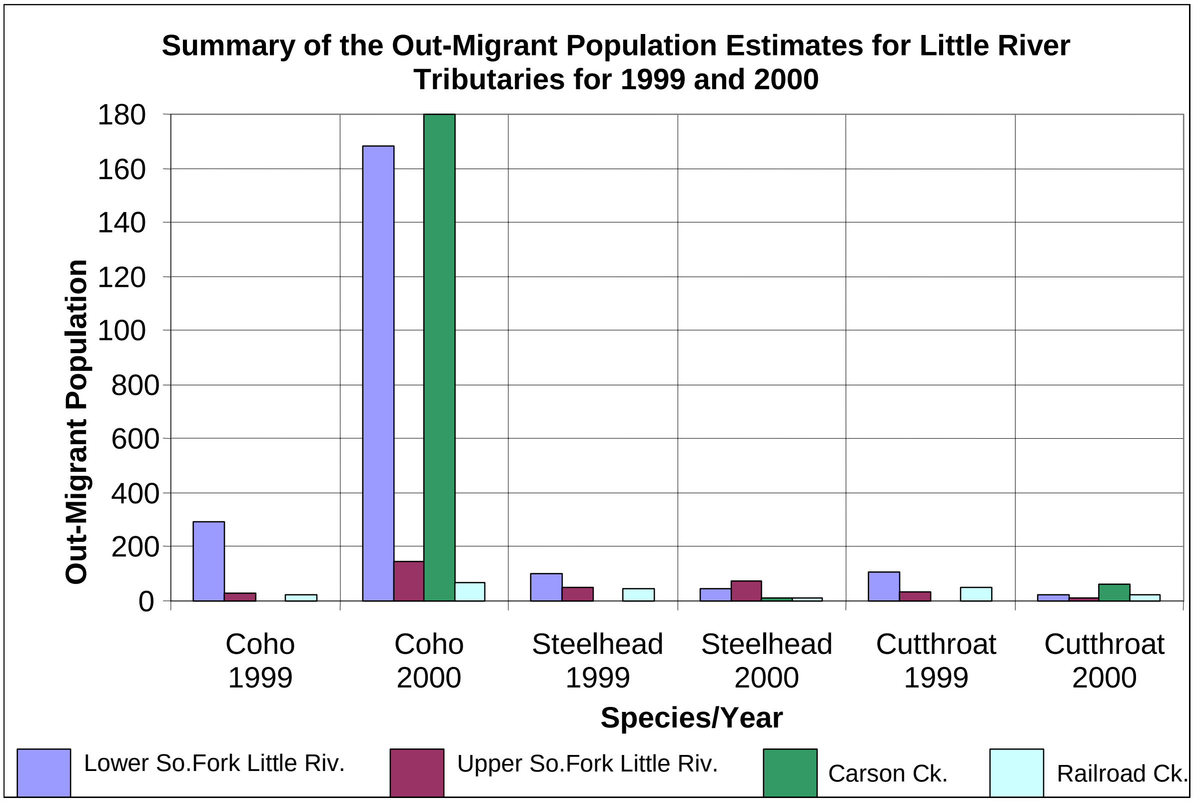


Figure 4-31. Summary of salmonid out-migrant population estimates for tributaries of Little River (1998-1999 and 1999-2000).

In the Upper South Fork Little River, small numbers of live chinook salmon, unknown carcasses, and redds were observed during the 1998-1999 and the 1999-2000 surveys. The Lower South Fork Little River surveys revealed a few live adult chinook, coho, and steelhead and (to a lesser degree) redds and carcasses of those species in 1998-1999. In 1999-2000 and 1998-1999, a good number of unidentified redds were observed in the Lower South Fork Little River during surveys. In summary, variable numbers of all three of these species have been observed spawning in the streams surveyed in the Little River HPA.

4.4.7.8 Covered Species Occurrence and Status

Presence/absence of the six Covered Species in the Little River HPA is presented by drainage in Table 4-10, and the recorded distribution is displayed in ***Figure 4-32***.

Table 4-10. Covered Species distribution in the Little River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Little River	2,3	1,2,3	2,3	2,3	3	3
Bullwinkle	A	A	U	U	U	U
Coon	A	A	U	U	U	U
South Fork Little River	3	1,2,3	2,3	2,3	P	3
Water Gulch	A	A	U	P	U	U
Freeman Cr.	A	3	P	3	P	P
Railroad	3	3	3	3	3	3
Lower South Fork Little River	2,3	1,2,3	2,3	2,3	3	3
Danielle Cr.	A	3	3	3	P	3
Heightman	P	3	P	3	P	P
Upper South Fork Little River	2,3	1,2,3	2,3	2,3	3	3
C-Line Cr.	A	A	3	3	P	P
Pattie's Cr	A	A	3	3	P	P

Codes
U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.7.8.1 Chinook Salmon

The Little River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the listing decision (64 FR 50405).

The Little River chinook population is depressed compared to historical estimates, but recent trends show a relatively stable population. Green Diamond has observed small numbers of live adult and carcasses of spawned out chinook salmon as well as redds during spawning surveys conducted within the Little River during 1998-2000. Other tributaries to Little River (Upper South Fork and Lower South Fork Little River) had many fewer numbers of spawning chinook salmon observed during those surveys. The Little River is considered one of the best local salmonid streams, with healthy genetic stocks, sufficient returns to seed the system, and good salmonid habitat (Weseloh and Farro, pers. comm. 1999).

4.4.7.8.2 Coho Salmon

Coho salmon populations are depressed throughout the Southern Oregon/Northern California Coasts Coho ESU, which encompasses the Little River HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995). This ESU was listed as threatened in May 1997.

The Little River coho population is depressed compared to historical estimates but appears to be relatively stable over the last decade. Recent data indicates high numbers and densities of juvenile coho from the 1998-99 brood year (see Appendix C). Spawning surveys conducted by Green Diamond have resulted in observations of live adult, carcasses of spawned out coho salmon, and coho redds within Little River during 1998-2000 and to a lesser degree in the Lower South Fork Little River during 1998-1999. The Little River is considered one of the best local salmonid streams, with healthy genetic stocks, sufficient returns to seed the system, and good salmonid habitat (Weseloh and Farro, pers. comm. 1999)

4.4.7.8.3 Steelhead and Resident Rainbow Trout

The Little River HPA includes the Northern California Steelhead ESU, which was listed as threatened on June 7, 2000 (65 FR 360744). Steelhead abundance data are limited for this DPS. Available data indicate that winter-run populations declined significantly prior to 1970 and that populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Specific information on steelhead populations in the Little River HPA indicates that the Little River has been and remains an excellent system for steelhead production, although current abundance is depressed compared to historical estimates. Out-migrant trapping conducted by USFWS in 1994 captured approximately 10,000 steelhead parr and 1100 smolts (Shaw and Jackson 1994). The ability of steelhead to utilize spawning and rearing habitat upstream of other salmonids in the Little River contributes to their success in this HPA (Weseloh and Farro, pers. comm. 1999)

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.7.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Specific information on coastal cutthroat trout populations in the Little River HPA is limited to recent estimates and observations. Historical information for comparison is lacking. Out-migrant trapping in the mainstem Little River in 1994 captured 403 coastal cutthroat, ranging in size from 50 to 275 mm, with the bulk around 150 mm (Shaw and Jackson 1994). A summary of recent outmigrant smolt trapping population estimates is shown in Figure 4-32 above. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.7.8.5 Tailed Frog

Green Diamond's ownership in the Little River HPA was acquired in 1998 after the presence/absence surveys for tailed frogs were completed. Sampling was not conducted in this HPA as part of the study of 72 streams. However, populations of tailed frogs have been confirmed in 15 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, tailed frogs streams in the Little River HPA are likely to be in good condition.

4.4.7.8.6 Southern Torrent Salamander

Green Diamond's ownership in the Little River HPA was acquired in 1998 after the presence/absence surveys for southern torrent salamanders were completed. Sampling was not conducted in this HPA as part of the study of 71 streams. However, populations of southern torrent salamanders have been confirmed in 18 streams throughout the HPA either through other types of amphibian surveys by the prior landowner or incidental observations since the acquisition of the property by Green Diamond.

Given the significant number of streams known to support the species, southern torrent salamander streams in the Little River HPA are likely to be in good condition.

4.4.7.9 Assessment Summary

Due to the coastal influence and high canopy closure, water temperatures are good in streams throughout the Original Assessed Ownership in the Little River HPA. The HPA has mixed geologic composition, characteristic of the Franciscan Complex. However, much of it is relatively stable compared with many of the other HPAs, and the parent material is relatively competent (consolidated) so that substrates are relatively coarse in most streams. Exceptions are found in some of the more extreme coastal sub-basins, such as Bullwinkle and Coon Creeks, where unconsolidated material results in a fining of the bed. The amount and quality of pool habitat and the overall amount of LWD in assessed streams in this HPA is the highest of all assessed streams on the Original Assessed Ownership. In addition, embeddedness was generally estimated lower than in assessed streams in most other HPAs, but this measure is highly subjective and may not be reliable. Green Diamond's qualitative assessment is that some streams on the Original Assessed Ownership in this HPA have relatively high levels of fine sediment including the mainstem Little River.

All of the salmonid species Covered Species are well distributed in streams on the Original Assessed Ownership in the Little River HPA, and the population levels are generally the highest among all assessed streams, particularly for coho salmon. This appears to be consistent with the generally good habitat conditions in Class I watercourses on the Original Assessed Ownership in this HPA. In contrast, the amphibian Covered Species do not appear to be particularly widespread in the Original Assessed Ownership in this HPA. However, as noted above, the ownership in this HPA was acquired by Green Diamond in 1998 after the amphibian surveys were completed. Green Diamond's qualitative assessment is that many of the headwater streams have excess sediment inputs from roads, which degrades the habitat for the amphibian Covered Species.

Given that sediment inputs have the potential to have a negative impact on both the salmonid and amphibian Covered Species, the highest conservation priority for the Plan Area in this HPA should be to address road-related sediment inputs.

4.4.8 Mad River HPA

4.4.8.1 HPA Type, Size, and Group

The Mad River HPA is a hydrographic area as defined in this Plan and is part of the Korbel HPA Group. It includes approximately 119,686 acres.

4.4.8.2 Eligible Plan Area

The Eligible Plan Area in the Mad River HPA includes approximately 99,163 acres: 49,376 acres of Initial Plan Area and 49,787 acres of Adjustment Area. All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.8.3 Geology

The Mad River HPA is within the Coast Ranges Geologic Province (see ***Figure 4-1***). Bedrock in this HPA is composed mostly of Central Belt Franciscan Complex and Quaternary – Tertiary Overlap deposits, juxtaposed by the Mad River thrust fault system.

Topography in the HPA is relatively steep and mountainous, but fairly extensive lowlands are present from the mouth of the river and upstream to the Mad River Hatchery, near the town of Blue Lake.

Central Belt Franciscan complex is composed of broken formation (schist, greywacke sandstone, shale, conglomerate, chert, pillow basalt, and greenstone) and mélange (primarily composed of discontinuous bodies of hard greywacke sandstone, chert, greenstone and pillow basalt in a weak, pervasively sheared claystone matrix). However, mapping of the units has not been systematic and consistent in all parts of the watershed. In much of the area, the Franciscan units have not been separately identified, and the rock is simply mapped as Undifferentiated Franciscan.

Quaternary – Tertiary Overlap deposits include the Falor Formation, which is generally described as poorly cemented clay, silty clay, and pebbly sandstone and fine-grained sandstone with pebbly stringers (James, 1982). The Falor Formation is correlated to the upper section of the Wildcat Group (James, 1982). Other Quaternary – Tertiary Overlap deposits include marine terraces, fluvial terraces, dune deposits, and Holocene alluvium and beach deposits.

Pleistocene to Holocene marine terrace deposits cover the bedrock surfaces on wave-cut benches within about two miles of the coastline, and up to 260 feet above sea level. These deposits are composed of slightly consolidated silts, sands and gravels, which have been uplifted and offset by subsequent fault movements (Kelley 1984; Kelsey and Carver 1988).

Pleistocene to Holocene fluvial terrace deposits cover the bedrock at various locations adjacent to the present stream and river channels, but at higher levels than the active channel deposits. As many as six separate terrace levels have been identified at some locations, with progressively older terrace deposits at correspondingly higher levels. These deposits are composed of unconsolidated, poorly sorted sands, gravels and boulder conglomerates. Fluvial terrace deposits are most extensive adjacent to Lindsay Creek in the Fieldbrook area and adjacent to the Mad River at Blue Lake and Butler Valley (Kelley 1984; James 1982; Kilbourne 1983-85).

Ancient dune sand deposits of Pleistocene to Holocene age overlie the bedrock up to four miles from the present coastline and up to 620 feet above sea level. These deposits are composed of unconsolidated fine to course grained sand (Kelley 1984). The ancient dune sands may be part of the Hookton Formation located south of the area covered in this study. These materials are extremely erodible where they are exposed, and they are subject to slumping where slopes are undercut.

Holocene alluvium, flood plain deposits and beach deposits are present in active stream and river channels, in valley bottoms and on the coastal plain. They are composed of poorly sorted, unconsolidated mixtures of boulders, gravel, sand, silt and clay (James 1982; Kelley 1984; Kilbourne 1983-85; Ristau 1979). These deposits are reworked by meandering and shifting stream channels, especially during the infrequent large flood events. The sediment progressively migrates downstream, with new material being added at multiple points along the channels by erosion and landslide movement. Some of that new material is transported out to sea or removed by gravel mining.

The construction of two dams, and the later removal of one of them, has modified the sediment migration pattern in the Mad River system. Sweasey dam was constructed about seven miles upstream from Blue Lake in 1938. By 1960, its 3,000 acre-foot reservoir was nearly filled with gravel, sand and silt. The dam was removed in 1970, releasing the sediment (almost five million cubic yards) for subsequent movement downstream. That pulse of material is still affecting the river channel below the dam site. Robert Matthews Dam at Ruth Reservoir was constructed in 1961, with a capacity of 51,800 acre-feet. Sediment is accumulating in the reservoir at a comparatively minuscule rate because it is located far upstream where the sediment load is very low (James 1982).

Published geologic maps indicate that both shallow and deep-seated landslides exist throughout this HPA. Deep-seated rotational/translational landslides and earthflows are common in the Franciscan mélange. Younger bedrock in the area is highly erodible and susceptible to slumping and rotational slide movement.

4.4.8.4 Climate

In the Mad River basin, 75% of the annual precipitation occurs between November and March. Snow usually occurs above 3000 feet, but snow levels may occasionally drop to as low as 1000 feet above sea level. Annual precipitation levels range from around 40 inches at the coast to greater than 70 inches in the central basin. The basin average is approximately 63 inches.

The four largest recorded flood events were on January 1953, December 1955, November 1960 and December 1964. The highest recorded peak discharge was during the 1955 event: 77,800 cfs. at the Arcata gauge station.

4.4.8.5 Vegetation

The Mad River HPA extends inland from the coast approximately 26 miles and reaches an elevation of 5200 feet. It encompasses a range of vegetative types from coastal scrub and Sitka spruce forest in the coastal area to Douglas-fir/white fir forests at elevations above 4000 feet in the extreme southeastern corner of the HPA.

Redwood/Douglas-fir forests dominate roughly the lower two-thirds of the HPA. This type also includes occasional grand fir, western red cedar, and western hemlock on lower slopes near the coast. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood, with pacific madrone occurring as a minor stand component on drier sites. As distance from the coast and elevation increase, the proportion of redwood in stands decreases and Douglas-fir and tanoak become more prevalent, with these species dominating the landscape at elevations above 2000 feet. Occasional incense cedar is also found at higher elevations along the HPA's western boundary.

Extensive prairies are particularly distinctive features on south to west slopes and ridgetops in the upper one-third of the HPA. In this area California black oak forms nearly pure stands as an ecotone between prairies and Douglas-fir forest.

Timber harvesting in this HPA began in the late 1800s near the coast as white settlers arrived. By 1930 almost all of the redwood type had been harvested. The Douglas-fir dominated forests in the upper reaches of the HPA were not extensively logged until the 1940s, and by 1970 very little timberland remained in the HPA that had not been logged. Harvesting of mature second-growth forests was initiated in the lower reaches of the HPA in the 1960s.

4.4.8.6 Current Habitat Conditions

4.4.8.6.1 <u>Water Temperature</u>

Water temperature monitoring in the Mad River HPA began in 1994 and is ongoing today (see Appendix C5 for details). From 1994-2000, 37 summer temperature profiles were recorded at 11 sites within 9 Class I watercourses in the HPA. An additional 53 summer temperature profiles were recorded at 20 headwater sites within 14 Class II watercourses. Figure 4-33 displays the 7DMAVG water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the period (1994-2000) indicate that 3 monitoring sites in one Class I watercourse (Cañon Creek) exceeded the red light thresholds 6 times: at the lowest monitoring site during 1996 through 2000 and at the mid reach site in 2000. In addition, one Class I site (Green Diamond Creek) exceeded the yellow light threshold in 1997 and 1999. No Class II sites exceeded the red or yellow light thresholds.

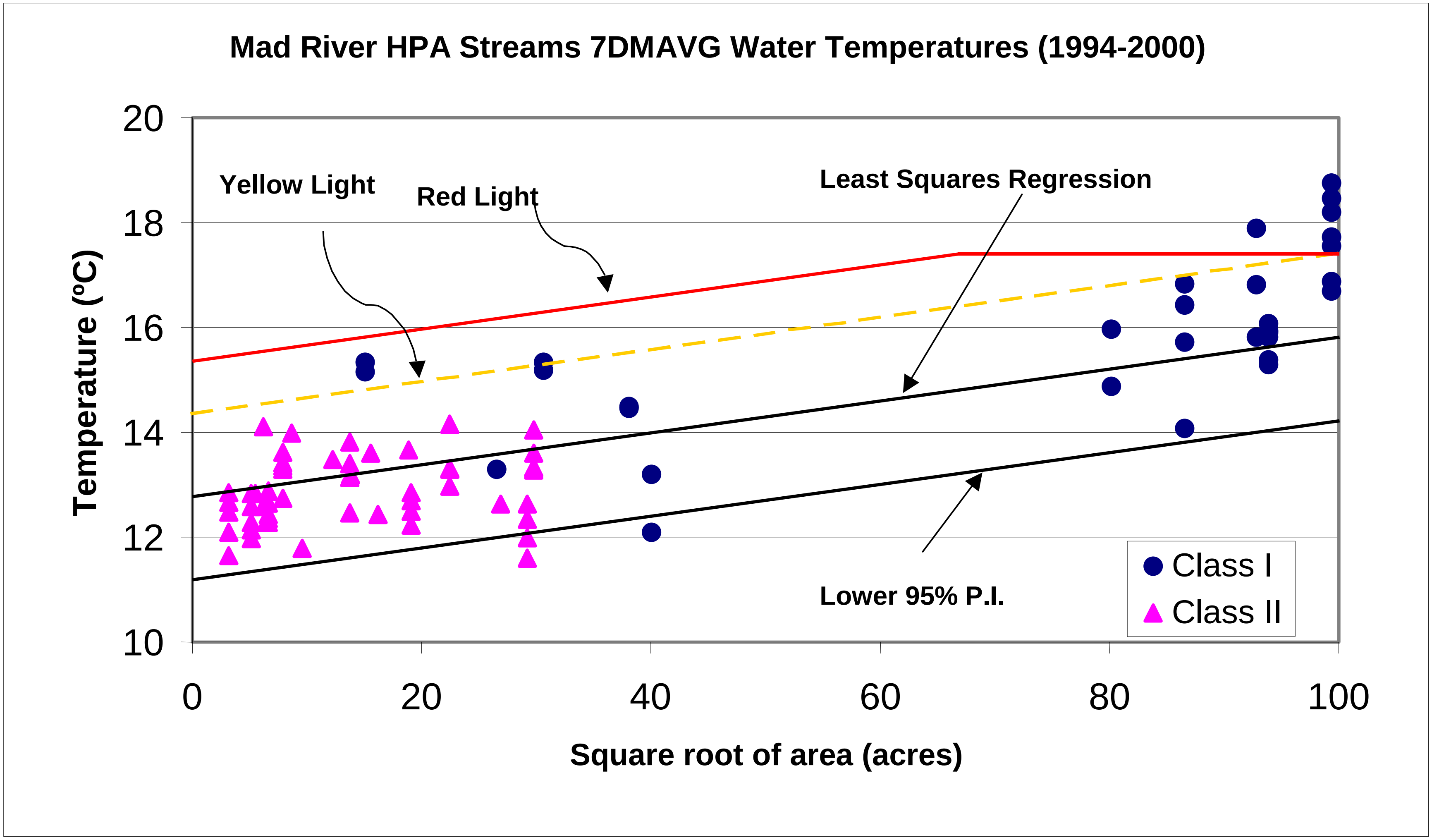


Figure 4-33. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Mad River HPA monitored between 1994 and 2000.**

4.4.8.6.2 Channel and Habitat Typing

Green Diamond assessed three streams in 1994-5 within the Mad River HPA. The assessed streams (in descending order of mid-point watershed area), their mid-point watershed areas, and their gradients are as follows (see Appendix C1 for details and Table C1-7 for summary of collected data):

Stream	Mid-point Watershed Area	Mid-point Gradient
Cañon Creek	8,595 acres	3.0%
Lindsay Creek	2,985 acres	1.0%
Dry Creek	1,492 acres	3.7%

The results of the assessments are summarized below and depicted in Figure 4-34 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the three assessed streams indicate:

- Percent canopy closure (79-92%) and percentage conifer canopy (15-25%) for the three assessed streams are somewhat typical of other assessed streams with similar watershed areas (Figure 4-34 [A and B]).

- For the three assessed streams, there was wide variability in percentage of stream length in pools (16-50%), but the percentages are generally similar to those for other streams of similar watershed area (Figure 4-30 [C]).

- The percentage of LWD as structural shelter in pools for the three streams varies widely (range 14-26.9%). Dry Creek's percentage (14%) is somewhat lower and Lindsey Creek's (26.9%) is somewhat greater than that for other assessed streams with similar watershed area (Figure 4-34 [D]).

- Figure 4-34 [E]) depicts the average residual pool depths in the 3 streams. Dry Creek (1,492 acres) has a lower and Lindsey (2,985 acres) has a much greater average residual pool depth than other assessed streams with similar watershed areas.

- Lindsey Creek has one of the highest embeddedness index values of all assessed streams on the Original Assessed Ownership (Figure 4-34 [F]).

In summary, the results suggest that the habitat in the assessed streams in the Mad River HPA are, in many instances, similar to other assessed streams of similar watershed size.

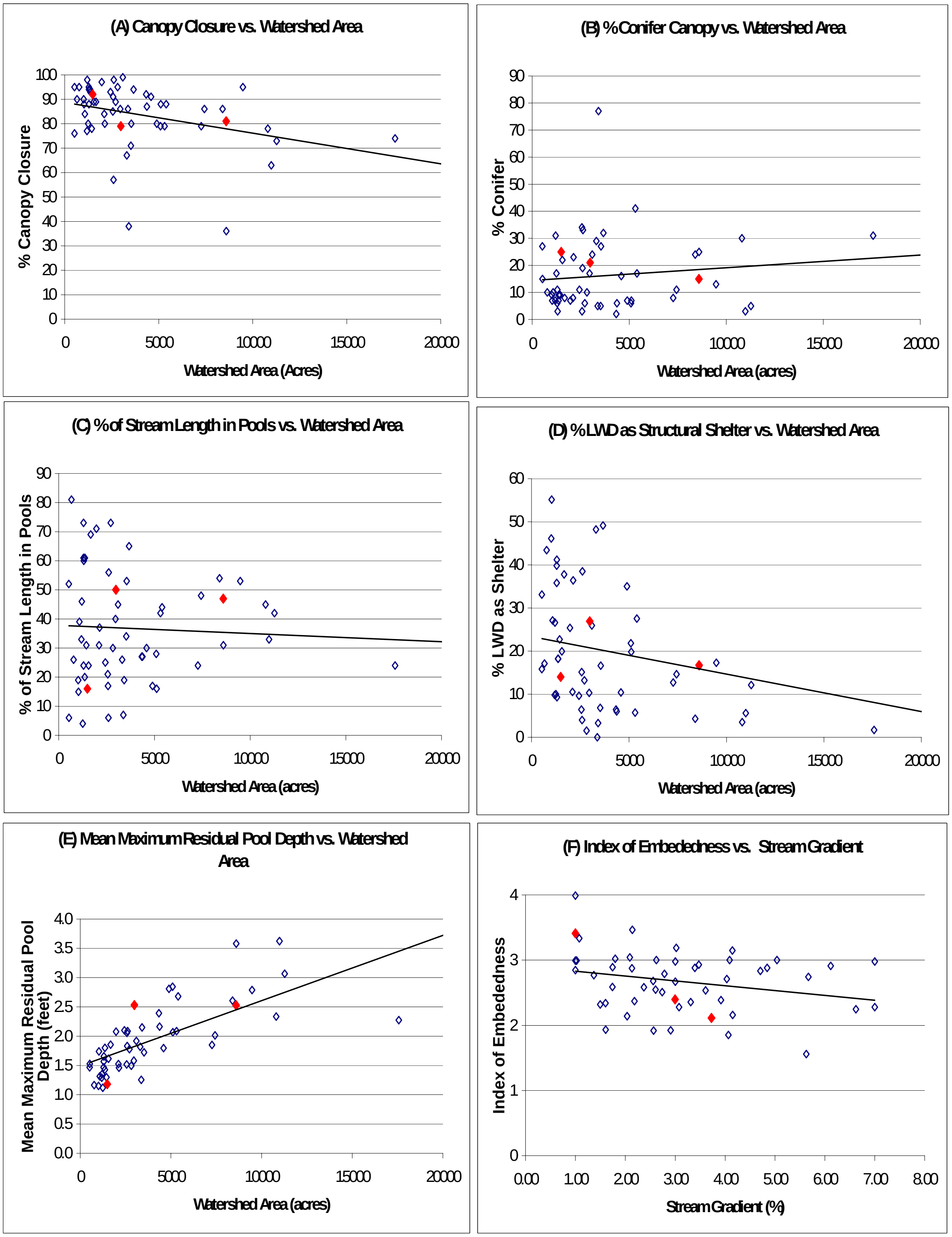


Figure 4-34. Channel and habitat types in three streams assessed in the Mad River HPA. (Solid diamonds are assessed streams in Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)

4.4.8.6.3

LWD Inventory

LWD survey/inventories were conducted in 1994 and 1995 in three streams in the Mad River HPA: Cañon, Lindsey, and Dry creeks (see Appendix C2 for details and Tables C2-5 and C2-13 for summary of collected data.) Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-35 (A-B).

- As shown in Figure 4-35 (A), Dry and Lindsey creeks have somewhat lower numbers of average in-stream LWD pieces per 100 feet of channel than other assessed stream of similar watershed area. The average number of LWD pieces per 100 feet of channel is 1.3 for Dry Creek, 3.5 for Lindsey Creek, and 1.8 for Cañon Creek. The average for Prairie Creek is 6.8.

- The LWD volume indices for the three streams in the HPA are shown in Figure 4-35 (B). In general, the indices are also somewhat lower than those for other assessed streams with similar watershed areas.

- As shown in Figure 4-35 [C], the average number of LWD pieces in riparian recruitment zone per 100 feet for the three assessed streams in this HPA ranges from 6 to 7.7 and is similar to other assessed streams with comparable watershed areas.

In summary, the three assessed streams in this HPA have some of the lowest average LWD piece counts per 100 feet of channel and lowest volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

4.4.8.6.4 Long Term Channel Monitoring

Using the information gathered in channel monitoring pilot studies that began in 1993, a revised methodology was developed and first implemented in Cañon Creek beginning in 1995. In 1996 and 1997, additional channel monitoring data was obtained from Cañon Creek. Re-surveys are scheduled to occur every two years or after a five-year flood event.

Appendix C3 provides the details of the surveys through 1997. Data collected in this HPA since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. No conclusions can be drawn at this point in the monitoring program.

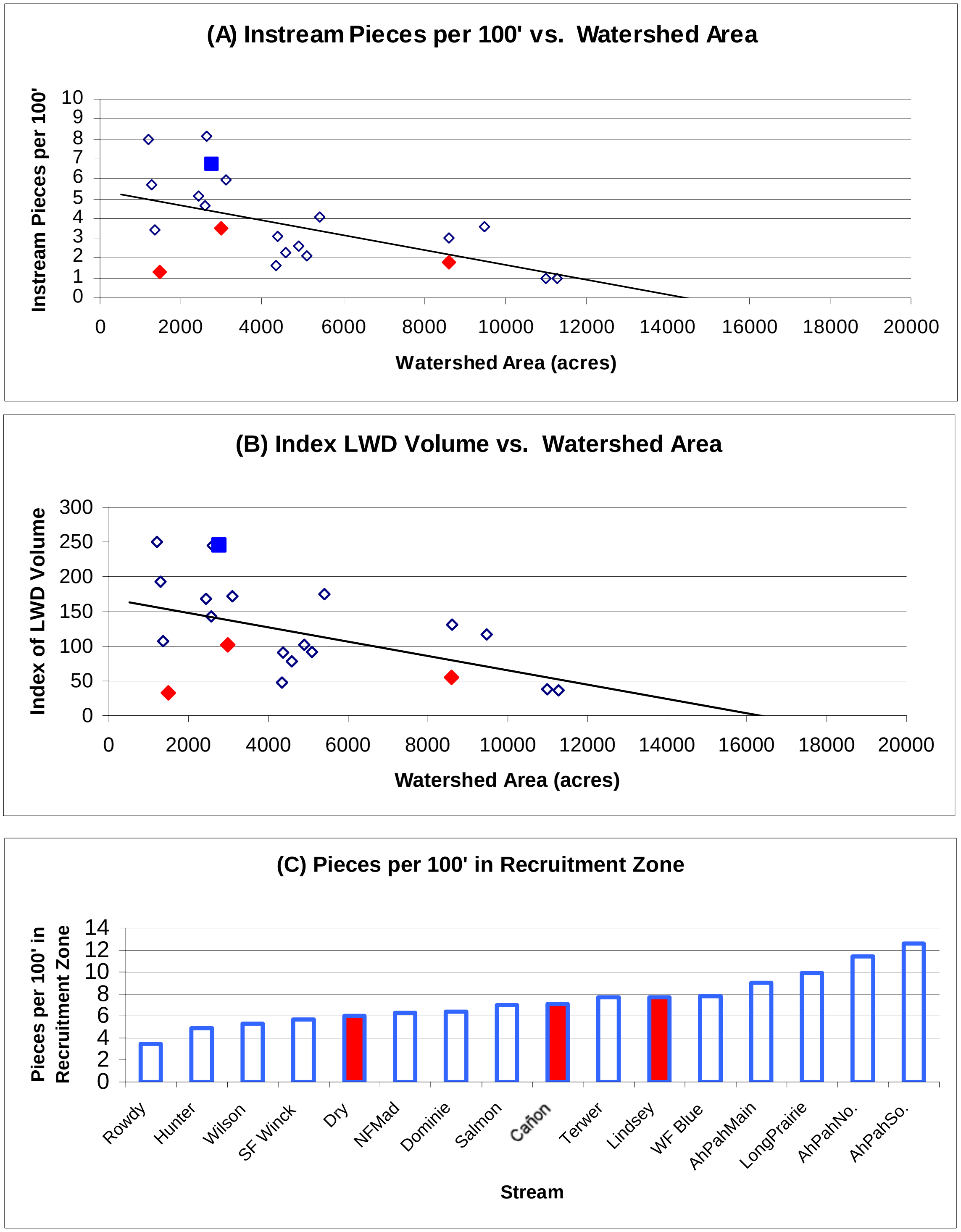


Figure 4-35. **LWD survey results for three streams assessed in the Mad River HPA. (Solid diamonds are assessed streams in Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

4.4.8.6.5 Estuarine Conditions

The Mad River estuary has been severely impacted by human settlement, beginning with the draining and diking of wetlands for agricultural use. The Arcata Bottoms (once the Mad River floodplain) has been extensively developed for livestock grazing and residential purposes. In addition, to prevent regular flooding of this area, a meander in the lower Mad River was cut off by excavation of a new channel segment in 1862. The lower channel was cleared of large woody debris jams to facilitate transport of logs in the late 1800s, and unrestricted removal of logs by firewood cutters in the lower reaches has inhibited re-establishment of large woody debris in this area. Gravel extraction occurs at numerous locations below the Mad River Hatchery and has been an important commercial activity for some time, removing approximately 15.5 million cubic yards of gravel between 1952 and 1992. The Humboldt Bay Municipal Water District, which provides water to communities and industry around Humboldt Bay, pumps its water from wells in the lower Mad, just above the Highway 299 bridge. This history of development has resulted in channelization of the lower 10 miles of the Mad River.

4.4.8.7 Salmonid Population Estimates

Cañon Creek is currently the only stream routinely monitored in the Mad River HPA. Spawner escapement survey frequency, spacing, and duration have helped to make it one of the most well monitored creeks for adult escapement.

4.4.8.7.1 Summer Juvenile Population Estimates

A summary of 1995 through 2000 juvenile coho salmon, steelhead, and cutthroat trout summer population estimates for Cañon Creek are shown in Figure 4-36 (A-C) (see Appendix C7 for details).

As seen in Figure 4-36 (A) the number of coho salmon in Cañon Creek ranged from 43 to 919 juveniles for the four years when surveys were conducted. No juvenile population estimates were made for 1996 and 1998. Steelhead estimates for the five years for which estimates were made ranged from nearly 600 to over 1,000 juveniles (Figure 4-36 [B]). No estimates were made for year 1998. Juvenile cutthroat trout populations in Cañon Creek for the four years estimates were made ranged from 0 to 21 juveniles (Figure 4-36 [C]). No cutthroat trout juvenile population estimates were made in 1998.

In summary, population estimates indicate that juvenile coho populations have been very variable in Cañon Creek over the period of surveys. Juvenile steelhead populations are somewhat stable between years and appear to be robust in Cañon Creek. Summer population estimates for cutthroat indicated there are small numbers of juveniles of these species, and some variability from year to year in the stream surveyed.

4.4.8.7.2 Adult Spawner Surveys

Spawning surveys have been conducted annually on Cañon Creek from 1995 through 2000 (see Appendix C9 for details). During these spawner surveys, chinook salmon were the most common species observed, followed by steelhead and coho salmon, respectively.

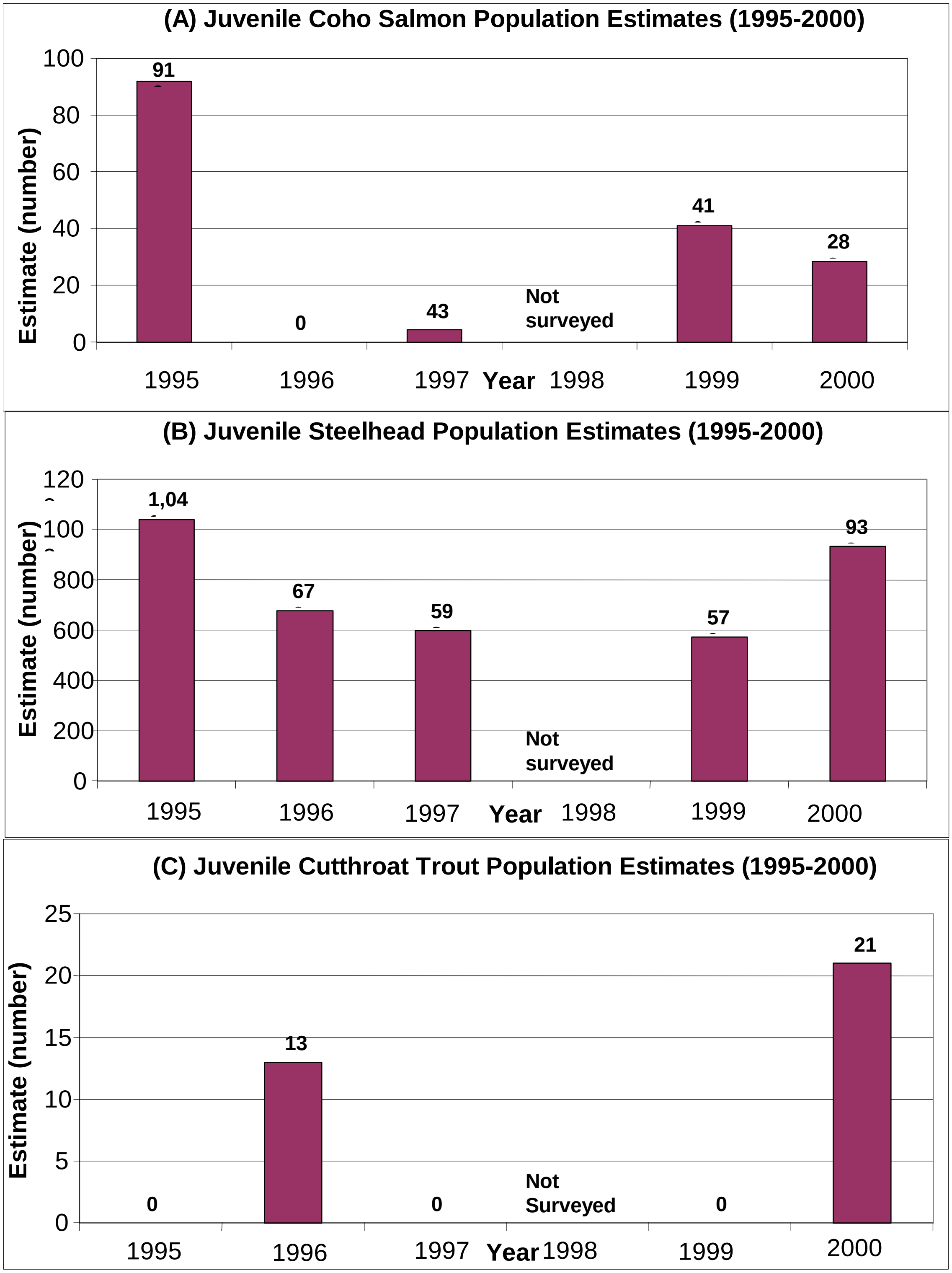


Figure 4-36. Summary of the juvenile population estimates for coho salmon, steelhead, and coastal cutthroat trout in Cañon Creek in the Mad River HPA (1995-2000).

The results to date indicate that large numbers of chinook adults, redds, and carcasses have been observed in Cañon Creeks during all years surveyed. Many fewer live steelhead, carcasses, and redds have been observed and only during the 1997-1998 and 1999-2000 surveys. Very few coho adults, redds, and carcasses have been observed in any years except during 1998-1999 when no coho were observed in Cañon Creek.

4.4.8.7.3 *Mad River Summer Steelhead Population Survey*

Since 1982 the U.S. Forest Service has surveyed 2 Mad River Index reaches that are upstream of the Green Diamond property from Ruth Dam downstream to Deer Creek. Comprehensive dive counts of adult summer steelhead in the Mad River have been conducted since 1994. The comprehensive surveys were initiated in response to observed declines in summer steelhead counts within index reaches surveyed annually by U.S. Forest Service personnel upstream of Green Diamond's Mad River property.

Green Diamond and CDFG personnel conduct annual dive surveys extending from Deer Creek to the CDFG's Mad River Hatchery (see Appendix C10 for details). This segment includes eight reaches and a total of approximately 36 miles of the mainstem Mad River. CDFG annually surveys the Mad River downstream of the Mad River Hatchery to Kadle Hole near the Highway 299 bridge. A summary of the results of the dive surveys for years 1994 through 2000 are shown in Figure 4-37.

As shown in Figure 4-37, the total number of adult and half-pounder steelhead in the Mad River during these surveys seemed to peak in the 1995 survey at 550, This peak maybe a result of factors such as different water-year types; variations in habitat conditions and in spawning, and rearing success; and changes in oceanic and climatic conditions prior to and since 1995.

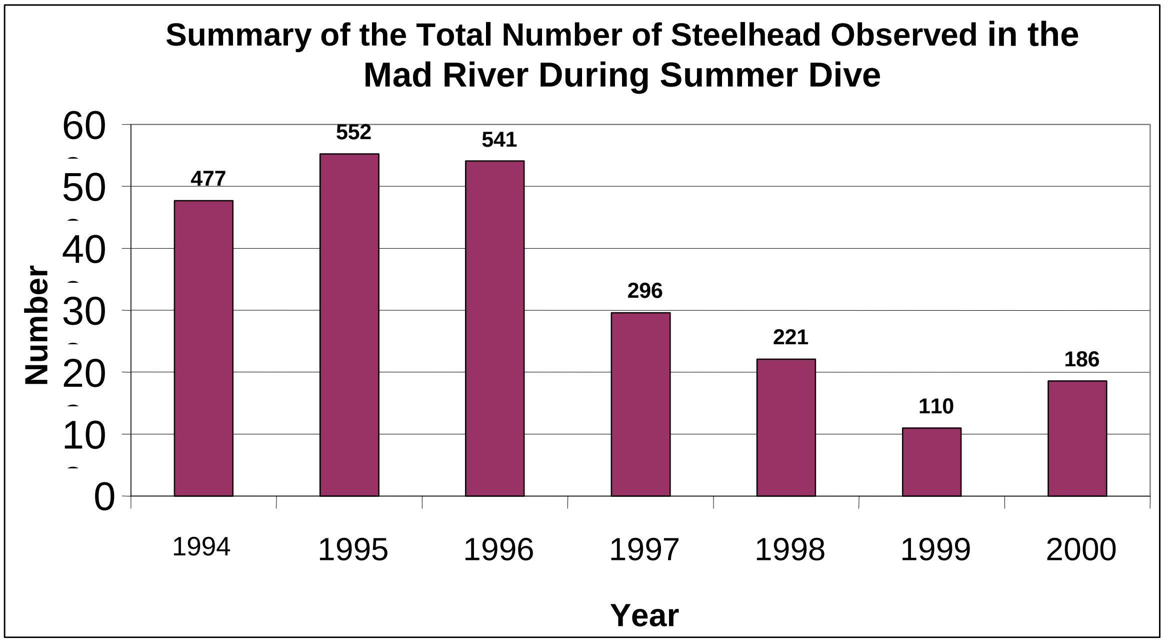


Figure 4-37. Summary of the Mad River summer steelhead population surveys (1994-2000).

4.4.8.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in the Mad River HPA is presented by drainage in Table 4-11, and the recorded distribution of the species is displayed in ***Figure 4-38.***

4.4.8.8.1 <u>Chinook Salmon</u>

The Mad River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405). Nehlsen et al. (1991) identified Mad River fall-run chinook as at moderate risk of extinction. Abundance trends have declined in the Mad River Basin over the long term but show signs of increasing in recent years (64 FR 50405).

Table 4-11. Covered Species distribution in the Mad River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Strawberry Creek	A	1,2	2	2,3	A	A
Mad River	2,3	1,2,3	2,3	2,3	3	3
Widow White Creek	2	2	2,3	2,3	A	A
Mill Creek	2	2,3	2,3	2	A	A
Essex Gulch	A	A	A	3	U	U
Lindsay Creek	2	1,2,3	2,3	2,3	U	3
Grassy Creek	3	1,2	2	2	U	U
Squaw Creek	2,3	1,2	2	2	U	U
Timmons Creek	A	A	A	3	U	U
Mather Creek	P	1,2,3	2,3	2,3	A	A
Noisy Creek	U	1,2	2	U	U	U
Mill Creek	2	1,2	2	P	U	U
Hall Creek	2	1	2	P	U	U
Powers Creek	P	1,2	2,3	P	P	P
Quarry Creek	A	1	2	A	P	P
Puter Creek	A	A	2	A	P	P
Boundary Creek	A	A	3	A	3	3
Black Dog Creek	A	A	3	A	3	3
Dry Creek	3	1,2	2,3	A	3	3
Cañon Creek	2,3	1,2,3	2,3	3	3	3
Simpson Creek	A	A	2,3	A	P	P
Devil Creek	A	A	2,3	A	3	3
No Name Creek	U	U	U	U	P	3
Maple Creek	2	1,2	2,3	U	3	3
Davis Creek	U	U	2	U	P	P
Bear Creek	U	U	U	U	U	U
Boulder Creek	2	1, 2	2,3	A	3	3
Little Boulder Creek	A	A	U	A	P	P
Goodman Prairie Creek	A	A	U	A	P	3
Graham Creek	A	A	U	A	3	3
Madrone Creek	A	A	U	A	P	P
Wilson Creek	A	A	2	A	P	P

Codes

U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.8.8.2

Coho Salmon

The Mad River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA as of May 1997 (62 FR 24588). Populations of coho are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Mad River Hatchery coho stocks are not considered part of the Southern Oregon/Northern California Coasts ESU, as they have included transplants from outside the area (Weitkamp et al. 1995). As shown in Table 4-11, coho are fairly well distributed within this HPA, but almost no information on total coho abundance or proportion of naturally spawning hatchery fish is available.

4.4.8.8.3 Steelhead and Resident Rainbow Trout

The Mad River HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS. Available data indicate that winter-run populations declined significantly prior to 1970 and that populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Summer steelhead abundance in the Mad River has been monitored from 1982 to the present, revealing unexpectedly high abundance in 1994-1996, with a sharp downward trend in more recent years (see Appendix C10 for details). Information on winter run steelhead is lacking. The genetic effect of the Mad River Hatchery steelhead releases on the native winter steelhead population is a source of concern within this HPA (Busby et. al. 1996).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.8.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Coastal cutthroat trout are only occasionally observed in the mainstem Mad River but are abundant in some lower Mad River tributaries, including Lindsay, Widow White, and Mill creeks (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.8.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs 12 streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Mad River HPA, 7 of 12 (58.3%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 17 other streams in the HPA either through other types of amphibian surveys or incidental observations.

Given the moderate rate of occurrence and somewhat limited number of streams known to support the species, tailed frog streams in the Mad River HPA appear to be in moderate condition. However, other tailed frog studies (e.g. headwaters monitoring and life history studies) in this HPA indicate that, depending on the localized geology, some streams provide excellent habitat for tailed frogs while others completely lack habitat for the species.

4.4.8.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders 12 streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond’s ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Mad River HPA, 8 of 12 (66.7%) sampled streams had torrent salamanders. In addition, populations of torrent salamanders were confirmed in 54 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given the moderate rate of occurrence, torrent salamander streams in the Mad River HPA appear to be in relatively poor condition. However, other southern torrent salamander studies (e.g., headwaters monitoring and life history studies) and the relatively large number of streams known to support the species in this HPA indicate that, depending on the localized geology, some streams provide excellent habitat for torrent salamanders while others completely lack habitat for the species.

4.4.8.9 Assessment Summary

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good in streams in the Original Assessed Ownership in the Mad River HPA. The primary exceptions are the lower reaches of Cañon Creek, which typically have very low flows in late summer. The majority of the canopy in the lower reaches of this stream is composed of alder and willow, and much of this was destroyed by high water during the winter of 1996/97. High incident solar radiation coupled with minimal flows resulted in high localized water temperatures during the late 90s in Cañon Creek.

The coastal portion of the HPA is largely composed of young marine sediments that are generally weakly consolidated and highly erodible. As a result, streams in this area have high levels of fine sediments. Although only three Class I watercourses on the Original Assessed Ownership in the Mad River HPA were assessed, the amount and quality of pool habitat is generally consistent with other assessed streams in Original Assessed Ownership. This habitat is probably less than optimum for salmonids, due primarily to a general deficiency in the larger classes of LWD resulting from past timber management and active removal programs.

The salmonid Covered Species are relatively common in the coastal streams of the Original Assessed Ownership in this HPA, while the amphibian Covered Species are more common in streams in the middle portions of this HPA. The primary explanation for this pattern is related to geology. The unconsolidated geology of the coastal streams creates substrates that are completely unsuitable for the covered amphibian species. The streams in the middle portions are located in more consolidated geologic parent material, which produces the necessary coarse stream substrates. However, most of these streams are too steep to provide habitat for salmonids. Cañon Creek is the only substantial sub-basin that has both low gradient reaches for salmonids and the appropriate geology for the amphibians. The streams on the Original Assessed Ownership in the upper portions of this HPA have a more interior climate and lower canopy closure that can result in higher water temperatures. In addition, the upper portion of this HPA is pervasively underlain by deep-seated landslides and earthflows associated with soft Franciscan Complex bedrock. Although there is consolidated geologic parent material that contribute coarse substrate material to streams, the extensive fine sediment inputs from prairie soils earthflows in this area result in streams that are heavily imbedded with fine sediments. In addition to the generally poor substrates in most streams, most of the tributaries off the mainstem Mad River in the upper portions of this HPA are sufficiently high gradient that no potential fish habitat exists.

It is not likely that water temperature limits populations of any Covered Species in streams on the Original Assessed Ownership, although temperatures may have had a temporary impact in the lower reaches of Cañon Creek. Spawning habitat may be limiting in some of the coastal streams on the Original Assessed Ownership in this HPA, including the Lindsay Creek sub-basin, but little data have been collected in these streams to quantify habitat conditions. Despite this, the limited biological data indicate that Lindsay Creek has high numbers of juvenile salmonids. Tannic waters and complex habitat preclude application of standard field protocols to allow quantification of their numbers. In Cañon Creek, stored sediment from past management activities and the need for greater amounts of LWD probably limits the amount and quality of summer and winter rearing habitat for the covered salmonid species. Debris flows triggered from roads have been documented to significantly impact several amphibian populations.

Therefore, the primary management emphasis for the Plan Area within the Mad River HPA should be to accelerate the recruitment of future LWD delivery to Class I watercourses and address road-related sediment inputs.

4.4.9 North Fork Mad River HPA

4.4.9.1 HPA Type, Size, and Group

The North Fork Mad River HPA is a hydrologic unit as defined in this Plan and is part of the Korbel HPA Group. It includes approximately 31,416 acres.

4.4.9.2 Eligible Plan Area

The Eligible Plan Area in the North Fork Mad River HPA includes approximately 31,416 acres: 28,209 acres of Initial Plan Area and 3,207 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.9.3 Geology

The North Fork Mad River HPA is within the Coast Ranges Province (see ***Figure 4-1***). Bedrock within the HPA is composed mostly of Central Belt Franciscan Complex with Quaternary – Tertiary Overlap deposits in the southwest section, juxtaposed by the complex northwest-trending, north-east dipping Mad River thrust fault system.

From east to west, the Franciscan bedrock within the area is Redwood Creek Schist along the east margin, Sandstone and Melange of Snow Camp Mountain and Undifferentiated Franciscan Complex rocks (also identified as Broken Formation rock on the west side of the Undifferentiated Franciscan (by McLaughlin) and Quaternary – Tertiary Overlap deposits. The northwest-trending, northeast-dipping Bald Mountain fault separates rocks of the Redwood Creek Schist and the Snow Camp Mountain unit in the east portion of the watershed.

The topography of the region is relatively steep and mountainous, similar to the rest of the Mad River Watershed. Similar to the rest of the Mad River hydrographic region, both shallow and deep-seated landslides exist throughout this HPA. Deep-seated rotational/translational landslides and earthflows are common in the Franciscan mélange. Younger bedrock in the area is generally described as poorly consolidated, uncemented, interbedded sands, silts, clays and gravels. These materials are extremely erodible, and they are very susceptible to slumping and rotational slide movement.

4.4.9.4 Climate

The average daily air temperature in the North Fork Mad River Hydrologic Unit ranges from a high of 62°F during August to a low of 40°F in January. The average annual precipitation in this Hydrologic Unit ranges from 60 to 80 inches, with rainfall increasing inland. Most precipitation occurs between October and May. The five largest instantaneous peak discharges recorded at the USGS gauging station along the Mad River near Arcata (Station No 11481000) occurred during water years 1953, 1956, 1965, 1972, and 1986.

4.4.9.5 Vegetation

The North Fork Mad River is one of the most heavily forested HPAs, with all but an estimated 300 acres of natural grassland in forest cover at the time of white settlement. The only changes in land use that have occurred since that time include Green Diamond's mill complex at Korbel, the right-of-way for State Highway 299 that bisects the HPA, and a portion of the town of Blue Lake.

The mouth of the North Fork is located approximately 8 miles from the coast, and its eastern-most edge is roughly 13 miles inland. Its elevation ranges from 200 feet to 3400 feet. Redwood occurs to around 2200 feet in elevation throughout most of the Unit. A notable exception, undoubtedly due to soil characteristics, is a band of Douglas-fir dominated forest on both sides of the drainage that begins just above Korbel and persists to a line across the watershed approximately where Highway 299 crosses the North Fork. This area contains only occasional individual redwoods, regardless of elevation, and has a higher proportion of western red cedar and western hemlock on lower slopes and in riparian areas than would normally be expected this far inland.

Higher elevations along the eastern and southern boundary of this HPA are forested entirely with Douglas-fir and tanoak, either in relatively pure stands or associated in mixed stands. Red alder occurs in riparian zones throughout the HPA, except at the highest elevations.

4.4.9.6 Current Habitat Conditions

4.4.9.6.1 Water Temperature

Water temperature monitoring in streams on the Original Assessed Ownership the North Fork Mad River HPA began in 1994 and is ongoing today (see Appendix C5 for details). Figure 4-39 displays the 7DMAVG (7 day maximum moving average) water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds in this Plan. From 1994-2001, 39 summer temperature profiles were recorded at 18 sites in 15 Class I watercourses in the HPA. An additional 13 summer temperature profiles were recorded at 6 headwater sites within 3 Class II watercourses. The results for the monitoring period (1994-2000) indicate that none of the Class I or Class II monitoring sites exceeded the yellow or red light threshold.

4.4.9.6.2 Channel and Habitat Typing

Green Diamond assessed two streams in 1994-5 within the North Fork Mad River HPA: (see Appendix C1 for details and Table C1-7 for summary of data collected):

Stream	Mid-point Watershed Area	Mid-point Gradient
North Fork Mad River	11,273 acres	1.4%
Long Prairie Creek	4,592 acres	2.6%

The results of the assessments are summarized below and depicted in Figure 4-40 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the two assessed streams indicate the following:

- Percentage canopy closure for the two streams (73-91%) is somewhat typical for other assessed streams of similar watershed area. The percentage of conifer canopy for North Fork Mad River is relatively low (5%) (Figure 4-40 [A and B]).

- Percentage of stream length in pools for the two streams (30-42%) are comparable to other assessed streams of similar watershed area (Figure 4-40 [C]).

- The percentage of LWD as structural cover in pools for the two streams (10-12%) is somewhat low, and the LWD in Long Prairie Creek is somewhat lower than in other assessed streams of comparable watershed area (Figure 4-40 [D]).

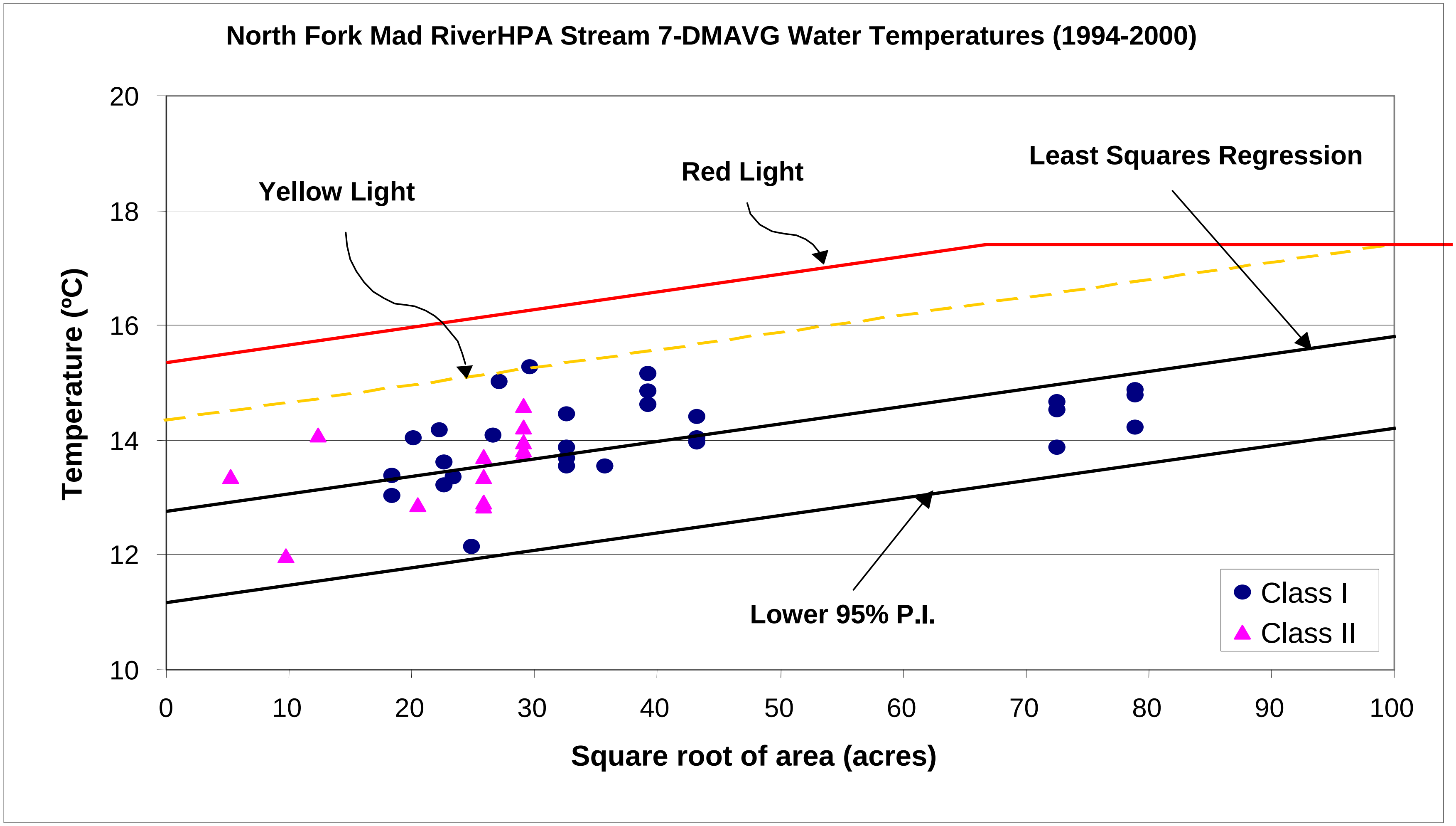


Figure 4-39. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the North Fork Mad River HPA monitored between 1994 and 2000.**

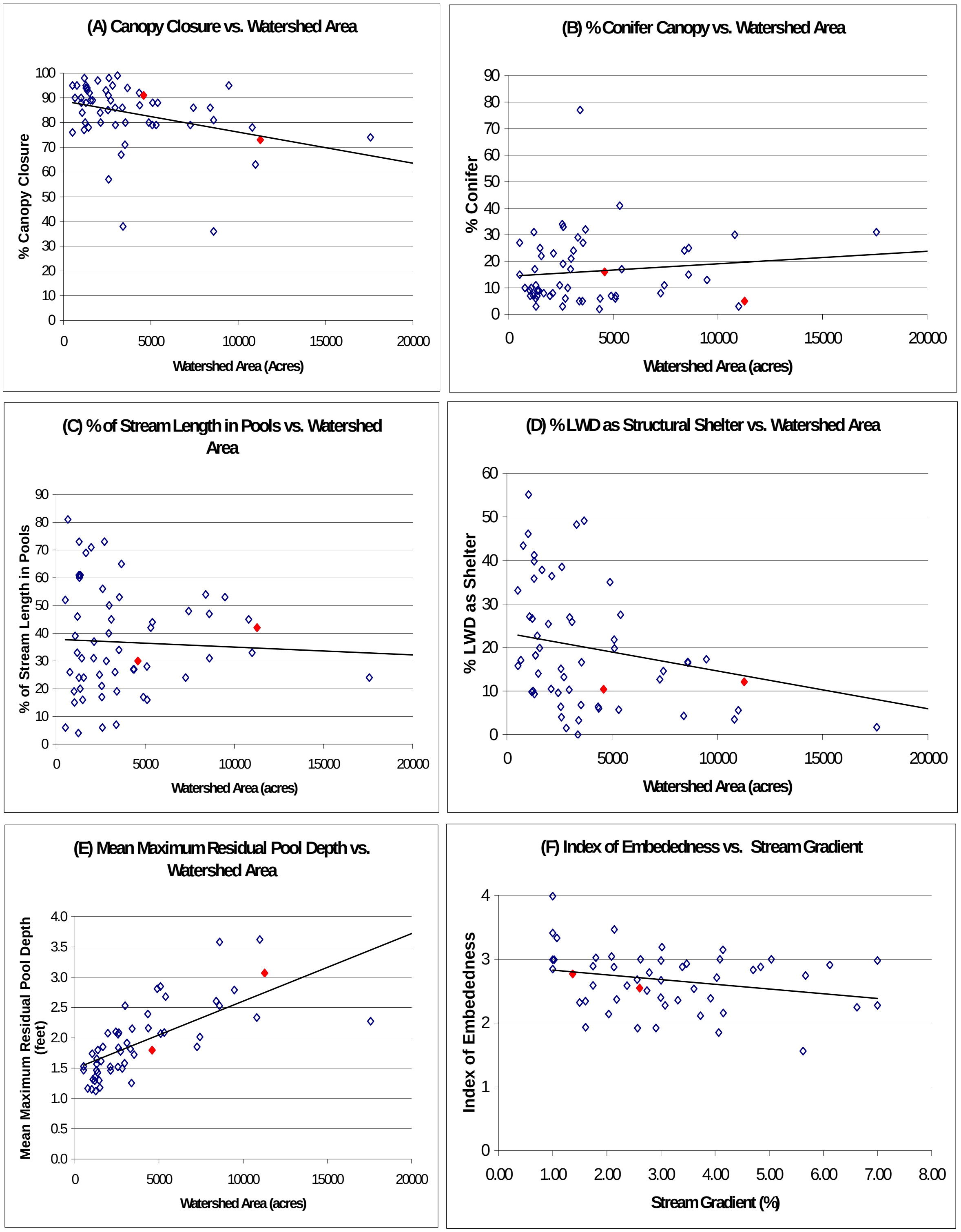


Figure 4-40. **Channel and habitat types in two streams assessed in the North Fork Mad River HPA. (Solid diamonds are assessed streams in North Fork Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)**

- Figures 4-40 [E]) and [F] depict the average residual pool depths and the substrate embeddedness for the two streams. The values for Long Prairie Creek and North Fork Mad River are generally typical for other assessed streams of similar watershed area. The exception is that the average residual pool depth in the North Fork Mad River (3.1 feet) is the third deepest of any assessed stream on the Original Assessed Ownership.

In summary, these results suggest that the habitat within the two assessed streams of the North Fork Mad River HPA is, in many instances, similar to other assessed streams of similar watershed area. There are, however, some habitat differences.

4.4.9.6.3 LWD Inventory

LWD survey/inventories were conducted in 1994 and 1995 in two streams within the North Fork Mad River HPA: North Forth Mad River and Long Prairie Creek (see Appendix C2 for details). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD. The results of these investigations are summarized below and presented in Figure 4-41 (A, B and C).

- As shown in Figure 4-41 (A), the average number of in-stream LWD pieces per 100 feet of channel for North Fork Mad River and Long Prairie Creek (1.0 to 2.3) were some of the lowest found in surveys on the Original Assessed Ownership. This average is similar to that for other assessed streams of comparable watershed area and approximately one-third of the average for Prairie Creek.

- LWD volume indices for the two streams are shown in Figure 4-41 (B). In general, the indices for the two streams are somewhat lower than those for other streams with similar watershed areas and are 15% to 32% of that for Prairie Creek.

- The average number of LWD pieces per 100 feet of channel in the riparian recruitment zone is relatively high for Long Prairie (9.9 pieces) and low for North Fork Mad River (6.3 pieces) (Figure 4-41 [C]).

In summary, the two assessed streams in this HPA have some of the lowest LWD piece counts and volume indices for their watershed size of all assessed streams on the Original Assessed Ownership.

4.4.9.6.4 Long Term Channel Monitoring

Using the information gathered in channel monitoring pilot studies that began in 1993, a revised methodology was developed and first implemented in Canyon Creek beginning in 1996. In 1997 additional channel monitoring data was obtained from Canyon Creek. These surveys have continued with scheduled re-surveys every two years or after a five-year flood event. Data collected at the monitoring sites since 1998 are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. The monitoring objectives, methods and results to date for channel monitoring activities in the North Fork Mad River HPA are presented in Appendix C3. No conclusions can be drawn at this point.

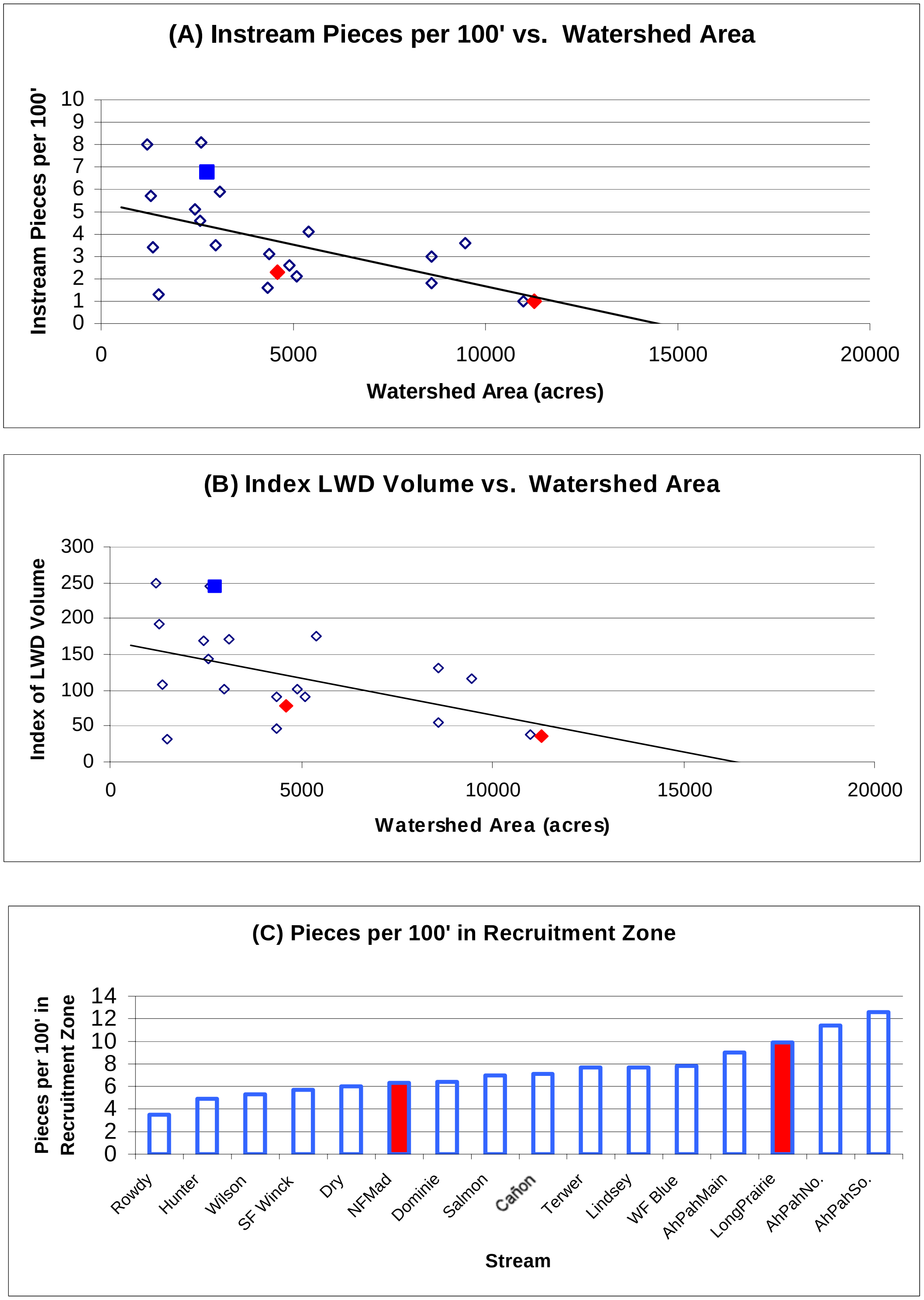


Figure 4-41. **LWD survey results for two streams assessed in the North Fork Mad River HPA. (Solid diamonds are assessed streams in North Fork Mad River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

4.4.9.7 Salmonid Population Estimates

Chinook are the most frequently recorded species in North Fork Mad River, followed by steelhead and coho, respectively. Chinook salmon escapement appears robust, with only one to two surveys each season recording large adult returns. Steelhead are fairly common in early winter surveys, but the majority of survey dates in late December are probably too early to record significant numbers. Coho are infrequently observed; however, this is likely a factor of water visibility and survey timing. Sullivan Gulch has been surveyed since 1996. Limited numbers of chinook, coho and steelhead have been observed. Chinook are the most frequently recorded salmonid, but steelhead may also make up a significant component of the survey if conducted later in the year. Based on juvenile population estimates, however, coho also make up a significant portion of the adult run, although they are rarely observed during spawning surveys.

4.4.9.7.1 Summer Juvenile Population Estimates

The 1999 and 2000 juvenile coho salmon and steelhead summer population estimates for Sullivan Gulch are shown in Figure 4-42. The number of coho salmon in Sullivan Gulch ranged from approximately 50 to nearly 800 juveniles for the two years surveyed. Steelhead estimates for the two years were very low and ranged from less than 20 to less than 60 juveniles. No coastal cutthroat trout were observed in Sullivan Gulch during population surveys. In summary, population estimates indicate that juvenile coho summer populations were variable in Sullivan Gulch between these two surveys, with good numbers found in 1999 and very low numbers seen in 2000. Juvenile steelhead summer populations were found to be very low in Sullivan Gulch during both years surveyed.

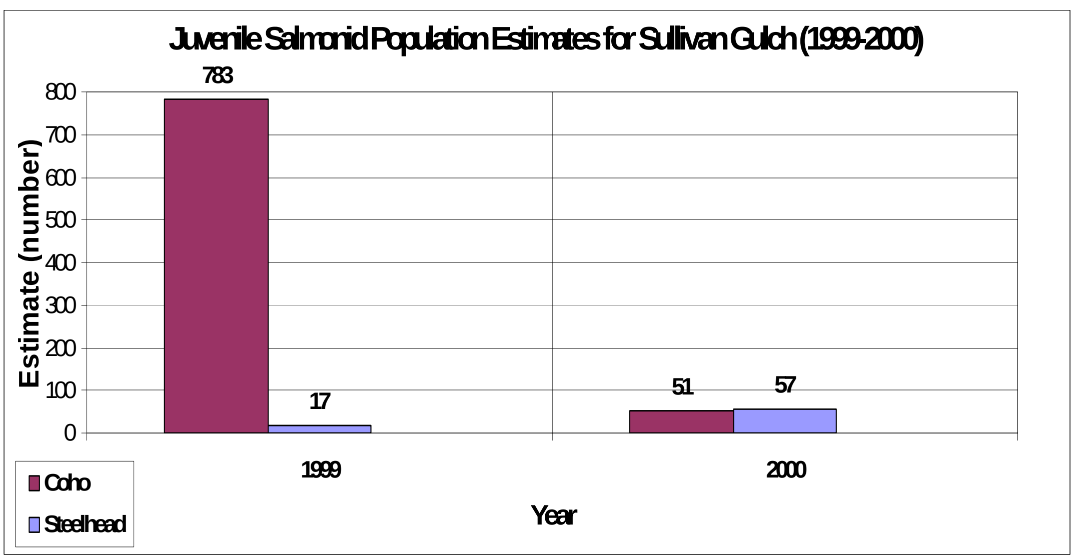


Figure 4-42. Summary of summer juvenile salmonid population estimates conducted in Sullivan Gulch in the North Fork Mad River HPA in 1999 and 2000.

4.4.9.7.2 Adult Spawner Escapement Surveys

Annual spawner surveys have been conducted on two streams (North Fork Mad River and Sullivan Gulch) in this HPA since 1996. The results to date indicate that large numbers of chinook adults (range 42 to 214), redds (range 15 to 213), and carcasses (range 21 to 293) have been observed in North Fork Mad River during the years surveyed. A few live steelhead (range 0 to 3) and redds (range 0 to 2) have been observed only during the 1996-7, 1998-1999, and 1999-2000 surveys. Very few coho adults (3) were observed in 1997-1998 in North Fork Mad River.

Adult spawner surveys for Sullivan Gulch also indicate spawning by chinook salmon although at lower numbers than the North Fork Mad River. Live chinook (range 12 to 220), redds (range 7 to 108), and carcasses (range 0-102) have been observed in all years except 1997-1998. Very few steelhead and coho salmon have been observed in Sullivan Gulch in these surveys, although a number of unidentified redds and a few unidentified carcasses are observed each year. Some of the unidentified redds and carcasses may have been steelhead or coho salmon.

4.4.9.8 Occurrence and Status of Covered Species

Presence/absence of the Covered Species in the North Fork Mad River HPA is presented by drainage in Table 4-12, and the recorded distribution of the species is displayed in ***Figure 4-43***.

4.4.9.8.1 Chinook Salmon

The North Fork Mad River HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Nehlsen et al. (1991) identified Mad River fall-run chinook as at moderate risk of extinction. Abundance trends have declined in the Mad River Basin as a whole over the long term but show signs of increasing in recent years (64 FR 50405). A barrier to chinook and coho salmon migration occurs at roughly RM 4 in the North Fork Mad River. This barrier severely restricts the spawning and rearing area available to chinook in this HPA. Spawner surveys in this HPA indicate highly variable chinook returns in the North Fork Mad and its tributaries below the barrier (see Appendix C9.).

Table 4-12. Covered Species distribution in North Fork Mad River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Mad River	2,3	1,2,3	2,3	2,3	3	3
North Fork Mad River	2,3	1,2,3	2,3	2,3	3	3
Mill Creek	A	A	3	3	A	A
Sullivan Gulch	2,3	1,2,3	2,3	U	P	3
Hatchery Creek	3	3	3	U	3	P
Jiggs Creek	A	A	A	A	3	3
Bald Mt. Creek	A	A	3	U	3	3
Pollock Creek	A	A	2,3	U	3	3
Long Prairie Creek	2	1,2	2,3	U	3	3
Pine Creek	A	A	2,3	U	3	P
Gossinta Creek	A	A	2,3	A	P	3
Denman Creek	A	A	3	A	3	3
Mule Creek	A	A	2	2,3	3	3
Jackson Creek	A	A	2	A	3	P
Krueger Creek	A	A	3	A	P	P
Railroad Creek	A	A	2	A	3	P
Canyon Creek	2	A	2,3	U	3	3
East Fork N. F. Mad River	A	A	2,3	2,3	3	P

Codes
U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.9.8.2 Coho Salmon

Populations are depressed throughout the Southern Oregon/Northern California Coho ESU, which encompasses the North Fork Mad River HPA. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp *et al.,* 1995). This ESU has been listed as threatened under the ESA as of May 1997 (62 FR 24588).

A barrier to chinook and coho salmon migration occurs at roughly RM 4 in the main stem North Fork Mad River, severely limiting the spawning and rearing area available to coho in this HPA. Spawner surveys and juvenile population estimates below the barrier indicate low numbers of coho returns in this HPA (Appendix C7 and C9).

4.4.9.8.3 Steelhead and Resident Rainbow Trout

The North Fork Mad River HPA includes the Northern California Steelhead DPS, which was listed as threatened effective August 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter-run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996).

Information on steelhead within this HPA is limited to the presence/absence information shown in Table 4-12 above. Steelhead are able to pass the barrier mentioned above for chinook and coho and therefore can utilize more of the North Fork drainage than other anadromous salmonids. NMFS found that for the seven populations of steelhead within this ESU only the small summer steelhead population within the Mad River, which has had large supplemental production from hatchery sources and Prairie Creek winter steelhead have shown recent trends of increasing abundance (65 FR 36082). The genetic effects of the Mad River Hatchery steelhead releases on the native winter steelhead population are a source of concern in the Mad River Basin (Busby et al. 1996). The extent of hatchery fish spawning naturally in the North Fork Mad River HPA is unknown.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.9.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Little is known about coastal cutthroat trout in the North Fork Mad River HPA. The barrier to anadromy on the main stem North Fork Mad implies that coastal cutthroat trout in most of this HPA (above the barrier) are resident fish. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.9.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in seven streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the North Fork Mad River HPA, 6 of 7 (85.7%) sampled streams had tailed frogs. In addition, populations of tailed frogs were confirmed in 28 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given this high rate of occurrence and large number of streams known to support the species, tailed frogs streams in the North Fork Mad River HPA seem to be in excellent condition.

4.4.9.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in seven streams in this HPA. The studies were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the North Fork Mad River HPA, 6 of 7 (85.7%) sampled streams had southern torrent salamanders. In addition, populations of southern torrent salamanders were confirmed in 80 other streams throughout the HPA either through other types of amphibian surveys or incidental observations.

Given this high rate of occurrence and large number of streams known to support the species, torrent salamanders streams in the North Fork Mad River HPA seem to be in excellent condition.

4.4.9.9 Assessment Summary

Due to the coastal influence and high canopy closure on most streams, water temperatures are generally good throughout streams on the Original Assessed Ownership in the North Fork Mad River HPA. The HPA has a mixed geologic composition, characteristic of the Franciscan Complex, but much of it is relatively stable compared with many of the other HPAs, and the parent material is relatively competent (consolidated) so that substrates are relatively coarse in most streams. Although only two Class I watercourses on the Original Assessed Ownership were assessed, the amount of pool habitat was generally consistent with assessed streams throughout the entire Original Assessed Ownership, but the quantity of LWD tended to be low. As a result, the amount of salmonid habitat is probably adequate for salmonids, but it is probably lacking in quality for both summer and winter rearing habitat.

Outside the lower mainstem of the North Fork Mad River and a few of the lower tributaries, the salmonid Covered Species are not widespread on the Original Assessed Ownership in this HPA. This is due to a natural barrier (falls/cascade) low in the system that prevents all but the most tenacious of steelhead from reaching the upper sub-basin. In addition, many of tributaries have steep gradients that would limit the amount of salmonid habitat even if the fish could get past the mainstem barrier. In contrast, the amphibian Covered Species are particularly abundant in all but a few streams on the Original Assessed Ownership in this HPA due to generally favorable geologic conditions.

Water temperatures are not likely to be limiting and may even be ideal for the Covered Species in streams on the Original Assessed Ownership, except for the lowest reaches of the mainstem where the water goes subsurface and forms isolated pools in late summer. The limited access for fish throughout the majority of the North Fork Mad River HPA appears to result in an under-utilization of the habitat, so that even if habitat quality were to improve, it would not likely result in a significant increase in salmonid numbers. A solution to the mainstem barrier for chinook and coho salmon would open up about 15 miles of habitat. This would probably result in dramatic increases in the productivity of this system. Sediment inputs from roads have the potential to negatively impact the amphibian Covered Species.

Except for addressing road-related sediment inputs, there would be little benefit of other conservation efforts in the Plan Area of the North Fork Mad River HPA without a permanent solution to the mainstem barrier.

4.4.10 Humboldt Bay HPA

4.4.10.1 HPA Type, Size, and Group

The Humboldt Bay HPA is a hydrographic area as defined in this Plan and is part of the Humboldt Bay HPA Group. It includes approximately 138,719 acres.

4.4.10.2 Eligible Plan Area

The Eligible Plan Area in the Humboldt Bay HPA includes approximately 38,870 acres: 17,484 acres of Initial Plan Area and 21,386 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.10.3 Geology

The Humboldt Bay HPA is within the Coast Ranges Province (see ***Figure 4-1***). Quaternary–Tertiary overlap deposits and Quaternary age alluvium occur in the HPA, with Yager Terrane near the southern boundary and Central Belt Franciscan Complex bedrock under the eastern quarter of the area.

The bedrock in the HPA includes both the Quaternary – Tertiary overlap deposits and the Central Belt Franciscan Mélange. The overlap deposits within the area include the Wildcat Group, which are composed of moderately consolidated, poorly cemented, weak siltstone, claystone and fine sandstone, as well as the Falor Formation. These strata were deposited on an erosional surface of Franciscan and Yager Formation rocks, and they have been subsequently eroded, faulted, folded and partly covered with younger sedimentary rocks. The Central Belt Franciscan Mélange is described as a weak, pervasively sheared claystone matrix, which encloses various-sized blocks of hard sandstone, greenstone, metavolcanic rock, serpentinite, chert and schist. Some of the different lithologic blocks in the melange are large enough to be mapped separately at a large enough scale.

The Fickle Hill Fault (part of the Mad River Fault zone), the Freshwater Fault, and the Little Salmon Fault are the three main faults within the Humboldt Bay region. They have north-northwest to northwest alignments and northeast dips. The Little Salmon Fault and the Table Bluff Anticline define the topographic high at the southwest boundary of the hydrographic region and the Freshwater Fault separates the Central Belt Franciscan Complex from the younger rock formations in the central portion of the region.
Topography within the Quaternary–Tertiary overlap deposits is well dissected and of relatively low relief. The Wildcat Group and younger rocks in most of the Humboldt Bay hydrographic region are highly erodible and fragments of the rock readily break-down in the streambeds to sand, silt and clay. Published landslide maps indicate that both shallow and deep-seated landslides exist within this HPA.

4.4.10.4 Climate

The watersheds that drain into Humboldt Bay are influenced by the coastal weather patterns of northern California. Typically, the majority of precipitation falls as rain between November and April with snowfall occurring sporadically at higher elevations. Eureka receives about 35 inches to 40 inches of rain annually, whereas inland areas of the basin may receive 60” or more per year. During the summer the climate is moderated by coastal fog which reduces solar radiation and contributes moisture by fog drip.

4.4.10.5 Vegetation

The Humboldt Bay HPA encompasses Humboldt Bay and the four major streams that drain into it, which, from north to south, are Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. Its eastern boundary is only 14 miles inland and elevation does not exceed 2800 feet. The entire HPA is within the summer fog zone, and all vegetative types reflect a strong coastal influence. Natural grasslands that typify the inland reaches of most HPAs exist as only a few small prairies at the extreme eastern margin of the HPA on or near the divide into the Mad River and Eel River drainages.

This HPA is the most heavily populated HPA. Residential, commercial, and agricultural development have eliminated or drastically altered most of the natural vegetative communities on the coastal plain and have significantly impacted most estuarine habitats. Although hillsides adjacent to the coastal plain still retain much of the indigenous redwood/Douglas-fir/red alder type, residential development permeates all but the steepest slopes surrounding the cities of Arcata and Eureka. Outside of developed areas, redwood/Douglas-fir forests dominate, and persist to the eastern boundaries of the HPA. Spruce is common near the coast, and minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood.

4.4.10.6 Current Habitat Conditions

4.4.10.6.1 Water Temperature

Water temperature monitoring in streams on the Original Assessed Ownership in the Humboldt Bay HPA began in 1994 and is ongoing today (see Appendix C5). From 1994-2000, 35 summer temperature profiles were recorded at 13 sites within 9 Class I watercourses in the HPA. No Class II temperature sites have been monitored to date. Figure 4-44 displays the 7DMAVG water temperatures for each site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. The results for the monitoring period (1994-2000) indicate that one Class I site (Salmon Creek) exceeded the red light threshold in 1997 and 1998.

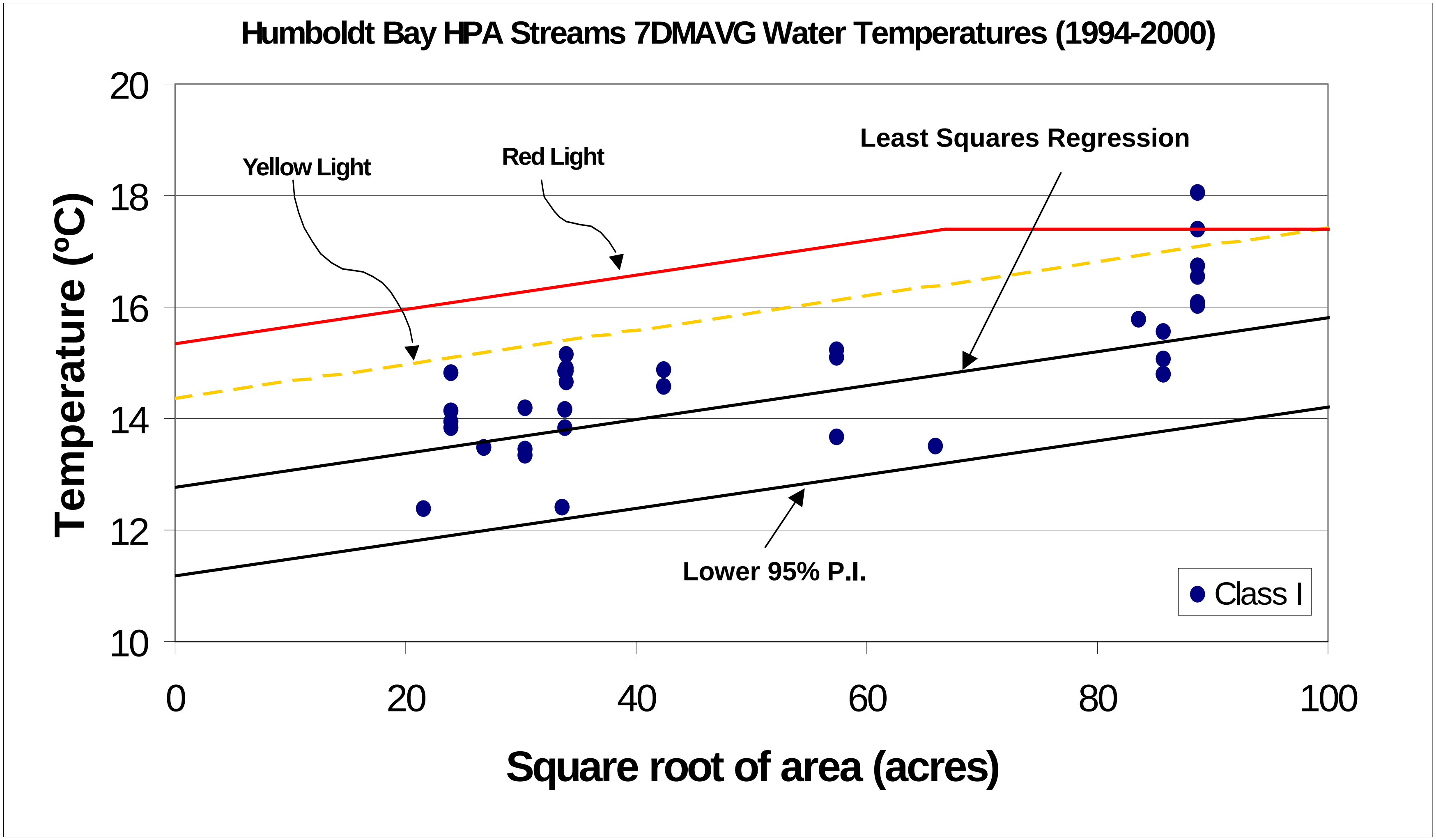


Figure 4-44. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Humboldt Bay HPA monitored between 1994 and 2000.**

4.4.10.6.2 Channel and Habitat Typing

Four creeks have been assessed within the Humboldt Bay HPA (see Appendix C1 for details and Table C1-8 for summary of data collected):

Stream	Mid-point Watershed Area	Mid-point Gradient
Ryan Creek	3,669 acres	1.0%
Salmon Creek	3,372 acres	1.o%
Ryan Creek Tributary 2	1,293 acres	1.0%
Ryan Creek Tributary 1	662 acres	1.0%

Ryan Creek and its 2 tributaries were assessed by California Conservation Corps (CCC) crews in 1995 and Salmon Creek was assessed by Green Diamond in 1994. The results of the channel and habitat typing surveys are summarized below and depicted in Figure 4-45 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

The results for the four assessed streams indicate the following:

- Percentage canopy closure for the four streams (88 to 94%) is somewhat above average compared with all other assessed streams (Figure 4-45 [A]).

- Only Ryan and Salmon creeks were assessed for percentage conifer canopy. Of the two, Ryan Creek had a rather large percentage of conifer (32%) and Salmon Creek had a rather typical percentage of conifer canopy (17%) compared with other assessed streams with similar watershed areas (Figure 4-45 [B]).

- Percentage of stream length in pools for the four streams varies widely (44-81%) but is generally higher than for other assessed streams regardless of watershed area (Figure 4-45 [C]).

- Percentage of LWD as structural cover for the four streams varies widely (17.1 to 49.1%) and, except for the first Ryan Creek tributary, generally is greater than that for assessed streams with similar watershed areas. (Figure 4-45 [D]).

- As shown in Figure 4-45 [E]) the average residual pool depth was determined only in Salmon Creek in this HPA. The data indicate that average residual pool depth in this stream (2.7 feet) is greater than most other assessed streams of similar watershed area.

- Pool tail-out embeddedness index values for the assessed streams in this HPA are very high (range = 2.89 to 3.99 on a scale of 4.0). The assessed streams are among those with the lowest gradient (Figure 4-45 [F]).

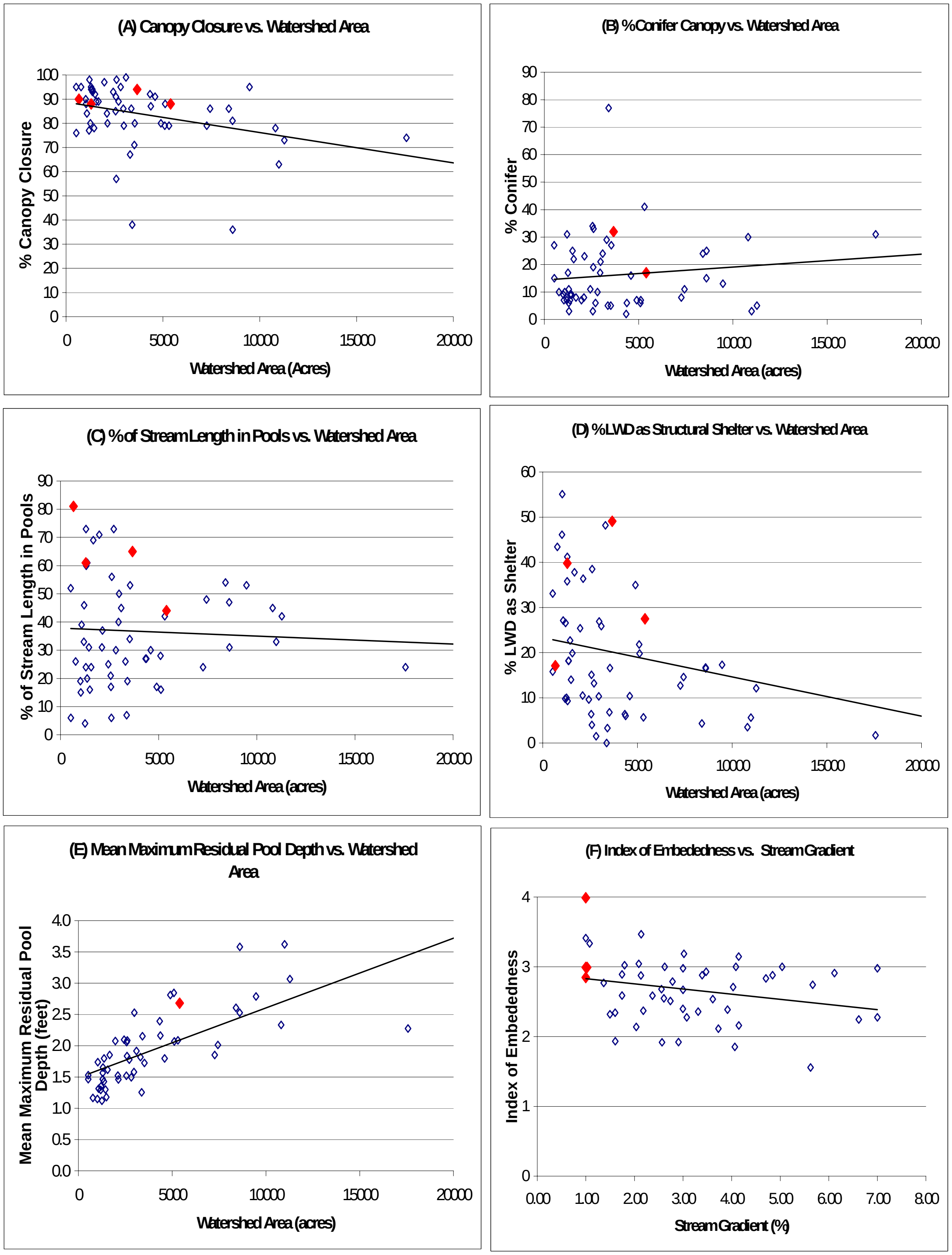


Figure 4-45. **Channel and habitat types in four streams assessed in the Humboldt Bay HPA. (Solid diamonds are assessed streams in Humboldt Bay HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)**

In summary, these results suggest that the habitat within the assessed streams in the Humboldt Bay HPA is in many instances similar to other assessed streams of similar watershed area. There are, however, some habitat differences. The four streams on average have a higher percentage of canopy cover than many of the other assessed streams. The four assessed streams show considerable variation in their percentage LWD as structural shelter in pools and lengths of pools as a percentage of total stream length.

4.4.10.6.3 *<u>LWD Inventory</u>*

LWD survey/inventories were conducted only in Salmon Creek in the Humboldt Bay HPA (see Appendix C2 for details and Tables C2-7 and C2-14 for summary data). Information regarding the presence of LWD as structural cover in pools was obtained in the channel and habitat typing assessment process. The importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of instream and riparian LWD.

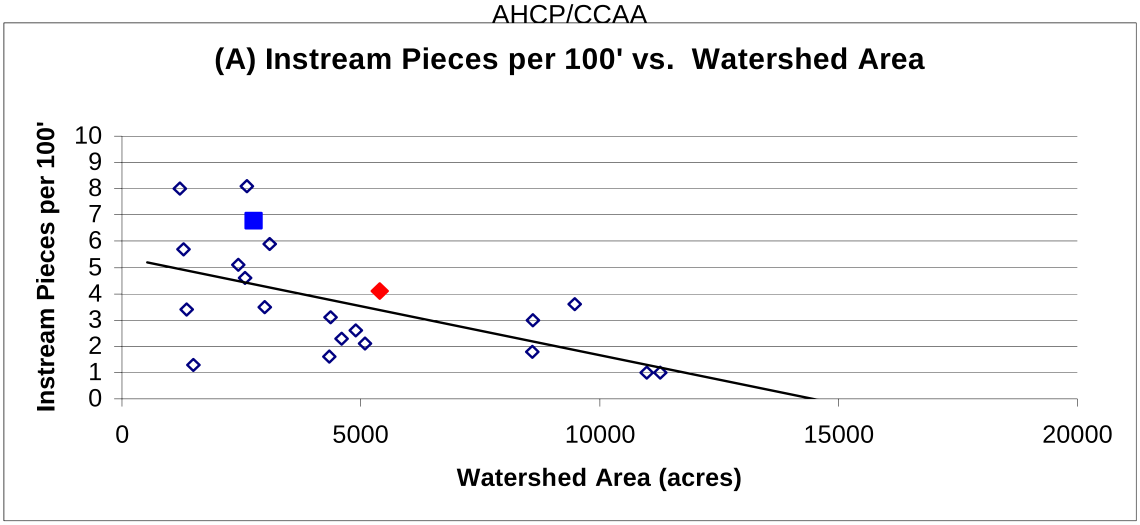
The results of these investigations are summarized below and presented in Figure 4-46 (A-B).

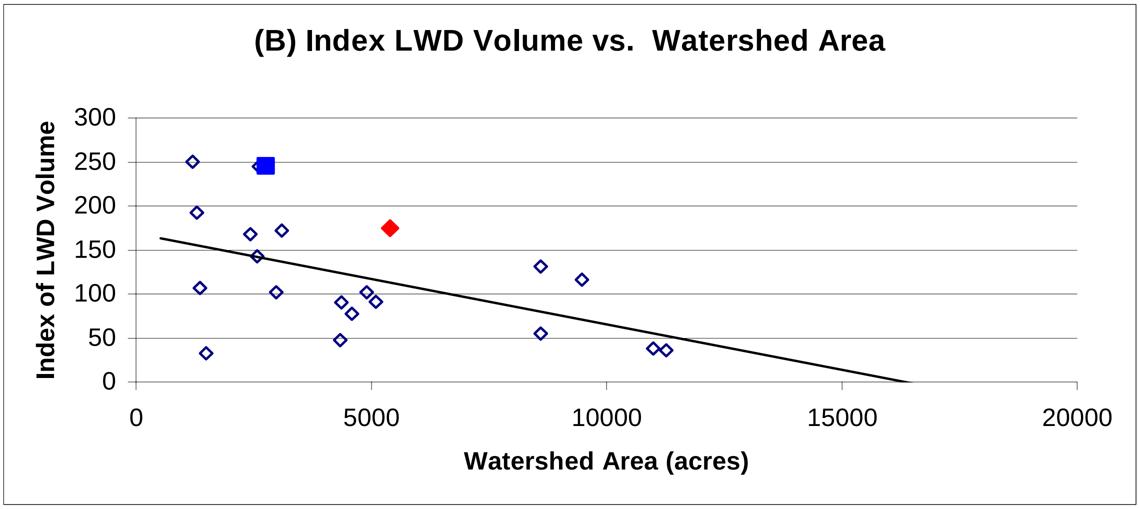
- As shown in Figure 4-46 (A), the average count of in-stream LWD pieces per 100 feet of channel for Salmon Creek (4.1 pieces) was greater than that for any assessed stream of similar watershed area but less than 60% of the average for Prairie Creek (6.8).

- The LWD volume index in Salmon Creek is greater than that for other assessed streams with similar watershed areas (Figure 4-46 [B]). The average number of pieces per 100 feet of riparian recruitment zone for Salmon Creek (7.0) is typical of the other assessed streams (Figure 4-46 [C]).

4.4.10.6.4 *<u>Long-term Channel Monitoring</u>*

The monitoring objectives and methods for long-term channel monitoring in the Humboldt Bay HPA are presented in Appendix C3. The primary watersheds of concern are Salmon Creek and Jacoby Creek, both tributaries to Humboldt Bay. The Salmon Creek watershed was of concern due to its highly unstable and erosive geology (Wildcat Formation) and past management practices. Using the information from pilot studies that began in 1993, a revised methodology was developed and first implemented on reaches of Salmon Creek (a Humboldt Bay tributary) in 1996. These surveys have continued with scheduled re-surveys every two years or after a five year flood event. Data collected at the monitoring sites are scheduled for analysis in 2003. Each monitoring reach should have at least 3 years of data prior to the first analysis and be updated biennially to coincide with the biennial report to the Services that will be prepared under this Plan. No conclusions can be drawn at this point in the monitoring program.





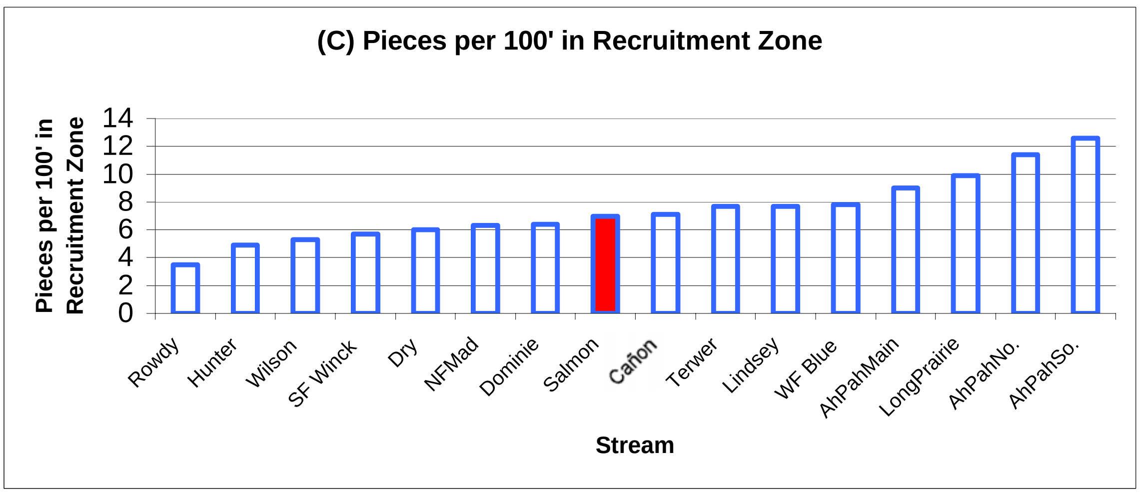


Figure 4-46. **LWD survey results for one stream assessed in the Humboldt Bay HPA. (Solid diamond is the assessed streams in Humboldt Bay HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Solid square indicates comparable data for Prairie Creek.)**

4.4.10.6.5 *Estuarine Conditions*

The estuaries of Humboldt Bay's watersheds have been vastly altered over the past century. Residential and agricultural development associated with early timber harvesting from the surrounding slopes of the bay greatly impacted watershed estuaries. Extensive areas of highly productive wetlands were converted to pasture and residential land through a complex series of dikes, tide gates and levees. The lower section of Salmon Creek was channelized to maximize the amount of available pastureland. The tide gate on Salmon Creek has been suspected as being impassable by adult and juvenile salmonids on a wide range of flows. Recently, a section of the lower channel (now a National Wildlife Refuge) was reconstructed to its natural meander and the tide gate was modified to improve fish passage.

4.4.10.7 Salmonid Population Estimates

No salmonid population estimates have been conducted for streams in the Humboldt Bay HPA, and only limited spawning surveys have been conducted in Salmon Creek to date.

4.4.10.7.1 *Spawner Escapement Surveys*

Spawner surveys were conducted in Salmon Creek during 1998-9. Only seven un-identified redds were identified during one survey conducted during January 1999. Limited winter access into the watershed and visibility generally prevents effective survey coverage of the stream. Also, near the mouth of Salmon Creek, a tide gate may limit salmonid migration into the watershed.

4.4.10.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in the Humboldt Bay HPA is presented by drainage in Table 4-13, and the recorded distribution of the species is displayed in ***Figure 4-47***.

4.4.10.8.1 *Chinook Salmon*

The Humboldt Bay HPA includes the California Coastal Chinook ESU, which was listed as threatened under the ESA in September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Drainages within the Humboldt Bay HPA are typically small, with no larger rivers, which are not typically preferred by chinook salmon. Chinook populations within this HPA are thought to be low, and while historical estimates are not available for comparison, the small size of the Humboldt Bay drainages makes it unlikely that this HPA was ever a significant producer of chinook.

Table 4-13. Covered Species distribution in the Humboldt Bay HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Humboldt Bay	3	3	3	3	3	3
Janes Creek	U	1	U	2*	U	U
Jolly Giant Creek	U	1	U	2*	U	U
Jacoby Creek	2	1,2,3	2,3	2	P	3
Washington Gulch	U	2	2,3	2	A	A
Morrison Gulch	P	2,3	2	U	A	A
Rocky Gulch	U	1	2	2*	3	U
Cochran Creek	U	1,2	2	2	U	U
Freshwater Creek	2	1	2	2	U	U
Ryan Creek	U	1,2,3	2,3	2,3	A	A
Henderson	U	1,3	3	3	A	A
Guptil	U	1,3	U	3	A	A
Bear	U	P	?	3	A	A
Cloney Gulch	U	1,2,3	2	2	U	U
Elk River	2	1,2,3	2	2	U	U
McCloud Creek	U	U	U	U	A	A
Salmon Creek	2,3	1,2,3	2,3	2	3	3
Little Salmon Creek	A	A	U	U	A	A

Codes
U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.10.8.2 Coho Salmon

The Humboldt Bay HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho populations are depressed throughout this ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Coho have been documented in almost all of the drainages feeding Humboldt Bay (see Table 4-13). Information on abundance in these creeks is limited. As with the ESU as a whole, current numbers are depressed compared with historical estimates (Weitkamp et al. 1995).

4.4.10.8.3 Steelhead and Resident Rainbow Trout

The Humboldt Bay HPA is within the Northern California Steelhead DPS, which was listed as threatened on May 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter-run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996). The presence/absence data presented in

Table 4-14 represent the extent of current biological information on steelhead in this HPA.

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.10.8.4 *Coastal Cutthroat Trout*

Cutthroat trout populations in this HPA are thought to be widely distributed in many small populations (Johnson et al. 1999).

Gerstung (1998) reports that low numbers of coastal cutthroat have been reported in most tributaries where other salmonids are present, while much higher numbers have been observed in tributaries or headwaters of tributaries where no other salmonids are present. Current populations are thought to be depressed relative to historic levels (Gerstung 1997). When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.10.8.5 *Tailed Frog*

Green Diamond conducted presence/absence surveys for tailed frogs in two streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Humboldt Bay HPA, tailed frogs were found in 1 of 2 sampled streams. In addition, tailed frogs have been found only in 3 other streams in the HPA as the result of incidental observations.

A relatively small portion (12.7%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to this HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on tailed frog occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1999). Therefore, Green Diamond concludes that most streams in the Humboldt Bay HPA are most likely not suitable for tailed frogs and have no potential to become suitable outside a geologic timeframe.

4.4.10.8.6 *Southern Torrent Salamander*

Green Diamond conducted presence/absence surveys for southern torrent salamanders in three streams in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Humboldt Bay HPA, none of the three sampled had southern torrent salamanders. In addition, southern torrent salamanders have been found only in 3 other streams throughout the HPA as the result of incidental observations.

A relatively small portion (12.7%) of the HPA is in Green Diamond's ownership, so it is difficult to extrapolate from Green Diamond's studies to the entire HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on torrent salamander occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1996). Therefore, Green Diamond concludes that most streams in the Humboldt Bay HPA are most likely not suitable for torrent salamanders and have no potential to become suitable outside a geologic timeframe.

4.4.10.9 Assessment Summary

The Humboldt Bay HPA has a coastal influence and most streams on the Original Assessed Ownership have high canopy closure, so it is expected that water temperatures in the streams should be cool. The lower reaches of Salmon Creek were an exception to this in 1997 and 1998, probably because of high flows in the winter of 1996/97 that reduced streamside vegetation. Much of the HPA is composed of weakly consolidated geologic parent material. As a result, most streams on the Original Assessed Ownership have relatively high levels of sediment inputs with high levels of fine sediments. The amount of LWD in the assessed streams in this HPA is generally good and has created more abundant and better quality pool habitat than that found in assessed streams in the other HPAs.

The salmonid Covered Species are relatively common in the Original Assessed Ownership in this HPA, and qualitative assessments indicate that many of these streams support relatively high numbers of juvenile salmonids. (Tannic waters of most of these low gradient streams preclude application of standard field protocols to allow quantification of their numbers.) The apparent high numbers of salmonids despite high levels of fine sediment inputs suggests that spawning habitat is not limiting even though suitable spawning gravels appear to be scare in many of these streams. Presumably high juvenile survival due to abundant pool habitat with LWD for cover offsets limited spawning opportunities. In contrast to the salmonids, the amphibian Covered Species are generally absent in habitat on the Original Assessed Ownership in this HPA. This is consistent with the strong relationship between streams in weakly consolidated geologic units with excessive fine sediments and the lack of headwater amphibian species. In addition, there are few Class II watercourses on the Original Assessed Ownership with perennial flow in the areas with young unconsolidated parent material.

Given that there is little potential habitat for the amphibian Covered Species, the primary conservation effort for the Plan Area in the Humboldt Bay HPA should be to minimize mass wasting events that have the potential to aggrade the lower reaches and fill pool habitat. The greatest management-related benefits would likely come from addressing legacy roads in the riparian areas that have the potential to deliver large amounts of sediment with little or no LWD inputs.

4.4.11 Eel River HPA

4.4.11.1 HPA Type, Size, and Group

The Eel River HPA is a hydrographic area as defined in this Plan and is part of the Humboldt Bay HPA Group. It includes approximately 205,160 acres.

4.4.11.2 Eligible Plan Area

The Eligible Plan Area in the Eel River HPA includes approximately 86,026 acres: 7,933 acres of Initial Plan Area and 86,026 acres of Adjustment Area (see ***Figure 1-2*** and Table 1-1). All of the Initial Plan Area in this HPA is part of the Original Assessed Ownership.

4.4.11.3 Geology

The Eel River HPA is within the Coast Ranges Province (see ***Figure 4-1***). Quaternary–Tertiary overlap deposits and Quaternary age alluvium with Coastal Belt Franciscan Complex bedrock occur near the southern boundary of the HPA, and Yager Terrane and Central Belt Franciscan bedrock underlie the eastern third of the area. Coastal Belt Franciscan bedrock underlies a very small area of the area at the south end of the HPA. The geologic structure of the area follows the northwest trend of regional geologic structure. The Little Salmon Fault, which is known to be presently active, passes through this HPA. The Freshwater Fault juxtaposes the Yager Terrane and Central Belt Franciscan bedrock and the Ferndale Fault roughly defines the trace of the Van Duzen River at its confluence with the Eel River. Topography within the Quaternary–Tertiary overlap deposits is highly variable and includes some steep slope segments. A maximum of a few hundred feet of relief exists within any of the five blocks of the area. Published and unpublished landslide maps indicate that both shallow and deep-seated landslides exist within this HPA.

4.4.11.4 Climate

Like the majority of Northern California, wet winters and dry summers characterize the Eel River basin. Nearly 80% of the annual precipitation falls between November and April. The average annual precipitation varies from less than 40 inches in the Eel River Plain and Round Valley to over 110 inches in the Bull Creek headwaters. The average annual precipitation for the entire Eel River basin is about 60 inches. Fog drip during the summer months is a source of precipitation not included in annual totals. The dense, often persistent, band of marine fog usually extends 20 to 30 miles inland. Measurements in the Bear River Ridge revealed fog drip accumulations of 12 inches in open areas and 8.5 inches under forest canopy. The two largest floods on record in the Eel River basin occurred in 1955 and 1964. The 1955 event had an instantaneous peak discharge of 541,000 cfs at Scotia. During the 1964 flood the instantaneous peak discharge at Scotia was 752,000 cfs.

4.4.11.5 Vegetation

The Eel River HPA extends 27 miles inland and reaches an elevation of 3700 feet at Iaqua Buttes, on the divide into the upstream portion of the Mad River HPA. Dune and salt marsh vegetation at the estuary give way to agricultural development that has occurred and throughout the extensive flood plain of the lower Eel and Van Duzen Rivers. Urban development has been restricted to a few small communities and a strip of residential development along Highway 36 in the lower Van Duzen. Above the alluvial plain, forest cover dominates, with the usual progression of redwood/Douglas fir forests near the coast to Douglas-fir and Douglas-fir/tanoak forests in the interior. Spruce is common on coastal faces and at the margins of the coastal plain; and minor amounts of grand fir, western red cedar, and western hemlock occur on lower slopes and in riparian zones. Red alder dominates many riparian zones, and tanoak is the most common mid to upper slope hardwood. Other common hardwoods are California laurel (pepperwood), Pacific madrone, and California black oak. Extensive prairies become prevalent in the most inland portions of the HPA, dominating many south to west slopes and ridgetops. Nearly pure stands of California black oak commonly form a transition type between prairies and conifer forest.

4.4.11.6 Current Habitat Conditions

4.4.11.6.1 Water Temperature

Water temperature monitoring in streams on the Original Assessed Ownership in the Eel River HPA began in 1994 and is ongoing today (see Appendix C5). From 1994-2000, 12 summer temperature profiles were recorded at 5 sites within 5 Class I watercourses in the HPA. No Class II temperature sites have been monitored to date. Figure 4-48 displays the 7DMAVG water temperatures for each monitored site in relation to the square root of the watershed area above that site and in relation to the red and yellow light thresholds of this Plan. Results for the monitoring period (1994-2000) indicate that one Class I site exceeded the red light threshold twice (Stevens Creek in 1999 and 2000) and one Class I site exceeded the yellow light threshold once (Wilson Creek in 1997).

4.4.11.6.2 Channel and Habitat Typing

Four creeks have been assessed within the Eel River HPA (see Appendix C1 for details and Table C1-8 for summary data):

Stream	Mid-point Watershed Area	Mid-point Gradient
West Fork Howe Creek	3,372 acres	7.0%
Stevens Creek	3,308 acres	3.3%
Howe Creek	2,594 acres	2.1%
Wilson Creek	1,250 acres	2.6%

Stevens and Wilson creeks were surveyed by CDFG in 1991, and Howe and West Fork Howe Creek were surveyed by CDFG in 1998. The results are summarized below and depicted in Figure 4-49 (A-F). The least squares regression displayed on these figures was added for comparison purposes only and is not intended for statistical analysis. The data were not transformed to find the best fit but simply plotted to provide a general sense of how conditions in one HPA compare with those in other HPAs.

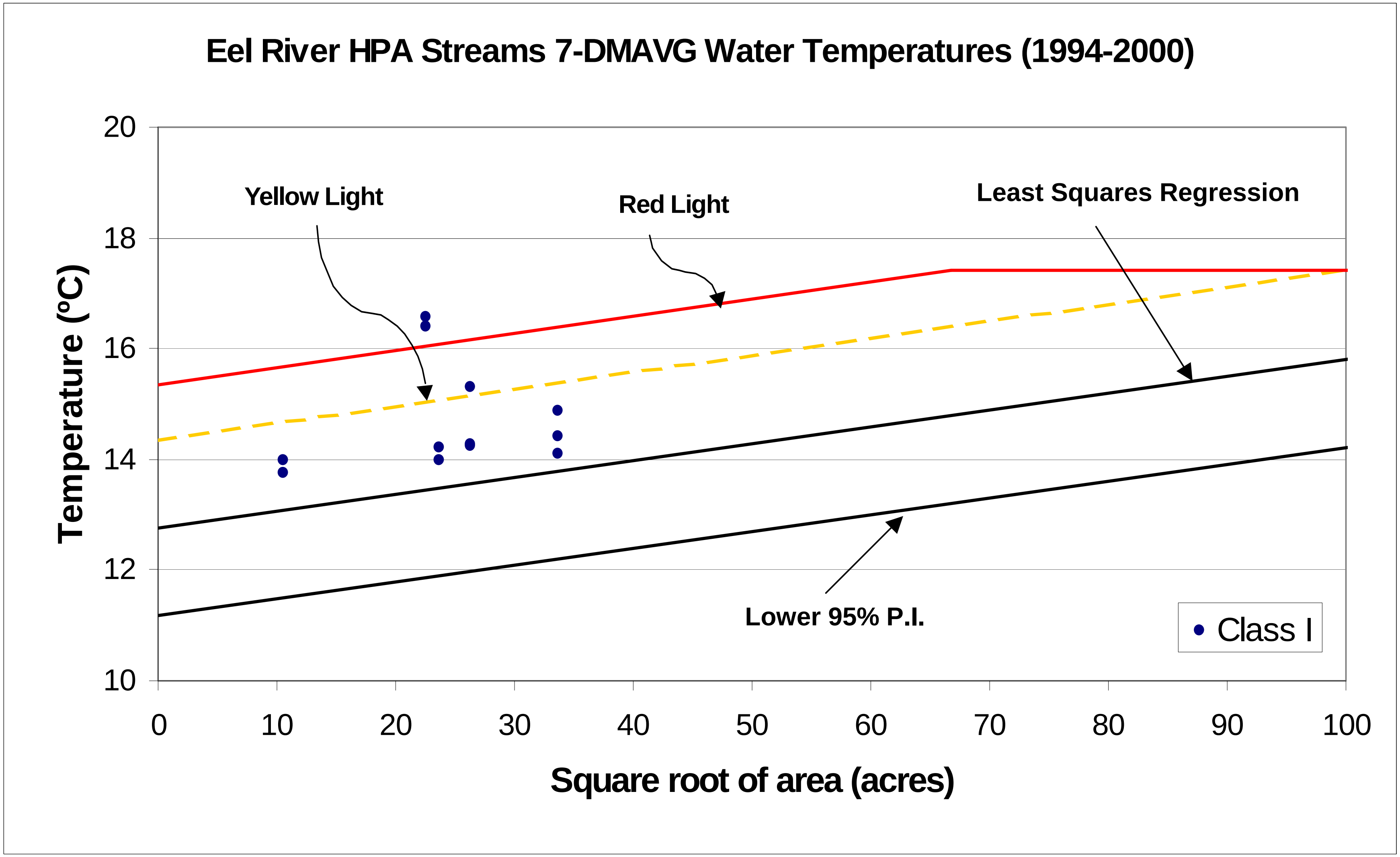


Figure 4-48. **7DMAVG water temperatures in relation to the square root of the watershed area for sites in the Eel River HPA monitored between 1994 and 2000.**

The results of the assessments indicate the following:

- Percentages of canopy closure for the streams ranges from 57% to 87% (Figure 4-49 [A]). Except for West Fork Howe Creek (87%), these percentages are somewhat below average compared with those for streams with similar watershed areas, except West Fork Creek. West Fork Howe Creek has a low percentage of conifer canopy (5%), indicating that the high percentage of canopy closure is from deciduous canopy (Figure 4-49 [B]).

- Three of the assessed streams have very low percentages of total stream length in pools (4-7%) compared to other assessed streams with similar watershed areas (Figure 4-49 [C]). The percentage for Stevens Creek 26% is typical of other assessed streams.

- The percentages of LWD as structural cover in pools for 3 of the 4 streams are some of the lowest for all assessed streams (Figure 4-49 [D]). For Howe, West Fork Howe, and Wilson creeks the percentage ranged from 0-10%. The percentage for Stevens Creek (48%) is relatively high.

- As shown in Figure 4-49 [E], the average residual pool depths in Wilson Creek and West Fork Howe are very low (1.1 to 1.3 feet) compared to streams with similar watershed areas. Pool tail-out embeddedness index values for Wilson and Stevens creeks also are comparatively low (Figure 4-49 [F]).

In summary, these results suggest that the habitat within the surveyed streams in this HPA is in many instances similar to that in other assessed streams of similar watershed area. On average, the assessed stream in this HPA have a comparatively low percentage of canopy cover, very low percentages of total pool length, low percentages of pool LWD cover, and low average residual pool depths.

4.4.11.6.3 Estuarine Conditions

The lower Eel River has lost valuable fisheries habitat through human activities. Wetlands, secondary channels, and sloughs have been impacted through extensive diking and channelizing. The original floodplain is now used for residential and agricultural purposes, mainly grazing of dairy cattle. Sediment deposits transported from upstream areas have turned once deep pools into shallow runs that offer marginal habitat to juvenile salmonids. The lower channel was also cleared of LWD jams for navigational purposes.

4.4.11.7 Salmonid Population Estimates

There were no salmonid population surveys in the Initial Plan Area of this HPA.

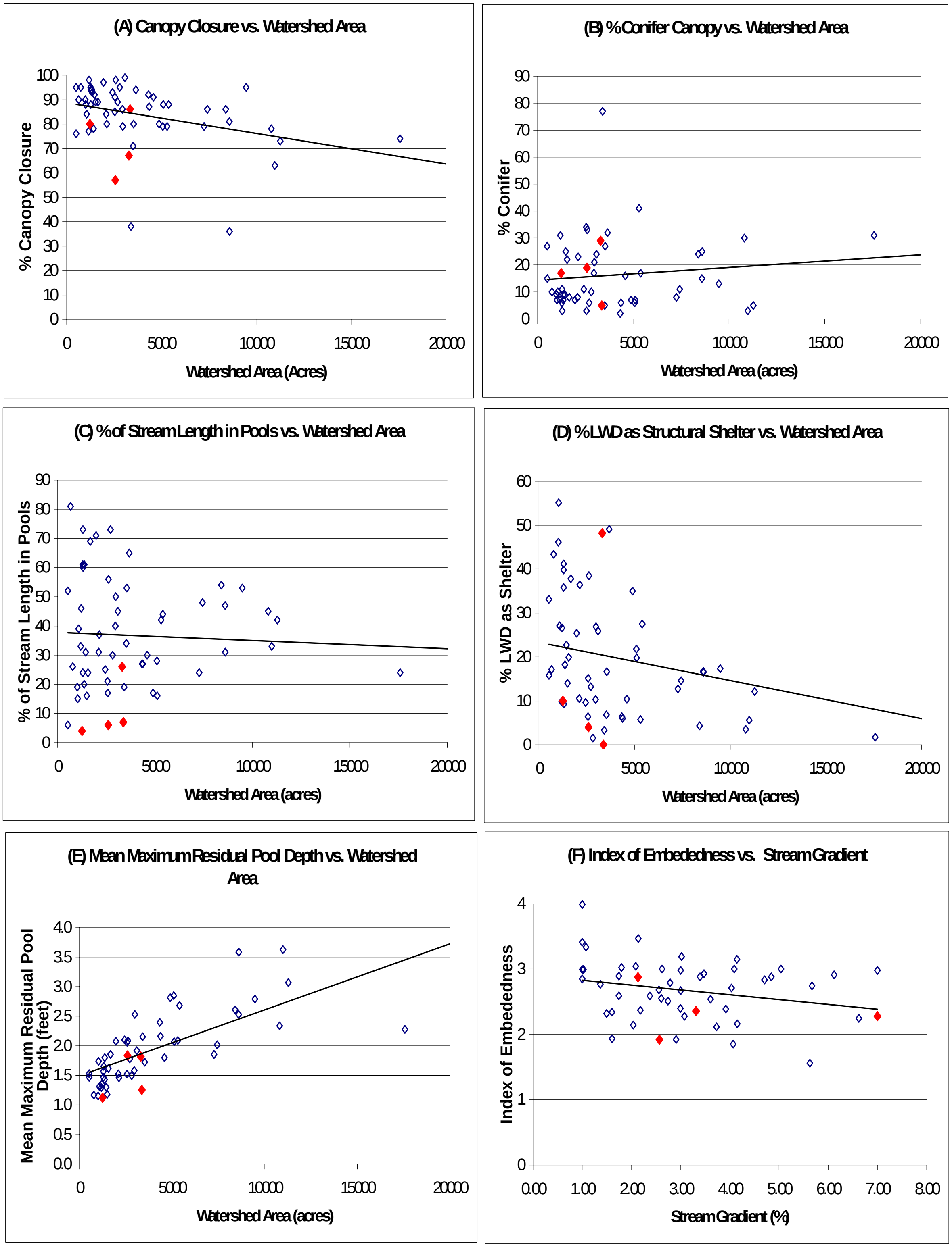


Figure 4-49. **Channel and habitat types in four streams assessed in the Eel River HPA. (Solid diamonds are assessed streams in Eel River HPA. Open diamonds are assessed streams in other HPAs. Solid line is trend line for assessed streams in all HPAs. Watershed area measured at mid-point of surveyed reach. Gradient determined based on channel type and length.)**

4.4.11.8 Covered Species Occurrence and Status

Presence/absence of the Covered Species in Eel River HPA is presented by drainage in Table 4-14 and displayed in ***Figure 4-50***.

Table 4-14. Covered Species distribution in the Eel River HPA.

Watersheds and Sub-basins	Chinook	Coho	Steelhead and RRT*	Coastal Cutthroat	Tailed Frog	Torrent Salamander
Eel River						
Palmer Creek	U	1	U	U	U	U
Rohner Creek	A	1	U	U	A	A
Van Duzen River	2	1	2	A	U	U
Yager Creek	2	1	2,3	A	U	U
Wilson Creek	A	1	2,3	A	U	U
Cuddeback Creek	A	1	2	A	U	U
Cummings Creek	2	1,2	2	A	U	U
Fielder Creek	2	1,A	2,3	A	U	U
Grizzly Creek	2	1	2	A	U	U
Stephens Creek	2	1,2	2,3	A	U	U
Fish Creek	U	U	2	A	U	U
Howe Creek	2	1,2	2	A	U	U
West Fork Howe	U	U	U	A	U	U
Slater Creek	A	A	A	A	A	A

Codes
U= Unknown (no data available)
P= Presumed present based on anecdotal information
A= Presumed absent based on anecdotal information
RRT= resident rainbow trout
*= Occurrence of RRT assumed possible in streams where steelhead occur
1= Present based on NMFS records as of 2001
2= Present based on CDFG Region 1 files
3= Present based on Green Diamond records

4.4.11.8.1 Chinook Salmon

The Eel River HPA is within the California Coastal Chinook ESU, which was listed as threatened under the ESA as of September 1999 (64 FR 50394). Low abundance levels, sporadic occurrence in some river systems, and negative long term trends in abundance in this ESU were cited in the decision to list this ESU as threatened (64 FR 50405).

Information specific to Green Diamond's ownership or the Eel River HPA as a whole is limited to the presence/absence data shown in Table 4-14. Available abundance trends represent the Eel River drainage as a whole. Peak index counts and carcass surveys in two tributaries to the Eel River have shown precipitous long term declines since the 1960s, with recent increases in one tributary. Similar monitoring in other tributaries conducted since the late 1980s also have shown steep declines. The spring-run chinook in the upper Eel are possibly extinct, representing a significant loss of life history diversity in this ESU as a whole (64 FR 50405).

4.4.11.8.2 Coho Salmon

The Eel River HPA includes the Southern Oregon/Northern California Coasts Coho ESU, which was listed as threatened under the ESA in May 1997 (62 FR 24588). Coho populations are depressed throughout the ESU. Current abundance in the California portion of this ESU is thought to be less than 6% of abundance in the 1940s (Weitkamp et al. 1995).

Specific information on coho abundance within the Eel River HPA is limited to the presence/absence data in Table 4-14. The abundance of introduced Sacramento pikeminnows in the Eel River is a cause for concern. Coho abundance in the Eel River, as in the rest of the ESU, is depressed (Weitkamp et al. 1995).

4.4.11.8.3 Steelhead and Resident Rainbow Trout

The Eel River HPA includes the Northern California Steelhead DPS, which was listed as threatened on June 7, 2000 (65 FR 36074). Steelhead abundance data are limited for this DPS, but available data indicate that winter run populations declined significantly prior to 1970, and populations have remained at depressed levels with no clear trends since then (Busby et al. 1996). Nehlsen et al. (1991) identified summer steelhead in the Eel River as at risk of extinction, although the Little Van Duzen River winter steelhead stock was identified as stable in further analysis by Higgins et al. (1992). Counts at Eel River dams in the 1930s and 40s averaged 4,400 adult steelhead annually at Cape Horn Dam and 19,000 adult steelhead annually at the Benbow Dam. Recent counts at Cape Horn Dam average 115 adults, of which only 30 are native fish. In addition to these declining trends, the abundance of the introduced Sacramento pikeminnow and sedimentation are some of the main concerns cited for steelhead in the Eel River (Busby et al. 1996).

It currently is not possible to estimate what numbers or proportion of rainbow trout in assessed streams in this HPA exhibit freshwater residency versus anadromy. For purposes of planning conservation measures, Green Diamond has assumed that freshwater residency also may occur in streams where steelhead are found.

4.4.11.8.4 Coastal Cutthroat Trout

Coastal cutthroat trout are found in one tributary to the lower Eel (Strongs Creek), one tributary to the Van Duzen (Fox Creek), and a few small streams that flow into the Salt River Slough (Gerstung, 1997). Green Diamond currently has no ownership in the drainages of these tributaries. When this fish was under NMFS jurisdiction in 1999, the Southern Oregon/California Coast Cutthroat Trout ESU was determined to not warrant listing (64 FR 16397). The population in this HPA is part of that ESU.

4.4.11.8.5 Tailed Frog

Green Diamond conducted presence/absence surveys for tailed frogs in two streams in this HPA. The surveys were part of a study of 72 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of tailed frogs (Diller and Wallace 1999). In the Eel River HPA, no tailed frogs were found in either of the two sampled streams. In addition, no tailed frogs have been found in other streams throughout the HPA as the result of incidental observations.

A very small portion (3.9%) of the HPA is in Green Diamond ownership, so it is not possible to extrapolate from Green Diamond's studies to the entire HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on tailed frog occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1999). Therefore, Green Diamond concludes that most streams in the Eel River HPA are most likely not suitable for tailed frogs and have no potential to become suitable outside a geologic timeframe.

4.4.11.8.6 Southern Torrent Salamander

Green Diamond conducted presence/absence surveys for southern torrent salamanders in one stream in this HPA. The surveys were part of a study of 71 streams conducted to estimate the proportion of streams on Green Diamond's ownership that support populations of southern torrent salamanders (Diller and Wallace 1996). In the Eel River HPA, no southern torrent salamanders were found in the one sampled stream. In addition, no torrent salamanders have been found in other streams throughout the HPA as the result of incidental observations.

A very small portion (3.9%) of the HPA is in Green Diamond's ownership, so it is not possible to extrapolate from Green Diamond's studies to the entire HPA. However, much of this HPA is located within young unconsolidated geologic formations, which have been shown to have a strong negative influence on torrent salamander occurrence due to a lack of suitable stream substrate in these geologic formations (Diller and Wallace 1996). Therefore, Green Diamond concludes that most streams in the Eel River HPA are most likely not suitable for torrent salamanders and have no potential to become suitable outside a geologic timeframe.

4.4.11.9 Assessment Summary

Little work has been done to assess streams in the Eel River HPA because the Original Assessed Ownership constitutes a very small portion (4%) of the HPA and does not include any major Class I watercourses. Available data indicate that the streams on the ownership in this HPA tend to have lower canopy closure compared to assessed streams in other HPAs. Like several other HPAs, the Eel River HPA is generally located in the coastal region. However, there is a north-to-south gradient that causes this southernmost HPA to experience relatively high summer temperatures. As a result, all of the recorded water temperatures for streams on the Original Assessed Ownership are above the trend line in the regression of water temperature on drainage area and several are above the red and yellow-light threshold. Most of the Original Assessed Ownership in this HPA is underlain by weakly consolidated geologic parent material and as a result, most of the streams have relatively high levels of sediment inputs with high levels of fine sediments. The amount of LWD is generally low, and there is relatively little pool habitat compared to that in assessed streams in most HPAs.

The salmonid Covered Species are generally scarce in the streams of the Original Assessed Ownership in this HPA. This is probably a combination of most of the streams being quite small and generally in poor condition. The amphibian Covered Species appear to be completely absent in habitat on the Original Assessed Ownership in this HPA. This is consistent with the strong relationship between streams in unconsolidated geologic regions with excessive fine sediments and a lack of headwater amphibian species.

Given that there is little potential habitat for the salmonid Covered Species and no habitat for the amphibians, the Plan Area in the Eel River HPA should be to the lowest priority for conservation efforts. Any future conservation activities initiated in the Plan Area of this HPA would probably be best focused on addressing legacy roads in riparian areas that have the potential to deliver sediment with little or no LWD inputs.

Section 5. Assessment of Potential Impacts to Covered Species and Their Habitats that May Result in Take

5.1 INTRODUCTION

Green Diamond has designed a conservation strategy to: (a) evaluate, and avoid or minimize, and mitigate the impacts of Green Diamond's operations and forest management activities on the Covered Species and other similarly situated species, (b) avoid jeopardy to the Covered Species and (c) contribute to conservation efforts for the Covered Species. For purposes of complying with the ESA, this Plan provides a particular focus on incidental take as provided by ESA Sections 9 and 10. As required for ITPs (but not explicitly for ESPs issued pursuant to CCAAs), this Plan is designed to minimize and mitigate the impacts of any incidental take of the Covered Species that could result directly from Covered Activities or indirectly from the environmental effects of such activities. The Plan is also designed to ensure that jeopardy will not result to any of the Covered Species as a result of any incidental take that is authorized pursuant to the ITP or ESP. As required for ESPs, the Plan is designed to contribute conservation benefits, which, when combined with the benefits that will be achieved if it is assumed that conservation measures also were implemented on other necessary properties, would preclude or remove a need to list the ESP Species. In addition to improving habitat conditions for the ESP species in the Initial Plan Area, many of the conservation benefits that will be provided the ESP species in this Plan are associated with measures designed to avoid or minimize and mitigate the impacts of incidental take. Therefore, although minimization and mitigation of the impacts of taking is not specifically mandated in the CCAA/ESP approval criteria, incidental take is still a principal focus of the Plan for ESP species as well as ITP species.

A more detailed literature review of the potential effects of timber management is provided in Appendix E. The effects of timber harvest on aquatic life depend on many factors and studies often result in contradictory results (Spence et. al. 1996). Factors that may influence responses include: aquatic species' diversity and adaptability, physical and vegetative conditions and harvest methods, biotic interactions and wide-ranging migratory behaviors can act to reduce impacts of habitat alterations, independent impacts that can accumulate, or interact collectively resulting in compensatory or synergistic responses, and large natural (catastrophic) events that create variable baseline conditions confusing other smaller scale variability.

Not all forest management activities and their effects have the potential to cause "take" of Covered Species. The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 USC section 1532(19)). Harm in the definition of "take" means an act which actually kills or injures fish and wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR part 222.102; also see 50 CFR part 17.3). Of the Covered Activities, Green Diamond's timber harvesting operations and the road construction maintenance or use, as well as construction, maintenance and use of landings, culverts and crossings associated with such harvesting have the greatest potential to cause environmental effects—both individual and cumulative—which, in turn, could result in take of Covered Species.

This Section describes the Covered Activities and associated environmental effects that have the greatest potential to cause take of Covered Species. These include not only individual environmental effects that could result in take, but also cumulative effects, i.e., individually minor environmental effects that themselves would not cause take but, when combined with other similar effects that are closely related temporally and spatially, could cause take of Covered Species. In addition, this Section discusses the potential impacts of such taking on the Covered Species if it were to result. The conservation measures described in Section 6 were designed to avoid, minimize, and mitigate these potential impacts of taking, as well as other environmental effects, in addition to providing other conservation benefits. The measures address the potential for each type of impact or cause of take to be a significant limiting factor for each of the species individually and the Covered Species collectively.

5.2 POTENTIAL FOR ALTERED HYDROLOGY

The basic components of the hydrologic cycle are precipitation, infiltration, evaporation, transpiration, storage and runoff. In the Pacific Northwest, where annual precipitation is highly seasonal, the timing, quantity and quality of rain and snowfall have great influence on salmonid life histories and have the potential to impact the aquatic phase of headwater amphibians. Thus, the effects of timber harvest activities on the hydrologic cycle are important. This discussion reviews how timber management activities may alter the hydrologic cycle, considers the potential for such altered hydrology to cause take of Covered Species, and discusses the possible impacts of such take on the Covered Species

5.2.1 Potential Effects of Covered Activities

Timber harvest temporarily reduces or eliminates leaves and stems. The surface area of this vegetation normally intercepts precipitation for short-term storage that is either evaporated or released as drip. The loss of forest vegetation also reduces the amount of water extracted from the soil by root systems via evapotranspiration and increases soil moisture and piezometric head. This was demonstrated by Keppeler and Brown (1998) after harvest of second growth redwood forest. Such increases in soil moisture can contribute to increased risk of mass wasting (Sidle et al. 1985, Fig. 10; Schmidt et al. in press). This is discussed further in Section 5.3.2.2. The effect of any reduction in evapotranspiration is typically short lived (3-5 years), as rapid regrowth of vegetation may consume more water than pre-timber harvest amounts (Harr 1977). This is likely to be true in redwood forests as well, in part owing to the stump-sprouting habit of redwood.

The primary effects of timber harvest on surface water hydrology pertain to (Spence et. al. 1996):

- peak flows,
- low (base) flows,
- water yield, and
- run-off timing.

Paired watershed experiments to measure changes in flow following timber harvest have been conducted north of the project area (Oregon) and south of the project area (Mendocino County, California). In relatively small watersheds (about 150 to 1200 ac), peak flow magnitude following harvest tends to increase, with the largest increases occurring in smaller runoff events (less than one-year) (Beschta et al. 2000, Ziemer 1998). For one-year recurrence interval events, peak flow magnitude increased 13-16%; these increases were 6-9% for five-year recurrence interval events (Beschta et al. 2000). At Caspar Creek in Mendocino County, increases in peak flow magnitude were about 10% for two-year storm recurrence interval events. The effect of timber harvest on peak flows generally diminishes with increasing watershed size and with increasing flow magnitude (Beschta et al. 2000, Ziemer 1998). Effects for larger watersheds are difficult to asses because they are influenced by many additional factors, including regulatory controls on the proportion of the landscape that can be harvested at any given time (e.g., clearcut adjacency and rotation age restrictions adopted by the Board of Forestry) and the extreme variability introduced when attempting to study large basins that experience relatively infrequent major hydrologic events.

The extent of harvest-related changes in hydrology within a watershed may be affected by whether the system is rain or snow dominated. Keppeler and Ziemer (1990, as cited by Spence et al. 1996) found increased summer flows in a Northern California stream following timber harvest but this diminished after five years. In many cases, for rain-dominated systems in the Coast Range, increases in peak flows (particularly in the fall) following timber harvest, are documented (Spence et al. 1996). The principal increases in peak flows following timber harvest in rain-dominated systems are likely as a result of reduced interception and evapotranspiration rates resulting from the loss of vegetation and the more rapid routing of water to stream channels because of soil compaction and roads (Spence et. al. 1996, Ziemer 1998). In contrast, generally in snow-dominated systems in the Northwest, peak flows have been shown to change little following timber harvest. In transient-snow systems studies have been somewhat inconclusive as to the effects of timber harvest on peak flows. However, Harr (1986 as cited by Spence et. al. 1996) found that in transient-snow systems where harvest had resulted in increased peak flows, the removal of vegetation increased the delivery of water to the soil from the snow-pack during rain-on-snow events. Other research has shown that increased snow melt rates and delivery of water to the soil occurs during rain-on-snow events accompanied by relatively high temperatures and wind speeds (Coffin and Harr, 1992, as cited by Spence et. al., 1996). The commercial timberlands within the 11 HPAs are entirely rain-dominated. Therefore, the effects of snow-dominated and rain-on-snow hydrology are not an issue for this Plan.

Timber harvest activities that compact or disturb the soil can reduce the infiltration capacity of soils and alter the process of subsurface water movement. Compacted soils found on roads and landings are relatively impermeable and water runs off them quickly.

Inboard ditches along truck roads not only collect and concentrate surface runoff, but also intercept subsurface flow and bring it to the surface (Furniss et al. 1991). Reduced evapotranspiration, reduced soil infiltration capacity, and the interception of surface flow may lead to increases in surface runoff, peak stream flows, and sediment inputs to watercourses.

Water and sediment from roads can enter stream channels by many mechanisms (Furniss et. al. 2000):

- Inboard ditches that deliver road drainage to stream channels at truck road watercourse crossings,
- Inboard ditches that deliver flow to culverts, road drainage dips or water bars with sufficient discharge to create a gully or generate a sediment plume that extends to a stream channel,
- Improperly spaced or located road drainage structures that discharge sufficient water to create a gully or generate a sediment plume that extends to a stream channel, and
- Roads located close enough to a stream that fill slope erosion or fill failures result in sediment discharge in to stream channel.

Some studies have shown that forest roads increase peak flows and sediment inputs to small watersheds when as little as 2.5%-3.9% of the watershed is composed of road surfaces (Harr et al. 1975; Cederholm et al. 1980; King and Tennyson 1984). Studies reporting increases in water yield from logged watersheds indicated that these increases were most evident in the start of the fall/winter wet season when rain quickly filled soil pore spaces in the logged areas and then ran off as surface flow. Differences were less apparent later in the rainy season as soil under mature canopies also became saturated, and runoff from harvested and un-harvested areas became similar (Hibbert 1967; Harr et al. 1979). Other studies have also shown that road construction and some timber harvest activities may lead to increased flows in the first (fall/early winter) small rain events but have no significant effect on larger flow events (Wright et al. 1990; Johnson and Beschta 1980).

Many paired watershed studies have found increases in summer base flow and total water yield (Bosch and Hewlett 1982), particularly in humid coniferous forest types. Studies north of the HPAs in southwest Oregon (Harr et al. 1979) and south of the HPAs at Caspar Creek in Mendocino County (Keppeler 1998) found increases in both total water yield and seasonal base flows.

5.2.2 Potential Effects on Covered Species

The effects of temporary changes in watershed yield, peak flow magnitude and timing, and summer base flows on salmonids and key salmonid habitat characteristics are difficult to assess. The life-cycles of salmonids species have adapted to temporal variations in flow conditions by timing the phases of their life cycles to take advantage of seasonal discharges characteristics (Sullivan et. al. 1987). Increased runoff in the early part of the rainy season may, in some cases, benefit salmonids by reducing water temperatures, improving water quality, and providing more flow for immigrating adult spawners. However, a harvest-related increase in peak flows may increase the number of times that channel substrates are mobilized by storm events and potentially damage developing eggs and alevins in redds (Hicks et al. 1991 as cited by Spence et. al., 1996). Damage to developing eggs and alevins in redds would constitute take. Channel forming flows may occur more frequently as a result of an increase in peaks flows and thus habitats for spawning, rearing and foraging may be affected, either adversely or beneficially. Increased peak flows may also affect the survival of over-wintering juvenile salmonids by displacing them out of preferred habitats. Displacement of juveniles could cause take if the displacement impairs individual sheltering needs to the extent of killing or injuring individuals. These flow increases could have marginal beneficial effects by increasing available aquatic habitat. Short-term increases in summer baseflows may improve survival of juveniles (Hicks et. al. 1991 as cited by Spence et. al., 1996) and increase the amount of aquatic habitat. However, these effects are proportional to harvested area and diminish with regrowth of forest vegetation, so the effects are greatest for small watersheds.

The specific effects of altered hydrology on the amphibian Covered Species and their habitat are not known currently and are equally difficult to assess. Green Diamond is not aware of any studies that have addressed this potential effect on species such as the torrent salamander or tailed frog. The speculation is that, in general, these headwater species would be less likely to be affected relative to salmonid species that spawn and rear lower in the watershed. Tailed frog habitat overlaps with the upper reaches of salmonid habitat, and it is possible that increases in peak flow during winter may have a negative impact on larval tailed frogs. This could occur through entrainment of the substrate, which may displace or directly harm the larvae. Further, in extreme circumstances, such increases in peak flow could cause take, which may result in local declines in tailed frog populations. However, this would not likely result in long-term changes in the habitat for the species, and therefore it would not likely to result in major changes in populations of the species. Increases in summer low flows due to harvesting activities may be beneficial to larval tailed frog populations, especially during drought years, so it is not possible to know if the overall impact of altered hydrology on tailed frog populations is positive or negative.

Southern torrent salamanders live in seeps and springs and the uppermost reaches of watercourses, and as a result increases in peak flow would be unlikely to have any negative impact on this species. Limited field observations of torrent salamanders during high flows suggest that they simply move to the margins of the channel and would not be impacted by entrainment of the substrate. Since torrent salamanders live in aquatic sites with minimal flows, it seems likely that increases in summer low flows would be beneficial for this species. However, they live in association with Pacific giant salamanders that have the potential to prey on or compete with torrent salamanders. Torrent salamanders specialize in utilizing sites with the most minimal flows, so biotic interactions may change with increases in summer low flows. All of these considerations are highly speculative, and Green Diamond does not believe it is possible to predict whether or not altered hydrology would have an impact, positive or negative, on southern torrent salamanders.

Increased runoff and peak flows and decreased infiltration capacity of soils due to timber management and road construction are also correlated with increased sediment inputs to watercourses (Harr et al. 1975; Cederholm et al. 1980; King and Tennyson 1984). The negative effects of increased sediment inputs on the Covered Species and their habitats are described in Section 5.3.

To summarize, the extent to which watershed hydrology is altered by timber harvesting activities and, similarly, the extent to which such altered hydrology may negatively impact the Covered Species, is a function of the amount and timing of those activities in a sub-basin or watershed. Given the cumulative relationship among those activities and this type of environmental effect, it is difficult to assess the potential for these activities to cause altered hydrology itself, and it is also difficult, in turn, to evaluate the potential for altered hydrology to cause take of the Covered Species. For example, management-altered hydrology has the potential to harm both the early stages of development (eggs and alevins) as well as over-wintering juvenile salmonids. On the other hand, the effects of altered hydrology may be beneficial for adults returning to spawn in the fall and summer juvenile populations. Therefore, depending on which potentially limiting factors are actually limiting for salmonid production in a given sub-basin, some levels of altered hydrology may be beneficial. However, if other factors are limiting, altered hydrology may cause take and lead to local declines in populations of salmonids. For instance, if summer water temperatures are limiting, increases in summer base flows could be beneficial. In contrast, increases in winter peak flows could cause take and lead to local declines if spawning or over-wintering survival rates were limiting. In conclusion, the potential impacts of altered hydrology are highly complex, and although it has the potential to cause take that could lead to local declines in populations of the Covered Species, the actual impact of various levels of altered hydrology remain unknown. In any event, as a means of avoiding or minimizing and mitigating any negative impacts that could result from altered hydrology, the Plan provides measures to minimize the potential for harvest operations to cause altered hydrology.

5.3 POTENTIAL FOR INCREASED SEDIMENT INPUT

Timber harvest and the construction and use of the associated road system have the potential to increase sediment inputs. Increased sediment inputs from such activities can reduce the quality of aquatic habitats for all six Covered Species through reduced depth of deep water habitats (primarily pools), increased embeddedness of gravel and cobble substrates, and the effects of chronic turbidity on the Covered Species and thereby result in incidental take. Sediment inputs that result in take can be caused by either a single activity or by the combination of minor inputs from multiple activities that combine spatially and temporally to become collectively significant.

Hillslope erosion, sediment delivery to streams, and sediment transport and sorting within streams are natural dynamic processes that are responsible for creating aquatic habitat for the Covered Species. Steep, geologically young, coastal mountains are especially prone to high natural rates of erosion and the Covered Species have evolved in this environment. However, excessive inputs of sediment (both coarse and fine) from a combination of anthropogenic and natural sources can overload a stream's ability to store and transport sediment, reducing the quality and quantity of aquatic habitat for the Covered Species. (See Appendix E for a more detailed discussion.)

5.3.1 Potential Effects of Covered Activities

The variations in bedrock geology, tectonics, and associated geomorphic characteristics in northern California result in different erosion and sedimentation conditions in different stream reaches (the geology and geomorphology of the area where the Plan will be implemented are described in Section 4.2). Sediment production (erosion) may be highly variable depending on the presence or absence of Franciscan mélange and other geologic formations that contain abundant deep landslides and earthflows and locally extensive shearing and faulting in sedimentary rocks. In contrast to regions where active earthflows and rockslides contribute massive amounts of sediment to streams, more competent sandstone units of the Franciscan Formation deliver less sediment. In these areas, hillslope geomorphology is characterized by V-shaped valleys with steep hillslopes where debris slides are the primary mass wasting process. Where active deep-seated landslides do not contribute a major component of sediment inputs, sediment yields are approximately an order of magnitude (a factor of 10) lower (Kelsey 1982; Lisle 1990). In addition, the impact of the covered activities on potential sediment increases is also variable. Based on data presented in Appendix E, management-related erosion at the watershed scale typically induces increases in erosion ranging from about 30% to over 300%.

5.3.2 Sediment Sources and Erosion Processes

Sediment of varying size from the smallest fines to large boulders can be generated from a variety of different sources involving different erosion processes. One such process, surface erosion, tends to generate smaller particles sizes, and is a two-part process in which particles are first detached and then transported downslope. The two hydrologic processes that transport surface erosion are channelized erosion by constricted flows (rilling and gullying) and sheet erosion in which soil movement is non-channelized (rolling and sliding) (Swanston 1991). Increases in channelized and non-channelized erosion occur when the infiltration capacities of soils are reduced by management activities, large storm events or fires. Chamberlain et al. (1991) reported that the potential for surface erosion is directly related to the amount of bare soil exposed to rainfall and runoff. A study in Redwood National Park indicated that higher erosion rates tended to occur where rill erosion was more common, which was associated with tractor-harvest, and to a lesser extent, cable yarding, on schist soils (Marron et al. 1995).

In general, surface erosion does not account for a large portion of the total sediment budget in a watershed. Hagans and Weaver (1987) analyzed the data used by Marron et al. (1995), as well as data on percent bare soil following harvest and data on sediment delivery to streams from surface erosion processes on logged areas, including skid trails, for the lower Redwood Creek basin for the period c. 1954-1980, and concluded that only 4% of erosion was caused by sheet and rill erosion. Rice and Datzman (1981) conducted detailed surveys in northern California of 102 harvested plots averaging about 11 acres in size over a range of geologic and slope conditions. In aggregate, they found that two-thirds of the observed erosion was associated with roads, landings or skid trails. Surface erosion in the form of rills and gulleys not associated with roads, landings or skid trails (i.e. harvested areas) accounted for about five percent of total erosion.

Mass wasting is another process that has the potential to produce large amounts of both coarse and fine sediment. In steep mountainous terrain, mass soil movement is a major type of hillslope erosion and sediment source in watersheds (Sidle et al. 1985, Swanston 1991). The frequency and magnitude of mass soil movements is governed by hillslope gradient, level of soil saturation, composition of dominant soil and rock types, degree of weathering, type and level of management activities, and occurrence of climatic or geologic events.

Mass soil movements are usually episodic events and tend to contribute significant quantities of sediment and organic debris to stream channels over time intervals ranging from minutes to decades (Swanston 1991). The resultant sediment and organic debris may have a profound effect on a stream channel including large increases in coarse and fine sediments, shifts of existing bed-load, and increases in woody debris that can lead to partial or complete stream blockages.

Forest management practices can affect slope stability and increase the risk of mass wasting by changing vegetative cover, hillslope shape, and water flow above and below the ground surface. Different forest management operations have distinct effects on the factors that control slope stability. For two of the major components of forest management operations—road construction (and to a lesser extent skid trail construction) and harvesting trees—the potential consequences with respect to shallow landslide processes and slope stability are relatively well known. Road and skid trail construction may:

1. Create cut slopes and fill slopes too steep to be stable,

2. Result in deposition of sidecast material (spoils) that overburdens and/or oversteepens slopes, and

3. Divert and/or concentrate both surface and subsurface runoff.

While harvesting trees may:

1. Reduce effective soil cohesion by disrupting networks of interlocking roots from living trees in the “window” of reduced root reinforcement up to about 15 years, and

2. Increase soil moisture by reducing interception of precipitation and evapotranspiration of soil water. This is significant because greater soil moisture reduces the amount of precipitation from a given storm event required to cause soil moisture levels to reach a critical level.

The actual influence of specific forest management activities on slope stability, however, depends on the design and construction of the road network, density of residual trees and under-story vegetation, rate and type of revegetation, topography, material strengths, patterns of surface and subsurface flow, and patterns of water inflow (Sidle et al., 1985; Yoshinori and Osamu, 1984). Landslide rates associated with roads are generally much greater than landslide rates associated with timber harvest alone (Sidle et al. 1985). However, separating the effects of timber harvest activities from the associated yarding, construction, maintenance and use of skid roads and the forest road system may be difficult. Further, the results vary between watersheds. Most studies indicate that the sediment inputs from timber harvesting alone are less than those of the associated road network (Sidle et. al. 1985; Raines and Kelsey 1991; Best et al. 1995). (See Appendix E for a more detailed discussion.)

Deep-seated landslides also have the potential to produce large amounts of both coarse and fine sediments. Natural mechanisms that may trigger deep-seated landslides include intense rainfall, earthquake shaking, and erosion of landslide toes by streams. It is generally acknowledged that deep-seated landslides (earthflows and rockslides) may be destabilized by undercutting of the landslide toe (e.g. by streambank erosion or excavation of road cuts), by adding significant mass to the landslide body (e.g. disposing of spoils from grading or excavation projects), or by significantly altering the groundwater conditions in a landslide (e.g. diversion of road drainage into head scarps or lateral scarps) (TRB 1996, Ch. 16). Deep-seated landslides may also be affected by these hydrologic changes associated with reduced evapotranspiration reduced canopy interception during rainstorms (DMG 1997). Potential increases in groundwater associated with timber harvest in areas upslope of active deep-seated slides may also be important.

The relatively few regional empirical landslide studies have produced varying conclusions on the effect of timber harvesting on earthflow stability (i.e. deep-seeded landslides). Short-term increases in ground displacement following clear cutting have been documented on several active earthflows in the Coast Range and Cascades of Oregon (Pyles et al. 1987; Swanson et al. 1988; Swanston et al. 1987; Swanston 1981). In contrast, work by Pyles et al. (1987) on the Lookout Creek earthflow in central Oregon concluded that timber harvesting was unlikely to induce a large increase in movement, primarily because the slide was well drained.

In summary, previous studies suggest that forest management activities can potentially increase the occurrence or rate of movement of deep-seated landslides. Recognition of active landslides and avoidance of management practices that are known to increase risks of movement can reduce the overall risk of erosion associated with deep landslides. Site-specific conditions pertaining to individual slides will always be important in development of site-specific forest management plans; nevertheless, substantial uncertainty is likely to remain regarding predicted effects of management on slide activity. Deep landslides are relatively common, naturally occurring geologic features in northern California that will continue to generate substantial quantities of sediment delivered to streams, regardless of management influences.

The preceding discussion indicates that erosion from roads, including landslides (mass wasting), gullying caused by improper drainage, and rainsplash and sheetwash erosion on road and cutslope surfaces, are generally the most significant component of erosion related to forest harvest activities. Timber harvesting operations have historically relied on an extensive network of unpaved roads and necessitated building new roads to access portions of timberlands being harvested. Roads are recognized as a significant source of sediment inputs to watersheds (as described above; see also Gibbons and Salo 1973, Weaver and Hagans 1994). Sediment input from roads can occur through both surface erosion and mass wasting.

Research has shown that road construction for timber harvesting can cause significant increases in erosion rates within a watershed (Haupt 1959; Gibbons and Salo 1973; Beschta 1978; Rice et al. 1979, Cederholm et al. 1980; Reid and Dunne 1984; Swanson et al. 1987; Furniss et al. 1991). Roads can affect watersheds by modifying natural drainage patterns and by accelerating erosion and sedimentation, potentially altering channel stability and morphology. If proper construction techniques and maintenance practices are not followed, sediment increases following road construction can be severe and long lasting. Gibbons and Salo (1973) concluded that the sediment contribution per unit area from forest roads is usually greater than that contributed from all other timber harvesting activities combined. Cederholm et al. (1980) reported a significant positive correlation between the percentage of basin area in road surfaces and percentage of fine sediments (less than 0.85 mm) in spawning gravels.

Forest road systems and their associated stream crossings in steep coastal watersheds have the potential to be a major cause of mass soil movements (Best et. al. 1995; Sidle et al. 1985; many others). Road inventories conducted in the Pacific Northwest have reported that erosion from older roads may contribute 40 to 70 percent of the total sediment delivered to the system (Best et al. 1995; Durgin et al. 1988; McCashion and Rice 1983; Raines and Kelsey 1991; Rice and Lewis 1991; Swanson and Dryness 1975).

The actual increases in hillslope failures due to roads that are observed in any given watershed are affected by variables such as hillslope gradient, soil type, soil saturation, bedrock type and structure, management levels and road placement. The literature suggests that road placement is the single most important factor, because it affects how much the other variables will contribute to slope failures (Anderson 1971; Larse 1971; Swanston 1971; Swanston and Swanson 1976; Weaver and Hagans 1994).

5.3.3 Sediment Transport Processes

There are three modes of sediment transport in stream channels: bedload, intermittent suspended load, and suspended load. Although each of these processes corresponds to a generally consistent size range of sediment, the processes occur over a physical continuum, and that there is substantial overlap among these modes of sediment transport. Depending on the intensity (i.e. velocity) of stream flow, the sediment transported in one mode may be transported in another mode. Many textbooks provide a description of sediment transport mechanics (e.g. Richards 1982, Raudkivi 1990, Yang 1996).

The typical size of material transported primarily as bedload in upland streams is gravel (2 mm to 64 mm diameter) and cobble (64 mm to 256 mm diameter). Larger material (boulders) are also transported as bedload, however, sediment particles of this size move relatively slowly and are more likely to form nodes of stability in stream channels (i.e. boulder steps or transverse bars, Grant 1990).

Bedload is transported by sliding, rolling, or skipping along the streambed. Bedload particles are rarely found in the water column far above the bed. Bedload sediment is typically routed through mountain channel systems slowly, with average annual transport distances from tracer studies of about 300 ft, ranging from about 60 to 1500 ft (NCASI 1999, p. 289). The volume of bedload sediment deposits is typically large in comparison with the annual transport rate.

Bedload sediment is broken and abraded as it collides with other sediment clasts on the bed or in transport; this gradual process of breakage and declining size is known as attrition. The attrition process converts a portion of the bedload to suspended load as larger sediment clasts produce smaller sediment particles. The attrition rate is usually estimated as a function of transport distance in the channel network. The magnitude of attrition varies, but as much as half of bedload material may be converted to suspended sediment over transport distances of about 20 km (Collins and Dunne 1989). Where bedrock is extremely weak (e.g. Wildcat Group rocks near Humboldt Bay), however, the attrition rate may be much higher, and where bedrock is relatively strong, the attrition rate much lower.

Intermittent suspended load (also called “saltation load” by Raudkivi (1990)) is typically comprised of fine gravel and coarse sand. It is transported partly in contact with streambed, and partly in suspension, depending on flow intensity and local channel morphology. These sediment sizes are often found in sorted deposits in the lee of channel obstructions or in pools, and are typically finer than typical median grain size on the surface of point bars and alternate bars. Intermittent suspended load is transported through channel systems more quickly, provided it is not deposited underneath coarse armor layers of bed and bar deposits. The typical annual velocity of intermittent suspended load is between that of bedload and suspended load, and is on the order of 1000’s of ft to miles.

Sand, silt and clay sizes (< 2 mm diameter) comprise the suspended sediment load in most upland stream systems. The sand fraction (> 0.06 mm and < 2 mm) is often a major constituent of the intermittent suspended load and a substantial constituent of the bedload. In many low-gradient rivers, sand is the dominant component of the bedload. Such conditions are found at the mouths of several coastal watersheds in northern California.

Suspended load is transported in suspension in the water column in relatively low-intensity flows. It typically is transported through the channel system rapidly; sediment velocity for suspended load is nearly equal to water velocity. If suspended sediment is present in or on the margins of channels it will be entrained rapidly with increasing stream discharge. This suspended sediment can be subsequently deposited in low-velocity areas downstream as stream discharge declines. Sediment of this type is rarely deposited in large quantities within the streambed in upland channel networks except in low-velocity environments such as unusually low gradient or hydraulically rough reaches, channel margins, side channels, and behind flow obstructions.

Much of the suspended load is removed from the upland stream system very rapidly and is deposited in floodplains, estuaries and offshore marine environments. Suspended load accounts for about 70 to 90% or more of the total sediment load in northern California watersheds. This includes the suspended load and, depending on measurement technique, some portion of the intermittent suspended load.

Suspended load transport in many northern California streams (e.g. Caspar Creek, Lewis 1998) is correlated with turbidity (an optical characteristic of water quantifying its clarity or cloudiness). Hence, the supply of suspended load sediment size fractions is the chief control on stream turbidity, a measure of water quality used by the California Regional Water Quality Control Board in its Basin Plan for northern coastal California. The silt and clay fraction in the suspended load strongly influences turbidity; hence control of sediment sources rich in silt and clay will provide the greatest reduction in turbidity.

The relationship between sediment inputs to a channel network and sediment transport capacity of the channel network will have a strong influence on channel sedimentation status (e.g. Montgomery and Buffington 1993, Buffington and Montgomery 1999). For example, channel systems that are said to be “transport-limited” have a high sediment supply such that supply is greater than the streams sediment transport capacity. The channel bed in transport-limited channels is expected to be relatively fine, typically composed of finer gravel and sand with little armoring of the bed surface. Transport-limited channels may be found where there are abundant sediment inputs (e.g. recent concentrated inputs from landslides) or where channel slope declines rapidly (e.g. where a relatively steep confined channel reaches a broad valley with lower channel gradient). In contrast "supply-limited" systems have a high sediment transport capacity relative to sediment supply. The channel bed of supply-limited systems is expected to be relatively coarse, with frequent armoring of bed deposits and frequent bedrock exposures. Although conditions are variable, depending on channel and valley morphology and watershed erosion history, many of the smaller, steeper upland streams important for anadromous fish would be expected to be supply-limited. This expectation is conditioned largely on the high degree of confinement, moderately high slopes, and moderate to intense storm runoff typical of such streams (i.e. factors suggestive of high sediment transport capacity).

The timing and frequency of coarse sediment inputs into stream channels tend to be dominated by mass wasting processes. With the exception of channel erosion, bank erosion and soil creep, mass wasting processes typically generate sediment inputs that are relatively concentrated near the point of entry to the channel network. Landslide deposits in channels typically include abundant coarse and fine sediment and LWD. Deposits may fill existing channels and induce erosion along stream banks. The transport and downstream routing of such coarse sediment budgets have been investigated both in model and field studies of upland rivers (Benda and Dunne, 1997a, 1997b; Lisle et al. 1997 and Lisle et al. in press (re: Floodgate slide)). While it is generally agreed that the local effect is greatest at the point of entry, consistent theoretical statements regarding the magnitude and timing of effects downstream and the governing processes are elusive. Regardless of the specific mechanism, the greatest short-term effects with respect to coarse sediment are localized, with only gradual (over a period of years to decades) translocation of effects (typically increased depth of gravel deposits and changes in size distribution of bed material).

5.3.4 Potential Effects on Covered Species

The potential negative impacts of increased sediment inputs on the covered species differs for coarse versus fine sediments and therefore need to be addressed separately. Coarse sediment in limited amounts that is introduced into the channel along with LWD can contribute positively to aquatic habitat conditions. However, in the most extreme case, landslide deposits may bury a channel reach to depths sufficient to entomb any organisms present such as larval tailed frogs, southern torrent salamanders and salmonid eggs in redds in the streambed. More common and widespread effects resulting from increases in bedload sediment supply may also result in channel aggradation and associated decreases in mean channel depth, decreases in pool depth and more mobile, less stable channels, reducing the quantity of rearing habitat for juvenile salmonids and potentially reducing emergence from redds (Bisson et al. 1992, Sullivan et al. 1987). If water temperatures are not increased, aggradation of the channel due to coarse sediment inputs potentially would have less of an impact on the amphibian Covered Species, because they select for riffle habitat and are generally not found in pools (Diller and Wallace 1996 and 1999; Welsh et al. 1996). Coarse sediment inputs of competent material with a small fraction of fines may actually be beneficial to southern torrent salamanders. Material of this type contains an extensive interstitial network through which the salamanders can move.

Negative effects of excess coarse sediment on pool habitat are believed to be potentially significant for the salmonid Covered Species. Pool abundance and depth has been positively correlated with salmon and trout abundance and density (Bisson et al. 1982; Murphy et al. 1986). Juvenile coho salmon as observed in Green Diamond's summer population estimates are found almost exclusively within pool habitats (Appendix C7). Pool habitats provide summer rearing habitat, and may act as cool water temperature refugia in the summer (Steele and Stacy 1994). Coarse sediment inputs have the potential to negatively impact the fish Covered Species through infilling of pool habitat and the localized burial of redds. Such habitat modification caused by Covered Activities, could constitute a take of salmonids if it interfered with the ability of those present to shelter or if it destroyed their eggs.

The relatively slow rate of transport of bedload sediment results in relatively persistent effects, depending on local transport rates and the magnitude of the effect. The slow movement of bedload sediment and the tendency for bedload inputs to be concentrated in space in association with landslides suggests that coarse sediment effects may frequently be localized, affecting stream reaches rather than entire watersheds. With the passage of time, assuming inputs of coarse sediment are reduced, negative effects of coarse sediment on salmonid habitat can be expected to dissipate (Sullivan et al. 1987).

The timing and frequency of fine sediment inputs are potentially distinct from timing and frequency of coarse sediment inputs. Both coarse and fine sediment inputs resulting from landslides tend to be concentrated in time and space. More dispersed and chronic inputs of fine sediment are likely, however, owing to widely-dispersed sources and the high frequency of rainfall-runoff events capable of mobilizing fine sediment from sources areas, particularly roads. Most rainstorms are likely to provide sufficient energy to erode and deliver available sediment from road surfaces to streams that are hydrologically connected. Hence, even in relatively dry years when mass wasting processes are insignificant, substantial road surface erosion could occur where conditions are conducive, i.e., sediment is available for erosion because of the condition of the roads and there is a pathway for delivery to streams. This stresses the importance of having well maintained road systems that are hydrologically disconnected from watercourses. Given the propensity for landslide events to be triggered during relatively intense rainstorms, mass wasting episodes tend to be concentrated in a few years over periods of decades at the watershed scale. During the intervening years of relatively low mass wasting, erosion of fine sediment from roads would likely be persistent, potentially magnifying its impact on aquatic habitat.

Negative effects of increased fine sediment input on the Covered Species vary with sediment particle size. Increased inputs of the coarser fraction of fine sediments are associated with increased embeddedness or cementing of the substrate, while the finer suspended load is primarily responsible for high turbidity levels (Chapman 1988). Increases in fine sediments deposition into stream gravels can lead to a reduction in spawning success, reduced food production, and loss of benthic cover for over-wintering juveniles (Hicks et. al. 1991, Wood and Armitage 1997). The larvae and adults of the southern torrent salamander and larval tailed frogs utilize the interstices within gravel and cobble substrate, and are not typically found in streams with embedded gravel and cobble substrates (Bury and Corn 1988a; Diller and Wallace 1996, 1999). Salmon and trout spawn in gravel and cobble substrates, and sedimentation or burial of these substrates would likely result in reduced reproductive success for these species (Chapman 1988). Subsurface flow through redds is essential in providing dissolved oxygen to embryos and carrying away metabolic wastes. Sedimentation can reduce the survival to emergence of the covered embryos by reducing subsurface flow, and by creating sediment 'cap' which prevents hatched fry from emerging (Reiser and White 1988). Accordingly, increased embeddedness caused by increased input from Covered Activities could result in take of salmonids by destroying eggs or fry. Laboratory studies have demonstrated that increases in fine sediment in redds reduces survival to emergence either by entombment or by reducing the supply of oxygenated water to the redd, but field experiments have found more variable effects depending on the experiment, region and other environmental factors (Everest et al. 1987).

Additional effects of excessive sediment inputs of either size class on aquatic habitat include aggradation of stream channels and loss of bank stability, resulting in a wide, shallow channel with low canopy cover, higher water temperatures, and intermittent surface flows in low flow conditions (Swanston 1991). These secondary effects are typically seen in the depositional reaches of streams, making them likely to impact the salmonid Covered Species but not the amphibian Covered Species.

High levels of the finer fraction of suspended sediment (primarily silt and clay) have been found, primarily in laboratory experiments, to have a range of deleterious effects on salmonids. An increase in chronic levels of turbidity can damage the gills of salmonids, impair the ability of fish to locate food, and negatively impact the macroinvertebrate production, which can reduce the growth rate of juvenile salmonids (Bozek and Young 1994; Sigler et. al. 1984; Newcombe and MacDonald 1991). Negative effects of suspended sediment on juvenile salmonids depend on sediment concentration and duration of exposure, and the interaction of these factors is not well understood (Newcombe and MacDonald 1991). In addition, the availability of localized refugia from high suspended sediment concentrations, such as side channels and backwater pools, may also affect both concentration and duration of exposure. Gregory (1993) indicated that suspended sediment may have some beneficial effects as well, such as providing cover from predators. Thus, fine sediment inputs from the Covered Activities could take salmonids by impairing their ability to respire, feed and grow.

It is not known if there are any direct effects of increased suspended sediment or turbidity on the amphibian Covered Species. Green Diamond speculates that it has the potential to impact the aquatic dependent larval stages of these amphibians in the same manner as was noted above for the salmonids. In addition, suspended sediments could influence the growth of diatoms on the stream's substrate, which is the sole food for larval tailed frogs. Southern torrent salamanders are less likely to be impacted by suspended sediments, because they occur in seeps, springs and the uppermost reaches of streams that are generally not influenced by the downstream transport of fine sediments. However, Green Diamond believes that it is more likely that increases in suspended sediment (especially the larger particle sizes) would impact the amphibians indirectly by reducing interstices in the substrate and causing substrate embeddedness.

Sediment inputs, both coarse and fine, are absolutely essential to maintain a healthy biotic system. However, excess sediment inputs can have diverse and highly negative impacts. As described in the discussions above, the potential impacts from increased sediment inputs vary depending on the primary particle size involved. The impacts are generally cumulative in nature, especially for the finer particle sizes that can stay suspended in the water column and potentially impact regions at great distances downstream of the sediment source. The life history stage of the Covered Species that are potentially impacted by various types of sediment inputs is also variable, but there is the potential for all life history stages to be negatively impacted in a manner resulting in take. Increased sediment inputs can produce a myriad of negative impacts on habitat, such as increased pool filling, embeddedness, increased temperature and turbidity can potentially result in direct mortality, and decreased survival rates of various life history stages of the Covered Species, particularly in early life stages. Such impacts of direct take, and more importantly, changes in population demographic parameters, may result in local population declines. Such declines could negatively affect the regional populations of the Covered Species.

5.4 POTENTIAL EFFECTS ON LWD RECRUITMENT

In addition to the assessment below, see Appendix B for an evaluation of timber harvest impacts on future potential recruitment of large woody debris.

5.4.1 Potential Effects of Covered Activities

Timber harvest and the presence or construction of roads in riparian areas may result in a decline in the recruitment of LWD and a resulting reduction of in-channel LWD. Timber harvest in riparian zones removes trees that could otherwise become in-channel LWD. Roads in riparian zones may reduce potential LWD by simply removing their surface area from tree production, and also through intercepting trees which fall toward the channel. Trees, which fall across roads, must be cleared, and traditionally these trees have been removed for commercial use where possible. This practice essentially eliminates potential LWD that is separated from a stream by a maintained road. See Appendix E.

In Green Diamond's view, harvesting trees that are potential sources of future LWD (i.e., trees located in a position that, if left in place, could grow to sufficient size to perform LWD functions and are located where they could be recruited to a watercourse) would not cause a "take" as it does not constitute a significant habitat modification or degradation which actually causes the death or injury of fish or wildlife by significantly impairing essential behavioral patterns (any injury would be so far into the future as to be speculative). Nevertheless, Green Diamond recognizes that such an action has the potential to result in potentially significant long term negative impacts (other than "take") on future habitat conditions and the ability of the local salmon stocks to maintain and recover. Green Diamond also believes that maintaining and improving LWD recruitment provides a significant conservation benefit for all the Covered Species. Accordingly, for purposes of developing and prioritizing conservation measures for this Plan, Green Diamond has (a) addressed the potential adverse environmental effects of removing possible sources of future LWD as if they are comparable in relative significance to the potential impacts of actual take, and (b) included in the proposed conservation strategy a number of measures designed to minimize and mitigate these impacts and to conservation benefits associated with maintenance and improved recruitment of LWD.

5.4.2 Potential Effects on Covered Species

In-channel LWD is recognized as a vital component of salmonid habitat, and to a lesser extent, but still important to the amphibian Covered Species. The physical processes associated with LWD include sediment sorting and storage, retention of organic debris, and modification of water quality (Bisson et al. 1987). The biological functions associated with LWD structures include important rearing habitats, protective cover from predators and elevated stream flow, retention of gravels for salmonid redds, and regulation of organic material for the in-stream community of aquatic invertebrates (Murphy et al. 1986; Bisson et al. 1987). Decreased supply of LWD can result in (Hicks et. al. 1991 as cited by Spence et al. 1996):

- reduction of cover,
- loss of pool habitats,
- loss of high velocity refugia,
- reduction of gravel storage, and
- loss of hydraulic complexity.

These changes in salmonid habitat quality can lead to increased predator vulnerability, reduction of winter survival, reduction in carrying capacity, lower spawning habitat availability, reduction in food productivity and loss of species diversity.

In headwater streams, LWD is also known to dissipate hydraulic energy, store and sort sediment, and create habitat complexity (O'Connor and Harr 1994). Creating and providing cover for pools, a primary function of LWD for salmonids, may be of limited benefit to the headwater amphibian Covered Species since torrent salamanders and larval tailed frogs prefer riffle habitats (Diller and Wallace 1996 and 1999; Welsh et al. 1996). The primary benefit of LWD to the amphibians is the creation of suitable riffle habitat through the storing and sorting of sediment. In addition, LWD that is perched a short distance above the streambed will often form a dam composed of coarse sediment and small woody debris through which water percolates. In streams that are otherwise too embedded with fine sediments to be used by torrent salamanders, this appears to form the only habitat that still supports the species (Diller, pers. comm.). There is circumstantial evidence that these same sites are utilized for egg laying by tailed frogs, but searching such sites is too destructive to adequately investigate the phenomenon (Diller, pers. comm.).

The decline of recruitment of potential LWD from riparian zones can be expected to reduce LWD recruitment to streams for decades following timber harvest of riparian areas. High in the watershed, the potential impacts would be primarily localized, but in larger streams lower in the watershed, LWD can be transported during higher flow events and the impacts may be cumulative. A decline in pool density, pool depth, in-stream cover, gravel retention, and sediment sorting are likely to result if LWD recruitment is reduced. These habitat changes may reduce the growth, survival, and total production of salmonids as well as the amphibian species (Steele and Stacy 1994; Murphy et al. 1986). Given that LWD is likely critical to provide habitat and cover for juvenile salmonids in both summer and winter, survival rates of these life history stages may be limited by the amount of LWD in some streams. Such potential impacts that reduce survival rates of key life history stages of the Covered Species may result in local population declines. Such declines could negatively affect the regional populations of the Covered Species.

5.5 POTENTIAL FOR EFFECTS FROM ALTERED THERMAL REGIMES AND NUTRIENT INPUTS

5.5.1 Potential Effects of Altered Riparian Microclimate

The riparian microclimate has potentially important indirect effects on the salmonid Covered Species and aquatic forms of the amphibian Covered Species through alteration of water temperature, which will be discussed in the following Section. However, the riparian microclimate also has potentially important direct effects on the adult forms of the amphibians. Reduction of riparian overstory canopy through timber harvesting could result in increased levels of incident solar radiation reaching the stream and riparian zone during the day and reduced thermal cover at night (Welch et al. 1998). It could also increase exposure to wind in the riparian areas due to an edge effect from an adjacent harvest unit with the overall net effect of increasing daily fluctuations in air temperature and relative humidity. Studies done in areas outside the coastal influence of the 11 HPAs indicate that microclimatic edge effects can be detected as much as 240 meters (787 feet) from the edge of a clearcut (Chen 1991). However, the greatest attenuation of edge effects on microclimatic changes occurs within the first 30 meters (98 feet) of the buffer (Ledwith 1996). Although the impact of altered riparian vegetation on the microclimate is ameliorated by the cool coastal climate in the region, reduction of riparian cover due to timber harvesting has the potential to cause greater daily and seasonal fluctuations in the microclimate of the riparian areas.

In addition, increased coarse sediment inputs from management activities, particularly when it occurs in the form of debris torrents, can result in widening of the channel and loss of streamside vegetation (Swanston 1991). Just as in overstory canopy loss, this has the potential to alter the riparian microclimate by increasing daily fluctuations in air temperature and relative humidity. It is unlikely that increases in air temperature with corresponding decreases in relative humidity during the day would directly impact the amphibians, because the adults are not surface active during the day. However, the corresponding drying effect of increased air temperature and decreased relative humidity could result in the loss of some daytime refugia habitat and nighttime foraging sites. It is also possible that the reduction of thermal cover at night may impact the ability of adults to forage at night.

5.5.2 Potential Effects of Altered Water Temperature

Loss of riparian overstory canopy through timber harvesting and increased coarse sediment inputs from management activities could result in alteration of the riparian microclimate as described above. However, changes in the riparian microclimate will also result in corresponding changes in the daily water temperature regime. In addition, both reduction of overstory canopy and increased coarse sediment inputs can result in altered water temperature through direct mechanisms. Removal of the riparian canopy will result in elevated summer water temperatures, often in direct proportion to the increase in incident solar radiation that reaches the water surface (Chamberlain et al. 1991). For a given exposure from solar radiation, water temperature increases directly proportional to the surface area of the stream and inversely proportional to stream discharge (Sullivan et al. 1990). Exposed channels will also radiate heat more rapidly at night. In addition, increased sediment inputs that results in aggradation will result in a wider and shallower channel that gains and losses heat more rapidly. Therefore, reduction of riparian vegetation and aggradation of a channel act synergistically to cause greater daily and seasonal fluctuations in water temperatures.

Increased water temperatures can have negative impacts on the salmonids (Beschta et al. 1987) as well as the amphibians. Potential impacts to salmonids from increased stream temperatures include (Hallock et al. 1970; Hughes and Davis 1986; Reeves et al. 1987; Spence et. al., 1996):

- reduction in growth efficiency,
- increased disease susceptibility,
- changes in age of smoltification.
- loss of rearing habitat, and
- shifts in the competitive advantage of salmonids over non-salmonid species.

Although the specific mechanisms are not known, many of the same physiological or ecological factors associated with elevated water temperatures presumably exist for the amphibian species, which have temperature thresholds below those of the fish Covered Species.

Although elevated water temperatures can be a relatively localized phenomenon, this factor generally functions in a cumulative manner throughout a sub-basin or watershed. The impact of elevated water temperature also tends to be cumulative on a temporal scale, such that short-term increases are less likely to be harmful compared to more chronic increases in water temperature. The potential harm or death associated with this factor would primarily influence the juvenile salmonids and larval amphibians during summer and early fall. Take of Covered Species could occur as the result of temperature increases causing the impairment of essential functions and injury or mortality. The potential impacts of such taking include potential reductions in the local or regional populations of the Covered Species and could affect a possible need to list currently unlisted Covered Species under the ESA in the future.

5.5.3 Potential Effects of Altered Nutrient Inputs

Unlike lentic systems and the mainstem of many rivers in which runoff from agricultural, suburban, industrial and other areas lead to eutrophication, the portion of lotic systems throughout the Pacific Northwest and Northern California in which salmonids spawn and rear are thought to be naturally oligotrophic due to low levels of nitrogen (Allan 1995; Triska et al. 1983). However, additions of nitrogen in these systems will only result in limited increases in primary productivity, because most of these streams, especially heavily shaded lower order channels, are also limited by light (Triska et al. 1983). While autochthonous inputs (derived from within the aquatic system through photosythesis) are important in higher order channels, much of the energy and nutrients in lower order channels (where many salmonids rear) comes from allochthonous inputs (derived from outside the aquatic system typically through detrital inputs). One of the most important sources of detrital inputs in streams throughout the Northwest comes from red alder, because it is readily available to the aquatic invertebrate community and its leaves are high in nitrogen (Murphy and Meehan 1991; pers. comm. K. Cummins, Humboldt State

University). The fact that red alder fixes atmospheric nitrogen also has important implications for increasing the total available nitrogen in these potentially oligotrophic lotic systems. In contrast to red alder leaves that can be 50% decomposed in less than 2 months, Douglas-fir needles may take over 9 months to reach the same level of decay and have far less nitrogen. Woody debris, even twigs and small branches, has limited nutritional value to streams because it decays so slowly and is very low in nitrogen (Murphy and Meehan 1991). Another potentially important source of nutrients to streams comes from annual spawning runs of anadromous salmonids. Reduced ocean-derived nutrients to stream and riparian ecosystems due to declines in salmon returns in many regions have received considerable attention in recent years (AFS: Nutrient Conference 2001). This has lead to numerous studies looking at the potential benefits of artificially increasing the productivity ("jump-starting") of these systems through the addition of salmon carcasses or other sources of nutrients.

Reduction of riparian vegetation due to timber harvest is likely to increase productivity of streams in several ways. Increased incident solar radiation would likely increase periphyton production (unless it is limited by nitrogen), which may increase the abundance of invertebrates and fish due to an enhanced quality of detritus. The mechanism of this increase is tied to the algae, a higher quality food than leaf or needle litter, which increases the abundance of invertebrate collectors, which in turn, can increase the abundance of predators such as juvenile salmonids (Murphy and Meehan 1991). In addition, timber harvest in riparian areas may reduce the number of conifers and increase deciduous vegetation such as red alder. Therefore, with increased input of nutritionally rich leaf detritus compared to conifer needles, productivity of the stream may increase. Of course, the salmonid response would only be realized if the alteration of the riparian vegetation did not also lead to adversely high water temperatures. An increase in stream productivity may also not ultimately result in increased production of salmonids, because it will primarily benefit summer rearing populations when the "bottleneck" (i.e. limiting factor) for many salmonid streams is winter rearing habitat (Murphy and Meehan 1991).

Larval tailed frogs feed exclusively on diatoms that grow on the surface of the stream's substrate (Metter 1964). Growth of the diatoms is influenced by factors such as sunlight, water temperature and nutrients, but there have been no studies to determine if diatomaceous growth is ever limiting for larval tailed frogs. As a result, it is not possible to speculate on how altered nutrients may influence this life history stage of tailed frogs. The adult frogs presumably feed in the riparian zone, but little is known of their foraging ecology and it would not be possible to speculate on how altered nutrients in the stream might influence the adults. Larval and adult southern torrent salamanders feed primarily on small aquatic invertebrates whose numbers would be influenced by detrital inputs. However, it is not known if food is ever limiting for this species such that changes in aquatic invertebrates would influence survival or growth of individual salamanders.

Take of Covered Species could occur as the result of temperature increases causing the impairment of essential functions, if injury or mortality resulted. The potential impacts of such taking include potential reductions in the regional populations of the Covered Species.

The impacts of altered nutrient inputs would most likely be subtle and difficult to predict. The greatest potential impact would be to juvenile salmonid populations that need to reach some threshold in size before smoltification and out-migration can occur.

Decreases in nutrient inputs would not likely result in direct harm, but they may reduce survival during the freshwater rearing period. In addition, ocean survival would likely be decreased if smolts out-migrate at smaller sizes. However, it would be difficult to determine that any management activities were responsible for take as the result of altered nutrients.

5.6 OTHER POTENTIAL EFFECTS

5.6.1 Potential Effects of Barriers to Fish and Amphibian Passage

Culverts can become impassable barriers to both adult and juvenile anadromous and resident salmonids (Evans and Johnson 1980). Culverts can become barriers to anadromous fish by:

- creating high flow velocities at the inlet, outlet or within the culvert,
- creating excessive height from downstream pool into the culvert outlet,
- providing in-adequate water depths for upstream passage,
- lacking resting pools at the culvert inlet, outlet, or within the culvert.

Juvenile salmonids have been observed dispersing upstream and downstream in response to various environmental factors. These include seeking refuge: from high stream temperatures; high flow conditions and predation; or seeking lower population densities with more favorable food and cover conditions (Bustard and Narver 1975, Cederholm and Scarlett 1981, Everest 1973, Fausch and Young 1995, Gowan et al. 1994, Hartman and Brown 1987, Shirvell 1994). Because adult and juvenile fish have different swimming and jumping abilities, a culvert that may pass adults could be a barrier to juvenile fish. (See Appendix E.)

The potential effects of these barriers on adults of the salmonids include blocking or delaying access to spawning grounds (Evans and Johnston 1972). The potential effects of these barriers on juvenile salmonids include significantly reducing available rearing and foraging habitat and reducing or eliminating low velocity refugia during high winter flows, possibly reducing survival of overwintering juveniles. The potential effects of installing and using culverts in areas where Green Diamond operates on adult and juvenile fish passage could lead to fish mortality or impairment of breeding and could constitute take. The impact of such take could include reductions in survival and production of fish in affected watersheds.

It is not known if culverts have the potential to affect the amphibian species. It is likely that they act as barriers to the larval forms but not the adults. Whether or not this has an impact on the populations is not known since the headwater amphibians are thought to have limited vagility.

Culvert failures due to blocking, undersize culverts, or poor maintenance, can result in mass wasting events that deliver large volumes of sediment to watercourses. Culvert related mass wasting events are accounted for in the figures and papers cited in the discussion of road-related sediment inputs and the potential effects of sediment on the Covered Species.

5.6.2 Potential for Direct Take from Use of Equipment

Some Covered Activities entail the use of equipment that could directly take Covered Species. Events that potentially could result in take include, but are not restricted to:

1. Operation of heavy machinery in streams during other Covered Activities, such as construction of watercourse crossings or stream enhancement work;

2. The falling and yarding of timber and pre- and post-harvest management activities (including construction and maintenance of roads) in stands adjacent to streams;

3. Drafting of water from watercourses for dust abatement; and

4. Incidental drippage or leakage of petroleum products such as fuel and lubricants from equipment used during other Covered Activities.

Such events have the potential to injure or kill adults, juveniles, larvae, and/or eggs of the Covered Species at the location where the impact occurs. These events would be highly stochastic and isolated in nature. As a result, the taking would have very localized impacts and would not be likely to cause even local declines in populations of the Covered Species.

5.7 SUMMARY OF POTENTIAL IMPACTS OF TAKE, INCLUDING CUMULATIVE IMPACTS

Green Diamond has identified cumulative effects issues associated with the impacts of take resulting from the Covered Activities described in Section 2.2.4 of the Plan related to timber management.

Cumulative impacts are relevant in the Services' issuance of the ITP/ESP, conducting the ESA section 7 internal consultation as part of permit issuance, and preparing an EIS under the National Environmental Policy Act ("NEPA"). Generally, cumulative impacts are the incremental impact which results from the federal action, i.e., approving the incidental take permits under the conditions of approval described in the AHCP/CCAA, when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

In the case of issuance of an ITP/ESP, the cumulative effects issue is whether the incremental impacts of take, when combined with impacts from other projects, will appreciably reduce the likelihood of survival and recovery in the wild of any Covered Species (the "jeopardy" standard); if so, the AHCP/CCAA would fail one of the significant approval criteria for both ITPs and ESPs.

Green Diamond evaluated cause-and-effect relationships among the Covered Activities, take of the Covered Species and the impacts of take, including cumulative impacts. The magnitude and significance of cumulative effects were considered, alternatives developed, and specific conservation measures incorporated into the Operating Conservation Plan to avoid, minimize or mitigate significant cumulative environmental effects. Where substantial uncertainties remain or multiple resource objectives exist, adaptive management provisions allow for flexible project implementation.

A significant premise of the AHCP/CCAA is that the Plan's conservation measures not only fully minimize and mitigate individual impacts of take by category and type of impact, but that Green Diamond's activities and management practices under the Operating Conservation Program outlined in Section 6.2 of the Plan will result in significant improvements in habitat conditions for the species. In Green Diamond's view, the Plan contributes to the maintenance and restoration of properly functioning habitat and, thereby, contributes to the recovery of the listed Covered Species. In other words, this Plan is designed expressly to exceed the requirements for HCPs and to meet the requirement for CCAAs (that a CCAA must contribute to efforts to reduce the need to list currently unlisted Covered ESP Species by providing early conservation benefits to those species).

In the context of cumulative impacts analysis, the incremental effect on the Covered Species of implementing the AHCP/CCAA will be positive. Therefore, the AHCP/CCAA's positive incremental effect will not cause or contribute to negative "cumulative effects." Green Diamond used the following analytical mechanism to develop a Plan that supports this conclusion. Green Diamond analyzed and described relevant baseline environmental conditions of the 11 HPAs in the Plan. As part of this analysis, Green Diamond identified those habitat conditions or factors that are "limiting" for the Covered Species in each of the HPAs. In any population of animals, there are one or more biotic or abiotic factors acting on one or more life stages that ultimately limit the growth of the population. If a single limiting factor acts on a single life stage, this can be viewed as the limiting factor or "bottleneck" for the population or species. For example, over-wintering habitat for juveniles has been frequently indicated as the likely bottleneck or limiting factor for coho salmon in their freshwater habitat (Murphy and Meehan 1991). If this is the case, then other factors that influence different life stages may have no impact on the production of coho from a given sub-basin or watershed. As an example, a hypothetical sub-basin may have 10,000 fry emerge from the spawning gravels during an average year, but there is only enough over-wintering habitat to support 1000 juvenile coho. In this example, survival of eggs and alevin could decline by 50%, but this would not cause a decline in the local population because there would still be a surplus of fry relative to the available habitat for the juveniles. Therefore, the concept of a population bottleneck or limiting factor implies that, potentially, there are factors that may result in harm or death for individuals at certain life history stages that would not result in an impact for the population, because the life stage effected is not limiting.

As described above, there are a variety of factors that have the potential to cause take of the Covered Species. Green Diamond has little site-specific data that would allow Green Diamond to determine quantitatively which of these factors are most likely limiting in any given watershed within the 11 HPAs. The matter is further complicated by the potential for various factors to interact synergistically making it even more difficult to predict the impact of changes in a given factor. For example, limited increases in water temperature may be beneficial, if there is ample food, because it will increase growth rates of the juvenile salmonids. However, the same increase will be detrimental when food is limited, because the increased water temperature will increase basal metabolic rates and reduce the amount of their ingested food that will go into growth.

Although the complex nature of these potential limiting factors makes the analysis difficult, Green Diamond's assessment of the HPAs (see Section 4.4) indicates that certain factors have a greater probability of being limiting in most HPAs. Through this analysis, Green Diamond has analyzed the potential for Covered Activities to cause or contribute to these limiting factors. In addition, Green Diamond analyzed baseline environmental conditions by evaluating site-specific data and ranking salmonid life history stages in terms of potential to represent the population bottleneck and then reviewed the potential for individual Covered Activities to cause environmental effects that themselves might not cause significant habitat impairment or cause take but, when combined with other similar effects that are closely related temporally and spatially, could cause take of Covered Species or cause or contribute to adverse habitat conditions for the Covered Species.

Based on this analysis, Green Diamond believes that available summer and winter rearing habitat is most likely to be limiting for the salmonids in most HPAs. If this is true, the interaction of excess coarse sediment input and a lack of LWD would have the greatest potential to negatively impact the local and regional population of these species. Excess coarse sediment inputs without LWD would aggrade the channels and eliminate high quality pool and backwater habitat for juvenile salmonids during both summer and winter. This could occur on a relatively localized scale in smaller sub-basins, but in larger systems (generally third order and larger), the effects would tend to be cumulative due to the capacity for these systems to transport coarse sediment during higher flows. Fine sediment inputs are less likely to be limiting, because it tends to have the greatest impact on spawning success. However, given the high potential for fine sediments to be transported downstream, the cumulative effect of multiple sources of fine sediment inputs throughout a sub-basin over extended periods could seriously impair the feeding efficiency of juvenile salmonids and cause local or regional population declines.

Excess sediment inputs, both coarse and fine, have the greatest potential to limit habitat and deter conservation efforts for the benefit of the amphibian species. However, rather than eliminating pool formation, the greatest impact would be the embedding of riffle habitat that eliminates the interstices in the substrate on which the larval phases of these species depend. The amphibian species do not appear to be as directly depend on LWD compared to the salmonids, but LWD does result in sorting of the substrate, which tends to create areas of suitable riffle habitat, even in a stream that otherwise suffers from excess sediment inputs. Being higher in the watershed, the amphibians are generally less impacted by cumulative effects relative to the salmonid species. In particular, the southern torrent salamander is typically found in the uppermost reaches of a watershed and is generally only sensitive to direct impacts.

As discussed above, altered hydrology has the potential to impact the Covered Species in a variety of ways that could be both positive and negative. Green Diamond does not believe that altered hydrology by itself could be a limiting factor for any of the Covered Species. However, it has the potential to exacerbate a situation in which there is excess sediment inputs with too little LWD present. Since it operates in a cumulative manner, it would also be necessary to alter the hydrology of a large portion of a sub-basin or watershed before the magnitude of the response would be large enough to impact the Covered Species.

Water temperature, as a single factor, has the potential to be a limiting for all of the Covered Species. The suite of Covered Species are all considered “cold water adapted” and each have relatively discrete upper thermal limits above which harm or death occurs. However, streams throughout the 11 HPAs generally do not have temperatures that are at or near these upper thresholds. A few isolated streams or stream reaches have water temperatures that could cause local declines in populations of the Covered Species, but it is not likely to be potentially responsible for regional declines.

Barriers to salmonid movements, both partial and complete, can limit local populations when all other habitat factors are good. As a result, the cumulative impact of barriers has the potential to limit populations over both a local and regional scale. However, within the 11 HPAs, anthropogenic barriers are relatively isolated so the impact of these barriers tends to only have localized impacts. As noted above, the mechanisms of direct take tend to only have localized impacts that would not likely to result in even local impacts on populations of the Covered Species.

As this analysis reflects, the complicated nature of these potential limiting factors makes it impossible to definitively assess the extent of the potential impact of take or the Covered Activities associated with any given factor. Therefore, Green Diamond‘s conservation strategy addresses all the factors as if they are limiting in each HPA; Green Diamond designed measures to be implemented during the course of the Plan that will provide for significant improvements in each of those factors over baseline conditions in all areas In other words, with a few exceptions where HPA-specific measures have been proposed, the measures designed to address each type of limiting factor will be applied throughout all 11 HPAs as if that factor is in fact limiting throughout the Initial Plan Area Under such conditions, the Plan will not result in negative cumulative impacts. For these reasons, the incremental effect of Plan implementation will be positive compared with existing baseline conditions and will result in generally improving habitat conditions for native salmonids over the term of the Permits in all HPAs. Therefore, Plan implementation will not result in negative cumulative effects

Section 6. Conservation Program

This Section identifies the biological goals and objectives of the Plan, sets forth the conservation program that Green Diamond will undertake in the Plan Area, and provides a detailed explanation of the rationale for the conservation program.

- Section 6.1 presents the goals and objectives.
- Section 6.2 sets forth the specific conservation measures that Green Diamond will undertake within the Plan Area during the term of the Permits. These measures are referred to as Green Diamond's "Operating Conservation Program." It includes measures to minimize and mitigate the impacts of incidental take, maintain and improve habitat conditions for the Covered Species, monitor implementation and effectiveness of the Plan, institute adaptive management, and respond to changed and unforeseen circumstances.
- Section 6.3 supplements the Operating Conservation Program with further discussion of the intent, rationale and analysis that underlie the specific measures and commitments outlined in Section 6.2. This section is provided to aid in the implementation of Green Diamond's Operating Conservation Program.

6.1 BIOLOGICAL GOALS AND OBJECTIVES

6.1.1 Introduction

To meet the statutory criteria for approval of an HCP/ITP, Green Diamond's conservation program must: (i) minimize and mitigate the impacts of authorized incidental take of Covered Species that may result from Covered Activities to the maximum extent practicable and (ii) ensure that any such taking will not appreciably reduce the likelihood of the survival and recovery of such species in the wild. While these statutory criteria themselves are biological in nature, NMFS and USFWS have issued an Addendum to the HCP Handbook (also known as the "Five Points Policy") calling for an HCP to identify specific biological goals and objectives based on the proposed action that necessitates incidental take permit issuance and the conservation needs of the Covered Species (Final Addendum; 65 FR 35251).

As the Services explained in proposing the Handbook Addendum, the "biological outcome of the operating conservation program for the Covered Species is the best measure of the success of an HCP" (64 FR 11585). Further, the Service stated:

> Explicit biological goals and objectives clarify the purpose and direction of an HCP's operating conservation program. They create parameters and benchmarks for developing conservation measures, provide the rationale behind the HCP's terms and conditions, promote an effective monitoring program, and, where appropriate, help determine the focus of an adaptive management strategy. . . .Biological goals provide broad, guiding principles for an HCP's operating conservation program and the biological goals are "the rationale behind the minimization and mitigation strategies (Final Addendum; 65 FR 35251).

Biological goals can be either habitat-based or species-based. Habitat-based goals are expressed in terms of the amount and or the quality of habitat. Species-based goals are expressed in terms specific to individuals or populations of that species. This Plan's biological goals and objectives are primarily habitat-based but include species-based objectives for the amphibian species. Biological objectives are more specific and include measurable parameters. Biological objectives are the different components needed to achieve the biological goals. Permittees are not required to achieve the HCP's biological goals and objectives to comply with their permits. Rather than being enforceable terms or conditions, the goals and objectives guide the development of the operating conservation measures.

Whether the HCP is based on prescriptions, results, or both, the permittee's obligation for meeting the biological goals and objectives is proper implementation of the operating conservation program of the HCP. In other words, to qualify for No Surprises assurances, a permittee is required only to implement the operating conservation program of the HCP; the IA, if used, and the terms and conditions of the permit. Implementation may include provisions for ongoing changes in actions in order to achieve results or due to results from an adaptive management strategy (65 FR 35251).

Accordingly, to minimize and mitigate the impacts of incidental take within the Plan Area as described in this AHCP and to ensure that such take does not jeopardize the Covered Species, Green Diamond intends to undertake management measures that will, during the term of the Permit protect, and, where needed allow development of the functional habitat conditions that are required for long-term survival to support well-distributed, viable populations of the Covered Species. These measures, set forth in the Operating Conservation Program in Section 6.2, are based on the biological goals and objectives set forth in this section.

The Biological Goals and Objectives cover not only the listed Covered Species but also the unlisted ITP Species under NMFS jurisdiction and the unlisted ESP Species under USFWS jurisdiction. According to the Handbook Addendum, each ITP Species "must be addressed as if it were listed and named on the permit" (65 FR 35251).

The HCP Handbook Addendum does not apply to CCAAs. Therefore, the Addendum does not directly guide the conservation planning for the ESP Species, and the establishment of biological goals and objectives is not required for ESP Species. Nevertheless, Green Diamond has established biological goals and objectives for the ESP Species consistent with the purposes of the CCAA policy. The CCAA policy is intended to facilitate the conservation of proposed and candidate species, and species likely to become candidates, by giving non-Federal property owners incentives to implement conservation measures for declining species (64 FR 32726). The CCAA portion of this Plan will provide benefits to the ESP Species through Green Diamond's implementation of the voluntary conservation measures contained in the Operating Conservation Program (Section 6.2). These measures are designed to provide conservation benefits of removing threats to the Covered Species and maintaining and improving habitat conditions in the Plan Area so as to help preclude or remove any need to list them as threatened or endangered under the ESA.

6.1.2 Biological Goals and Objectives

The Covered Species in this Plan are six stream-dwelling species. The preferred area of freshwater habitat for these species ranges from the lowest portions of watersheds to the uppermost headwater areas, but they all share some common habitat needs. Although the specifics vary, they all have adapted to relatively cool water temperatures, and require streams with complex habitat both in terms of stream morphology and substrate composition. The six species exhibit life history variability, with the result that different portions of their life cycles depend on freshwater habitat. Of the fish species, chinook salmon spends the least time in freshwater where the spawning and estuarine rearing habitats are the most critical freshwater elements. In comparison, coho salmon and steelhead generally spend up to two years or more of their life in freshwater habitat so that spawning, and summer and winter rearing habitats are important. Most of the coastal cutthroat trout probably spend their entire lives in freshwater. This fish species is completely dependent on the freshwater habitat, although some individuals of certain populations may exhibit anadromy. The amphibian species spend their entire lives within relatively small areas in the upper reaches of watersheds, although the adults of both species are terrestrial and presumably capable of limited overland movements during certain times of year.

Based on these considerations, Green Diamond has established the five goals and five objectives to reflect in biological terms the intended result of the proposed conservation program.

6.1.2.1 Biological Goals

As a result of the shared habitat requirements of the Covered Species and in addition to the overall purpose of the Plan as stated in Section 1.2, the specific biological goals of this AHCP/CCAA are to:

- Maintain cool water temperature regimes that are consistent with the requirements of the individual species,
- Minimize and mitigate human-caused sediment inputs,
- Provide for the recruitment of LWD into all stream classifications so as to maintain and allow the development of functional stream habitat conditions,
- Allow for the maintenance or increase of populations of the amphibian Covered Species in the Plan Area through minimization of timber harvest-related impacts on the species, and

- Monitor and adapt the Plan as new information becomes available, to provide those habitat conditions needed to meet the general goals that benefit the Covered Species.

6.1.2.2 Biological Objectives

There are five biological objectives for the Plan. Three are habitat-based, one is population-based, and one is monitoring-based.

6.1.2.2.1 Summer Water Temperature Objective

For 4th order or smaller Class I and II watercourses with drainage areas less than approximately 10,000 acres, the biological objective for the highest 7DMAVG will be below the upper 95% PI as described by the following regression equation:

Water temperature (^{o}C) = 14.35141 + 0.03066461 x square root of watershed area (acres)

In addition, even when temperatures are below the values listed above, it is a biological objective of this Plan to have no significant increases (>2°C) in the 7DMAVG water temperature in Class I or II watercourses following timber harvest that are not attributable to annual climatic variation. A graphical representation of the temperature regression analysis is shown in Figure 6-1.

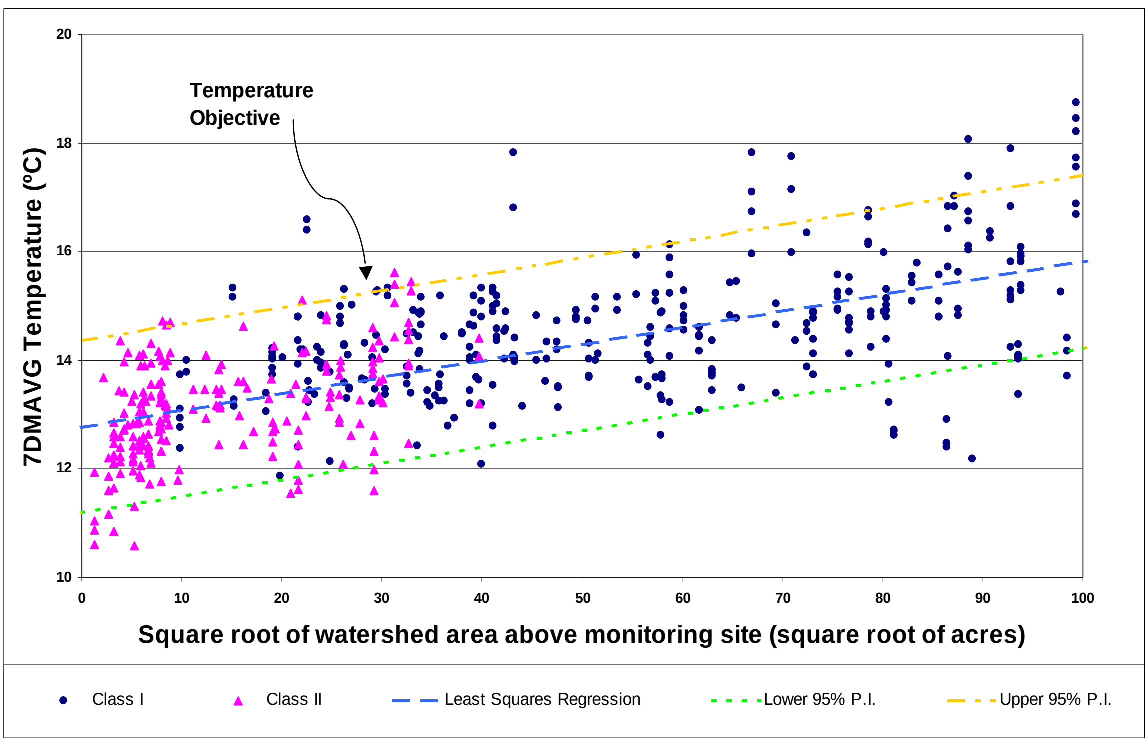


Figure 6-1. Representation of the temperature analysis underlying the summer water temperature objectives based on 7DMAVG water temperatures for all monitoring sites on the Original Assessed Ownership (1994-2000).

6.1.2.2.2 LWD Objective

The biological objective for LWD is to increase the abundance and size class of inchannel and potential LWD in watersheds in the Plan Area. Based on projections of future stand composition in riparian zones through the life of the Plan, the objective is that 99% of riparian zones will be stocked with mature stands greater than 60 years in age and over 70% will have stands greater than 80 years in age. In addition, the potential recruitment based on managed potential tree height will be greater than 80 and 70% attainment for Class I and II watercourses respectively.

6.1.2.2.3 Amphibian Population Objective

The biological objective for amphibian populations is based on two targets:

1. Future monitoring results of paired sub-basins will indicate that timber harvest activities have no measurable impact on populations of the covered amphibians.

2. Estimates of the occurrence of tailed frogs and southern torrent salamanders will be at least 75 and 80%, respectively, in Plan Area Class II watercourses (Diller and Wallace 1996 and 1999).

6.1.2.2.4 Sediment Objective

The biological objective for reducing management-related sediment delivery into watercourses is based on two targets:

1. Treat some of the high and moderate priority sites (classified in terms of likelihood to deliver sediment to Plan Area watercourses), to reduce the amount of road-related sediment at such sites by more than 46% (change high and moderate potential delivery sites to low potential delivery sites) within the first 15 years of the Permits, and the remaining percentage over the last 35 years of the Permits.

2. Achieve a 70% reduction in sediment delivery from management-related landslides in harvested steep streamside slopes compared to delivery volumes from appropriate reference areas within clearcut stands.

6.1.2.2.5 Monitoring and Adaptive Management Objective

The biological objective for monitoring and adaptive management will be to measure detectable changes in biological conditions so as to make appropriate adjustments to the Operating Conservation Program.

6.2 GREEN DIAMOND'S OPERATING CONSERVATION PROGRAM

Based upon the biological goals and objectives, Green Diamond has developed a comprehensive conservation program with a number of specific conservation measures. These measures are termed the “Operating Conservation Program” and reflect all the binding, enforceable commitments Green Diamond will make to satisfy the requirements of ESA Section 10(a). The Operating Conservation Program will be incorporated by reference in the section of the IA that describes all Green Diamond’s conservation planning commitments that must be made and carried out to qualify for and comply with the ITP and ESP that Green Diamond is seeking. Section 6.3, which follows, provides a supplement to the Operating Conservation Program, with a detailed discussion of the background, rationale, and intent of the measures. Section 6.3 is not an expressed element of the Operating Conservation Program but is intended to guide its implementation.

Pursuant to the Operating Conservation Program, Green Diamond will undertake the following measures on its fee-owned lands and the 1,866 acres in which it owns perpetual harvesting rights granted by Simpson Timber Company on June 28, 2002 within the Plan Area during the term of the Plan and Permits.

In all areas where Green Diamond holds perpetual harvesting rights in the Initial Plan Area, with the exception of the above-referenced 1,866 acres granted on June 28, 2002, and any Harvesting Rights areas added to the Plan Area over time, all measures will be implemented except as follows: 1) the road assessment and implementation plan measures (6.2.3.1 and 6.2.3.2) will not apply, and 2) routine road maintenance and inspection plan measures (6.2.3.9) will apply only where Green Diamond has exclusive road-use rights. Furthermore, when Green Diamond acquires Harvesting Rights and plans to make an election to add such areas to the Plan Area pursuant to IA Paragraph 11.2, Green Diamond will use its best efforts to enter into an agreement with the fee owner to allow for the application of the road assessment and implementation plan measures (6.2.3.1 and 6.2.3.2) on such lands and, if successful, will apply these measures in such Harvesting Rights areas. Where Green Diamond does not have exclusive road-use rights in a Harvesting Rights area, Green Diamond will conduct road maintenance and inspection activities in accordance with existing FPRs and Green Diamond's management policies and practices. Harvesting Rights acreage with exclusive road-use rights added to or deleted from the Plan Area pursuant to the IA will be taken into account for purposes of the annual adjustments made pursuant to 6.2.3.2.1#4.

Regarding roads that are subject to Road Access Rights and included in the Plan Area pursuant to Section 1.3.2.1 and Implementation Agreement Paragraph 3.11.1, Green Diamond will conduct the assessment of road-related sediment sources for existing roads pursuant to 6.2.3.1.1-6.2.3.1.4 where the fee owner allows Green Diamond to do so, and Green Diamond will report the results of the assessment to the Services. Green Diamond will apply the routine road maintenance and inspection plan measures (6.2.3.9) on such roads only where Green Diamond has exclusive road-use rights. Where Green Diamond does not have exclusive road-use rights in a Harvesting Rights area, Green Diamond will conduct road maintenance and inspection activities in accordance with existing FPRs and Green Diamond's management policies and practices. Furthermore, Green Diamond will apply the following specified measures relating to time of year restrictions (6.2.3.4.1- 6.2.3.4.3), design flow (6.2.3.4.5 #1-3), washed out or replacement culverts (6.2.3.4.7), reshaping (6.2.3.4.8), new road construction standards (6.2.3.5), drainage structures (6.2.3.6), erosion control measures (6.2.3.8) and road and landing use limitations (6.2.3.11). Green Diamond will not apply the remainder of the measures of section 6.2 to these roads, and the acreage of such roads will not be taken into account for purposes of the accelerated road implementation plan and the annual adjustments made pursuant to 6.2.3.2.1#4.

6.2.1 Riparian Management Measures

6.2.1.1 Class I RMZ Width

1. Green Diamond will apply a riparian management zone (RMZ) of at least 150 feet (slope distance) on each bank of all Class I watercourses. The width will be measured from the watercourse transition line or from the outer Channel Migration Zone (CMZ) edge where applicable.

2. Where the floodplain is wider than 150 feet on one side, the outer zone of the RMZ will extend to the outer edge of the floodplain. An additional buffer will be added to the RMZ immediately adjacent to a floodplain, as follows:

Side Slopes	Additional Floodplain Buffer
0-30%	30 feet
30-60%	40 feet
>60%	50 feet

6.2.1.1.1 Inner Zone RMZ Width

Green Diamond will establish an inner zone within the RMZ, the width of which will depend upon the streamside slope in accordance with the following:

Side Slopes	Inner Zone Width
0-30%	50 feet
30-60%	60 feet
>60%	70 feet

6.2.1.1.2 Outer Zone RMZ Width

Green Diamond will establish an outer zone of the RMZ within the RMZ, which will extend from the outside limit of the inner zone edge to at least 150 feet from the bankfull channel (or CMZ edge) with the additional floodplain buffer set forth above.

6.2.1.2 Conservation Measures within Class I RMZs

During the life of the Plan, Green Diamond will carry out only one harvest entry into Class I RMZs, which will coincide with the even-aged harvest of the adjacent stand. Green Diamond will apply the restrictions in this subsection of Section 6.2.1.2 during such entry. If cable corridors through RMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the RMZs will be limited to cable corridors only. Any cable roads established in the RMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stands. These Class I RMZs will be subject to the restrictions identified in Section 6.2.1.2.

6.2.1.2.1 Overstory Canopy Closure

1. Green Diamond will retain at least 85% overstory canopy closure within the inner zone.

2. At least 70% canopy overstory closure will be retained within the outer zone.

3. CDF protocol in effect as of the date of the Plan will be used for sampling overstory canopy cover to determine compliance with the overstory canopy closure requirements.

6.2.1.2.2 Retention Based on Bank Stability

1. Within the RMZ, Green Diamond will harvest no trees that contribute to maintaining bank stability.

2. Redwoods will be preferentially harvested over other conifers.

6.2.1.2.3 Conifer Density Requirements

1. If the inner zone is predominantly composed of hardwoods (it contains less than 15 conifer stems per acre that are greater than 16 inches dbh), Green Diamond will take no conifers from the inner zone.

2. No harvesting within the RMZ will be undertaken that would reduce the conifer stem density within the RMZ to less than 15 conifer stems that are greater than 16 inches dbh per acre.

6.2.1.2.4 Retention Based on Likelihood to Recruit

The following criteria will be used to identify trees within the RMZ as potential candidates for marking to harvest due to their low likelihood of recruitment to the watercourse. (The determination of trees to be marked within the RMZ will be predicated on ensuring that overstory canopy retention standards and slope stability measures are met (See Sections 6.2.1 and 6.2.2), as well as ensuring that trees that are likely to recruit to the watercourse are not marked for harvest.)

Criteria for trees that have a low likelihood of recruiting are:

1. Tree has an impeded “fall-path” to the stream (e.g., upslope family members of a clonal group blocked by downslope stems); or

2. Tree or the majority of the crown weight of the tree is leaning away from stream and the tree is not on the stream bank or does not have roots in the stream bank or stream; or

3. The distance of the tree to the stream is greater than the height of the tree; or

4. Tree is on a low gradient slope such that gravity would not carry the fallen tree into the stream or objects such as trees and large rocks impede its recruitment path; or

5. Tree is not on an unstable area or immediately downslope of an unstable area; or

6. Harvesting of the tree will not compromise the stream bank or slope stability of the site or directly downslope of the site.

6.2.1.2.5 *Tree Falling for Safety Purposes*

Trees may be felled within RMZs to create cable yarding corridors as needed to ensure worker safety, subject to the canopy closure requirements set forth above. Such trees will be part of the harvest unit. This measure supercedes Section 6.2.1.2.4 (retention based on likelihood to recruit) when required by law.

6.2.1.2.6 *Equipment Exclusion Measures*

The Class I RMZ is an equipment exclusion zone (EEZ), except for a) existing roads and landings; b) construction of new spur roads to extend operations outside the RMZ; c) road watercourse crossings; d) skid trail watercourse crossings; and e) designated skid trail intrusions.

The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

1) Construction and use of skid trail watercourse crossings within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the RMZ over establishing new skid trail watercourse crossing sites in the RMZ.

2) Skid trail watercourse crossings shall not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

3) Within the Class I RMZ, trees may be felled to facilitate skid trail watercourse crossing construction and use. All such felled trees will be retained as downed wood in the RMZ and will be counted towards estimated reductions in full tree equivalent (FTE) values and reductions in potential recruitment of LWD.

4) Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

The exception for skid trail intrusions is only applicable when the following conditions are met:

1. RMZ hillslopes are less than 25%.

2. Construction and use of skid trails within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trails in the RMZ over construction of new skid trails in the RMZ.

3. Skid trails will not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

4. Within the RMZ, only trees less than 10 inches in dbh may be felled to facilitate skid trail use. All such felled trees will be retained as downed wood in the RMZ and will be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

5. Green Diamond has submitted to the Services an explanation, justification, and map of the proposed skid trail and use in the RMZ as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.1.2.7 Management-related Ground Disturbance Treatment

1. Any ground disturbance caused by management activities that is larger than 100 square feet within an RMZ will be mulched and seeded or otherwise treated to reduce the potential for sediment delivery from sheet and gully erosion.

2. Minimum standards for seeding and mulching operations are 30 pounds per acre of seed and a minimum mulching depth of two inches, covering at least 90% of the surface area.

3. Hand-constructed firelines (established by removing the duff and litter layers to expose, but not disturb, the mineral soil) will not be subject to the 100-square foot ground disturbance standard, but other measures will be applied as necessary to ensure that hand-constructed firelines within a Class I RMZ do not deliver sediment to Class I watercourses.

6.2.1.2.8 Snag Retention Measures

Green Diamond will retain all safe snags within the RMZ, and fall and leave unsafe snags on-site.

6.2.1.2.9 Inner Zone Salvage

Green Diamond will not carry out salvage within the inner zone of the Class I RMZ. If any part of the salvageable piece is in the inner zone, the entire piece will be left.

6.2.1.2.10 Floodplain or CMZ Salvage

Green Diamond will not carry out salvage within an identified floodplain or CMZ.

6.2.1.2.11 Outer Zone Salvage

Within the outer zone of the Class I RMZ Green Diamond will conduct salvage operations only of downed trees and if all of the following criteria is met:

1. The wood is not currently, and is unlikely in the future to be, incorporated into the bankfull channel (including wood located below unstable areas);

2. The wood is not contributing to bank or slope stability; or

3. The wood is not positioned on a slope such that it can act to intercept sediment moving toward the stream.

6.2.1.3 Class II RMZ Width

1. Green Diamond will establish an RMZ of at least 75 or 100 feet on each bank of all Class II watercourses.

2. A 75-foot minimum buffer will be used on the first 1,000 feet of 1st order Class II watercourses (Class II-1 watercourses). Downstream of this first 1000-foot section, the RMZ will be expanded to at least 100 feet.

3. A 100-foot minimum buffer will be used on all 2nd order or larger Class II watercourses (Class II-2 watercourses).

6.2.1.3.1 <u>Inner Zone RMZ Width</u>

Green Diamond will establish an inner zone within the RMZ, the width of which will be 30 feet measured from the first line of perennial vegetation.

6.2.1.3.2 <u>Outer Zone RMZ Width</u>

Green Diamond will establish an outer zone of the RMZ within the RMZ, which will extend the remaining 45 feet or 75 feet (depending on whether it is a Class II-1 watercourse or a Class II-2 watercourse, respectively).

6.2.1.4 Conservation Measures within Class II RMZs

During the life of the Plan, Green Diamond will carry out only one harvest entry into Class II RMZs, which will coincide with the even-aged harvest of the adjacent stand. Green Diamond will apply the restrictions in this subsection of Section 6.2.1.4 during such entry. If cable corridors through RMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the RMZs will be limited to the cable corridors only. Any cable roads established in the RMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stand. These Class I RMZs will be subject to the restrictions identified in Section 6.2.1.4.

6.2.1.4.1 <u>Overstory Canopy Closure</u>

1. Green Diamond will retain at least 85% overstory canopy closure within the inner zone.

2. At least 70% overstory canopy closure will be retained within the outer zone.

6.2.1.4.2 <u>Retention Based on Bank Stability</u>

Within the RMZ, Green Diamond will harvest no trees that contribute to maintaining bank stability. Redwoods will be preferentially harvested over other conifers.

6.2.1.4.3 *Retention Based on Likelihood to Recruit*

Riparian management zones along the first 200 feet of the Class II RMZ adjacent to the Class I RMZ will be subject to the same criteria that are listed in section 6.2.1.2.4 to determine possible candidate trees for marking due to their low likelihood of recruitment.

6.2.1.4.4 *Tree Falling for Safety Purposes*

Trees may be felled within RMZs to create cable yarding corridors as needed to ensure worker safety, subject to the canopy closure requirements set forth above. Such trees will be part of the harvest unit.

6.2.1.4.5 *Equipment Exclusion Measures*

The Class II RMZ is an EEZ, except for a) existing roads and landings; b) construction of new spur roads to extend operations outside the RMZ; c) road watercourse crossings; d) skid trail watercourse crossings; and e) designated skid trail intrusions.

The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

1. Construction and use of skid trail watercourse crossings within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the RMZ over establishing new skid trail watercourse crossing sites in the RMZ.

2. Skid trail watercourse crossings shall not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

3. Within Class II-1 RMZs, trees may be felled and harvested to facilitate skid trail watercourse construction and use. All harvested trees will be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

4. Within Class II-2 RMZs, trees may be felled to facilitate skid trail watercourse crossing construction and use. All such felled trees shall be retained as downed wood in the RMZ and shall be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

5. Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

The exception for skid trail intrusions is only applicable when the following conditions are met:

1. RMZ hillslopes are less than 25%.

2. Construction and use of skid trails within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trails in the RMZ over construction of new skid trails in the RMZ.

3. Skid trails will not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

4. Within the RMZ, only trees less than 10 inches in dbh may be felled to facilitate skid trail use. All such felled trees shall be retained as downed wood in the RMZ and shall be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

5. Green Diamond has submitted to the Services an explanation, justification, and map of the proposed skid trail and use in the RMZ as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.1.4.6 *Management-related Ground Disturbance Treatment*

1. Green Diamond will mulch and seed any area where ground disturbance caused by management activities is larger than 100 square feet within a Class II RMZ, or otherwise treat the area to reduce the potential for sediment delivery from sheet and gully erosion.

2. Minimum standards for seeding and mulching operations are 30 pounds per acre of seed and a minimum mulching depth of two inches, covering at least 90% of the surface area.

3. Hand-constructed firelines (established by removing the duff and litter layers to expose, but not disturb, the mineral soil) will not be subject to the 100-square foot ground disturbance standard, but other measures will be applied as necessary to ensure that hand-constructed firelines within a Class II RMZ do not deliver sediment to Class II watercourses.

6.2.1.4.7 *Snag Retention*

Green Diamond will retain all safe snags within the RMZ, and will fall unsafe snags and leave them onsite.

6.2.1.4.8 *Inner Zone Salvage*

Green Diamond will not conduct salvage on downed trees within the inner zone. If any part of the salvageable piece is in the inner zone, the entire piece will be left.

6.2.1.4.9 *Outer Zone Salvage*

Green Diamond will carry out salvage operations within the outer zone only of downed trees and if all of the criteria listed in 6.2.1.2.11 are met.

6.2.1.5 Class III Protections

Green Diamond will apply one of two tiers of protection measures within Class III watercourses in accordance with HPA Groups and slope gradient (the average slope as measured with a clinometer, starting from the watercourse bank and running upslope for a distance of 50 feet), as follows:

HPA Group	Slope Gradient
Smith River	<65%=Tier A
	>65%=Tier B
Coastal Klamath	<70%=Tier A
	>70%=Tier B
Korbel	<65%=Tier A
	>65%=Tier B
Humboldt Bay	<60%=Tier A
	>60%=Tier B

6.2.1.6 Class III Tier A Protection Measures

6.2.1.6.1 Equipment Exclusion Zone

Green Diamond will establish a 30-foot EEZ, except for a) existing roads; b) road watercourse crossings; and c) skid trail watercourse crossings.

The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

1. Construction and use of skid trail watercourse crossings within the Class III EEZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the Class III over establishing new skid trail watercourse crossing sites in the Class III.

2. Within Class III EEZs, trees may be felled and harvested to facilitate skid trail watercourse crossing construction and use.

3. Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.1.6.2 LWD Retention

Green Diamond will retain all LWD on the ground (not including felled trees) within the EEZ.

6.2.1.6.3 Site Preparation

Green Diamond will not ignite fire during site preparation within the EEZ.

6.2.1.7 Class III Tier B Protection Measures

6.2.1.7.1 Equipment Exclusion Zone

Green Diamond will establish a 50-foot EEZ, except for a) existing roads; b) road watercourse crossings; and c) skid trail watercourse crossings.

The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

1. Construction and use of skid trail watercourse crossings within the Class III EEZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the Class III over establishing new skid trail watercourse crossing sites in the Class III.

2. Within Class III EEZs, trees may be felled and harvested to facilitate skid trail watercourse crossing construction and use.

3. Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.1.7.2 Hardwood Retention

Green Diamond will retain all hardwoods and nonmerchantable trees within the EEZ except where necessary to create cable corridors or for the safe falling of merchantable trees.

6.2.1.7.3 Site Preparation

Green Diamond will not ignite fire during site preparation within the EEZ.

6.2.1.7.4 Conifer Retention

1. Green Diamond will retain conifers where they contribute to maintaining bank stability or if they are acting as a control point in the channel.

2. A minimum average of one conifer 15 inches dbh or greater per 50 feet of stream length within the EEZ will be retained.

6.2.1.7.5 LWD Retention

Green Diamond will retain all LWD on the ground (not including felled trees) within the EEZ.

6.2.1.8 Mapping of Unique Geomorphic Features

6.2.1.8.1 *Floodplains*

1. Green Diamond will map all floodplains of Class I watercourses within the Plan Area within five years after the Permits' effective date. For any lands added to the Plan Area after the end of the third year, Green Diamond will complete mapping within two years of the addition.

2. Any sites that show the potential attributes of a floodplain based on geographic information system (GIS) analysis will be further analyzed using aerial photographs, maps, and historic field information.

3. The final determination of the boundaries of all floodplains within the Plan Area will be based on field verification with the oversight of a team of experts that may include a hydrologist, fluvial geomorphologist, geologist, and fisheries biologist representing the Green Diamond and the Services.

4. Following field verification, the floodplains (with any additional buffers as provided in 6.2.1.1) will be flagged in the field and mapped on Green Diamond's GIS.

6.2.1.8.2 *CMZs*

1. Green Diamond will map all CMZs of Class I watercourses within the Plan Area within five years after the Permits' effective date. For any lands added to the Plan Area after the end of the third year, Green Diamond will complete mapping within two years of the addition.

2. Any sites that show the potential attributes of a CMZ based on GIS analysis will be further analyzed using aerial photographs, maps, and historic field information.

3. The final determination of the boundaries of all CMZs within the Plan Area will be based on field verification with the oversight of a team of experts that may include a hydrologist, fluvial geomorphologist, geologist, and fisheries biologist representing the Green Diamond and the Services.

4. Following field verification, the CMZs will be flagged in the field and mapped on Green Diamond's GIS.

6.2.2 Slope Stability Measures

Implementation of the Plan involves and requires close coordination and cooperation between registered professional foresters (RPFs) and professional geologists (PGs) who will work together to accomplish the designated tasks. Any Covered Activities that involve geologic issues and require the expertise of a PG would need to be carried out by, or occur under the supervision of, a PG as required by California law. See Business and Professions Code §§7800 *et seq*. These provisions apply within the Plan Area regardless of Plan approval and permit issuance.

6.2.2.1 Steep Streamside Slopes

6.2.2.1.1 Identification

During THP layout, Green Diamond will identify all steep streamside slopes leading to Class I or II watercourses with the following characteristics within the proposed THP area:

HPA Group	HPAs	Initial Slope Gradient
Smith River	Smith River	Greater or equal to 65%
Coastal Klamath	Coastal Klamath Blue Creek	Greater or equal to 70%
Korbel	Mad River North Fork Mad River Little River Coastal Lagoons Redwood Creek Interior Klamath	Greater or equal to 65%
Humboldt Bay	Humboldt Bay Eel River	Greater or equal to 60%

6.2.2.1.2 Initial Default Slope Distance

Where steep streamside slopes have been identified within the THP area, Green Diamond will create a Steep Streamside Slope (SSS) zone with the following initial default maximum widths:

	SSS Zone Slope Distance from Watercourse Transition Line (feet)		
HPA Group	Class I	Class II-2	Class II-1
Smith River	150	100	75
Coastal Klamath	475	200	100
Korbel	200	200	75
Humboldt Bay	200	200	75

6.2.2.1.3 SSS Outer and Inner Zone Distances

1. The SSS zone will be comprised of an inner zone (Riparian Slope Stability Management Zone [RSMZ]) and an outer zone (Slope Stability Management Zone [SMZ]).

2. The width of the RSMZ will be the same as the applicable RMZ set forth in 6.2.1.1, except where a qualifying slope break exists within that distance the RSMZ may only extend to the slope break. A “qualifying slope break” is an interruption of slope gradient of sufficient degree and scale to reasonably impede sediment delivery to watercourses from shallow landslides originating above the slope break.

3. The width of the SMZ will be either the remainder of the distance to the default maximum SSS distance for that HPA or to a qualifying slope break, whichever is shorter.

6.2.2.1.4 RSMZ Inner and Outer Zone Distances

1. The RSMZs will be comprised of an inner zone and an outer zone.

2. The inner zone of RSMZs on all Class I watercourses will be 70 feet, except where a qualifying slope break exists within that distance the RSMZ inner zone may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.

3. The inner zone of RSMZs on all Class II watercourses will be 30 feet, except where a qualifying slope break exists within that distance then the RSMZ inner zone may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance.

6.2.2.1.5 Prescriptions for RSMZs in Coastal Klamath and Blue Creek HPAs

In the Coastal Klamath and Blue Creek HPAs, Green Diamond will not conduct harvesting in RSMZs.

6.2.2.1.6 Prescriptions for RSMZs in All HPAs except Coastal Klamath and Blue Creek

1. On Class I and Class II-2 watercourses, Green Diamond will not conduct harvesting on the inner zone of the RSMZ and there will be 85% overstory canopy retention in the outer zone of the RSMZ.

2. On Class II-1 watercourses, Green Diamond will retain 85% overstory canopy in the inner zone of the RSMZ and 75% overstory canopy in the outer zone of the RSMZ.

6.2.2.1.7 Default Prescriptions for SMZs

1. The silviculture prescription employed within SMZs will be single tree selection, as that term is defined in the Glossary of the Plan.

2. Even spacing of unharvested trees will be provided where the trees are available to allow it, and all hardwoods will be retained. All species and size classes represented in pretreatment stands will be represented post harvest where feasible.

3. If cable corridors through SMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the SMZs will be limited to cable corridors only. Any cable roads established in the SMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stands. The SMZs will be subject to the restrictions identified in Section 6.2.2.1.

4. Where no SMZ is identified, the standard default prescriptions for RMZs will apply.

6.2.2.1.8 Tree Falling for Safety and Cable Yarding

Green Diamond may fall trees within RSMZs and SMZs for worker safety and to create cable yarding corridors of up to 25 feet in width.

6.2.2.1.9 Road Construction

Green Diamond's road construction will avoid RSMZs and SMZs where feasible. Where such zones cannot be avoided or where major road reconstruction is required, the road alignment within a RSMZ or SMZ will be evaluated by a PG and a RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.2.2 Headwall Swales

6.2.2.2.1 Identification

During THP layout, Green Diamond will identify all headwall swales within the proposed THP area based primarily on field observations by trained and qualified personnel of slope qualities that are characteristic of the landform. Field review of headwall swale areas will focus on slope characteristics that are considered at present to be most important to landslide processes in such areas. These characteristics include slope steepness (typically greater than 70%) of the slopes, slope composition and structure, slope and soil drainage characteristics, the appearance of a concave or inverted teardrop- or spoon-shaped slope, the relative degree of slope convergence, the presence of a build-up of colluvium or a thick colluvial mantle, various vegetative indicators, and the apparent landslide history of the site and similar sites in the area. Perhaps the most important physical characteristic of a headwall swale is its location at the headwaters of a watercourse. Green Diamond will use the SHALSTAB computer model analysis (>1/4 ac) using a 10m DEM or better and a q/T less than or equal to –2.8) as a screening tool to identify areas that may be more likely to contain headwall swales than the general landscape.

6.2.2.2.2 Default Prescription

The default prescription for headwall swales is uniform across the Plan Area and is not subject to adaptive management.

6.2.2.2.3 Silvicultural Prescription

1. The silviculture prescription employed on a field verified headwall swale will be single tree selection (as defined in the Glossary of the Plan).

2. Even spacing of unharvested trees will be provided where the trees are available to allow it, and all hardwoods will be retained.

3. All species and size classes represented in pretreatment stands will be represented post harvest where feasible.

4. There will be only one harvesting entry in headwall swales during the term of the Permits.

6.2.2.2.4 *Tree Falling for Safety and Cable Yarding*

Green Diamond may fall trees on a field verified headwall swale for worker safety and to create cable yarding corridors of up to 25 feet in width.

6.2.2.2.5 *New Road Construction*

Green Diamond's new road construction will avoid field-verified headwall swales where feasible. Where such areas cannot be avoided or where road reconstruction is required, the terrain will be evaluated by a PG and RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.2.3 Deep-Seated Landslides

6.2.2.3.1 *Identification*

All active deep-seated landslides identified by RPFs within the proposed THP area that meet one of the following two criteria will trigger the conservation measures identified in this subsection:

- First Criterion: A scarp or ground crack that exhibits at least three inches of horizontal displacement or at least six inches of vertical displacement that typically exposes bare mineral soil, but that may be partially revegetated, and where field observations clearly indicate that the movement occurred within approximately the past 100 years; or

- Second Criterion: A convex, lobate landslide toe that exhibits indicators of instability that can be interpreted based on ground conditions or forest stand characteristics to have been active within approximately the past 100 years.

6.2.2.3.2 *Default Prescription for Active Deep-seated Landslides*

1. Where neither criterion in 6.2.2.3.1 is exhibited, other conservation measures in the Plan may apply and the California FPRs will apply, but no default prescription will be required. The California FPRs will also apply to all parts of deep-seated landslides.

2. The default prescription for deep-seated landslides is uniform across the Plan Area and is not subject to adaptive management.

6.2.2.3.3 *Harvesting near Active Deep-seated Landslides Identified by the First Criterion*

Where an active deep-seated landslide exhibits the first criterion stated in 6.2.2.3.1, Green Diamond will not harvest within 25 feet upslope from the identified scarp or ground crack.

6.2.2.3.4 Harvesting near Active Deep-seated Landslides Identified by the Second Criterion

Where an active deep-seated landslide exhibits the second criterion stated in 6.2.2.3.1, Green Diamond will not harvest on the toe or within 25 feet upslope from the inflection point of the convex, lobate landslide toe.

6.2.2.3.5 Tree Falling for Safety and Cable Yarding

Green Diamond may fall trees on active deep-seated landslides for worker safety and to create cable yarding corridors of up to 25 feet in width.

6.2.2.3.6 New Road Construction

Green Diamond will not construct new roads across active deep-seated landslide toes or scarps, or on steep (greater than 50% gradient) areas of dormant slides, without approval by a PG and a RPF with experience in road construction in steep forested terrain.

6.2.2.4 Shallow Rapid Landslides

This conservation measure will apply only to field-verified individual shallow rapid landslides that are at least 200 square feet in plan view and that observably delivered sediment to a watercourse or exhibit indicators of instability with the potential to deliver sediment directly to a watercourse. This conservation measure will not apply to road related failures. Road related failures will be addressed by the road maintenance plan.

1. The default prescription for landslides that do meet the above listed criteria will be no cut within the landslide boundaries, and a minimum of 70% overstory canopy within 50 feet above a slide and 25 feet on the sides of a slide. Site-specific geologic review of this default prescription, pursuant to Sections 6.2.2 and 6.3.2, may result in an alternative prescription for shallow rapid landslides.

2. Green Diamond's new road construction will avoid landslides that meet the above listed criteria where feasible. Where such areas cannot be avoided or where major road reconstruction is required, the terrain will be evaluated by a PG and RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.2.2.5 Training

1. RPFs writing timber harvesting plans for Green Diamond will be trained to address issues relating to the conservation measures set forth in 6.2.2.

2. The training will be administered by a qualified California PG or a Certified Engineering Geologist (CEG).

6.2.2.6 Application of Prescriptions and Alternatives

1. During THP development, Green Diamond's RPF will do one of the following when he or she determines that any portion of the THP meets the steep streamside slope, headwall swale, or deep-seated landslide definitions:

   a. Impose the default prescription applicable to that feature as set forth above, or

   b. Retain a California PG to:

      1) Evaluate the likelihood that timber harvest operations will cause, or significantly elevate, the risk of causing or reactivating landslides within the prescription zone that will likely result in sediment delivery to watercourses; and

      2) Work with the RPF to prepare a more cost-effective, site-specific alternative to the default prescription designed to minimize that likelihood, which will have the benefit of minimizing and mitigating potentially significant impacts on the Covered Species from sediment delivery resulting from landslides caused or exacerbated by timber harvest operations.

2. A qualified biologist will be involved in evaluating the potential biological consequences whenever a more cost-effective alternative to the default prescription is proposed.

3. The alternative to the default prescription may be applied to any SMZ (except an RSMZ), field verified headwall scarp, or deep-seated landslide.

4. THPs for which a geologic report was prepared and the conclusions of which allowed for alternatives to replace the default prescriptions will be flagged as such when submitted for review by CDF and other agencies. A THP map and letter of notice that describes the alternative to replace the default prescriptions will be sent to the Services when a THP with such an alternative is proposed.

6.2.3 Road Management Measures

6.2.3.1 Road Assessment Process and Priority for Repair

6.2.3.1.1 <u>Road-related Sediment Source Identification</u>

Green Diamond will identify road-related sediment sources in accordance with the sub-watershed road work unit (RWU) priority set forth in this subsection for the Lower Klamath River basin and the rest of the Plan Area.

6.2.3.1.2 <u>Aerial Photo Analysis and Maps</u>

1. Green Diamond will conduct an analysis of historical aerial photos to identify all the roads that were constructed in each watershed.

2. When possible, photographic coverage from a number of years will be selected to "bracket" major storms in the watershed.

3. From the information gained in the photo analysis, detailed land use and erosion history maps, including road location and road construction history, will be developed.

6.2.3.1.3 Field Inventories

1. Green Diamond will conduct field inventories to identify and quantify road-related sediment sources. During the field assessment, aerial photographs will be used to record the location of each road feature that exhibits potential to deliver sediment to a stream.

2. A data form will be completed for each potential sediment delivery site, and the data form will be stored in a database.

6.2.3.1.4 Documentation of Fish-passage Problems

Green Diamond will document any potential fish passage problems, including culverts that are impeding fish passage, during the field inventory.

6.2.3.1.5 Development of Prescriptions for Erosion Control and Prevention

Green Diamond will develop a prescription for erosion control and erosion prevention for each source of treatable erosion that is field-identified. The prescription for each site will involve temporary or permanent decommissioning, or road upgrading for Green Diamond's Management Road system, and will include the following kinds of information:

- types of equipment needed
- equipment hours
- need for armoring
- diversion potential
- hand labor for culvert installation
- downspouts
- seeding and mulching
- estimated costs for each work site
- estimate of expected sediment savings

Road Work Unit Prioritization for the Plan Area, excluding the Lower Klamath Basin

Sub-watershed Road Work Units		Ranking				Total	Rank
		Covered Species Occurrence	Habitat Quality	Slope Risk	Watercourse Crossing Risk		
	(area included)	High=6	High=6	High=6	High=6	High=24	
South Little River	(Upper S.F., Lower S.F., S.F, Bullwinkle, Mainstem Little River)	6	5	4.67	6.00	21.67	**1**
S. F. Winchuck	(S.F. Winchuck)	6	5	4.80	5.37	21.16	**2**
Rowdy	(Rowdy, S.F. Rowdy, Ravine, Savoy)	6	5	4.07	5.35	20.44	**3**
Wilson	(Wilson)	6	4	5.30	4.69	20.00	**4**
Long Prairie	(Canyon, Railroad, Mule, Long Prairie, Pollock, Bald Mtn., Jiggs, Hatchery, Sullivan, Watek)	6	5	3.87	4.47	19.34	**5**
Maple Creek	(Gray, Beach, M-Line, Clear)	6	4	3.90	5.16	19.06	**6**
North Little River	(Water, Freeman, Railroad)	6	3	4.36	5.00	18.36	**7**
Dominie	(Dominie, Ritmer, Lopez, Gilbert)	5	4	3.66	5.22	17.88	**8**
Jacoby Creek	(Jacoby Creek, Cloney, Washington, Rocky, Janes)	6	2	4.44	5.13	17.57	**9**
Lindsay Creek	(Powers, Mill, Hall, Lindsay, Essex, Mill, Widow White, Strawberry)	4	4	4.15	5.27	17.42	**10**
Dry Creek	(Devil, Dry, Blackdog, Boundary, Putter, Quarry)	4	3	5.47	4.91	17.38	**11**
Salmon Creek	(Salmon Creek)	5	3	4.58	4.70	17.28	**12**
Panther Creek	(Panther, Coyote)	5	4	3.98	3.98	16.96	**13**
Ryan Creek	(Ryan Creek et al.)	4	3	4.56	5.06	16.62	**14**
N.F. Maple Creek	(Diamond, Pitcher, N.F. Maple)	6	4	2.32	3.89	16.21	**15**
Canon Creek	(Maple, Simpson, Cañon, Vincent)	5	2	4.55	4.53	16.08	**16**
East Little River	(Mainstem above barrier)	4	4	3.54	4.49	16.03	**17**
Gossinta	(Krueger, Jackson, Denman, Gossinta, Poverty)	4	2	4.71	4.87	15.59	**18**
Basin	(Dolf, Tyson, East Fork North Fork)	4	3	3.47	4.48	14.95	**19**
Goose	(Goose)	4	3	4.04	3.74	14.78	**20**
Little Mill	(Peacock, Sultan, Little Mill, Hutsinpillar, Tryon, Camp Six, Fort Dick)	4	3	3.69	3.99	14.68	**21**
Eel/VanDuzen	(Eel/VanDuzen et al.)	3	1	4.78	4.62	13.39	**22**
Noisy Creek	(Noisy, Lake Prairie, Pardee, Snow Camp)	4	3	2.68	3.16	12.84	**23**
McDonald Creek	(McDonald)	4	2	2.95	3.85	12.80	**24**
Dolly Varden	(Dolly Varden, Toss-up, Lupton)	3	3	2.92	3.58	12.50	**25**
Joe Marine	(Aikens, Joe Marine, Cananaugh, Gist, Bens, Burrill, Pine, Devil, Cappell)	3	3	2.91	2.86	11.77	**26**
Coastal Tribs	(Burris, McNeil, Mill, McConnahas, Luffenholtz)	2	2	3.10	4.36	11.47	**27**
Boulder Creek	(Madrone, Graham, Goodman, Boulder)	3	1	2.96	3.27	10.22	**28**

Lower Klamath River Basin Road Work Unit Prioritization

Sub-Basin	Diversity (1-5)	Importance (1-5)	Condition (1-5)	Connectivity (1-5)	Density (1-5)	Density (1-5)	Total (1-30)	Rank (1-30)
Mainstem Blue Creek	5	5	5	5	2	2	24	1
Crescent City Fork	5	5	5	5	1	1	22	2
Terwer Creek	5	5	4	3	2	2	21	3
Tectah Creek	4	5	3	3	2	3	20	4
McGarvey Creek	4	4	3	4	3	2	20	5
Mettah Creek	4	4	3	4	2	2	19	6
South Fork Ah Pah	3	3	2	2	4	5	19	7
West Fork Blue Creek	3	3	3	4	2	3	18	8
Mainstem Ah Pah	3	3	2	2	5	3	18	9
Roaches Creek	3	3	3	3	2	3	17	10
Hunter Creek	5	4	2	2	2	2	17	11
Hoppaw Creek	4	3	2	1	3	3	16	12
Nickowitz Creek	2	3	4	4	1	1	15	13
North Fork Ah Pah	3	2	3	3	2	2	15	14
Bear Creek	3	2	2	2	3	3	15	15
Johnsons Creek	4	3	2	2	2	2	15	16
Pine Creek	3	3	3	3	1	1	14	17
Pecwan Creek	3	2	3	2	2	2	14	18
Tully Creek	1	3	3	3	2	2	14	19
Slide Creek	1	3	4	4	1	1	14	20
Surpur Creek	3	1	1	2	4	3	14	21
Tarup Creek	4	2	2	1	3	2	14	22
Cappell Creek	1	2	3	2	2	2	12	23
Waukell Creek	2	1	1	1	4	3	12	24
High Prairie Creek	2	1	3	1	2	2	11	25
Salt Creek	2	2	2	2	2	1	11	26
Morek Creek	1	1	3	2	2	2	11	27
Little Surpur Creek	1	1	1	2	3	3	11	28
Omagaar Creek	3	1	2	1	2	2	11	29
Saugep Creek	2	1	1	2	3	2	11	30

6.2.3.1.6 Prioritization of Implementation of Treatment Prescriptions

Green Diamond will prioritize road-related sediment sources for treatment as "high," "moderate" or "low" based on a balancing of the following factors: (1) volume of future sediment delivery; (2) treatment immediacy; and (3) treatment cost-effectiveness.

6.2.3.2 Implementation Plan

1. Green Diamond will memorialize the prescriptions to be applied and the priority of application in an implementation plan.

2. Implementation will be carried out consistent with the Road Decommissioning Standards (6.2.3.3) and the Management Road Upgrading Standards (6.2.3.4).

3. Implementation of road treatment sites identified as "high" or "moderate" priority of all sites will be carried out during the term of the Permits.

6.2.3.2.1 Acceleration of Implementation Plan

1. Green Diamond will provide for an average of $2.5 million per year (to be inflation adjusted in 2002 dollars for each year of the acceleration period) for the first 15 years of the Permits' 50-year term (the "acceleration period") to implement the treatment of high and moderate priority sediment sites identified in the implementation plan, for a total of $37.5 million (unless the acceleration period is adjusted as provided in 6.2.3.2.3).

2. All funds provided by Green Diamond to treat high and moderate sites during the acceleration period, including high and moderate sites on roads appurtenant to THPs, will be counted toward the $2.5 million per year commitment.

3. During any of the first three years of the acceleration period, Green Diamond may provide for substantially more or less than $2.5 million, as long as a total of $7.5 million (inflation adjusted in 2002 dollars for each year) has been provided by the end of the three-year period.

4. On an annual basis the $2.5 million per year will be adjusted proportionally to reflect the current acreage of the Plan Area in relation to the acreage of the Initial Plan Area.

6.2.3.2.2 Five-year Assessment of Future Sediment Yield

1. At the end of the first five year period of the Permits, Green Diamond will refine its estimate of the amount (in cubic yards) of future sediment yield from high and moderate priority sites on roads owned by Green Diamond within the Plan Area.

2. For RWUs that have not yet been totally inventoried at the time of the five-year assessment, a stratified random sampling approach will be utilized: 15 to 20% of the roads will be sampled in 0.5-mile segments.

3. If the refined estimate is within 5% of the original estimate (i.e., is from 6,118,000 cubic yards to 6,762,000 cubic yards), then Green Diamond will continue to provide for $2.5 million per year for the remaining ten-year term of the acceleration period.

6.2.3.2.3 Revisions to Acceleration Period Based on Five-year Assessment

1. If the refined estimate is greater than 5% more than the original estimate of future sediment yield from high and moderate priority road sites, then the commitment to provide for $2.5 million per year for the remaining term of the acceleration period will be proportionally increased in 1% increments to add up to an additional 1.5 years to the acceleration period (i.e., Green Diamond will provide for up to $3.75 million more over an additional 1.5 years).

2. If the refined estimate is greater than 5% less than the original estimate of future sediment yield from high and moderate priority road sites, then the commitment to provide for $2.5 million per year for the remaining term of the acceleration period will be proportionately reduced in 1% increments to subtract up to 1.5 years from the acceleration period (i.e., Green Diamond will provide for up to $3.75 million less and the remaining acceleration period will be reduced by up to 1.5 years).

6.2.3.3 Road Decommissioning Standards

6.2.3.3.1 Time of Year Restrictions

1. Green Diamond will not carry out road decommissioning during the winter operating period (October 16th through May 14th), except that road decommissioning may occur from October 15th through November 15th if “unseasonably dry fall” occurs (less than four inches of cumulative rainfall from September 1st through October 15th) and the following occurs:

   a. Each project site is completed that operational day with erosion control measures installed; or

   b. If a site requires multiple days for completion, a long-range forecast of no rain for the next five days has been issued.

2. Sites that require multiple days for completion will not be started during the winter period unless there is an emergency situation. A situation is an ‘emergency’ for the purpose of this section if the elements of Section 6.2.3.11 are satisfied.

6.2.3.3.2 Watercourse Crossings

1. Green Diamond will remove fill from the stream channel on all watercourse crossings on decommissioned roads.

2. The excavation will extend down to the original channel bed, with the excavated channel at least as wide as the original channel.

3. The side slopes will be sloped back to the original or a stable angle and spoil material transported to a stable location.

4. Appropriate erosion control measures such as seeding and mulching will be utilized to prevent surface erosion at excavated crossings.

6.2.3.3.3 Road-related Unstable Areas

1. Green Diamond will pull back unstable or potentially unstable road or landing fill identified during the road assessment process and deposit spoil in a stable location.

2. Appropriate erosion control measures such as seeding and mulching will be utilized to prevent surface erosion at excavated unstable areas.

6.2.3.3.4 Road Surface Runoff

1. Green Diamond will establish maintenance-free surface drainage for temporarily and permanently decommissioned roads that are hydrologically disconnected from watercourses.

2. Inside ditches and springs and seeps will be properly drained with deep cross-drain ditches. Discharge from the ditches will not be directed onto unstable areas.

3. Localized outsloping will be utilized as necessary to adequately drain the road surface.

4. Permanently decommissioned roads will be ripped and planted with commercial tree species where appropriate to reestablish timber production.

6.2.3.3.5 Erosion Control

Green Diamond will perform seeding, mulching and planting, and installation of energy dissipation (rock armor or woody debris) when determined necessary by qualified and trained personnel for additional erosion control on the decommissioned roads to minimize erosion and prevent sediment from entering watercourses.

6.2.3.4 Management Road Upgrading Standards

6.2.3.4.1 Time of Year Restrictions

Green Diamond will not conduct road upgrading during the winter operating period, except as stated in 6.2.3.4.2 and 6.2.3.4.3.

6.2.3.4.2 Dry Fall

1. Road upgrading may occur from October 16th through November 15th if “unseasonably dry fall” occurs (less than four inches of cumulative rainfall from September 1st through October 15th), and the following restrictions are followed:

   a. Each project site is completed that operational day with erosion control structures installed; or

   b. If a site requires multiple days for completion, a long-range National Weather Service forecast of no rain for the next five days has been issued.

2. Sites that require multiple days for completion will not be started during the winter period unless there is an emergency situation. A situation is an ‘emergency’ for the purpose of this section if the elements of Section 6.2.3.11 are satisfied.

6.2.3.4.3 *Early Spring Drying*

Green Diamond may conduct road upgrading from May 1st through May 14th when “early spring drying” has occurred (no measurable rainfall occurred within the last 5 days and no rain forecasted by the National Weather Service for the next 5 days) and the following restrictions are followed:

1. Class I watercourse crossings will not be installed or replaced; and

2. Any other watercourse crossings where significant surface flows could prevent effective diversion of flow around the work site will not be installed or replaced; and

3. Erosion control supplies are retained on-site and applied to each completed site by the end of that operational day.

6.2.3.4.4 *Road Upgrading Methods*

Where road upgrading is the recommended treatment in the implementation plan, Green Diamond will follow the applicable location, design, timing, and construction standards of 6.2.3, the methods stated in 6.2.3.4.5 through 6.2.3.4.9, and be generally governed by the techniques described in Weaver and Hagans (1994) unless and until a more “state of the art” manual is published and mutually agreed upon by Green Diamond and the Services for application.

6.2.3.4.5 *Design Flow*

1. All culverted watercourse crossing replacements will be designed to handle a 100-year return interval flow event.

2. The design flow will be calculated using the Waananen and Crippen (1977) method for drainage areas greater than or equal to 80 acres. The Rational Method (Chow 1964) will be used when the drainage area for a crossing is less than 80 acres.

3. Culverts will be sized to pass the 100-year flow event without overtopping (HW/D = 1.0).

4. Culverts that are functioning properly but are undersized according to the standard might not be replaced if all of the following are true: (a) the existing culvert’s capacity is within 15% of the design flow, (b) the headwater depth to culvert diameter ratio at fill overtopping is greater than or equal to 2.0, and (c) the channel is not transporting significant amounts of sediment, based on information from road inventories or current observations.

5. Other flow design estimation methods developed in the future for the North Coast Region may be substituted if comparable.

6.2.3.4.6 Fish-bearing Watercourses

1. Green Diamond will install bridges on fish-bearing watercourses where feasible.

2. When a bridge installation is not feasible, a countersunk or bottomless culvert (or other fish-friendly structure) will be installed on grade that will provide upstream and downstream passage for all life stages of fish. Installed culverts will not restrict the active channel flow.

6.2.3.4.7 Washed Out or Replacement Culverts

1. Green Diamond will use the same installation standards for new roads when replacing washed out culverts, upgrading existing culverts, or replacing culverts on previously decommissioned roads.

2. Any buried logs or other large organic debris will be removed from the crossing fill.

6.2.3.4.8 Reshaping

1. Green Diamond will reshape the existing roadbed to assure proper surface drainage where necessary.

2. Reshaping is restricted to the time periods described for road upgrading except it will not be conducted during the early spring drying period (May 1st through May 14th).

6.2.3.4.9 Additional Ditch Relief Culverts

Green Diamond will install additional ditch relief culverts to meet the maximum spacing specifications of 6.2.3.6.12.

6.2.3.5 New Road Construction Standards

6.2.3.5.1 Single-use THP Roads

Green Diamond will classify new roads designed for a single-use in a THP as temporary, and decommission the roads upon completion of operations.

6.2.3.5.2 Seasonal Restrictions

Green Diamond will not construct or rock new roads during the winter period (October 16th through May 14th).

6.2.3.5.3 Clearing Width

Green Diamond will provide a clearing with a width which is based on the slope of the ground (it must be able to adequately displace organic material so that organics are not incorporated in the fill) and the presence of green trees (to avoid having fill material butt up against green trees), and will normally range from 75 to 100 feet.

6.2.3.5.4 Tree Removal

1. Green Diamond will clear all trees over 12 inches dbh within five feet of the top of the cut slope.

2. Trees greater than 12 inches dbh within five feet of the top of the cut slope may be retained if they will not be susceptible to windthrow or of being undercut.

6.2.3.5.5 Slash and Debris

1. Green Diamond will not incorporate slash and other debris from road construction into the road prism, fills or sidecast material.

2. When feasible, slash and debris will be placed parallel to the toe of road fill slopes as a filter windrow.

3. Slash will not be bunched against residual trees or placed in locations where it may gain entry into Class I, II or III watercourses.

6.2.3.5.6 Organic Layer

On slopes greater than 35%, Green Diamond will substantially remove the organic layer of the soil prior to fill placement.

6.2.3.5.7 Location

1. Green Diamond will avoid locating roads on steep slopes, inner gorge or steep toe slopes, headwall swales or debris slide slopes, and deep-seated landslides, and will follow the slope stability measures when it is not possible to avoid these features. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

2. Wherever feasible, roads will be located on or close to ridge tops or on benches where the road prism can be built with the least soil displacement.

3. New roads will be constructed so the road network will not drain directly into watercourses (i.e., will be hydrologically disconnected).

6.2.3.5.8 Road Width Specifications

1. Green Diamond will construct management roads to have a running surface width of 16 to 18 feet (mainline roads) and 14 to 16 feet (secondary roads).

2. Mainline and secondary roads will typically have a combination of outsloped (with rolling dips) and crowned (with inside ditches) road construction where appropriate, and occasional turnouts.

3. Temporary roads will have a width of 14 to 16 feet, will typically be outsloped with rolling dips, will be planned and designed for a single harvest entry, and will be decommissioned upon completion of harvest operations.

4. Exceptions to the road width specifications will be made where necessary considering topographic constraints, landing locations, turnouts, engineered berms, and curve widening, as measured in 200 foot lineal segments. Greater widths will be allowed to satisfy requirements of alignment, safety, and equipment. Curves will be widened to an additional width based on the following:

Radius	Additional Width
100+ feet radius	+ three feet
75-100 feet radius	+ five feet
50-74 feet radius	+ eight feet

6.2.3.5.9 *Road Construction within RMZs*

1. Green Diamond will not construct new roads within RMZs with the exception of watercourse crossings or spur roads off of existing roads within RMZs which would be designed to extend outside the RMZ.

2. Green Diamond will not build new roads that parallel watercourses within RMZs.

6.2.3.5.10 *Surfacing for Roads*

1. Green Diamond will not use roads during the winter period for hauling (logs and rock) unless they have surfacing specifications of a minimum compacted depth of 12 inches of rock.

2. Only rock that is durable and does not break down with vehicle or heavy equipment use will be applied to road surfaces.

3. During the winter period, Green Diamond will not use vehicles on roads for administrative purposes unless the roads have rock applied as needed to prevent runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface which drains into a Class I, II, or III watercourse.

6.2.3.5.11 *Final Grades*

Green Diamond will ensure that final grades of new roads do not exceed 15% except to avoid unstable slopes, steep slopes, inner gorges, inner gorge crossings, or to access a suitable watercourse crossing location, as measured in minimum 100 feet increments.

6.2.3.5.12 *Overhanging Cut Slopes*

Green Diamond will remove all overhanging cut slopes.

6.2.3.5.13 *Existing Road Bank Cuts*

For new road construction in areas where existing road bank cuts have exhibited failures, Green Diamond will evaluate site specific situations and apply measures as appropriate such as seeding and mulching, buttressing, and erosion mats to ensure cut bank stability and to minimize erosion.

6.2.3.5.14 *Use of Through Cuts*

Green Diamond will avoid the use of through cuts where feasible. In areas where through cuts cannot be avoided (e.g. to avoid steep slopes, unstable slopes) permanent ditch-outs will be installed at the beginning and end of the through cut.

6.2.3.5.15 *Slope Cut Design*

Except for certain soil types or site conditions that require vertical cut slopes (e.g. Tonnini soils, rock outcrops), slope cuts will be designed and constructed to minimize the risk of slope failure, soil disturbance, and excessive excavation.

6.2.3.5.16 *Deposit of Excess Material*

1. For areas requiring “end-haul” or some degree of “waste management” Green Diamond will deposit excess material in a stable location where sediment will not deliver to any watercourses.

2. Waste material will be seeded and mulched prior to October 15th in the year it is produced.

6.2.3.5.17 *Bench Construction*

On side slopes greater than 50%, where the length of the road section is greater than 100 feet, Green Diamond will construct fills greater than four feet in vertical height at the outside shoulder of the road on a bench that is excavated at the proposed toe of the fill and is wide enough to compact the first lift and subsequent lifts in approximately one-foot intervals from the toe to the finished grade.

6.2.3.5.18 *Fill Construction*

Green Diamond will construct fills to minimize erosion using techniques such as insloping, berms, rock armoring (where appropriate), or other suitable methods.

6.2.3.5.19 *Rocked Roads*

Green Diamond will use a combination of outsloped and crowned roads with inboard ditches where appropriate on roads that are to be rocked.

6.2.3.5.20 *Roads Crossing Watercourses*

Where roads cross watercourses, Green Diamond will ensure that the road prism has a gradual transition to an insloped vertical curve as the road approaches and leaves the crossing.

6.2.3.5.21 *Native Surface Roads*

Green Diamond will generally use an outsloped road prism for native surface roads.

6.2.3.5.22 *Turnouts*

1. Green Diamond will place turnouts at reasonable intervals along the alignment and will be located where a minimum of excavation will be necessary to increase the road width.

2. Turnouts will not be constructed if fill is required on side slopes for their construction.

6.2.3.5.23 *Soil Moisture Conditions*

Green Diamond will not construct roads when soil moisture conditions would result in:

1. Reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performances;

2. Inadequate traction without blading wet soil; or

3. Soil displacement in amounts that cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II, III or IV watercourse; except that construction may occur on isolated wet spots arising from localized groundwater such as seeps or springs.

6.2.3.6 Drainage Structures for New Road Construction

6.2.3.6.1 *Fill Minimization*

Green Diamond will construct all new watercourse crossings to minimize fill over the culvert.

6.2.3.6.2 *Design Flow*

1. All new watercourse crossing culverts will be designed to handle a 100-year return internal flow event.

2. The design flow will be calculated using the Waananen and Crippen method (1977) for drainage areas greater than or equal to 80 acres. The Rational Method (Chow 1964) will be used when the drainage area for a crossing is less than 80 acres.

3. Culverts will be sized to pass the 100-year flow event without overtopping (headwater depth to culvert diameter ratio =1.0).

4. On an annual basis the $2.5 million per year will be adjusted proportionally to reflect the current acreage of the Plan Area in relation to the acreage of the Initial Plan Area.

6.2.3.6.3 *Temporary Road Watercourse Crossings Design*

1. Watercourse crossings on temporary roads designed for one time summer season use will be designed to carry the flow at the time of construction and will be removed prior to October 15th in the year it was installed.

2. A minimum six-inch pipe size will be used on small seeps and springs.

6.2.3.6.4 Fish-bearing Watercourses

1. Green Diamond will install bridges on fish-bearing watercourses where feasible.

2. When a bridge installation is not feasible, a countersunk or bottomless culvert (or other fish-friendly structure) will be installed on grade that will provide upstream and downstream fish passage for all life stages of fish. Installed culverts will not restrict the active channel flow.

6.2.3.6.5 Diversion Prevention

Green Diamond will construct permanent watercourse crossings, road approaches to crossings, and associated fills to prevent the potential diversion of stream overflows down the road and to minimize fill erosion should the drainage structure become obstructed.

6.2.3.6.6 Erosion Protection Measures

1. Green Diamond will install erosion protection measures such as inlet and outlet armoring of pipes and energy dissipaters where necessary to prevent erosion concurrently with the fill at all culverted watercourse crossings. If it is determined that site specific conditions do not warrant additional erosion protection measures, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

2. Armoring will extend at least one foot above the expected head and tail water elevations at the culvert.

3. All bare soil on fill slopes at the culvert crossing will be seeded and/or mulched prior to the first winter period following installation.

6.2.3.6.7 Alignment

Green Diamond will align all watercourse crossings with the natural grade and course of the stream.

6.2.3.6.8 Compaction

Green Diamond will compact fill material over culvert installations in one-foot lifts and will compact fill faces during construction.

6.2.3.6.9 Minimum Culvert Sizes

Green Diamond will install a minimum culvert size of 24 inches in all watercourse crossings on management roads, except for springs and seeps where such size would be unnecessary or impractical.

6.2.3.6.10 Discharge

1. No culvert will be discharged onto erodible material or unstable slopes.

2. When downspouts are used, they will be adequately secured to the culvert and they will be supported at intervals along their entire length.

6.2.3.6.11 Ditches

1. Ditches will be V-shaped and will be approximately one-foot deep relative to the subgrade.

2. Green Diamond will excavate ditches into the road subgrade and will not undercut the road cut slope.

3. Where conditions warrant it, ditch alignment will be pulled away from the cut slope to provide storage room for hillslope ravel, and slumps, and to provide protection of ditch conveyance capability.

6.2.3.6.12 Maximum Spacing of Ditch Relief Culverts and/or Rolling Dips

Green Diamond will install ditch relief culverts and/or rolling dips at intervals based on the following maximum spacing:

	Maximum Spacing (feet) by Erosion Hazard Rating		
Road Grade	Extreme	High	Moderate/Low
2%	600	---	---
4%	530	600	---
6%	355	585	600
8%	265	425	525
10%	210	340	420
12%	180	285	350
14%	155	245	300
16%	135	215	270
18%	115	190	240

6.2.3.6.13 Additional Culverts and Rolling Dips

Green Diamond will install additional ditch relief culverts and rolling dips where appropriate to adequately disconnect the roads from the watercourses and to minimize ditch water accumulation on slide prone landforms such as inner gorges.

6.2.3.6.14 Ditch Relief Culverts

Ditch relief culverts will consist of culverts with a minimum size of 18 inches.

6.2.3.6.15 Ditch Relief Culvert Discharge

1. Ditch relief culverts will be discharged 50 to 100 feet before water enters a Class I or II watercourse.

2. Drains will discharge onto stable landforms with adequate energy dissipation and sediment filtering capacity.

3. Outlets discharging onto erosion prone areas will be avoided or provided with effective erosion protection measures.

6.2.3.6.16 Ditch Relief Culvert Grades

Ditch relief culverts will have a grade that is at least 2% greater than a contributing ditch.

6.2.3.7 New Landing Construction

6.2.3.7.1 Landings in RMZs or EEZs

Green Diamond will not construct new landings in an RMZ or EEZ.

6.2.3.7.2 Limitation on New Landing Construction

1. Green Diamond will limit new landing construction and associated excavation by landing logs on existing roadways where site-specific conditions allow.

2. When it is necessary to construct landings, landings will be located on topographic flats and divergent slopes where possible.

3. New landing construction will not occur during the winter period (October 16th through May 14th).

6.2.3.7.3 Soil Moisture Conditions

Green Diamond will not carry out landing construction when soil moisture conditions would result in (1) reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performance; (2) inadequate traction without blading wet soil; or (3) soil displacement in amounts that cause a visible increase in turbidity in any ditch or landing surface that drains into a Class I, II, III or IV watercourse.

6.2.3.7.4 Steep Slopes

For new landing construction, Green Diamond will not place fill, and will minimize sidecast, on slopes greater than 65%.

6.2.3.7.5 Risk Assessment and Pull Back

1. Green Diamond will assess all landings used as part of the current operations after completion of operations to determine whether or not overhanging or perched fill or organic material in such landings poses a risk of failure and sediment delivery to a watercourse.

2. If a risk of failure and sediment delivery to a watercourse exists, fill material will be pulled back to a stable condition and excavated material will be deposited in a stable location. The pull back will be accomplished prior to October 15th following the completion of operations. Waste material will be seeded and mulched prior to October 15th in the year it is produced.

6.2.3.7.6 Sidecast Treatment

1. On side slopes less than 50%, Green Diamond will seed, plant, mulch, remove or treat sidecast or fill material extending more than 20 feet in slope distance from the outside edge of the landing and within 200 feet of a watercourse or lake to minimize soil erosion.

2. Excess material will be deposited in a stable location where downstream beneficial uses of water will not be adversely affected.

6.2.3.7.7 Waste Organic Materials

1. Green Diamond will not bury waste organic material such as uprooted stumps, cull logs, accumulations of limbs and branches, or unmerchantable trees in landing fills.

2. Slash and other organic debris may be placed and stabilized at the toe of landing fills to restrain fill soil from moving downslope.

6.2.3.7.8 Drainage of Landings

1. Upon completion of timber operations, Green Diamond will drain landings to prevent water from accumulating.

2. Concentrated flows will not be channeled over fills and will only be discharged onto stable areas.

3. Discharge points will be located on stable landforms and where stable discharge points are absent adequate erosion protection and energy dissipation will be employed.

6.2.3.7.9 Surfacing for Landings

Landings that will be used during the winter period will have surfacing specifications of minimum compacted depth of 12 inches of rock. Only rock that is durable and does not readily break down with vehicle or heavy equipment use will be applied to landing surfaces.

6.2.3.8 Erosion Control Measures for New Road and Landing Construction

6.2.3.8.1 Erosion Control during Construction

Green Diamond will use appropriate erosion control measures to minimize erosion and prevent sediment from entering watercourses during all road and landing construction activities. Such measures will include but are not limited to:

1. Road surfacing
2. Dispersing runoff into stable vegetated filter areas
3. Armoring with rock rip-rap
4. End hauling waste material to stable locations
5. Construction of rolling dips, critical dips, and waterbars
6. Mulching
7. Revegetating disturbed surfaces as soon as practical

6.2.3.8.2 *Construction in Close Proximity to Watercourses*

Where construction activities are conducted in close proximity to watercourses, Green Diamond will use additional erosion control protection measures to trap sediment and minimize its entry into the watercourse. Slash filter windrows, silt fences, mulching, and/or straw bale check dams will be used to control runoff over fill slopes and along concentrated runoff flow paths, on an as-needed basis.

6.2.3.8.3 *Construction of Features*

1. All watercourse crossings and cross drains will be installed and functional prior to October 15th.
2. By October 15th, all waterbars, rolling dips, and road and landing construction associated with straw mulching and grass seeding will be completed in order to minimize suspended or mobilized sediment delivery to a watercourse.

6.2.3.8.4 *Seeding and Mulching*

Prior to the beginning of the first winter period following construction, Green Diamond will seed all new cut and fill slopes on roads constructed within an RMZ or EEZ of a Class I, II, or III watercourse at a rate of at least 30 pounds per acre and mulched to a depth of at least two inches (before settling) with 90% surface coverage.

6.2.3.8.5 *Temporary Crossings*

1. At temporary crossings, Green Diamond will pull back the fill slope to the natural side slopes and deposit the material in a stable location where sediment will not deliver to any watercourses.
2. All exposed areas associated with the crossing will be seeded at a rate of at least thirty pounds per acre and mulched to a depth of at least two inches (before settling) with 90% surface coverage.

6.2.3.9 Routine Road Maintenance and Inspection Plan

6.2.3.9.1 Distribution of Information

Green Diamond will distribute information about proper road use and reporting of maintenance problems to all of its woods personnel and woods contractors and to members of the public who have road access to the Plan Area.

6.2.3.9.2 Time of Year Restrictions

1. Green Diamond may carry out patch (spot) rocking, brushing, cleaning inlets and outlets of culverts, cleaning ditches where poor drainage is occurring, repairing or maintaining existing waterbars, replacement of a failed or imminently failing culvert along a needed access road, and site specific road surface grading for maintaining the integrity of the road surface year-round, including during the winter period.

2. Grading will not be used to blade off wet soil to provide conditions for extended periods of operation on a deteriorated road surface.

3. The installation of waterbars, rolling dips and critical dips, general project grading for shaping the road surface, road outsloping, road rocking, resurface rocking, cleaning ditch lines, and general culvert replacements may occur only during the period when road upgrading may occur (see 6.2.3.4.1, 6.2.3.4.2, and 6.2.3.4.3).

6.2.3.9.3 Road Maintenance Schedules for Mainline and Appurtenant Roads

1. Prior to September 15th of each year, Green Diamond will inspect all mainline roads for needed maintenance.

2. Other roads that are appurtenant to THPs will be inspected at least through the prescribed maintenance period for erosion controls specified in the THP.

3. The inspections of mainline and other roads will assess the effectiveness and condition of all erosion control and drainage structures.

6.2.3.9.4 Road Maintenance Schedules for All Secondary Management Roads or Roads Not Yet Decommissioned

1. Green Diamond will maintain all secondary management roads or roads yet to be decommissioned that are accessible to maintenance crews.

2. The maintenance schedule will be completed on a three-year rotating basis in accordance with the following:

Rotating Annual Schedule	Routine Maintenance Areas
1	Smith River HPA
1	Coastal Klamath HPA (on northern side of the Klamath River) minus the Bear Creek RWU
2	Coastal Klamath HPA (on southern side of the Klamath River)
2	Blue Creek HPA plus the Bear Creek RWU
3	Interior Klamath HPA
3	Redwood Creek HPA
2	Coastal Lagoons HPA
1	Little River HPA
1	Mad River HPA minus the Boulder Creek RWU
2	North Fork Mad River HPA
3	Humboldt Bay HPA plus the Boulder Creek RWU
3	Eel River HPA

6.2.3.9.5 Inspection Content

1. Green Diamond will conduct inspections on roads that are accessible by truck. Problems identified during the inspections will be documented and recommendations for their repair will be provided.

2. The inspections will assess the following:

   a. Adequate waterbar spacing, depth, interception of the ditch line, and complete diversion of water flow onto undisturbed soil.

   b. Areas having poorly drained low spots or inadequately breached outside berms.

   c. That ditches are open and properly functioning, free of debris that could plug the ditch or a culvert and cause a diversion of water onto the road surface.

   d. Culverts are functioning properly (i.e., the culvert is not rusted out or separated at a joint; water is flowing through the pipe and not underneath; sediment and debris is not reducing the pipe capacity).

3. Green Diamond will prioritize maintenance or repairs that are needed based on treatment immediacy (a subjective combination of event probability and potential sediment delivery evaluated as either low, moderate, or high). Green Diamond's goal will be to complete all the priority tasks prior to the winter period. If the priority workload exceeds that which can be accomplished in the current maintenance year, lower priority sites will be held over until the following maintenance year.

6.2.3.9.6 Emergency Inspections

6.2.3.9.6.1 Emergency Inspection Trigger

If a storm occurs that produces three inches of precipitation or more in a 24-hour period at a gauge location identified below, then Green Diamond's timberlands staff will conduct emergency inspections of all accessible rocked roads in the corresponding region, to the extent the roads can be traveled without causing road damage during or immediately after such event.

Gauge Location	Associated Inspection Area
Crescent City	Smith River HPA
Klamath River near Terwer Creek	Coastal Klamath and Blue Creek HPAs
Trinity River at Hoopa	Interior Klamath HPA
Redwood Creek at Orick	Redwood Creek HPA downstream of Dolly Varden and Coastal Lagoons HPA
O'Kane (Blue Lake)	Redwood Creek HPA upstream of Dolly Varden
Korbel	North Fork Mad River and Mad River HPAs
Eureka	Humboldt Bay, and Eel River HPAs

6.2.3.9.6.2 Emergency Inspection Repairs

1. Green Diamond will make repairs during the emergency inspections if hand labor can correct the problem.

2. Any major problems observed during emergency inspections that would require the use of heavy equipment for repair will be reported to a designated "storm response coordinator." The coordinator will prioritize and schedule repairs so that they are accomplished as soon as possible. If access is prohibited because of adverse conditions, these sites will receive priority for treatment during the following summer's road maintenance schedule.

6.2.3.9.7 Road Daylighting

1. Green Diamond will perform road daylighting (removal of trees within 25 feet slope distance of the shoulder or cut bank of a road) to accelerate drying of roads and provide stable road surfaces for log hauling or other vehicular traffic. Within RMZs for Class I and II watercourses, no trees will be cut that could cause channel de-stabilization. No trees larger than 16 inches dbh will be cut from the downstream side of Class I watercourse crossings.

2. Green Diamond will evaluate daylighting within RMZs on a site-specific basis to determine where it will be necessary in order to accelerate drying of the road and provide a stable road surface.

6.2.3.10 Road and Landing Use Limitations

6.2.3.10.1 <u>Turbidity Restrictions</u>

1. Green Diamond will cease log hauling, road decommissioning, road upgrading, road construction, and use of landings when the use of any portion of a road or landing results in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II or III watercourse.

2. Use of roads for log hauling, road decommissioning, road upgrading, road construction, and use of landings, will not resume until the road surface has dried sufficiently to allow use without resulting in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II or III watercourse. This criterion will apply any time of year (including during summer storms).

6.2.3.10.2 <u>Seasonal Restrictions</u>

1. Green Diamond will carry out hauling or loading during the winter period only on rocked surfaces.

2. Hauling and loading will be allowed on unsurfaced roads from May 1st through May 14th if “early spring drying” occurs or from October 16th through November 15th if an “extended dry fall” occurs.

6.2.3.10.3 <u>Helicopter Landing Areas</u>

Helicopter service landing areas will be considered appurtenant to a THP and will be subject to the limitations described in 6.2.3.10.1 and 6.2.3.10.2.

6.2.3.10.4 <u>ATVs</u>

1. Green Diamond will use only ATVs on unsurfaced seasonal roads during the winter period.

2. Other vehicular use of seasonal roads will be allowed from May 1st through May 14th if “early spring drying” occurs, or from October 16th through November 15th if an “extended dry fall” occurs.

3. Any damage caused to drainage or erosion control structures by using ATVs on any road will be repaired immediately following damage.

4. Exceptions for seasonal road use during the winter period for management include fire control vehicles for site preparation burning, pickup access for transportation of monitoring supplies and equipment, and pickup trucks and vans for transportation of seedlings and reforestation crews. Upon completion of each specified activity all drainage facilities will be returned to the condition prior to road use or brought up to a condition where they are functioning properly.

6.2.3.10.5 *Landings on Roads within RMZs*

1. Green Diamond will not use landings on roads (including roadside decking) within RMZs from October 16th through May 14th.

2. Ditchlines and drainage facilities associated with existing roads within RMZs that are used for landings or roadside decking during the summer period will be repaired immediately following completion of operations and prior to October 16th.

3. Any proposed use of existing landings and roads within an RMZ will be discussed and mapped in THPs and also included on the THP map submitted to the Services. Alternatives to roadside decking in RMZs will be evaluated during the THP preparation. Green Diamond will select the most feasible alternative with the least amount of impact to the aquatic resource.

6.2.3.11 Emergency Road Repair

If there is an imminent threat to life, property, or public safety, or a potential for a massive sediment input with catastrophic environmental consequences, and the appropriate emergency response action is otherwise prohibited by this Section of this Plan, Green Diamond will notify the Services' designated contacts, but a formal notification will not be required prior to response actions being taken.

6.2.3.12 Water Drafting

Green Diamond will restrict its water drafting and use of gravity-fed water storage systems for timber operations as identified in this subsection. These restrictions will not apply to water drafting for wildfire. However, if a watercourse has larval tailed frogs, then the drafting requirements for the site will be modified to avoid temporary dewatering of the Class II watercourse or another drafting site will be used.

6.2.3.12.1 *Within Class I Watercourse Channels*

Water drafting for timber operations within the channels of Class I watercourses will conform with the following standards:

1. The pumping rate will not exceed 350 gallons per minute.

2. The pumping or gravity fed lines to storage tanks will not remove more than 10% of the daily above-surface flow.

3. Drafting will not occur in watercourses that have less than one cubic foot per second surface flow.

6.2.3.12.2 *Within Class I Watercourse Impoundments*

Water drafting for timber operations from impoundments within the channels of Class I watercourses that do not have surface outflow will conform with the following standards:

1. The pumping rate will not exceed 350 gallons per minute.

2. Drafting or pumping to storage tanks will not reduce maximum pool depth by more than 10%.

6.2.3.12.3 *Within Class II Watercourses or Impoundments*

Gravity fed lines to storage tanks from within Class II watercourses or impoundments will not divert more than 50% of the flow, and water drafting for timber operations from within Class II watercourses or impoundments will not reduce maximum pool depth by more than one-third and the pool will be fully recharged before any additional drafting occurs.

6.2.3.12.4 *Drafting Screen Specifications*

Green Diamond will screen intakes, including gravity fed lines, in Class I and II watercourses. Green Diamond will install intakes in pools to avoid entrainment of amphibian larval stages. The screens will be designed to prevent the entrainment of all life stages of Covered Species and will meet the minimum design criteria specified in Section 6.3.3.12 of the Plan.

6.2.3.12.5 *Herbicide Mix Trucks*

Green Diamond will not use herbicide mix trucks to directly draft water from any watercourse.

6.2.3.13 Rock Quarries

6.2.3.13.1 *Locations of New Rock Quarries*

Green Diamond will not establish new rock quarries and borrow pits within a Class I or II RMZ.

6.2.3.13.2 *Portions of Existing Quarries within RMZs*

Green Diamond will not use any portion of an existing rock quarry or borrow pit that is within 150 feet of a Class I watercourse, 100 feet of a Class II-2 watercourse, or 75 feet of a Class II-1 watercourse.

6.2.3.13.3 *Turbidity*

1. Green Diamond will carry out rock quarrying or rock extraction from borrow pits, or hauling operations associated therewith, so as not to cause a visible increase in turbidity in watercourses or hydrologically connected facilities which discharge into watercourses.

2. If an increase in turbidity does occur as the result of such operations, interim erosion control measures will be install and the operations causing the increase will be immediately ceased.

6.2.3.13.4 Overburden

Green Diamond will place overburden generated during development of rock quarries and borrow pits in a stable location away from watercourses and RMZs. The overburden disposal area will be grass-seeded and straw-mulched where erosion has the potential to deliver sediment to the stream network.

6.2.3.14 Training

1. Green Diamond will provide the training specified below for all equipment operators and supervisors involved with the road plans specified in this Plan, and all foresters, as provided for his or her position.

2. The training courses will be offered every year for new employees or contractors who will be involved in the road plan. Refresher courses will be provided every two years as appropriate to review concepts and introduce any new state-of-the-art techniques.

6.2.3.14.1 Training Courses

The following training courses will be offered:

1. Basic training in road decommissioning (foresters, supervisors and operators);

2. Basic training in road location and design (foresters) and road construction (foresters, supervisors and operators);

3. Basic training in road upgrading (foresters, supervisors and operators);

4. Basic training in road maintenance (foresters, supervisors and operators).

6.2.3.14.2 Training Course Format

Each of the above-listed courses will follow the following format:

1. Office and classroom—2-4 hours. Presentation of concepts and theory of road treatments; review of the difference between typical past practices and currently acceptable methods; slide presentation depicting road-related problems and appropriate treatments; comparison of effective and ineffective treatments; question and answer session.

2. Field workshop—6 hours. Viewing of sites depicting various untreated problems; review of road reaches which have been correctly and appropriately treated; review of road reaches or sites showing examples of partially or incorrectly applied treatments.

3. Practical field workshop—8 hours. Observation and participation in proper road treatments and demonstration projects actively underway; discussions with other operators on techniques and practices employed in designing, staging and applying proper road treatments.

4. On-the-job training for foresters and supervisors—variable. Training on road design and layout; problem identification; problem quantification; prioritization; and development of cost-effective treatments.

5. On-the-job training for operators—2 to 6 months. Application of road treatments with technical oversight and review of road treatment practices and operations (beginning with regular, repeated field review and terminating in intermittent checking of new or unusual operations, as needed).

6.2.4 Harvest-Related Ground Disturbance Measures

6.2.4.1 Field Trials with Mechanized Equipment

Green Diamond will not conduct field trials with mechanized equipment for silvicultural operations unless it has provided assurances to the Services that the equipment will not cause compaction or soil displacement that is measurably greater than the equipment or methods previously used. Such assurances will be supported by available documented evidence.

6.2.4.2 Site Preparation Standards

Green Diamond will plan and execute harvest operations so as to facilitate the purposes of the site preparation conservation measures described in this subsection.

6.2.4.2.1 Design

Green Diamond will design all site preparation operations to limit the amount of ground and forest floor disturbance to that which is required for fuel reduction and reforestation operations.

6.2.4.2.2 Priority for Treatment

Green Diamond will plan site preparation operations so that areas having the greatest need of treatment for fuel reduction and/or reforestation access are assigned the highest priority for treatment.

6.2.4.2.3 Mechanized Site Preparation Methods

1. Green Diamond will minimize use of machine piling with tractor-and-brushrake; other mechanized methods or equipment will be used preferentially.

2. Use of mechanized site preparation methods will be limited to the period beginning May 15th and ending October 15th.

6.2.4.2.4 Prescribed Fire Operations

Green Diamond will design prescribed fire operations to produce burns that have the following “low intensity” attributes:

1. The burning operation will consume only a limited portion of the fuelbed.

2. Non-targeted portions of the fuelbed, such as the duff layer and woody fuels greater than three inches in diameter, will be generally only lightly consumed.

3. The fires will tend to self-extinguish when they burn into a fireline or into an adjacent area with a continuous overstory canopy.

6.2.4.2.5 Desired Post-operation Fuelbed and Forest Floor Attributes

Green Diamond will use reasonable efforts to achieve the following attributes following site preparation:

1. Down woody material greater than 3.0 inches diameter to reflect the pre-disturbance condition throughout the prepared area.

2. The litter layer to be minimally displaced or consumed.

3. Bare mineral soil exposure that occurs through the displacement or consumption of logging slash and forest floor material to be less than 5% of the area of any harvest unit (skid trails and skyline roads are not included in the estimate of exposed area).

6.2.4.2.6 Fireline Drainage

All firelines that are not in an RMZ or EEZ will have drainage facilities adequate to prevent the delivery of sediments to RMZs or EEZs.

6.2.4.2.7 Fireline Construction with Tractors

1. Green Diamond will limit fireline construction with tractors to the period beginning May 15th and ending October 15th.

2. If the proposed fireline location may cause hillslope sediment delivery to a RMZ or EEZ adjacent to a Class I, II or III watercourse, then equipment use will be limited to slopes less than 45%.

3. If the proposed fireline location is not likely to cause sediment delivery to a RMZ, and if slopes are greater than 50%, then the tractors will operate only on fireline segments less than 100 feet.

6.2.4.2.8 Fireline Construction, Reconstruction, and Use within RMZs and EEZs

Green Diamond will limit fireline construction, reconstruction, and use within RMZs and EEZs as follows:

1. Firelines will only be constructed or reconstructed with hand tools.

2. Existing skid roads or firelines within RMZs or EEZs will be reconstructed for fireline usage only if they are located advantageously for fire containment. Reconstruction will only be done with hand tools, and only to the minimum width required for fire containment. All prior drainage failures on the existing skid roads or firelines will be remedied during reconstruction.

3. All constructed or reconstructed firelines within RMZs or EEZs will have drainage structures that will minimize the movement of sediments from the exposed fireline surface but are not subject to the 100 square foot ground disturbance standard for seeding and mulching as described in Section 6.2.1.

6.2.4.3 Release, Pre-commercial Thinning, and Commercial Thinning

1. Green Diamond will use self-propelled, mechanized equipment for release and pre-commercial thinning operations only as specified in the seasonal limits on ground-based yarding.

2. The uses of logging equipment in commercial thinning operations are subject to all applicable limitations on felling, yarding and loading in 6.2.4.4 through 6.2.4.8 below.

6.2.4.4 Measures Common to All Felling, Yarding, and Loading Operations

1. Erosion control measures for the treatment of disturbed areas in RMZs or EEZs resulting from felling, bucking, and yarding activities will be implemented as provided in Section 6.2.1.

2. Any bare mineral soil exposure, greater than 100 square feet in RMZs or EEZs that is caused by logging activities, will be mulched and seeded or treated by other means prior the end of logging operations or prior to October 15, whichever comes first. Seeding will be at a rate of at least 30 pounds per acre and mulching to a depth of at least 2 inches (before settling) with 90% surface coverage.

6.2.4.5 Tractor, Skidder, and Forwarder Operations

6.2.4.5.1 <u>Time of Year Restrictions</u>

1. Green Diamond will limit the construction and reconstruction of skid trails to the period beginning May 15th and ending October 15th.

2. Ground-based yarding with tractors, skidders, and forwarders may occur from May 15th through October 15th on existing skid trails. This period for skid trail use (which excludes construction and reconstruction of skid trails) may be extended to include the periods May 1st to May 15th or October 16th to November 15th when the following procedures are followed:

    a. Skid trail use during this period will not result in visibly turbid water that flows into hydrologically connected drainage facilities, or discharges directly into watercourses, seeps, or springs.

        1) If an increase in turbidity does occur as the result of such operations, interim erosion control measures will be installed and the operations causing the increase will be immediately ceased.

2) Use of skid trails by ground-based logging equipment will not occur when soil moisture conditions would result in (a) reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performance; (b) inadequate traction without blading wet soil, or (c) soil displacement in amounts that cause movement of waterborne sediments off of a skid trail surface.

3) If any of the foregoing conditions is caused during skid trail use, interim erosion control measures will be installed and the operation causing the condition will be immediately ceased.

b. Ground-based yarding operations will use minimal ground disturbing equipment without bladed skid trail construction or reconstruction where feasible. Where this is not feasible, yarding operations during this period will be limited to existing skid trails for ground-based equipment that are hydrologically disconnected from Class I, II, or III watercourses or drainage facilities that discharge into Class I, II, or III watercourses.

c. Use of skid trails during the period will not occur within at least 100 feet, slope distance, of the upper extent of any designated Class II watercourse, and on slopes greater than 30% within at least 100 feet of Class III watercourses. Long-line yarding or lifting logs with a shovel from outside these zones may occur as long as the skid trails are hydrologically disconnected from Class I, II, or III watercourses or drainage facilities that discharge into Class I, II or III watercourses.

d. During the period, all bare mineral soils greater than 100 square feet created by ground-based yarding that are within an RMZ or EEZ will be treated with seed, mulch or slash by the end of the working day. Such treatment outside the zones will be performed at the discretion of the RPF or Green Diamond's supervisor based on an evaluation of the potential of the site to deliver sediment to a watercourse or hydrologically connected facility, taking into consideration the potential for large storm events to cause sediment delivery.

e. During the period, prior to commencement of yarding operations, sufficient erosion control materials, including but not limited to straw, seed (barley seed and/or the Green Diamond's seed mix), and application equipment will be retained on-site or otherwise accessible (so as to be able to procure and apply that working day) in amounts sufficient to provide at least two inches depth of straw with minimum 90% coverage, and 30 pounds per acre of Green Diamond's seed mix. In lieu of the above listed materials, native slash may be substituted and applied if depth, texture, and ground contact are equivalent to at least two inches straw mulch.

f. If operations expose an area of bare mineral soil late in the day and it is not feasible to completely finish erosion control treatment that day, the erosion control treatment may be completed the following morning prior to start of yarding operations provided there is no greater than a 30% chance of rain forecasted by the National Weather Service within the next 24 hours.

6.2.4.5.2 Use on Steep Slopes

Green Diamond will not use ground-based yarding systems that require constructed skid trails on slopes over 45% unless greater soil or riparian zone disturbance would be expected from cable yarding due to unfavorable terrain that reduces skyline deflection and payload capability, or additional haul road construction would be required to accommodate the use of cable logging systems.

6.2.4.5.3 RMZ and EEZ Exclusions

Green Diamond will not use ground-based yarding, or skidding, equipment in RMZs or EEZs adjacent to Class I, II and III watercourses, except as provided in Sections 6.2.1, 6.2.3, and 6.2.4 of the Plan.

6.2.4.6 Skid Trails

1. During THP preparation, Green Diamond will note existing skid trails within the proposed harvest area that are diverting a watercourse, have a potential to divert a watercourse, or are not properly draining and will have them evaluated for repair by a fisheries biologist, hydrologist, geologist, or other qualified personnel.

2. Necessary repairs will be performed by the completion of timber operations.

6.2.4.7 Feller-Buncher and Shovel Logging Operations

1. Where appurtenant haul roads are not surfaced for all weather conditions or do not have appropriate drainage facilities, or when the operation involves use of constructed skid trails for skidding and forwarding, Green Diamond will not carry out feller-buncher or shovel logging operations during the winter period.

2. Feller-buncher and shovel logging operations will cease during storm events where logging operations, combined with significant rainfall, are likely to cause delivery of sediments in RMZs or EEZs along Class I, II or III watercourses.

3. Forwarding over constructed skid trails, when used in conjunction with the feller-buncher or shovel operation, will be governed by 6.2.4.3.

6.2.4.8 Skyline Yarding Operations

6.2.4.8.1 Cable Logging Suspension

Green Diamond will fully suspend logs above the ground when cable yarding across Class I and II RMZs, and to the extent practicable when cable yarding across Class III EEZs.

6.2.4.8.2 Bare Soil Exposure Treatment

1. Green Diamond will mulch and seed or treat by other means areas of bare soil exposed in skyline roads within RMZs or EEZs that are greater than 100 square feet and are caused by logging activities prior to the end of logging operations or prior to October 15th, whichever occurs first.

2. Where sections of skyline road upslope of RMZs or EEZs have created furrowing of the ground which can channelize surface flow and result in gullying and possible delivery of sediments into or through the RMZ or EEZ, those affected areas will be treated with the installation of one hand-built waterbar per 50 lineal feet of affected skyline road, except in areas of known erodible soil types and on formations or slopes greater than 65%, where waterbars will be placed after a linear disturbance distance of 30 feet and the spacing between waterbars thereafter will be 20 feet.

6.2.4.9 Helicopter Yarding Operations

In harvest planning, Green Diamond will consider helicopter yarding as an alternative to ground-based or skyline logging methods where road construction to access harvest units would traverse overly steep and/or unstable terrain, and will justify the final choice of logging method in the THP.

6.2.4.10 Loading and Landing Operations

6.2.4.10.1 Landing Construction

Green Diamond will minimize the need for landing construction to the extent practicable, considering safe operation of equipment.

6.2.4.10.2 Landing Size

Green Diamond will minimize the size of new landings to the extent practicable, considering safe operation of equipment, by designing them for shovel, or heel-boom, loaders instead of front-end loaders.

6.2.4.10.3 Loading Surfaces and Operations

Green Diamond will not conduct loading on unrocked surfaces during the winter period except from May 1st through May 14th if early spring drying occurs, or October 16th through November 15th if extended dry fall occurs.

6.2.5 Effectiveness Monitoring Measures

Effectiveness monitoring measures include four categories of projects and programs: "Rapid Response Monitoring," "Response Monitoring," "Long-term Trend Monitoring/Research," and "Experimental Watersheds Program." The projects and programs in each category are as follows:

- Rapid Response Monitoring
    - Summer Water Temperature Monitoring
        - Property-wide Water Temperature Monitoring
        - Class II BACI Water Temperature Monitoring
    - Spawning Substrate Permeability Monitoring
    - Road-related Sediment Delivery (Turbidity) Monitoring
    - Headwaters Monitoring
        - Tailed Frog Monitoring
        - Southern Torrent Salamander Monitoring

- Response Monitoring
  - Class I Channel Monitoring
  - Class III Sediment Monitoring

- Long-term Trend Monitoring/Research
  - Road-related Mass Wasting Monitoring
  - Steep Streamside Slope Delineation Study
  - Steep Streamside Slope Assessment
  - Mass Wasting Assessment
  - Long-term Habitat Assessments
  - LWD Monitoring
  - Summer Juvenile Salmonid Population Estimates
  - Out-migrant Trapping

- Experimental Watersheds Program
  - Area-limited Effectiveness Monitoring Projects and Programs
  - BACI Studies of Harvest and Non-Harvest Areas under the Plan
  - BACI Studies of Conservation and Management Measures
  - New and Refined Monitoring and Research Protocols

The monitoring projects and programs described in 6.2.5.1 through 6.2.5.4 will be designed using the considerations identified in subsection 6.3.5. Rapid Response, Response Monitoring, and Long-term Trend Monitoring/Research will be implemented using the protocols identified or developed as described in Appendix D. The Experimental Watershed Program will be implemented using the protocols identified in Appendix D where appropriate and new or refined protocols developed in response to monitoring results.

6.2.5.1 Rapid Response Monitoring

6.2.5.1.1 Property-wide Summer Water Temperature Monitoring

Green Diamond will monitor summer water temperatures annually at sites in Class I and Class II watercourses across the Plan Area using the protocols identified in Appendix D.1.2. This monitoring will document the highest 7DMAVG, 7DMMX, and seasonal water temperature fluctuations for each monitoring site.

6.2.5.1.2 Class II BACI Water Temperature Monitoring

Green Diamond will conduct BACI studies of water temperatures before and timber harvesting in selected reaches of Class II watercourses using the protocol described in Appendix D.1.3. The goal is to assess potential effects of harvesting and the adequacy of riparian buffers by comparing maximum temperature differentials across fixed length of stream.

6.2.5.1.3 Spawning Substrate Permeability Monitoring

Green Diamond will monitor spawning gravel permeability in selected Class I watercourses throughout the Plan Area to determine if conditions are suitable for the fish Covered Species and to track trends in permeability. Several Plan Area sites in each HPA will be monitored using the protocol described in Appendix D.1.4.

6.2.5.1.4 Road-related Sediment Delivery (Turbidity) Monitoring

Green Diamond will monitor the road-related delivery of fine sediments into Plan Area streams (turbidity) and evaluate the effectiveness of the road upgrading measures in reducing those inputs. Turbidity will be measured immediately above and below Class II-1 and II-2 watercourse crossing using the protocol identified in Appendix D.1.5. There will be one permanent continuous monitoring station in each of the four drainages included in the Experimental Watersheds Program (see 6.2.5.4).

6.2.5.1.5 Tailed Frog Monitoring

Green Diamond will monitor changes in larval populations of tailed frogs in the Plan Area using a BACI experimental design as described in Appendix D.1.6. Treatment and control sites will be monitored to determine if timber harvesting under the Plan has a measurable effect on the larval populations in the Plan Area. Long-term changes in tailed frog populations across the Plan Area also will be monitored.

6.2.5.1.6 Southern Torrent Salamander Monitoring

Green Diamond will monitor changes in the persistence of sub-populations of southern torrent salamanders in the Plan Area using a BACI experimental design as described in Appendix D.1.6. Treatment and control sites will be monitored to determine if timber harvesting under the Plan has a measurable effect on the persistence on sub-populations in the Plan Area. Long-term changes in southern torrent salamander populations across the Plan Area also will be monitored.

6.2.5.2 Response Monitoring

6.2.5.2.1 Class I Channel Monitoring

Green Diamond will measure monitoring reaches in Class I watercourses in the Plan Area at least every other year for the duration of the Plan, using the protocol identified in Appendix D.2.2. The measurements will include cross-sectional and thalweg profiles, substrate size distributions, and bankfull and active channel widths.

6.2.5.2.2 Class III Sediment Monitoring

Green Diamond will monitor sediment delivery from Class III watercourses using a BACI design, as described in Appendix D.2.3. The collected data will be analyzed to determine the amount of sediment delivered from Class III watercourses following timber harvesting. This monitoring will occur in the drainages designated for the Experimental Watersheds Program (see 6.2.5.4).

6.2.5.3 Long-term Trend Monitoring/Research

6.2.5.3.1 Road-related Mass Wasting Monitoring

Green Diamond will monitor the effectiveness of the road upgrading and decommissioning measures in reducing the frequency and severity of sediment inputs from road-related mass wasting. Monitoring will follow the protocols discussed in Appendix D.3.2 and will entail before and after examination of sediment inputs from upgraded and decommissioned roads and comparison of sediment inputs from upgraded and non-upgraded roads. Implementation will occur within the four drainages of the Experimental Watershed Program (see subsection 6.2.5.4).

6.2.5.3.2 Steep Streamside Slope Delineation Study

Green Diamond will complete the SSS Delineation Study within seven years after the effective date of the Permits to modify the initial minimum slope gradient and maximum slope distances stated in 6.2.2.1 (Slope Stability Measures). The study will determine minimum slope gradient and maximum slope distance for Plan Area lands in each HPA based on a percentage of the measured cumulative sediment delivered to watercourses from shallow landslides originating from within the streamside slopes. The study will be conducted as described in Appendix D.3.3.

6.2.5.3.3 Steep Streamside Slope Assessment

Green Diamond will assess the effectiveness of the SSS prescriptions by collecting and analyzing data relevant to landslides in SSS zones. Data collection will occur over the first 15 years of the Permits' term. Data analysis will begin when data collection is complete. Data collection and analysis will occur as described in Appendix D.3.4.

6.2.5.3.4 Mass Wasting Assessment

Green Diamond will conduct a Mass Wasting Assessment (MWA) to examine the relationships between mass wasting processes and timber management practices. A preliminary MWA will be completed within the seven years after the Permits' effective date and at a minimum will include a landslide inventory and reporting of statistics collected to date. A final MWA will be completed within 20 years after the Permits' effective date and will include an updated landslide inventory and identification of patterns or trends in mass wasting processes as they relate to management practices. Both the preliminary and final MWA may be done incrementally across the Plan Area, with results presented as they become available or in a single report. The preliminary and final MWA will be conducted as described in Appendix D.3.5.

6.2.5.3.5 Long-term Habitat Assessments

Green Diamond will assess channel and habitat types of selected streams in the Plan Area every ten years during the Plan duration, beginning in 2004-2005. The assessments will be coordinated with LWD Monitoring (6.2.5.3.6) and will be conducted as described in Appendix D.3.6.

6.2.5.3.6 LWD Monitoring

Green Diamond will conduct LWD surveys on the stream reaches selected for the Long-term Habitat Assessments (see 6.2.5.3.5). Abundance and size of LWD will be inventoried. Monitoring will occur every ten years during Plan implementation, beginning in 2004-2005, and will be conducted as described in Appendix D.3.7.

6.2.5.3.7 *Summer Juvenile Salmonid Population Estimates*

Green Diamond will conduct sampling surveys each summer to estimate young of the year coho and age 1+ steelhead and coastal cutthroat trout. As described in Appendix D.3.8, the methodology developed by Dr. Scott Overton of Oregon State University (retired) and Dr. David Hankin of Humboldt State University, as previously refined by Green Diamond will be used.

6.2.5.3.8 *Out-migrant Trapping*

Green Diamond will conduct out-migrant trapping annually in the Little River HPA to monitor smolt abundance, size, and out-migration timing. The overwinter survival of juvenile coho also will be estimated based on a comparison of out-migrant trapping results and summer juvenile population estimates from 6.2.5.3.7. Trapping will occur as described in Appendix D.3.9. The Little River HPA is one of the four drainages designated for the Experimental Watersheds Program. Out-migrant trapping may be expanded to the other three experimental watersheds (see 6.2.5.4).

6.2.5.4 Experimental Watersheds Program

Green Diamond will designate the Little River in the Little River HPA, South Fork Winchuck River in the Smith River HPA, Ryan Creek in the Humboldt Bay HPA, and Ah Pah Creek in the Coastal Klamath HPA as experimental watersheds for additional monitoring and research on the interactions between forestry management and riparian and aquatic ecosystems may occur. The four watersheds were selected because they are representative of different geologic and physiographic provinces throughout the Plan Area.

Green Diamond will conduct the following types of monitoring and research in the four watersheds:

1. Effectiveness monitoring projects and programs that due to their complexity and expense of implementation can only be applied in limited regions (these include turbidity monitoring (6.2.5.1.4), Class III sediment monitoring (6.2.5.1.4), and road-related mass wasting monitoring (6.2.5.2.2);

2. BACI studies of harvest and non-harvest areas, allowing for more effective evaluation of conservation measures and increased understanding of the effects of forest management on the habitats and populations of the Covered Species.

3. BACI studies of conservation and management measures, allowing for a refinement of measures and an assessment of the relative benefits of different measures under the Plan; and

4. Development and implementation of new or refined monitoring and research protocols.

In addition, Green Diamond may expand Out-migrant Trapping in the Little River HPA to one or more of the other experimental watersheds.

No monitoring or research which involves the application of measures other than those prescribed in this Plan will occur without the concurrence of the Services.

6.2.5.5 Monitoring Thresholds for Rapid Response and Response Monitoring

Measurable thresholds that will trigger management responses when exceeded will be established for all Rapid Response and Response Monitoring projects and programs. Each project/program will have a “yellow light” and “red light” threshold that triggers different levels of review and response. Thresholds that have already been established and the process for establishing thresholds for the other projects/programs are described in this subsection.

6.2.5.5.1 Property-wide Temperature Monitoring

Yellow and red light thresholds have been established for Property-wide Temperature Monitoring and are as follows:

1. The yellow light threshold In Class I and II watercourses with drainage areas generally less than 10,000 acres is:

   a. A 7DMAVG water temperature above the upper 95% PI, as described by the regression equation: *Water Temperature* (^{o}C) *= 14.35141 + 0.03066461x square root of Watershed Area (acres);* or

   b. Any statistically significant increase in the 7DMAVG water temperature of a Class I or II watercourse where recent timber harvest has occurred, which cannot be attributed to annual climatic effects.

2. The red light threshold in Class I and II watercourses with drainage areas generally less than 10,000 acres is:

   a. A 7DMAVG water temperature above the upper 95% P. plus one °C, as described by the regression equation: *Water Temperature* (^{o}C) *=15.35141+ 0.03066461x square root of Watershed Area (acres)*;

   b. An absolute water temperature of 17.4 °C (relevant for fish); or

   c. A 7DMAVG water temperature that triggers a yellow light for three successive years.

6.2.5.5.2 Class II BACI Water Temperature Monitoring

The yellow light threshold/trigger for Class II BACI Water temperature monitoring is the determination of one or more statistically significant effects from harvesting in at least one-third of the treatment sites. The red light threshold is the determination of one or more statistically significant effects from harvesting in three successive years in at least one-third the treatment sites.

6.2.5.5.3 *Tailed Frog Monitoring*

Yellow and red light thresholds have been established for Tailed Frog Monitoring and are as follows:

1. The yellow light threshold is:

   a. Any statistically significant decrease in the larval populations of treatment streams relative to control streams, or

   b. A statistically significant downward trend in both treatment and control streams.

2. The red light threshold is:

   a. A statistically significant decline in larval populations in treatment streams relative to control streams in >50% of the monitored sub-basins in a single year;

   b. A statistically significant decline in treatment vs. control sites continuing over a three year period within a single sub-basin or;

   c. A statistically significant downward trend in both treatment and control streams that continues for three years or more.

6.2.5.5.4 *Southern Torrent Salamander Monitoring*

Yellow and red light thresholds have been established for Southern Torrent Salamander Monitoring and are as follows:

1. The yellow light threshold is:

   a. Any extinction of a sub-population, or

   b. An apparent decline in the average index of sub-population size in treatment sites compared to control sites.

2. The red light threshold is:

   a. A statistically significant increase in the extinction of treatment sub-populations relative to control streams, or

   b. A significant increase in the net rate of extinctions over the landscapes.

6.2.5.5.5 *Other Rapid Response and Response Monitoring Projects and Programs*

Yellow and red light thresholds will be established for Spawning Substrate Permeability Monitoring, Road-related Sediment Delivery (Turbidity) Monitoring, Class I Channel Monitoring, and Class III Sediment Monitoring as follows.

1. The thresholds will be established based on data collected from reference sites, either within stream reaches within the Plan Area that have been demonstrated to support populations of the Covered Species of interest whose abundance and persistence are similar to reference populations monitored outside the Plan Area, or reaches in which the habitat conditions have been shown to be within the range of good conditions based on studies done outside the Plan Area.

2. If the list of potential reference sites is greater than 12, a spatially distributed randomized sample of sites will be chosen for monitoring; if the list of reference sites is 12 or less, then all reference sites will be monitored.

3. While the reference site data are being collected, Green Diamond will collect data on a variety of potentially explanatory covariates that may reduce the natural variation observed in the response variable.

4. Prior to setting the thresholds for a program, an appropriate statistical analysis will be conducted to remove the effects of any relevant environmental covariates, and the 95% confidence or prediction interval will be calculated. Depending on the response variable of interest, either the lower or upper 95% confidence or prediction interval endpoint in any given year will be used to trigger the yellow light threshold. Depending on the temporal correlation of the response variable, three to five years of a yellow light condition will trigger a red light threshold, or one year exceedence of the 99% confidence interval endpoint.

5. Thresholds for Spawning Substrate Permeability Monitoring and Road-related Sediment Delivery will be established within five years of the date that each is fully operational; thresholds for Class I Channel Monitoring and Class III Sediment Delivery Monitoring will be established within ten years of the date that each is fully operational.

6.2.5.6 Phase-in Period for Effectiveness Monitoring

Except as noted herein, the monitoring projects and programs are continuations and expansions of the studies described in Section 4.3 of this Plan. The exceptions are 6.2.5.1.3, 6.2.5.1.4, 6.2.5.3.1, 6.2.5.3.8, and those portions of 6.2.5.4 not tied to other Effectiveness Monitoring studies. Continuations and expansions of existing projects and programs will be implemented in their identified time lines as of the effective date of the Permits. Design and implementation of the other projects and programs (6.2.5.1.3, 6.2.5.1.4, 6.2.5.3.1, 6.2.5.3.8, and portions of 6.2.5.4) will occur in phases during Plan implementation. Excluding those aspects of the Experimental Watersheds Program that will be developed in response to monitoring results, all Effectiveness Monitoring projects and programs will be ready for implementation by the end of the third year following the effective date of the Permits.

6.2.6 Adaptive Management Measures

Green Diamond will initiate reviews and implement adaptive management measures in response to the triggers and within the range of changes identified within this subsection. Green Diamond also will establish an Adaptive Management Reserve Account (AMRA) to fund adjustments over the term of the Plan and Permits. No adaptive management change will be made unless there is a sufficient balance in the AMRA to make the change.

6.2.6.1 Adaptive Management Triggers

Green Diamond will institute the adaptive management process in the event of a yellow light threshold trigger, a red light threshold trigger, SSS trigger, or results from the experimental watersheds monitoring program that identify an appropriate change in the conservation measures**.**

6.2.6.1.1 Yellow Light Threshold Trigger

When a yellow light threshold for Rapid Response or Response Monitoring is exceeded, the following will occur:

1. Exceedence of a yellow light threshold will trigger an internal assessment to determine the cause of the exceedence.

2. Green Diamond will design the internal assessment to identify the cause behind the yellow light condition, its relationship to management activities, and what, if any, changes to management are appropriate. Green Diamond will use all available information to make this determination, including results from other monitoring sites throughout the Plan Area, and results from other monitoring projects where applicable.

3. Green Diamond will notify NMFS and USFWS within 30 days after the analysis indicates that any yellow light threshold has been exceeded. Green Diamond will request the technical assistance of NMFS and USFWS in determining the cause of the exceedence. All available information will be used to make this determination.

4. Any and all management changes resulting from the yellow light threshold must be made with the concurrence of the Services and a management change will only be made to the extent of the availability of a balance in the AMRA.

5. The procedures followed, conclusions reached, and any changes in management undertaken to address a yellow light condition will be documented in a report to the Services.

6.2.6.1.2 Red Light Threshold Trigger

When a red light threshold for Rapid Response or Response Monitoring is exceeded, the following will occur:

1. In the event that a red light threshold is exceeded, Green Diamond will notify the Services within 30 days of that determination.

2. Green Diamond will endeavor to obtain input from the Services regarding identification of any feasible interim changes in the Operating Conservation Program in the area in which the red light threshold is exceeded that could be made by Green Diamond to avoid management-caused exacerbation of the red light condition pending a full assessment of the causes of the exceedence.

3. An in-depth assessment with the full participation of the Services will be conducted to determine the likely causes of the red light threshold condition, and appropriate management changes to address the issue.

4. A scientific review panel which consists of independent experts on the subject at hand will be assembled at the request of either party if Green Diamond and the Services cannot agree on the course of action to address the red light condition.,

   a. The role of the panel will be to provide technical analysis of the data and any other available information to the extent it is relevant to the conservation of the Covered Species in the Plan Area.

   b. The panel will attempt to reach conclusions on whether the exceedence of the red light threshold was management induced.

   c. The panel will have three members, one appointed by the Services, one by the Green Diamond, and a third selected by the first two panel members.

   d. Adaptive management changes will not be made unless the analysis is conclusive in the opinion of a majority of the scientific review panel; if the results are not conclusive, the monitoring will be extended for another five years and the monitoring protocol will be evaluated to insure that appropriate methodologies are being applied.

5. Just as the biological goals and objectives set forth in Section 6.1 guided the development of the prescriptions set forth in the Plan, Green Diamond will look to the applicable goals and objectives to guide the development of any changes to the prescriptions pursuant to a red light trigger, using the information gained from the monitoring and adaptive management processes.

6.2.6.1.3 SSS Triggers

If monitoring determines that the SSS default widths and slope gradients set by the SSS Delineation study need to be changed, the following will occur:.

1. A scientific review panel will be convened to analyze the data gathered during the 15-year SSS Assessment.

   a. The panel will have three members, one appointed by the Services, one by the Green Diamond, and a third selected by the first two panel members.

b. If the SMZ prescriptions are determined to be less than 70% effective at reducing management-related sediment delivery (by volume) from shallow landslides to the stream network compared to landslides in appropriate historical clearcut reference stands in the opinion of two of the three experts, then the default SSS prescriptions will be changed based on the data analysis to make these defaults 70% effective.

6.2.6.1.4 *<u>Experimental Watersheds Program Triggers</u>*

The results of one or more designed experiments under the experimental watersheds program may indicate that a conservation measure could or should be modified. If Green Diamond believes that is the case, it will convene the scientific review panel to analyze the findings and recommend whether a change is warranted. An adaptive management change will not be made as the result of one or more experimental watershed program experiments unless the results conclusively suggest that a conservation measure should be changed.

6.2.6.2 Range of Adaptive Management Changes

Adaptive management changes that may be made in response to the triggering events identified in 6.2.6.1 are as follows.

1. RMZ widths and prescriptions may be changed to fall anywhere within the following range of options (up to the balance of the account): state forestry regulations applicable at the time the change is made (lower bound) to interim Northwest Forest Plan riparian measures (upper bound).

2. SSS default widths and slope gradients may be changed as a result of the SSS delineation study (6.2.5.3.2). Changes to the SSS default widths and slope gradients as a result of the initial mass wasting assessments are not subject to the AMRA.

3. SMZ default prescriptions may be changed after the 15-year SMZ assessment.

4. The following road management prescriptions may be changed:

    a. The rate of accelerated high and moderate priority sites within the first 15 years may be increased;

    b. Drainage structure prescriptions set forth in 6.2.3.6 may be changed; and

    c. Erosion control prescriptions set forth in 6.2.3.8 may be changed.

6.2.6.3 Adaptive Management Reserve Account

Green Diamond will establish the AMRA to fund the adjustments that may be made during the life of the Plan.

1. The AMRA will be charged with an opening balance of 1,550 Fully Stocked Acres (FSA), and the AMRA account balance will be factored in FSA throughout the term of the Plan and Permits. If the balance falls to zero through the debit process described below, then no more debits will be made until the account is credited.

2. FSAs will be comprised of a stand with 42,000 board feet per acre (50-year stand with an index of 350 square feet of basal area) and a species composition of 50% redwood, 34% Douglas-fir, 10% white woods, and 6% hardwoods. The current California State Board of Equalization (SBE) Harvest Value Schedule will be used to translate FSA to equivalent specific road management plan prescriptions. The percentage of SBE harvest categories will be 60% cable yarding, 35% tractor, and 5% helicopter.

3. The AMRA will be used to accommodate changes in riparian protection measures from conclusive results of the monitoring program.

4. Any modification of the current riparian measures described in Section 6.3.1, areas included in SMZs, or specific road management plan prescriptions will be credited to or debited from the AMRA. Debits and credits will be reflected in the account on an on-going basis as the account acres are retained or harvested, and the account will be summarized biennially. The balance within the account will fluctuate proportionately to the addition and deletion of properties.

5. Depletion of the AMRA balance by translating FSA to funds for road prescriptions is limited to 2% per year of the opening balance (i.e., the equivalent of 31 FSA). There is no limit on the annual use of the AMRA for RMZ or SMZ modifications.

6.2.7 Implementation Monitoring Measures

6.2.7.1 Internal Plan Compliance Team

1. Green Diamond will form and maintain an internal compliance team consisting of a Plan Coordinator working in conjunction with Green Diamond's internal forestry, fisheries, wildlife, and geologic staff.

2. Green Diamond will staff the Plan Coordinator position with a person who is academically trained and experienced as a fisheries biologist/hydrologist or a fluvial geomorphologist.

3. Green Diamond will ensure that the Plan Coordinator reviews each proposed THP during its development, and informs the RPF preparing the THP on the appropriate status of watercourses in the THP area and the occurrence of any special restrictions and/or mitigations in the area (e.g., unstable slopes, inner gorges or CMZs). Green Diamond also will ensure that the RPF completes a pre-harvest checklist during THP development that covers all necessary compliance elements.

4. During THP development, if there is any uncertainty about the appropriate status of streams (e.g., watercourse classification, presence of amphibians, presence of fish, anadromous or resident species, location of monitoring sites, etc.) or the existence of special restriction/mitigation areas, Green Diamond will ensure that the Plan Coordinator directs the appropriate field personnel to do the appropriate field assessment/survey. When additional field expertise is called upon by the Plan Coordinator or RPF to delineate some special restriction/mitigation area, Green Diamond will ensure that the designated expert flag or otherwise designate the appropriate areas that will require special treatment/mitigation. When additional field expertise is not required, Green Diamond will ensure that the RFP preparing the THP or his/her designee flag the appropriate RMZs or other special mitigation areas in the field.

5. Following completion of a first draft of the THP, Green Diamond will assure that the Plan Coordinator reviews the THP for accuracy and completeness. For every THP within the Plan Area, the Plan Coordinator or compliance team members will prepare for internal use and maintain on file documentation indicating compliance with the Plan.

6. Following state review and approval of the THP, Green Diamond will direct the RPF to insure that the THP is actually implemented as written, and to fill out a THP post-harvest completion form documenting compliance of the THP with the provisions of the Plan, and to submit the form to the Plan Coordinator. Green Diamond will direct the Plan Coordinator to review the form to insure compliance.

6.2.7.2 THP Notice of Filing and THP Area Map

At the time of submitting any proposed THP within the Plan Area to CDF, Green Diamond will provide an informational copy of the THP notice of filing and a map of the THP area to the Services.

6.2.7.3 "Likelihood of Recruitment" Audit

Green Diamond gathered data to estimate the relative change in potential LWD recruitment before and after harvest, to assess the effectiveness of the RMZ measures in terms of potential LWD recruitment to Class I watercourses (see Appendix B). These data were collected and summarized as changes in 'full tree equivalents' (FTE). The findings from this assessment work demonstrated that the RMZ measures detailed in Section 6.2.1 of the AHCP/CCAA were effective in minimizing the loss of trees through harvesting practices that would potentially recruit to the stream as LWD. However, the language used to communicate the "likelihood to recruit" judgment may be susceptible to interpretation so to ensure consistent application of this language, the Services may audit the efficacy of the RMZ measures annually, by selecting three to five harvest units and requiring Green Diamond to gather before/after data and calculate an estimate of relative change in FTE. The protocol used in the potential recruitment of LWD report (Appendix B) will be used in any future audits. If the results of the audit indicate that the FTE values were reduced by more than 3.2% post-harvest, then the Services may call a meeting with Green Diamond to recalibrate the interpretation of the likelihood to recruit judgment in the field. The 3.2% post-harvest FTE value reduction is a trigger for recalibration of the interpretation. If an agreement cannot be reached in the recalibration among the Services and Green Diamond, then the dispute resolution provisions of Section 6.2.7.6 will be initiated.

6.2.7.4 Biennial Reports

Green Diamond will prepare and submit a biennial report to the Services on March 1 following the first full year after the effective date of the Plan and every two years thereafter during the term of the Plan. These reports will summarize compliance with the Operating Conservation Program, the results of the Effectiveness Monitoring Measures set forth in 6.2.5, and any scheduled field reviews (as provided in 6.2.7.4) conducted in the period since the last report. The post-harvest completion forms described in 6.2.7.1 will be part of the biennial report to the Services.

6.2.7.5 Scheduled Reviews

Green Diamond will schedule annual meetings with the Services for the first five years of the Plan as described in the IA. In the second and fourth years, the annual meeting will be followed with a field review of implemented conservation measures to allow technical evaluation of conservation measure implementation. In the event that the Services determine as the result of a field review that the conservation measures are not being implemented in accordance with this Operating Conservation Program, then recommendations will be developed with the Services regarding implementation and additional field reviews may be scheduled.

6.2.7.6 Dispute Resolution

Green Diamond and the Services recognize that reasonable differences of opinion may arise from time to time regarding implementation of various elements of the Operating Conservation Program. Should a dispute arise at the technical level, either of the Services or Green Diamond will have the option of calling a meeting to discuss and attempt to resolve the issues at that level. If the Services call a meeting under this provision, Green Diamond would arrange to meet within one month of receiving such notice. Should it be necessary to resolve the issues at a policy level following an initial meeting at the technical level, Green Diamond would arrange to meet at the policy level within one month of receiving a request. Green Diamond would have the right to request meetings for the same purpose and the Services’ commitment to engage in this process will be incorporated in the dispute resolution provisions in the IA. The Service’s participation in this process would be in the nature of providing technical assistance. Green Diamond’s and the Services’ rights and obligations regarding informal dispute resolution and matters that could be addressed in such a process would remain as provided in the IA.

6.2.8 Special Project

6.2.8.1 Transport of Anadromous Salmonids around Barriers

Green Diamond will undertake one project in the Plan Area involving the trapping and transportation of coho salmon that are native to the stream system around a barrier during spawning season for a ten-year period. Prior to undertaking the project, Green Diamond will evaluate the selected stream to determine that salmonids residing in the basin above the barrier will not be adversely affected by the project. The translocation project will include monitoring of subsequent spawning, utilization of the summer rearing habitat by the juvenile fish, and out-migrant trapping to document the number of smolts leaving the system. At the end of the ten-year period Green Diamond will review the effectiveness of the project. Additional projects in other areas, involving either coho salmon or other covered fish species, will be carried out as part of the Plan's conservation measures in Green Diamond's sole discretion after evaluating the initial project's success, subject to additional pre-project stream evaluations.

6.2.9 Measures for Changed Circumstances

Five types of changes are identified in the Plan as potential "changed circumstances" as defined in applicable federal regulations and policies:

1. Fire covering more than 1,000 acres within the Plan Area or more than 500 acres within a single watershed within the Plan Area, but covering 10,000 acres or less;

2. Complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream; but less than 900 feet of trees within an RMZ, due to a windstorm;

3. Loss of 51% or more of the total basal area within any SSS, headwall swale, or Tier B Class III watercourses as a result of Sudden Oak Death or stand treatment to control Sudden Oak Death*;*

4. Landslides that deliver more than 20,000 cubic yards and less than 100,000 cubic yards of sediment to a channel; and

5. Listing of a species that is not a Covered Species but is affected by the Covered Activities.

As described in this subsection, Green Diamond also has considered the potential for floods and earthquakes to have effects that would constitute "changed circumstances."

If changed circumstances occur, Green Diamond will implement supplemental prescriptions set forth in this subsection. In some cases, the conservation measures set forth in other parts of Section 6.2 are adequate to address changed circumstances. No supplemental prescriptions are included for those changed circumstances.

6.2.9.1 Fire

Fire suppression is not a Covered Activity. However, if a fire covering less than 10,000 acres occurs in the Plan Area during the term of the Plan, Green Diamond might take all measures reasonably necessary to extinguish such a fire, including measures that deviate from the other Section 6.2 measures. The strategy for responding to and suppressing forest fires is generally established by CDF, and Green Diamond may have little ability to influence such strategy. However, to the extent reasonably possible and where consistent with the primary goal of containing and extinguishing the fire, Green Diamond will encourage the development of a fire-response strategy that is consistent with the other Section 6.2 measures and that furthers rather than diminishes the functions that such measures have been designed to provide.

If the fire involves more than 1,000 acres within the Plan Area, or involves more than 500 acres within a single watershed within the Plan Area, Green Diamond will provide both Services with information regarding the fire within 30 days. Once such a fire is extinguished, unless such fire is an “unforeseen circumstance” (i.e., exceeds 10,000 acres in the Plan Area), Green Diamond will apply the following supplemental prescriptions on its fee-owned lands within the Plan Area:

1. Trees damaged or killed outright by fire, including those in riparian and stream side management zones, will be considered by Green Diamond for salvage. Removal of standing dead or damaged trees and downed trees will be conditioned by the application of the conservation standards in Section 6.2 regarding likely to recruit and salvage within RMZs.

2. Salvage of trees downed or dead by fire must comply with state law. In addition, the conduct of any salvage operations within an RMZ or SMZ will be done with reasonable care to minimize soil erosion, to retain structural features that contribute to bank or slope stability, and to retain standing dead trees that will contribute to the recruitment of LWD to watercourses within the area affected by the fire.

3. Reforestation of any RMZ or SMZ affected by the fire will be implemented as soon as reasonably possible.

6.2.9.2 Wind

Small-scale windthrow is not expected to have a long-term significant adverse impact on stream shading or water temperatures and will have the beneficial effect of introducing large woody debris into streams that currently lack this habitat-forming element. Thus, small-scale windthrow does not pose so substantial an impact as to threaten an adverse change in the status of any Covered Species, and may actually benefit aquatic species through natural modifications to stream habitat. Based on historical experience within the HPAs, a windstorm that results in a complete blow-down of 900 feet or more, measured along the length of the stream, of trees within an RMZ, is not reasonably foreseeable, and would be considered an unforeseen circumstance.

If a windstorm results in a complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream, Green Diamond will provide both Services with information regarding such windthrow within 30 days of its discovery. With respect to such windthrow, unless the windstorm constitutes an “unforeseen circumstance” as defined above, Green Diamond will apply the following supplemental prescriptions within the Plan Area:

1. Other than trees that are downed or dead due to the wind, Green Diamond will not be allowed to remove more timber than it would have been allowed to remove under the other portions of Section 6.2 had no windthrow occurred in the stand, unless the Services determine that the removal of such additional timber would not materially reduce the functional benefit of such habitat for any Covered Species.

2. Salvage of trees downed or dead by wind must comply with state law. In addition, the conduct of any salvage operations within an RMZ or SMZ will be done with reasonable care to minimize soil erosion, to retain structural features that contribute to bank or slope stability, and to retain standing dead trees that will contribute to the recruitment of LWD to watercourses within the area affected by the windstorm.

3. Reforestation of any RMZ or SMZ affected by the windstorm will be implemented as soon as reasonably possible.

6.2.9.3 Earthquakes

The Plan Area is located in an area that is well known for frequent, but generally small, earthquakes. Earthquakes are quite common and are generally of a relatively insignificant magnitude, typically magnitude 2 to 3 on the Richter scale. Occasionally, greater magnitude events occur, but they are impossible to predict. In the forest environment, earthquakes of magnitude 6 or less on the Richter scale produce little, if any, visible change, and apparently no significant impact to wildlife or fishery habitat. It is possible that some trees have fallen as a result of earthquake activity, however fallen trees in the forest are generally attributed to wind or landslide effects. Regardless of cause, fallen trees in the forest are not of so significant a number as to require additional mitigations and/or changes in the management scenario or restrictions outlined in this Plan. While it may be speculated that localized landslides or other earth movements resulted from these earthquakes, there are no data to document that this occurred within the Plan Area. Landslides caused by earthquakes are addressed separately in this “Changed Circumstances” subsection. Earthquakes of such magnitude (greater than magnitude 6 on the Richter scale) that may substantially alter habitat status or require additional conservation or mitigation measures in excess of those already included in the Plan, are not reasonably foreseeable during the life of the Plan, and would be considered “unforeseen circumstances.”

6.2.9.4 Floods

Floods are a natural and necessary component of aquatic and riparian ecosystems but also can cause damage to forest transportation systems (e.g. watercourse crossings, bridges, roads) and forest stands. The frequency with which floods occur and their relative magnitude are inversely related. Large floods are infrequent while smaller floods can go unnoticed and may recur as often as once every year. Severe floods may occur once in 15 or even 100 years. A flood that is of lesser magnitude than a 100-year recurrence interval event (i.e., less than a 100-year flood) is part of the expected normal ecology of the forest. The conservation measures in the other portions of Section 6.2 are adequate mitigation for such an event. Based on historical evidence in the Plan Area, a flood that is equal or greater in magnitude than a 100-year recurrence interval event is not reasonably foreseeable during the term of this Plan, and thus it would be considered an “unforeseen circumstance.”

6.2.9.5 Pest or Pathogen Infestation

Insects and diseases can usually be kept under control through careful forest management and proper treatments. Site quality and nutrient availability play a key role in forest health and vigor. Because much of the Plan Area is of high site quality, infestations are less likely to occur within the healthy forests that occupy these sites.

Infestations by generally recognized types of forest pests or pathogens are not be expected to have significant adverse effects on the Covered Species within the Plan Area, will be adequately addressed by the other measures in Section 6.2, and are not considered changed circumstances. A possible exception is the recently identified sudden oak death disease caused by *Phytophthora ramorum*. If 51% or more of the preharvest total tree basal area within any SSS, headwall swale, or Tier B Class III watercourses is lost as a result of sudden oak death or stand treatment to control sudden oak death, on site review will be made by an RG and RPF to develop additional prescriptions to compensate for the loss of hardwood root strength through retention of additional conifers. An infestation of sudden oak death that crosses to redwood or other conifers or infestation by other pests that has significant effect on the forest ecosystem within the Plan Area are not reasonably foreseeable and would be considered an "unforeseen circumstance."

6.2.9.6 Landslides

Landslide rates and processes differ in the various geologic settings across the Plan Area. In the Coastal Klamath and Blue Creek HPAs, shallow rapid landslides are the most common kinds of landslides, whereas the upstream portions of the Mad River HPA are pervasively underlain by deep-seated landslides and earthflows. Still other HPAs are subject to both deep-seated landslides and shallow landslides. These different landscapes with their particular mass wasting processes present varying sensitivities to management activities. Conservation measures within this Plan were designed to address sediment and other habitat effects from past landslides, to take advantage of future naturally-occurring landslides, and through a combination of stream buffer prescriptions, land management restrictions, slope stability analyses, and stream monitoring, to avoid significant adverse impacts from management related landslides and mass wasting events in the future.

Based on historic experience within the Plan Area, a landslide that results in the delivery of more than 100,000 cubic yards of sediment is not reasonably foreseeable and is considered an unforeseen circumstance. If a landslide results in the delivery of more than 20,000 cubic yards of sediment to a channel (either from a source area or from combined source area and propagated volumes), Green Diamond will provide both Services with information regarding such landslide within 30 days of its discovery. With respect to such a landslide, and unless this landslide constitutes an "unforeseen circumstance", i.e. delivery of more than 100,000 cubic yards, Green Diamond and the Services will confer to determine if it is reasonably possible that management activities on or adjacent to the area of the landslide could have materially contributed to causing such landslide. If either Service or Green Diamond concludes that it is reasonably possible that management activities materially contributed to the occurrence of such a landslide, Green Diamond, at its own expense, will retain a qualified geo-technical expert to analyze the slide and develop a written report. The report will include, at a minimum, an assessment of the factors likely to have caused the slide and any changes to management activities which had they been implemented on or adjacent to the area of the slide would have likely prevented the slide from occurring. Upon receipt of such a report, Green Diamond will forward the report to the Services. Where appropriate, the recommendations set forth in the report may form the basis for adaptive management changes to the SSS measures.

6.2.9.7 New Listing of Species that are Not Covered Species

The preamble to the No Surprises rule states that the listing of a species as endangered or threatened could constitute a changed circumstance. Therefore, if a species is listed under the federal ESA subsequent to the effective date of the Permits, and that species (i) is not a Covered Species, and (ii) is affected by the Covered Activities, such listing will constitute a changed circumstance. Where a new listing that constitutes a changed circumstance occurs, Green Diamond will follow the procedures set forth in the IA.

6.2.10 Measures for Unforeseen Circumstances

All other changes in circumstances affecting a Covered Species or its habitat in the Plan Area that are not designated changed circumstances in Section 6.2.9.1 are considered not reasonably foreseeable in the context of this Plan. For purposes of this Plan such changes, including those described in Section 6.2.9.1 as such, are Unforeseen Circumstances. In the event that Unforeseen Circumstances occur, modifications to the Plan will be made only in accordance with the procedures set forth in the IA.

6.3 RATIONALE AND ANALYSIS UNDERLYING GREEN DIAMOND'S OPERATING CONSERVATION PROGRAM

This Section provides a detailed description of the components and rationale of the conservation programs. The measures identified in the Operating Conservation Program, Section 6.2, are presented in the context of the biological goals and objectives, presented in Section 6.1 with a more detailed summary of the purpose and intent of the measures. Although this section is not part of the Operating Conservation Program itself, it is included to provide the basis for and intent of the specific measures included in the Operating Conservation Program, so as to assist in guiding its implementation.

6.3.1 Riparian Management Measures

As described in Section 3, the riparian zone adjacent to streams is a vital component of salmonid and amphibian habitat, providing temperature control, nutrient inputs, channel stability, sediment control, and LWD recruitment. Following the distinctions used in California's FPRs, riparian management measures will vary among three broad classes of watercourses, Class I, Class II, and Class III watercourses. Further divisions within some watercourse classes are based on their size (Class II watercourses) and side slopes/terrains (Class III watercourses) and are represented in Table 6-1. Class I watercourses include all current or historical fish-bearing watercourses and domestic water supplies within 100 feet downstream of the intake. Class II watercourses contain no fish, but support or provides habitat for aquatic vertebrates. Seeps and springs that support or provide habitat for aquatic vertebrates will also be considered Class II watercourses with respect to the conservation measures. Class III watercourses are small seasonal channels which do not support aquatic species, but have the potential to transport sediment to Class I or II watercourses.

The classification of streams, springs, and seeps occurs on the ground through a physical inspection of the watercourses. The initial inspection may be the result of fish or amphibian surveys by a trained biologist, or by a RPF during the initial layout of the THP. The documentation of fish or other aquatic vertebrate species permanently designates the watercourse to an appropriate class such that it is never “downgraded” to a lesser class. In the classification process a Class I designation is given to any watercourse even if fish can only use the watercourse seasonally. In watercourses which are clearly not fish bearing, the presence of habitat for other aquatic vertebrate species is sufficient to give a Class II designation to a watercourse even if no animals are observed. If the initial inspection of watercourses is being made by a RPF (something that typically only happens in Class II and III watercourses), any uncertainty regarding the appropriate watercourse classification is resolved by a trained biologist. Watercourses and wet areas that have been inadvertently created by harvesting and road building activities (e.g. interception of an aquifer that creates a continuously flowing inboard ditch) range in function from providing essential habitat for fish and non-fish aquatic species, to sites that have the potential to have a significant negative impact on aquatic resources (e.g., water diverted onto a landing that could result in saturation and ultimate failure of the fill). As a result, protection associated with these sites will be determined on a case-by-case basis. If the feature has no potential to have a negative impact and provides habitat for fish or non-fish aquatic species, it should be evaluated for protection. For flowing inboard ditches, the appropriate protection may include eliminating periodic ditch cleaning with some canopy retention depending on topographic shading. Wet areas may be protected with a 25-foot EEZ, but overstory canopy retention would normally not be required, unless the site is known to provide critical habitat for a cold-water adapted species. Manmade watercourses and wet areas that have the potential to harm aquatic resources will be redirected or drained as part of adjacent timber operations or as part of the road implementation plan. Conservation measures designed to maintain and enhance the key riparian functions in each of these watercourse types are described below. Conservation measures associated with unique channel types such as CMZs and floodplains are addressed in Section 6.3.1.4.

6.3.1.1 Maintenance of Riparian Function in Class I Watercourses

All Class I watercourses will have a RMZ of at least 150 feet (slope distance) on each bank (Table 6-1). The RMZ width will be measured from the first line of perennial vegetation (the watercourse transition line as defined in the Glossary), or from the outer CMZ edge, where applicable. The outer zone of the RMZ will be extended, where necessary, to cover the entire floodplain and an additional 30-50 foot beyond the outer edge of the floodplain. The additional buffer outside the floodplain will depend on the slope immediately adjacent to the floodplain as follows: 30 feet for slopes of 0-30%; 40 feet for slopes of 30-60% and 50 feet for slopes >60%. Floodplains and CMZs are defined in Section 6.3.1.

Table 6-1. Watercourse classes and minimum buffer widths.

Watercourse Class	Further Subdivisions	Total Width[2]	Inner Zone Width	Outer Zone Width
Class I	None	150 ft RMZ	50-70 ft	80-100 ft
Class II	2nd order or larger	100 ft RMZ	30 ft	75 ft
	1st order[1]	75 ft RMZ	30 ft	45 ft
Class IIIA	Dependent on Terrains[3]	30 ft EEZ	NA	NA
Class IIIB	Dependent on Terrains[3]	50 ft EEZ plus tree retention	NA	NA

Notes
1 Some Class II-1 watercourses will receive the protections of Class II-2 watercourses. See Figure 6-2 and Section 6.3.1.2 for details.
2 one side.
3 For Class III watercourses see Section 6.3.1.3.1.3 for details of slope and terrain criteria

The RMZ for Class I watercourses will be divided into an inner zone and an outer zone. The width of the inner zone will be adjusted for slope according to Table 6-2. The outer zone will extend from the outside limit of the inner zone edge to at least 150 feet from the bankfull channel (or CMZ edge) respectively.

Table 6-2. Adjustments to the inner zone width for side slopes.

Side Slopes	Inner Zone Width
0-30%	50 feet
30°-60%	60 feet
>60%	70 feet

6.3.1.1.1 Conservation Measures within All Class I RMZs

During the life of the Plan, Green Diamond will carry out only one harvest entry into Class I RMZs, which will coincide with the even-aged harvest of the adjacent stand. Green Diamond will apply the restrictions in this subsection of Section 6.3.1.1.1 during such entry. If cable corridors through RMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the RMZs will be limited to cable corridors only. Any cable roads established in the RMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stands. The minimum conservation measures within all Class I RMZs are described below. Where features of instability (as defined in Section 6.3.2) are identified within or immediately adjacent to the RMZ, additional site-specific conservation measures for the identified area will be applied as well.

1. At least 85% overstory canopy closure will be retained on the inner zone.

2. If the inner zone is predominately composed of hardwoods (based on stand surveys defined as <15 conifer stems per acre >16 inches dbh), no conifers will be taken from in the inner zone. In addition, harvest within RMZs would not reduce the conifer stem density to less that 15 conifer stems > 16 inches dbh per acre.

3. At least 70% overstory canopy closure will be retained in the outer zone.

4. Overstory canopy closure is the overhead shade provided by the crowns of intermediate, co-dominant, and dominant trees in the stand (for canopy definitions see Berbach et al. 1999). Compliance with overstory canopy standards will be measured using the current CDF protocol for canopy cover sampling (Robards 1999).

5. The following criteria listed below will be used to identify trees within the RMZ as potential candidates to be marked for harvest due to their low likelihood of recruitment to the watercourse. (The determination of trees to be marked within the RMZ will be predicated on ensuring that overstory canopy retention standards and slope stability measures are met (see sections 6.2.1 and 6.2.2), as well as ensuring that trees that are likely to recruit to the watercourse are not marked for harvest.)

    a. Tree has an impeded “fall-path” to the stream (e.g., upslope family members of a clonal group blocked by downslope stems); or

    b. Tree or the majority of the crown weight of the tree is leaning away from stream and the tree is not on the stream bank or does not have roots in the stream bank or stream; or

    c. The distance of the tree to the stream is greater than the height of the tree; or

    d. Tree is on a low gradient slope such that gravity would not carry the fallen tree into the stream or objects such as trees and large rocks impede its recruitment path; or

    e. Tree is not on an unstable area or immediately downslope of an unstable area; or

    f. Harvesting of the tree will not compromise the stream bank or slope stability of the site or directly downslope of the site.

6. In addition to the canopy requirements, no trees will be harvested which contribute to maintaining bank stability. The distinction in retention levels between inner and outer zones of the RMZ will be reduced on increasingly steeper slopes (generally >50%), because of the increased potential for trees to recruit at greater distances from the stream. Redwoods will be preferentially harvested over other conifers, because of their ability to sprout from the remaining root system.

7. The Class I RMZ will be an equipment exclusion zone (EEZ), except for a) existing roads and landings; b) construction of new spur roads to extend operations outside the RMZ; c) road watercourse crossings; d) skid trail watercourse crossings; and e) designated skid trail intrusions.

a. The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

   1) Construction and use of skid trail watercourse crossings within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the RMZ over establishing new skid trail watercourse crossing sites in the RMZ.

   2) Skid trail watercourse crossings shall not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

   3) Within the Class I RMZ, trees may be felled to facilitate skid trail watercourse crossing construction and use. All such felled trees will be retained as downed wood in the RMZ and will be counted towards estimated reductions in full tree equivalent (FTE) values and reductions in potential recruitment of LWD.

   4) Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.3.7).

b. The exception for skid trail intrusions is only applicable when the following conditions are met:

   1) RMZ hillslopes are less than 25%.

   2) Construction and use of skid trails within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trails in the RMZ over construction of new skid trails in the RMZ.

   3) Skid trails will not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

   4) Within the RMZ, only trees less than 10 inches in dbh may be felled to facilitate skid trail use. All such felled trees will be retained as downed wood in the RMZ and will be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

   5) Green Diamond has submitted to the Services an explanation, justification, and map of the proposed skid trail and use in the RMZ as part of the informational copy of the THP notice of filing (see Section 6.3.7).

   The intent is to minimize the effects of disturbances to RMZs that would result in degradation of stream habitat.

8. Any ground disturbance larger than 100 square feet caused by management activities will be mulched and seeded or otherwise treated to reduce the potential for sediment delivery. Seed will be spread at a rate of at least 30 pounds per acre, and mulched to a depth of at least 2 inches (before settling) with 90% surface coverage. The intent is to minimize sediment delivery from sheet and gully erosion. Hand constructed firelines are not subject to the 100 square foot ground disturbance standard. Hand constructed firelines are established by removing the duff and litter layers to expose mineral soil but does not disturb the mineral soil. Other measures will be applied as necessary to ensure that hand constructed firelines do not deliver sediment to watercourses.

9. Trees may be felled within RMZs to create cable yarding corridors as needed to ensure worker safety. These trees will be part of the harvest unit and their removal will be subject to the canopy requirements described above. This measure supercedes item 5 above (retention based on likelihood to recruit) when required by law.

10. All safe snags will be retained (unsafe snags will be felled and left onsite).

11. No salvage will occur in the inner zone. If any part of the salvageable piece is in the inner zone, the entire piece will be left.

12. Salvage will be limited to downed trees in the outer zone and will occur only if all of the following criteria are met:

    a. The wood is not currently or unlikely in the future to be incorporated into the bankfull channel; including wood located below unstable areas,

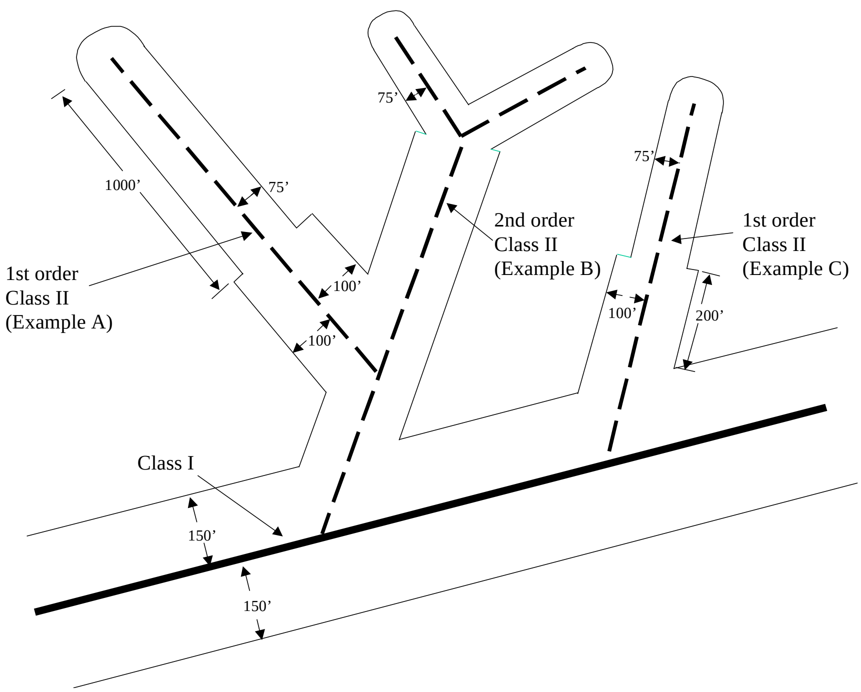
    b. The wood is not contributing to bank or slope stability, or

    c. The wood is not positioned on a slope such that it can act to intercept sediment moving towards the stream

13. Salvage will be prohibited on the floodplain or CMZ.

6.3.1.2 Maintenance of Riparian Function in Class II Watercourses

All Class II watercourses will have a RMZ of at least 75 or 100 feet on each bank. The 75-foot minimum buffer will be used on the first 1,000 feet portions of the smallest (1st order) Class II watercourses, and the 100-foot minimum buffer used on all 2nd order or greater Class II watercourses. Downstream of this 1000-foot section, the RMZ will be expanded to at least 100 feet. The specific applications of these buffers are depicted in Figure 6-2 and explained in the examples provided below. All Class II RMZs will be divided into an inner zone and an outer zone. The inner zone will be the first 30 feet, as measured from the first line of perennial vegetation (the watercourse transition line as defined in the Glossary). The outer zone will be the remaining 45 feet or 75 feet (depending on stream order).



Example A
The RMZ on the first 1000 feet of a 1st order channel, (a small, typically intermittent, headwater stream with no tributaries), will be at least 75 feet. Downstream of this first 1000-foot section, the RMZ will expand to at least 100 feet.

Example B
All 2nd order or greater Class II watercourses will have a minimum 100-foot RMZ. Example B shows two first order channels, with 75-foot RMZs, joining to form a 2nd order channel, which has a 100-foot RMZ.

Example C
Where a 1st order Class II watercourse flows directly into a Class I watercourse, the Class II RMZ will be at least 100 feet on each bank for the first 200 feet Of channel upstream of the Class I RMZ boundary, after which the Class II RMZ will be dictated by the length of the stream, as per example A.

Figure 6-2. Class II riparian management zones.

The current information in Green Diamond's GIS database was used to calculate the proportions of total Class II watercourse lengths with 75 and 100 feet RMZ widths respectively in three randomly selected watersheds on Green Diamond's ownership in the HPAs. The results are presented in Table 6-3. This preliminary assessment indicates that 100-foot RMZs would apply on approximately 61% of the assessed Class II watercourse lengths and 75-foot RMZs would apply on the remaining 39%.

Table 6-3. Application of the Class II RMZ widths in three previously assessed watersheds.

Watershed (HPA)	Total Class II watercourse length (miles)	Percent of total length with a 100' RMZ	Percent of total length with a 75' RMZ
Carlotta (Eel River HPA)	7.7	69.4%	30.6%
Dominie Creek (Smith River HPA)	21.0	45.1%	54.9%
NF Mad River (NF Mad River HPA)	33.8	67.9%	32.1%
Total	62.5	60.8%	39.2%

General Class II RMZ Conservation Measures

1. During the life of the Permits, there will only be a single harvest entry into Class II RMZs, which will coincide with the even-aged harvest of the adjacent stand. Green Diamond will apply the restrictions in this subsection of Section 6.3.1.2.1 during such entry. If cable corridors through RMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the RMZs will be limited to the cable corridors only. Any cable roads established in the RMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stand. The minimum conservation measures within all Class II RMZs are described below. Where features of instability (defined in Section 6.3.2) are identified within or immediately adjacent to the RMZ, additional site-specific conservation measures for the identified area will be applied. At least 85% overstory canopy closure will be retained on the inner zone (0-30 feet). (Overstory canopy closure is defined and measured as with Class I watercourses above).

2. At least 70% overstory canopy closure will be retained on the outer zone (30-75 or 30-100 feet).

3. Riparian management zones along the first 200 feet of the Class II RMZ adjacent to the Class I RMZ will be subject to the same criteria that are listed in section 6.3.1.1.1 #5 to determine potential candidate trees for marking due to their low likelihood of recruitment.

4. In addition to the canopy requirements, no trees will be harvested which contribute to maintaining bank stability. The distinction in retention levels between inner and outer zones of the RMZ will be reduced on increasingly steeper slopes (generally >50%), because of increased needs to retain trees to maintain bank stability. Redwoods will be preferentially harvested over other conifers because of their ability to sprout from the remaining root system.

5. The Class II RMZ is an EEZ, except for a) existing roads and landings; b) construction of new spur roads to extend operations outside the RMZ; c) road watercourse crossings; d) skid trail watercourse crossings; and e) designated skid trail intrusions.

   a. The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

      1) Construction and use of skid trail watercourse crossings within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the RMZ over establishing new skid trail watercourse crossing sites in the RMZ.

      2) Skid trail watercourse crossings shall not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

      3) Within Class II-1 RMZs, trees may be felled and harvested to facilitate skid trail watercourse construction and use. All harvested trees will be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

      4) Within Class II-2 RMZs, trees may be felled to facilitate skid trail watercourse crossing construction and use. All such felled trees shall be retained as downed wood in the RMZ and shall be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

      5) Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.3.7).

   b. The exception for skid trail intrusions is only applicable when the following conditions are met:

      1) RMZ hillslopes are less than 25%.

      2) Construction and use of skid trails within the RMZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trails in the RMZ over construction of new skid trails in the RMZ.

3) Skid trails will not be constructed or used in the RMZ to provide access to RMZs for the purpose of their harvest.

4) Within the RMZ, only trees less than 10 inches in dbh may be felled to facilitate skid trail use. All such felled trees shall be retained as downed wood in the RMZ and shall be counted towards estimated reductions in FTE values and reductions in potential recruitment of LWD.

5) Green Diamond has submitted to the Services an explanation, justification, and map of the proposed skid trail and use in the RMZ as part of the informational copy of the THP notice of filing (see Section 6.3.7).

The intent is to minimize the effects of disturbances to Class II watercourse RMZs that would result in degradation of stream habitat.

5. Any ground disturbance larger than 100 square feet caused by management activities that is likely to result in sediment delivery to a watercourse will be mulched and seeded or otherwise treated to reduce the potential for such delivery. Seed will be spread at a rate of at least 30 pounds per acre, and mulched to a depth of at least 2 inches (before settling) with 90% surface coverage. The intent is to minimize sediment delivery from sheet and gully erosion. Hand constructed firelines are not subject the 100 square foot ground disturbance standard. Hand constructed firelines are established by removing the duff and litter layers to expose mineral soil but does not disturb the mineral soil. Other measures will be applied as necessary to ensure that hand constructed firelines do not deliver sediment to watercourses.

6. Trees may be felled within RMZs to create cable-yarding corridors as needed to ensure worker safety. These trees will be part of the harvest unit and their removal will be subject to the canopy requirements described above.

7. All safe snags will be retained (unsafe snags will be felled and left on site).

8. No salvage of downed trees will occur in the inner zone (0-30 feet). If any part of the salvageable piece is in the inner zone, the entire piece will be left.

9. Salvage of downed trees in the outer zone (30 to either 75 or 100 feet) will only occur if all of the following criteria are met:

   a. The wood is not currently or unlikely in the future to be incorporated into the bankfull channel, including wood located below unstable areas;

   b. The wood is not contributing to bank stability, and

   c. The wood is not positioned on a slope such that it can act to intercept sediment moving towards the stream.

6.3.1.3 Maintenance of Riparian Function in Class III Watercourses

Protection of Class III watercourses will occur in a two-tiered system, where the tiers correspond to two slope classes. Where features of instability (defined in Section 6.3.211.2.) are identified, additional site-specific conservation measures for the identified area will be applied.

6.3.1.3.1 Tier A Protection Measures

Tier A protections will be applied to Class IIIA watercourses using the adjacent streamside slope gradient (the average slope as measured with a clinometer, starting from the watercourse bank and running upslope for a distance of 50 feet), for the appropriate HPA Groups, as shown in Table 6-4 below. For example, within the Smith River HPA Group, Tier A protections would be applied if streamside slopes were less than 65%.

Table 6-4. Criteria for applying Class III Tier A and B protection measures.

HPA Group	Slope Gradient
Smith River	<65% = Tier A >65% =Tier B
Coastal Klamath	<70% = Tier A >70% = Tier B
Korbel	<65% = Tier A >65% = Tier B
Humboldt Bay	<60% = Tier A >60% = Tier B

The conservation measures for Tier A Class III watercourses will include:

1. Green Diamond will establish a 30-foot EEZ, except for a) existing roads; b) road watercourse crossings; and c) skid trail watercourse crossings.

   The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

   a. Construction and use of skid trail watercourse crossings within the Class III EEZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the Class III over establishing new skid trail watercourse crossing sites in the Class III.

   b. Within Class III EEZs, trees may be felled and harvested to facilitate skid trail watercourse construction and use.

   c. Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.3.7).

2. All LWD on the ground (not including felled trees) will be retained within the 30-foot EEZ.

3. No ignition of fire during site preparation within the EEZ.

6.3.1.3.2 Tier B Protection Measures

Tier B protections will be applied to all Class IIIB watercourses using the adjacent streamside slope gradient (the average slope as measured with a clinometer, starting from the watercourse bank and running upslope for a distance of 50 feet), for the appropriate HPA Group, as shown in Table 6-4 above. For example, within the Smith River HPA Group, Tier B protections would be applied if streamside slopes were greater than 65%. Conservation measures for Tier B Class III watercourses will include:

1. Green Diamond will establish a 50-foot EEZ, except for a) existing roads; b) road watercourse crossings; and c) skid trail watercourse crossings. The exception for skid trail watercourse crossings is only applicable when the following conditions are met:

   a. Construction and use of skid trail watercourse crossings within the Class III EEZ may occur only when construction and use of alternative routes to otherwise inaccessible areas outside of the RMZ would result in substantially greater impacts to aquatic resources. Preference shall be given to utilizing existing skid trail watercourse crossing sites in the Class III over establishing new skid trail watercourse crossing sites in the Class III.

   b. Within Class III EEZs, trees may be felled and harvested to facilitate skid trail watercourse construction and use.

   c. Green Diamond will submit to the Services an explanation, justification, and map of any proposed skid trail watercourse crossings as part of the informational copy of the THP notice of filing (see Section 6.3.7).

2. All hardwoods and nonmerchantable trees within the 50-foot EEZ will be retained except where necessary to create cable corridors, or for the safe falling of merchantable trees.

3. No ignition of fire during site preparation within the EEZ

4. In stream reaches that currently show evidence of bank instability (i.e., bank erosion, sloughing, or channel downcutting), conifers will be retained where they contribute to maintaining bank stability. The primary criterion for making this decision will be based on whether or not removal of a tree will contribute to additional erosion where it currently exists or likely promote erosion where it currently does not exist. In addition, conifers will be retained if they are acting as a control point (retaining sediment and/or preventing headcuttng) in the channel. A minimum average of one conifer 15 inches dbh or greater per 50 feet of stream length within the 50-foot EEZ will be retained.

5. All LWD on the ground (not including felled trees) will be retained within the 50-foot EEZ.

6.3.1.4 Measures to Address Unique Geomorphic Features

Unique geomorphic features which may warrant separate or additional conservation measures include CMZs and floodplains. CMZs are important in determining where RMZs should be measured from, while the occurrence of floodplains may require the RMZ width to be expanded to ensure the entire floodplain and a 30- to 50-foot buffer are protected. The definitions, specific issues, and conservation measures designed to address each are described below.

6.3.1.4.1 Mapping Channel Migration Zones and Floodplains

Green Diamond will map all floodplains and CMZs of Class I watercourses throughout the Plan Area within the first five years of the Permits' effective date. For any lands added to the Plan Area after the end of the third year, Green Diamond will complete mapping within two years of the addition. Potential floodplains and CMZs will be screened initially using GIS. Any sites that show the potential attributes of a floodplain or CMZ based on the GIS analysis will be further analyzed using aerial photographs, maps and historic field information. The final determination of the boundaries of all floodplains and CMZs will be based on field verification with the oversight of a team of experts that may include a hydrologist, fluvial geomorphologist, geologist and fisheries biologist representing Green Diamond and the Services. Following field verification, the floodplains and CMZs with any additional buffers, where appropriate, will be flagged in the field and mapped in Green Diamond's GIS.

Floodplains

The floodplain is defined as the area adjacent to the stream constructed by the river in the present climate and inundated during periods of high flow (NMFS 1999). A stream's floodplain will be specified as two times its maximum bank full depth as a starting point, but will be modified if necessary by field verification at a later date. The floodplain typically acts as a depositional zone during floods. While high velocity flow is occurring in the main channel, the velocity breaks created by live and down trees and other vegetation, combined with the distribution of water across a broad, typically low gradient floodplain result in generally low velocity flow across the floodplain.

Maintaining and promoting development of functioning riparian habitat is a biological goal of this Plan. This includes allowing that the floodplain is well stocked with trees and vegetation of sufficient size to act as velocity breaks during floods and with their root systems minimizing erosive scour from flooding. The conservation measures are expected to provide adequate riparian stands for this purpose in most smaller streams (3^{rd} order), but additional protections will be applied in the lower depositional reaches of larger Class I watercourses in cases where the floodplain with a 30- to 50-foot buffer may extend beyond the proposed RMZ boundary.

The normal conservation measures (Section 6.3.1) of the RMZ Class I outer zone will be extended, where necessary, to cover the entire floodplain and an additional 30- to 50-foot beyond the outer edge of the floodplain. The additional buffer outside the floodplain will depend on the slope immediately adjacent to the floodplain as follows: 30 feet for slopes of 0-30%; 40 feet for slopes of 30-60% and 50 feet for slopes >60%.

<u>Channel Migration Zones</u>

Channel migration is a natural process in which streams shift position laterally on their floodplain or valley floor. Channel migration can occur either by gradual bank erosion processes or by sudden channel avulsion where high flows and/or reduced channel conveyance capacity result in the formation of alternate channels on the floodplain or valley floor (Leopold and Dunne 1978). Morphological features such as stream gradient, side slopes, bed material, and floodplain width influence the likelihood and rate of channel migration, and analyzing such features can allow for identification of areas where channel migration is likely to occur. Channel migration zones (CMZs) are areas that generally correspond to the modern floodplain, but can also include river terraces subject to significant bank erosion (NMFS 2000). CMZs identified on the Original Assessed Ownership tend to occur along the lower depositional reaches of larger (3rd order or greater) Class I watercourses and seem to be associated with channel aggradation.

Identifying potential CMZs in the Plan Area is necessary to ensure that the riparian conservation measures can achieve their desired effects of maintaining functional riparian and aquatic conditions. The RMZs described above are intended to extend a specific distance (e.g. 150 feet for Class I watercourse RMZ) from the permanent vegetation line adjacent to the channel in order to achieve their desired protective benefits. RMZs created without regard for channel migration zones could leave at least one bank of the stream entirely without or with a substantially reduced riparian buffer as a result of channel migration. To avoid this possibility, the RMZ will be measured from the outer edge of the CMZ.

6.3.2 Slope Stability Measures

6.3.2.1 Introduction

The goal of the slope stability measures is to reduce management-related sediment delivery to the aquatic system from landslides and landslide-related erosion that might occur in specific portions of the landscape.

The potential effects of forest management on factors that may contribute to slope failure are discussed in Section 5 and 7. These effects can be partially mitigated through prescriptions that limit changes in root strength and hillslope hydrology that can result from timber harvesting, and by improving construction standards associated with road or skid trails. Such prescriptions will be applied to reduce management-related slope failure and associated sedimentation in specified landscape areas that were found to have a relatively high potential for sediment delivery.

The measures focus on silvicultural prescriptions and also consider road construction. Slope stability and erosion problems associated with the existing road network are addressed through conservation measures pertaining to road maintenance (Section 6.3.3).

6.3.2.2 Overview of the Approach

6.3.2.2.1 Assumptions

The following assumptions form the foundation of the analytical approaches used to identify slope stability hazards in the Plan Area and contributed to the development of management rules to mitigate potential hazards:

1. The majority of landslides occur in discrete areas of the landscape (e.g. inner gorges and steep streamside slopes, headwall swales, and existing deep-seated landslide areas).

2. The location of existing mass wasting features can be used to predict likely locations of future instability. Areas prone to these processes can be mapped based on physical characteristics (such as topography, geology, and soils), as interpreted from aerial photographs, topographic maps, geologic and soils maps, and field observations.

3. Effects of past land use activities on landslides can be inferred and sediment delivery estimated from historical aerial photographs and field reconnaissance. It is acknowledged that small landslides may not be detectable in aerial photographs because of variability in forest canopy, timing, quality and scale of photography, and because revegetation of some landslide may occur rapidly.

4. Historical management activities on the landscape provide a valid empirical example of the likely effects of forest management on future landslide activity. It is acknowledged that all parts of the landscape may not have been fully “tested”, that is, subjected to high magnitude storm events following harvest when the potential for landslides is greatest. Nevertheless, the vast majority of Green Diamond’s forestland property has been logged, and significant storm events occur frequently enough to reasonably assume that most portions of the landscape prone to mass wasting will be identifiable.

6.3.2.2.2 Mass Wasting Prescription Zones (Summary)

The slope stability measures address discrete parts of the landscape with grossly similar physical characteristics that have been established both in the literature (Best et al. 1995; Best 1997; Kelsey et al. 1995; PWA 1999a; Raines and Kelsey 1991) (PWA 1998) and from unpublished Green Diamond data from pilot watersheds as having relatively high landslide-related sediment delivery rates, and which are assumed to be sensitive to management activities. The areas are referred to as Mass Wasting Prescription Zones (MWPZs). The three MWPZs are:

- Steep Streamside Slopes
- Headwall Swales
- Deep-Seated Landslides

The three MWPZs the associated conservation measures are discussed in Section 6.3.2.

A default slope stability conservation measure will also be applied to some shallow rapid landslides. Shallow rapid landslides are not considered a MWPZ, but rather they may be found within any of the MWPZs or outside of a MWPZ. Shallow rapid landslides and the associated conservation measure are discussed in Section 6.3.2.

Steep Streamside Slopes

As indicated in Section 6.2.2.1.3, SSS zones will be identified based on field measurements of cumulative sediment delivery from landslides, slope gradients, and landslide crown distances from Class I and II watercourses. A default maximum slope distance and a minimum slope gradient for SSS zones will be based on a percentage of the measured cumulative sediment delivered to watercourses from shallow landslides wholly originating from within streamside slopes. The initial default maximum slope distance and minimum slope gradient for the SSS zones are different for the various HPA Groups.

Two slope stability monitoring programs are designed to refine the default prescriptions for SSS zones: the SSS Delineation Study and the SSS Assessment. The SSS Delineation Study can modify the initial default maximum distance and minimum slope gradient for SSS for the 11 individual HPAs. The SSS Assessment can modify the initial HPA Groups' initial default maximum distance and minimum slope gradient and prescriptions for SSS in the 11 individual HPAs. Both of these slope stability monitoring programs are further described in Section 6.3.5 and Appendix D.

Headwall Swales

Headwall swales will be identified primarily based on field observations of characteristic landforms described in Section 6.2.2.2. A GIS-based analyses of shallow hillslope stability (SHALSTAB) will be used to aid in identification of headwall swales. The default prescription is uniform across the Plan Area and is not subject to adaptive management.

Deep-Seated Landslides

Deep-seated landslides will be identified from published landslide maps, review of aerial photographs and field observations, coupled with verification of the criteria described in Section 6.3.2. The default prescription for deep-seated landslides is uniform across the Plan Area and is not subject to adaptive management changes.

6.3.2.2.3 Implementation

All RPFs who write THPs for Green Diamond will participate in training that addresses issues related to timber harvesting, slope stability, and the Slope Stability Measures. The training will be administered by a qualified California PG or CEG. In addition, Green Diamond will employ or retain a California PG or CEG with substantial experience in forest management to provide professional review of MWPZs and unstable areas on a project-by-project basis at the RPFs' discretion.

The purpose of the training is to help Green Diamond RPFs identify and more fully understand the slope stability measures as well as the possible implications of various timber management scenarios for landslide and other unstable areas. The training program is not intended to supplant the need for input from a licensed geologist in THP development when geological concerns exceed the experience and scope of license of the project RPF. Training will be offered biennially or as necessary to accommodate contractors and new employees and as necessary to present new relevant scientific or regulatory information.

During the period of initial THP layout and data collection, all site-specific knowledge or concerns regarding aquatic biota or habitat known to Green Diamond's resources staff will be made known to the project forester in order that the THP may be voluntarily designed to further reduce risk to resources.

During the development stage of a THP, the RPF will determine if any portion of the potential THP meets the HCP definition of an MWPZ. If a MWPZ is identified, the following protocol will apply:

1. Impose the default prescription for that MWPZ, or

2. Retain a California PG to

    a. Evaluate the likelihood that timber harvest operations will cause, or significantly elevate the risk of causing or reactivating landslides within the prescription zone that will likely result in sediment delivery to watercourses, and

    b. Work with the RPF to prepare a more cost-effective, site-specific alternative to the default prescription designed to minimize that likelihood, which will have the benefit of minimizing and mitigating potentially significant impacts on the Covered Species from sediment delivery resulting from landslides caused or exacerbated by timber harvest operations. Alternative prescriptions can be applied to any of the MWPZs except RSMZs. A qualified biologist will be involved in evaluating the potential biological consequences whenever a more cost effective alternative to the default prescription is proposed.

THPs for which a geologic report was prepared and the conclusions of which allowed for alternatives to replace the default prescriptions will be flagged as such when submitted for review by CDF and other agencies. Also, a THP map and a letter of notice that describes the alternative to replace the default prescriptions will be sent to the Services when a THP with such an alternative is proposed. The intent of this procedure is to encourage professional geologic review by agency staff to ensure that the intent of the conservation measures is fulfilled.

The internal compliance monitoring procedure, described in Section 6.3.7, will assure that the measures are properly administered.

6.3.2.2.4 Slope Stability Monitoring and Assessments

The slope stability measures are subject to adaptive management changes identified as a result of the SSS Delineation Study and SSS Assessment. The SSS Delineation Study will determine the minimum slope gradient and maximum slope distance for SSS zones in each HPA. The SSS Assessment will evaluate the effectiveness of the SSS prescriptions (including minimum slope gradient and maximum slope distance).

Green Diamond will also complete a preliminary Mass Wasting Assessment (MWA) within seven years after Plan approval and an update along with a final report within 20 years of Plan approval. The purpose of the MWA is to examine any relationships between mass wasting processes and timber management practices. The MWA is further described in Section 6.3.5 and Appendix D.3.5.

6.3.2.3 Steep Streamside Slopes

Steep streamside slopes are generally characterized by steep slopes that descend directly to Class I and Class II watercourses without intervening topographic benches. An inner gorge is a subset of steep streamside slopes where a more-or-less distinct break-in-slope separates steeper inner gorge slopes below the break-in-slope from lesser-gradient slopes above the break. The SSS zone classification includes inner gorge slopes as well as those steep slopes without a distinct break-in-slope.

Sediment budget and landslide inventories conducted in northcoast California have documented that streamside landslides constitute the bulk (50% to 90%) of landslide-derived sediment delivered to streams (Best 1997; Forest Soil & Water 1998; Harden et al. 1995; Kelsey et al. 1981; PWA 1998, 1999a, b; Raines and Kelsey 1991). This is consistent with preliminary landslide data collected on the Plan Area through the studies identified in Section 4.3. Moreover, preliminary landslide data collected on Green Diamond property reveals the bulk of sediment appears to be derived from landslides originating on the larger watercourses (Class I and Class II-2).

The goal of the default prescriptions for SSS zones is to achieve a 70% reduction in management-related sediment delivery from landslides compared to delivery volumes from landslides in appropriate historical clearcut reference areas. A maximum of a 30% relative increase in landslide-related sediment delivery compared to merchantable-sized second growth uncut SSS zones may be used as another comparative standard to determine the effectiveness of the conservation measures. The objectives of the prescriptions for SSS zones are to maintain a sufficient live root network and overstory canopy which limits the loss of root strength and provides for rainfall interception and evapotranspiration. These objectives are designed to reduce landslide occurrences that result in sediment delivery, and thereby achieve the goal.

6.3.2.3.1 Steep Streamside Slopes: Identification

Steep streamside slopes in the various HPAs are defined by: 1) a minimum slope gradient leading to a Class I or Class II watercourse, 2) a maximum distance from a Class I or Class II watercourse, and 3) a reasonable ability for slope failures to deliver sediment to a watercourse. Whether or not slope failures have a reasonable ability to deliver sediment to a watercourse will be determined based on the presence or absence of a qualifying slope break. A qualifying slope break is a break-in-slope of sufficient degree (below the minimum for an HPA) and distance that it would likely impede sediment delivery to watercourses from shallow landslides originating above the slope-break. Qualifying slope breaks will be identified on a site-specific basis through the THP process.

Landslide data for steep streamside slopes were grouped into four HPA Groups, as shown on Table 6-5, for purposes of developing and implementing initial default prescriptions for SSS zones. The initial default minimum slope gradients and maximum default slope distances are summarized in Table 6-6. The initial default minimum slope gradients and initial default maximum slope distances and default prescriptions for SSS zones can be modified through the SSS Delineation and SSS Assessment programs as described in Section 6.3.5 and Appendix D.3.3 and D.3.4.

Table 6-5. HPA Groups for initial SSS default prescriptions.

HPA Group	HPA
Smith River	Smith River
Coastal Klamath	Coastal Klamath Blue Creek
Korbel	Mad River North Fork Mad River Little River Coastal Lagoons Redwood Creek Interior Klamath
Humboldt Bay	Humboldt Bay Eel River

Table 6-6. Initial default maximum slope distances and minimum slope gradient for SSS zones in each HPA Group.

HPA Group	Slope Gradient	Slope Distance from Watercourse Transition Line (feet)		
		Class I	Class II-2	Class II-1
Smith River	65%	150[1]	100[1,2]	75[1]
Coastal Klamath	70%	475	200	100
Korbel	65%	200	200	75[1]
Humboldt Bay	60%	200	200	75[1]

Notes
1 Initial default maximum SSS zone is equal to the RMZ width; but the RSMZ prescriptions will apply.
2 There are no data available for Class II-2 watercourses in the Smith River HPA Group; values presented here are based on Class I watercourses which is assumed to be more restrictive.

The physical characteristics of streamside slopes that deliver sediment from landslides to Class-I and Class-II watercourses were used to develop the criteria for defining steep streamside slopes. A field inventory of 471 non-road related shallow streamside landslides on Green Diamond's ownership in the HPAs formed the basis for determining the physical characteristics of SSS zones. A more complex method of identifying slopes prone to shallow landslides based on current GIS topographic data (i.e. SHALSTAB or SINMAP) was not employed since available digital terrain models (DEMs) often underestimates slope gradients along slopes leading into watercourses and therefore would underestimate the landslide risk.

For logistical reasons, the initial field inventory was directed to those areas where aerial photographs revealed a relatively high concentration of recent failures. Data collected in the field inventory included landslide type, slope gradient, distance of the landslide headscarp from watercourse transition line and volume of sediment delivery. Landslides were classified according to a simplified version of Cruden and Varnes (1996). Slope gradients were measured using hand-held clinometers. Headscarp distances were measured from the watercourse transition line to the crowns of landslides using a range finder. Volume of sediment delivery was estimated from direct field observation.

A relatively simple relationship between slope gradient, headscarp distance from watercourse, and cumulative landslide delivery volumes form the basis for determining initial default minimum SSS slope gradients and initial default maximum slope distances. Because management goals are focused on reducing the amount of sediment delivered to stream systems, distance and slope gradient relationships were based on landslide delivery volumes instead of landslide frequency. The distance and slope gradient relationships with cumulative landslide delivery volume are illustrated as graphs in Figures 6-3 and 6-4). Criteria used to develop minimum steep streamside slope gradients were developed separately from that used for the initial default maximum slope distance.

Going forward, the SSS Delineation Study will be continued using a statistically valid sampling method as described in Section 6.3.5. The initial default minimum gradients and initial default maximum distances for SSS zones can be modified pursuant to the results of this work, as discussed in Section 6.3.2, 6.3.5, and Appendix D.

6.3.2.3.2 Steep Streamside Slopes: Slope Gradient

With the exception of the Smith River and Coastal Klamath HPA Groups, a cumulative sediment delivery volume of 80% was used to determine minimum SSS gradients (Figure 6-3 and Table 6-6). In the Smith River and Coastal Klamath HPA Groups, the relatively strong and competent bedrock coupled with the deeply incised nature of the larger watercourses results in steeper streamside slopes in comparison to the other regions. In the Smith River HPA Group, 80% of the delivered sediment volume came from slopes that were 70% gradient or steeper. In the Coastal Klamath HPA Group, 80% of the delivered sediment volume came from slopes that were 85% gradient or steeper. Because the data may be biased towards steeper slopes and may not accurately assess the slope gradient on which the overburden soils are prone to failure, the minimum SSS gradient for the Smith River HPA Group was reduced to 65% and the Coastal Klamath HPA Group was reduced to 70%, both pending additional analysis. This slope gradient reduction provides a more conservative value whereby SSS prescriptions would be applied.

The critical slope gradients found in Table 6-6 and Figure 6-3 may increase or decrease for each watershed pending the analysis of additional streamside landslide data collected in the SSS Delineation Study. For a slope break to truncate an SSS zone before its maximum distance, the slope break must be of a sufficient decline in slope gradient (below the minimum slope gradient for the given HPA) and of sufficient distance that it may be reasonably expected to impede sediment delivery to watercourses from shallow landslides originating above the slope break.

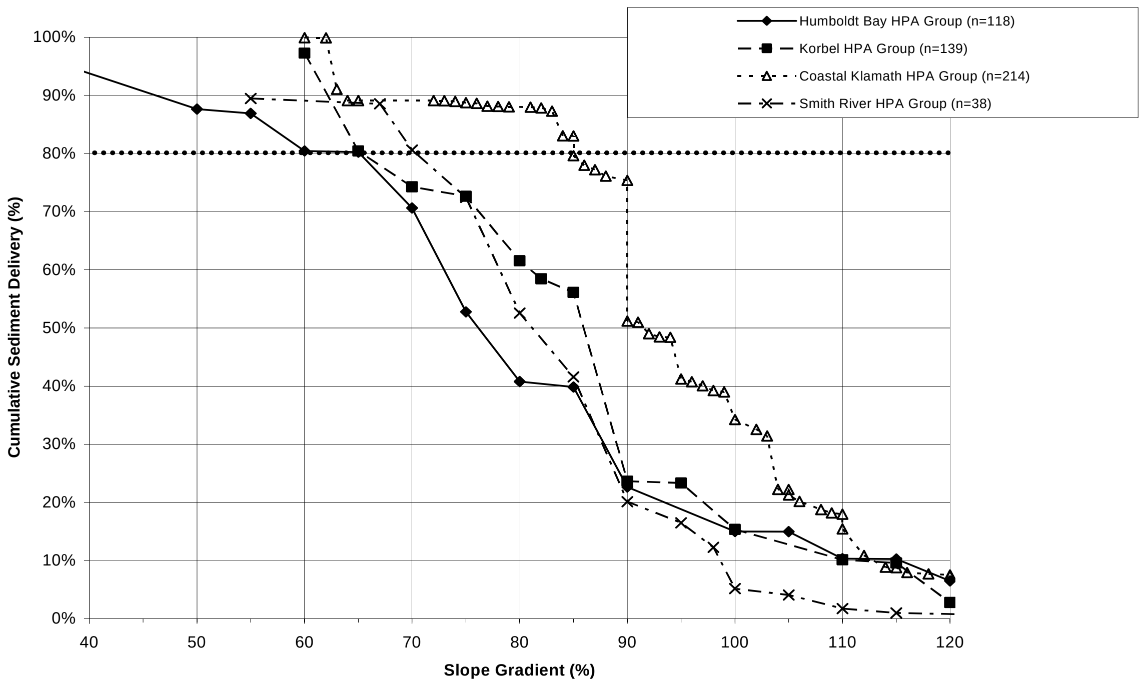


Figure 6-3. Cumulative landslide delivery vs. slope gradient.

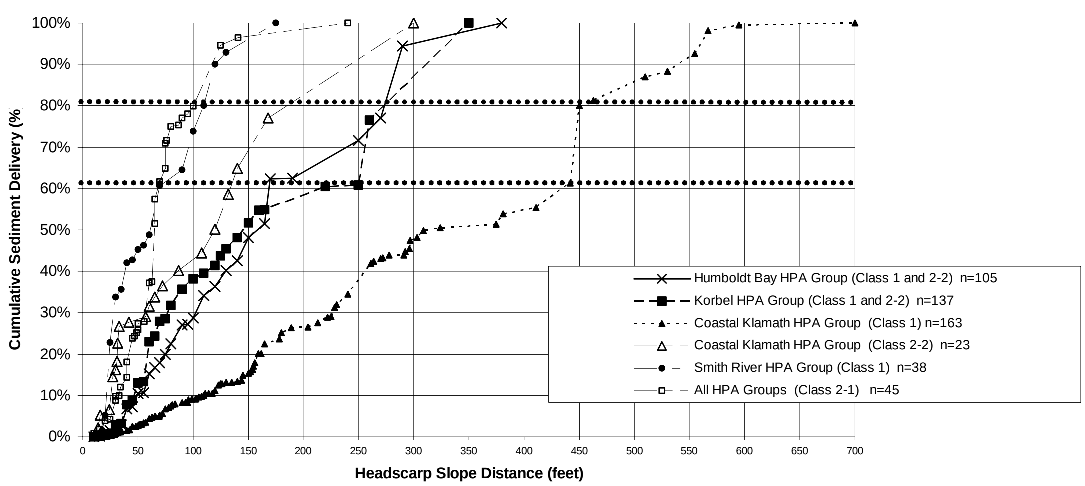


Figure 6-4. Cumulative landslide delivery volume vs. headscarp slope distance.

6.3.2.3.3 Steep Streamside Slopes: Slope Distance

With the exception of the Coastal Klamath HPA Group, a cumulative sediment delivery volume of 60% was used to determine initial default SSS distances (Figure 6-4 and Table 6-6). In Coastal Klamath HPA Group, the relatively strong and competent bedrock coupled with the deeply incised nature of the larger watercourses results in substantially longer streamside slopes in comparison to the other regions. In this area, the slope length of the default SSS zone was based on 80% of measured sediment delivered to streams by shallow landslides that initiated on streamside slopes (i.e. the headscarp of measured slides are located at or below this distance).

Total sediment volumes were plotted at the maximum headscarp distance rather than averaging the landslide volume over the slide length or attempting to determine the location of initiation of slope failure. It is important to keep in mind that the use of headscarp distance is a conservative approach since the initiation point of a slope failure is typically located some distance downslope from the headscarp. Therefore, the upslope delineation of the MWPZ as a function of headscarp distance is likely to provide an additional increment of risk reduction by protecting a portion of the hillslope above the probable initiation point.

In the Humboldt Bay and Korbel HPA Groups, Class I and Class II-2 watercourses are grouped together since the geomorphic characteristics of these two classes of watercourses are substantially similar. In the Coastal Klamath HPA Group, however, Class I and Class II-2 watercourses are grouped separately since the geomorphic characteristics of these two classes of watercourses are apparently different. In the Smith River HPA Group, Class II-2 data were unavailable and therefore results are based on Class I measurements. In general, Class I watercourses tend to be more deeply incised and have longer SSS zones compared to Class II-2 watercourses. This is illustrated by the landslide data (Figure 6-4).

As indicated in Section 6.2.2.1.3, SSS zones will be divided into an inner zone (RSMZ) and an outer zone (SMZ). A RSMZ is a subset of a RMZ but where slopes exceed the minimum SSS gradients. The maximum slope distance of a RSMZ is equal to that of a RMZ. The width of the SMZ will be either the remainder of the distance to the initial default maximum SSS distance for that HPA or to a qualifying slope break, whichever is shorter.

The RSMZs will be comprised of an inner zone and an outer zone. The inner zone of RSMZs on all Class I watercourses will be 70 feet, except where a qualifying slope break exists within that distance the RSMZ inner zone may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance. The inner zone of RSMZs on all Class II watercourses will be 30 feet, except where a qualifying slope break exists within that distance then the RSMZ inner zone may only extend to the slope break, and the outer zone, if any, will be the remainder of the applicable RMZ distance except where a qualifying slope break exists within that distance. A conceptual illustration of an RMZ and an opposing SSS with an SMZ and inner and outer RSMZ zones is shown on Figure 6-5.

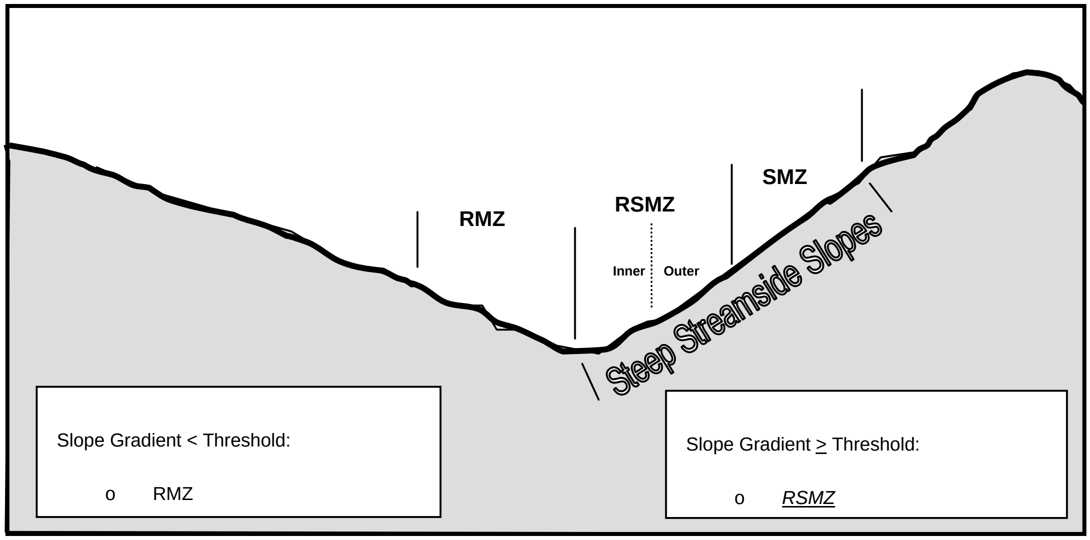


Figure 6-5. Conceptual RMZ and an opposing SSS with an SMZ and inner and outer RSMZ.

The initial default SSS slope distances found in Table 6-6 and Figures 6-4 and 6-5 may increase or decrease pending the analysis of additional streamside landslide data collected during the SSS Delineation Study for each HPA.

6.3.2.3.4 Steep Streamside Slopes' Prescriptions: Silviculture and Roads

Tree retention will be greatest along the lower slope positions in RSMZs, where slope failures are expected to have an immediate effect on the aquatic system. Tree retention will decrease up-slope in SMZs. The higher level of retention along the lower slope positions will also limit the degree of ground disturbance that might otherwise result in greater amounts of surface erosion. In addition, tree retention will be greatest in RSMZs on Class I and Class II-2 watercourses where landslides tend to be larger and where LWD delivered to the stream channel from streamside landslides is expected to be most beneficial to fish habitat.

If cable corridors through SMZs are necessary to conduct intermediate treatments (e.g., commercial thinning) in adjacent stands prior to even-aged harvest, Green Diamond will apply the restrictions in this section except harvesting of trees in the SMZs will be limited to cable corridors only. Any cable roads established in the SMZ as part of the intermediate treatment will, to the extent feasible, be reused during the even-aged entry in the adjacent stands. The SMZs will be subject to the restrictions identified in this section. RSMZ silviculture prescriptions are:

- In Coastal Klamath and Blue Creek HPAs, no harvesting in RSMZs.
- In all other HPAs on Class I and Class II-2 watercourses, no harvesting on the inner RSMZ band and 85% overstory canopy retention on the outer RSMZ band.

- In all other HPAs on Class II-1 watercourses, 85% overstory canopy retention on the inner RSMZ band and 75% overstory canopy retention on the outer RSMZ band.
- Where no SMZ is identified, the standard default prescriptions for RMZs will apply.

The silviculture prescription employed within SMZs will be single tree selection, as defined in the Glossary of this Plan, with a target for even-spacing of residual conifers where the trees are available to allow it and retention of all hardwood. All species and size classes represented in pretreatment stands will be represented post harvest where feasible.

The intent of these prescriptions is to maintain a viable root network and some overstory canopy within steep side slopes. Single tree selection will limit the loss of root strength and provide canopy for rainfall interception and evapotranspiration.

Trees may be felled within RSMZs and SMZs (as well as RMZs) where necessary to create cable-yarding corridors or for safe falling of merchantable trees. Cable corridors will be no greater than 25 feet wide. The intent of this exemption is to provide for operational worker safety consideration when other options are deemed impractical and while still imparting the intended mitigation described in this document. Most sediment budget studies and erosion inventories for watersheds in northern California have documented that the frequency of shallow landslides from forest road systems (including skid trails and landings) is high compared to landslide rates in unmanaged forests or from the harvesting of timber alone. Most past road-related problems occur on slopes steeper than 65% and are generally attributable to loose, sidecast road fill perched on steep slopes or to road runoff concentrated and discharged onto such sidecast fill. Road-related impacts to the aquatic system can be managed by regulating where and how roads are constructed.

Where feasible, road construction will avoid RSMZs and SMZs. Where such zones cannot be avoided or where major road reconstruction is required, the road alignment will be evaluated by an PG and an RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2). Upgrading and storm proofing of existing roads, where major reconstruction is not required, will be undertaken under the Road Management Plan.

The default prescriptions for SSS zones are summarized in Table 6-7.

Table 6-7. Summary of default prescriptions for steep streamside slopes.

Watercourse	Inside RSMZ and within Steep Streamside Slope Zone		SMZ (Outside RSMZ but within Steep Streamside Slope Zone) Initial default maximum slope distance or to qualifying break-in-slope (whichever is shorter)			
	Inner Zone[1]	**Outer Zone[1]**	**Humboldt Bay HPA Group**	**Korbel HPA Group**	**Coastal Klamath HPA Group**	**Smith River HPA Group**
	(see HPA for minimum slope gradient)	*(see HPA for minimum slope gradient)*	*(≥60% slopes)*	*(≥65% slopes)*	*(≥70% slopes)*	*(≥65% slopes)*
Class I	*(0-70 feet)*	*(70-150 feet)*	*(150 – 200 feet)*	*(150 – 200 feet)*	*(150-475 feet)*	
	• No cut • No new roads or major road reconstruction without approved review	• 85% overstory canopy retention. • Harvest biased to redwood and only if unlikely to recruit. • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	See footnote 2
Class II-2	*(0-30 feet)*	*(30-100 feet)*	*(100-200 feet)*	*(100-200 feet)*	*(100-200 feet)*	
	• No cut • No new roads or major road reconstruction without approved review	• 85% overstory canopy retention. • Harvest biased to redwood and only if unlikely to recruit. • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	• See footnote 2
Class II-1	*(0-30 feet)*	*(30-75 feet)*			*(75-100 feet)*	
	• 85% overstory canopy retention. • Harvest biased to redwood and only if unlikely to recruit. • No new roads or major road reconstruction without approved review	• 75% overstory canopy retention. • No new roads or major road reconstruction without approved review	• See footnote 2	• See footnote 2	• Single tree selection with even spacing of residual conifers • Hardwood retention • No new roads or major road reconstruction without approved review	See footnote 2

1 Listed default prescriptions apply to the Smith River, Korbel, and Humboldt Bay HPA Groups. The Coastal Klamath HPA Group default prescriptions for RSMZs are no harvest and no new roads or major road reconstruction without approved review . The slope distance for RSMZs in the Coastal Klamath HPA Group is the same as described for the other HPA Groups. Trees may be felled for cable corridors or as needed for worker safety).

2 The initial default maximum SSS distance is equal to the total RSMZ width; but the RSMZ prescriptions will apply.

6.3.2.4 Headwall Swales

Headwall swales are generally characterized by steep (typically greater than 70% gradient) convergent topography within steep valleys upstream of Class III watercourses, where accumulation of thick soils and shallow subsurface runoff tend to be concentrated. Many shallow debris slides and debris flows initiate in headwall swales (Dietrich et al. 1982).

The rate of landslides in headwall swales on northern California forestlands tends to be much less in comparison to failures originating along steep streamside slopes. For example, recent landslide inventories conducted in Bear River, Jordan Creek, and Freshwater Creek by Pacific Watershed Associates, report that landslides from steep swales comprised 9% to 22% of the total number of slides inventoried (PWA 1998, 1999a, b). This is consistent with the preliminary landslide data collected in Little River and Salmon Creek. In some watersheds, headwall swale areas may be quite numerous across the landscape. The intent of this measure is to identify those relatively high-risk swales where management activities are likely to result in failure during a stressing storm and apply the default prescriptions, or an alternative prescription pursuant to Section 6.3.2.

6.3.2.4.1 <u>Headwall Swale: Identification</u>

Headwall swales will be identified primarily by field observation by trained and qualified personnel. Green Diamond also will use a SHALSTAB computer model analysis (>1/4 ac) using a 10m DEM or better as a screening tool to identify areas of convergent topography that may be more likely to contain headwall swales (see below for additional detail).

Field review of headwall swale areas will focus on slope characteristics that are considered at present to be most important to landslide processes in such areas. These characteristics include slope steepness (typically greater than 70%) of the slopes, slope composition and structure, slope and soil drainage characteristics, the appearance of a concave or inverted teardrop- or spoon-shaped slope, the relative degree of slope convergence, the presence of a build-up of colluvium or a thick colluvial mantle, various vegetative indicators, and the apparent landslide history of the site and similar sites in the area. Perhaps the most important physical characteristic of a headwall swale is its location at the headwaters of a watercourse.

SHALSTAB is a GIS-based slope stability model that uses topographically driven, steady-state shallow subsurface flow theory. The model assumes cohesionless soils and uses an infinite-slope representation of the balance of forces on soil masses to delineate the relative potential for shallow landslides across the landscape (Dietrich et al. 2000 (in press); Dietrich et al. 1992; Dietrich et al. 1993; Montgomery and Dietrich 1994). SHALSTAB identifies potential unstable areas based on both slope steepness and contributing upslope drainage area.

SHALSTAB calculates a dimensionless ratio (log q/T) that reflects soil hydrologic conditions and the relative likelihood of soil saturation that is associated with shallow landslide initiation. Validation studies conducted in 7 watersheds in northern California conclude that for topography defined by 10 meter resolution digital elevation model

(DEM), a log (q/T) threshold of less than –2.8 delineates a portion of the landscape within which about 60% of the shallow landslides mapped from aerial photographs are found (Dietrich et al. 2000 (in press); Dietrich et al. 1998).

6.3.2.4.2 Headwall Swale Prescriptions: Silviculture and Roads

The default silviculture prescriptions for headwall swales are:

- Single tree selection (as defined in the Glossary) with a target for even spacing of residual conifers where the trees are available to allow it; and retention of all hardwood. All species and size classes represented in pretreatment stands will be represented post harvest where feasible.

- Trees may be felled within these zones where necessary to create cable-yarding corridors or for the safe falling of merchantable trees. Yarding corridors will not be greater than 25 feet wide. The intent of this exemption is to provide for operational and worker safety considerations when other options are impractical while still imparting the intended mitigation described in this document.

- Only one harvesting entry will be allowed in headwall swales per the term of the permit.

Default silviculture prescriptions will apply to field-verified headwall swales, unless an approved geologic review indicates that a particular headwall swale is not a high-risk site.

The intent of these prescriptions is to maintain a viable root network and some overstory canopy within the headwall swale. Single tree selection will limit the loss of root strength and provide canopy for rainfall interception and evapotranspiration. Typically, tree retention should be greatest along the axis of the headwall swales and decrease up-slope.

The impact of roads on headwall swales can be managed by regulating where and how roads are constructed. New road construction will avoid field verified headwall swales where feasible. Where such features cannot be avoided, or where road reconstruction is required, the terrain will be evaluated by a PG and RPF with experience in road construction in steep forested terrain. New or reconstructed roads in this terrain should be built to a high standard as prescribed by a PG and RPF. Upgrading and storm proofing of existing roads, where major reconstruction is not required, and road decommissioning in these areas will be undertaken under the Road Management Plan (Section 6.3.3). In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

The default prescriptions for headwall swales are summarized in Table 6-8.

Table 6-8. Default prescriptions for headwall swales.

Silviculture Prescriptions	• Single tree selection (as defined in the Glossary) with a target for even spacing of residual conifers where the trees are available to allow it; and retention of all hardwood. • All species and size classes represented in pretreatment stands will be represented on site after harvest where feasible. • Trees may be felled within these zones where necessary to create cable-yarding corridors or for the safe falling of merchantable trees. Yarding corridors will not be greater than 25 feet wide. The intent of this exemption is to provide for operational and worker safety considerations when other options are impractical while still imparting the intended mitigation described in this document.
Road Prescriptions	• Headwall Swales will be avoided where feasible. • Where such slopes cannot be avoided or where major road reconstruction is required, the road alignment will be evaluated by a California PG and California RPF with experience in road construction in steep forested terrain. • Upgrading and storm proofing of existing roads, where major reconstruction is not required, will be undertaken under the Road Management Plan

6.3.2.5 Deep-Seated Landslides

For purposes of this Plan, deep-seated landslides include translational/rotational rockslides and earth flows. These are typically relatively large-scale landslides with a relatively deep failure plane, particularly in comparison to shallow debris slides and channelized debris flows.

Translational/rotational rockslides are characterized by the relatively slow movement of a largely intact slide mass above a comparatively deep failure plane. The slide plane typically extends below the colluvial layer into the underlying and more competent bedrock. The landslide toe is typically found at the base of the hillside and is typically adjacent to a stream channel. Some “perched” landslides, however, may be located higher on the slope, and their toes may not impinge upon stream channels.

Commonly, larger landslides consist of several smaller slide blocks that coalesced to form the larger landslide complex. Differential movement between individual slide blocks is common. Most slides move incrementally in response to climatic or seismic events. Catastrophic failure of the slope is rare.

Sediment from deep-seated landslides is delivered to the stream system by stream bank erosion and shallow slope failures (debris slides and debris flows) occurring along the toe of the slide and the watercourses draining the interior of the slide mass.

Earthflows are characterized by slow progressive deformation or creep of the slide mass in a semi-viscous, plastic state. Most earthflows are comprised of a heterogeneous mixture of fine-grained soils and rock (most commonly found in areas underlain by Franciscan mélange bedrock). The degree of activity varies among earthflows. Most lie dormant or exhibit very slow rates of movement while some move somewhat faster. Rapid movement and catastrophic failure of earthflows is relatively uncommon and unlikely. The materials in earthflows typically erode easily, often resulting in gullying and irregular drainage patterns.

In general, large-scale deep-seated landslides are considered less sensitive to most forest management activities compared to shallow landslides. The principal effects of forest management on deep-seated slope stability from the geotechnical perspective include: increased soil moisture from reduced rainfall interception and reduced evapotranspiration, undercutting or overloading of the slide by roads or skid trails, and delivery of concentrated surface runoff from roads or skid trails from areas outside the natural contributing area to the area of the landslide. The potential impact of harvest activities on the stability of deep-seated landslides may be partially mitigated by retaining a component of the timber stand on and upslope of active or historically active landslides and constructing or reconstructing roads across such slides under the guidance of an experienced geologist or geotechnical engineer.

Unlike shallow-seated landslides, nearly all deep-seated landslides are reactivations of existing slides with comparatively few initiating in new locations. Therefore, management objectives are focused on existing slides. Because it is assumed that the impact of harvest activities is greater on active slides than on dormant slides with respect to sediment production, conservation measures for deep-seated landslides will apply only to deep-seated landslides that meet the criteria described in 6.3.2.5.1.

6.3.2.5.1 Deep-Seated Landslides: Identification

Deep-seated landslides can be identified in aerial photographs or in the field based on various criteria described in the FPRs, California Department of Conservation Division of Mines and Geology publications, and many other publications. For purposes of this Plan, a deep-seated landslide must exhibit either of the following two criteria for this measure to apply:

1. A scarp or ground crack that exhibits at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement that typically exposes bare mineral soil, but that may be partially revegetated, and where field observations clearly indicate that the movement occurred within approximately the past 100 years, or

2. A convex, lobate landslide toe that exhibits evidence of activity within approximately the past 100 years.

6.3.2.5.2 Deep-Seated Landslide Prescriptions: Silviculture and Roads

Where the first criterion is exhibited, there will be no harvesting within 25 feet upslope from the identified active scarp or active ground crack. Where the second criterion is exhibited, there will be no harvesting on the toe and no harvesting within 25 feet upslope from the inflection point of the active convex, lobate landslide toe. Where neither criterion is exhibited, other Plan conservation measures may apply and the California FPRs will apply, but no default prescription will be required. The California FPRs also will apply to all parts of deep-seated landslides.

The intent of these prescriptions is to provide tree retention that maintains a viable root network to mitigate possible headward regression of the headscarp and shallow landslides that might occur on the toe and result in sediment delivery to a watercourse.

A possible benefit of these conservation measures on some landslides will be some measure of rainfall interception and evapotranspiration to reduce the migration of water from the crown area into the slide mass, although this may not be related to sediment delivery in all cases. The conservation measures for deep-seated landslides are subject to alternative prescriptions, as described in Section 6.3.2.

Trees may be felled within these no cut zones where necessary for worker safety or to create cable-yarding corridors. Such yarding corridors will not be greater than 25 feet wide. The intent of this exemption is to provide for operational and worker safety considerations when other options are impractical while still imparting the intended mitigation described in this document.

The impact of roads on deep-seated landslides can be managed by regulating where and how roads are constructed. No new roads will be constructed across deep-seated landslide toes or scarps that meet the criteria for this measure, or on steep (>50% gradient) areas of dormant slides, without approval by a PG and RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2) when these features cannot be avoided. Upgrading and storm proofing of existing roads, where major reconstruction is not required, will be undertaken under the Road Management Plan.

The default prescriptions for deep-seated landslides are summarized below in Table 6-9.

6.3.2.6 Shallow Rapid Landslides

Shallow rapid landslides are typically characterized by an arcuate headscarp and somewhat distinct sidescarps that can be approximately 1 foot to 10 feet deep, a partly or fully depleted source area and transport reach (commonly a bare scar), and a deposition zone, which may be subdued or eroded away. These landslides are commonly vegetated with brush, pioneering hardwood trees, and sometimes conifers, or they may be relatively devoid of vegetation. Older slides may support varying amounts and types of vegetation. Small groundwater seeps are sometimes found within landslide boundaries.

This conservation measure will apply only to those shallow rapid landslides that are field-verified to be active or which are likely to be reactivated by harvesting, and that have a reasonable potential to deliver sediment directly to a watercourse, and that are at least 200 square feet in plan view. It is expected that in some cases, an RPF will be able to determine if a landslide meets these criteria, and in other cases, an PG may be necessary to make this determination. This conservation measure will not apply to road related failures. Road related failures will be addressed by the road maintenance plan.

Table 6-9. Default prescriptions for deep-seated landslides

Historically Active	**<u>Landslide Toe</u>** • A historically active deep-seated landslide toe is defined as the area below the inflection point of the convex, lobate landform at the downslope end of the landslide that exhibits evidence of activity within approximately the past 50 to 100 years. In these areas the following default prescriptions will apply: • No cut zone within the toe and no-cut 25 feet upslope from the inflection point of a historically active toe. • Where a historical active toe is not present, standard RMZ, RSMZ, and SMZ prescriptions will apply. • No new roads will be constructed across historically active landslide toes without an approved field review. • Pre-existing roads within these areas will be evaluated and prioritized for decommissioning according the road management plan **<u>Landslide Scarp</u>** • A historically active deep-seated landslide scarp will be defined as any ground crack or scarp on a deep seated landslide that exhibits at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement that typically exposes bare, mineral soil, but that may be partially revegetated, and were active within approximately the past 50 to 100 years. In these areas the following default prescriptions will apply: • No cut zone within 25 feet upslope from the historically active scarp, • Where there are no discernable historically active ground cracks or scarps that exhibit at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement, standard RMZ, RSMZ, SMZ and Headwall Swale Protection will apply. • No new roads will be constructed across historically active scarps without an approved field review. • Pre-existing roads crossing scarps these areas will be evaluated and prioritized for decommissioning according the road management plan.
All Activity Classes	• Standard RMZ, RSMZ, SMZ and Headwall Swale Protection will apply. • No new roads or major road reconstruction across toe slopes steeper than 50% without geologic input from a California licensed Geologist. • No new skid trails or major skid reconstruction across toe slopes steeper than 50% without geologic input from a California licensed Geologist.
Other	• Trees may be felled within no cut zones where necessary to create cable-yarding corridors for the safe falling of merchantable trees. Yarding corridors will not be greater than 25 feet wide. The intent of this exemption is to provide for operational and worker safety considerations when other options are impractical while still imparting the intended mitigation described in this document.

The default prescription for landslides that do meet the above listed criteria will be no cut within the landslide boundaries, and a minimum of 70% overstory canopy within 50 feet above a slide and 25 feet on the sides of a slide. The intent of this conservation measure is to minimize any backwasting of landslide scarps or erosion of the scarps, scar, or deposit that might result in ongoing sediment delivery. Site specific geologic review of this default prescription, pursuant to Section 6.3.2, may result in an alternative prescription for shallow rapid landslides. Green Diamond's new road construction will avoid landslides that meet the above listed criteria where feasible. Where such areas cannot be avoided or where major road reconstruction is required, the terrain will be evaluated by a PG and RPF with experience in road construction in steep forested terrain. In addition, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

6.3.3 Road Management Measures

6.3.3.1 Introduction

Road related risk assessment is focused on identifying potential sediment delivery sources from areas such as the road surfaces, in-board ditches, side-cast from the road prism or at watercourse crossings. The amount of road-related sediment entering watercourses is highly variable, but in some watersheds, may comprise a large percentage of management related sediment delivery. The definition of "risk" for roads is strictly related to sediment delivery into watercourses and does not include events such as fill slope and cut bank failures that will not deliver sediment to a stream. Any potential fish passage problems also will be documented during the road related sediment risk assessment. Culverts that are impeding fish passage will be prioritized for replacement with a bridge or other "fish friendly" structure.

6.3.3.1.1 Road-related Sediment Sources

Three geomorphic processes are responsible for sediment delivery from roads: 1) surface erosion; 2) road related landslides (mostly from the fill slope, but also including some cut-bank failures); and 3) watercourse crossing failures (washouts and diversions).

In general, chronic surface erosion delivers sediment every winter, whether or not there are any large storms. Sediment delivery from chronic road erosion is generally greatest on roads that are used during the winter, and where ditches are connected to watercourses. Newly constructed roads also exhibit increased risk of surface erosion for the first several years following construction. Roads that are abandoned and overgrown typically contribute far less sediment from chronic surface erosion. Although chronic surface erosion represents a threat or risk to the aquatic system, it is not one that results in catastrophic sediment inputs.

Sediment delivery from road-related landslides and watercourse crossing failures are more episodic in nature, and are linked to large storm events. The more extreme the hydrologic event, the more frequent and larger are the failures from these two sediment sources. These episodic sediment sources deliver relatively large quantities of sediment (including both fine and coarse grain sizes) to watercourse channels. The risk is typically greatest on old or abandoned roads with undersized culverts that are not properly maintained.

6.3.3.2 Risk Assessment

6.3.3.2.1 Transportation Plan

Green Diamond has developed a preliminary transportation plan for its road network that categorized truck roads into three classes:

- management roads,
- temporarily decommissioned roads, and
- permanently decommissioned roads.

Management roads are defined as roads that are needed to either support long term management activities on the property or provide access to timber that will be harvested within the next 20 years. There are two sub-classifications of management roads 1) mainline roads and 2) secondary roads. Mainline roads support significant amounts of traffic annually from major tracts of timber or provide the main access into a tract for non-harvest management activities. Secondary roads support periodic traffic into portions of tracts with the level of use dependent upon location of harvest units. Management roads will be maintained for seasonal or year-round use (depending on their surface). Some management roads will change to a decommission category as timber harvesting operations along them are completed.

Temporarily decommissioned roads are those roads that may be used again in the future (typically unused for 20 years). A schedule will be developed for decommissioning these roads throughout the Plan Area. Decommissioning is described in Section 6.3.3. and will include pulling all watercourse crossings, backsloping of fills at crossings to the approximate natural slope contours, waterbarring road surfaces (including interception of the ditch line), pulling back excess overburden where there is a significant risk of fill failure that would deliver sediment to a watercourse, and grass seeding and mulching of cut and fill surfaces exposed during decommissioning operations. Assessment may show that some roads or road segments are completely revegetated, and no longer pose a threat to aquatic systems. These roads are in a condition that would render the disturbance, inherent in decommissioning, counter-productive.

Permanently decommissioned roads are roads that will not be needed for future management activities. Most of the roads that will be permanently decommissioned are those that were constructed on unstable slopes, or within or adjacent to riparian zones. Treatment of permanent decommission roads is essentially the same as the treatment for temporarily decommissioned roads. The storage location of waste material could be different between permanent and temporary decommissioning, but the distinct difference is the intent of future use. Permanently decommissioned roads are not intended to be used again at any point in time in the future. Assessment may show that some roads or road segments have been abandoned for such a long time that they are completely revegetated, no longer pose a significant threat to aquatic systems. These roads are in a condition that would render the disturbance inherent in decommissioning counter-productive.

Table 6-10 provides an estimate of road miles per road classification for the Initial Plan Area. Presently, the majority of the roads are in a management status, however, the table shows the course the road plan will lead as the plan is implemented over time. Throughout the life of the plan, the mileage of management roads is anticipated to decrease and the mileage of decommissioned roads is expected to increase (both temporary and permanent). See Section 6.3.3 for a description of the road plan implementation schedule. The intent is to decrease the mileage of management roads over time. Every five years the entire classification system will be reviewed to ensure that management roads no longer needed for log transportation or administrative access are changed to the appropriate decommission status. Roads newly constructed pursuant to THPs will be classified using this system, but will not contribute toward the treatment implementation total. The newly constructed roads will be built to the higher standards and will not require treatment.

Table 6-10. Miles of road per road classification as projected for the Initial Plan Area.

Road Classification	Miles
Management roads	2,157
Temporary decommissioning	1,755
Permanent decommissioning	126
TOTAL	4,038

6.3.3.2.2 Prioritization of Sub-Watershed RWUs

The Plan Area will be divided into two areas from which sub-watershed RWUs will be established and prioritized: 1) Lower Klamath River and 2) remaining portion of Green Diamond's ownership in the HPAs.

Basins within Green Diamond's ownership outside of the Lower Klamath River were divided into 28 sub-watershed RWUs that range in size from 2,000 to 21,500 acres. To facilitate watershed prioritization for assessment, the units were delineated by: 1) individual hydrologic watersheds; 2) grouping small individual hydrologic watersheds; or 3) separating larger watersheds into two or more smaller watersheds. These sub-watershed work units were prioritized for assessment based on biological, geomorphic, and road-related management criteria (Table 6-11). Biological factors used in the prioritization included species occurrence and habitat quality. A work unit received a point for each Covered Species known or suspected to be present (range 0-6). In addition, biologists qualitatively ranked each unit from low (1) to high (6) based on habitat quality. A rating of 6 represented very high habitat quality for the Covered Species present, 5 (high), 4 (high-moderate), 3 (moderate), 2 (low-moderate), 1 (low).

Table 6-11. Road work unit prioritization criteria for Green Diamond's ownership, excluding the Lower Klamath Road Work Unit.

Sub-watershed Road Work Units		Ranking				Total	Rank
		Covered Species Occurrence	Habitat Quality	Slope Risk	Watercourse Crossing Risk		
	(area included)	High=6	High=6	High=6	High=6	High=24	
South Little River	(Upper S.F., Lower S.F., S.F, Bullwinkle, Mainstem Little River)	6	5	4.67	6.00	21.67	**1**
S. F. Winchuck	(S.F. Winchuck)	6	5	4.80	5.37	21.16	**2**
Rowdy	(Rowdy, S.F. Rowdy, Ravine, Savoy)	6	5	4.07	5.35	20.44	**3**
Wilson	(Wilson)	6	4	5.30	4.69	20.00	**4**
Long Prairie	(Canyon, Railroad, Mule, Long Prairie, Pollock,	6	5	3.87	4.47	19.34	**5**
	Bald Mtn., Jiggs, Hatchery, Sullivan, Watek)						
Maple Creek	(Gray, Beach, M-Line, Clear)	6	4	3.90	5.16	19.06	**6**
North Little River	(Water, Freeman, Railroad)	6	3	4.36	5.00	18.36	**7**
Dominie	(Dominie, Ritmer, Lopez, Gilbert)	5	4	3.66	5.22	17.88	**8**
Jacoby Creek	(Jacoby Creek, Cloney, Washington, Rocky, Janes)	6	2	4.44	5.13	17.57	**9**
Lindsay Creek	(Powers, Mill, Hall, Lindsay, Essex, Mill, Widow White, Strawberry)	4	4	4.15	5.27	17.42	**10**
Dry Creek	(Devil, Dry, Blackdog, Boundary, Putter, Quarry)	4	3	5.47	4.91	17.38	**11**
Salmon Creek	(Salmon Creek)	5	3	4.58	4.70	17.28	**12**
Panther Creek	(Panther, Coyote)	5	4	3.98	3.98	16.96	**13**
Ryan Creek	(Ryan Creek et al.)	4	3	4.56	5.06	16.62	**14**
N.F. Maple Creek	(Diamond, Pitcher, N.F. Maple)	6	4	2.32	3.89	16.21	**15**
Canon Creek	(Maple, Simpson, Cañon, Vincent)	5	2	4.55	4.53	16.08	**16**
East Little River	(Mainstem above barrier)	4	4	3.54	4.49	16.03	**17**
Gossinta	(Krueger, Jackson, Denman, Gossinta, Poverty)	4	2	4.71	4.87	15.59	**18**
Basin	(Dolf, Tyson, East Fork North Fork)	4	3	3.47	4.48	14.95	**19**
Goose	(Goose)	4	3	4.04	3.74	14.78	**20**
Little Mill	(Peacock, Sultan, Little Mill, Hutsinpillar,	4	3	3.69	3.99	14.68	**21**
	Tryon, Camp Six, Fort Dick)						
Eel/VanDuzen	(Eel/VanDuzen et al.)	3	1	4.78	4.62	13.39	**22**
Noisy Creek	(Noisy, Lake Prairie, Pardee, Snow Camp)	4	3	2.68	3.16	12.84	**23**
McDonald Creek	(McDonald)	4	2	2.95	3.85	12.80	**24**
Dolly Varden	(Dolly Varden, Toss-up, Lupton)	3	3	2.92	3.58	12.50	**25**
Joe Marine	(Aikens, Joe Marine, Cananaugh, Gist,	3	3	2.91	2.86	11.77	**26**
	Bens, Burrill, Pine, Devil, Cappell)						
Coastal Tribs	(Burris, McNeil, Mill, McConnahas, Luffenholtz)	2	2	3.10	4.36	11.47	**27**
Boulder Creek	(Madrone, Graham, Goodman, Boulder)	3	1	2.96	3.27	10.22	**28**

Geomorphic and road-related management criteria used in the screening level risk assessment include stream density (mi/mi^2) and road density (mi/mi^2). Road related erosion that results in sediment delivery typically occurs at a few relatively predictable geomorphic locations. Generally, the more frequently these “susceptible” locations occur along a road, the greater will be the chance for accelerated erosion and sediment delivery. These “weak points” or “susceptible locations” include watercourse crossings, locations where roads have been constructed across steep inner gorge hillslopes, and locations where roads have been built across the steep approaches to incised tributary stream channels. High stream and road densities were used as a surrogate for more “susceptible” sites which established the watercourse crossing risk. Sub-watersheds that had higher stream and road densities received a higher priority. Road densities for the sub-watershed RWUs range from 2.8 to 8 mi/mi^2 and the stream densities range from 4.6 to 8.9 mi/mi^2. The road density and stream density for each work unit was averaged and multiplied by 0.7177 to construct the watercourse crossing risk scale with a range from 2.86 to 6. A slope risk was also established for each work unit which incorporated slope steepness and road density. A GIS analysis calculated the proportion of area in each work unit by slope classes that ranged from 0-30%, 31-50%, and >50%. A weighting procedure was applied to each slope class. The proportion of the work unit in the >50% slope class was multiplied by 5, the proportion of the work unit in the 31-50% slope class was multiplied by 2, and the proportion of the work unit in the 0-30% received no weighting. Next, each work unit received a road density rank of 1 if the road density ranged from 2.8 to 4.5, a 2 if the road density ranged from 4.6 to 6.2, or a 3 if the road density ranged from 6.3 to 8.0. To determine the slope risk value for each work unit, the sum of the weighted slope classes was added to the road density rank. Sub-watersheds that had steeper slopes and higher road densities received a higher priority. This process standardized the slope classes and the road and stream densities so the biological, geomorphic, management criteria had equal weight when determining the overall priority rank of the sub-watershed work units. The maximum total score possible for any work unit was 24.I

n 1995, the Lower Klamath Restoration Partnership (LKRP), developed a “Watershed Restoration and Enhancement Plan” for the Lower Klamath River. To facilitate and enhance existing partnership established between Green Diamond and the Yurok Tribe, the prioritization plan already established for the Lower Klamath Basin was utilized. That plan identified 30 sub-watershed RWUs within the Lower Klamath River for prioritizing assessment work. These 30 sub-watershed work units were similarly prioritized for assessment based on biological, in-stream, and upslope parameter (Table 6-12). Two categories were established for each parameter, resulting in 6 scoring criteria. Each criteria was scored on a scale from 1-5, with a maximum total score possible of 30. Stream drainage area was used as a tiebreaker for any streams that received equal scores, with larger watersheds receiving priority. This was based on the assumption that all other things being equal, a larger watershed has a greater biological production potential.

The first two parameters were developed with the intent of ranking work units based on the diversity and significance of fish populations and the overall condition and accessibility of in-stream habitat. Unlike the other prioritization criteria, these criteria do not include the amphibian Covered Species, however, both amphibian species are ubiquitous throughout the Lower Klamath region and would not affect the overall ranking of any given sub-watershed work unit.

The upslope parameter factors in road and watercourse crossing densities, which like the prioritization criteria established for the ownership outside the Lower Klamath River, were used as a surrogate for more “susceptible” sites. Sub-watersheds in the best biological and physical condition and with the largest number of potential erosion sites received a higher priority rank. See Gale and Randolph (2000) for a detailed description of the ranking criteria that was used in the prioritization Table 6-12 from the Lower Klamath River sub-basin watershed restoration plan.

Table 6-12. Lower Klamath River road work unit prioritization criteria.

Sub-Basin	Anadromous Salmonid Diversity (1-5)	Relative Biological Importance (1-5)	Channel & Riparian Condition (1-5)	Habitat Connectivity (1-5)	Road Density (1-5)	Stream Crossing Density (1-5)	Total (1-30)	Rank (1-30)
Mainstem Blue Creek	5	5	5	5	2	2	24	1
Crescent City Fork	5	5	5	5	1	1	22	2
Terwer Creek	5	5	4	3	2	2	21	3
Tectah Creek	4	5	3	3	2	3	20	4
McGarvey Creek	4	4	3	4	3	2	20	5
Mettah Creek	4	4	3	4	2	2	19	6
South Fork Ah Pah	3	3	2	2	4	5	19	7
West Fork Blue Creek	3	3	3	4	2	3	18	8
Mainstem Ah Pah	3	3	2	2	5	3	18	9
Roaches Creek	3	3	3	3	2	3	17	10
Hunter Creek	5	4	2	2	2	2	17	11
Hoppaw Creek	4	3	2	1	3	3	16	12
Nickowitz Creek	2	3	4	4	1	1	15	13
North Fork Ah Pah	3	2	3	3	2	2	15	14
Bear Creek	3	2	2	2	3	3	15	15
Johnsons Creek	4	3	2	2	2	2	15	16
Pine Creek	3	3	3	3	1	1	14	17
Pecwan Creek	3	2	3	2	2	2	14	18
Tully Creek	1	3	3	3	2	2	14	19
Slide Creek	1	3	4	4	1	1	14	20
Surpur Creek	3	1	1	2	4	3	14	21
Tarup Creek	4	2	2	1	3	2	14	22
Cappell Creek	1	2	3	2	2	2	12	23
Waukell Creek	2	1	1	1	4	3	12	24
High Prairie Creek	2	1	3	1	2	2	11	25
Salt Creek	2	2	2	2	2	1	11	26
Morek Creek	1	1	3	2	2	2	11	27
Little Surpur Creek	1	1	1	2	3	3	11	28
Omagaar Creek	3	1	2	1	2	2	11	29
Saugep Creek	2	1	1	2	3	2	11	30

6.3.3.2.3 Assessment of Road Network

Green Diamond will coordinate assessment activities using both prioritization tables beginning in the highest priority RWUs. Road-related sediment sources from truck roads will be identified through a two-step process of air photo analysis and field inventories. An analysis of the available historical aerial photos will be conducted to identify all the roads that were constructed in the watershed, whether they are currently maintained and drivable, or are now abandoned and overgrown with vegetation. When possible, photographic coverage from a number of years will be selected to “bracket” major storms in the watershed. This analysis will lead to the construction of detailed land use and erosion history maps for the watershed, including road location and road construction history. Finally, field inventories and site analyses will be conducted to identify and quantify road-related sediment sources and to develop plans for erosion reduction or prevention. Culverts that are identified on fish bearing watercourses during the assessment will be documented for high priority replacement with a “fish friendly” crossing. The field inventories of the RWUs should precede implementation no more than a few years. The time period is dependant on the weather conditions since the data were collected.

The two most important factors that will be used to evaluate the risk of road-related sediment delivery include: 1) an assessment of the probability of erosion or failure at all “susceptible” points along the alignment (“erosion potential”) and 2) an estimation of the volume of potential sediment delivery to a stream (if no preventive work were done). These two factors will form the basis of the road assessment, and the data collected will be used to develop a cost-effective plan for mitigating or preventing road-related sediment delivery.

The most common sediment source sites include watercourse crossings, potentially unstable road and landing fills, and “hydrologically connected” road segments which exhibit surface erosion and sediment delivery. For the detailed field assessment, aerial photographs will be used to record site locations. A data form will be completed for each potential sediment delivery site identified in the field which will be stored in a database. Road failures or erosion features with no potential to deliver sediment to a stream will not be included in the inventory.

Once sites are identified and quantified, prescriptions for erosion control and erosion prevention will be developed for each source of treatable erosion that is field-identified. Prescriptions developed for each site will involve temporary or permanent decommissioning, or road upgrading for Green Diamond’s Management Road system, and will include information about the types of equipment needed, equipment hours, need for armoring, potential for diversion, hand labor for culvert installation, downspouts, seeding and mulching, estimated costs for each work site and quantitative estimates of expected sediment savings.

6.3.3.2.4 Implementation Prioritization

Following development of treatment prescriptions, roads will be prioritized for treatment based on: 1) future sediment delivery (yds^3/site or yds^3/mile); 2) treatment immediacy (a subjective combination of event probability and sediment delivery which is evaluated as High, Moderate or Low); and 3) treatment cost-effectiveness. The estimated cost-effectiveness of treating a work site is defined as the amount of money that would be spent to prevent one cubic yard of sediment from entering or being delivered to the stream system, expressed as $/yd^3 (dollars spent per cubic yard of sediment "saved"). The estimated cost effectiveness will be calculated for each individual site recommended for treatment or for groups of sites along a single road.

By using this quantitative methodology, a variety of different techniques and proposed projects can be using the same criteria, and a prioritized list of proposed erosion prevention treatments can be developed for each road or for individual road segments and spur roads.

Some sites that have a low cost-effectiveness may be critically important to treat because of a large volume of potential sediment delivery and a high likelihood of occurrence of a triggering event. These sites will receive priority for treatment, even if the road on which they occur does not otherwise rank high on the list of treatment candidates.

Generally, individual sites will be given priority for upgrading or decommissioning treatment if they exhibit: 1) potential for substantial (>25 yds^3) sediment delivery to a Class I or II channel, 2) a high or moderate treatment immediacy, and 3) a predicted cost-effectiveness value averaging no more than about $15/yd^3. Roads or road segments will be prioritized for treatment if they contain an unusually large number of sites with a high treatment immediacy (#H/mile), or if they display a comparatively large unit future sediment delivery volume (yds^3/mile).

6.3.3.2.5 <u>Implementation Plan and Accelerated Schedule</u>

The final product from road assessment and treatment prioritization will be an implementation plan that involves one of three outcomes: 1) temporary road decommissioning, 2) permanent road decommissioning, and 3) road upgrading.

Green Diamond will treat all high and moderate sites by the end of the Permit period. Green Diamond will front load the treatment implementation by providing for an average of $2.5 million per year for the first 15 years (for a total of $37.5 million unless adjusted as provided below) on implementing the treatment of high and moderate priority sites beginning in the high priority RWUs. The preliminary estimate of future sediment yield from high and moderate sites on roads within the Plan Area is 6,440,000 yds^3. A refined estimate of the future sediment yield (yds^3) from high and moderate sites will be made by the end of the first five years of Plan implementation. A stratified random sampling approach will be used in RWUs that have not been 100% inventoried. Fifteen to twenty percent of the roads within each RWU will be randomly sampled in 0.5-mile segments.

The estimated future sediment from each RWU will be added to the estimates from the 100% inventories. If the refined estimate is within ±5% of the original estimate (6,118,000 to 6,762,000 yds^3) there will be no change in the level of mitigation. If the refined estimate is within ±5-10% of the original estimate, the level of mitigation will adjust according to the sediment yield percentage difference in 1% increments (± $375,000 per 1% sediment yield difference) by increasing or decreasing the initial 15-year period by up to 1.5 years. If the refined estimate is more than ±10% of the original estimate (<5,796,000 or >7,084,000 yds^3), the level of mitigation will adjust to no more than ±$3.75 million for ±1.5 years of the first 15 years. The maximum extent of the accelerated commitment will be $2.5 million per year for 16.5 years and the minimum extent of the accelerated commitment will be 13.5 years. The $2.5 million commitment will be inflation adjusted in 2002 dollars each year of the accelerated term.

All high and moderate sites, including those fixed on roads appurtenant to THPs, will count towards the $2.5 million. In general this will not dramatically shift the proposed prioritization schedule because a large proportion of Green Diamond's current harvest activities are in high priority RWUs. There will likely be a three-year implementation phase in period. A short-term time lag may occur between identifying specific road projects, acquiring necessary 1603 permits, locating capacity for the actual implementation, and completing required training courses. Green Diamond is expected to be at a full implementation level by the end of the third year (i.e. $7.5 million spent (inflation adjusted in 2002 dollars for each year)). On an annual basis the $2.5 million per year will be adjusted proportionally to reflect the acreage of the current Plan Area in relation to the acreage of the Initial Plan Area.

Examples of possible commitment level adjustments:

Example #1.

Original estimate:	6,440,000 yds^3
Refined estimate:	6,311,200 (2% less than the original estimate)
Commitment:	$2.5 million per year for 15 years

Example #2.

Original estimate:	6,440,000 yds^3
Refined estimate:	6,955,200 (8% more than the original estimate)
Commitment:	$2.5 million per year for 16 years plus $0.5 million the following year.

6.3.3.3 Training Courses

All equipment operators and supervisors involved with the implementation plan will complete training to ensure proper implementation of treatments. In addition foresters will complete a training course to ensure proper road layout and design. The training courses will be offered every year as necessary for new employees or contractors who will be involved with implementing the road plan. Refresher courses will be provided every two years as appropriate to review concepts and to introduce any new state-of-the-art techniques.

6.3.3.3.1 Purpose of Training

- To present technical training on the topics of proper road construction, road upgrading, road maintenance and road decommissioning practices with a dual emphasis on practicality as well as effective erosion and sediment control

- To build a company-wide understanding of state-of-the-art, cost-effective road treatments

- To make road treatment procedures uniform, consistent and up-to-date across the ownership
- To introduce new procedures and techniques to field personnel as they are developed or refined
- To bring Green Diamond operators and contractors up-to-speed on tasks and methods for proper road treatments
- To introduce new operators to the concepts and techniques for proper road treatments
- To work with supervisors to develop an understanding of the theory and proper application of the standards and practices for modern forest road treatments
- To work with foresters on identifying common road-related problems and developing effective and cost-effective treatment prescriptions for erosion prevention and sediment control

6.3.3.3.2 Training Format

Training for forest road activities and practices will consist of a four-phase procedure.

1. Office and classroom presentation of concepts and theory of road treatments; review of the difference between typical past practices and currently acceptable methods; slide presentation depicting road-related problems and appropriate treatments; comparison of effective and ineffective treatments; question and answer session.
2. Field workshop to view sites depicting various untreated problems, review of road reaches which have been correctly and appropriately treated; review of road reaches or sites showing examples of partially or incorrectly applied treatments.
3. Practical field workshop to observe and participate in proper road treatments and demonstration projects actively underway; discussions with other operators on techniques and practices employed in designing, staging and applying proper road treatments

4a. On-the-job training for foresters and supervisors on road design and layout, problem identification, problem quantification, prioritization and development of cost-effective treatments

4b. On-the-job application of road treatments with technical oversight and review of road treatment practices and operations (beginning with regular, repeated field review and terminating in intermittent checking of new or unusual operations, as needed)

6.3.3.3.3 Duration of Road Treatment Workshops and Training

- Phase 1 Office and class room 2 - 4 hours
- Phase 2 Field workshop 6 hours
- Phase 3 Practical field workshop 8 hours
- Phase 4a On-the-job training for foresters and supervisors Variable
- Phase 4b On-the-job training for operators 2 - 6 months

6.3.3.3.4 Training Courses

1. Basic training in Road Decommissioning (foresters, supervisors and operators)

2. Basic training in Road Location and Design (foresters) and Road Construction (foresters, supervisors and operators)

3. Basic training in Road Upgrading (foresters, supervisors and operators)

4. Basic training in Road Maintenance (foresters, supervisors and operators)

6.3.3.4 Summary of Time Periods When Road Work May/May Not Occur

Table 6-13 summarizes the time periods when road decommissioning, upgrading, and new construction may occur in the Plan Area.

Table 6-13. Time periods when road work may/may not occur within the Plan Area.

Activity	Nov. 16 –April 30	May 1-May 14	May 15-Oct. 15	Oct. 16-Nov. 15
Road Decommissioning	None	None	Yes	Yes if (1, 3)
Road Upgrades	None	Yes if (2)	Yes	Yes if (1, 3)
New Road Construction	None	None	Yes	None
New Landing Construction	None	None	Yes	None

Notes
1. Cumulative rainfall from September 1st through October 15th is less than 4" and activity will cease when cumulative rainfall reaches 4".
2. No measurable rainfall has occurred within the last 5 days and no rain is forecast by the National Weather Service for the next 5 days.
3. A project can be completed in one day and erosion control structures can be installed. If a site requires multiple days for completion, a long-range National Weather Service forecast of no rain for the next 5 days is required.

6.3.3.5 Road Decommissioning

The treatments listed below briefly describe some techniques for decommissioning roads and landings. Techniques described in Weaver and Hagans (1994) will generally be followed when decommissioning roads.

6.3.3.5.1 Time of Year Restrictions

Road decommissioning will not occur during the winter operating period (October 16th through May 14th) unless unseasonably dry weather persists in the fall at the beginning of the winter period (see Table 6-13). Unseasonably dry fall is defined as less than 4 inches cumulative rainfall from September 1st through October 15th. Road decommissioning will cease when 4 inches cumulative rainfall is reached or a National Weather Service forecasted rainfall amount will reach or exceed the 4 inch cumulative total. No road decommissioning will occur prior to May 15th or after November 15th.

Average weekly rainfall from the Fieldbrook 4D Ranch rain gauge from October 1956 through May 1986 was examined with respect to the average weekly discharge for Little River stream gage near Trinidad for the same period. The relationship between rainfall and stream flow response was examined to determine the amount of rainfall that was required to generate elevated and sustained stream flow above a summer base flow (Figure 6-6). From that examination, the week of October 9th through October 15th is the period where the stream flow begins to increase above a summer base flow. This week was then selected as the period where the average cumulative rainfall would indicate saturated soil conditions. For purposes of this evaluation, the beginning point for the cumulative rainfall was set on September 1st. Rainfall occurs prior to this date during the summer; however the amount is generally not sufficient to contribute to soil moisture storage. From inspection of the historical data, the average cumulative rainfall between September 1st and October 15th is 4 inches. October 15th also corresponds to the last day of the summer period. Therefore the 4 inch cumulative rainfall can be considered an indicator of when the soil first becomes saturated on average (as indicated by the increased stream flow response).

Based on this evaluation, road decommissioning can occur outside the summer period (after October 15th) during an unusually dry fall up through November 15th or when 4 inches of cumulative rainfall is reached (which ever occurs first). An unusually dry fall is defined as less than 4 inches of cumulative rainfall from September 1st through October 15th. The above analysis was based upon data from the Little River area but it will be applied to the entire Plan Area. This was the only area where there were data with sufficient record length or gauges in close proximity to perform the analysis. As more data become available (e.g. from project work from the Experimental Watersheds within Plan Area) the relationship between rainfall and stream flow response estimates may be refined.

Between October 15th and November 15th, each project site (i.e. watercourse crossing fill removal) will be completed that operational day with erosion control structures installed. If a site requires multiple days for completion (i.e. 2-3 days), a long-range forecast of no rain for the next 5 days is required. The intent is to have at least one operational day prior to a rain event to ensure erosion control structures are installed. Sites that require multiple days for completion will not be started during the winter period unless there is an emergency situation. A situation is an ‘emergency’ for the purpose of this section if the elements of Section 6.3.3.10 are satisfied.

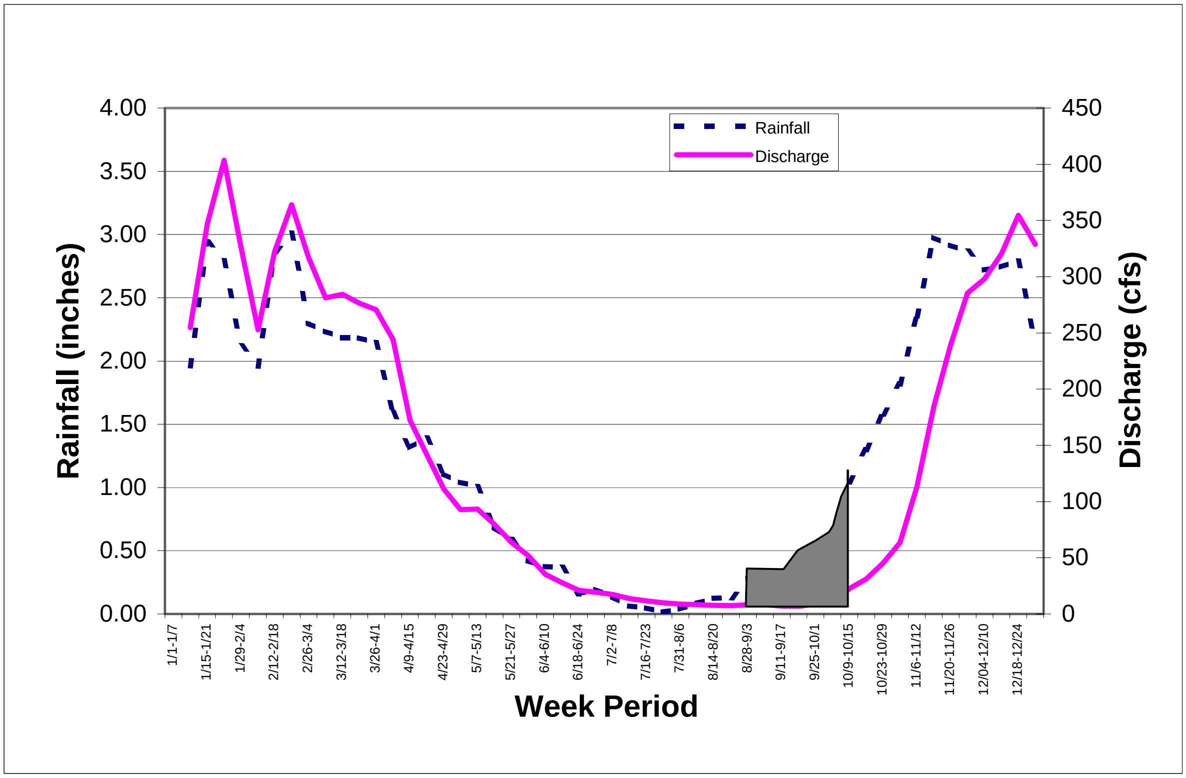


Figure 6-6. Average rainfall for Fieldbrook 4D Ranch, CA, and average discharge for Little River near Trinidad, CA, by week from 10/1956 through 5/1986. Shaded area represents 4 inches of cumulative rainfall from September 1st through October 15th.

6.3.3.5.2 Permanent and Temporary Decommissioning

Some roads have been abandoned and are in a condition where no treatment would be required because they are completely revegetated, no longer pose a threat to aquatic systems, and are in a condition that would render the disturbance inherent in decommissioning counter-productive. The road assessment process will determine whether treating certain roads or road segments would be counter-productive.

6.3.3.5.3 Watercourse Crossings

Green Diamond will remove the fill from the stream channel on all watercourse crossings on decommissioned roads. The excavation will extend down to the original channel bed, with the excavated channel at least as wide as the original channel. The side slopes will be sloped back to the original or a stable angle and spoil material transported to a stable location. Appropriate erosion control measures such as seeding and mulching will be utilized to prevent surface erosion at excavated crossings.

6.3.3.5.4 Road-related Unstable Areas

Any unstable or potentially unstable road or landing fill identified during the assessment process will be pulled back and spoil deposited in a stable location to ensure that perched fill or organic material does not pose a risk of failure and sediment delivery to a watercourse. Appropriate erosion control measures such as seeding and mulching will be utilized to prevent surface erosion at excavated unstable areas.

6.3.3.5.5 Road Surface Runoff

Both temporarily and permanently decommissioned roads will have maintenance free surface drainages that are hydrologically disconnected from watercourses. Inside ditches and springs and seeps will be properly drained with deep cross-drain ditches. Discharge from ditches will not be directed onto unstable areas. Localized outsloping may be necessary to adequately drain the road surface. Permanently decommissioned roads will be ripped and planted with commercial tree species where appropriate to reestablish timber production.

6.3.3.5.6 Erosion Control

Green Diamond will perform erosion control (e.g., seeding, mulching and planting, and installation of energy dissipation such as rock armor or woody debris) as needed to minimize potential sediment delivery. The majority of erosion control work will be accomplished by excavating the watercourse crossings and unstable areas, and by ensuring proper road surface drainage.

6.3.3.6 New Roads – Location, Design, Timing, and Construction Standards

Minimization of both the length of road construction and the number of watercourse crossings are basic Green Diamond engineering principles. However, because of topographic limits and climatic conditions found on the north coast the lineal feet of watercourse per square mile is much higher than for interior forests. This situation requires that foresters assess larger portions of watersheds or their sub-basins to obtain the topographic and hydrologic information necessary to insure the best overall road design for an area. Because Green Diamond has a wide variety of modern road construction and harvesting equipment available, more options are available to allow for application of low impact road designs and construction techniques.

6.3.3.6.1 Location

As part of THP preparation, Green Diamond foresters perform a detailed field reconnaissance to identify and locate the best access between topographic control points that are critical to a harvesting operation. Mainline and secondary roads will typically have a combination of outsloped (with rolling dips) and crowned (with inside ditches) road construction where appropriate, and occasional turnouts. New roads will be constructed so the road network will not drain directly into watercourses (hydrologically disconnected. New roads designed for a single-use in a THP will be classified as temporary and decommissioned upon completion of operations. This minimizes the risk of sedimentation from unused roads and reduces the amount of future maintenance liability. The construction standards for new temporary roads or new management roads are the same except where specifically noted below.

6.3.3.6.2 Time of Year Restrictions

Green Diamond will not construct or rock new roads during the winter period (October 16th through May 14th). (Also see Table 6-13.)

6.3.3.6.3 Right-of-way and Pioneering

1. Clearing limits will normally range from 75 to 100 feet. The width of the clearing limits depends on the slope of the ground to adequately displace organic material so the organics are not incorporated in the fill. In addition the width needs to be sufficient to avoid having fill material butt up against green trees.

2. All trees over 12 inches dbh within 5 feet of the top of the cut slope will be cleared. Trees greater than 12 inches dbh within 5 feet of the top of the cut slope may be retained if they will not be susceptible to windthrow or of being undercut.

3. Slash and other debris from road construction will not be incorporated into the road prism, fills or sidecast material. When feasible, slash and debris will be placed parallel to the toe of road fill slopes as a filter windrow. Slash will not be bunched against residual trees or placed in locations where it may gain entry into Class I, II, or III watercourses.

4. On side slopes greater than 35%, the organic layer of the soil will be substantially removed prior to fill placement.

5. Every attempt will be made to avoid locating roads on steep slopes, inner gorge or steep toe slopes, headwall swales or debris slide slopes, and deep-seated landslides as identified in Section 6.3.2. The Slope Stability Measures outlined in Section 6.3.2 will be followed when it is not possible to avoid these features.

6.3.3.6.4 Excavation and Construction

1. Road Width Specifications

    a. Management Roads

        1) Mainline Road – 16 to 18 feet wide running surface, with combination of outsloped and crowned roads plus inside ditches where appropriate and occasional turnouts (see c below for exceptions).

        2) Secondary Road - 14 to 16 feet wide running surface, with combination of outsloped and crowned roads plus inside ditches where appropriate and occasional turnouts (see c below for exceptions).

    b. Temporary Road – 14 to 16 feet wide running surface, typically outsloped with rolling dips. Planned and designed for a single harvest entry and will be decommissioned upon completion of harvesting operation (see c below for exceptions).

c. Exceptions for increasing widths include topographic constraints, landing locations, turnouts, engineered berms, and curve widening (see #4 below), as measured in 200-foot lineal segments.

2. New road construction will not occur in RMZs with the exception of watercourse crossings or spur roads off of existing roads within RMZs which would be designed to extend outside the RMZ. New roads will not be built that parallel watercourses within RMZs. The intent is to minimize the amount of road within the RMZ when crossing watercourses and to use spur roads outside the RMZ when appropriate to avoid paralleling watercourses. The alternative with the least impact to cross watercourses and construct spur roads will be selected.

3. Roads that will be used during the winter period for hauling (logs and rock) will have surfacing specifications of a minimum compacted depth of 12" of rock. Only rock that is durable and does not readily break down (e.g. sandstones, graphitic schist, etc) with vehicle or heavy equipment use will be applied to road surfaces. Vehicular access on roads used for administrative purposes during the winter period will have rock applied as needed to prevent runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface which drains into a Class I, II, or III watercourse.

4. Greater road widths will be allowed to satisfy requirements of alignment, safety and equipment. Curves will be widened to an additional width based on the following table:

100 feet + radius	+ 3 feet
75 – 100 feet radius	+ 5 feet
50 – 74 feet radius	+ 8 feet

5. Final grades will not exceed 15% except to avoid unstable slopes, steep slopes, inner gorges, inner gorge crossings, or to access a suitable watercourse crossing location, as measured in minimum 100-foot increments. The intent is to minimize steeper road grades to have a lower risk road; but have the flexibility to run steeper grades where appropriate to reach strategic control points and avoid higher risk topography.

6. All overhanging cut slopes will be removed.

7. For new road construction in areas where existing road bank cuts have exhibited failures, Green Diamond will evaluate site specific situations and apply measures as appropriate such as seeding and mulching, buttressing, and erosion mats to ensure cut bank stability and to minimize erosion.

8. Green Diamond will avoid the use of through cuts where feasible. In areas where through cuts cannot be avoided (e.g., to avoid steep slopes, unstable slopes) permanent ditch-outs will be installed at the beginning and end of the through cut.

9. Except for certain soil types or site conditions that require vertical cut slopes (e.g. Tonnini soils, rock outcrops) slope cuts will be designed and constructed to minimizing the risk of slope failure, soil disturbance and excessive excavation.

10. For areas requiring “end-haul” or some degree of “waste management” (hill slopes greater than 60%, or locations where sidecast could directly enter stream channels) excess material will be deposited in a stable location where sediment will not deliver to any watercourses. Waste material will be seeded and mulched prior to October 15th of the same year.

11. On side slopes greater than 50%, where the length of the road section is greater than 100 feet, fills greater than 4 feet in vertical height at the outside shoulder of the road will be constructed on a bench that is excavated at the proposed toe of the fill and is wide enough to compact the first lift and subsequent lifts compacted in approximately 1-foot intervals from the toe to the finished grade.

12. Fills, including fills across watercourses, will be constructed to minimize erosion using techniques such as insloping, berms, rock armoring where appropriate, or other suitable methods.

13. A combination of outsloped and crowned roads with inboard ditches will be used where appropriate on roads that are to be rocked.

14. Where roads cross watercourses, the road prism will have a gradual transition to an insloped vertical curve as the road approaches and leaves the crossing (critical dip).

15. An out-sloped road prism will generally be used for native surface roads.

16. Turnouts will be placed at reasonable intervals along the alignment and will be located where a minimum of excavation will be necessary to increase the road width. Turnouts will not be constructed if fill is required on side slopes for their construction.

17. No road construction will occur when soil moisture conditions would result in: a) reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performance, b) inadequate traction without blading wet soil, or c) soil displacement in amounts that cause a visible increase in turbidity in any ditch or road surface that drains into a Class I, II, III, or IV waters, except that construction may occur on isolated wet spots arising from localized groundwater such as seeps or springs.

6.3.3.6.5 Drainage Structures

1. All new watercourse crossings will be constructed to minimize fill over the culvert.

2. All new watercourse crossing culverts will be designed to handle a 100-year return interval flow event. The design flow will be calculated using the Waananen and Crippen (1977) method for drainage areas greater than or equal to 80 acres. The Rational Method (Chow 1964) will be used when the drainage area for a crossing is less than 80 acres. Culverts will be sized to pass the 100-year flow event without overtopping (headwater depth to culvert diameter ratio = 1.0). Other comparable flow design estimators that are developed for the North Coast Region may also be used.

3. Watercourse crossings on temporary roads designed for one time summer season use will be designed to carry the flow at the time of construction and will be removed prior to October 15th of the same year. A minimum 6 inch pipe size will be used on small seeps and springs to ensure a dry and stable road surface.

4. Bridges will be installed on fish bearing watercourses where feasible. When a bridge installation is not feasible, a countersunk or bottomless culvert or other "fish-friendly" structure will be installed that will provide upstream and downstream passage for all life stages of fish. Installed culverts will not restrict the active channel flow.

5. Permanent watercourse crossings, road approaches to crossings, and associated fills will be constructed to prevent the potential diversion of stream overflows down the road and to minimize fill erosion should the drainage structure become obstructed (critical dip).

6. Erosion protection measures such as inlet and outlet armoring of pipes and energy dissipaters (e.g., down spouts, rocks, or logs) will be installed where necessary to prevent erosion concurrently with the fill at all culverted watercourse crossings. Armoring will extend at least 1 foot above the expected head and tail water elevations at the culvert. All bare soil on fill slopes at the culvert crossing will be seeded and/or mulched prior to the first winter period following installation to prevent erosion and promote revegetation. If it is determined that site specific conditions do not warrant additional erosion protection measures, Green Diamond will submit to the Services an explanation, justification, and a map of the proposed exception as part of the informational copy of the THP notice of filing (see Section 6.2.7.2).

7. All watercourse crossings will be aligned with the natural grade and course of the stream to the fullest extent possible.

8. Fill material over culvert installations will be compacted in 1-foot lifts and fill faces will be compacted during construction.

9. Green Diamond will install a minimum culvert size of 24 inches in all watercourse crossings on management roads, except for springs and seeps where such size would be unnecessary or impractical.

10. No culvert will be allowed to discharge onto erodible material or unstable slopes. When downspouts are used, they will be adequately secured to the culvert and they will be supported at intervals along their entire length.

11. Ditches will be V-shaped and be approximately 1 foot deep relative to the subgrade. Ditches will be excavated into the road subgrade and not undercut the road cut slope. Where conditions warrant it, ditch alignment will be pulled away from the cut slope to provide storage room for hillslope ravel, and slumps, and to provide protection of ditch conveyance capability.

12. Ditch relief culverts and/or rolling dips will be installed at intervals based on the maximum spacing in Table 6-14. Additional ditch relief culverts and rolling dips will be installed where appropriate to adequately disconnect the roads from the watercourses and to minimize ditch water accumulation on slide prone landforms such as inner gorges.

Table 6-14. Maximum spacing (feet) for ditch relief culverts and/or rolling dip installations.[1]

Road Grade	Maximum Spacing (Feet) per Erosion Hazard Rating[2]		
	Extreme	High	Moderate and Low
2%	600		
4%	530	600	
6%	355	585	600
8%	265	425	525
10%	210	340	420
12%	180	285	350
14%	155	245	300
16%	135	215	270
18%	115	190	240

Notes
1 Modified from Weaver and Hagans (1994)
2 EHR from California FPRs, 14CCR 912.5

13. Ditch relief culverts will normally consist of culverts with a minimum size of 18 inches.

14. Ditch relief culverts will be discharged 50 to 100 feet before water enters a Class I or II watercourse to hydrologically disconnect the roads from the watercourse. Drains will discharge onto stable landforms with adequate energy dissipation and sediment filtering capacity. Outlets discharging onto erosion prone areas will be avoided or provided with effective erosion protection measures.

15. Ditch relief culverts will have a grade that is at least 2% greater than a contributing ditch to prevent ponding and to ensure that they are self-cleaning.

16. In general, steeper road grades (>8%) will utilize cross drains, and more moderate grades will utilize rolling dips and/or outsloping.

6.3.3.6.6 *New Landing Construction*

1. New landing construction will not occur during the winter period (October 16 through May 14).

2. Landings will be constructed to the minimum width, size and number consistent with the yarding and loading systems to be used.

3. New landings will not be constructed in RMZs or EEZs.

4. Every reasonable effort will be made to limit new landing construction and associated excavation by landing logs on existing roadways where site-specific conditions allow. When it is necessary to construct landings, an emphasis will be placed on avoiding locating landings on steep or convergent slopes (topographic flats and divergent slopes will be used where possible).

5. No landing construction will occur when soil moisture conditions would result in: a) reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performance, b) inadequate traction without blading wet soil, or c) soil displacement in amounts that cause a visible increase in turbidity in any ditch or landing surface which drains into a Class I, II, III, or IV waters.

6. No fill will be placed and sidecast will be minimized on slopes greater than 65%.

7. All landings used as part of current operations will be assessed after completion of operations to determine whether or not overhanging or perched fill or organic material poses a risk of failure and sediment delivery to a watercourse. If such a risk exists, fill material will be pulled back to a stable condition and excavated material will be deposited in a stable location. The pullback will be accomplished prior to October 15th following the completion of operations. Waste material will be seeded and mulched prior to October 15th.

8. On side slopes less than 50%, sidecast or fill material extending more than 20 feet in slope distance from the outside edge of the landing and within 200 feet of a watercourse or lake will be seeded, planted, mulched, removed, or treated to minimize soil erosion. The intent is to minimize the amount of side cast particularly in locations where sidecast could directly enter a stream channel. Excess material will be deposited in a stable location where sediment will not deliver to any watercourses.

9. Waste organic material such as uprooted stumps, cull logs, accumulations of limbs and branches, or unmerchantable trees will not be buried in landing fills. Slash and other organic debris may be placed and stabilized at the toe of landing fills to restrain fill soil from moving downslope.

10. Upon completion of timber operations, landings will be drained to prevent water from accumulating. Concentrated flows will not be channeled over fills and will only be discharged onto stable areas. Discharge points will be located on stable landforms and where stable discharge points are absent, adequate erosion protection and energy dissipation will be employed.

11. Landings that will be used during the winter period will have surfacing specifications of minimum compacted depth of 12 inches of rock. Only rock that is durable and does not break down with vehicle or heavy equipment use will be applied to road surfaces.

6.3.3.6.7 *Erosion Control*

1. Appropriate erosion control measures will be utilized to minimize erosion and prevent sediment from entering watercourses during all road and landing construction activities. Erosion control measures to be utilized will include, but not be limited to, road surfacing, dispersing runoff into stable vegetated filter areas, armoring with rock rip-rap, end hauling waste material to stable locations, construction of rolling dips, critical dips and waterbars, mulching, and revegetating disturbed surfaces as soon as practical.

2. Where construction activities are conducted in close proximity to watercourses, additional erosion control protection measures will be utilized to trap sediment and minimize its entry into the watercourse. As required, slash filter windrows, silt fences, mulching and/or straw bale check dams will be used to control runoff over fill slopes and along concentrated runoff flow paths.

3. All watercourse crossings and cross drains will be installed and functional prior to October 15th. In addition, by October 15th, all waterbars, rolling dips, and road and landing construction associated with straw mulching and grass seeding will be completed in order to minimize suspended or mobilized sediment delivery to a watercourse.

4. Prior to the beginning of the first winter period (October 15th) following construction, all new cut and fill slopes on road construction within the RMZ or EEZ of a Class I, II, or III watercourses will be seeded at a rate of at least 30 pounds per acre and mulched to a depth of at least 2 inches (before settling) with 90% surface coverage.

5. At temporary crossings, the fill slope will be pulled back to the natural side slopes and deposited in a stable location where sediment will not deliver to any watercourses. All exposed areas associated with the crossing will be seeded at a rate of at least 30 pounds per acre and mulched to a depth of at least 2 inches (before settling) with 90% surface coverage.

6.3.3.7 Upgrading of Management Roads

6.3.3.7.1 <u>Time of Year Restrictions</u>

Road upgrading will not occur during the winter operating period (October 16th through May 14th) unless unseasonably dry weather persists in the fall at the beginning of the winter period or early spring drying has occurred at the end of the winter period. An unseasonably dry fall is defined as less than 4 inches cumulative rainfall from September 1st through October 15th. Road upgrading will cease when 4 inches cumulative rainfall is reached or a forecasted rainfall amount will reach or exceed the 4 inch cumulative total. See Road Decommissioning Section 6.3.3 for a rationale of the 4 inch cumulative rainfall.

Road upgrading can take place from May 1st to May 15th when early spring drying has occurred. Early spring drying is defined as 1) no measurable rainfall within the last 5 days, 2) no rain forecast by the National Weather Service for the next 5 days. The use of any portion of the road should not result in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface which drains into a Class I, II, or III watercourse. The intent of the early spring drying from May 1st to May 15th is to ensure that a drying trend during this period has occurred and will continue to occur for an extended period with favorable conditions to upgrade roads.

No road upgrading will occur prior to May 1st or after November 15th. Restrictions for road upgrading from May 1st through May 14th include:

1. Class I watercourse crossings will not be installed or replaced; and

2. Any other watercourse crossings where significant surface flows could prevent effective diversion of flow around the work site will not be installed or replaced; and

3. Erosion control supplies are retained on-site and applied to each completed site by the end of that operational day.

The intent is to avoid replacing or installing watercourse crossings on larger watercourses during late spring when there may be significant surface flow that would prevent diversion of flow around the work site effectively. Erosion control supplies will be retained on site from May 1st through May 14th and applied to each completed site by the end of that operational day.

After October 15th, each project site (i.e. replacing a watercourse crossing) will be completed in one operational day with erosion control structures installed if feasible. If a site requires multiple days for completion (i.e., 2-3 days), a long-range National Weather Service forecast of no rain for the next 5 days is required. The intent is to have at least one operational day prior to a rain event to ensure erosion control structures are installed. Specific sites that require more than one week for completion will not be started during the winter period unless it is an emergency situation.

6.3.3.7.2 *Methods*

Techniques described in Weaver and Hagans (1994) will generally be followed when upgrading roads. The Weaver and Hagans (1994) manual will be used unless and until a more "state of the art" manual is published and mutually agreed upon by Green Diamond and the Services for application. The following is a description of road upgrading techniques.

1. All culverted watercourse crossing replacements will be designed to handle a 100-year return interval flow event. The design flow will be calculated using the Waananen and Crippen (1977) method for drainage areas greater than or equal to 80 acres. The Rational Method (Chow 1964) will be used when the drainage area for a crossing is less than 80 acres. Culverts will be sized to pass the 100-year flow event without overtopping (headwater depth to culvert diameter ratio (HW/D) = 1.0). Other comparable flow design estimators that are developed for the North Coast Region may also be use.

2. Culverts that are functioning properly but are undersized according to the standard might not be upgraded if all of the following are true: (a) the existing culvert's capacity is within 15% of the design flow, (b) the headwater depth to culvert diameter ratio is greater than or equal to 2.0, and (c) the channel is not transporting significant amounts of sediments, based on information from road inventories or current observations.

3. Bridges will be installed on fish-bearing watercourses where feasible. When a bridge installation is not feasible, a countersunk or bottomless culvert or other "fish-friendly" structure will be installed that will provide upstream and downstream fish passage. Installed culverts will not restrict the active channel flow.

4. Green Diamond will use the same installation standards for new roads when replacing washed out culverts, upgrading existing culverts, or replacing culverts on previously decommissioned roads. Any buried logs or other large organic debris will be removed from the crossing fill.

5. The existing roadbed will be reshaped where necessary to assure proper surface drainage. Reshaping is restricted to the time periods described for road upgrading except it will not be conducted during the early spring drying period (May 1st through May 14th).

6. Additional ditch relief culverts will be installed to meet the specifications listed in Table 6-14.

7. Upgrading of roads will follow the New Roads – Location, Design, Timing and Construction Standards discussed in Section 6.3.3.

6.3.3.8 Routine Road Maintenance / Inspection Plan

6.3.3.8.1 Type and Timing of Maintenance Activities

Road maintenance activities that will be conducted include but are not limited to brushing, waterbarring, constructing rolling dips, culvert replacement, grading (including berm removal or maintenance where appropriate), installation of critical dips at watercourse crossings to reduce diversion potential, outsloping roads, patch rocking, dust abatement, resurface rocking, cleaning ditches, and cleaning inlets and outlets of culverts. Patch (spot) rocking, brushing, cleaning inlets and outlets of culverts, cleaning ditches where poor drainage is occurring (e.g., cleaning a ditch line along a sloughed cut-bank), repairing or maintaining existing waterbars, replacement of a failed or imminently failing culvert along a needed access road, and site specific road surface grading for maintaining the integrity of the road surface (i.e. redistribution of existing rock, filling pot holes, and distributing new patch rock) will be allowed year round including during the winter period. The intent is to allow winter grading to fix localized bad spots on the road surface before the deterioration of longer road segments. Grading will not be used to blade off wet soil to provide conditions for extended periods of operation on a deteriorated road surface. The installation of waterbars, rolling dips and critical dips, general project grading for shaping the road surface, road outsloping, road rocking, resurface rocking, cleaning ditch lines, and general culvert replacements will be allowed only during the period when road upgrading can occur (Section 6.3.3).

6.3.3.8.2 Distribution of Information

Information about proper road use and reporting of maintenance problems will also be distributed to all Green Diamond woods personnel and woods contractors and will be made available to the public who have road access to Green Diamond property.

6.3.3.8.3 *Inspection and Maintenance Schedules*

Prior to September 15 of each year, all mainline roads will be inspected for needed maintenance (***Figure 6-7 [A-C]***). Other roads that are appurtenant to THPs will also be inspected at least through the duration of the prescribed maintenance period for erosion controls specified for each THP. This inspection will assess the effectiveness and condition of all erosion control and drainage structures.

All other management roads (secondary roads) or roads yet to be decommissioned that are accessible to maintenance crews will be maintained. The maintenance schedule will be based on the HPAs with a slight modification that incorporates additional RWUs from another HPA to create regions of the ownership that are more uniform in size. The maintenance schedule will be completed on a 3-year rotating basis (Table 6-15)

Table 6-15. Routine maintenance schedule.

Routine Maintenance Areas	Initial Plan Area Acres in Maintenance Area	Miles of Road	Rotating Annual Schedule
Smith River HPA	21,589	207	1
Coastal Klamath HPA (on the northern side of the Klamath River) minus the Bear Creek RWU	40,066	375	1
Coastal Klamath HPA (on the southern side of the Klamath River)	42,498	434	2
Blue Creek HPA plus the Bear Creek RWU	39,981	401	2
Interior Klamath HPA	7,933	100	3
Redwood Creek HPA	35,185	285	3
Coastal Lagoons HPA	66,139	553	2
Little River HPA	26,041	310	1
Mad River HPA minus the Boulder Creek RWU	31,675	365	1
North Fork Mad River HPA	28,209	300	2
Humboldt Bay HPA plus the Boulder Creek RWU	33,038	284	3
Eel River HPA	44,177	425	3
TOTAL	---	4,039	

All the maintenance areas listed with "1" under the rotating annual schedule column will be maintained during the first year, fourth year, seventh year, etc. The regions were selected combined based on blocks of the ownership that contained approximately equal miles of road and would allow efficient implementation of the maintenance schedule. Approximately 45% of all of Green Diamond's roads will be maintained annually following this routine maintenance schedule. The actual percentage of roads that are maintained will increase over time because a portion of the current road network is planned for decommissioning. In addition, as the road management plan is implemented and more roads are decommissioned, the overall miles of roads that require maintenance will decrease.

Green Diamond will conduct inspections on roads that are accessible by truck. Problems identified during the inspections will be documented and recommendations for their repairs will be provided. The inspections will assess the following:

- Adequate waterbar spacing, depth, interception of the ditch line, and complete diversion of water flow onto undisturbed soil.
- Areas having poorly drained low spots or inadequately breached outside berms.
- That ditches are open and properly functioning, free of debris that could plug the ditch or a culvert and cause a diversion of water onto the road surface.
- Culverts are functioning properly (i.e., the culvert is not rusted out or separated at a joint; water is flowing through the pipe and not underneath; sediment and debris is not reducing the pipe capacity).

6.3.3.8.4 *Prioritization of Maintenance and Repairs*

Maintenance or repairs that are needed will be prioritized based on treatment immediacy (a subjective combination of event probability and potential sediment delivery evaluated as either low, moderate, or high). The goal will be to complete all the priority tasks prior to the winter period. If the priority workload exceeds that which can be accomplished in the current maintenance year, lower priority sites may be held over until the following maintenance year.

6.3.3.8.5 *Emergency Inspections*

If a storm occurs that produces 3 inches of precipitation or more in a 24-hour period, as measured at Crescent City, Klamath River near Terwer Creek, Trinity River at Hoopa, Redwood Creek at Orick, Redwood Creek at O'Kane, Korbel, and Eureka (Table 6-16). Green Diamond's Timberlands staff will conduct emergency inspections of all accessible rocked roads that can be traveled without causing road damage, during or immediately after such an event. Repairs will be made during these inspections (e.g., fix damaged waterbars, unplug culvert inlets) if hand labor can correct the problem. Any major problems observed during these inspections that would require the use of heavy equipment for repair will be reported to a designated "storm response coordinator". This coordinator will prioritize and schedule repairs so that they are accomplished as soon as possible. If access is prohibited because of adverse conditions, these sites will receive priority for treatment during the following summer's road maintenance schedule.

Table 6-16. Rain gauge stations and associated inspection areas for storm period inspections.

Gauge Location	Applied Area
Crescent City	Smith River HPA
Klamath River near Terwer Cr.	Coastal Klamath HPA
Trinity River at Hoopa	Interior Klamath HPA
Redwood Creek at Orick	Redwood Creek HPA downstream of Dolly Varden and Coastal Lagoons HPA
O'Kane (Blue Lake)	Redwood Creek HPA upstream of Dolly Varden
Korbel	North Fork Mad River and Mad River HPAs
Eureka	Humboldt Bay, and Eel River HPAs

6.3.3.9 Road Daylighting

Road daylighting (removal of trees within 25 feet slope distance of the shoulder or cut bank of a road) will be done to accelerate drying of roads and provide stable road surfaces for log hauling or other vehicular traffic. Within RMZs for Class I and II watercourses, no trees will be cut that could cause channel de-stabilization. No trees greater than 16 inches dbh will be cut from the downstream side of Class I watercourse crossings. Daylighting within RMZs where it is necessary to accelerate drying of the road and provide a stable road surface will be evaluated on a site specific basis.

6.3.3.10 Road and Landing Use Limitations

1. Log hauling, road decommissioning, road upgrading, road construction and use of landings will cease when the use of any portion of a road or landing results in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface which drains into a Class I, II, or III watercourse.

2. Use of roads for log hauling, road decommissioning, road upgrading, road construction and landing use will not resume until the road surface has dried sufficiently to allow use without resulting in runoff of waterborne sediment in amounts sufficient to cause a visible increase in turbidity in any ditch or road surface which drains into a Class I, II, or III watercourse. This criterion applies to any time of the year (e.g., summer storms).

3. Hauling and loading during the winter period (October 16th through May 14th) will only occur on rocked surfaces. Hauling and loading will be allowed on unsurfaced roads from May 1st through May 14th if early spring drying occurs as defined in Section 6.2. or from October 16th through November 15th if an extended dry fall occurs as defined in Section 6.2. 4

4. Helicopter service landing areas will be considered appurtenant to a THP and will be subject to the road use limitations described above.

5. Only ATVs will be used on unsurfaced seasonal roads during the winter period. Other vehicular use of seasonal roads will be allowed from May 1st through May 14th if early spring drying occurs as defined in Section 6.3.4 or from October 16th through November 15th if an extended dry fall occurs as defined in Section 6.2. Any damage caused to drainage or erosion control structures by using ATVs on any road will be repaired immediately following damage. Exceptions for seasonal road use during the winter period for management include fire control vehicles for site preparation burning, pickup access for transportation of monitoring supplies and equipment, and pickup trucks and vans for transportation of seedlings and reforestation crews. Upon completion of each specified activity all drainage facilities will be returned to the condition prior to road use or brought up to a condition where they are functioning properly.

6. Landings on roads (including roadside decking) within RMZs will not be used from October 16th through May 14th. Ditchlines and drainage facilities associated with existing roads within RMZs that are used for landings or roadside decking during the summer period (May 15th through October 15th) will be repaired immediately following completion of operations and prior to October 16th. Any proposed use of existing landings and roads will be discussed and mapped in THPs and also included on the THP map submitted to the Services. The intent of utilizing existing roadways and landings within RMZs and restricting the expansion of existing roads or landings is to minimize potential aquatic impacts and new road or landing construction near watercourses. Alternatives to roadside decking in RMZ (such as building new spur roads that extend out of the RMZ and constructing a designated landing, building a new road system into the THP, or using alternative yarding systems) will be evaluated during the THP preparation. The intent is to use the most feasible alternative that will have the least amount of impact to the aquatic resource.

6.3.3.11 Emergency Road Repair

If there is an imminent threat to life, property, or public safety, or a potential for a massive sediment input with catastrophic environmental consequences, Green Diamond will notify the Services of the emergency and the proposed action, but will not be required to submit a formal notification in order to perform a quick response to the situation. An individual contact from both of the Services will be designated. The Services will notify Green Diamond of any changes in their personnel contacts.

6.3.3.12 Water Drafting

The potential impacts of drafting water from watercourses during summer are dramatically different between fish and amphibians in the Plan Area. Juvenile salmonids are vulnerable to rapid changes in flow that could leave them stranded in a de-watered or very restricted portion of the wetted channel. In addition, reduction in the flow may reduce dissolved oxygen and/or increase water temperature that would put these fishes at risk. In contrast, studies done in the Plan Area indicate that many of the Class II watercourses have very minimal flows or even sub-surface flows during late summer. In spite of these, these amphibians are well distributed throughout the Plan Area indicating that they are well adapted for streams with low flow regimes during summer. When flows are reduced to the point of having no surface flow, these amphibians can survive by retreating to interstices within the substrate that retain subsurface flow. As a result, the potential impacts of reduced flows from drafting should not have a significant impact on these amphibian species. If a watercourse has larval tailed frogs, then the drafting requirements for the site will be modified to avoid temporary dewatering the Class II watercourse or another drafting site will be used.) The following restrictions for water drafting are intended to avoid dewatering any portion of Class I watercourses and only localized temporary dewatering on Class II watercourses.

Most water trucks hold approximately 3500 gallons of water. With the proposed drafting standards, the minimum fill up time per truck is 10 minutes. Depending on the distance from the source of water and the level of operating activities, 4-6 loads per day is a typical drafting frequency from a site. Some drafting sites with flows well above the minimum flow (i.e. >5 cfs) or larger impoundments may be drafted from more than 6 times per day depending upon the level of operating activities.

6.3.3.12.1 Restrictions

To protect Covered Species from water drafting or from gravity fed water storage systems the following restrictions will apply.

1. Water drafting for timber operations from within the channels of Class I watercourses will conform to the following standards:

    - pumping rate will not exceed 350 gallons per minute (0.78 cfs),

    - pumping or gravity fed lines to storage tanks will not remove more than 10% of the daily above-surface flow, drafting will not occur in watercourses that have less than 1 cfs surface flow.

2. Water drafting for timber operations from impoundments within the channels of Class I watercourses that do not have surface outflow will conform with the following standards:

    - pumping rate will not exceed 350 gallons per minute (0.78 cfs),

    - drafting or pumping to storage tanks will not reduce maximum pool depth by more than 10%.

3. Gravity fed lines to storage tanks from Class II watercourses will not divert more than 50% of the flow.

4. Water drafting for timber operations from within Class II watercourse or impoundment:

    - will not reduce maximum pool depth by more than 1/3, and

    - the pool will be fully recharged before any additional drafting will occur

5. Intakes will be screened in Class I and Class II watercourses (including gravity fed lines). Screens will be designed to prevent the entrainment of all life stages of Covered Species. The intakes will be installed in pools to avoid the entrainment of amphibian larval stages. See Section 6.3.3.12 for drafting screen specifications.

6. Herbicide mix trucks will not be used to directly draft water from any watercourse.

These drafting criteria do not apply to water drafting for wildfire.

6.3.3.13 Drafting Screen Specifications

In 1997, Green Diamond designed a drafting screen for use on all pumping site locations in Class I watercourses. This screen was design to meet or exceed the Fish Screening Criteria published by CDFG) on April 14, 1997. The CDFG criteria were modified from Fish Screening Criteria for Anadromous Salmonids published by NMFS in January 1997. The CDFG guidelines are more restrictive that the NMFS guidelines. The specific modification applies to “Not Self-Cleaning” screens such as Green Diamond’s design.

The following specifications were designed for Class I watercourses, however the design and specifications also will be applied to Class II watercourses.

The screen is an open top box constructed from a framework of 1-inch angle iron with 1/16-inch mesh screen attached to the four vertical sides. Each side is 3 feet long by 2 feet high. The bottom of the box is a 3 feet x 3 feet piece of plywood inserted within the framework. The drafting hose is placed in the middle of the box. Future modifications to the drafting screen may occur, however any new designs will at least meet the current design criteria.

6.3.3.13.1 *Approach Velocity*

Approach velocity is defined as the local velocity component perpendicular to the screen face. For non self-cleaning screens, the CDFG criteria requires an approach velocity of no more than 25% of the velocity allowed on a self-cleaning screen, or 25% of 0.40 feet per second (fps). An instantaneous velocity of 0.10 fps is beyond the accuracy of our flow meter (0.50 fps); however, the flow meter will measure 0.10 fps in an averaging mode. Green Diamond's drafting screen is designed to have no measurable flow, in the averaging mode, at the screen's surface while pumping. This velocity is slow enough that you should barely be able to detect water movement when holding your hand against the drafting box screen while drafting.

6.3.3.13.2 *Screen Area*

"The required wetted screen area (square feet), excluding the area affected by structural components, is calculated by dividing the maximum diverted flow (cubic feet per second) by the allowable approach velocity (feet per second)" (CDFG, Fish Screening Criteria, 1997). The maximum pump rate will be 350 gallons per minute (gpm), or 0.78 cfs.

0.78 cfs / 0.10 fps = 7.8 square feet

Green Diamond's drafting box design provides 24 square feet of screened area when submerged to the level of the top angle iron rail. When submerged to a depth of 8 inches, or a maximum of 16 inches sideboard exposed, the screen provides 8 square feet of screen area. As a safety buffer the drafting box should always be submerged at least one foot deep.

6.3.3.13.3 *Sweeping Velocity*

Sweeping velocity is the velocity component parallel to the screen face. This is essentially the stream flow outside of the box that helps prevent debris buildup on the screen surface. The CDFG Fish Screening Criteria, Section 3a, requires that the sweeping velocity should be at least two times the allowable approach velocity. In this case a sweeping velocity of 0.20 fps should be met if there is any measurable flow past the face of the screen.

6.3.3.13.4 *Screen Openings*

Square screen openings, such as is used in Green Diamond's drafting screen, will not exceed 3.96 mm (5/32 inches), or when steelhead fry are present, 2.38 mm (3/32 inches) measured diagonally. Green Diamond assumes that any Class I watercourse where drafting occurs will potentially have steelhead fry and thus has designed the screen with the more restrictive criteria. The 1/16 inch mesh provides for diagonal openings of 3/32 inches.

6.3.3.14 Rock Quarries and Borrow Pits

1. New rock quarries and borrow pits will not be established within Class I or II RMZs.

2. No portion of an existing rock quarry or borrow pit that is within 150 feet of a Class I watercourse or 100 feet of a Class II-2 watercourse or 70 feet of a Class II-1 watercourse will be used.

3. Rock quarrying, rock extraction from borrow pits, or hauling will not result in a visible increase in turbidity in watercourses or hydrologically connected facilities which discharge into watercourses. If an increase in turbidity does occur as a result of such operations, then the operator will install interim erosion control measures and cease operations at once.

4. During development of rock quarries and borrow pits, overburden will be placed in a stable location away from watercourses and associated RMZs. The overburden disposal area will be grass seeded and straw mulched where erosion has the potential to deliver sediment to the stream network.

6.3.4 Harvest-Related Ground Disturbance Measures

6.3.4.1 Summary of Time Period when Harvest-related Ground Disturbances May/May Not Occur

Table 6-17 summarizes the time of year restrictions on harvest-related ground disturbances (also see Table 6-7 for time of year restrictions for road work).

6.3.4.2 Field Trials with Mechanized Equipment

Green Diamond may wish to conduct field trials with mechanized equipment for silvicultural operations (e.g., site preparation, release or pre-commercial thinning, logging). Successful trials may lead the company to adopt the tested equipment for future operational use. However, before field trials proceed, the Services must receive some assurance that the equipment will not cause ground disturbance, in the form of compaction or soil displacement that is measurably greater than the equipment or methods previously used for the same purposes. Assurances will be supported by available documented evidence including, but not limited to, manufacturers specification sheets (with attention to parameters such as ground pressure or traction characteristics), published or unpublished field trials by independent (university) researchers, by researchers for government land management agencies, or by the manufacturer or its customers.

Table 6-17. Time periods when harvest-related ground disturbances may/may not occur within the Plan Area.

Activity	Nov 16 –April 30	May 1-May 14	May 15-Oct. 15	Oct. 16-Nov. 15
Ground-Based Yarding – Tractor, Skidder, and Forwarder	None	Yes if (1)	Yes	Yes if (1)
Ground-Based Yarding – Feller-Buncher and Shovel Logging	Yes if (2)	Yes	Yes	Yes
Skyline and Helicopter Yarding	Yes	Yes	Yes	Yes
Mechanized Site Preparation	None	None	Yes	None
Skid Trail Construction and Reconstruction	None	None	Yes	None

Notes
1 See Section 6.3.4.6 for operating measures
2 See Section 6.3.4.8 for operating measures

6.3.4.3 Site Preparation Standards

Harvest operations will be planned and executed so as to facilitate the purposes of the conservation measures for site preparation as specified in below.

1. The purpose of the conservation measures in this Section is to minimize surface erosion from site preparation operations. The practices outlined in this Section address this purpose in four ways:

    a. Minimization of bare soil exposure within harvest units,

    b. Minimization of the need for fireline construction,

    c. Maintenance of a nearly continuous forest floor layer of duff and woody material to intercept and limit the channelization of surface water, and

    d. Prevention of drainage failures and sediment delivery from firelines.

2. All site preparation operations will be designed to limit the amount of ground and forest floor disturbance to that which is required for fuel reduction and reforestation operations. For example, reforestation personnel may arrange with logging operators to remove a portion of the logging debris to landings. This practice can reduce fuel levels in the treatment area, facilitate greater control of prescribed burns, and minimize the chance of excessive forest floor consumption in the burning operation.

3. Operations will be planned so that areas having the greatest need of treatment for fuel reduction and/or reforestation access are assigned the highest priority for treatment. High priority areas are treated earliest in an operating season. Low priority areas are either treated later in the operating season, deferred to a subsequent season or not treated.

4. Use of machine piling with tractor-and-brushrake will be minimized. Other mechanized methods such as grapple piling with shovel loaders, or use of mechanized choppers or cutters, are preferred. All types of mechanized site preparation methods are subject to the seasonal operating limitations for ground-based yarding in Section 6.3.4

5. Prescribed fire operations will be designed to produce burns of "low-intensity". For the purposes of this Section, a low-intensity prescribed burn has the following desired attributes:

    a. The burning operation is designed to consume only a limited portion of the fuelbed; for example, woody fuels 0.25 inch to 3.0 inches in diameter,

    b. Non-targeted portions of the fuelbed, such as the duff layer and woody fuels > 3.0 inches in diameter are generally only lightly consumed,

    c. Low-intensity prescribed fires will tend to self-extinguish when they burn into a fireline, or into an adjacent area with a continuous overstory canopy, such as an RMZ or other unharvested stand, thus minimizing the need for firelines.

6. Following site preparation, by machine or prescribed fire, the desired post-operation fuelbed and forest floor attributes are as follows:

    a. Down woody material greater than 3.0 inches diameter to reflect the pre-disturbance condition throughout the prepared area,

    b. The litter layer is minimally displaced or consumed,

    c. Bare mineral soil exposure that occurs through the displacement or consumption of logging slash and forest floor material to be less than 5% of the area of any harvest unit. Skid trails and skyline roads are not included in the estimate of exposed area.

7. All firelines that are not in an RMZ or EEZ will have drainage facilities adequate to prevent the delivery of sediments to RMZs, EEZs.

8. Fireline construction with tractors is subject to the same seasonal limitations as skid trail construction in Section 6.3.4, plus the following limitations:

    a. If the proposed fireline location may cause hillslope sediment delivery to a riparian management zone or equipment exclusion zone adjacent to Class I, II or III watercourses, then equipment use is limited to slopes less than or equal to 45%.

b. If the proposed fireline location is not likely to cause sediment delivery to an RMZ, and if slopes are greater than 50% then tractors may operate only on fireline segments less than 100 feet. (Note: slope limitations on fireline construction are less than for skid road construction; the rationale is that fireline construction involves substantially less excavation).

7. Fireline construction, reconstruction and use within RMZs and EEZs are subject to the following limitations:

   a. Firelines will only be constructed or reconstructed with hand tools.

   b. Existing skid roads or firelines within RMZs or EEZs may be reconstructed for fireline usage if they are located advantageously for fire containment. Reconstruction must only be done with hand tools, and only to the minimum width required for fire containment. All prior drainage failures on the existing skid roads or firelines must be remedied during reconstruction.

   c. All constructed or reconstructed firelines within RMZs or EEZs must have drainage structures that will minimize the movement of sediments from the exposed fireline surface but are not subject to the 100 square foot ground disturbance standard for seeding and mulching as described in Section 6.3.1.

6.3.4.4 Release, Pre-Commercial Thinning, and Commercial Thinning

1. The uses of self-propelled, mechanized equipment for release and pre-commercial thinning operations (e.g., boom-mounted cutters) are subject to the seasonal limitations on ground-based yarding in Section 6.3.4 below.

2. The uses of logging equipment in commercial thinning operations are subject to all applicable limitations on felling, yarding and loading in Section 6.3.4 below.

6.3.4.5 Measures Common to All Felling, Yarding, and Loading Operations

1. Erosion control measures for the treatment of disturbed areas in RMZs or EEZs resulting from felling, bucking and yarding activities will be implemented as provided in Section 6.3.1. Any bare mineral soil exposure, greater than 100 square feet in RMZs or EEZs that is caused by logging activities, will be mulched and seeded or treated by other means prior the end of logging operations or prior to October 15, whichever comes first. The purpose of treatment of exposed soil is to reduce the potential for the delivery of sediment to streams in the first three to five years following harvest and site preparation. The purpose of mulching and seeding is to provide temporary vegetative cover on the exposed site until native vegetation can re-colonize the site.

2. Seeding will be at a rate of at least 30 pounds per acre and mulching to a depth of at least 2 inches (before settling) with 90% surface coverage.

6.3.4.6 Ground-Based Yarding - Tractor, Skidder, and Forwarder Operations

In field usage, the terms '*skid trail*', '*skid road',* and '*tractor road'* are common synonyms. The measures below use the term 'skid trail'.

1. The construction and reconstruction of skid trails is limited to the period beginning May 15th, and ending October 15th (see Table 6-17).

2. Ground-based yarding with tractors, skidders, and forwarders may occur from May 15th through October 15th on existing skid trails. Skid trail use (excluding construction and reconstruction of skid trails) may be extended to include the periods May 1st through May 14th, and October 16th through November 15th, when the following procedures are followed:

   a. Skid trail use during this period will not result in visibly turbid water that flows into hydrologically connected drainage facilities or discharges directly into watercourses, seeps, or springs. If an increase in turbidity occurs while operations are underway, then the operator will install interim erosion control measures and cease operations at once. Use of skid trails by ground-based logging equipment will not occur when soil moisture conditions would result in: 1) reduced traction by equipment as indicated by spinning or churning of wheels or tracks in excess of normal performance, 2) inadequate traction without blading wet soil, or 3) soil displacement in amounts that cause movement of waterborne sediments off a skid trail surface. If any of the foregoing conditions is caused during skid trail use, interim erosion control measures will be installed and the operation causing the condition will be immediately ceased.

   b. Ground based yarding operations will use minimal ground disturbing equipment (e.g. tracked shovel loaders) without bladed skid trail construction or reconstruction where feasible. Where this is not feasible, yarding operations from May 1st through May 14th and October 16th through November 15th will be limited to existing skid trails for ground-based equipment which are hydrologically disconnected from Class I, II, or III watercourses or drainage facilities that discharge into Class I, II, or III watercourses. The intent is to have no or minimal skid trail construction or reconstruction near any watercourse, and no channelized flow resulting from timber operations or facilities reaching Class I, II, or III watercourses or hydrologically connected ditches. Operations can occur on hydrologically connected skid trails from May 15th through October 15th provided Procedure (a) is met.

   c. Use of skid trails from May 1st through May 14th and October 16th through November 15th will not occur within at least 100 feet, slope distance, of the upper extent (e.g. top or head) of any designated Class II watercourse, and on slopes greater than 30% within at least 100 feet of Class III watercourses. (Note: Long-line yarding or lifting logs with a shovel loader from outside this zone is permitted as long as the skid trails are hydrologically disconnected, as in Procedure (b). The intent is to minimize the amount of ground disturbance created by tractor operations near watercourses during May 1st through May 14th and October 16th through November 15th. Operations may occur in these zones from May 15th through October 15th provided Procedure (a) is met.

d. From May 1st through May 14th and October 16th through November 15th Green Diamond will treat with seed, mulch, or slash (see Procedure (e) below), all areas of bare mineral soils greater than 100 square feet created by ground based yarding (e.g. long lining, use of approved watercourse crossings) within an RMZ, or EEZ by the end of the working day. Application of erosion control materials beyond 100 feet slope distance of Class I watercourses, Class II RMZ widths, or beyond EEZs will be discretionary, based on the potential of the site to deliver sediment to a watercourse or hydrologically connected facility. This will be subject to the RPF's (or designated Green Diamond Supervisor's) evaluation of the site, taking into consideration the potential for large storm events to cause sediment delivery.

e. From May 1st through May 14th and October 16th through November 15th prior to commencement of ground based yarding operations, sufficient erosion control materials, including but not limited to straw, seed (barley seed and/or Green Diamond seed mix), and application equipment will be retained on-site or otherwise accessible (so as to be able to procure and apply that working day**) in amounts sufficient to provide at least 2 inches depth of straw with minimum 90% coverage, and 30 pounds per acre Green Diamond seed mix. In lieu of the above listed erosion control materials, native slash may be substituted and applied if depth, texture, and ground contact are equivalent to at least 2 inches straw mulch. If an area of exposed bare mineral soil is caused by operations late in the day and it is not feasible to completely finish erosion control treatment, the erosion control treatment may be completed the following morning prior to start of yarding operations provided there is no greater than a 30% chance of rain forecasted by the National Weather Service within the next 24 hours.

3. The use of ground-based yarding systems that require constructed skid trails is prohibited on slopes over 45%. Two exceptions are permitted as follows:

   a. Where greater soil or riparian zone disturbance would be expected from cable yarding, due to unfavorable terrain that reduces skyline deflection and payload capability and,

   b. Where additional haul road construction would be required to accommodate the use of cable logging systems. Regardless of the site-specific situation, the company is expected to use every practicable means to minimize soil disturbance within ground-based yarding units through the use of proper unit layout, appropriate equipment, operator education and training (see Section 6.3.3 Road Management Plan). (Note: slope limitations in this paragraph are more restrictive than for fireline construction; the rationale is that skid road construction often involves excavation.)

4. Ground-based yarding, or skidding, equipment is prohibited from operating in riparian management zones and equipment exclusion zones adjacent to Class I, II and III watercourses (for exceptions see Sections 6.3.1, 6.3.3, and 6.3.4).

6.3.4.7 Existing Skid Trails

Existing skid trails (roads used for skidding logs and not associated with hauling), including legacy skid trails, that are diverting a watercourse, have a potential to divert or are not properly draining will be noted and evaluated for repair by a RPF, fisheries biologist, hydrologist, geologist or other qualified personnel during THP preparation within the proposed harvest area. Any needed repairs will be made by the completion of timber operations.

6.3.4.8 Ground-Based Yarding - Feller-Buncher and Shovel Logging Operations

1. With one exception, feller-buncher and shovel logging operations may continue throughout the winter period when appurtenant haul roads are surfaced for all weather conditions and have appropriate drainage facilities, and when the operation does not involve the use of constructed skid trails for skidding or forwarding (see Table 6-17). The exception is during storm events where logging operations, combined with rainfall that is likely to deliver sediments into the RMZs or EEZs along Class I, II or III watercourses.

2. Measure 1 above applies solely to feller-buncher and shovel operations. Forwarding over constructed skid trails, when used in conjunction with the feller-buncher or shovel operation, is governed by Ground-Based Yarding – Tractor, Skidder, Forwarder Operations described above). Loading and landing operations are governed by the Loading and Landing Operations below. Hauling operations are also governed by Road and Landing Use Limitations.

6.3.4.9 Skyline Yarding Operations

1. When cable yarding across Class I and II riparian management zones, logs will be fully suspended above the ground.

2. When cable yarding across Class III equipment exclusion zones, logs will be fully suspended to the extent practicable.

3. Sections of skyline roads upslope of RMZs or EEZs may have bare mineral soil (i.e. no duff layer). Where sections of skyline roads have created furrowing of the ground which can channelize surface flow and result in gullying and possible delivery of sediments into or through the RMZ or EEZ, those affected areas will be treated as follows: one hand-built waterbar per 50 linear feet of affected skyline road. An exception to this standard would be in areas of known erodible soil types (e.g. Tonnini's) and formations (e.g. Wildcat) or slopes are over 65%. In these site specific instances, waterbars will be placed after a linear disturbance distance of 30 feet (minimum) and then 20-foot spacing between water bars after 30 feet.

6.3.4.10 Helicopter Yarding Operations

In harvest planning, helicopter yarding will be considered as an alternative to ground-based or skyline logging methods where road construction to access harvest unit(s) would traverse overly steep and/or unstable terrain. The final choice of logging method must be justified in the THP.

6.3.4.11 Loading and Landing Operations

1. To the extent practicable, (considering safe operation of equipment) minimize the need for landing construction. This can be accomplished through roadside decking, or by loading trucks at the roadside at approximately the same rate they are arriving to the roadside from yarding operations (see “hot-logging” or “hot-loading” in Glossary).

2. To the extent practicable, (considering safe operation of equipment) minimize the size of new landings by designing them for shovel, or heel-boom loaders in preference to front-end loaders.

3. Loading may occur only on rocked surfaces, subject to limitations in Road and Landing Use Limitations). Loading will be allowed on unsurfaced roads from May 1st through May 14th if early spring drying occurs as defined in the Road Management Measures or from October 16th through November 15th if an extended dry fall occurs also as defined in Road Management Measures.

6.3.5 Effectiveness Monitoring Measures

Monitoring and adaptive management form a key component of Green Diamond’s science-based approach to management. A wide variety of monitoring projects will be used to evaluate the implementation and the overall effectiveness of the Operating Conservation Program and to allow for changes to the Plan as necessary. Extensive assessment and monitoring of the Covered Species and their habitats has been conducted throughout Green Diamond’s ownership in the HPAs (see Appendix C and Section 4), and this Plan is predicated on the results of these studies. Several of the monitoring projects presented here are a continuation of ongoing projects, and significant new monitoring projects are also proposed.

Monitoring can only be a useful component of the Operating Conservation Program when it is designed to address specific questions and objectives. The two main types of monitoring projects proposed under the Plan, implementation monitoring and effectiveness monitoring, are separated by their respective objectives. Implementation monitoring projects will focus on evaluating and documenting Green Diamond’s implementation of and compliance with this Plan and is described in Section 6.3.7. Effectiveness monitoring will focus on measuring the success of both individual and collective conservation measures in achieving the biological goals and objectives of the Plan and is described in this subsection (6.3.5) and Appendix D.

The proposed conservation measures in Section 6.2 are science-based using site-specific data, and Green Diamond fully expects that they will successfully achieve the biological goals and objectives of this Plan. The monitoring and adaptive management program provide the framework needed to ensure these expectations are met, and if necessary, to fine-tune specific measures through adaptive management. Adaptive management has two key features: 1) a direct feedback loop between science and management, and 2) the use of management strategies as a scientific experiment (Halbert 1993). The monitoring and adaptive management program described below incorporates both of these features. First, there are measurable thresholds associated with specific monitoring projects, which if exceeded, trigger corrective action to provide the direct link between science and management. Second, the implementation of specific management measures in selected watersheds will be designed to work in concert with monitoring projects as a scientific experiment.

A brief summary of each monitoring project, including the background, monitoring objective(s), biological objectives and measurable thresholds (where applicable), and the spatial and temporal scales of each project, is provided below. Monitoring protocols for the projects and programs, excluding those to be developed in response to monitoring results and those for new and refined approaches developed through the Experimental Watersheds Program, are described in Appendix D.

6.3.5.1 Overview of Effectiveness Monitoring Measures

Effectiveness Monitoring projects and programs will measure the success of the Operating Conservation Program in relation to the Plan's biological goals and objectives. Effectiveness monitoring will track trends in the quality and quantity of habitat for the Covered Species as well as the distribution and relative abundance of the Covered Species, and provide information to better understand the relationships between specific aquatic habitat elements and the long-term persistence of the Covered Species.

6.3.5.1.1 Program Flexibility and Temporal Scale

Each Effectiveness Monitoring project and program is based on current monitoring technology and methodologies and on current understanding of the limiting habitat conditions required by the Covered Species (i.e., LWD, sediment, and water temperature). It is reasonable to expect that monitoring techniques and related technology will change significantly through the fifty-year life of this Plan, and that understanding of riparian function will also change. Therefore, it is essential to build flexibility into the monitoring program to respond to these changes. Some monitoring approaches may be retired or replaced by more efficient and/or accurate techniques to address the same issues, and entirely new approaches may be implemented to address currently unforeseen issues. Changes to the monitoring program will be evaluated to insure that they do not reduce the ability of the program to achieve its objectives: to evaluate the effectiveness of the conservation measures and provide feedback for adaptive management. Periodic reviews, at least every ten years or following changed circumstances, will provide the assessment needed to justify changes. Changes to the monitoring program will be subject to the concurrence of the Services.

As indicated in Table 6-18, the projects and programs fall into four categories: Rapid Response Monitoring, Response Monitoring, Long-term Trend Monitoring and Research, and Experimental Watersheds Program. The first three categories are based on the minimum time frame over which feedback for adaptive management is likely to occur. The time scales are a product of the specific variables or processes being measured as well as the available monitoring protocols.

Table 6-18. Effectiveness monitoring projects and programs.

Rapid Response Monitoring	Response Monitoring	Long-term Trend Monitoring/Research	Experimental Watersheds Program
• Summer Water Temperature Monitoring – Property-wide Water Temperature Monitoring – Class II BACI Water Temperature Monitoring • Spawning Substrate Permeability Monitoring • Road-related Sediment Delivery (Turbidity) Monitoring • Headwaters Monitoring – Tailed Frog Monitoring – Southern Torrent Salamander Monitoring	• Class I Channel Monitoring • Class III Sediment Monitoring	• Road-Related Mass Wasting Monitoring • Steep Streamside Slope Delineation Study • Steep Streamside Slope Assessment • Mass Wasting Assessment • Long Term Habitat Assessments • LWD Monitoring • Summer Juvenile Salmonid Population Estimates • Outmigrant Trapping	• Area-limited Effectiveness Monitoring Projects • BACI Studies of Harvest and Non-Harvest Areas under the Plan • BACI Studies of Conservation and Management Measures • New and Refined Monitoring and Research Protocols

- Rapid Response Monitoring projects have the potential to provide feedback to adaptive management on a time scale of months up to two years.
- Response Monitoring projects will generally require a minimum of three years to provide feedback to adaptive management.
- Long-term Trend Monitoring/Research projects are designed to monitor long-term trends and/or provide an understanding of the relationship between management and riparian function. They do not have set thresholds for adaptive management.
- The Experimental Watersheds Program provides a unique spatial scale for individual projects and for the development of new and refined approaches.

6.3.5.1.2 <u>Monitoring Thresholds and Feedback to Adaptive Management</u>

The Rapid Response and Response Monitoring projects form the backbone of the adaptive management process. Each project has measurable thresholds which, when exceeded, initiate a series of steps for identifying appropriate management responses. To provide the ability to respond rapidly to early signs of potential problems while providing assurances that negative monitoring results will be adequately addressed, a two-stage "yellow light, red light" process will be employed. The yellow light threshold will serve as an early warning system to identify and rapidly address a potential problem. As such, the yellow light thresholds can typically be exceeded by a single negative monitoring result (i.e., summer water temperatures). The red light threshold is usually triggered by multiple negative monitoring responses (a series of yellow light triggers) and indicates a more serious condition than the yellow light threshold (i.e., headwaters population monitoring for tailed frogs).

There have not yet been thresholds established for some of the monitoring projects, either due to the scarcity of available scientific literature, site-specific baseline data or both. For these monitoring projects, a process has been created that will allow establishment of yellow and red light thresholds in the future. The process to establish thresholds to trigger yellow and red light evaluations will be based on data collected from "reference sites". Reference sites will either be stream reaches within the Plan Area that have been demonstrated to support populations of the Covered Species of interest whose abundance and persistence are similar to reference populations monitored outside the Plan Area, or reaches in which the habitat conditions have been shown to be within the range of good conditions based on studies done outside the Plan Area. If the list of potential reference sites within the Plan Area is large (greater than 12-15), a spatially distributed randomized sample of sites will be chosen for monitoring. Otherwise, if the list of reference sites is small (less than 12-15), all reference sites within the Plan Area will be monitored. The first phase of setting the thresholds will be collecting baseline data to establish the average condition and range of natural variability for the response variable of interest. During the time that baseline data are being collected, Green Diamond will also collect data on a variety of potentially explanatory covariates that may reduce the natural variation observed in the response variable. The length of time that baseline data will need to be collected will depend on annual temporal correlation of the selected response variable (e.g. annual mean maximum water temperature probably is not temporally correlated, but the depth of sediment stored in a given stream reach probably is), natural range of variability and the degree to which climatic conditions during the monitoring period are representative of "normal" conditions. There should be sufficient data available to set these thresholds within five years for the Rapid Response Monitoring projects, but it will take at least ten years for the Response Monitoring projects.

Once sufficient data have been collected, the appropriate statistical analysis (e.g. simple linear regression, analysis of covariance, randomization or a bootstrap technique) will be conducted to remove the effects of any relevant environmental covariates and calculate the 95% confidence interval. Depending on the response variable of interest, either the lower or upper 95% confidence interval endpoint in any given year will be used to trigger the yellow light threshold. Depending on the temporal correlation of the response variable, two to five years of a yellow light condition will trigger a red light threshold, or one year exceedence of the 99% confidence interval endpoint.

The results of the Long-Term Trend Monitoring/Research will be evaluated within at least 15 years to determine if the data suggest trends that may trigger adaptive management actions. However, assessment of trend monitoring data will be more of a qualitative evaluation and not conducive to the establishment of rigorous thresholds.

Monitoring data may be collected year-round, as with some instream temperature recorders, or seasonally, as with the Class I channel dimensions monitoring. The data collected through each monitoring project will be analyzed on an annual basis for every monitoring project (see Appendix D), and that analysis will determine if any yellow or red light thresholds were exceeded over the previous monitoring period. The intent is to provide a timely review of monitoring data to allow for corrective actions to occur, if necessary, prior to the next season. The procedures followed if a yellow or red light threshold is exceeded are described below.

The yellow light threshold will trigger an internal assessment to determine the source of the problem, and NMFS and USFWS will be notified within 30 days after the analysis indicates that any yellow light threshold has been exceeded. Their technical assistance will be requested in addressing the problem, and any and all management changes resulting from the yellow light threshold must be made with the concurrence of the Services. Changes in management will also be consistent with the AMRA described in Section 6.3.6. The procedures followed, conclusions reached, and any changes in management undertaken to address a yellow light condition will be documented and included in a report to the Services.

The internal assessment will be designed to identify the cause behind the yellow light condition, its relationship to management activities, and what, if any, changes to management are appropriate. All available information will be used to make this determination, including results from other monitoring sites throughout the Plan Area, and results from other monitoring projects where applicable. For example, if the yellow light threshold for water temperature was exceeded, air and water temperature profiles from across the entire Plan Area would be examined to determine if high temperatures were found everywhere. This would indicate that an unusually hot summer caused water temperatures to rise significantly throughout the Plan Area irrespective of management activities in any particular basin. In this case, the internal assessment might conclude that the condition is due to weather, and no changes in management would be taken. However, if temperatures in basins which had been recently harvested were to rise, while those in undisturbed areas did not, then further assessment in the affected basins would follow. The assessment would include measures such as on the ground inspections of RMZs and creation of a basin thermal profile to isolate specific problem areas. Should management activities be implicated as the likely cause of temperature increases, corrective measures would likely include adjustments to RMZ widths or canopy retention standards. For a discussion of the RMZ buffer widths and canopy cover conservation measures see Section 6.3.1.

The red light trigger is typically a result of multiple negative monitoring responses (a series of yellow light triggers). The Services will be notified within 30 days after the analysis of monitoring results indicates that any red light threshold has been exceeded. Green Diamond will endeavor to obtain input from the Services regarding identification of any feasible interim changes in the Operating Conservation Program (in the area in which the red light threshold is exceeded) that could be made by Green Diamond to avoid management-caused exacerbation of the red light condition pending a full assessment of the causes of the exceedence.

An in-depth assessment with the full participation of the Services will be conducted to determine the likely causes of the red light threshold condition, and appropriate management changes to address the issue. A scientific review panel which consists of independent experts on the subject at hand may be assembled at the request of either party if Green Diamond and the Services cannot agree on a course of action to address the red light condition. The panel will have three members, one appointed by the Services, one by Green Diamond, and a third selected by the first two panel members. The role of the scientific review panel is to provide technical analysis of the data and any other available information to the extent it is relevant to the conservation of the Covered Species in the Plan Area and attempt to reach conclusions on whether the exceedence of a red light threshold was management induced. Modifications will not be made to the default prescriptions unless the analysis is conclusive in the opinion of a majority of the scientific review panel. If the results are not conclusive, the monitoring will be extended for another five years and the monitoring protocol will be evaluated to insure that appropriate methodologies are being applied. A similarly constructed scientific panel will provide technical analysis of the SMZ data, after a 15 year data collection period, and attempt to reach conclusions on the effectiveness of the SMZ prescriptions relative to the goal of the SMZ conservation measures. Modifications will not be made to the default SSS prescriptions unless the analysis is conclusive in the opinion of a majority of the scientific review panel. If the results are not conclusive, the monitoring protocol will be evaluated to ensure that appropriate methodologies are being applied and the monitoring will be extended for another five years.

Just as the biological goals and objectives set forth in Section 6.1 guided development of the prescriptions set forth in the Plan, Green Diamond will look to the applicable goals and objectives to guide development of any changes to the prescriptions pursuant to a red light trigger, using the information gained from the monitoring and adaptive management processes. Any adjustments to the Plan will be in keeping with the AMRA and responses to changed circumstances. The two-stage yellow light-red light threshold process for adaptive management is outlined in the Figure 6-8.

6.3.5.1.3 Monitoring Sites

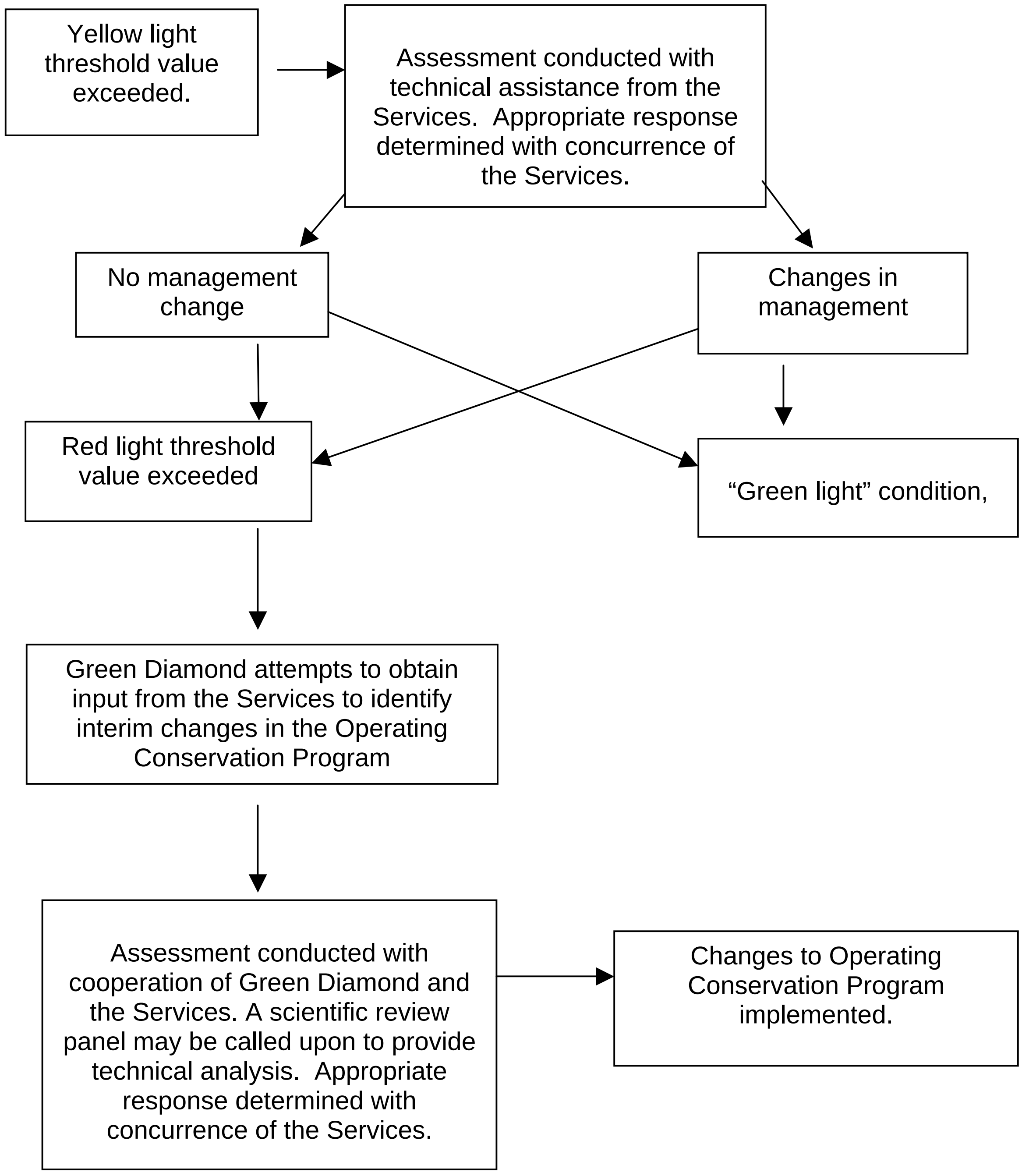
The Effective Monitoring projects and programs will be implemented in the Plan Area.

Figure 6-9 identifies the location of many of the existing monitoring sites. Some monitoring sites have not yet been established or cannot be shown effectively on a map of this scale and consequently are not included on the figure. The figure also does not show existing water temperature monitoring sites because of the high density of sites across the Plan Area would obscure the other depicted sites.

6.3.5.1.4 Phase-in Period

There will be a phase-in period for some of the monitoring measures (e.g., within the Experimental Watersheds). By the end of the third year of Plan implementation, all of projects and programs identified below will be up and running. The first biennial report will include information from the projects and programs that are operational and a progress statement on the remaining measures. The second biennial report will include information from all of the projects and programs.

Figure 6-8. Two-stage threshold process for adaptive management.



6.3.5.2 Rapid Response Monitoring

The Rapid Response Monitoring projects and programs will provide the early warning signals necessary to ensure that the biological goals and objectives of the Plan will be met. While trends which occur over longer time scales will also be monitored through these projects, they are distinguished from the response and trend monitoring projects by their potential to provide rapid feedback for adaptive management. The yellow light threshold for these projects can typically be triggered in less than one year, although the annual analysis of results will be necessary to identify the yellow light condition. The red light threshold will generally take two to three years to be triggered. A brief summary of each Rapid Response Monitoring project is provided below.

6.3.5.2.1 Property-wide Water Temperature Monitoring

Background

Cool water temperatures are essential to all six Covered Species. Timber harvest has the potential to cause increased water temperatures through a reduction in stream canopy cover or through channel widening and shallowing as a result of increased sediment inputs. As a result, maintaining cool water temperatures is one of the primary biological goals of this Plan.

Water temperature monitoring on Green Diamond's ownership began in 1994 and is ongoing today. Between 1994 and 2000, 400 summer water temperature profiles were recorded at 156 locations in 109 Class 1 watercourses, and 209 summer temperature profiles were recorded at 87 locations in 66headwater (Class II) watercourses. Water temperature monitoring will continue on an annual basis throughout the Plan Area.

Using one or several set water temperature values to establish biological objectives or thresholds was problematic because of the relationship between water temperature at a site and the drainage area above that site (Figure 6-10). Water temperatures were positively associated with drainage area and relatively predictable up to a size of approximately 10,000 acres. In drainages with greater watershed area, water temperatures tended to have increasingly greater variation probably in response to a variety of complex interacting physical factors (Beschta et al. 1987)

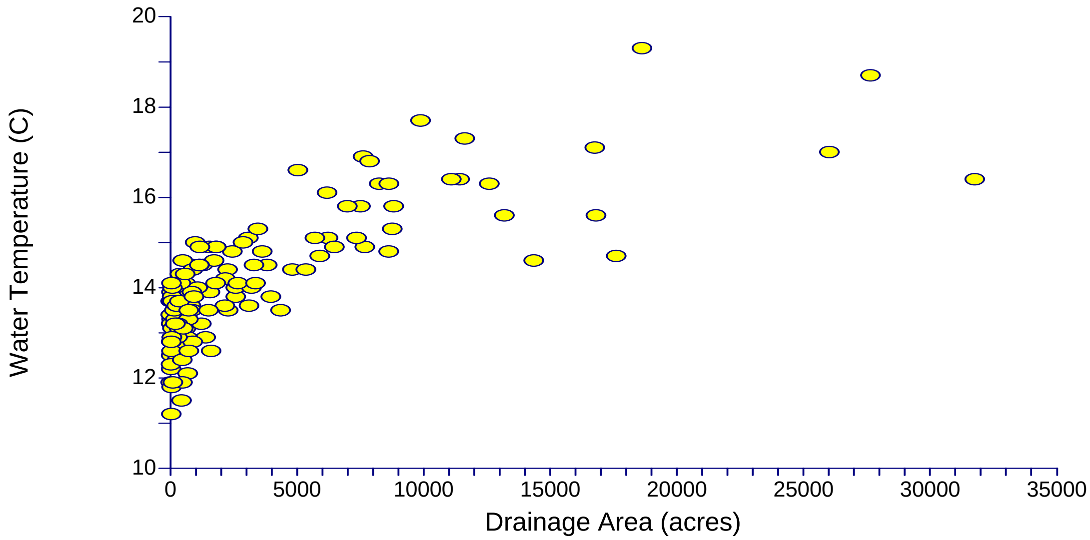


Figure 6-10. Relationship between the 7-day highest mean water temperature and drainage area above the monitoring site for 139 locations.

To account for the relationship between water temperature and drainage area, Green Diamond regressed temperature on the square root of drainage area at locations known to support populations of southern torrent salamanders, tailed frogs or coho salmon (Figure 6-11). The square root transformation was used to create a linear relationship between the two variables. As described in more detail in Section 4.3.1 and Appendix C5, the upper 95% PI (of individual sample sites as the yellow light threshold for drainages up to approximately 10,000 (100 square root) acres. One degree above the upper 95% PI was set as the red light threshold until a maximum of 17.4 °C was reached. It should be noted that using the regression of water temperature versus drainage area to establish biological objectives and threshold values was only intended to apply to 4th order or smaller streams that generally occur in drainages less than 10,000 acres. As noted above, this is because the relationship gets weaker for increasingly larger watersheds. In addition, the Covered Species in this Plan generally rear in smaller watersheds during the summer months.

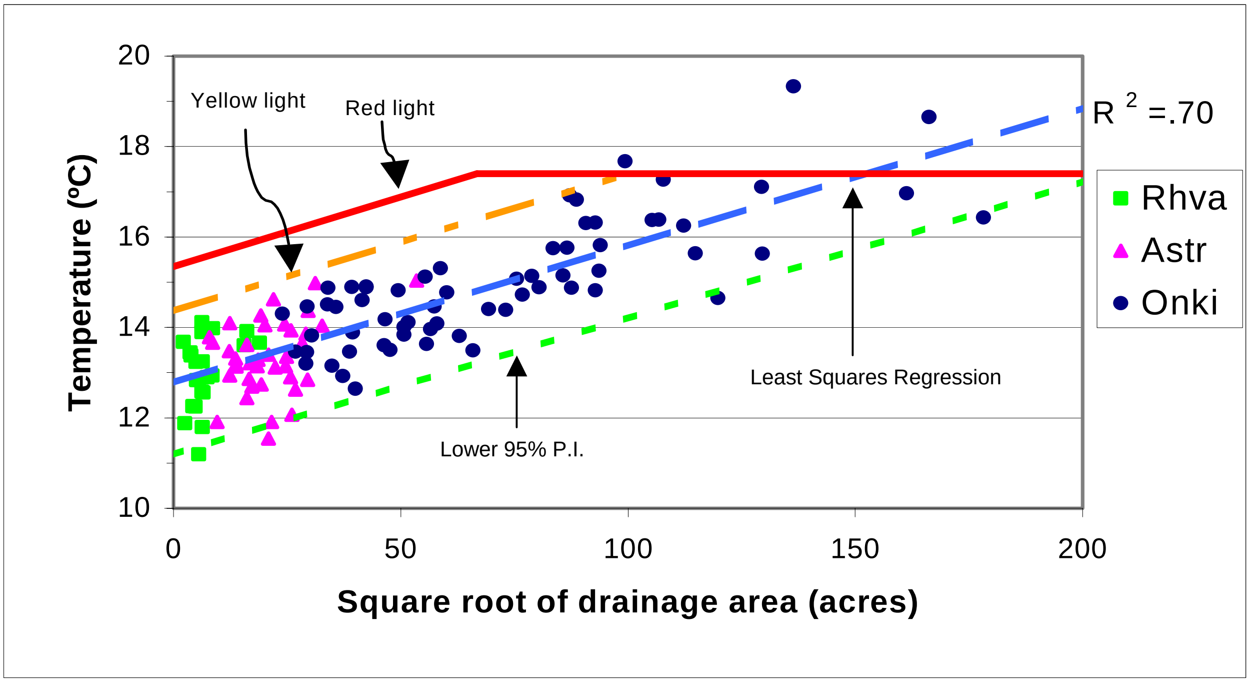


Figure 6-11. **Regression of the 7-day highest mean water temperature versus the square root of drainage area for 139 locations. (Rhva = streams with southern torrent salamanders, Astr = streams with tailed frogs and Onki = streams with coho salmon).**

Monitoring Objectives

The monitoring objectives are to:

- Document the highest 7DMAVG, 7DMMX, and seasonal water temperature fluctuations for each site.
- Identify stream reaches with water temperatures which may exceed the thresholds relative to the drainage area above the monitoring site.

Biological Objectives

Summer water temperatures in 4th order or smaller Class I and II watercourses with drainage areas less than approximately 10,000 acres will have a 7DMAVG below the upper 95% PI described by the following regression equation:

Water temperature (°C) = 14.35141 + 0.03066461x square root of Watershed Area (acres).

In addition, even when temperatures are below the values listed above, it is a biological objective of this Plan to have no significant increases (>2°C) in the 7DMAVG water temperature in Class I or II watercourses following timber harvest that are not attributable to annual climatic variation.

Thresholds/triggers

In Class I and II watercourses with drainage areas generally less than 10,000 acres the yellow light thresholds will be:

- A 7DMAVG above the upper 95% PI described by the regression equation: *Water Temperature* (^{o}C) *= 14.35141 + 0.03066461x square root of Watershed Area* (acres) or,

- Any statistically significant increase in the 7DMAVG of a stream where recent timber harvest has occurred, which cannot be attributed to annual climatic effects.

The red light thresholds will be:

- A 7DMAVG above the upper 95% P.I. plus one °C as described by the regression equation: *Water Temperature* (^{o}C) *=15.35141+ 0.03066461x square root of Watershed Area (acres)*,

- An absolute value of 17.4 °C (relevant for fish) or,

- A 7DMAVG value that triggers a yellow light for three successive years.

Temporal Scale

The response variable for water temperature monitoring is direct measurements of water temperature in Class I and II watercourses. Temperature increases due to timber harvest would likely appear in the first measurement (one summer) following harvest. The thresholds for adaptive management can likewise be triggered by one summer's results, so the time from impact to management response could be as little as one year. It is possible that unusually cool weather could mask a management-related increase, so that it might not be evident until a normal or hot summer occurs.

Spatial Scales

The results of individual temperature recorders reflect an integration of physical and biological conditions upstream of the monitoring site in a specific basin or sub-basin. The specific upstream area that influences the water temperature at the recorder (thermal reach) cannot be readily estimated, because it varies with stream depth, discharge, water temperature, canopy closure and a variety of other physical and biological parameters. However, the high numbers and wide distribution of water temperature monitoring sites across the Plan Area should permit identification potential management related increases, and allow for comparisons to Plan Area-wide trends which are related to larger climatic variations.

If a yellow or red-light threshold is surpassed, the assessment and potential management adjustments will be applied to the zone of monitoring influence associated with each site. Due to variations among thermal reaches and the inability to precisely define them, the zone of monitoring influence for each temperature monitoring site will be estimated on a site specific basis. However, if the water temperatures cannot be attributed to a specific thermal reach, the zone of monitoring influence will be applied to the entire sub-basin area above the monitoring reach, and any adjacent sub-basins that do not have temperature monitoring sites.

6.3.5.2.2 Class II BACI Water Temperature Monitoring

Background

In addition to the general property-wide water temperature monitoring project, experiments were initiated beginning in 1996 to compare water temperatures in Class II watercourses in eight paired sub-basins. These were designed as BACI experiments in which water temperatures were monitored before and after timber harvesting in both treatment and adjacent control streams. (See Appendix C5 for the full description of the study design and the results to date.)

In summer 1996, Green Diamond initiated water temperature monitoring in nonfish bearing (Class II) watercourses to assess potential impacts of harvesting and adequacy of the riparian buffers. The goal of this effort was to examine changes in stream temperature after timber harvest by comparing maximum temperature differentials across fixed lengths of stream. These temperature differentials were measured on pairs of similar streams, one member of which ran through a harvest unit, the other of which was undisturbed. Measurements were initiated in both streams of a pair prior to harvesting timber surrounding one member of the pair. Monitoring of the stream pair will continue until the stream pair returns to pretreatment conditions. These data represent a BACI (Green 1979; Stewart-Oaten et al. 1986; Skalski and Robson 1992) observational study. While observational studies cannot infer cause and effect relationships, BACI studies represent the best available setup for detecting changes after disturbance. Five paired sites were selected in 1996; three additional pairs were identified in 1999.

Monitoring Objective

The monitoring objective of the Class II BACI Studies is to directly assess the effects of timber harvest on water temperatures in Class II watercourses.

Biological Objective

The biological objective of the Class II BACI Studies is to examine the effectiveness of riparian buffers in mitigating the potential impacts on Covered Species from increased water temperatures following harvest adjacent to a Class II watercourse.

Thresholds/triggers

The yellow light threshold will be a statistically significant effects from harvesting in at least one-third of the sites. The red light threshold will be statistically significant effects from harvesting continuing for three successive years following treatment in at least one-third of the sites.

Temporal Scale

The impacts of timber harvest on water temperature in small Class II watercourses will be assessed at the warmest time of day during the warmest time of the year. This will be done to ensure the maximum test of the effectiveness of riparian buffers in mitigating the potential impacts of increased water temperatures following harvest adjacent to a watercourse. In addition, the assessment will focused on the warmest time of the year, since it is believed that the Covered Species are most likely to be impacted by increases in water temperature that may cause water temperature to exceed some biological threshold.

Monitoring of existing pairs where harvesting has been completed at the treatment site will continue for at least three years after harvest or until the temperature profile of the pair returns to the pre-treatment pattern. Monitoring of pairs where harvesting has not yet occurred will begin at least one-year prior to harvest of the treatment site and will continue for at least three years after harvest or until the temperature profile of the pair returns to the pre-treatment pattern.

Spatial Scale

Monitoring will continue at the eight existing paired sites, and additional sites will be established across the Plan Area as opportunities exist. (New BACI sites cannot be initiated unless there is going to be harvesting in the area to create the treatment reach.) The goal is to have a minimum of 12 to 15 paired sites that are well distributed across the Plan Area to represent different physiographic regions. If there is little variance among sites in the response of water temperature to the treatment effect, this minimum number will be adequate to reach a definitive conclusion on the impact of harvesting on Class II water temperature. However, if there is substantial variation in the treatment response, it will be necessary to add additional sites. The actual maximum number is a statistical question that cannot be answered until the data are collected and analyzed.

6.3.5.2.3 Spawning Substrate Permeability

Background

Reducing management-related sediment inputs to Plan Area streams is a biological goal of this Plan. Maintaining adequate spawning substrate permeability is one of the measurable biological objectives associated with this goal. Salmon and trout spawn in gravel and cobble substrates, and subsurface flow through redds is essential in providing dissolved oxygen to embryos and carrying away metabolic wastes. Sedimentation can reduce the survival to emergence of the covered embryos by reducing subsurface flow (Reiser and White 1988). Permeability monitoring is a way to measure subsurface flow, and permeability has been correlated with survival to emergence of salmonids (McCuddin 1977; Tagart 1976; Tappel and Bjorn 1993).

Monitoring Objective

Spawning gravel permeability will be monitored in selected Class I watercourses throughout the Plan Area to determine if conditions are currently suitable for the covered fish species and to track trends in permeability.

Biological Objective

Appropriate biological objective and threshold values for spawning substrate permeability in the Plan Area are not known at this time. Field measurements in streams across the Plan Area will be combined with the available literature and field data from additional streams, including pristine portions of the Prairie Creek watershed, to determine appropriate threshold and biological objective values. Approximately five years of initial trend monitoring is expected to be necessary for this process. A complete description of the spawning substrate permeability monitoring project, including the process for determining appropriate threshold values, is presented in Appendix D.

Thresholds

As described above, approximately five years of initial trend monitoring is expected to be necessary to determine appropriate threshold values. At the end of five years a review and evaluation of trend monitoring results will be conducted. In addition, at other times agreed upon with the consensus of the Services, periodic reviews will be conducted to evaluate progress in determining substrate permeability thresholds.

Temporal Scale

The response variable for permeability monitoring is inflow rate in likely salmonid spawning substrates of Class I watercourses. Changes in inflow rates should respond within hours or days to sediment inputs, but the interval between monitoring periods will likely be one to two years. The time period needed to distinguish between natural process variation and management-related trends may be at least five to ten years, but once threshold values are established, adaptive management response may occur over a time frame of one to two years.

Spatial Scale

The permeability recorded at a monitoring site will reflect the total sediment inputs upstream of the monitoring site, along with sediment stored in-channel which is mobilized due to high flows. The selection of all the monitoring sites has not yet occurred, but permeability will be monitored at all the long term channel sites, along with additional sites selected to insure that there will be at least several sites monitored in each HPA. The zone of monitoring influence will generally apply to the entire sub-basin above the monitoring site, but may be extrapolated to other drainages with similar conditions (i.e., geology, slope classes, etc) that lack monitoring sites.

6.3.5.2.4 Road Related Surface Erosion (Turbidity Monitoring)

Background

Surface erosion from roads is recognized as a potentially significant source of management related fine sediment inputs to Plan Area streams. Road upgrading measures and winter use limitations are expected to reduce road related surface erosion under this Plan. Inboard ditches collect surface runoff from roads, and in many cases, channel this runoff directly into streams. Part of the road upgrading process is to hydrologically disconnect the roads from the streams, eliminating these pathways for road runoff to directly enter streams.

Turbidity monitoring will be focused on the four watersheds which make up the Experimental Watershed Program. Turbidity monitoring will be used to measure the road-related fine sediment inputs to Plan Area streams, and evaluate the effectiveness of the road upgrading measures in reducing these inputs. Turbidity will be measured immediately above and below watercourse crossings in Class II-1 and II-2 watercourses, with the difference in turbidity between the two assumed to be due to surface runoff from the road. The road related surface erosion monitoring will also compare this change in turbidity on individual road segments before and after road upgrading, and between roads which have been upgraded and those which have not. The implementation of the road upgrading will be designed to allow for these experiments. Permanent turbidity monitoring stations will also be employed in the four drainages which make up the Experimental Watersheds Program. Permanent turbidity monitoring stations will be monitoring all changes in the experimental watersheds (i.e. all effects). Therefore these data can be used for comparing changes within each of the Experimental Watersheds.

Monitoring Objective

Turbidity monitoring will be used to determine the extent to which management roads are chronic contributors of fine sediment to Plan Area streams. Turbidity will also be monitored in a BACI experimental design to determine the effectiveness of road upgrading in reducing the hydrologic connections between the road network and Plan Area streams. The first objective will be used as a threshold for adaptive management, while the latter objective will be used to fine-tune road upgrading work. Both will contribute to the biological objective described below.

Biological Objective

Road upgrading (primarily measures to reduce or eliminate the hydrologic connections between the road network and Plan Area streams) and winter use limitations will reduce the amount of road related fine sediments entering Plan Area streams.

Thresholds

Appropriate threshold values for turbidity monitoring cannot be determined at this time. Approximately five years of initial trend monitoring are expected to be necessary to set the appropriate biological objectives and threshold values. At the end of five years a review and evaluation of trend monitoring results will be conducted. In addition, at other times agreed upon with the consensus of the Services, periodic reviews will be conducted to evaluate progress in determining turbidity thresholds.

Temporal Scale

The response variable for the road-related surface erosion monitoring will be the change in turbidity of a stream above and below a watercourse crossing. Turbidity responds almost instantly to changes in fine sediment inputs. Monitoring will occur continuously throughout each winter, so it will be possible to detect average changes within each sub-basin after each appropriate storm event. As a result, a yellow light condition could be reached in as little as three consecutive days of rain.

Spatial Scale

Turbidity monitoring will occur in the four drainages which make up the Experimental Watershed Program. The results from the permanent turbidity monitoring stations will integrate the effects of all upstream sources of turbidity in the watershed. The results from each watercourse crossing will directly reflect the fine sediment inputs from the particular road segment adjacent to that crossing. The extrapolation of results and potential adaptive management measures across the Plan Area will depend on the specific findings. For instance, if the monitoring results indicate that additional measures are needed to effectively disconnect roads from the stream network in certain geologic formations or soil types, that work would be done everywhere those formations or soil types exist. Alternatively, monitoring results could indicate that winter use limitations need to be expanded in particular geologic formations or soil types.

6.3.5.2.5 Headwaters (Tailed Frog and Southern Torrent Salamander) Monitoring

Background

Most of the research and protocols developed for monitoring forest aquatic systems in the Pacific Northwest have focused on anadromous fish populations and their habitat conditions within third order or larger streams. Using the fish populations as indicators of watershed health is problematic, as factors outside the freshwater system have a major impact on population levels. As a result, much of our monitoring program is focused on the habitat conditions within the fish-bearing reaches of streams. However, it is possible that habitat conditions will be shown to improve throughout the life of the Plan, but fish populations will continue to decline. Green Diamond believes it is critical to the monitoring program to provide a definitive biological link to freshwater habitat conditions.

The headwaters monitoring project will provide this biological link by focusing on the populations of the two obligate headwater species (tailed frog and southern torrent salamander) that are the most sensitive to the potential impacts of timber harvest. These species are unique relative to anadromous fish species in lower stream reaches in that they have relatively limited vagility and typically live out their entire lives in or immediately adjacent to a relatively short reach of stream. Therefore, the population levels of obligate headwater species are influenced by the conditions that exist within or immediately adjacent to the stream course. Although there are many demonstrated risks associated with the use of biological indicator species, the population levels of the headwater amphibian species covered in this Plan should provide a good biological indicator of the general effectiveness of the Plan in achieving the biological goals of maintaining cold water temperatures and reducing excessive sediment inputs into streams.

In addition to the need to provide a biological indicator, the focus of the headwaters monitoring will be on populations because there are no well defined protocols that can be directly applied to monitor the habitat conditions within headwater streams. Research in smaller headwater streams has typically focused on the populations and habitat associations of the species that live in these streams. In comparison to numerous studies designed to monitor the impact of watershed processes on stream morphology in fish bearing watercourses, little has been done to monitor the impact of those same processes on headwater streams. It is known that headwater streams typically have higher gradients and more confined channels than lower stream reaches, and as a result are primarily sediment transport reaches. There are no readily implemented techniques to monitor how sediment movement through these systems impacts the quality of the habitat in the stream. Although Green Diamond will monitor some elements of habitat conditions in headwater streams, the headwaters monitoring program will be primarily focused on populations of the two obligate headwater species covered under this Plan, the tailed frog and southern torrent salamander. Populations of tailed frogs and southern torrent salamanders should provide the best indicator of overall habitat conditions in headwater streams.

Differences in our ability to effectively sample populations of tailed frogs and southern torrent salamanders affect the temporal scales required for effective feedback to adaptive management. Tailed frog monitoring can trigger both yellow and red light thresholds in one and three years respectively. Southern torrent salamander monitoring has the potential to trigger a yellow light threshold in less than one year, but is expected to require at least five years before statistically significant results can be determined to trigger a red light threshold. These differences are described in more detail below.

6.3.5.2.5.1 *Tailed Frog Monitoring*

Tailed frogs occur primarily in larger first order and second order streams, and may be influenced by direct impacts of timber management. Direct impacts could include activities such as excessive canopy removal at the site leading to elevated water temperature, or destabilizing soil leading to direct sediment inputs at the site. However, they are also vulnerable to cumulative impacts in the upper reaches of watersheds that could result in elevated water temperatures or excessive sediment loads. In this regard they are similar to the salmonid species, except that such cumulative impacts could effect tailed frog populations before the impacts were manifest in the lower fish-bearing reaches of a watershed.

The primary focus of the tailed frog monitoring will be on the larval population. While the adults can move between the stream and adjacent riparian vegetation, the larvae respire with gills and are tied to the stream environment. They require a minimum of one year to reach metamorphosis, which necessitates over-wintering in the streams. They feed on diatoms while clinging to the substrate with sucker-like mouth parts and have limited swimming ability. This makes them potentially vulnerable to excessive bed movement of the stream during high flows, which Green Diamond previously documented to drastically reduce the larval cohort that is in the stream during the high flow event. As a result of their life history requirements, the larvae provide the most immediate and direct response to changes in stream conditions. In addition, larval tailed frogs can be captured with ease while causing minimal disturbance to the site. Ongoing studies have allowed us to develop a protocol that has been shown to be highly effective in estimating larval populations. Methodologies for estimating larval tailed frog populations are shown in Appendix C11. Adults can also be captured with minimal disturbance to the site, but in contrast to the larvae, their population size cannot be readily estimated. As a result of all the factors discussed above, the primary response variable for the tailed frog monitoring will be the size of the larval population.

A decline in tailed frog populations could be caused by a number of factors including elevated water temperatures, change in the algal community due to an increase in insolation or increases in sediment inputs. However, our previous research and monitoring of tailed frogs indicated that they were most likely to be impacted by increases in sediment inputs. Given that Green Diamond will be monitoring water temperature, canopy closure and substrate composition along with the larval populations, Green Diamond believes that the likely cause of some future decline will be determined.

Monitoring Objectives

The primary monitoring approach will employ a paired sub-basin design. Changes in larval populations of tailed frogs will be compared in randomly selected streams in watersheds with (treatment) and without (control) timber harvest. In some cases, control sub-basins will not be available in which case changes in larval populations will be compared to the amount of timber harvest. In either case, the monitoring objective will be to determine if timber harvest activities have a measurable impact on larval populations.

A secondary monitoring objective will be to document long-term changes in tailed frog populations across Green Diamond's ownership. As indicated in Section 4.3, studies of the Original Assessed Ownership determined that 75% of the assessed streams (80% excluding geologically unsuitable areas) had tailed frog populations (Diller and Wallace 1999). Given that this occurrence rate is near the highest reported for the species even in pristine conditions (Corn and Bury 1989; Welsh 1990), a secondary objective is to sustain the occupancy of tailed frog populations in Class II watercourses in the Plan Area at a minimum of 75% through time. To determine if this objective is being met, the landscape study previously completed (Diller and Wallace 1999) will be repeated at 10-year intervals.

Biological Objective

No significant impact from timber harvest on the larval populations of tailed frogs.

Thresholds/triggers

Changes in larval tailed frog populations can be used as both yellow and red light thresholds to trigger adaptive management.

The yellow light thresholds are:

- Any statistically significant decrease in the larval populations of treatment streams relative to control streams, or
- A statistically significant downward trend in both treatment and control streams.

The red light thresholds are:

- A statistically significant decline in larval populations in treatment streams relative to control streams in >50% of the monitored sub-basins in a single year;
- A statistically significant decline in treatment vs. control sites continuing over a three year period within a single sub-basin or;

- A statistically significant downward trend in both treatment and control streams that continues for three years or more.

The change in the occurrence of tailed frog populations across the ownership would not be suitable to use as a trigger to initiate management review due to the extended time-lag between successive data points. However, the occurrence of tailed frogs in Class II watercourses across the Plan Area would serve as corroborative evidence to support the findings of the larval population monitoring, and a significant decrease in the occurrence rate would initiate a review of the probable cause of the decline.

Temporal Scale

If a significant change occurs in the larval populations of treatment streams relative to controls, it will most likely occur during winter high flow events. This change would then be detected during the summer survey season immediately following the winter event. Therefore, the yellow light threshold for adaptive management could be initiated in a single year. The red light threshold would require three years to be initiated.

Spatial Scale

The spatial scale over which results from an individual monitoring site should apply, (the zone of monitoring influence), will be analyzed on a case-by-case basis. The inherent variability associated with monitoring of a biological indicator necessitates this approach. If a yellow or red light condition is detected, results from all sites across the Plan Area will be examined carefully to determine if the observed population decline(s) appear to be associated with management activity, if they are localized or area wide, and if they appear to be correlated with other factors such as underlying geology or annual climate variation. Field inspection of the problem site(s) will also attempt to identify potential causes of the decline. Because populations in both treatment and control streams could decline for reasons beyond our control that may not be related to habitat (e.g. stochastic disease outbreaks), it is essential to examine the results from all monitoring sites to look for patterns in the observed decline. The spatial scale of any resulting adaptive management changes will depend on the particular results. Potential management changes could occur within a HPA, across the Plan Area, or in all areas with similar geology, for example, depending on the nature of the monitoring results.

6.3.5.2.5.2 Southern Torrent Salamander Monitoring

Torrent salamanders are generally found in springs, seeps and the most extreme headwater reaches of streams. They are a small salamander that appears to spend most of its time within the interstices of the stream's substrate, which make them difficult to locate and capture without disturbing their habitat. The larvae have gills and are restricted to flowing water while adults also appear to spend most of their time in the water, but are capable of movements out of the water. They are thought to have very limited vagility (Nussbaum and Tait 1977), and given the highly disjunct nature of their habitat, individuals at a given site (sub-population) are likely to be isolated from other adjacent sub-populations. The degree of isolation of these sub-populations probably varies depending on the distance and habitat that separates them, so that torrent salamanders could be best described as existing as a meta-population.

Although there is some evidence for cumulative effects of sediment input in certain sites, torrent salamanders are primarily vulnerable only to potential direct impacts from timber harvest (Diller and Wallace 1996). Direct impacts could include activities such as excessive canopy removal at the site leading to elevated water temperature, operating heavy equipment in the site, or destabilizing soil leading to excessive sediment deposits at the site. Past observations have indicated that these direct impacts can lead to extinction of the sub-population at the site. Due to the survey difficulties noted above, an attempt to get a statistically rigorous estimate of the number of individuals at monitored sites would be impractical. Despite this, an index of the number of individuals at each site will be obtained and the life history stage of each individual will be recorded. However, given the unreliability of the index of sub-population size, the persistence of individual sub-populations will be used as the primary response variable for the torrent salamander monitoring.

Concerns could be raised that there are too few sub-populations in the meta-population of torrent salamanders to expect to see significant changes over time, or that any loss in sub-populations would threaten the long-term persistence of torrent salamanders within the Plan Area. However, over 550 torrent salamander sites (sub-populations) already have been located in what is estimated to be no more than 25-30% of the total potential habitat in the Original Assessed Ownership. In addition, without a formal monitoring protocol, Green Diamond already documented both the apparent extinction and re-colonization of several torrent salamander sites. This would indicate that the meta-population concept does appear to apply to torrent salamanders in this region.

<u>Monitoring Objectives</u>

The primary monitoring approach for southern torrent salamanders will employ a paired sub-basin design. Changes in the persistence of sub-populations will be compared in randomly selected sites in watersheds with (treatment) and without (control) timber harvest. In some cases, control sub-basins will not be available in which case changes in sub-populations will be compared to the amount of timber harvest. In either case, the objective will be to determine if timber harvest activities have a measurable impact on the persistence of sub-populations. Therefore, the monitoring will determine if there is a difference in the persistence rate for treatment and control sub-populations, and document any apparent changes in the habitat conditions or index of sub-population size at each site.

A secondary monitoring objective will be to document long-term changes in torrent salamander populations across Green Diamond's ownership. As indicated in Section 4.3, studies of the Original Assessed Ownership estimated that 80% of the assessed streams (almost 90% excluding geologically unsuitable areas) had torrent salamander populations (Diller and Wallace 1996). Given that this occurrence rate is near the highest reported for the species even in pristine conditions (Carey 1989; Corn and Bury 1989; Welsh et al. 1992), an additional objective is to sustain the occupancy of torrent salamander populations in Class II watercourses in the Plan Area at a minimum of 80% through time. To determine if this objective is being met, the landscape study previously completed (Diller and Wallace 1996) will be repeated at 10-year intervals. Results and methodology of these investigations are shown in Appendix C11.

The change in the occurrence of torrent salamander populations across the ownership would not be suitable to use as a trigger to initiate management review due to the extended time-lag between successive data points. However, the occurrence of torrent salamanders in Class II watercourses across the Plan Area would serve as corroborative evidence to support the findings of the meta-population monitoring, and a significant decrease in the occurrence rate would initiate a review of the probable cause of the decline.

Biological Objective

No significant impact of timber harvest on the persistence rate of southern torrent salamander sub-populations. Specifically, no significant difference in the persistence rate of southern torrent salamander sub-populations between treatment (harvest) and control (no harvest) sub-populations.

Thresholds

The yellow light thresholds will be:

- Any extinction of a sub-population, or
- An apparent decline in the average index of sub-population size in treatment sites compared to control sites.

The red light thresholds will be:

- A statistically significant increase in the extinction of treatment sub-populations relative to control streams, or
- A significant increase in the net rate of extinctions over the landscapes.

The extinction of a sub-population of torrent salamanders is a stochastic event that will not be likely to occur on a regular basis, and therefore will not provide a responsive trigger to incremental changes in habitat conditions for torrent salamanders. It is likely that Green Diamond would only be able to document a red light condition after many years of monitoring. This means that torrent salamander monitoring may be effective in the short term for detecting extinctions of localized sub-populations, but on a Plan Area wide scale, it will be more useful in establishing long term population trends than in providing triggers for adaptive management.

Temporal Scale

Based on previous monitoring of torrent salamander sites, the extinction of a site will likely be due to a catastrophic event (natural or anthropogenic). This will be detected during the first survey season following the event. Therefore, yellow light conditions will trigger an evaluation in a single year. As noted above, the torrent salamander monitoring is not well suited for a red light threshold, because the temporal scale would likely be too long for effective use in adaptive management.

Spatial Scale

The zone of monitoring influence for a specific site will be determined on a case-by-case basis. Given that torrent salamanders are most likely to be impacted by direct site impacts, assessment of yellow conditions will include a field inspection of the affected site to determine likely causes. Results from all sites will be examined to determine if extirpations or declines are localized, area-wide, or associated with specific management activities, geologies, climatic variations, or other variables. Potential adaptive management changes could occur within a HPA, across the Plan Area, or in all areas with similar geology, for example, depending on the nature of the monitoring results.

6.3.5.3 Response Monitoring

The Response Monitoring projects, like the Rapid Response projects described above, monitor the effectiveness of the conservation measures in achieving specific biological goals and objectives of the Plan. These monitoring projects are distinguished from the Rapid Response projects by the greater lag time required for feedback to the adaptive management process. The Response Monitoring projects are focused on the effects of cumulative sediment inputs on stream channels. Natural variation in stream channel dimensions, combined with the potential time lag between sediment inputs and changes in the response variables of these projects, make it difficult to determine appropriate thresholds for adaptive management at this time. When yellow and/or red light thresholds are determined, they are expected to require more than three years of results to be triggered in most cases.

6.3.5.3.1 Class I Channel Monitoring

Background

Timber management has the potential to increase sediment inputs to streams through both surface erosion and mass wasting. Increased sediment inputs are in turn associated with a decline in the quality of aquatic habitat for all six of the Covered Species. As a result, reducing anthropogenic sediment inputs to Plan Area streams is one of the primary biological goals of the Plan. The long term channel monitoring project is one of four monitoring projects designed to measure the effectiveness of the conservation measures in reducing management related sediment inputs to area streams. This technique is generally best suited for establishing long term trends due to the potential lag times between sediment inputs and the measured response in the monitoring reach.

Green Diamond initiated the long term channel monitoring project with the goal of improving management within the Plan Area and determining the effectiveness of current management standards in minimizing sediment inputs to Plan Area streams. Pilot projects in 1993 and 1994 provided valuable information regarding effective methods and response variables, and the difficulties of analyzing the resulting data. Using the information gathered in these pilot studies, a revised methodology was developed and first implemented in Cañon Creek in 1995.

Nine monitoring reaches are currently established in eight streams across the Plan Area. Two additional reaches are established with a reduced protocol (thalweg profile only), because the sites do not meet the criteria necessary for doing the full protocol. These eleven reaches will be measured at least every other year for the duration of the Plan. The channel dimensions measured in each reach include cross-sectional and thalweg profiles, substrate size distributions (pebble counts), and bankfull and active channel widths. A complete description of the long term channel monitoring protocol, reach locations, and results to date is presented in Appendix C3.

Monitoring Objectives

The monitoring objectives of the channel monitoring project are to track long term trends in the sediment budget of Class I watercourses as evidenced by changes in channel dimensions. Within most stream systems there are both transport and depositional reaches where sediment either moves through the system or tends to accumulate. When sediment inputs overwhelm the ability of a stream to transport sediment, aggradation of the stream channel occurs within depositional reaches. Conversely, a decrease in sediment input to levels below the transport capability of a stream can result in degradation of the stream channel in these same reaches. Both of these channel responses can be observed and quantified through the monitored channel dimensions in depositional reaches, allowing for identification of, and responses to, changes in sediment inputs to a watershed. The long term channel monitoring project is not designed to identify the potential sources or causes of changes in the sediment budget, only to document that they are occurring.

Biological Objective

Sediment inputs to Plan Area streams will not cause a significant negative change in channel dimensions in Class I depositional reaches. Negative changes in channel dimensions will be those changes associated with aggradation of the channel due to increased sediment inputs.

Thresholds

Appropriate biological objectives and threshold values for the Class I channel monitoring project cannot be determined at this time. Approximately five years of initial trend monitoring are expected to be necessary to set the appropriate objective values. At the end of five years, a review and evaluation of trend monitoring results will be conducted. In addition, at other times agreed upon with the consensus of the Services, periodic reviews will be conducted to evaluate progress in determining channel monitoring thresholds. Determining appropriate thresholds for adaptive management may require as much as 15 years due to the long time scales involved in the dynamics of channel morphology.

Temporal Scale

The response variables of the long-term channel monitoring project include thalweg elevation and variance, substrate size distributions (pebble counts), and bankfull and active channel widths. Monitoring of these channel features is generally most useful in observing long term (>10 years) trends in channel characteristics, because of the potential lag time between a hillslope event and a resultant change in the depositional reach. However, under ideal conditions the monitoring site is the first depositional reach immediately below a continuous transport reach. Under this scenario, previous monitoring has demonstrated that mass wasting associated with major storm events can create significant changes in channel dimensions over a period of hours or days. The interval between measurement periods will be one or two years at each site, so that the yellow light threshold can be triggered by a mass wasting event in as few as one to two years under ideal conditions. Monitoring sites that are separated from transport reaches by some distance of transitional reaches, which temporarily store sediments, would respond to hillslope sediment inputs with increasing lag times depending on the length of the transitional reaches. Green Diamond believes that our current monitoring sites have a range of response times but will not likely have lag times of greater than one to two years following greater than five-year storm events. This will be confirmed through additional monitoring.

The red light threshold requires a minimum of three years to be triggered following three successive winters with major storm events and minimal lag time for sediments to impact the monitoring reach. Green Diamond estimates that it will likely take a minimum of four to six years to trigger a red light in most of our monitoring reaches.

Spatial Scale

The long term channel monitoring project responds to the total sediment inputs in the watershed above the monitoring reach. The current 11 (9 complete and 2 partial) monitoring reaches are distributed throughout the Plan Area, so that even though there will be additional monitoring reaches added in the future, some HPAs have no monitoring reaches while others will have more than one. The results at each monitoring site, including any indicated adaptive management changes, will therefore be extrapolated throughout the Plan Area to other basins with similar conditions (i.e. geology, drainage size, slope classes, etc.) which lack monitoring reaches.

6.3.5.3.2 Class III Sediment Monitoring

Background

Under Green Diamond's Plan, Class III watercourses (do not support aquatic species) are protected under a 2-tiered system.

Under tier A, the watercourse has a delineated equipment exclusion zone and ground disturbance will be minimized, but there will be little or no retention of existing forest canopy. There are existing concerns that complete removal of trees from Class IIIs will result in destabilizing these headwater areas resulting in an upslope extension of the channel and increased risk of shallow rapid landslides. The net effect is that there may be significant increases in sediment production even though Class I and II watercourses may have ample buffer retention. Because the majority of a channel network is made up of the 1st order channels, the overall impact of destabilized Class IIIs may be quite large even though the increased sediment delivery in any given Class III might be small.

Using a BACI (before, after, control, impact) experimental design, Green Diamond has initiated a monitoring program to determine the amount of sediment delivered from Class III watercourses following timber harvest. The objectives will be to monitor Class III watercourses to quantify the amount of sediment delivered from treatment channels following timber harvest relative to control channels. Quantification of sediment delivery will be estimated utilizing four basic approaches: 1) documentation of changes in channel morphology, 2) monitoring of turbidity during storm events; 3) placement of sediment traps at potential sediment delivery sites, and 4) placement of silt fences at the lower extent of watercourse below the harvest unit. Each of these techniques will quantify sediment delivery in different ways, and measure a different component of the total sediment budget in Class III watercourses for a comprehensive evaluation of sediment delivery.

Monitoring Objective

The objectives are to monitor Class III watercourses to quantify the amount of sediment delivered from treatment channels following timber harvest relative to control channels.

Threshold/trigger

Appropriate biological objectives and threshold values for Class III sediment delivery cannot be determined at this time. Approximately five years of initial trend monitoring are expected to be necessary to set the appropriate biological objectives and threshold values. At the end of five years a review and evaluation of trend monitoring results will be conduced. In addition, at other times agreed upon with the consensus of the Services, periodic reviews will be conducted to evaluate progress in determining thresholds.

Temporal Scale

Class III Sediment Monitoring is a medium to long term project that will occur during approximately the first ten years of this Plan. Sediment inputs to streams are episodic in nature and are triggered by rainfall events. At the end of five years of monitoring a review and evaluation of the results obtained will be conduced to determine turbidity and sediment thresholds. Following that review and the establishment of these thresholds, the time scale required to accurately assess sediment delivery into Class III watercourses may require monitoring for up to five years or more following timber harvest in Class III watercourses within the Experimental Watersheds.

Spatial Scale

This monitoring program will only be employed in the four basins that make up the Experimental Watersheds Program.

6.3.5.4 Long-term Trend Monitoring/Research

The Long-term Trend Monitoring/Research projects are those monitoring projects for which no thresholds for adaptive management are set. For some projects, this reflects the multitude of factors which affect the response variables, in others, the long time scales required to distinguish the 'noise' from the underlying relationships. Research projects designed to reveal relationships between habitat conditions and long-term persistence of the Covered Species are also included in this Section. Each of these projects has the potential to provide feedback for adaptive management, but in some circumstances, decades may be required before that can occur.

6.3.5.4.1 Road-related Mass Wasting Monitoring

Background

Roads can lead to increases in the frequency and severity of all types of mass soil movement. Increased sediment inputs to streams can in turn negatively impact all six of the Covered Species. The road upgrading and decommissioning process described in Section 6.3.3 is expected to significantly reduce the frequency and/or severity of road related mass wasting sediment inputs. As such, it is an integral component of the suite of conservation measures designed to achieve the biological goal of reducing management-related sediment inputs to Plan Area streams.

Monitoring Objectives

The road-related mass wasting monitoring project will monitor the effectiveness of the road upgrading and decommissioning measures in reducing the frequency and severity of road-related course sediment inputs. This will involve before and after monitoring of particular road segments, comparisons within basins or sub-basins of upgraded and non-upgraded roads, and Plan Area wide comparisons of upgraded and non-upgraded roads. If no significant effect (i.e. reduced frequency and severity of road-related mass wasting inputs) can be attributed to the road upgrading and decommissioning measures, the monitoring results will be used to adjust and revise the road upgrading and decommissioning measures to improve their effectiveness.

Temporal Scale

Road upgrading and decommissioning are long term projects that will occur throughout the life of this Plan. In addition, road-related mass wasting sediment inputs to streams are episodic in nature and typically triggered by intense rainfall events. As a result, the time scale required to accurately assess the effectiveness of road upgrading and decommissioning may be on the order of decades.

Spatial Scale

The road related mass wasting monitoring project will be employed in the four basins which make up the Experimental Watershed Program. Any changes to the road decommissioning and upgrading measures and process which occurs will be applied according to the specific monitoring results. Such changes could apply to the entire Plan Area, or results could indicate that additional work is required only in specific areas defined by geology, soil type, or slope class, for example.

6.3.5.4.2 Steep Streamside Slope Delineation Study

Monitoring Objectives

The monitoring objective of the Steep Streamside Slope (SSS) Delineation Study is to determine the minimum slope gradient and maximum slope distance of SSS zones for each HPA. The initial default minimum slope gradients and maximum slope distances for the HPA Groups will be adjusted for each HPA based on the results of this study.

Temporal Scale

The SSS Delineation Studies for each of the 11 HPAs are scheduled to be conducted within seven years after the effective date of the Permits. The results for the SSS delineation study for each HPA will be subject to modification throughout the term of the permit following the completion of the initial delineation study. Such modification will be based on additional SSS data collected in each HPA. Additional SSS data for each HPA will be collected depending on climatic cycles across the region during the term of the permit. It is expected that the SSS distances and slope gradients for any given HPA may be subject to review and modification approximately every 10 to 20 years.

Spatial Scale

The objective of the SSS Delineation Study will be to develop HPA -specific default measures for minimum slope gradients and maximum slope distance. In order to collect data that will allow statistical inferences to be made that will apply to the entire HPA, it will be necessary to sample study sites across the HPA using a probability based sampling design that is spatially distributed. The specific sampling design has not been determined yet, because Green Diamond has not set the sampling frame or acceptable levels of variance in the estimates. Once this has been done, there are a variety of possible sampling schemes that will achieve the objective of obtaining a statistically valid sample from which to draw inferences to the entire HPA, and the specific sampling scheme selected will be based on minimizing variance and while maximizing efficiency of data collection.

6.3.5.4.3 *Steep Streamside Slope Assessment*

Monitoring Objectives

The goal of the SSS Assessment is to determine the effectiveness of SSS prescriptions and to recommend appropriate changes to the SSS conservation measures, if any such change is necessary, that will more closely achieve the effectiveness goal of the SSS conservation measures. The SSS conservation measures are designed to be at least 70% effective at preventing management-related sediment delivery from landslides compared to that from appropriate historical clear-cut reference areas. A maximum of a 30% relative increase in landslide-related sediment delivery compared to similar, modern, but uncut (advanced second-growth) SSS areas may be used as another comparative standard to determine the effectiveness of the conservation measures.

The objectives of the SSS Assessment are to collect data relevant to landslides in SSS zones and to determine the effectiveness of the SSS conservation measures by comparative analysis of cumulative sediment delivery volumes and associated data. The procedure will be based on the assumptions described in Section 6.3.2 and it will utilize similar methods as were employed in the three pilot watershed areas to determine the initial default SSS slope gradients and distances. For each HPA, this will include conducting an office-based Steep Streamside Slope inventory and a landslide inventory using aerial photographs and field surveys, designing a statistically valid field-based data collection program (as described for the SSS Delineation Study), field verifying the office-based SSS and landslide inventory, collecting field data, data analysis, reporting and implementation of adaptive SSS slope gradients and distances.

Temporal Scale

Data collection for the SSS Assessments for the 11 HPAs is scheduled to be completed after 15 winters following the signing of the HCP. Data analysis by a scientific review panel will begin after the 15 years of data is collected. If at least two of the panel members agree that the data analysis results are conclusive, then the panel will make recommendations regarding SSS prescriptions based on those results. If two panel members agree that the data interpretation is not conclusive, the data collection procedure may be modified and the study will be continued for an additional five years before another panel is convened for data analysis.

Spatial Scale

Landslide data will be collected across the landscape and on many different landscape elements in order to provide a meaningful data set for analytical purposes. The SSS Assessments for individual HPAs may result in a uniform prescription for an entire HPA, or it may result in several prescriptions within an HPA. Different HPAs or areas from different HPAs that are found to be substantively similar may receive similar prescriptions as a result of the SSS Assessment.

6.3.5.4.4 Mass Wasting Assessment

Monitoring Objectives

Green Diamond will conduct a property-wide Mass Wasting Assessment (MWA) within 20 years. The goal of the MWA is to examine relationships between mass wasting processes and timber management practices. The objectives of the Mass Wasting Assessment are to collect a thorough data set that represents a wide range of mass wasting processes and management practices, to analyze the data, and to present the results in a report or in several reports. The results of the MWA will not be subject to the adaptive management mechanisms provided by the plan.

The landslide inventory and analysis will generally follow the procedures outlined in the Washington State Department of Natural Resources (WDNR) methodology for mass wasting analysis, with some modifications. Modifications to the WDNR method may be implemented based on data or at the professional discretion of the supervising geologist. A California PG will oversee the MWA. All data will be stored in a database and appropriately represented on maps in order to facilitate data analysis.

Green Diamond and the Services will jointly review the final MWA results to determine if slope stability monitoring should continue. If the Services and Green Diamond cannot reach agreement on the finality of the study, a scientific panel will be convened to determine if continued MWA is necessary. If a scientific panel is required, the panel will be convened in the same manner and generally follow the same procedure as the panel for the SSS Assessment.

Temporal Scale

A preliminary MWA will be completed within the 7th anniversary of the Services' approval of the Permits. The final MWA will be completed within the 20th anniversary of the Services' approval of the Permits. The preliminary MWA will at least include a landslide inventory and some statistical reporting with limited comments and discussion. The final MWA will include updating the preliminary data and it will attempt to identify patterns or trends in mass wasting processes as they relate to management practices. The final MWA will be presented in a report or in several reports. The MWA may be done incrementally across the property and the results for the study may be presented as results become available. The results of the study may apply to entire HPAs, or any combination of smaller or larger areas.

Spatial Scale

The SSS Assessments will be conducted for each of the 11 HPAs. Although the initial default prescriptions are uniform across the entire Plan Area, the SSS assessment could modify the prescriptions on a per-HPA basis.

6.3.5.4.5 Long-term Habitat Assessment

Background

Channel and habitat typing assessment was conducted by Green Diamond fisheries personnel in 1994 and 1995 following the CDFG methods described by Flosi and Reynolds (1994) and Hopelain (1994). As indicated in Section 4.3, Green Diamond fisheries personnel assessed sixteen streams in 1994 and 1995, identifying 75 reaches by channel type for a total of nearly 104 miles of stream channel assessed. The sixteen streams assessed were selected based on their biological significance as producers of salmonids, and the size of Green Diamond's ownership in the watershed's anadromous reaches.

Channel and habitat typing assessments also were conducted on the Original Assessed Ownership by the YTFP, CCC, LP, and CDFG. They assessed 42 streams, covering 140 reaches for a total of 131.0 miles of channel.

The data collected in this process are intended to provide information about the health of the stream, especially with respect to salmonid habitat, including:

- Percent canopy cover
- Percent LWD as structural shelter
- Habitat types as a percent of length
- Dominant substrate composition
- Pool embeddedness
- Pool depths
- Shelter rating in pools

Monitoring Objectives

The monitoring objective of the Habitat Assessment Monitoring Project is to document long term trends in habitat quality and quantity under the Plan. The trends observed through this long term, comprehensive assessment will be valuable for comparison with the results of the other more specific monitoring projects to ensure that the individual biological objectives described above, i.e., permeability, channel dimensions, water temperature, etc., are accurately capturing the larger picture of overall aquatic stream health and function.

For example, if the individual biological objectives were being achieved, but a negative long term trend in habitat quality was observed through the habitat assessment process, a detailed assessment would be conducted to evaluate this apparent contradiction. The assessment would examine the specific habitat conditions of concern and determine why the other biological objectives monitoring projects were failing to detect an overall decline in habitat quality. Possible results of such an assessment include changes to specific management and conservation measures which correspond to the specific aspects of habitat quality determined to be a source of concern. Additional changes could include adding new biological objectives with associated monitoring projects, or adjusting the threshold values of other monitoring projects.

Temporal Scale

The channel and habitat assessment process will be repeated on the original 46 surveyed streams every ten years for the life of the Plan. As the first assessments were completed in 1994-1995, the next assessment will be in 2004 and 2005. Detection of significant trends will probably require at least a third assessment.

Spatial Scale

The channel and habitat typing reaches are and will be distributed throughout the Plan Area. Each assessment identifies the channel types and habitat features in the particular stream assessed. Significant differences between streams based on unique features, including management history and underlying geology, reduce the value of applying the long term trends documented through this monitoring to streams which are not assessed. However, consistent trends observed in assessed streams would be assumed to accurately reflect conditions in Plan Area streams which were not assessed.

6.3.5.4.6 LWD Monitoring

Background

In-channel LWD is recognized as a vital component of salmonid habitat. The physical and biological processes associated with LWD have been described in this document. Current levels of the large size class of in-channel and potential LWD are estimated to be low throughout the Plan Area. As a result, providing for the recruitment of large size class LWD into Plan Area streams is a biological goal of this Plan, and aspects of the riparian conservation measures and the road management plan described above were designed with this goal in mind. The conservation measures, including providing adequate buffer strips, may result in an increase in the long-term rate of inchannel LWD recruitment (and conversely decrease the rate of long-term of loss of LWD), over the life of the Plan. This long-term monitoring project will document whether these expectations are met.

As indicated in Section 4.3, an in-channel and recruitment zone LWD inventory was conducted on fifteen streams in 1994 and 1995 using CDFG's LWD inventory protocol (Flosi and Reynolds 1994). Information regarding the presence of LWD was also obtained in the channel and habitat typing assessment process, but the importance of LWD to biological and physical processes in the stream channel justified the need for a more thorough assessment of this critical habitat component. The information collected in the inventory includes:

- Total abundance of both inchannel LWD and potential LWD (all live and dead trees within 50 feet of the bankfull channel margin).

- Size distribution of inchannel and potential LWD.

Monitoring Objectives

The monitoring objectives of the LWD assessment project are to document long term trends in the abundance and size class of inchannel and potential LWD under this Plan.

The development of potential LWD in riparian areas throughout the Plan Area is relatively predictable. In contrast, the recruitment of potential LWD into the stream (in-channel LWD) is a highly stochastic process which occurs over long time scales. For this reason, the LWD assessment project does not lend itself to be used as measurable thresholds for adaptive management. The conservation measures as a whole are expected to increase potential LWD, and may increase inchannel LWD, over the life of the Plan, and this monitoring project will document whether this expectation is met.

Temporal Scale

The LWD assessments will occur concurrently with the habitat assessment every ten years for the life of the Plan. The next assessment will be in 2004 and 2005. The recruitment of potential LWD into the stream (inchannel LWD) is a highly stochastic process which occurs over long time scales. Detecting increasing trends in potential LWD may require at least 10 to 20 years, and trends in inchannel LWD may become evident in 30-40 years

Spatial Scale

LWD assessments will be conducted throughout the Plan Area. Each assessment reflects the LWD conditions in the particular stream assessed. The stochastic nature and long time scales involved in LWD development and recruitment make it difficult to apply the results from a particular stream to other areas. However, consistent trends observed in assessed streams across the Plan Area would be assumed to reflect conditions in streams which were not assessed.

6.3.5.4.7 Summer Juvenile Salmonid Population Estimates

In 1995 Green Diamond initiated a study designed to estimate summer populations of young-of-the-year coho and age 1+ and older steelhead and cutthroat trout, and to track trends in these populations over time. The number of streams sampled has expanded from three in 1995 to eight in 1999. The population estimate project has served as a pilot study to test and refine a sampling methodology developed by Dr. Scott Overton (Oregon State University, retired) and Dr. David Hankin (Humboldt State University) in conjunction with funding from the Fish, Forests, and Farm Communities (FFFC).

The results to date are summarized in Section 4 and Appendix C. The summer juvenile population monitoring project will continue under the Plan. The sampling methodology has been refined and should require little change in the future, allowing for better comparisons between estimates.

Monitoring Objectives

The objectives of the summer population estimates are to estimate summer populations of young-of-the-year coho and age 1+ and older steelhead and cutthroat trout, and to track trends in these populations over time.

The sampling and process variance associated with the population estimates and the uncertainty related to the possible causes of observed long term trends preclude the use of summer population estimates as measurable thresholds for adaptive management purposes. While changes (positive or negative) in summer population estimates will clearly be a source of interest, it remains unclear what, if any, changes can be related to management. The summer population data, in combination with other monitoring efforts, may provide valuable information about the relationships between coho populations in different streams throughout the Plan Area, and the climatic and/or habitat conditions which affect summer population size. In addition, trends in summer population estimates will be valuable in determining the recovery status of the coho populations within the Plan Area.

In the Little River HPA, the population estimate information will be combined with out-migrant trapping data and spawning surveys in an attempt to understand the mortality associated with specific life-history stages.

Temporal Scale

The summer population estimates are conducted annually, and significant changes in summer population estimates have already been observed on a year-to-year basis within individual streams.

Spatial Scale

Summer population estimates are currently conducted in eight streams, located within 5 of the 11 HPAs. Judging from the results to date, applying the results of these estimates to streams which have not been surveyed may be possible for general trends within a single basin, but is not advisable beyond that. For example, a significantly larger than normal estimate in a tributary of Little River may reasonably be assumed to reflect a larger than average summer population in other tributaries of the Little River as well, but may have no relationship with populations in other Plan Area streams.

6.3.5.4.8 *Out-migrant Trapping*

Background

The out-migrant trapping project is designed to monitor the abundance, size, and timing of out-migrating smolts, and to look for long term trends in any or all of these variables. The results of the outmigrant trapping will be used in conjunction with the summer population monitoring to estimate overwinter survival in the Little River HPA. Eventually this information will be further analyzed to correlate specific habitat conditions with overwinter survival of coho salmon.

The out-migrant trapping of juvenile salmonids was initiated on three tributaries to the Little River watershed in 1999: Upper South Fork Little River, Lower South Fork Little

River, and Railroad Creek, using a pipe trap (Figure C8-1 in Appendix C8.) An additional trap site was established on Carson Creek in 2000 within this same watershed. Each trapped fish was identified by species and year class, and fork length was measured on all fish except 0+ trout. The summarized results are presented in Section 4 and detailed methods and results to date are presented in Appendix C8.

Monitoring Objectives

The objectives of the out-migrant trapping project are to estimate overwinter survival of juvenile coho by comparing out-migrant abundance to the summer population estimates, and to monitor the abundance, size, and timing of out-migrating smolts and look for long term trends in any or all of these variables.

The use of measurable thresholds for adaptive management is not appropriate for this monitoring project, but significant feedback for adaptive management is expected to result from the combined results of the out-migrant trapping, summer population estimates, and information on habitat conditions in the Little River HPA. If and when correlations between overwinter survival or total fish production and specific habitat features or conditions can be made, appropriate management measures to encourage or create those conditions will be implemented throughout the Plan Area. Similar out-migrant trapping projects have been conducted on Mill Creek in Del Norte County (Stimson Timber Co.) and are ongoing in pristine portions of the Prairie Creek watershed in Redwood National Park. The results of these studies will aid in evaluating the suitability of habitat conditions in the Little River.

Temporal Scale

Smolt abundance, size, and timing will be monitored annually. The time required to correlate these results with habitat information and summer population estimates is truly unknown, but will probably require a minimum of ten years due to the high variability observed in both summer population estimates and smolt abundance.

Spatial Scale

Out-migrant trapping is currently being conducted in four tributaries of the Little River. The immediate results will reflect only the smolt production of these four tributaries, which is thought to be the majority of smolt production in the Little River as a whole. In the event that correlations between habitat conditions and smolt production can be made through these studies, the results will be applied throughout the Plan Area to increase smolt production wherever possible.

6.3.5.5 Experimental Watersheds Program

While the majority of the Plan's monitoring projects will be conducted throughout the Plan Area, four experimental watersheds judged to be representative of the different geologic and physiographic provinces across the Plan Area have been designated for additional monitoring and research on the interactions between forestry management and riparian and aquatic ecosystems. Those watersheds are the Little River (Little River HPA), South Fork Winchuck River (Smith River HPA), Ryan Creek (Humboldt Bay HPA), and Ah Pah Creek (Coastal Klamath HPA) (see ***Figure 6-9***).

In general, the program will entail:

- Effectiveness monitoring projects and programs that due to their complexity and expense of implementation can only be applied in limited regions (these include turbidity monitoring, Class III sediment monitoring, and road-related mass wasting monitoring;

- BACI studies of harvest and non-harvest areas, allowing for more effective evaluation of conservation measures and increased understanding of the effects of forest management on the habitats and populations of the Covered Species.

- BACI studies of conservation and management measures, allowing for a refinement of measures and an assessment of the relative benefits of different measures under the Plan; and

- Development and implementation of new or refined monitoring and research protocols.

In addition, Green Diamond may expand Out-migrant Trapping in the Little River HPA to one or more of the other experimental watersheds.

In the program, management will be implemented as a large scale experiment where possible, allowing for more effective evaluation of conservation measures and increased understanding of the effects of forest management on the habitats and populations of the Covered Species. Where possible, harvest with a variety of different conservation measures will be the "treatments" in a BACI experimental design, with an adjacent unharvested area as the control. Specific effectiveness monitoring projects will compare the treatment and control before and after harvest to determine the effectiveness of the conservation measures.

Road-related turbidity and mass wasting monitoring are designed in part to measure the effectiveness of the road management plan's upgrading and decommissioning measures in reducing road-related sediment inputs. For these road-related monitoring projects, the experimental design occurs as monitoring is implemented both spatially and temporally to allow comparisons of road-related sediment inputs before and after road upgrading and decommissioning.

Upgrading and decommissioning the roads as effectively and efficiently as possible is the first priority, therefore monitoring will essentially be conducted "around" the road work schedule. The prioritization process (see Section 6.3.3.) used to schedule the road work will provide the information needed to design an effective monitoring program without slowing the implementation of the road upgrading and decommissioning process. For example, the prioritization table may dictate that, within a specific sub-basin, one road work unit will be upgraded before another. Monitoring could begin in both units before any work is done, and continues while first one, and then the other work unit is upgraded. This experiment would not be conducted in a true BACI design, because Green Diamond will not leave any sub-basins as "controls" in the untreated condition. However, over time it will be possible to make a cumulative comparison of treated versus untreated roads and sub-basins to determine if the road management plan is effective in reducing road-related mass wasting inputs and road-related increases in turbidity.

Green Diamond and CDFG are already implementing an experimental management program in the Little River HPA to assess the relative benefits of two different mitigation measures to protect aquatic resources following timber harvest. A randomized BACI experiment will be conducted in blocks of three streams, wherein the two sets of mitigation measures are viewed as two different treatments with the third stream as a control. During the course of the experiment, both mitigation measures will be applied to an approximately equal number and linear distance of streams. The primary objectives of the study will be to:

- Determine if there are any detectable changes in environmental and biological variables measured on watercourses following timber harvest, and if there are,
- Which mitigation strategy is more effective in reducing negative impacts.

The response variables will be monitored pre and post harvest and will include water temperature, shallow landslide activity, Class III sediment delivery, and potential LWD. Air temperature, relative humidity, wind speed, turbidity, and stream amphibian populations will also be monitored in selected sites.

The development and implementation of new research and monitoring protocol will provide an opportunity for Green Diamond to refine existing conservation measure to make them more effective and efficient. This will include state-of-the-art existing study designs along with original research approaches that will require the input from academic, agency, and private scientists.

No experiment which involves the application of conservation measures other than those prescribed in this Plan will occur without the concurrence of the Services.

6.3.6 Adaptive Management Measures

Adaptive management is an important tool for natural resource management when significant scientific uncertainty regarding appropriate management and conservation strategies is present (Walters 1986). Adaptive management has two key features: 1) a direct feedback loop between science and management, and 2) the use of management strategies as a scientific experiment (Halbert 1993; Walters 1986). Green Diamond's monitoring and adaptive management program incorporates both these features with the goals of increasing our understanding of watershed processes and the effects of management activities on the habitats and populations of the Covered Species over the life of the plan, and adapting the Plan's conservation measures in response to this new information.

6.3.6.1 Triggering and Application of Adaptive Management Measures

The Plan is designed to minimize and mitigate all identified impacts of taking the Covered Species to the maximum extent practicable, based on current knowledge. However, specific conservation measures may change over time as the result of the adaptive management provisions and geologic evaluations of the Plan. Because this is a long-term Plan, and it incorporates a strong monitoring program to confirm the effectiveness of the certain Plan measures, mechanisms to alter certain conservation measures are proposed. Those mechanisms include the adaptive management process working in conjunction with the monitoring program. The adaptive management measures become applicable through the triggering of a “Yellow or Red Light” condition determined through on-going monitoring, the slope stability monitoring, or through the outcome of a designed experiment in one or more of the Experimental Watersheds. Results from on-going monitoring and experiments from the Experimental Watersheds must be conclusive before adaptive management measures become applicable. If Green Diamond believes that is the case, it will convene a Scientific Review Panel to analyze the findings and any other available information to the extent it is relevant to the conservation of the Covered Species in the Plan Area and recommend whether a change is warranted. If the results are not conclusive, further monitoring is required before changes can be made. Adaptive management changes will be subject to the availability of a balance in the AMRA, as described below. Adaptive management changes will be limited to the Plan’s RMZs, SMZs, and specific road management plan prescriptions described below. The widths and prescriptions within RMZs can be modified. In addition, the account will apply to the SMZ default widths and slope gradients after they have been set following the 7-year mass wasting analysis. Prescriptions in SMZs will be evaluated after 15 years of monitoring (see Section 6.3.2 and 6.3.5 and Appendix D for more details), and any subsequent changes will be subject to the AMRA. The upper bound of modifications to RMZs will be limited to the interim measures outlined in the Northwest Forest Plan (up to the balance of the AMRA) and the lower bound will be limited to the State forestry regulations applicable at the time the adaptive management change is made. SMZ prescriptions can range from no cut to even-age management. Specific road management plan prescriptions that can be modified are: increased rate of accelerated road implementation, drainage structure prescriptions and erosion control prescriptions. Just as the biological goals and objectives set forth in Section 6.1 guided the development of the prescriptions set forth in the Plan, Green Diamond will look to the applicable goals and objectives to guide the development of any changes to the prescriptions pursuant to a red light trigger, using the information gained from the monitoring and adaptive management processes.

6.3.6.2 Adaptive Management Reserve Account

As part of the conservation program, the Plan establishes the AMRA to fund the adjustments that may be made during the life of the Plan.

The AMRA will be “charged” with an “opening balance” of 1,550 FSA (FSA), and the AMRA account balance will be factored in FSAs throughout the term of the Plan. If the balance falls to zero through the debit process described below, then no more debits will be made until the account is credited. FSA will be defined as a stand with 42,000 BF/acre (50 year stand with an index of 350 square feet of basal area) and a species composition of 50% redwood, 34% Douglas fir, 10% white woods, and 6% hardwoods. The current California SBE Harvest Value Schedule will be used to translate FSA to equivalent specific road management plan prescriptions. The percentage of SBE harvest categories will be 60% cable yarding, 35% tractor, and 5% helicopter. The AMRA will be used to accommodate changes in riparian protection measures from conclusive results of the monitoring program and experimental watersheds.

Depletion of the AMRA balance by translating FSA to funds for road prescriptions is limited to 2% per year of the opening balance (i.e., the equivalent of 31 FSA). There is no limit to the annual use of the AMRA for RMZ or SMZ modifications. The balance within the adaptive management reserve account will fluctuate proportionately to the addition and deletion of properties.

The current set of riparian measures will be set as the standard for all future comparisons. The areas to be included in SMZs will be determined at the end of the 7-year property-wide geologic review. Any modification of the standard riparian measures, areas included in SMZs or specific road management plan prescriptions (obtained via monitoring, paired watershed analysis or subsequent geologic review) will be credited or debited from the AMRA. For instance, an increase in the width of a zone will debit the balance, and a decrease in a zone width will credit the balance. Debits and credits will be reflected in the account on an on-going basis as the account acres are retained or harvested, and the account will be summarized biennially.

The opening balance of the AMRA (1,550 FSA) was determined based on the amount needed to address risks associated with management prescriptions for SMZs, which Green Diamond estimates will include approximately 8,850 acres. These SMZ acres will be managed using uneven-aged silviculture, which is defined in the Glossary of this Plan as single tree selection. By applying single tree selection, Green Diamond will harvest approximately 65% of the conifer volume on the 8,850 acres. Thus, approximately 35% of the volume will be retained within the SMZs to produce conservation benefits as the Plan is implemented over time. As proposed the prescriptions will represent approximately 3,100 acres (or 0.35 x 8,850 acres) of fully stocked timberland. To reduce the risk of potentially underestimating the protection needs of SMZs, Green Diamond will allow up to a 50% increase in the retained volume in SMZs. In terms of fully stocked acres, this will equate to 1,550 acres (0.50 x 3,100 acres = 1,550 acres) that can be applied to these zones. As mentioned above, the opening AMRA balance of 1,550 FSA may increase or decrease in response to findings through the monitoring programs or through the results from projects in the Experimental Watersheds.

Example of the AMRA fluctuating over time:

1. Facts

    - The opening balance is set at 1,550 acres.

    - A red light consideration in 3 HPAs requires 50’ extra width on class II watercourses. In 2002, this will result in an additional 120 acres being retained, and in 2003 this will result in an additional 160 acres being retained.

    - Paired watershed studies show that Class I watercourses require 25’ less width on all HPAs. In 2002, this will result in an additional 350 acres being harvested; and in 2003, this will result in an additional 400 acres being harvested.

2. At the end of each year, the effect of the adaptive management will be reflected in the AMRA balance, as follows:

    - Opening Balance 2002 1,550 acres
    - Class II debit 2002 (120) acres
    - Class I credit 2002 350 acres
    - Closing Balance 2002 1,780 acres

- Opening Balance 2003 1,780 acres
- Class II debit 2003 (160) acres
- Class I credit 2003 400 acres
- Closing Balance 2,020 acres

6.3.7 Implementation Monitoring Measures

6.3.7.1 Compliance Team and Process

Implementation monitoring will be composed of the following elements:

- An internal compliance team consisting of a Green Diamond Plan Coordinator with assistance from internal forestry, fisheries, wildlife and geologic staff. Documentation indicating compliance with the Plan will be prepared for internal Green Diamond use on every THP and will be kept on file by Green Diamond.

- At the time of submission of a proposed THP to CDF, the Green Diamond Plan Coordinator will provide the Services an informational copy of the THP Notice of Filing and will attach a map of the THP area.

- As appropriate, the Services may provide technical assistance, including during pre-approval THP preparation and review, before Green Diamond carries out covered activities that are subject to evaluation of compliance.

- Pursuant to applicable regulations, the Services may conduct inspections of completed covered activities, including post-harvest THP areas, to evaluate compliance with conservation measures set forth in Section 6.2.

- Biennial reports will be prepared and submitted to the Services. These reports will summarize compliance and the results of effectiveness monitoring. The first Biennial Report will be due on March 1 following the first full year after the effective date of the Plan and every two years thereafter during the term of the Plan.

- Scheduled reviews. There will be annual meetings conducted jointly by representatives of Green Diamond, NMFS, and USFWS for the first five years of the Plan as described in the IA. In the second and fourth years, the annual meeting will be followed up with a field review of implemented conservation measures to allow technical evaluation of conservation measure implementation.

The roles and responsibilities of Green Diamond personnel for compliance with the Plan as part of the timber harvesting process are shown in Figure 6-12.

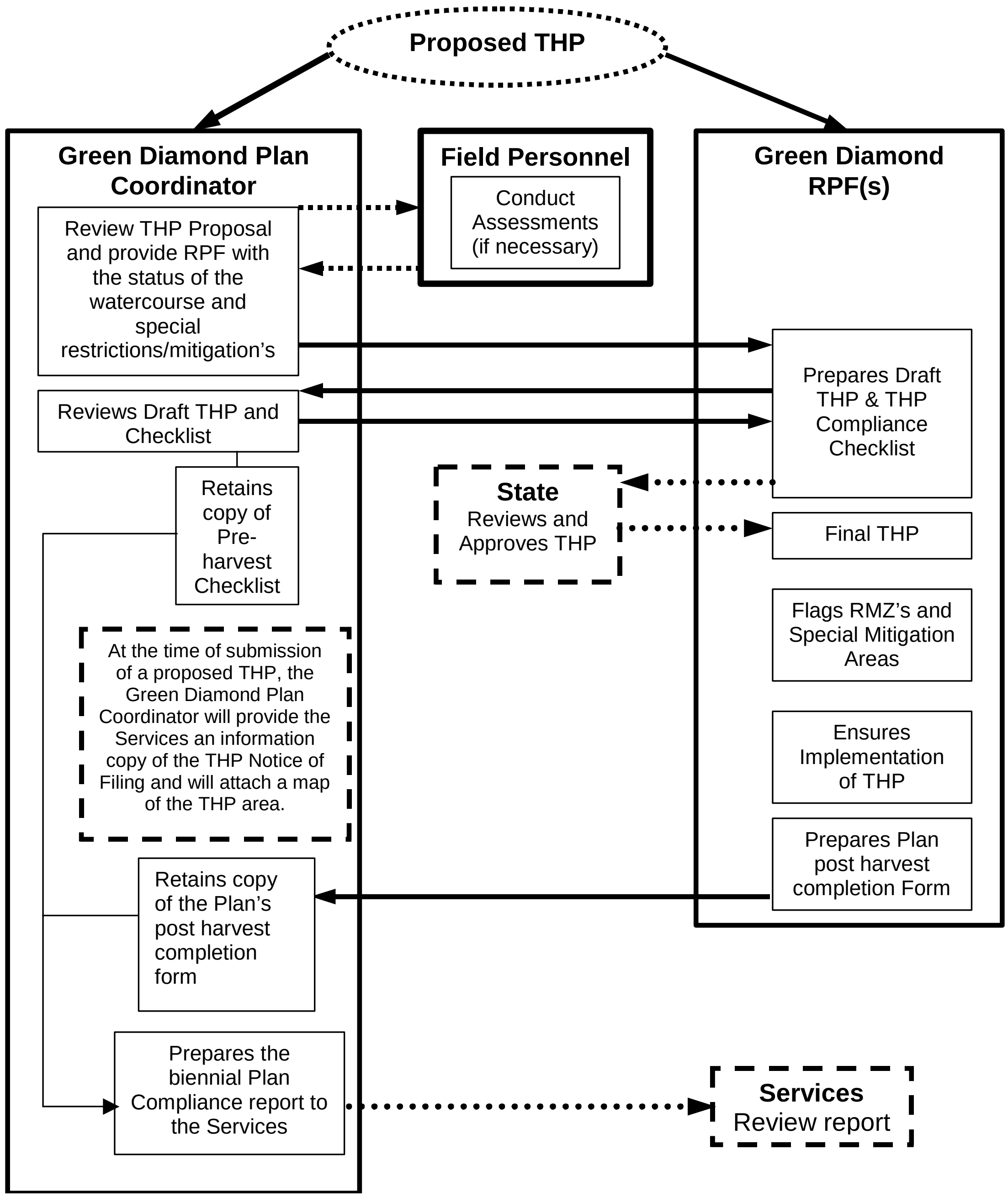


Figure 6-12. Schematic diagram of the internal compliance process for Plan implementation.

Internal compliance with the Plan will be primarily the responsibility of Green Diamond's Plan Coordinator. (A position similar to the HCP Coordinator who maintains compliance for Green Diamond's current successfully operating NSO HCP.) This position will be filled by an academically trained and experienced fisheries biologist/hydrologist or fluvial geomorphologist. The Plan Coordinator will review each proposed THP prior to its development, and inform the RPF preparing the THP on the appropriate status of watercourses in the THP area and the occurrence of any special restrictions and/or mitigations in the area (e.g. unstable slopes, inner gorges or channel migration zones). If there is any uncertainty about the appropriate status of streams (e.g., watercourse classification, presence of amphibians, presence of fish, anadromous or resident species, location of monitoring sites, etc.) or the existence of special restriction/mitigation areas, the Plan Coordinator will direct the appropriate field personnel (e.g. fisheries biologist, geologist or other trained personnel) to do the appropriate field assessment/survey. The RPF preparing the THP or his/her designee will be responsible to flag the appropriate RMZs or other special mitigation areas in the field when additional field expertise is not required. When additional field expertise is called upon by the Plan Coordinator or RPF to delineate some special restriction/mitigation area, the designated expert will be responsible to flag or otherwise designate the appropriate areas that will require special treatment/mitigation.

During development of the THP, the RPF will complete a pre-harvest checklist that will cover all necessary compliance elements for the THP. Following completion of a first draft of the THP, the Plan Coordinator will review the THP for compliance including a review of the checklist for accuracy and completeness. Following state review and approval of the THP, the responsible RPF will insure that the THP is actually implemented as written.

Following completion of the THP, the responsible RPF will fill out a Plan post-harvest completion form documenting compliance of the THP with the provisions of the Plan. The post-harvest completion form will be submitted to the Plan Coordinator who will also review it to insure compliance. The pre-harvest checklists and post-harvest completion forms will be kept as a record of compliance by the Plan Coordinator, and they will be part of the biennial report to the Services.

Scheduled field reviews of implemented conservation measures will be conducted jointly by Green Diamond and the Services biennially for the first four years of the Plan. The purpose of the field reviews will be to evaluate implementation of the Operating Conservation Program. If the Services determine that the Operating Conservation Program is not being implemented in accordance with its terms, then Green Diamond and the Services will attempt to resolve the issue in accordance with Section 6.3.7.1. A summary of the field review and any recommendations that are developed will be included in the biennial report to the Services.

6.3.7.2 "Likelihood of Recruitment" Audit

Green Diamond gathered data to estimate the relative change in potential LWD recruitment before and after harvest, to assess the effectiveness of the RMZ measures in terms of potential LWD recruitment to Class I watercourses (see Appendix B). These data were collected and summarized as changes in 'full tree equivalents' (FTE). The findings from this assessment work demonstrated that the RMZ measures detailed in

Section 6.2.1 of the AHCP/CCAA were effective in minimizing the loss of trees through harvesting practices that would potentially recruit to the stream as LWD. However, the language used to communicate the "likelihood to recruit" judgment may be susceptible to interpretation so to ensure consistent application of this language, the Services may audit the efficacy of the RMZ measures annually, by selecting three to five harvest units and requiring Green Diamond to gather before/after data and calculate an estimate of relative change in FTE. The protocol used in the potential recruitment of LWD report (Appendix B) will be used in any future audits. If the results of the audit indicate that the FTE values were reduced by more than 3.2% post-harvest, then the Services may call a meeting with Green Diamond to recalibrate the interpretation of the likelihood to recruit judgment in the field. The 3.2% post-harvest FTE value reduction is a trigger for recalibration of the interpretation. If an agreement cannot be reached in the recalibration among the Services and Green Diamond, then the dispute resolution provisions of Section 6.3.7.2 will be initiated.

6.3.7.3 Dispute Resolution

Green Diamond and the Services recognize that reasonable differences of opinion may arise from time to time regarding implementation of various elements of the Operating Conservation Program. Should a dispute arise at the technical level, either of the Services or Green Diamond will have the option of calling a meeting to discuss and attempt to resolve the issues at that level. If the Services call a meeting under this provision, Green Diamond would arrange to meet within one month of receiving such notice. Should it be necessary to resolve the issues at a policy level following an initial meeting at the technical level, Green Diamond would arrange to meet at the policy level within one month of receiving a request. Green Diamond would have the right to request meetings for the same purpose and the Services’ commitment to engage in this process will be incorporated in the dispute resolution provisions in the IA. The Service’s participation in this process would be in the nature of providing technical assistance. Green Diamond's and the Services' rights and obligations regarding informal dispute resolution and matters that could be addressed in such a process would remain as provided in the IA. .

6.3.8 Special Project

6.3.8.1 Increased Habitat for Anadromous Salmonids above Nature Barriers

Across the Plan Area, there are a variety of stream reaches that occur above natural barriers to anadromy that appear to have good habitat for anadromous salmonids, particularly coho salmon. Current surveys or anecdotal observations indicate that some of these stream reaches appear to be currently under utilized, or inaccessible by some or all salmonids. Of all the fish Covered Species, coho appear to be generally the lowest in numbers and pose the greatest challenge for enhancement of future habitat conditions. Given the uncertainty and extended time associated with improvements of habitat for coho salmon, Green Diamond will undertake a special project which it anticipates will “jump start” the conservation of this species by increasing the available habitat for spawning and rearing. It is recognized that permanent removal of natural barriers may be logistically infeasible as well as having undesirable and/or unanticipated consequences. It is also recognized that artificial propagation of the species in these stream reaches has the potential to produce undesirable consequences on the genetics and overall biological fitness of local runs. Therefore, Green Diamond will undertake one project to trap and transport coho that are native to the respective stream system around a barrier and allow them to spawn unassisted in the previously unutilized habitat. The project period will be ten years. The goal would be to provide a rapid (within a few years) increase in smolt production of these selected streams while habitat conditions are continuing to improve across the Plan Area. At the end of the ten-year period Green Diamond will review the effectiveness of the project.

It is possible that this same augmentation of available habitat could also be applied to chinook salmon or steelhead, but Green Diamond is committing to only one project. Additional projects will be carried out at Green Diamond's sole discretion, after evaluation of the initial project and the impacts evaluation described below.

Before the initial coho project, or any additional project, is initiated on any stream, the stream will be evaluated in terms of the current use by other salmonids and the potential for negative impacts to any of the other Covered Species. In particular, the area will be assessed for all salmonids to insure that the introduction of coho will not harm or displace a unique population of fish. The project area will also be evaluated in terms of the potential quality and quantity of habitat (spawning, summer and winter rearing) for coho. If the evaluation suggests a high probability of success, the translocation of fish will only involve a small number of adults (probably a maximum of 10-15). These fish will be monitored to insure that they do spawn in the new habitat, and if they spawn, surveys will be conducted to assess the utilization of summer rearing habitat by the juvenile fish. These summer surveys will also allow an assessment of the potential interaction between the translocated population of fish and any resident salmonids. Finally, out-migrant traps will be operated the following winter/spring to document the number of smolts that leave the system.

Potential sites for the initial project have already been identified, with the upper North Fork Mad River being one of the top candidates. There is a barrier low in the sub-basin created by a high gradient reach of step pools and small falls that prevent all access to salmonid anadromy except for a few of the most tenacious and athletic steelhead. The upper North Fork Mad River sub-basin also has resident cutthroat trout, but they appear to occur in relatively low population densities. Above the barrier is approximately 15 miles of suitable habitat of which a portion appears to be high quality coho habitat. The prime coho habitat appears to be very similar to Carson Creek in the Little River system that has been documented to be able to produce more than 1000 coho smolts per mile of stream. Carson Creek also has resident and probably anadromous cutthroat trout, which coexist with coho in high numbers. Given the propensity for cutthroat trout to feed on coho or any other salmonid, Green Diamond believes this translocation of coho would also benefit the resident cutthroat population.

All of the other potential sites that have been identified to date have shorter reaches of suitable habitat above the barrier, but collectively they could represent a substantial increase in habitat for coho across the Plan Area. Some of these other sites also have the added advantage that they do not have resident salmonids that may be impacted by the translocation of coho.

For a more detailed analysis of the special project for increasing habitat for anadromous salmonids above natural barriers see Appendix G.

6.3.9 Measures for Changed Circumstances

The conservation measures in this Plan were designed within the context of the forestland ecosystems in the Plan Area. These ecosystems are dynamic rather than static; they are regularly impacted by various natural physical processes that shape and reshape the habitat for the affected species that occupy those areas. Indeed, the aquatic and riparian species for whose conservation this Plan is crafted evolved in close association with this ever-changing mosaic of natural physical elements.

The natural physical processes that affect the biodiversity and landscape ecology are usually of moderate intensity and relatively confined in geographic extent and magnitude of impact. Nonetheless, natural physical processes have on occasion been of catastrophic intensity, particularly from the standpoint of impact to individual plants and animals. That these natural physical processes can significantly alter aquatic and riparian habitat has been a substantive consideration in the development of this Plan, and the Plan is designed to minimize and mitigate management-related disturbances and create conditions that enable natural disturbances to create productive habitat.

Green Diamond recognizes that the temporal and spatial configurations of future natural disturbances (and their specific related effects on the aquatic and wildlife species covered under the Plan) are inherently unpredictable. The fact that certain types of natural disturbances will occur at some time during the term of this Plan and at some location in the Plan Area is, however, reasonably foreseeable. The conservation measures set forth in the other portions of Section 6 of the Plan were designed, in large part, to be responsive to historic disturbance patterns. Indeed, many of the prescriptions are intended to develop a landscape capable of delivering valuable functions in response to such natural disturbances. Therefore, the occurrence of most natural disturbances will not create conditions that should require the implementation of revised prescriptions.

Certain reasonably foreseeable disturbances, however, may be of such magnitude, occur with such frequency or impact particular portions of the Plan Area as to require the application of supplemental prescriptions for the protection of the Covered Species. These supplemental prescriptions are set forth below.

“Changed Circumstances” will mean the changes in circumstances substantially affecting a Covered Species that are described in this Section 6.3.9. Except as specifically provided in this Section 6.3.9, any other changed circumstances will be adequately addressed by the application of the conservation measures set forth in the other portions of Section 6.2 of the Plan.

Five types of changes are identified in the Plan as potential “changed circumstances” as defined in applicable federal regulations and policies:

1. Fire covering more than 1,000 acres within the Plan Area or more than 500 acres within a single watershed within the Plan Area, but covering 10,000 acres or less;

2. Complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream; but less than 900 feet of trees within an RMZ, due to a windstorm;

3. Loss of 51% or more of the preharvest total tree basal area within any SSS, headwall swale, or Tier B Class III watercourses as a result of Sudden Oak Death or stand treatment to control Sudden Oak Death;

4. Landslides that deliver more than 20,000 cubic yards and less than 100,000 cubic yards of sediment to a channel; and

5. Listing of a species that is not a Covered Species but is affected by the Covered Activities.

As described in this subsection, Green Diamond also has considered the potential for floods and earthquakes to have effects that would constitute “changed circumstances.”

6.3.9.1 Fire

6.3.9.1.1 The Role of Fire in Coastal Northern California

Fire is a significant agent in determining forest structure in the coastal Northern California region, but its effects, intensity, and frequency vary considerably. Although it is possible to generalize that fire is an important element of forest ecology in the region, it is not possible to specify the temporal or spatial effects of fire for any given area, since fires are not distributed uniformly through time, the areas affected often differ markedly, and the intensity and scale vary considerably.

The fire history of Coastal Northern California is reasonably well-documented for the last 1,000 years (from tree ring counts) but prior to that only inferences can be made based on charcoal in core samples from bogs and lakes and other paleoecological evidence. Fritz (1931) describes ring counts between fire scars on over 100 redwood stumps in a 31 acre area of Humboldt County. His counts include 45 or more fires during an 1100 year period. He reports major fires in 1147, 1595, 1789, 1806, and 1820. Various other studies estimating fire history within the region have not been able to agree on actual dates of occurrence. The most common dates reported for large fires have been 1640, 1700, 1745, 1894, and 1974 (Abbott, 1987). Differences in conclusions can be attributed to the various ways fire occurrences are estimated as well as differences within areas examined for fire history, although all agree that redwood forests are not burning nearly as often today as they were in the pre-settlement era. Many smaller fires have burned in the region since settlement but none have been of the magnitude represented by these large fires which appear to have been driven primarily by climatic variation.

Research by Veirs (1980, 1982) using tree age distribution in old growth redwood forest suggests that fires which significantly influenced stand composition and age distribution occurred at 250 to 500 year intervals in moist, coastal sites. Intervals for intermediately moist sites were reported as 100 to 250 year intervals while summer dry, interior sites at higher elevation were in the range of 33 to 50 year intervals. These fires were most commonly reported as surface fires burning under story fuels with little canopy involvement. Fires in redwood dominated forests will generally kill the thin barked trees and shrubs, however larger redwood and Douglas-fir survive due to the insulating effect of their thick bark. Similar research since these studies found low intensity ground fires to be common in Douglas-fir forests, with maximum fire free intervals of 35 to 90 years (Wills 1991).

In addition, other studies have examined the correlation of fire intensity to fire size, as well as the typical size of fires in coastal northern California and the Klamath Mountains. Stuart (1987) found that fire size was not correlated with fire frequency while using basal sprouts to determine fire frequency and estimate the area burned by fires just south of the Plan Area. One estimate for mean fire size in this study was reported as 4,319 acres (+/- 299 ac. SE) for the post European settlement period. CDF fire records reviewed by Stuart and Fox (1993) for the same area of Humboldt County from 1940 to 1993 report 30 fires ranging in size from 247 acres to 4,416 acres. These averages are less than the fire that occurred within the Plan Area in 1988, which burned over 6,000 acres of the Klamath property. Another report on fires in the Klamath Mountains (Taylor and Skinner 1998) documents lightning strikes in 1987 and 1994 that burned a total of 240,838 and 27,181 acres, respectively. Approximately 25% of the Plan Area is representative of a more inland, dryer vegetation type which is subject to these larger burn estimates.

In light of this analysis, it is not reasonably foreseeable that large-scale, stand-replacing fires (i.e., a fire covering more than 10,000 acres) will occur in the Plan Area during the life of this Plan. Thus, such fires are unforeseen circumstances and it is unnecessary to provide for new, different, or additional conservation measures based on the possibility that such events could occur. Certain supplemental procedural prescriptions, however, will be applicable in the event of smaller fires.

6.3.9.1.2 Fire – Supplemental Prescriptions

Fire suppression is not a Covered Activity. However, Green Diamond might take all measures reasonably necessary to extinguish a fire less than 10,000 acres, including measures that deviate from the Section 6.2 conservation measures, if one occurs during the term of the Plan. The strategy for responding to and suppressing forest fires is generally established by CDF, and Green Diamond may have little ability to influence such strategy. However, to the extent reasonably possible and where consistent with the primary goal of containing and extinguishing the fire, Green Diamond will encourage the development of a fire-response strategy that is consistent with the Section 6.2 conservation measures and that furthers rather than diminishes the functions that such measures have been designed to provide.

If the fire involves more than 1,000 acres within the Plan Area, or involves more than 500 acres within a single watershed within the Plan Area, Green Diamond will provide both Services with information regarding the fire within 30 days. Once such a fire is extinguished, unless such fire is an “unforeseen circumstance” as defined above, Green Diamond will apply the following supplemental prescriptions on its fee-owned lands within the Plan Area:

- Trees damaged or killed outright by fire, including those in riparian and stream side management zones, will be considered by Green Diamond for salvage. Removal of standing dead or damaged trees and downed trees will be conditioned by the application of the conservation standards in Section 6.2 regarding likely to recruit and salvage within RMZs.

- Salvage of trees downed or dead by fire must comply with state law. In addition, the conduct of any salvage operations within an RMZ or SMZ will be done with reasonable care to minimize soil erosion, to retain structural features that contribute to bank or slope stability, and to retain standing dead trees that will contribute to the recruitment of LWD to watercourses within the area affected by the fire.

- Reforestation of any RMZ or SMZ affected by the fire will be implemented as soon as reasonably possible.

6.3.9.2 Wind

6.3.9.2.1 The Role of Wind in Coastal Northern California

Topography determines where the strongest winds within a region are found, such as ridge tops or orientation of slope to wind direction. Forest stands that are most endangered by wind are those growing on slopes exposed to winds that blow unobstructed across broad expanses of water or flat terrain. When wind passes up over a ridge or mountain range, its passageway is constricted from below and speed is accelerated. Wind damage associated with topography can be common on windward slopes. However, as the slopes increase in steepness, damage is often worst just leeward of the ridge crest due to gusty downbursts of air that take place in a turbulent zone on the lee sides of the crests. Wind can cause damage to trees by breakage or the uprooting of stems, which is due to compression failure of stems or roots on the leeward sides of trees. Different soil types provide limitations to rooting, and therefore can influence the amount of wind throw. The greater the mass of soil adhering to the root system the more wind firm the tree becomes. Another resistive force to wind throw can be attributed to support given by adjacent crowns. Contact between tree crowns is common in maturing even aged stands of conifers, and reduces the vulnerability to intense gusts, which cause sway and oscillation leading to blow down or mechanical damage.

Stem damage, canopy damage, volume losses, and mortality are categories of damage that can occur and are generally classified by severity. They can have an effect on the structure of the stand, influence future growth and yield, or reduce lumber value. Understory trees may be susceptible to indirect damage from other trees falling on them while larger trees are more likely to sustain direct damage, such as a broken top. Previous mechanical damage to trees may increase subsequent wind damage, while continued exposure may prevent any healing or recovery from damage. Leaning, or trees bent more than 40° from vertical, as well as pinned trees that are bent by other stems, are effectively damaged and will reduce the volume obtained from the stand at rotation.

Average wind speeds are light over much of the Plan Area, although strong winds are occasionally experienced in connection with migrant storms that move across the area during the winter. Since the major river valleys generally extend in a northwest to southeast direction, the prevailing wind direction for much of the Plan Area is dominated by this feature. Southwest or northeast winds only occur where local valleys run in this direction or along the coast where the mountain influence is less pronounced. A study of Eureka data over a 3-1/2 year period indicated that wind was from a northwest or north direction 29% of the time and from a southeast or south direction 19% of the time. Winds from the southeast prevail from November through March and from the north or northwest from April through October. Wind speeds of 40 to 50 mph can be expected once every two years, on average, while speeds of 80 to 90 mph occur about once in 100 years. The most damaging winds are from the southerly quarter and are associated with the approach of cyclonic storms. Historic winds accompanied major storms in 1955, 1962, and 1964.

Small-scale windthrow is not expected to have a long-term significant adverse impact on stream shading or water temperatures and will have the beneficial effect of introducing large woody debris into streams that currently lack this habitat-forming element. Thus, small-scale windthrow does not pose so substantial an impact as to threaten an adverse change in the status of any Covered Species, and may actually benefit aquatic species through natural modifications to stream habitat. Based on historical experience within the HPAs, a windstorm that results in a complete blow-down of 900 feet or more, measured along the length of the stream, of trees within an RMZ, however, is not reasonably foreseeable, and would be considered an unforeseen circumstance.

6.3.9.2.2 Windthrow – Supplemental Prescriptions

If a windstorm results in a complete blow-down of more than 150 feet of previously standing timber within an RMZ, measured along the length of the stream, Green Diamond will provide both Services with information regarding such windthrow within 30 days of its discovery. With respect to such windthrow, unless the windstorm constitutes an "unforeseen circumstance" as defined above, Green Diamond will apply the following supplemental prescriptions within the Plan Area:

- Other than trees that are downed or dead due to the wind, Green Diamond will not be allowed to remove more timber than it would have been allowed to remove under the other portions of Section 6.2 had no windthrow occurred in the stand, unless the Services determine that the removal of such additional timber would not materially reduce the functional benefit of such habitat for any Covered Species.

- Salvage of trees downed or dead by wind must comply with state law. In addition, the conduct of any salvage operations within an RMZ or SMZ will be done with reasonable care to minimize soil erosion, to retain structural features that contribute to bank or slope stability, and to retain standing dead trees that will contribute to the recruitment of LWD to watercourses within the area affected by the windstorm.

- Reforestation of any RMZ or SMZ affected by the windstorm will be implemented as soon as reasonably possible.

6.3.9.3 Earthquakes

The Plan Area is located in an area that is well known for frequent, but generally small, earthquakes. The surface trace of the Cascadia Subduction Zone San Andreas fault is offshore within 25 miles of most of the Plan Area and numerous smaller, less-significant faults are found throughout the region. Because earthquakes are quite common, they are generally of a relatively insignificant magnitude, typically magnitude 2 to 3 on the Richter scale. Occasionally, greater magnitude events occur, but they are impossible to predict.

In April of 1992, three earthquakes of magnitude 6 or greater on the Richter scale occurred in relatively short succession. These earthquakes produced ground shaking to cause incidental damage to some structures in the region. However, in the forest environment, earthquakes of magnitude 6 or less on the Richter scale produce little, if any, visible change, and apparently no significant impact to wildlife or fishery habitat.

It is possible that some trees have fallen as a result of earthquake activity, however fallen trees in the forest are generally attributed to wind or landslide effects. Regardless of cause, fallen trees in the forest are not of so significant a number as to require additional mitigations and/or changes in the management scenario or restrictions outlined in this Plan.

While it may be speculated that localized landslides or other earth movements resulted from these earthquakes, there are no data to document that this occurred within the Plan Area. Landslides caused by earthquakes will be addressed pursuant to the "Landslide" subsection of this Changed Circumstances Section.

Thus, earthquakes of such magnitude (greater than magnitude 6 on the Richter scale) that may substantially alter habitat status or require additional conservation or mitigation measures in excess of those already included in the Plan, are not reasonably foreseeable during the life of the Plan, and would be considered “unforeseen circumstances.” Landslides caused by earthquakes and other natural phenomena are addressed below.

6.3.9.4 Flood

Floods are a natural and necessary component of aquatic and riparian ecosystems. For example, floods transport and sort sediment, deposit fine sediments, organic materials and chemical nutrients onto flood surfaces, recruit large woody debris, and scour pools and create other beneficial aquatic habitats. Changing river courses also periodically provide opportunities for the establishment of new riparian stands. Alluvial terraces along river valleys provide ideal growing conditions for hardwood and conifer stands and are one of the most dynamic vegetative mosaics in the forested landscape. The Plan recognizes the dynamic nature of channel networks and accounts for the effects of floods by, among other things, prohibiting salvage in flood plains or channel migration zones in Class I RMZs.

The Plan Area is a region of moderate temperatures and considerable precipitation. Rainfall can be experienced each month of the year, although amounts are very light during the summer. Most of the precipitation occurs associated with winter storms that move inland from the Pacific. Total seasonal precipitation can exceed 100 inches at some points in the northern part of the area and decrease to less than 40 inches near Eureka. The Plan Area is traversed by a number of streams that generally flow northwest as they traverse Del Norte and Humboldt Counties. Major drainages include the Smith River, Klamath River, Trinity River, Redwood Creek, Mad River, Little River, and Eel River.

Floods can cause damage to forest transportation systems (e.g. watercourse crossings, bridges, roads). Floods can also cause damage to forest stands by undermining trees, washing out soil from around the roots, or softening the soil and causing trees to fall. Likewise, floods also suffocate roots by reducing available oxygen in the rooting zone.

The frequency with which floods occur and their relative magnitude are inversely related. Large floods are infrequent while smaller floods can go unnoticed and may recur as often as once every year. Severe floods may occur once in 15 or even 100 years. Existing gauging station records provide evidence of historic floods in 1861 and 1955 that were equal in magnitude but less damaging than that of December 1964, which is noted as the most severe flood ever recorded in California history. Two other floods, possibly similar in magnitude to that of 1964, occurred around 1600 and 1750. The latest intense flood occurred in 1997, and was the result of a large rainstorm preceded by a month of heavy rainfall.

A flood that is of lesser magnitude than a 100-year recurrence interval event (i.e., less than a 100-year flood) is part of the expected normal ecology of the forest. The conservation measures in the other portions of this Section 6 are adequate mitigation for such an event. Based on historical evidence in the Plan Area, a flood that is equal or greater in magnitude than a 100-year recurrence interval event is not reasonably foreseeable during the term of this Plan, and thus it would be considered “unforeseen circumstance.”

6.3.9.5 Pest Infestation

6.3.9.5.1 Insects and Disease

Insects and diseases can usually be kept under control through careful forest management and proper treatments. Natural control of insects can take place through climatic conditions, parasites, or predators via biological control. Integrated pest management (IPM) uses ecological principles to be effective, practical, economical, and protective of human health and environment while controlling pest infestation. By definition, IPM employs known practices, new ideas, policy considerations, treatment techniques, prediction, monitoring, and decision making to work together with the least amount of impact on the environment while providing silvicultural, biological, and chemical control. Defoliators, borers, bark beetles, and various terminal and root feeders, along with sucking insects are common types of insects in California forests. However, large outbreaks are uncommon to the redwood forest type since redwood has no known pests that cause damage or reduce growth and survival. Many problems with pests result from growing trees in habitats to which they are not adapted, or are off-site.

Site quality and nutrient availability play a key role in forest health and vigor. Since much of the Plan Area is of high site quality, infestations are less likely to occur within the healthy forests that occupy these sites. Likewise, many infestation problems can be linked to introducing exotic species, which become new hosts for pests. Tree species introduced outside their natural range may flourish for a time and then suffer serious attack as they encounter difficulties with pests native to the new habitat. Similarly, introduced pathogens can lead to the decline of native tree species. One example is Port-Orford-cedar (POC) root rot caused by *Phytophthora* spp. This pathogen is at chronic levels within portions of the four northern-most HPAs and its effect is to diminish the presence of live POC in the riparian areas. Under a worse case circumstance, as infected trees die the niche they occupied becomes colonized by other forest tree species. As a consequence of natural replacement of POC by other species the disease is not expected to have a measurable adverse effect on the Covered Species or on the functional attributes of the Plan.

Infestation by generally recognized types of forest pests or pathogens would not be expected to have significant adverse effects on the Covered Species within the Plan

Area and are not considered changed circumstances. A possible exception is the recently identified sudden oak death disease caused by *Phytophthora ramorum*. Supplemental prescriptions were developed for this pathogen and will be applied if this disease becomes prevalent within the Plan Area (see supplemental prescriptions below). The conservation measures in other portions of Section 6 provide adequate mitigation for other pest invasions, but a pest invasion that results in a significant impact on the Covered Species would be considered to be an "unforeseen circumstance." An infestation of sudden oak death that crosses to redwood or other conifers could have a significant effect on the forest ecosystem within the Plan Area; however, such an event that could actually have a significant impact on the Covered Species is not reasonably foreseeable, and thus it would be considered an "unforeseen circumstance."

6.3.9.5.2 Pest Infestation – Supplemental Prescriptions

On SSSs, headwall swales and along Tier B Class III watercourses, if 51% or more of the total basal area is lost as a result of Sudden Oak Death or through stand treatment to control the disease then prior to any harvesting of such areas, on site review will be made by a PG and RPF to develop additional prescriptions to compensate for the loss of hardwood root strength through retention of additional conifers.

6.3.9.6 Landslides

6.3.9.6.1 The Role of Landslides in Coastal Northern California

Landslides are known to have local and often significant impacts on the physical character of stream habitat and their biological communities. However, landslides and earthflows of many dimensions and driving processes are a natural part of the forested landscape in the Pacific Northwest, replenishing channels with gravel and wood derived from valley slopes and tributary systems (Bench 1990). Without the catastrophic transfer and replenishment of these materials, the habitat of streams in this region ultimately simplifies, supporting fewer species and a less diverse fish community (Reeves et. al. 1995). Thus while the short term effects of landslides can devastate local populations of aquatic vertebrates, landslides and their legacies can actually serve to preserve and perpetuate the habitat that they require and support long term persistence of metapopulations. This Plan is expected to reduce management related landslides and develop forest conditions that enable natural landslides to deliver sufficient quantities and quality of wood for the creation of productive stream habitat.

Landslide rates and processes differ in the various geologic settings across the Plan Area. In the Coastal Klamath and Blue Creek HPAs, shallow rapid landslides are the most common kinds of landslides, whereas the upstream portions of the Mad River HPA is pervasively underlain by deep seated landslides and earthflows. Still other HPAs are subject to both deep seated landslides and shallow landslides. These different landscapes with their particular mass wasting processes present varying sensitivities to management activities. Conservation and mitigation measures within this Plan were designed to address sediment and other habitat effects from past landslides, to take advantage of future naturally-occurring landslides, and through a combination of stream buffer prescriptions, land management restrictions, slope stability analyses, and stream monitoring, to avoid significant adverse impacts from management related landslides and mass wasting events in the future.

Generally, landslides that cause alteration of the instream habitat condition in any watershed are part of the ordinary ecology of the forested landscape and are adequately addressed by the existing conservation and mitigation measures. Based on historic experience within the Plan Area, a landslide that results in the delivery of more than 100,000 cubic yards of sediment is not reasonably foreseeable, i.e. an unforeseen circumstance.

6.3.9.6.2 Landslides –Supplemental Prescriptions

If a landslide results in the delivery of more than 20,000 cubic yards of sediment to a channel (either from a source area or from combined source area and propagated volumes), Green Diamond will provide both Services with information regarding such landslide within 30 days of its discovery. With respect to such a landslide, and unless this landslide constitutes an "unforeseen circumstance", i.e. delivery of more than 100,000 cubic yards, Green Diamond and the Services will confer to determine if it is reasonably possible that management activities on or adjacent to the area of the landslide could have materially contributed to causing such landslide. If either Service or Green Diamond concludes that it is reasonably possible that management activities materially contributed to the occurrence of such a landslide, Green Diamond, at its own expense, will retain a qualified geo-technical expert to analyze the slide and develop a written report. The report will include, at a minimum, an assessment of the factors likely to have caused the slide and any changes to management activities which had they been implemented on or adjacent to the area of the slide would have likely prevented the slide from occurring. Upon receipt of such a report, Green Diamond will forward the report to the Services. Where appropriate, the recommendations set forth in the report may form the basis for adaptive management changes to the SSS conservation measures under Sections 6.2.2 of this Plan.

6.3.9.7 New Listing of Species that are Not Covered Species

6.3.9.7.1 Changed Circumstance.

The preamble to the No Surprises rule states that the listing of a species as endangered or threatened could constitute a changed circumstance. Therefore, if a species is listed under the federal ESA subsequent to the effective date of the Permits, and that species (i) is not a Covered Species, and (ii) is affected by the Covered Activities, such listing will constitute a changed circumstance herein.

6.3.9.7.2 Supplemental Prescriptions

Where a new listing that constitutes a changed circumstance occurs, Green Diamond will follow the procedures set forth in the IA.

6.3.10 Measures for Unforeseen Circumstances

Unforeseen Circumstances will include those changes in circumstance identified as “unforeseen circumstances” in Section 6.3.9 but will not include any other changes in circumstances described in Section 6.3.9. In the event that Unforeseen Circumstances occur, modifications to the Plan will be made only in accordance with the procedures set forth in the IA.

This page intentionally blank.

Section 7. Assessment of the Conservation Strategy's Effectiveness in Fulfilling the Plan's Purposes

7.1 INTRODUCTION

This Section of the Plan discusses the expected effectiveness of the operating conservation strategy in fulfilling the Plan's purposes of coordinating and facilitating Green Diamond's compliance with the federal ESA and providing the Services with the bases for authorizing Green Diamond to take Covered Species pursuant to an ITP and an ESP.

The analysis in this Section extends the assessment in Section 4 of the current conditions for the Covered Species in the area where the Plan will be implemented and the general assessment in Section 5 of the potential impacts of Covered Activities that may result in take and the types of effects that such take may have on Covered Species. This Section examines the effects of Covered Activities on habitat conditions and Covered Species with the Plan in place, the potential for those effects to result in actual take of Covered Species, the effectiveness of the conservation strategy in avoiding take wherever possible and, where it occurs, minimizing and mitigating its effects on the listed Covered Species, and the effectiveness of the conservation strategy in providing early conservation benefits for the unlisted Covered Species. The analysis also addresses how the conservation strategy meets the ITP and ESP requirements identified in Section 1.2.1. Specifically, this Section considers the following:

1. With regard to ITP requirements:

    a. Does the Plan minimize and mitigate, to the maximum extent practicable, the impacts of any incidental take of the Covered Species that could result directly from the Covered Activities or indirectly from the environmental effects of such activities?

    b. Does the Plan ensure that any such taking will not jeopardize the continued existence of the Covered Species?

2. With regard to ESP requirements:

   a. Would the benefits of the Plan for the ESP Species, when combined with the benefits for those species that would be achieved if it is assumed that conservation measures also were implemented on other necessary properties, preclude or remove any need to list those species? (The CCAA policy defines “other necessary properties” as those other properties, in addition to those that are the subject of the CCAA, on which conservation measures would have to be implemented in order to preclude or remove any need to list the covered species.)

   b. Does the Plan ensure that the probable and indirect effects of any authorized take will not appreciably reduce the likelihood of survival and recovery in the wild of any species?

Generally, the Plan achieves these requirements by one or more of the following:

1. Avoiding an environmental “effect” that could cause take and result in impacts of taking,

2. Minimizing or mitigating a specific impact with specific measures designed to do so (both in nature and extent of impact), and/or

3. Providing other conservation benefits to the Covered Species.

Although the take avoidance and “minimize and mitigate” standards are legally applicable only to the ITP Species, the Plan applies both to the ESP Species as well. Application of these standards to the ESP Species helps to ensure that jeopardy is avoided. Moreover, the minimization and mitigation measures are themselves “conservation” measures that help to provide the early benefits for ESP Species as called for in the CCAA policy. Likewise, the ITP Species benefit from the measures applied for the conservation benefit of ESP Species; and such conservation benefits go beyond those required to minimize and mitigate the impacts of taking and avoid jeopardy to the ITP Species.

In addition to the measures designed to avoid or address specific impacts, the Plan includes measures designed to improve conditions for the Covered Species and/or their habitats overall. These additional measures provide a level of mitigation over and above the anticipated impacts of taking. Examples include the road decommission and upgrade measures (and the accelerated implementation of the measures) and the LWD recruitment measures. In addition, Green Diamond has proposed a special project: the fish bypass project that would open up anadromy to coho on one of the Mad River tributaries. While no “mitigation” credit is claimed for the project at this point, it could provide significant conservation benefits to the species if it proves successful. In any case, the information and insights gained from the project will provide a contribution toward the conservation of the Covered Species.

The conservation benefits provided by the additional measures also provide extra confidence that the Plan meets and in some cases exceeds the ITP and ESP standards that apply to each identified impact. Stated another way, the extra measures supply added assurance that a sufficient level of conservation is being provided to address any concern about the sufficiency of any particular measure to address the extent of a particular type of impact. Furthermore, the improvement in conditions that will result from these measures over and above that needed to meet the ITP “minimize and mitigate” standard will assure the achievement of properly functioning habitat and thereby contribute both to the recovery of the ITP Species and to efforts to preclude or remove the need to list the ESP Species.

The analysis that follows describes in detail how individual measures in the AHCP/CCAA will serve to:

1. Avoid take of the Covered Species within the Plan Area wherever possible, and

2. Where incidental take would occur,

    a. Avoid, minimize or mitigate the specific potential impacts of taking the ITP and ESP species caused by the Covered Activities within the Plan Area to the maximum extent practicable,

    b. Contribute to conservation benefits which, when combined with those benefits that would be achieved if it is assumed that the conservation measures also would be implemented on other necessary properties, would preclude or remove the need to list currently unlisted ESP Species in the future; and

    c. Avoid jeopardy to any Covered Species resulting from authorized take.

All possible impacts (individual and cumulative) of taking that may occur are examined, together with their relative significance to each species by category and in relation to all potential impacts and measures. Conservation benefits for all Covered Species are addressed in the evaluation of impacts and measures, with benefits for each ESP Species also summarized in a separate subsection for CCAA purposes.

7.2 TAKE AVOIDANCE, IMPACT MINIMIZATION AND MITIGATION, AND PROVISION OF CONSERVATION BENEFITS

This subsection analyzes the effectiveness of the Plan’s conservation strategy in terms of avoiding take of Covered Species wherever possible and minimizing and mitigating impacts of authorized take to the maximum extent practicable. The analysis is organized by category of environmental effect on Covered Species and their habitat from Covered Activities as identified in Section 5:

- Potential for altered hydrology
- Potential for increased sediment input (overview)
- Potential for increased sediment from surface erosion
- Potential for increased sediment from mass wasting

- Potential effects on LWD recruitment
- Potential for altered thermal regimes and nutrient inputs
- Potential effects of barriers to fish and amphibian passage
- Potential for direct take from use of equipment

As discussed in Section 5, a number of potential causes of take and their resulting impacts were determined not to require HCP-specific conservation measures. In some cases, a particular cause of take or potential impact identified in Section 5 was determined not to be potentially significant on Green Diamond's ownership based on a site- or ownership-specific analysis,. In other cases, existing regulatory regimes ensure that the environmental effect that could result in take is sufficiently addressed and either mitigated adequately or avoided altogether. The latter also reflects another aspect of the Plan's purpose. As noted in Section 1, the Plan is intended to assist Green Diamond in meeting other legal mandates--such as protecting water quality in compliance with the Porter-Cologne Water Quality Control Act, and mitigating or avoiding all significant individual and cumulative environmental impacts of timber harvest under CEQA.

7.2.1 Potential for Altered Hydrology

7.2.1.1 Potential for Take and Other Impacts

The hydrology of a watershed is controlled by many complex interacting factors. Increases in runoff and peak flows could result from harvesting activity and road construction (either from individual harvesting activities or from the combined effects of multiple harvesting operations in a watershed that are temporally or spatially related). Such increases in runoff and peak flows could in turn cause some taking of Covered Species. Increased runoff in the early part of the rainy season could provide marginal benefit to the Covered Species by reducing water temperatures and providing more flow for migrating spawners. However, a harvesting-related increase in peak flow could increase the frequency that storm events mobilize channel substrates and damage developing eggs and alevins in redds and amphibian larvae and adults. Increased peak flows could also affect the survival of over-wintering juvenile salmonids by displacing them out of preferred habitats. Displacement of juveniles could cause take if the displacement impairs individual sheltering needs to the extent of killing or injuring individuals. In addition, increased peak flows and concentrated surface runoff could increase sediment input through mass soil movement. (See Section 6.3.2 for a description of how the conservation measures address increased sediment input.)

The impacts of such taking could include decreased survival rates and increased mortality in the early life stages of the Covered Species and cause temporary declines in their local populations.

7.2.1.2 Plan Measures and Strategy

As proposed, the Conservation Program's Riparian Management and Slope Stability Measures will act to reduce or avoid the impacts of altered hydrology and therefore avoid take or minimize and mitigate the impacts of any taking that results from altered hydrology (see Section 6.3.1) to the maximum extent practicable and contribute to conservation efforts benefiting ESP Species.

7.2.1.2.1 Existing Limits on Potential Impacts

The California FPRs have become increasingly restrictive over time, so Green Diamond considers the conservation benefits of the current rules as the base case. The Plan's conservation measures will augment existing FPRs that constrain the timing, location, and intensity of timber harvesting operations, and thus limit the hydrologic effects that might result from such operations. There are three rule Sections that are the primary sources of these constraints: those dealing with canopy retention along watercourses (14 CCR 916 et seq.), those restricting the size and spacing of even-aged management harvest units (14 CCR 913.1(a)(3) and (4)(a)), and those limiting harvest rotation age (14 CCR 913.1(a)(1) and 913.11 et seq.).

Under existing FPRs that define watercourse protection zone widths, in concert with provisions of the NSO HCP, approximately 12% (48,800 acres) of Green Diamond's ownership in the 11 HPAs is in riparian buffers. These Watercourse and Lake Protection Zones include no-cut areas within a defined riparian management zone and a minimum 70% post-harvest canopy retention outside of those zones. The net effect is that any hydrologic effect from "management" of this portion of the land base would be insignificant to non-existent.

The potential for even-aged management to alter hydrologic regimes is further constrained by FPRs that place strict limits on:

- The size of even-aged management units, which can be no more than 20 acres for ground-based yarding systems, 30 acres for aerial and cable systems, and 40 acres when justified according to specified criteria;

- The distance between even-aged management units, which must be "separated by a logical logging unit that is at least as large as the area being harvested or 20 acres, whichever is less, and shall be separated by at least 300 feet in all directions"; and

- The timing of the harvest of contiguous even-aged management units, which cannot occur unless regenerating stand in a previously harvested, adjacent clearcut unit is at least five years of age or five feet tall, and three years of age from the time of establishment on the site. (The net effect of this rule is that four to seven years must elapse between initiation of timber harvesting operations on adjacent even-aged management units, depending on how long it takes to complete timber harvesting operations and reforestation efforts and the growth rate of subsequent regeneration on the site.)

Long-term planning of timber harvesting operations in large tracts of mature timber in compliance with these temporal and spatial constraints becomes a complex challenge. The terrain typical of north coast forests, the need to consider road placement, appropriate logging systems, and other operational constraints, as well as varying stand ages and species compositions add complexity to the planning and further constrain Green Diamond's harvest schedule, meaning that it is not even possible to harvest at the pace that the minimum acreage, timing and spacing constraints would, in theory, allow. Even with the most optimistic operational assumptions, Green Diamond's planning efforts have demonstrated that the net effect of these constraints is that large tracts (~ 2000 acres) of relatively homogeneous rotation-aged timber cannot be completely harvested in less than 25 years, assuming a steady demand for forest products. Larger tracts typically encompass a range of both mature and younger age-classes that will extend this hypothetical cut-out period to near rotation age length.

Pursuant to the provisions of 14 CCR 913.11(a), which imposes requirements relating to Maximum Sustained Production, Green Diamond has an approved plan that limits its even-aged harvests to 50 year and older age classes. This provision further limits the frequency with which the hydrologic characteristics of any site can be altered. Even though intermediate treatments such as pre-commercial thinning and commercial thinning may result in transitory and minor changes in the hydrologic regime, this constraint on rotation age ensures that many decades of full hydrologic recovery follow any even-aged timber harvesting operation. Also, restrictions on the size and spacing of even-aged management harvest units, described above, effectively constrain the rotation age on many harvesting units well past the 50 year age class, with some stands reaching to 70 years of age or more before harvest, thus lengthening the cycle of disturbance significantly. Accordingly, existing requirements and Green Diamond's planning regime significantly limit the potential for increased runoff and peak flows and limit the risk that take could result from them.

In addition, measures proposed in this Plan will help to avoid take and, where take could occur as a result of harvest-related increased runoff and peak flows, minimize and mitigate the impacts of such taking and thereby contribute to conservation efforts benefiting the currently unlisted Covered Species.

7.2.1.2.2 Riparian Management Measures

The riparian measures specify no salvage in the inner zone of Class I and II watercourses and salvage in outer zone if non-functional criteria are met. This conservation measure maintains in-channel LWD and allows for further recruitment of downed LWD from the RMZ which will increase overwintering habitat for juvenile salmonids. The increased pool habitat will help avoid displacement or minimize the effects of displacement of juvenile salmonids caused by peak flows. The amphibian species do not necessarily benefit directly from the creation of pool habitat. The LWD in headwater streams function primarily to create suitable riffle habitat through the storing and sorting of sediment and to dissipate hydraulic energy during peak flows.

The riparian conservation measures were also designed to increase LWD recruitment though enhanced widths and canopy retention standards. On Class I watercourses and the first 200 feet of a Class II watercourse where it enters a Class I watercourse, no trees that are judged likely to recruit will be harvested. Over time, this conservation measure will increase the amount of LWD in streams, which will ultimately increase overwintering habitat for juvenile salmonids. Large woody debris recruitment will mitigate the impacts of displacing Covered Species that results from altered hydrology by providing increased habitat alternatives for juveniles that are displaced during a storm event.

7.2.1.2.3 Slope Stability Measures

Most past road related failures on steep streamside slopes are generally attributed to perched road fill loosely sidecast on steep slopes or concentrated road runoff discharging onto the fill. The slope stability conservation measures for SSS zones avoid building new roads or substantial upgrading on these features without the evaluation of a registered geologist. Upgrading or decommissioning of roads on SSS will address areas with perched unstable fill and sites with concentrated road runoff on fill material.

A benefit of tree retention with regard to slope stability on deep-seated landslides, headwall swales, and SMZs is the maintenance of forest canopy, which will preserve some measure of rainfall interception and evapotranspiration. Although these benefits of tree retention cannot be readily modeled across the entire Plan Area, such maintenance of rainfall interception and evapotranspiration is expected to contribute to acceptable slope stability conditions in some locations through partially mitigating high ground water ratios that may be management related.

7.2.1.2.4 Road Management Measures

Through the road upgrading and decommissioning program, the road network will be hydrologically disconnected from the watercourses. Inboard ditches collect surface runoff and intercept subsurface flows, then quickly route the water (and sediment) to streams, if hydrologically connected, thereby potentially producing higher and early peak flows. Through the use of decreased cross-drain and rolling dip spacing, and outsloping, as specified in the Road Plan, the amount of concentrated surface runoff at any point will decrease. The ditch water will be dispersed onto the forest floor where it can infiltrate and reduce the effects of increased peak flow caused by the road network.

Both the road management and decommissioning measures will significantly reduce the impacts of any operations-related altered hydrology by reducing the magnitude of peak flows and reducing the volume of sediment available for runoff during such events.

7.2.1.2.5 Harvest-related Ground Disturbance Measures

Timber harvest activities that compact or disturb the soil can reduce the infiltration capacity of soils and alter the process of subsurface water movement. Soil compaction can increase surface runoff and increase the rate which runoff reaches the watercourses as compared to subsurface flow. Site preparation measures are designed with seasonal operating limitations and minimized use of tractor-and-brushrake piling which can cause soil compaction during saturated soil conditions. There are also seasonal limitations for ground-based yarding operations with tractors, skidders, and forwarders which are intended to minimize soil compaction and risk of sediment delivery to watercourses. These Harvest-related Ground Disturbance Measures will significantly reduce the impacts of any operations-related to altered hydrology by minimizing soil compaction which can increase the magnitude of peak flows and the volume of sediment available for runoff during such events.

Altogether, these measures will work to minimize take of individuals of the Covered Species that could result from harvest-related increases in runoff and peak flows. Further, these measures will, to the maximum extent practicable, minimize and mitigate the impacts of any taking that may result from altered hydrology in the Plan Area and will contribute to conservation efforts benefiting ESP Species. They will reduce runoff and sediment transport, reduce the impacts of peak flow, reduce the amount of individual displacement that occurs during large storm events and improve the alternative habitat available for individuals that are still displaced during storm events. These measures will improve conditions over those that exist before the Plan, thereby contributing to the development and maintenance of properly functioning habitat for the Covered Species.

7.2.2 Potential for Increased Sediment Inputs

7.2.2.1 Potential for Take and Other Impacts

As described in Section 5.3, increased sediment inputs can reduce the quality of aquatic habitats for all six Covered Species through reduced depth of deep water habitats (primarily pools), increased embeddedness of gravel and cobble substrates, and the effects of chronic turbidity on the Covered Species.

7.2.2.2 Plan Measures and Strategy (Overview)

Green Diamond's conservation measures are designed in part to avoid taking that could be associated with increased sediment inputs related to the Covered Activities, by minimizing erosion and sediment-causing activities. However some potential exists for take of the Covered Species as the result of management related increases in sediment input. Therefore, the Plan provides for additional sediment reductions, beyond minimization measures associated with the Covered Activities. In particular, the Plan proposes to reduce the potential for existing sediment sources—legacy road conditions--to deliver sediment to Plan Area watercourses. The Road Management Measures relating to existing sediment sources will provide additional mitigation and compensation for take-related impacts to the Covered Species.

Green Diamond's operations under the Plan will reduce management-related sediment input into the stream network with the result of reducing associated impacts of increased sediment on the Covered Species. The conservation measures that will contribute to the sediment input reduction and associated reduction in impacts to Covered Species will be Riparian Management Measures, Slope Stability Measures, and Road Management Measures. The Riparian Management Measures and Slope Stability Measures are designed to reduce potential harvest related sediment inputs into the stream network through tree retention on slopes adjacent to watercourses and in MWPZs. The Road Management Measures are designed to reduce potential road related sediment inputs into the stream network, which represents a significant percentage of the sediment budget for most managed watersheds, through road repairs and upgrades.

7.2.2.3 Plan Measures and Strategy for Surface Erosion

Sediment production from erosion of hillslopes is assumed to be most important with regard to the sediment budget on slopes that are adjacent to watercourses, although erosion does occur higher on the hillslope and within harvest units. Eroded sediment can be delivered to watercourses through gullies or rills or through sheet transport processes.

The RMZ harvest prescriptions and harvest-related ground disturbance prescriptions described in Section 6.2.1/6.3.1 and 6.2.4/6.3.4, respectively, will reduce management related surface erosion and contribute to decreased sediment loads, which is intended to mitigate the possible effects of management related sediment input on the Covered Species.

7.2.2.3.1 Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. Class II watercourses will have a minimum RMZ width of 70-100 feet with 85% overstory canopy retention in the inner zone (30 feet) and 70% on the remaining outer zone. Tier B, Class III watercourses will have an EEZ width of 50 feet with 100% hardwood retention and one conifer per 50 feet of stream length. These retention standards, with the inherently associated understory retention, will ensure that there will be almost no loss in total forest canopy in the inner RMZ along Class I and II watercourses and greatly increased canopy along Class III watercourses. This canopy coverage will impede grain detachment in these critical areas, where detached sediment would have relatively short transport distances to reach watercourses.

In addition to the canopy requirements, general RMZ conservation measures such as the limitations on equipment in the RMZs (EEZs), seeding and mulching of areas of ground disturbance larger than 100 square feet in Class I and II RMZs, and limitations on site preparation in RMZs and EEZs will also contribute to mitigating the effects of timber harvest on erosion processes on hillslopes that are adjacent to watercourses by preventing and remediating harvest related exposure of bare mineral surface soil.

Retention of trees that are judged to be critical to maintaining bank stability along Class I, II, III (Tier B) watercourses and retention of trees with roots that act as control points in Tier B Class III watercourses will contribute to mitigating accelerated bank erosion and down-cutting by maintaining a live root network that will increase total cohesion in the surface soil.

Other RMZ conservation measures, such as retention of trees that are likely to recruit and restrictions on salvage logging, may also contribute to mitigating the effects of management related increased sediment loads on the Covered Species to the extent that those trees and that downed wood do actually recruit to fish bearing watercourses. The beneficial role of large woody debris, boulders, and bedrock outcrops in creating channel structure are widely known and well documented (Bisson et al. 1987, Lisle 1986, Grant et al. 1990).

7.2.2.3.2 Harvest-Related Ground Disturbance Measures

The conservation measures outlined in the Harvest-Related Ground Disturbance section are specifically designed to minimize management related surface erosion. In particular, there are time period restrictions on silvicultural and logging activities when operations conducted during those time periods have a greater risk of sediment delivery to watercourses. Harvesting activities generally result in some level of ground disturbance. The time period restrictions allow those harvest activities with relatively low ground disturbance (and associated low risk of surface erosion), such as certain ground based yarding (not requiring constructed skid trails) and skyline and helicopter yarding, to be conducted during the winter period. Those harvest activities that can create more ground disturbance (e.g. skid trail construction, mechanized site preparation) are limited to the summer period only, with some activities (e.g. ground based yarding with tractors, skidders or forwarders) extending into the early spring or late fall, as well, if certain favorable climatic conditions occur. In addition, harvest related ground disturbances and exposure of bare mineral soil within harvest units will be minimized by way of carefully designed site preparation methods, limiting use of ground based yarding equipment that require constructed skid roads to slopes less than 45% (with some exceptions), preferential use of cable yarding systems versus ground based yarding systems, and water-barring of cable corridors where necessary. Evaluation of existing skid trails that have the potential to divert a watercourse and cause gully erosion or surface erosion will be evaluated on a site specific basis for repair during THP layout. All of these harvest related ground disturbance conservation measures will contribute directly to minimize management related surface erosion potential within harvest units by reducing harvest related ground disturbance and exposure of bare mineral soil.

Sediment production from the erosion of road surfaces is addressed in Section 6.2.3 and 6.3.3.

7.2.2.4 Plan Measures and Strategy for Mass Wasting

As discussed in Section 6.3.2, the slope stability conservation measures are twofold. First, the Plan includes default prescriptions. Second, the Plan provides for establishment of site-specific alternatives to the default prescriptions. These measures are designed to achieve the following conservation benefits.

Sediment production from mass wasting is most significant in riparian management zones (RMZs), steep streamside slopes, headwall swales, and active deep-seated landslides, as discussed in Sections 4.2, 5.3, and 6.3.2. These areas, with the exception of RMZs, are collectively referred to as Mass Wasting Prescription Zones (MWPZs) and are subject to specific slope stability conservation measures that are intended to reduce landslide occurrences and sediment production from landslides.

7.2.2.4.1 Slope Stability and Riparian Management Measures

The Slope Stability Measures will require tree retention in MWPZs, which areas are regarded as the most important with regard to sediment production from landslides. In SMZs, single tree selection harvest will be the most intensive silvicultural prescription permissible without geologic review. The RSMZ is no cut in the Coastal Klamath and Blue Creek HPAs. For the rest of the HPAs, the inner RSMZ band for Class I and Class II-2 is no cut and 85% canopy retention on the outer band. SSSs along Class I watercourses will be a maximum slope distance of 150 feet in the Smith River HPA, 475 feet in the coastal Klamath HPA, and 200 feet in all other HPAs. SSSs along class-II watercourses will be a maximum slope distance of 100 feet in the Smith River HPA, and 200 feet in all other HPAs. EEZs along Tier B, Class III watercourses will require retention of all hardwoods and an average of one conifer per 50 of stream length, plus all trees that are judged to be critical to bank stability. In high-risk headwall swales that are field verified as Shalstab areas, selection harvest will be the most intensive silvicultural prescription permissible. Active deep-seated landslides will be prescribed limited areas of 100% tree retention above their scarps and on the lower portions of their toes. Also, road construction and reconstruction will be limited in MWPZs.

Tree retention in the MWPZs is expected to maintain a network of live roots that will preserve total soil cohesion and contribute to acceptable slope stability conditions in these areas. Another benefit of tree retention with regard to slope stability is the maintenance of forest canopy, which will preserve some measure of rainfall interception and evapotranspiration. Although these benefits of tree retention cannot be modeled in a simple and practical manner across the entire Plan Area, such maintenance of rainfall interception and evapotranspiration is expected to contribute to acceptable slope stability conditions in some locations through partially mitigating high ground water ratios that may be management related.

Limited road construction and reconstruction in MWPZs is intended to avoid and reduce the undercutting and overburdening of sensitive hillslopes and also avoid unnatural concentration of storm runoff to these slopes. Additional road related conservation measures pertaining to road cut and road fill failures as well as watercourse crossing failures are discussed in Sections 6.2.3 and 6.3.3.

The Slope Stability Measures are intended to reduce management related landslide occurrences and contribute to decreased sediment loads, which is intended to mitigate the possible effects of management related sediment input on the Covered Species and the impacts of take from mass-wasting events.

The default slope stability prescriptions are based on a presumption that (a) carrying out harvest-related activities on any unstable feature that meets the AHCP/CCAA definitions poses a certain level of environmental risk to Covered Species (e.g., as a result of causing movement of the unstable area and delivery of sediment from unstable areas to watercourses) and (b) applying the default prescription to harvesting activities on that feature provides a sufficient level of risk avoidance or mitigation of such impacts to the Covered Species. The AHCP/CCAA also provides for the development of site-specific alternatives based upon unique site conditions that would minimize the risk of sediment delivery and provide a level of protection for Covered Species that equals or exceeds that provided by the default prescription. In other words, the alternatives would be designed to achieve the same conservation objective as the default. Therefore, applying the alternative will achieve protection and conservation benefits for Covered Species that is equal to or better than that provided by the default prescriptions.

These measures will minimize and mitigate impacts of any authorized taking resulting from mass wasting associated with Covered Activities to the maximum extent practicable, will contribute to the maintenance and development of properly functioning habitat in the Plan Area, and will contribute to conservation efforts benefiting ESP Species. The relative benefits of the minimization and mitigation of the impacts of mass wasting for the ESP Species compared to ITP Species is discussed in Section 7.5 below.

7.2.2.5 Plan Measures and Strategy for Road-Related Sediment

Road related erosion and mass wasting is known to be a significant contributor to the sediment budget in most managed watersheds. Eroded sediment can be delivered to watercourses through gullies or rills or through sheet transport processes from roads or through mass wasting. The Road Management Measures described in Section 6.2.3 and 6.3.3 will reduce road related sediment production.

7.2.2.5.1 Road Management Measures

The Road Management Measures will classify roads by necessity of use, prioritize road work units and site specific repairs, improve standards for road repairs and upgrades, improve standards for watercourse crossing and culvert repairs and upgrades, improve standards for temporary and permanent road decommissioning, and require personnel training program, all of which are described in Section 6.3.3. These and other road-related conservation measures will reduce road related sediment production, which is intended to partially mitigate the possible effects of management related sediment inputs into the stream network on the Covered Species.

Green Diamond has performed an analysis pertaining to the road-related sediment sources on its current ownership in the HPAs that would require treatment (e.g., stabilization of soil or other remediation to prevent road-related sediment-producing failures or mass wasting events). Green Diamond has categorized road sites that could require treatment into high, moderate, and low priority sites (based on the both the probability of delivery to watercourses and the sediment volume associated with such delivery). Green Diamond has estimated the volume of potential sediment associated with high and moderate sites to be approximately 6,440,000 cubic yards (see Appendix F). As part of the Road Management Measures, Green Diamond will carry out a road decommissioning and upgrading that ensure treatment of all of the high and moderate priority sites over the term of the Plan in order to avoid their potential delivery to riparian and aquatic areas. In addition, Green Diamond will provide for the expenditure of $2.5 million per year for the first 15 years of the Plan in order to accelerate implementation of the high and moderate priority site treatments. In Green Diamond's experience, the sites that will be treated pursuant to the Road Management Measures are located throughout the watersheds. To varying degrees, all the Covered Species are "downslope" from sites that will be treated; the Road Management Measures will therefore benefit all of the Covered Species with the relative benefit dependent on their different locations in the watershed.

Based on the original estimate of 6,440,000 cubic yards of sediment requiring treatment, $2.5 million/year for 15 years will result in approximately 47.5% of the overall volume being treated in the first 15 years of the Plan. This 47.5% equates to 3,057,000 cubic yards of sediment that could have otherwise delivered to streams on or adjacent to Green Diamond's ownership being removed within the first 15 years of the Plan. Accelerating the road-related sediment treatment of high and moderate sites will also decrease the rate of potential sediment delivery on an annual basis (Figure 7-1). This figure (and Figure F3-1) shows the road-related sediment component asymptotically approaching 3,000 cubic yards during the last decade of the Plan. This implies that the Road Management Measures will be 96.1% effective in controlling sediment associated with high and moderate priority treatment sites (See Tables F3-13 and F3-14, Road Upgrade Effectiveness Factor in Appendix F3).

The Road Management Measures will minimize and mitigate any impacts of take of Covered Species that may result from Covered Activities associated with Plan Area roads and will contribute appropriately toward conservation efforts intended to preclude or remove the need to list a currently unlisted Covered Species in the future. In addition, these measures will provide a significant benefit to all the Covered Species by significantly accelerating the natural recovery of the stream network and related habitats that may be negatively impacted by road-related impacts of prior management activities.

7.2.2.6 Plan Measures and Strategy for Minimizing Reduced Bank Stability

Erosion and mass wasting of watercourse banks can result from management operations. This can be in part due to increased peak flow intensity and duration as well as the reduction of root reinforcement of total soil cohesion. General riparian conservation measures are expected to partially mitigate the potential for stream bank erosion and instability.

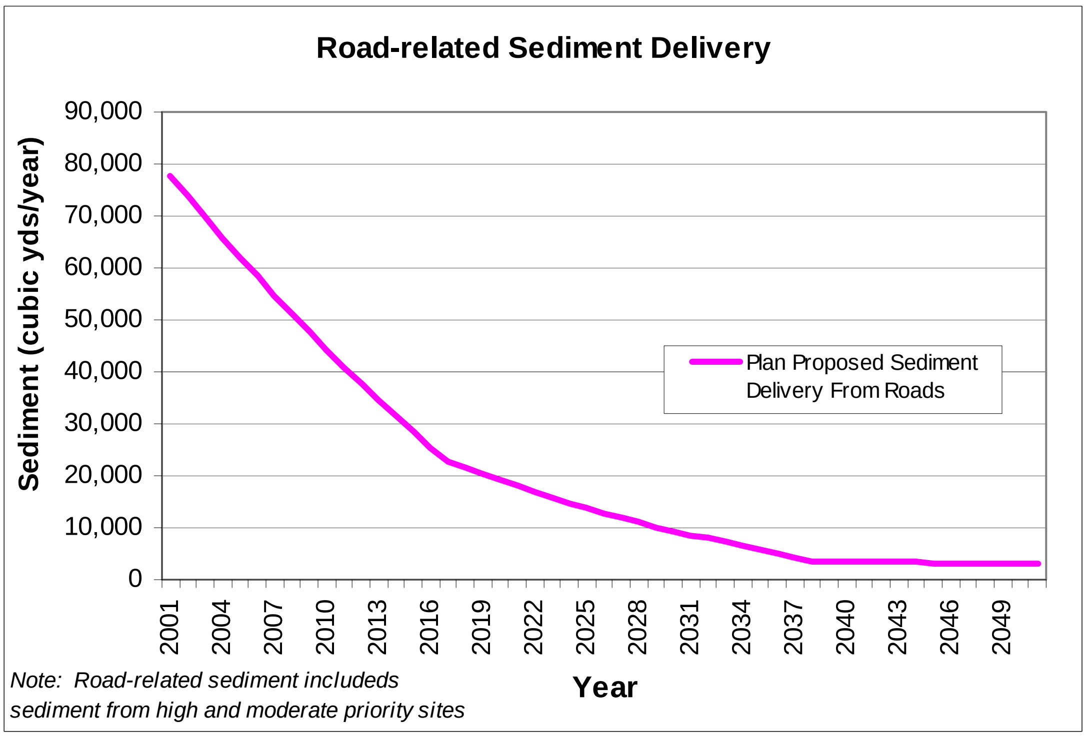


Figure 7-1. Sediment production estimates over the term of the Plan.

7.2.2.6.1 <u>Riparian Management Measures</u>

The riparian conservation measures for Class I and II watercourses that require 85% canopy retention in the inner RMZ and prohibit harvesting of trees that are likely to recruit, as well as the conservation measures for tier B Class-III watercourses that require retention of trees that are judged to be critical to maintaining bank stability and that act as stream control points will ensure that removal of trees and reduction of root reinforcement of soil shear strength is minimized to an acceptable level. These measures are expected to mitigate management related sediment inputs from stream bank instability, which is intended to contribute to mitigating the possible effects of increased sediment input to the stream network on the Covered Species.

Green Diamond has performed an assessment pertaining to proportional volume of sediment from various sources within the Plan Area that is likely to be delivered to the stream network under the Plan (see Appendix F). The aggressive road treatment program and other conservation measures will result in accelerated benefits with respect to sediment delivery to the stream network and the possible related adverse affects to all the Covered Species.

7.2.3 Potential Effects on Recruitment of LWD

7.2.3.1 Overview

Green Diamond's operations under the Plan will minimize and mitigate impacts associated with loss of LWD. The measures that will contribute here will be the Riparian Management measures and certain Slope Stability measures. Maintenance of riparian management zones (RMZs) provides several biological and watershed functions. In addition to functions such as maintaining the riparian microclimate and providing nutrient inputs, one of the most important functions of the RMZs is to provide for the recruitment of LWD. As noted in Section 5, LWD is recognized as a vital component of salmonid habitat. The physical processes associated with LWD include sediment sorting and storage, retention of organic debris, and modification of water quality (Bisson et al. 1987). The biological functions associated with LWD structures for the salmonid species include important rearing habitats, protective cover from predators and elevated stream flow, retention of gravels for salmonid redds, and regulation of organic material for the in-stream community of aquatic invertebrates (Murphy et al. 1986; Bisson et al. 1987). Decreased supply of LWD can result in increased vulnerability to predators, reduction in winter survival, reduction in carrying capacity, lower spawning habitat availability, reduction in food productivity and loss of species diversity (Hicks et. al. 1991 as cited by Spence et. al. 1996).

In headwater streams, LWD, which can be functional at much smaller sizes, is known to dissipate hydraulic energy, store and sort sediment, and create habitat complexity (O'Connor and Harr 1994). Creating and providing cover for pools, a primary function of LWD for salmonids, may contribute limited conservation benefits to the headwater amphibian species since torrent salamanders and larval tailed frogs prefer riffle habitats (Diller and Wallace 1996 and 1999; Welsh et. al. 1996). The primary benefit of LWD to the amphibians is the creation of suitable riffle habitat through the storing and sorting of sediment. In addition, LWD will often form a dam composed of coarse sediment and small woody debris through which water percolates. In streams that are otherwise too embedded with fine sediments to be used by torrent salamanders, this appears to form the only habitat that still supports the species (Diller, pers. comm.). There is circumstantial evidence that these same sites are utilized for egg laying by tailed frogs, but searching such sites is too destructive to adequately investigate the phenomenon (Diller, pers. comm.).

7.2.3.2 Potential for Take and Other Impacts

Green Diamond does not remove LWD from watercourses or salvage from the inner zone of RMZs. In Green Diamond's view, as defined in the ESA, incidental take is not caused by the harvesting of standing trees that are potential sources of future LWD (i.e., trees located in a position that, if left in place, could grow to a sufficient size to perform LWD functions when they are recruited into a watercourse).

Harvesting that results in a failure to allow long term natural recruitment of wood for future habitat would not cause a "take" as it does not constitute a significant habitat modification or degradation which actually causes the death or injury of fish or wildlife by significantly impairing essential behavioral patterns (any injury that might occur would be so far into the future as to be speculative). Nevertheless, Green Diamond recognizes that such an action has the potential to result in potentially significant long term negative impacts other than "take" on future habitat conditions and the ability of the local salmon stocks, steelhead, cutthroat trout, and, to a lesser degree, the amphibians, to maintain and recover. In addition, Green Diamond has identified certain areas within the Plan Area that are relatively low in functional LWD as a result of past harvesting practices (e.g., complete harvest in riparian areas, extensive removal of in-stream LWD).

Long term reductions in LWD can result in less stream complexity and reduce the amount of high quality rearing habitat for salmonids and other fish species. LWD in a watercourse provides a sediment storage and sorting function that benefits both fish and amphibian species. A decline in pool density, pool depth, in-stream cover, and gravel retention are likely to result from LWD losses. Harvesting practices that result in low levels of LWD may, accordingly, impact the growth, survival, and total production of the Covered Species.

7.2.3.3 Plan Measures and Strategy

For purposes of developing and prioritizing conservation measures for this Plan, Green Diamond has (a) addressed the potential environmental impacts of removing possible sources of future LWD as if they are comparable in relative significance to the potential impacts of actual take and (b) included in the proposed conservation strategy a number of measures designed to minimize and mitigate these impacts and contribute significant conservation benefits to the Covered Species.

7.2.3.3.1 Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. However, probably the most important measure relative to the potential recruitment of LWD is that no trees will be harvested that are judged likely to recruit. There are a variety of criteria that will be used to make this judgment including, but not restricted to, distance from the stream, direction of the lean, intercepting trees and potential for stream undercutting.

The abundance and distribution of LWD in a stream is a function of six fundamental variables: tree growth, tree mortality, bank erosion, mass wasting, stream transport and decay. Since all of these factors are likely to vary from one region to another and some of the variables are difficult to estimate over large areas (e.g. relative contribution of LWD through tree mortality, windthrow, bank erosion and mass wasting), predicting future supply of LWD in a stream is highly problematic. A potential solution is to simplify the process by using site potential tree height with windthrow and tree mortality as the only recruitment mechanisms. Using this approach, the potential future recruitment of LWD can be crudely estimated based on a variety of different published source-distance curves for coarse woody debris (Murphy and Koski 1989; McDade et al. 1990; Van Sickle and Gregory 1990; Reid and Hilton 1998). The different studies generated source-distance curves based on both empirical and model-based studies from different regions and it is difficult to know which curve would be most applicable to Green Diamond's region. Reid & Hilton (1998) were chosen as being the most appropriate for this region and did the evaluation built around a "median" source-distance curve. Six variables were considered in the evaluation: RMZ inner zone width, RMZ total width, managed potential tree height, site potential tree height, site index 100, and site index 120. A minimum buffer width of 150 feet used was with inner zones of 50 and 70 feet on Class I watercourses and an inner zone of 30 feet on Class IIs with total RMZ widths of 70 and 100 feet. For Class I watercourses, the total RMZ provided for 99 and 88%, respectively, of the total potential recruitment for managed and site potential tree height for site index 100. For site index 120, the attainment was 98 and 84%, respectively, for managed and site potential tree height. (There was no difference in the estimate attainment for 50 versus 70 foot inner zones.) On the second order Class IIs (100 foot total RMZ width), the attainment was 95 and 73%, respectively, for managed and site potential tree height for site index 100, and 90 and 67%, respectively, for site index 120. On the first order Class IIs (70 foot total RMZ width), the attainment was 85 and 57%, respectively, for managed and site potential tree height for site index 100, and 78 and 52%, respectively, for site index 120.

However, this analysis does not account for the fact that most of the trees that will be harvested are those on the outer edge of the riparian buffer that have the lowest potential to be functional in the stream since only the upper portion of the tree would reach the stream. Excluding geologic processes (see below), the riparian conservation measures will insure that all the trees with the greatest potential for significant LWD function (e.g. LWD recruited by fluvial processes, windthrow or tree mortality with sufficient size and proximity to the stream that it can influence fluvial processes and provide cover for fish) will be retained. The small proportion of trees that will be harvested within the RMZs will not only have a very low probability of contributing significant LWD to the stream, but by removing some trees, the surrounding trees should have increased growth with even greater potential functionality in larger Class I watercourses. Therefore, Green Diamond concludes that the riparian conservation measures for Class I watercourses will provide for fully functional LWD recruitment rates and may actually enhance LWD recruitment compared to natural rates from no cut buffers.

As noted above, LWD performs many similar functions in Class II watercourses, but also has some unique functions in Class II watercourses, particularly in the smaller headwater streams. The piece size that is functional tends to decrease as the stream and associated hydraulic energy of the stream decreases. In addition, pool habitat, which is probably not a limiting habitat type for the amphibians, is more likely to be formed by bedrock and boulders in small confined channels. Finally, there is little evidence for a reduction of LWD in most Class II watercourses in the Plan Area. Instead, past logging practices may have resulted in an overabundance of LWD in many of these smaller streams. As a result, LWD recruitment is less of a conservation priority in these streams and much of the benefit of the Class II RMZ is thought to be for the maintenance of microclimate and bank stability. Even so, it is still important that there are adequate sources of LWD for these channels into the future.

As described above, using an analysis of managed and site potential tree height with windthrow and tree mortality as the only recruitment mechanisms, the minimum buffer width of 70-100 feet on Class II watercourses will reduce the total number of potential trees recruited by an estimated 5-48% relative to maximum potential rate depending on the RMZ width and other assumptions made. However, this analysis does not take into account the mechanism by which LWD becomes functional in 1st and 2nd order channels (most Class II watercourses). These channels often have an inner gorge feature with a distinct break in slope, which limits recruitment of trees from outside this zone. Trees from outside the inner gorge often end up spanning the channel and do not reach the streambed until they have completely decayed. In contrast, trees that are growing close to the channel and/or within the inner gorge have much greater potential for at least some portion of the tree to be incorporated into the channel. Green Diamond's headwater amphibian studies also indicate that small woody debris is often functional in Class II watercourses. Most of the smaller material comes from tree branches and roots, which originate from trees near the watercourse. Therefore, even though the buffer widths provide for approximately 5-48% of the potential maximum recruitment, we believe the majority of the functional LWD will be provided by the Class II RMZs along with maintaining bank stability and the riparian microclimate (see Appendix C1).

The preceding discussion of future LWD recruitment potential from RMZs has focused on the proportion of trees that will be available for recruitment, but it is also necessary to assess both the number (density) and size of trees that will be retained in the RMZs. As part of the riparian conservation measures, there will only be a single entry into RMZs to harvest trees during the term of the Permits for both Class I and II watercourses. Only a small proportion of the trees within RMZs will be harvested (85% retention in inner zone and 70% in the outer), and those remaining will continue to age following removal of the adjacent stands. Therefore, the future age of RMZs can be projected, based on the current age of RMZs at the time the Plan is being developed.

Figure 7-2 indicates that RMZs will be increasing in age throughout the term of the Plan, so that by the end of the permit period over one third of the stands comprising the RMZs will be greater than 100 years old and the remainder will be between 51-100 years. Given that the level of harvest will be lighter than a commercial thinning, good growing conditions are expected for trees in the RMZs following harvest of the adjacent stand. At age 100 in a typical RMZ in the redwood zone, there will be approximately 120 trees per acre, with 12% of the trees > 36" DBH. A few trees will exceed 48" DBH and the tallest trees in the stand will be about 170 feet tall. Under exceptional conditions (little competition, very good soils, lots of light, water and nutrients) a 100 year old redwood can exceed 5 - 6 feet in diameter. In the more interior Douglas fir/hardwood zone, growth will not be quite as rapid, but there will be approximately 130 trees per acre, with 6% of the trees > 36" DBH. An occasional tree will exceed 48" DBH and the tallest trees in the stand will be about 180 feet tall.

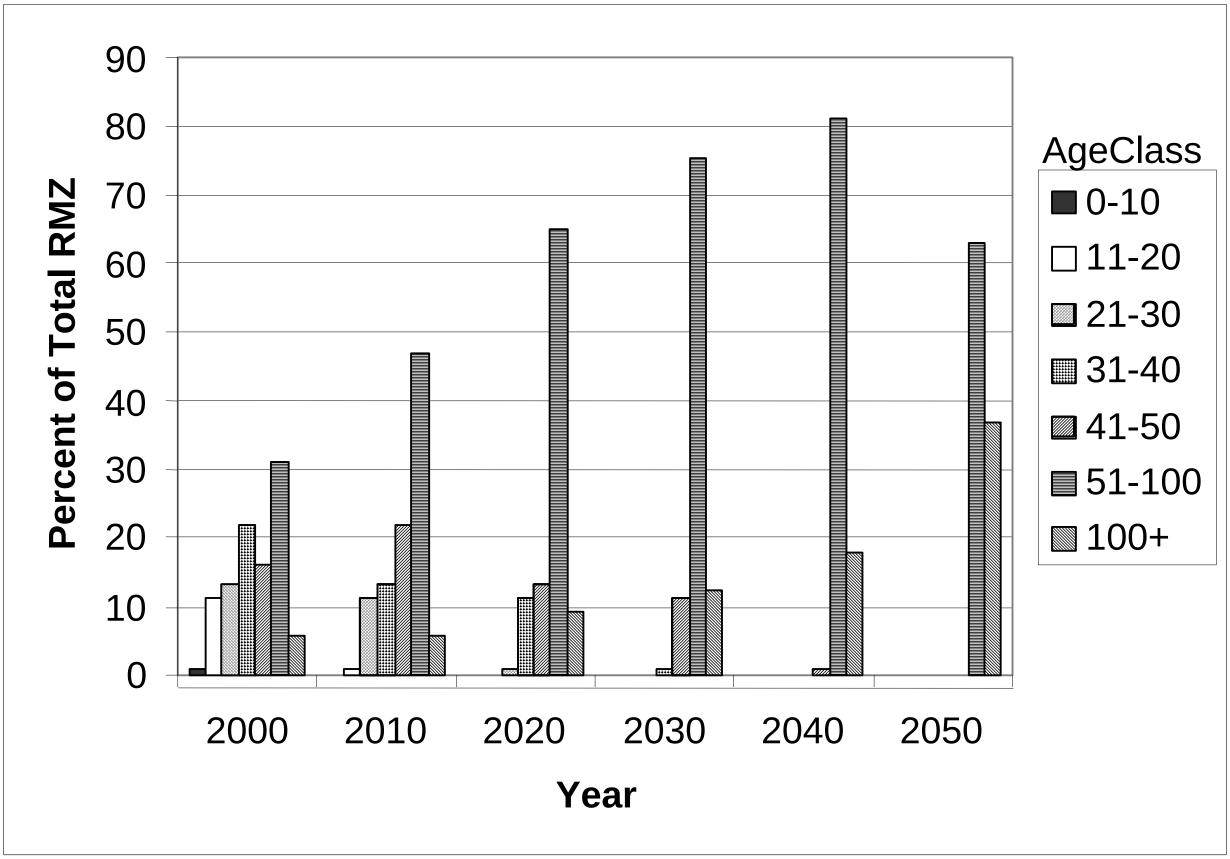


Figure 7-2. Projected age distribution of Class I and Class II RMZs over the term of the Permits.

7.2.3.3.2 *Slope Stability Measures*

Most of the Slope Stability Measures are designed to minimize management induced sediment inputs into Plan Area watercourses and to contribute conservation benefits for both ITP and ESP Species. However, geologic processes can be important mechanisms to provide LWD into streams, and in some situations, it may be the predominate mechanism by which LWD reaches streams. In particular, shallow rapid landslides have the potential to deliver large amounts of LWD when they form in steep streamside slopes or inner gorges. In addition, debris torrents from small headwater Class II and III watercourses can be an important source of LWD when they empty directly into Class I or large Class II watercourses. This latter phenomenon has not been frequently observed within the most of the Plan Area, but there are isolated areas where debris torrents are sufficiently common to be a potential important source of LWD.

The slope stability management zones (SMZs) occur outside of RMZs in areas (inner gorges and steep streamside slopes, headwall swales and toes of deep-seated landslides) that have been determined to be prone to shallow rapid landslides (see Section 6.2.2 and 6.3.2). As noted above, the primary objective of the SMZ is to minimize the likelihood of management-induced landslides. However, landslides do occur in these areas with or without management activities, and the SMZ conservation measures will insure that when a landslide does occur, it has the potential to deliver large amounts of LWD to the stream.

7.2.4 Potential for Altered Riparian Microclimate

7.2.4.1 Potential for Take and Other Impacts

The riparian microclimate is potentially important to the adult forms of the amphibian species. (The riparian microclimate has indirect effects on the salmonids and aquatic forms of the amphibians through alteration of water temperature, which will be discussed in the following Section.) Loss of riparian overstory canopy through timber harvesting could result in increased levels of incident solar radiation during the day and reduced thermal cover at night. It would also increase exposure to wind in the riparian areas with the overall net effect of increasing daily fluctuations in air temperature and relative humidity. In addition, increased coarse sediment inputs from Covered Activities, particularly when it occurs in the form of debris torrents, can result in widening of the channel and loss of streamside vegetation. Just as in overstory canopy loss, this has the potential to alter the riparian microclimate by increasing daily fluctuations in air temperature and relative humidity. It is unlikely that increases in air temperature with corresponding decreases in relative humidity during the day would directly impact the amphibian species, because the adults are not surface active during the day. However, the corresponding drying effect of increased air temperature and decreased relative humidity could result in the loss of some daytime refugia habitat and nighttime foraging sites. It is also possible that the reduction of thermal cover at night may impact the ability of adults to forage at night.

7.2.4.2 Plan Measures and Strategy

7.2.4.2.1 Riparian Management Measures

The minimum width of RMZs on Class I (fish bearing) watercourses is 150 feet with 85% overstory canopy retention in the inner zone (50-70 feet depending on slope class) and 70% overstory retention in the remaining outer zone. Class II watercourses will have a minimum buffer width of 70-100 feet with 85% overstory canopy retention in the inner zone (30 feet) and 70% on the remaining outer zone. These retention standards will insure that there will be almost no loss in canopy in the critical inner zone where microclimatic effects would have the greatest potential to directly impact the amphibians or indirectly impact the salmonid species. There will be an immediate net reduction of canopy cover of approximately 15-20% following timber harvest in the outer zone, which will be replaced within 5-10 years by recovery of the remaining tree crowns. On average, approximately 1000 feet of watercourse would be influenced by the average-sized harvest unit (currently about 25 acres) if the unit surrounds or is adjacent to a watercourse.

While studies done in other areas indicate that microclimatic edge effects can be detected as much as 240 meters (787 feet) from the edge of a clearcut (Chen 1991), the greatest attenuation of edge effects on microclimatic changes occurs within the first 30 meters (98 feet) of the buffer (Ledwith 1996). These studies reported above were done in areas with much higher extremes in air temperatures, so it is assumed that the cool coastal climate associated with most of the Plan Area will greatly ameliorate these potential impacts. In addition, the potential impacts to the microclimate would be highly localized and short-term given the rapid rate of regrowth of vegetation in the Plan Area. Although little direct data have been collected to support this conclusion that microclimatic effects should be minimal, there is strong circumstantial evidence for the conclusion based on the occurrence of the amphibians in streams that had little or no protection under past unregulated harvesting. As described in Section 4.3.11 and Appendix C11, presence/absence surveys indicated that southern torrent salamanders and tailed frogs were found in 80.3 and 75.0%, respectively, of sampled Plan Area streams in stands that ranged from recent clearcuts to mature second growth (Diller and Wallace 1996 and 1999). In contrast, studies done in more interior areas to the east of the Plan Area indicated that only 11% of streams in young stands contained both species, 50 and 56%, respectively, had torrent salamanders and tailed frogs in mature stands and 70 and 81%, respectively, of streams in old growth forests had both species (Welsh 1990). It is not likely that sediment inputs or other direct impacts to the streams in the Plan Area were less relative to the interior streams, so the best explanation for the difference in the study results was due to climatic differences. Green Diamond's assumption is that if these species could survive in streams with no or only minimal protection in the past, then any short-term minor microclimatic changes under the planned riparian conservation measures will have no measurable biological effect.

7.2.4.2.2 Slope Stability and Road Management Measures

The Slope Stability Measures are designed to minimize management induced sediment inputs into watercourses throughout the Plan Area, but of particular importance are the road management measures designed to reduce the likelihood of road-related mass wasting. Observations since 1992 as part of Green Diamond's property-wide amphibian studies indicated that all of the known damaging debris flows in headwater streams have been related to road failures. The commitment associated with the road conservation measures is projected to result in the treatment of more than 47% of the sediment from high and moderate probability future road failures sites within the first 15 years of the Plan and treat all of the high and moderate sites by the completion of the Plan will greatly reduce the potential negative impacts of road-related mass wasting events. These measures will minimize and mitigate the impacts of any taking that will occur associated with altered microclimate. Further, these measures will contribute conservation benefits for both ITP and ESP Species by helping to maintain and improve properly functioning habitat.

7.2.5 Potential for Altered Water Temperature

7.2.5.1 Potential for Take and Other Impacts

Loss of riparian overstory canopy through timber harvesting and increased coarse sediment inputs from Covered Activities could result in alteration of the riparian microclimate as described above. However, changes in the riparian microclimate will also result in corresponding changes in the daily and seasonal water temperature regime. In addition, both reduction of overstory canopy and increased coarse sediment inputs can result in altered water temperature through direct mechanisms. Open sky along the solar path will allow direct sunlight to warm the water during the day (Chamberlain et al. 1991) and radiate heat at night, while increased sediment inputs that results in aggradation will result in a wider and shallower channel that gains and losses heat more rapidly.

Increases in water temperatures during summer can have negative impacts on the salmonids (Beschta et al. 1987) as well as the amphibians. Potential impacts to salmonids are a reduction in growth efficiency, increase in disease susceptibility, change in age of smoltification, loss of rearing habitat, and shifts in the competitive advantage of salmonids over non-salmonid species (Hallock et al. 1970; Hughes and Davis 1986; Reeves et al. 1987; Spence et. al. 1996). In some situations, increased light levels and increased autotrophic production can also have a positive effect through an increase in food production and higher growth rates. Although the specific mechanisms are more poorly understood, many of the same physiological or ecological factors associated with elevated water temperatures presumably exist for the amphibian species, which have temperature thresholds below those of the fish species. Little is known of the potential impacts of greater daily fluctuations in temperature or colder nighttime and winter temperatures on streams with reduced canopy and aggraded channels. However, it seems likely that this is relatively unimportant compared to increases in temperature especially with the mild climate associated with the Plan Area.

7.2.5.2 Plan Measures and Strategy

7.2.5.2.1 <u>Riparian Management Measures</u>

As noted above, the riparian conservation measures will insure that there will be almost no loss in canopy in the critical inner zone and only minimal short-term effects in the outer zone. As a result, there should be little or no measurable change in water temperature as the result of canopy reduction following timber harvest. Although the sample size is still small, Green Diamond has direct experimental data to support the conclusion that the proposed riparian conservation measures will prevent impacts to water temperature. A BACI experimental design was used to assess the influence of clearcut timber harvest on water temperature in small Class II watercourses where the influence of reduction of canopy has the greatest potential to impact water temperature (see Appendix C, Class II Temperature Assessments). The riparian protection measures were based on past California FPRs and Green Diamond's NSO HCP guidelines, which included 50-70 foot buffers with 70% total (overstory and understory) canopy retention. Two of the treated streams showed minor (0.5-1.0 ºC) increases in water temperature within the limits of the harvest unit relative to the controls during the warmest time of day in the warmest 14-day period of the summer and two of the treated streams showed minor decreases (-1.3-1.4 ºC). (The decreases in temperature were likely the result of increased ground water inputs following harvesting of the adjacent stand.) Considering the small magnitude of change under the most extreme annual conditions, opposite direction of the response and the fact that riparian protection measures are going to be substantially increased under the Plan, Green Diamond believes there should be no measurable change in water temperature in Class I or larger Class II watercourses due to minor reductions in canopy following timber harvest. Even if there continue to be minor positive and negative changes in water temperature in the smaller Class II watercourses, the limited time and area of the impacts should result in no biological effects.

7.2.5.2.2 <u>Slope Stability and Road Management Measures</u>

Green Diamond's qualitative assessment (review of past air photographs and looking for physical indicators of past conditions such as historical terraces and location of riparian vegetation) of Class I watercourses that are being monitored as part of the long term channel monitoring program (see Appendix D) indicate that streams generally reached peaks in aggradation during the 1960's and 1970's. Since that time, most channels have dramatically downcut and narrowed. More recently, changes in channel morphology has been more subtle, and it is expected that this trend will continue with periodic adjustments due to the severity of winter storms. The long term channel monitoring was designed to detect such minor changes, but the work has not been conducted sufficiently long to quantitatively confirm the average change in stream morphology. With the slope stability and road management measures that are designed to minimize management related sediment inputs, Green Diamond believes that sediment inputs will be reduced relative to past practices (including not aggressively addressing the potential for road-related mass wasting). Given that water temperatures are generally favorable throughout the Plan Area even with past sediment inputs (see Appendix C), Green Diamond believes that future sediment minimization measures under the Plan will further reduce the likelihood that aggradation of channels will result in elevated water temperatures. The only documented cases of sediment inputs causing elevated water temperatures within the Plan Area have been associated with road-related debris flows in headwater streams as noted above. Given the measures under the Plan to locate and treat the legacy of potential threats from roads, Green Diamond believes that even these isolated impacts will be rapidly diminished as time passes under the Plan.

7.2.6 Potential for Altered Nutrient Inputs

7.2.6.1 Potential for Take and Other Impacts

Salmonid streams throughout the Pacific Northwest and Northern California are thought to be naturally oligotrophic due to low levels of nitrogen (Allan 1995; Triska et al. 1983). In addition, primary productivity of the lower order channels is also limited by light (Triska et al. 1983). Much of the energy and nutrients in lower order channels (where many salmonids rear) comes from allochthonous inputs such as leaf litter. One of the most important sources of detrital inputs in these streams comes from red alder, because it is readily available to the aquatic invertebrate community and its leaves are high in nitrogen (Murphy and Meehan 1991; pers. comm. K. Cummins, Humboldt State University). In contrast to red alder leaves that can be 50% decomposed in less than 2 months, Douglas fir needles may take over 9 months to reach the same level of decay and have far less nitrogen. Woody debris, even twigs and small branches, has limited nutritional value to streams because it decays so slowly and is very low in nitrogen (Murphy and Meehan 1991). Another potentially important source of nutrients to streams comes from annual spawning runs of anadromous salmonids. This has lead to numerous studies looking at the potential benefits of artificially increasing the productivity ("jump-starting") of these systems through the addition of salmon carcasses or other sources of nutrients.

Reduction of riparian vegetation due to timber harvest is likely to increase productivity of streams in several ways. Increased incident solar radiation would likely increase periphyton production (unless it is limited by nitrogen), which may increase the abundance of invertebrates and fish due to an enhanced quality of detritus. The mechanism of this increase is tied to the algae, a higher quality food than leaf or needle litter, which increases the abundance of invertebrate collectors, which in turn, can increase the abundance of predators such as juvenile salmonids (Murphy and Meehan 1991). In addition, timber harvest in riparian areas may reduce the number of conifers and increase deciduous vegetation such as red alder. Therefore, with increased input of nutritionally rich leaf detritus compared to conifer needles, productivity of the stream may increase. Of course, the salmonid response would only be realized if the alteration of the riparian vegetation did not also lead to adversely high water temperatures. An increase in stream productivity may also not ultimately result in increased production of salmonids, because it will primarily benefit summer rearing populations when the "bottleneck" (i.e. limiting factor) for many salmonid streams is winter rearing habitat (Murphy and Meehan 1991).

7.2.6.1.1 Riparian Management Measures

Site-specific data on nutrient levels in streams within the Plan Area is not available, so the assessment of the impact of the conservation measures on current nutrient levels is somewhat speculative and based on general aquatic ecological principles. The riparian conservation measures will favor conifers over hardwoods within the RMZs. The level of harvesting in both the inner and outer zones of all RMZs will maintain the overstory canopy, so that the longer-lived conifers will ultimately tend to replace the short-lived hardwoods. Ultimately, this will reduce the nutrient inputs relative to current levels. However, this will be long process that will extend beyond the life of this Plan, and even then, would not result in the total elimination of hardwoods from the riparian areas. There is the potential for a slight increase in primary productivity due to increased incident solar radiation following timber harvest, which could offset some of the negative effects of increased conifers in the riparian zone. However, the retention of 85% canopy closure in the inner zone and 70% in the outer zone of Class I and IIs, should not allow measurable increases in light reaching the stream. Therefore, although Green Diamond anticipates an overall very minor decrease in nutrient inputs and productivity over time due to the riparian conservation measures, the change should not be sufficient to impact the Covered Species. In addition, any minor negative impact from loss in nutrient inputs due to an overall decrease in riparian hardwoods throughout the term of the Permits should be more than compensated for by the benefit of LWD from the increased retention of conifers. This is especially true if the limiting factor for many of the Plan Area streams is winter habitat created by backwater areas associated with LWD in the channel.

7.2.6.1.2 Slope Stability and Road Management Measures

Aggradation of channels and scour from debris flows favors recolonization by the more rapidly growing hardwoods such as red alder. Therefore, both the slope stability and road management measures will tend to cause a decline in riparian hardwoods over time and a corresponding decrease in nutrient inputs. However, as noted above, this will be a long and gradual process that will not result in the total elimination of hardwoods. Therefore, Green Diamond does not anticipate an impact to any of the Covered Species as a result of reduced nutrient inputs.

Future studies in experimental watersheds within the Plan Area will greatly increase Green Diamond's understanding of the role of nutrients and primary productivity in limiting salmonid numbers in streams throughout the Plan Area. Should it become apparent, pursuant to the experimental watershed studies, that salmonid production is being limited by nutrients or low primary productivity in some or all watersheds within the Plan Area, it is anticipated that Green Diamond will initiate measures under the adaptive management program to promote greater productivity of its aquatic systems.

7.2.7 Potential for Barriers to Fish and Amphibian Passage

7.2.7.1 Potential for Take and Other Impacts

Culverts installed on fish bearing watercourses may be impassable to both adult and juvenile fish migrating upstream due to 1) high velocities at the inlet, outlet or within the culvert, 2) a high entrance jump into the culvert outlet, 3) shallow water depths, or 4) lack of resting pools at the culvert inlet, outlet, or within the culvert. In addition, such barriers could reduce the availability of low velocity refugia for juvenile salmonids and thereby increase predation and other mortality. The potential effects of these barriers on adults of the fish species include delaying access to spawning habitat or blocking access to spawning habitat and rearing habitat to their offspring.

Culverts that act as barriers could result in take of juvenile salmonids, specifically by causing actual death or injury associated with impairment of essential behavioral patterns: reducing available rearing habitat, reducing or eliminating low velocity refugia during high winter flows, and possibly reducing survival of overwintering juveniles. The impact of such taking could include reductions in survival and production of fish in affected watersheds.

It is not known if culverts have the potential to affect the amphibian species. It is likely that they act as barriers to the larval forms but not the adults. Whether or not this has an impact on the populations is not known since the headwater amphibians are thought to have limited vagility.

7.2.7.2 Plan Measures and Strategy

The conservation strategy includes a measure that will act to reduce and ultimately avoid this type of taking altogether as the Plan is implemented over time.

7.2.7.2.1 <u>Road Management Measures</u>

The Plan addresses fish access issues associated with new roads by installing bridges on fish bearing watercourses where feasible. When a bridge installation is not feasible, a “fish-friendly” structure will be installed that will provide upstream and downstream fish passage. During the road inventory process potential fish passage problems at existing watercourse crossings will be documented and culverts that are impeding fish passage will be prioritized for replacement with a bridge where feasible or other “fish friendly” structure. As the Road Management Measures are implemented over time fish passage problems at watercourse crossings will be eliminated. Rearing habitat and low velocity refugia for the juvenile salmonids will be available. In addition, the “fish-friendly” watercourse crossings will not limit access to upstream spawning habitat for adults and subsequent rearing habitat for their offspring.

7.2.8 Potential for Direct Take from Use of Equipment

In addition to the above indirect potential takings that may result from habitat changes, there are Covered Activities that have the potential to cause two types of direct take of the Covered Species. The first of these types of activities only has the potential to take single individuals or small groups of individuals. These activities include, but are not restricted to the following:

- Operation of heavy machinery in streams during Covered Activities such as construction of watercourse crossings or stream enhancement work (potentially injuring or killing adults, juveniles, larvae, and/or eggs of the species);

- The falling and yarding of timber and pre- and post-harvest management activities (including construction and maintenance of roads) in stands adjacent to streams (possibly injuring or killing the Covered Species).

Other activities that have the potential to directly take the Covered Species could affect larger groups of individuals or whole stream segments. These activities include, but are not restricted to the following:

- Drafting of water from streams for dust abatement (potentially injuring or killing individuals suctioned up with the water and potentially damaging or destroying the incubating eggs of such species);

- Use of petroleum products as fuel and lubricants in machinery and equipment in connection with other Covered Activities (potentially injuring or killing individuals and incubating eggs in the event of incidental drippage or leakage).

7.2.8.1 Plan Measures and Strategy

There are a variety of Road Management and Harvested-Related Ground Disturbance Measures to insure that the Covered Species are not directly taken due to any of the first type of activities described above. However, if some accident did result in direct physical harm in such a manner, it would be an isolated very infrequent event and only affect one or a few isolated individuals. Therefore, Green Diamond concludes that this form of direct take would not have an impact on the populations of Covered Species.

Although the second type of direct taking has the potential to impact more individuals, a number of Road Management and Harvested-Related Ground Disturbance Measures minimize the risk that such taking will occur. For example, water drafting is not done except under strict guidelines to insure that no Covered Species are accidentally suctioned up with the water or harmed by dewatering of the stream in which they reside. There are also a variety of other measures that limits the proximity of trucks and other heavy equipment near streams. These measures minimize the potential of incidental leakage or drippage from heavy equipment reaching a stream. Best Management Practices governed by other agencies that are outside the scope of this Plan are also designed to insure that accidental spills do not reach any watercourses.

7.3 BENEFITS OF MONITORING AND ADAPTIVE MANAGEMENT

The conservation strategy for this Plan has been the product of field data collection and analysis that began in 1993. A wealth of site-specific data has allowed us to craft a Plan that is designed to effectively and efficiently protect aquatic resources in the context of a managed landscape. Green Diamond is very confident that this Plan will successfully protect existing aquatic resources that have been shown to be in good condition and allow others to recover that have been impacted from past management or natural disturbance factors. However, Green Diamond recognizes that additional monitoring and the development of experimental data could provide an opportunity for us to modify the Plan in an adaptive way to make it even more effective, as well as increasing the efficiency through re-allocation of resources associated with the conservation Plan. Green Diamond does not anticipate that new data will require major adjustments in the Plan, but subtle changes may be necessary as more is learned about these aquatic systems and how they respond to management activities. With the goal of "fine tuning" the conservation measures over time, a comprehensive monitoring and adaptive management component was developed for the Plan that is designed to monitor all of the key factors (response variables) that have the greatest probability to impact (be limiting for) the Covered Species and their habitat. The response variables selected were also chosen because they could be quantified with minimum subjectivity, statistically analyzed and used to modify management in an adaptive manner. In addition, four experimental watersheds have been designated in which scientifically credible BACI experiments will be conducted to further refine Green Diamond's knowledge of the effectiveness of various aspects of Green Diamond's conservation strategy.

The overall benefit of Green Diamond's monitoring and adaptive management program will be to: 1) continuously validate that habitat and populations of the Covered Species are in good condition where it currently exists; 2) document the trend in recovery in areas that have been impacted from past management activities or natural disturbance factors; 3) modify or augment existing conservation measures where "fine tuning" is necessary; and 4) re-allocate resources to make the conservation program more efficient where warranted. In addition to these direct benefits for the conservation of the Covered Species within the Plan Area, Green Diamond believes the monitoring and experimental studies that are conducted as part of this Plan will further the knowledge of conservation of aquatic species on managed landscapes that will benefit throughout the entire range of those species. Much of the monitoring and proposed research as part of this Plan are new "state of the art" studies that should provide benefits far beyond the scope of the Plan Area.

7.4 SUMMARY OF MITIGATION AND MINIMIZATION OF THE IMPACTS OF TAKING, INCLUDING CUMULATIVE IMPACTS

The impact of the different factors that have the potential to cause take of the Covered Species is highly variable, particularly when considering potential cumulative impacts. In the case of an ITP/ESP, the cumulative effects analysis considers whether the incremental impacts of take, when combined with impacts from other projects, will appreciably reduce the likelihood of survival and recovery in the wild of any Covered Species (this is the ESA "jeopardy" standard); if so, the AHCP/CCAA would fail one of the significant approval criteria for both ITPs and ESPs.

The magnitude and significance of potential cumulative effects were considered, alternatives developed, and specific conservation measures incorporated into the Operating Conservation Program to avoid, minimize or mitigate significant cumulative environmental effects. Where substantial uncertainties remain or multiple resource objectives exist, adaptive management provisions allow for flexible project implementation.

Green Diamond evaluated cause-and-effect relationships among the Covered Activities, the potential for take of the Covered Species, and the potential impacts of take, including cumulative impacts. Specifically, Green Diamond analyzed the potential for cumulative effects that could cause take and that result from incidental take in each of the 11 HPAs by examining baseline conditions in each HPA and evaluating the potential for incremental impacts of the Covered Activities and take that results from them to interact in space and time with those conditions to result in or exacerbate any significant negative existing conditions.

As described in Section 5, in each of the HPAs, there are one or more factors that act on different life stages of the Covered Species that have a greater likelihood of limiting the capability of limiting the survival, growth or recovery of resident populations. Green Diamond's cumulative effects analysis associated with the 11 HPAs identified the most likely limiting factors for the Covered Species in each HPA that could be negatively impacted by the Covered Activities and take that might result from them (Table 7-1). The factors can interact in complex ways spatially and temporally, which make it difficult to know with certainty which factor or factors are actually limiting. However, the conservation strategy is designed to address these limiting factors that could be associated with or exacerbated by Covered Activities so as to minimize and mitigate the impacts of taking (including cumulative impacts), avoid jeopardy and provide significant conservation benefits to the Covered Species.

The Plan is designed to put the greatest effort into addressing factors that are recognized to have the greatest probability to be limiting. For example, Green Diamond's assessment of the Plan Area indicates that sediment inputs interacting with a general lack of LWD in Class I watercourses have the greatest potential to be limiting within the majority of the Plan Area for all the Covered Species. Green Diamond's assessment also indicates that the majority of the management related sediment comes from roads, particularly from legacy sites associated with old roads. Therefore, the conservation efforts are focused on preventing management related sediment from entering watercourses with particular attention to removing sediment that is likely to be delivered from roads—without regard to whether that sediment delivery is associated with Green Diamond's Covered Activities or prior management activities carried out under different regulatory regimes or by different landowners.

The biological need to increase LWD in Class I watercourses is being addressed by a riparian conservation program that maximizes the retention of those trees that not only have the greatest probability of being recruited into the stream, but also have the potential to interact with the fluvial processes of the stream and provide critical summer and winter habitat for the salmonid species.

Although the conservation measures focus on those conditions that are thought to have the greatest likelihood of being limiting in each HPA, the Plan is also designed, as described in the proceeding Sections, to address each of the potential impacts that might cause and result from take of the Covered Species. Green Diamond designed measures to be implemented during the course of the Plan that will provide for significant improvements in each of the potential limiting factors over baseline conditions in all areas. In other words, with a few exceptions where HPA-specific measures have been proposed, the measures designed to address each type of limiting factor will be applied throughout all 11 HPAs as if that factor is in fact limiting throughout the Plan Area

Table 7-1. Limiting habitat factors for the Covered Species and the relative benefits of the conservation measures for each HPA. (See Section 4.4, for a review of the data supporting these conclusions.)

HPA	Primary Limiting Factor(s)	Covered Species Most Affected	Most Relevant Conservation Measures
Smith River	Lack of LWD resulting in limited rearing habitat (summer and winter) for most salmonids	Primarily the anadromous salmonids	Riparian measures that promote LWD recruitment
Coastal Klamath	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat for salmonids and embedded substrates for amphibians	All of the salmonids and to a lesser extent the amphibians	Riparian management, slope stability, and road management measures
Blue Creek	Lack of LWD resulting in limited rearing habitat for most salmonids	Primarily the anadromous salmonids	Riparian management measures that promote LWD recruitment
Interior Klamath	Excess sediment resulting in embedded substrates and aggraded channels	Primarily tailed frogs and resident salmonids	Road management and slope stability measures
Redwood Creek	Excess sediment resulting in embedded substrates and aggraded channels	Primarily resident salmonids and the amphibians	Road management and slope stability measures
Coastal Lagoons	Excess sediment (mostly fines) resulting in embedded substrates	Primarily cutthroat trout and the amphibians	Primarily road management measures that reduce fine sediment inputs to watercourses
Little River	Excess sediment resulting in embedded substrates and aggraded channels	Primarily the amphibians and the anadromous salmonids	Primarily road management measures
Mad River	General lack of wood and excess sediment (coarse and fine) in some watersheds resulting in limited rearing habitat for salmonids and embedded substrates for amphibians	All	Riparian management, slope stability, and road management measures
North Fork Mad River	Excess sediment resulting in embedded substrates	Primarily the amphibians	Primarily road management measures
Humboldt Bay	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates	Primarily the anadromous salmonids	Slope stability and road management measures
Eel River	Excess sediment inputs from geologically unstable areas resulting in aggraded channels and embedded substrates	Primarily the anadromous salmonids – there are few salmonids and no known amphibian populations in this HPA	Road management and slope stability measures, but the limited numbers of covered species in the HPA would put it at the lowest priority

Through this approach, the incremental impacts associated with take that themselves might not be significant, were analyzed in light of their potential to combine with the impacts of other projects and activities to become significant (i.e., .limiting) in the future. For example, cumulative impacts could result from the spatial and temporal interactions of factors such as water temperature, hydrology, nutrients and barriers to movements with sediment and LWD. The measures in this Plan are designed to minimize the incremental impacts of Covered Activities that could combine with impacts of other projects to cause cumulative impacts.

Significantly, Green Diamond believes that, as designed, the Plan provides for a significant improvement in the habitat of Covered Species during the Plan period. In particular, the road conservation measures will provide for a significant acceleration of recovery of stream conditions negatively impacted by sediment in the first fifteen years of the Plan. Other measures will provide similar improvements of habitat conditions.

Green Diamond's activities and management practices under the Operating Conservation Program outlined in Section 6.2 of the Plan will result in significant improvements in habitat conditions for the species. In Green Diamond's view, the Plan contributes to the maintenance and restoration of properly functioning habitat and, thereby, contributes to the recovery of the listed Covered Species.

Based on this analysis, Green Diamond believes that this Plan will not only minimize and mitigate the impacts of taking and contribute to conservation efforts for ESP Species, but, by providing measures that address the above-discussed potential limiting habitat factors, will not have a negative cumulative effect but instead will have a cumulative benefit for all Covered Species and their habitats in that portion of the Plan Area in each of the HPAs. The Plan will contribute significantly to the development and maintenance of properly functioning habitat and thereby contribute to the recovery of the listed species. With respect to the unlisted species, the habitat improvement benefits projected to result from this Plan, in addition to other measures that minimize and mitigate the impacts of incidental take, will contribute to efforts that, when combined with the benefits that would be achieved if conservation measures also were implemented on other necessary properties, would preclude or remove the need to list the ESP Species in the future. In other words, this Plan is designed expressly to exceed the requirements for HCPs and to meet the requirement for CCAAs (that a CCAA must contribute to efforts to reduce the need to list currently unlisted Covered ESP Species by providing early conservation benefits to those species).

7.5 BENEFITS OF THE CONSERVATION MEASURES FOR THE ESP SPECIES

As discussed above, the Plan covers three ITP species (coho and chinook salmon and steelhead) and four ESP species (resident rainbow trout, coastal cutthroat trout, tailed frog and southern torrent salamander). Included in the CCAA/ESP approval criteria is a requirement that the Plan provide conservation benefits to the Covered Species that, when combined with those benefits that would be achieved if it is assumed that the conservation measures were also implemented on other necessary properties would preclude or remove any need to list the Covered Species. This subsection summarizes the Plan's particular conservation benefits for the ESP species.

Both the ITP and ESP Species are covered in this Plan, because the best available scientific data and site specific information discussed in Sections 3, 4, and 5 and Appendix C indicate that all of the species are sensitive to the same general suite of potential impacts. Therefore, the conservation measures designed to minimize and mitigate those potential impacts and enhance the species' habitats will generally benefit all of the Covered Species. However, the ESP species generally occur in smaller streams and higher in the watershed relative to the ITP species (see Section 3). The ESP species also are not anadromous with the exception of some populations of coastal cutthroat trout and the occasional resident rainbow trout that becomes anadromous. If there are conservation measures that primarily benefit the larger tributaries lower in the watershed, they would have relatively little benefit for the ESP species. However, our assessment of potential impacts to the larger tributaries lower in the watershed was based on the premise that off-site or cumulative factors from higher in the watershed were primarily responsible for conditions in the lower watersheds. As a result, none of the conservation measures were developed to benefit either group of Covered Species exclusively. Nevertheless, there are differences in the ecology, life history requirements, and Plan Area distribution of each Covered Species that create subtle species-specific interactions between potential impacts and the conservation measures designed to minimize and mitigate those impacts and maintain and improve the species' habitat.

In general, the Plan's conservation measures were developed based on the concept that if sufficient protection is provided for the most sensitive of the Covered Species, the other less sensitive species will also be protected adequately even though there are subtle differences in how the individual species respond to the conservation measures.

7.5.1 Coastal Cutthroat Trout and Resident Rainbow Trout

Coastal cutthroat trout and resident rainbow trout are well distributed throughout the coastal portions of the Plan Area with the exception of the coastal cutthroat trout in the southern-most HPA (Eel River), which is south of the range of the species. Although the presence of coastal cutthroat trout and resident rainbow trout populations has been well documented, Green Diamond has little direct evidence of their abundance and population status. The tendency for coastal cutthroat and resident rainbow trout to occur as resident populations, often upstream of barriers to anadromy, make their population levels more directly correlated to local conditions in a given watershed or sub-basin relative to the anadromous salmonids. The fact that most of the coastal streams in the Plan Area still have resident populations of coastal cutthroat and resident rainbow trout despite all of the watersheds having been harvested at least once with little or no protection of riparian habitat suggests that these fish populations are relatively resilient and unaffected by disturbance. A study in British Columbia compared coastal cutthroat trout densities in a pristine stream reach to reaches harvested with no riparian buffers, but with different levels of LWD and logging slash retained (Young et al. 1999). The harvested stream reach with LWD and logging slash removed showed an initial decline in coastal cutthroat densities that recovered to greater than reference levels in 9 years after LWD was added to the reach. The harvested stream reach with LWD and logging slash retained showed no change in coastal cutthroat densities relative to the reference reach. In another study of the response of coastal cutthroat trout populations to timber harvesting activities in the western Cascades of Oregon, Moore and Gregory (1988) reported that the highest growth rates of coastal cutthroat were in hardwood dominated stream reaches approximately 40 years after harvesting. Coastal cutthroat in open stream reaches that had been recently clearcut and pristine old growth streams had similar growth rates. Presumably resident rainbow trout would have a similar response to timber harvesting activities as coastal cutthroat trout populations; but there have been no specific studies that have examined these effects on the resident form of the rainbow trout.

The different conservation measures (riparian management, slope stability, harvest-related ground disturbance, and road management) were designed to maintain cool water temperatures and stable riparian micro-climates, allow for the recruitment of LWD and minimize management-related sediment input. The measures were designed to protect the most sensitive of the Covered Species (generally thought to be coho salmon). Therefore, coastal cutthroat trout and resident rainbow trout populations should be equally protected. Subtle differences in the conservation benefits for the coastal cutthroat trout and resident rainbow trout probably relate to their preference for generally smaller and colder coastal tributaries relative to the other salmonids covered in the Plan. Given that the Plan Area streams are at or near the southern limits for coastal cutthroat trout, the riparian measures designed to maintain and improve cold water temperatures are likely to provide the most critical benefit for this species.

7.5.2 Tailed Frog

Unlike the anadromous salmonids, the headwater amphibians, which include the tailed frog and southern torrent salamander, live their entire lives in or near headwater streams. As a result, populations of these species are totally dependent on local conditions in the watershed. Tailed frog habitat has been characterized as perennial, cold, fast flowing mountain streams (generally larger Class II and small Class I watercourses) with dense vegetation cover (Bury 1968, Nussbaum et al. 1983). To support larval tailed frogs, streams must have suitable gravel and cobble for attachment sites and diatoms for food (Bury and Corn 1988). Tailed frogs are well distributed throughout the Plan Area except for geologically unconsolidated areas. Previous studies done within the Plan Area determined that 75% of all streams (80% excluding geologically unsuitable areas) across the Plan Area had tailed frog populations (Diller and Wallace 1999). This occurrence rate is similar to the highest reported for the species even in pristine conditions (Corn and Bury 1989; Welsh 1990; Bull and Carter 1996). Currently, there are 283 streams known to support tailed frogs throughout the Plan Area, which is the majority of known sites in California. The abundance of tailed frogs in individual streams has only been estimated for a limited number of streams associated with the headwaters monitoring, so it is not possible to characterize abundance across the Plan Area. In addition, there are no comparable estimates of tailed frog abundance from other regions to which Plan Area populations can be compared. However, qualitative comparisons suggest that some of the populations of tailed frogs in the Plan Area are equal or greater than any populations studied.

Headwater areas in the Plan Area have been harvested at least once, many with little or no protection for streams or unstable areas. The distribution and abundance of tailed frogs, despite the previous lack of protection, suggest that they are relatively resistant to the impact of past timber harvesting in this region. Apparently, the primary impact of past timber harvesting on tailed frogs was to restrict their occurrence to higher gradient stream reaches that were less likely to be embedded with fine sediments (Diller and Wallace 1999). Presumably, tailed frog populations declined following extensive past unregulated harvesting but were able to survive in or recolonize the higher gradient stream reaches. Subsequent to the massive impacts of unregulated harvesting, these streams have generally recovered, except for some of the lower gradient reaches that still have higher levels of fine sediments and embeddedness.

The conservation measures that are designed to minimize management related sediment inputs (e.g. Road Management and Slope Stability Measures) will likely have the greatest benefit for tailed frogs. Observations as part of previous habitat association and life history studies (Wallace and Diller 1998; Diller and Wallace 1999) and ongoing tailed frog monitoring suggest that fine sediment inputs which cause embeddedness of the substrate (generally sand-sized particles) have the greatest impact on larval tailed frog populations. This impact is particularly apparent downstream of watercourse crossings that are hydrologically connected to a Class II watercourse. In addition, failed log-stringer bridges, Humboldt crossings and culverts have been known to trigger debris torrents that have dramatic immediate, but short-term, impacts on larval populations and stream habitat.

Observations of debris torrents that destroyed stream-side vegetation and exposed the stream to direct solar radiation indicate that the impact on larval tailed frog populations was relatively ephemeral. Immediately following denuding of streamside vegetation, water temperatures increased and excessive growth of filamentous green algae excluded larval tailed frogs. However, after 2-3 years, recovery of vegetation such as alder and willows allowed water quality to recover sufficiently so that larval tailed frogs could recolonize the site. Based on these observations, Green Diamond concludes that the maintenance of shade and micro-climate as part of the riparian conservation measures are relatively less important to larval tailed frogs compared to sediment inputs. However, there are no direct observations on how modification of the riparian micro-climate may affect the “adult” (all metamorphosed age classes) frogs. In the terrestrial stage, tailed frogs are strictly nocturnal and night-time observations as part of a new mark-recapture study of the adult population indicate that they are commonly found in relatively xeric sites. This suggests that the adult population is relatively insensitive to changes in micro-climate, but direct evidence is still lacking.

The input of LWD from the RMZs is likely important to sort and meter sediment in the channel and create suitable habitat for larval tailed frogs. However, the value of LWD for cover and pool formation is probably relatively unimportant for tailed frogs compared to the salmonids, because the larval frogs select for riffle habitat and avoid pools. Amphibian studies throughout the Plan Area indicated that many Class II watercourses received large amounts of LWD as the result of past unregulated timber harvesting and this LWD was generally not removed from these channels. Therefore, in contrast to most Class I watercourses, the Class IIs in the Plan Area are generally not deficient in LWD and may actually have greater than normal amounts. In summary, LWD recruitment is likely an important component of the riparian function for tailed frogs, but it is not likely to be currently limiting. Further, LWD recruitment should be maintained and enhanced in the future by the riparian conservation measures.

7.5.3 Southern Torrent Salamanders

Southern torrent salamanders generally exist in seeps and springs and the uppermost headwater streams (Nussbaum et al. 1983; Stebbins 1985). They are a small salamander that appears to spend most of its time within the interstices of the stream’s substrate, which make them difficult to locate and capture without disturbing their habitat. The larvae have gills and are restricted to flowing water while adults also appear to spend most of their time in the water, but are capable of movements out of the water. They are thought to have limited dispersal abilities and small home ranges so that recolonization of extirpated sites may take decades (Nussbaum and Tait 1977; Welsh and Lind 1992; Nijhuis and Kaplan 1998). Given the highly disjunct nature of their habitat, individuals at a given site would constitute a sub-population and are likely to be isolated from other adjacent sub-populations. The degree of isolation of these sub-populations probably varies depending on the distance and habitat that separate them, so that torrent salamanders could be best described as existing as a meta-population. They are well distributed throughout the Plan Area except for geologically unconsolidated areas. Previous studies done within the Plan Area estimated that 80% of all streams (almost 90% excluding geologically unsuitable areas) across the Plan Area had torrent salamander populations (Diller and Wallace 1996). This occurrence rate is similar to the highest reported for the species even in pristine conditions (Carey 1989; Corn and Bury 1989; Welsh et al. 1992). Currently, there are 598 known torrent salamander sites (sub-populations) throughout the Plan Area, which is the majority of known sites in California. Due to the survey difficulties associated with this species, there are no reliable estimates of abundance for any of these sub-populations, and there are no estimates available from other areas for comparison. However, the number of individuals that can potentially be found during any given survey varies from several individuals up to a 100 or more.

As noted above for tailed frogs, almost all headwater areas in the Plan Area have been harvested at least once, many with little or no protection provided at the time for streams or unstable areas. This is particularly true for the seeps, springs and small headwater streams in which torrent salamanders are found. The distribution of torrent salamanders, despite the previous lack of protection, suggests that they are relatively resistant to the impact of past timber harvesting in this region. Because they occur in small relatively isolated patches of habitat, torrent salamanders are primarily vulnerable to potential direct impacts from timber harvest (Diller and Wallace 1996). Direct impacts could include activities such as excessive canopy removal at the site leading to elevated water temperature, operating heavy equipment in the site, or destabilizing soil leading to excessive sediment deposits at the site. Past observations have indicated that these direct impacts can lead to extinction of a sub-population at a site. However, given their limited ability to recolonize sites and current extensive distribution throughout the Plan Area, most populations of torrent salamanders must not have gone extinct following extensive past unregulated harvesting. Presumably populations declined, but apparently there were sufficient refugia to allow the populations to persist. Diller and Wallace (1996) noted that torrent salamanders were restricted to the highest gradient reaches in streams that were heavily impacted from past timber harvesting activities. They hypothesized that high gradient reaches were important because they were transport areas where finer sediments did not accumulate and gravel and cobble did not become embedded. Subsequent to the impacts of unregulated harvesting, these streams have generally recovered except for the lower gradient reaches that still have high levels of fine sediments and embeddedness. It is likely that in most streams in the Plan Area, habitat probably existed further downstream in lower gradient reaches prior to timber harvest but was reduced or eliminated by the accumulation of sediments. In summary, Green Diamond concludes that past unregulated and less regulated timber harvesting practices caused a reduction in the number of individuals in most headwater streams in consolidated geologic areas, but probably did not often cause the total extinction of populations in a stream, because virtually all streams in our study area have some high gradient reaches.

One of the greatest conservation benefits provided by Green Diamond's conservation measures for southern torrent salamanders is Green Diamond's emphasis on identifying, and improving its ability to identify and thereby protect, the small and often isolated patches of habitat in which the species can be found. Green Diamond has an ongoing program to field train foresters to recognize habitat for the species. Field studies and monitoring across the Plan Area indicate that populations of southern torrent salamanders have a high probability of persisting following timber harvesting, if their habitat is recognized and direct impacts avoided.

There are certain situations where indirect effects from timber harvesting activities do impact southern torrent salamanders. The most common indirect impact on salamander populations observed in the Plan Area is related to fine sediment inputs (particularly sand-sized particles) from offsite roads that enter headwater streams. (Seeps and springs are generally not impacted by roads, because roads are located to avoid such wet areas.) These fine particles fill the interstices in the stream's gravel and cobble substrates and eliminate the refuge sites for the salamander. Differences in the abundance of salamanders and the stream's substrate above and below hydrologically connected watercourse crossings provide strong evidence for the potential negative impact of roads on habitat for the species. Based on this observation, provisions in the Road Management Measures that provide for hydrologically disconnecting roads from watercourse crossings will provide significant benefits to southern torrent salamanders.

Failed log-stringer bridges, Humboldt crossings, and culverts have the potential to deliver large amounts of sediment and destroy habitat for torrent salamanders, but typically these failures occur lower in the watershed in stream reaches primary occupied by tailed frogs and Pacific giant salamanders. Most of the uppermost stream reaches occupied by torrent salamanders are too small to generate sufficient energy to cause a road failure. As a result, removal of these potential sediment sources as part of road decommissioning and upgrading will likely have relatively little direct benefit for torrent salamanders.

Headwater seeps and springs, where torrent salamanders are particularly abundant, are often associated with headwall swales and at the heads of landslides. During the natural cycle of these geologic features, the headwall swales gradually fill with colluvium and eventually fail producing a shallow rapid landslide or debris torrent that scours the feature down to bedrock. This phenomenon has been observed in a variety of sites across the Plan Area, and the best habitat for torrent salamanders appears to occur relatively soon after a failure (probably 10-20 years) when the feature is only partially filled with loose colluvium from a consolidated geologic formation. Unsorted colluvium that is angular and of mixed sizes provides particularly good habitat because of the extensive interstitial network through which the salamanders can move. In general, shallow rapid landslides in consolidated geologic formations do not appear to result in a net harm to torrent salamanders, because new habitat is created as other sites are temporarily destroyed. (This relationship does not hold in regions with unconsolidated geologic formations, because torrent salamanders are not found in these areas.) This observation is corroborated by the high density of torrent salamander sites in regions (e.g. Hunter and Terwer Creeks) with unusually high densities of shallow rapid landslides. Based on these observations, Green Diamond does not believe that the slope stability conservation measures will have much direct benefit for southern torrent salamanders.

The riparian conservation measures will benefit southern torrent salamanders because they prevent heavy equipment to directly impact the habitat for the species. Maintenance of cold water and a cool riparian micro-climate also would appear to be important, because the species is known to have very limited thermal tolerance (Welsh and Lind 1996). However, Green Diamond has documented literally hundreds of torrent salamander sites that have been clearcut in the past and the salamanders have persisted. (The limited vagility of the species would rule out recolonization in most of these sites.) Our explanation for this phenomenon is based on the ameliorating cool coastal climate throughout much of the Plan Area and the ability of the salamanders to persist at the interface where ground water first emerges on the surface. Being an ectothermic animal that is relatively long lived, individuals could probably persist for several years until the regrowth of vegetation provides for more suitable stream conditions. Therefore, the riparian conservation measures are probably not critical to allow for persistence of the species in many of the more coastal regions of the Plan Area, but the RMZs on small headwater streams will allow for more stable populations that will be able to occupy a more extensive portion of headwaters streams. In the more interior portions of the Plan Area with greater temperature extremes, the RMZs are probably critical for maintaining cool water temperatures and riparian micro-climate.

The LWD provided from the RMZs is probably of limited direct benefit to southern torrent salamanders. A study of habitat associations for torrent salamanders in the Plan Area (Diller and Wallace 1996) indicated that woody debris can be important to the species, but relatively small wood was functional in these small headwater streams. Broken branches and dead saplings are the size of wood that most commonly creates sediment traps in which torrent salamanders seek refuge in these small streams. In addition, leaf drop and small woody debris (allochthonous inputs) are vital in these streams to fuel the detrital trophic system. Therefore, Green Diamond concludes that the large wood that is so important in many of the salmonid stream reaches is of relatively less importance to southern torrent salamanders. However, smaller size woody input from the trees growing in the RMZs of headwater streams still provides a vital benefit to southern torrent salamanders.

7.6 CONCLUSIONS REGARDING MITIGATION OF IMPACTS, PROVISION OF CONSERVATION BENEFITS, AND AVOIDANCE OF JEOPARDY

As explained above, each of the potential impacts discussed above and summarized in Section 5, including cumulative impacts, will be minimized and mitigated to the maximum extent practicable. Although any particular type of impact or potential limiting factor may not be significant in a particular HPA or watershed in the Plan Area, the AHCP/CCAA addresses each type of potential impact or potential limiting factor as if it is significant individually and is the “bottleneck” for the local population of each of the Covered Species. In addition, the operating conservation program as a whole addresses the potential impacts and limiting factors collectively so as to ensure that Green Diamond’s Covered Activities pursuant to the operating conservation program will minimize and mitigate all individual and cumulative impacts to the maximum extent practicable and will contribute to conservation efforts benefiting the ESP (as well as the ITP) Species.

Furthermore, the Plan includes an extensive monitoring and adaptive management program that provides mechanisms to adjust the conservation measures as appropriate to provide further assurances that the AHCP/CCAA will meet the statutory and regulatory criteria described above. Under these circumstances, any incidental take of Covered Species is not expected to appreciably reduce the likelihood of survival and recovery of any of the Covered Species in the wild.

Finally, the individual conservation measures and the operating conservation program as a whole are projected to provide significant net benefits to the Covered Species and their habitats over the term of the Permits. These benefits include maintaining and improving properly functioning habitat and related environmental conditions that may have been negatively impacted under previous regulatory and management regimes. The conservation program will contribute to the recovery of the listed Covered Species and to conservation efforts intended to preclude or remove a need to list the unlisted Covered Species in the future.

Section 8. Alternatives Considered

In accordance with the requirements for the ITP, Green Diamond has considered alternatives to the proposed taking of Covered Species and explained why the alternatives were not selected. The alternatives were identified during preparation of the AHCP/CCAA and as part of the scoping process for the EIS. The alternatives considered in the Plan also are considered in the EIS for the Services' actions on the ITP and ESP. The primary alternatives considered by Green Diamond are:

- No Permits/No Plan
- Listed ITP Species Only
- Simplified Prescriptions Strategy
- Expanded Plan Area/Species List

8.1 NO PERMITS/NO PLAN

This alternative is comparable to the "no action" alternative considered in the EIS and would require Green Diamond to continue to be subject to existing legal and regulatory requirements, including the ESA take prohibition which would apply to all of the ITP species as well as all other listed species in the Plan Area (excluding NSO). Under the No Permits/No Plan Alternative,

- Green Diamond would not seek authorization for take of the listed or unlisted Covered Species;
- The proposed ITP and ESP would not be issued;
- This AHCP/CCAA would not be implemented; and
- Timber operations and related activities would occur in the Plan Area in accordance with existing state and federal regulations, the approved NSO ITP and associated HCP, the approved sustained yield plan for the Plan Area, and Green Diamond's operational policies and plans.

As currently occurs, Green Diamond foresters would develop and design site-specific measures to address potentially significant environmental effects that otherwise might not be adequately addressed by application of the prescriptive measures contained in the FPRs. A multi-disciplinary team composed of representatives from North Coast RWQCB, CDFG, the California Department of Mines and Geology, and other resource agencies such as NMFS and USFWS would review each proposed THP and, where necessary, would identify additional site-specific measures to avoid or mitigate potentially significant environmental impacts.

Some measures benefiting ITP and/or ESP species would be implemented in the Plan Area (a) under the NSO HCP; (b) in compliance with existing laws and regulations that apply to watershed impacts, sensitive species, cumulative impacts, and the prohibition on take; and (c) as a result of Green Diamond's continued participation in monitoring and habitat enhancement projects within the region.

Green Diamond considered but rejected the No Permits/No Plan Alternative because it does not offer a long-term solution for reconciling Green Diamond's operations with ESA requirements that apply to ITP species (or the ESP species should they be listed). Further, as discussed in Section 7, Green Diamond believes that the Plan as proposed will have significant beneficial effects for Covered Species that the No Permit/No Plan strategy cannot provide.

8.2 LISTED ITP SPECIES ONLY

Under the Permit/Plan for ITP species Only Alternative,

- NMFS would issue the ITP for the three listed salmonids;
- The unlisted salmonids under NMFS jurisdiction would not be covered by the ITP but could be added to the Plan and ITP through amendments if listed;
- Green Diamond would not seek an ESP for the three unlisted species under USFWS jurisdiction; and
- The Plan's purpose and scope and Green Diamond's responsibilities under the Plan would be narrowed technically and legally to the listed ITP species.

Incidental take of the three listed salmonids would be authorized under the Plan and ITP; however, no advance authorization for take of the ESP species or the unlisted ITP species would be given. If one or more unlisted species became listed, Green Diamond would be subject to the ESA prohibition on take and could seek take authorization from the Services.

Except for certain monitoring measures, the conservation program under the Listed ITP species Only Alternative would be very similar to that in Section 6.2. This is because, as discussed in Section 7, the Plan as proposed is based on the premise that factors higher in the watersheds (where the ESP amphibian species occur) are responsible for conditions in the lower watersheds (where the ITP species occur). None of the conservation measures was specifically intended to benefit either group of Covered Species (amphibians or salmonids) exclusively, and no distinction was made based on the listing status of the species. Under this alternative, measures implemented higher in the watersheds would be beneficial, improving conditions for the listed salmonids, and also for the unlisted Covered Species. Benefits for the unlisted ITP species would likely be the same as under the Plan as proposed. However, without the CCAA/ESP, the incentive as well as the requirement to provide conservation benefits for the ESP species is removed.

Green Diamond considered the Listed ITP Species Only alternative during preparation of the Plan and rejected it as counter to sound planning principles. In addition, the alternative would not provide adequate long-term assurances to Green Diamond that operations could continue in watersheds covered by the Plan if one or more of the unlisted Covered Species were listed.

8.3 SIMPLIFIED PRESCRIPTIONS STRATEGY

Under the Simplified Prescriptions Strategy Alternative,

- The Services would issue the Permits for Covered Species as proposed in this Plan; and
- Green Diamond would implement a modified AHCP/CCAA with a simplified conservation strategy of fixed, no-cut riparian buffers.

Instead of the combination of programs and default prescriptions in the Plan as proposed, the conservation strategy of this alternative would focus on establishing permanent, uniform buffers on Class I and II watercourses, with existing protections maintained at Class III sites. Under this modified strategy, existing measures employed by Green Diamond to protect Class I, Class II, and Class III watercourses would be supplemented as follows;

- Class I buffers would have fixed widths of 200 feet (slope distance). No timber harvesting, forest management, or use of heavy equipment would be allowed in the buffer (with the exception of creating cable-yarding corridors when other options are impractical and use of existing roads and watercourse crossings for log hauling and access purposes).
- Class II buffers would have fixed widths of 130 feet (slope distance). No timber harvesting, forest management, or use of heavy equipment would be allowed in the buffer (with the exception of creating cable-yarding corridors when other options are impractical and use of existing roads and watercourse crossings for log hauling and access purposes).
- Ponds, swamps, bogs, and seeps that support aquatic species would also be afforded the same protection as other Class II watercourses.
- Protection for Class III watercourses where no aquatic life is present would be the same as under existing regulations (i.e., 25- to 50-foot ELZs; limits on heavy equipment use; timber harvesting allowed in ELZs). Under some circumstances, WLPZs could be established for Class III watercourses in lieu of ELZs.

Some monitoring would be conducted to demonstrate compliance and track effectiveness, as required for the ITP and ESP. This alternative would avoid incidental take of Covered Species associated with the impacts of harvesting, management, and equipment use in riparian zones, and the fixed no-cut buffers would be means of assuring avoidance, setting aside habitat for the species, and mitigating any indirect or cumulative impacts from other activities. Because no harvesting or management of the Class I and II buffers would occur, thus minimizing take and thereby limiting the impacts of any take that could occur, there would be less of a rationale and need for the other components of the Plan as proposed, which consist primarily of special measures for riparian zones, impact-specific mitigation, and interactive monitoring and adaptive management measures. The premise of this approach is that Covered Species and their habitats would benefit from the impact avoidance.

Green Diamond considered this alternative during preparation of the Plan and rejected it because the permanent commitment of land and resources represented by the fixed buffers would be disproportionate mitigation for minimal impacts under this take avoidance strategy. Green Diamond also believes that the Plan as proposed is a superior conservation strategy because it would avoid take to the maximum extent practical in riparian zones while enacting additional measures to improve, not just avoid impacts to, habitat conditions.

8.4 EXPANDED PLAN AREA/SPECIES LIST

Under the Expanded Plan Area/Species List Alternative:

- The Plan Area would be expanded to include an additional 26,116 acres of “rain-on-snow” areas;
- The ITP from NMFS would cover the same listed and unlisted salmonid ESUs/DPSs as the Plan as proposed;
- Green Diamond would seek an ITP from USFWS that would cover a total of 9 species: the three ESP species identified in the Plan as proposed, one listed fish species (tide water goby), two listed bird species (bald eagle and marbled murrelet), two additional unlisted amphibians (foothill yellow-legged frog and northern red-legged frog) and one unlisted reptile (western pond turtle) (see Table 8-1);
- The Plan would be modified to include impact avoidance, impact minimization and mitigation, and monitoring measures that meet ITP standards for each of the added species and to address the potential for unique impacts in the rain-on-snow areas.

Table 8-1. Added Species under Expanded Plan Area and Species List Alternative.

Common Name	Scientific Name	Federal Status	State Status
Tidewater goby	*Eucyclogobius newberryi*	FE	CSC
Foothill yellow-legged frog	*Rana boylii*	FSC, FSS	CSC/CFP
Northern red-legged frog	*Rana aurora aurora*	FSC, FSS	CSC/CFP
Western pond turtle	*Clemmys marmorata marmorata*	FSC, FSS	CSC/CFP
Marbled murrelet	*Brachyramphus marmoratus*	FT	SE
Bald eagle	*Haliaeetus leucocephalus*	FT	SE

Federal Status
FE Federal endangered species
FT Federal threatened species
FSC Federal species of concern
FSS Forest Service sensitive species
State Status
SE California endangered species
CSC CDFG Species of Special Concern
CFP California Fully Protected Species

Under this alternative, incidental take of the original list of Covered Species potentially would be greater than under the Plan as proposed because of the expansion in Plan Area and potential for harvesting to occur in areas currently subject to “no take” regulations because of the presence of other listed species. However, as required for the ITP and ESP, the impacts of such take would be minimized and mitigated to the maximum extent practicable and early conservation benefits would be provided. The take of other Covered Species under this alternative also would be subject to ITP and ESP avoidance, mitigation and other requirements. Excluding potential modifications for rain-on-snow areas, the measures for the original list of Covered Species would not change, and the beneficial effects for them would likely be essentially the same as under the Plan as proposed.

Green Diamond considered this approach during the preparation of the Plan and rejected it in favor of limiting the Plan and permit application to the six cold-water adapted aquatic species. This decision does not preclude future amendments to the Plan to include other species or the development of separate HCP/ITPs or CCAA/ESPs for other species. Further, as discussed in Section 1.4, Green Diamond proposes to use the Plan as proposed as the framework for other conservation efforts; and implementation of the AHCP/CCAA in combination with Green Diamond's NSO HCP will provide significant protection and benefits to a broad range of aquatic and terrestrial species in the Plan Area.

This page intentionally blank.

Section 9. Literature Cited

Allan, J. D. 1995. Stream Ecology-- Structure and function of running waters. 1st ed. Chapman & Hall. xii, 388pp.

American Fisheries Society, 2001. AFS: Nutrient Conference 2001. Eugene, Oregon.

Anderson, D.G. 1988. Juvenile Salmonid Habitat of the Redwood Creek Basin, Humboldt County, California. M.S. Thesis. Humboldt State University, Arcata, CA. 99p.

Anderson, H. W. 1971. Relative contributions of sediment from source areas and transport processes. Proc. Symp. Forest Land Uses and Stream Environment, Corvallis, Ore. 1970: 55-63.

Bates, K.M. 1992. Fishway design guidelines for Pacific salmon. Washington Department of Fish and Wildlife, Working Paper 1.5, 11/94.

Bell, M. C., 1973. Temperature – Effects on fish. In Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, Corps of Engineers, North Pacific Division, Portland, Oregon. Pages 92-101.

Benda, L. and T. Dunne, 1997a. Stochastic forcing of sediment supply to channel networks from landsliding and debris flow. Water Resources Research. 33(12):2849-2863.

Benda, L. and T. Dunne. 1997b. Stochastic forcing of sediment routing and storage in channel networks. Water Resources Research, 33(12):2865-2880.

Beschta, R.L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research. 14(6):1011-1016.

Beschta, R.L., Pyles, M.R., Skaugset, A.E., and Surfleet, C.G., 2000, Peakflow responses to forest practices in the western cascades of Oregon.: Journal of Hydrology, v. 233, p. 102-120.

Beschta, R.L., R,E. Bilby, G.W. Brown, L.B. Holtby and T.D. Hofstra, 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 In Streamside management: forestry and fishery interactions. E.O. Salo and T.W. Cundy, editors, Contribution No. 57, College of Forest Resources, University of Washington, Seattle, Washington.

Best, D.W., Kelsey, H., Hagans, D.K., and Alpert, M., 1995, Role of fluvial hillslope erosion and road construction in sediment budget of Garrett Creek, Humboldt County, CA: Redwood National Park, CA, in Nolan, K.M., Kelsey, H.M., and Marron, D.C., eds., Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California, U.S. Geological Survey Professional Paper 1454, p. M1-M9.

Best, T.C., 1997, Mass Wasting Assessment, Watershed and Aquatic Wildlife Assessment, unpublished report., Volume Section 4.2, Coastal Forestlands, Ltd., Willits, CA.

Bisson, P. A., J. L. Nielsen, R. A. Palmason, and L. E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. Pages 62-73 in Armantrout (1982).

Bisson, P.A., R.E. Bibly, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski, and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. Pages 143-190 in Streamside management: forestry and fishery interactions. E.O. Salo and T.W. Cundy, editors. Contribution No. 57. College of Forest Resources, University of Washington, Seattle, WA.

Bisson, P.A., T.P. Quinn, S.V. Gregory, and G.H. Reeves. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. In R.J. Naiman, ed., Watershed Management: Balancing Sustainability and Environmental Change. New York: Springer-Verlag.

Bjornn, T. C., and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society. Special Publication 19: 83-139.

Blake, M.C., W.P. Irwin, R.G. Colman, 1967, . Upside-down metaphorphic zonation blueshcist facies along a regional thrust in California and Oregon, U.S. Geological Survey Professional Paper 575-C, p. C1-C9

Bosch, J. M., and J. D. Hewlett. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. J. Hydrol., 55: 3-23.

Bozek, M. A., and M. K. Young. 1994. Fish mortality resulting from delayed effects of fire in the Greater Yellowstone Ecosystem. Great Basin Nat. 54:91-95.

Brown, H. A. 1975. Temperature and development of the tailed frog, Ascaphus truei. Comp. Biochem. Physiol. 50A:397-405.

Brown, R.A. 1988. Physical Rearing Habitat for Anadromous Salmonids in the Redwood Creek Basin, Humboldt County, California. M.S. Thesis. Humboldt State University, Arcata, CA. 132p.

Buffington, J.M. and D.R. Montgomery. 1999. Effects of hydraulic roughness on surface texture of gravel-ged rivers. Water Resources Research 35(11): 3507-3521.

Bull, E. L., and B. E. Carter. 1996. Tailed Frogs: distribution, ecology, and association with timber harvest in northeastern Oregon. USDA Forest Service, Res. Pap. PNW-RP-497, Portland, Oregon.

Bury, R. B. 1968. The distribution of Ascaphus truei in California. Herpetologica. 24(1):39-46

Bury, R. B., and P. S. Corn. 1988. Douglas-fir forests in the Oregon and Washington Cascades: relation of the herpetofauna to stand age and moisture. Pages 11-22 in R. C. Szaro, K. E. Severson, and D. R. Patton, technical coordinators. Management of amphibians, reptiles, and small mammals in North America. U.S. Forest Service General Technical Report RM-GTR-166

Busby, P. J., O. W. Johnson, T. C. Wainwright, F. W. Waknitz, and R. S. Waples. 1993. Status review for Oregon’s Illinois River winter steelhead. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-10, 85 p.

Busby, P. J., T.C. Wainwright, and R.S. Waples. 1994. Status review for Klamath Mountains Province steelhead. NOAA technical memorandum NMFS-NWFSC-19. 130 p.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review for west coast steelhead from Washington, Idaho,Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-WFSC-27, 261 p.

Bustard, D. R. and D. W. Narver. 1975. Aspects of the winter ecology of juvenile coho Salmon (Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri). J. Fish Res. Board Can. 32:667-680.

Department of Fish and Game (CDFG). 1986. Little River, Humboldt Co., Field Note regarding beach seining by CDFG on Little River estuary. Prepared by David A. McLeod.CDFG, 1986.

California Division of Mines and Geology, 1997, Factors Affecting Landslides in Forested Terrain: California Division of Mines and Geology Note 50, 5 p.

Carey, A. B. 1989. Wildlife associated with old-growth forests in the Pacific Northwest. Natural Areas Journal 9:151-161.

Carling, P. A. 1984. Deposition of fine and coarse sand in an open-work gravel bed. Can. J. Fish. Aquat. Sci. 41: 263-270.

Carver, G. and R. B. Burke, 1989, Active convergent tectonics in northwestern California, *in* K.R. Aalto and G. Harper, eds. Geologic evolution of the northernmost Coast Ranges ans western Klamath Mountains, California: Field Trip Guidebook T308, 28th International Geologic Congress, p. 64-82.

Cashman, S.M., H.M. Kelsey, and D.R. Harden, 1995, Geology of the Redwood Creek Basin, Humboldt County, California: Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California. U.S. Geological Survey Professional Paper 1454-B, p. B1-B13.

Cederholm, C. J. and W. J. Scarlett. 1981. Seasonal immigrations of juvenile salmonids into four small tributaries of the Clearwater River, Washington, 1977-1981. IN: Brannon, E. L. and E. O. Salo, editors. 1981. Salmon and Trout Migratory Behavior Symposium. Washington Department of Natural Resources, Forks, Washington. p. 98-110.

Cederholm, C.J., Reid, L.M. and Salo, E.O. 1980. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. Presented to the conference Salmon-Spawning Gravel: A Renewable Resource in the Pacific Northwest? Seattle, Washington, October 6-7, 1980, Contribution No. 543, College of Fisheries, University of Washington, Seattle, WA. 35 p.

Chamberlain, T.W., R.D. Harr and F.H. Everest. 1991. Timber harvesting, silviculture, silviculture and watershed processes. Pages 181-205 in Influences of forest and rangeland management on salmonid fishes and their habitats. W.R. Meehan, editor. Am. Fish. Soc. Spec. Pub. 19, Bethesda, Maryland.

Chapman, D. W., and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Transactions of the American Fisheries Society 109:357-363.

Chapman. D.W. 1988. Critical Review of Variables Used to Define Effects of Fines in Redds of Large Salmonids. Transactions of the American Fisheries Society. 117: 1-21.

Chen, J.T. 1991. Edge Effects: Microclimatic Pattern and Biological Responses in Old-growth Douglas-fir Forests. Ph.D. Dissertation, University of Washington, Seattle, Washington.

Chow, V.T. 1964. Handbook of Applied Hydrology, McGraw-Hill Book Company,1964..

Claussen, D. L. 1973. The thermal relations of the tailed frog, *ascaphus Ascaphus truei*, and the Pacific treefrog, *hHyla regilla*. In Comp. Biochem. Physiol. 137153. Great Britain: Pergamon Press.

Coffin, B. A., and R. D. Harr, 1992. Effects of forest cover on volume of water delivery to soil during rain-on-snow. Final report to Sediment, Hydrology and Mass Wasting Steering Committee, Timber-Fish-Wildlife Group, Project 18.

Coleman, S.M., 1973, The history of mass movement processes in the Redwood Creek basin, Humboldt County, CA: Pennsylvania State University, University Park, paper presented in lieu of MS thesis, 180 p.

Collins, B.D. and T. Dunne, 1989. Gravel transport, gravel harvesting, and channel-bed degradation in rivers draining the Southern Olympic Mountains, Washington, USA, Environmental Geology and Water Science, 13, 213-224.

Corn, P. S., and R. B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. For Ecology Mangmt. 29:39-57.de Vlaming, V. L., and R. B. Bury. 1970. Thermal selection in tadpoles of the tailed frog, *Ascaphus truei*. J. Herpetol. 4:179-189.

Cruden, D.M., and Varnes, D.J., 1996, Landslide types and processes, in Turner, A.K., and Schuster, R.L. eds., Landslides, investigation and mitigation: Transportation Research Board, National Research Council, Special Report 247, p. 36.Crunden and Varnes, 1996 3.3 geology

Davenport, C.W. 1982-84. Geology and Geomorphic Features Related to Landsliding, Crescent City, Hiouchi, High Divide, Smith River, Leggett, Noble Butte, Childs Hill, Requa and Tan Oak Park 7.5 - minute Quadrangles, Calif. Div. of Mines and Geology, Open File Reports 82-21, 83-4, 83-18, 83-19, 83-40, 83-41, 84-7, 84-8 and 84-17, San Francisco Office.

Dietrich, W.E., Bellugi, D., and Real de Asua, R., 2000 (in press), Validation of the Shallow Landslide Model, SHALSTAB, for Forest Management, in Wigmosta, M.S., and Burges, S.J., eds., Influence of Urban and Forest Land Use on the Hydro-Geomorphic response f Watersheds, American Geophysical Union Water Resources Monograph.

Dietrich, W.E., Dunne, T., Humphrey, N.F., and Reid, L.M., 1982, Construction of Sediment Budgets for Drainage Basins, In Sediment Budgets and Routing in Forest Drainage Basins, Swanson, F.J., R.J. Janda, T. Dunne, D. N. Swanston, eds., USDA Forest Service General Technical Report PNW-141, p. 5-23.

Dietrich, W.E., Real de Asua, R., Coyle, J., Orr, B., and Trso, M., 1998, A validation study of the shallow slope stability model, SHALSTAB, in forested lands of Northern California; unpublished report prepared for Louisiana-Pacific Corporation, Calpella, CA, p. 16.

Dietrich, W.E., Willson, C.J., Montgomery, D.R., McKean, J., and Bauer, R., 1992, Channelization thresholds and land surface morphology: Geology, v. 20, p. 675-679.

Dietrich, W.E., Wilson, C.J., Montgomery, D.R., and McKean, J., 1993, Analysis of erosion thresholds, channel netwrks and landscape morphology using digital terrain model: Geology, v. 101, p. 259-278.

Diller, L. V. and R. L. Wallace. 1996. Distribution and habitat of Rhyacotriton variegatus in managed, young growth forests in north coastal California. J. Herpetol. 30:184-191.

Diller, L. V. and R. L. Wallace. 1999. Distribution and habitat of Ascaphus truei in streams on managed, young growth forests in north coastal California. J. Herpetol. 33:71-79.

Dunne, T. and L. Leopold. 1978. Water in environmental planning. W. H. Freeman, San Francisco, CA. 818 pp

Durgin, P.P., Johnston, R.R., and Parsons, A.M., 1988, Causes of erosion on private timberlands in northern California. In: Critical Sites Erosion Study: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, v. I, p. 50p.

Evans, W. A., and B. Johnston. 1980. Fish migration and fish passage: a practical guide to solving fish passage problems. USDA Forest Service. Region 5. No. EM-7100-12. 43 p.

Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Fishery Res. Rep. No. 7, Oregon State Game Commission. 48p.

Everest, F.H., R.L. Beschta, J.C. Schrivener, K.V. Koski, J.R. Sedell, and C.J. Cederholm. 1987. Chapter 4. Fine sediment and salmonid production: A paradox. In: Salo, E.O., T.W. Cundy, editors.

Farro, M.. 1999. Pacific Coast Fish, Wildlife and Wetlands Restoration Association. Interview, November 2, 1999.

Fausch, K. D. and M. K. Young. 1995. Evolutionarily Significant Units and Movement of Resident Stream Fishes: A Cautionary Tale. American Fisheries Society Symposium. 17:360-370.

Flosi, G. and F.L. Reynolds. 1994. California salmonid stream habitat restoration manual. IFD, CDFG, Sacramento, CA.

Flosi, G., S. Downie, J. Hoplain, M. Bird, R. Coey, and B. Collins. 1998. ClaiforniaCalifornia salmonid stream habitat restoration manual. 3rd ed. IFS, CDFG, Sacramento, CA.

Furniss, M.J., S. A. Flanagan, and B. McFadin. 2000. Hydrologically-Connected Roads: An Indicator of the Influence of Roads on Chronic Sedimentation, Surface Water Hydrology,and Exposure to Toxic Chemicals. In Stream Notes: To aid in securing favorable conditions of water flows. USDA, Rocky Mountain Research Station. July 2000.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance, p. 297-323. In W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 751 p.

Gale, D. B., T. H. Hayden, L.S. Harris, and H. N. Voight. 1998. Assessment of Anadromous Fish Stocks in Blue Creek, Lower Klamath River, California, 1994-1996. Yurok Tribal Fisheries Program, Habitat Assessment and Biological Monitoring Division, Technical Report No. 4.

Gale, D.B., and D.B. Randolph. 2000. Lower Klamath river sub-basin watershed restoration plan. Yurok Tribal Fisheries Program, Klamath CA.

Gerstung, E.R. 1997. Status of Coastal Cutthroat Trout in California. Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation. Oregon Chapter, Amer. Fish. Soc., 1997 Pgs. 43-56.

Gibbons, D.R., and E.O. Salo. 1973. An annotated bibliography of the effects of logging on fish of the western U.S. and Canada. Gen. Tech. Rep. PNW-10. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland Oregon.

Gowan, C., M. K. Young, K. D. Fausch and S. C. Riley. 1994. Restricted movement in resident stream salmonids: a paradigm lost? Can. J. Fish. Aquat. Sci. 51: 2626-2637.

Grant, G.E., F.J. Swanson, and M.G Wolman. 1990. Pattern and origin of stepped-bed morphology in high-gradient streams, western Cascades, Oregon. Geological Society of America Bulletin, 102: 340-352.

Gregory, R. S., 1993. Effect of turbidity on the predator avoidance behavior of juvenile chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci. 50:241-246.

Hagans, D.K. and W.E. Weaver. 1987. Magnitude, cause and basin response to fluvial erosion, Redwood Creek basin, northern California. 419-428 in Erosion and sedimentation in the Pacific rim. Beschta, R.L., Blinn, T., Grant, G.E., Ice, G.G. and Swanson, F.J. [Eds]. IAHS 165. Washington, DC: International Association of Hydrologic Sciences.

Halbert, C.L. 1993. "How Adaptive is Adaptive Management? Implementing Adaptive Management in Washington State and British Columbia." Reviews in Fisheries Science, 1(3): 261-283.

Hallock, R.I., R.F, Elwell, and D.H. Fry, Jr. 1970. Migrations of adult king salmon Oncorhynchus tshawytscha in the San Joaquin Delta as demonstrated by the use of sonic tags. Calif. Dept. Fish and Came, Fish Bull. 151.

Hankin, D.G, 1999. Unpublished MS, a modification of the "Hankin and Reeves" (1988) survey designs, as summarized in detail by Dolloff et al. (1993).

Harden, D. R., 1998, California Geology. Upper Saddle River, N.J., Prentice Hall, Inc, 427 pp.

Harden, D.R., Coleman, S.M., and Nolan, K.M., 1995, Mass Movement in the Redwood Creek Basin, Northwest California: Geomorphic processes and aquatic habitat in the Redwood Creek basin, northwestern California. U.S. Geological Survey Professional Paper 1454, p. G1-G11.

Harden, D.R., H.M. Kelsey, S.D. Morrison, and T.A. Stephens. 1981. Geologic Map of the Redwood Creek Drainage Basin, Humboldt County, California, U.S. Geological Survey, Water Resources Division, Menlo Park, California, Open File Report 81-496.

Harden, D.R., H.M. Kelsey, S.D. Morrison, and T.A. Stevens, 1982, Geologic Map of the Redwood Creek Drainage Basin, Humboldt County, California: U.S. Geological Survey Water Resources Division Open-File Report 81-496 Map, scale 1:62,500.

Harr, R. D., 1986, Effects of clear-cut logging on rain-on-snow runoff in western Oregon: A new look at old studies, Water Resources Research, 22(7), 1095-1100.

Harr, R.D. 1977. Water flux in soil and subsoil on a steep forested slope. J. Hydrology 33:37-58.

Harr, R.D., R.L. Fredriksen, and J. Rotacher. 1979. Changes in streamflow following timber harvest in Southwestern Oregon. USDA For. Serv., Res. Paper PNW-249. 22 pp.

Harr, R.D., W.C. Harper, and J.T. Krygier. 1975. Changes in storm hydrographs after road building and clear cutting in the Oregon Coast Range. Water Res. Research 11:436-444

Hartman, G. F. and T. G. Brown. 1987. Use of small, temporary, floodplain tributaries by juvenile salmonids in a west coast rain-forest drainage basin, Carnation Creek, British Columbia. Can. J. Fish Aquat. Sci. 44:262-270.

Haupt, H.F. 1959. Road and slope characteristics affecting sediment movement from logging roads, J. Forestry, 57(5): 329-339.

Hibbert, A.R. 1967. Forest treatment effects on water yield. Pp. 527-543 In: Sopper, W.E., H.W. Lull (editors), Forest hydrology. Proceedings of a National Science Foundation advanced science seminar; August 29-September 10, 1965; University Park, PA. Pergamon Press, New York, NY.

Hicks, B.J., J.D. Hall, P.A. Bisson and J.R. Sedell. 1991. Responses of salmonids to habitat changes. American Fisheries Society Special Publication 19:483-518.

Higgins, P.T., S. Dobush, and D. Fuller. 1992. Factors in Northern California Threatening Stocks with Extinction. Humboldt Chapter of American Fisheries Society. Arcata, CA. 25pp.

Howard, C.F. and P. Albro. 1997. Juvenile outmigrant monitoring program. 1997 Report for the West Branch and East Fork of Mill Creek. Unpublished report, Stimson Lumber Company. Crescent City, California.

Hughes, R. M. and G.E. Davis. 1986. Production of coexisting juvenile coho salmon and steelhead trout in heated model stream communities. ASTM Spec. Tech, Pub. 920: 322-337.

James, S.M. 1982. Mad River Watershed Erosion Investigation, Calif. Dept. of Water Resources, Northern District, June 1982.

Johnson, M.G. and R.L. Beschta. 1980. Logging, infiltration capacity, and surface erodibility in western Oregon. J. For.78:334-337.

Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, F.W. Waknitz, A.M. Garrett, G.J. Bryant, K. Neeley, and J.J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California.

Judson, S. and D. F. Ritter. 1964. Rates of regional denudation in the United States. Jour. Of Geophys. Research. Vol. 69(11):3395-3401.

Keller, E. A., A. MacDonald, T. Tally, and N. J. Merrit. 1995. Effects of large organic debris on channel morphology and sediment storage in selected tributaries of Redwood Creek, Northwestern California. Pp. 1-29, in: Nolan, K. M., H. M. Kelsey, and D. C. Marron, eds. Geomorphic processes and aquatic habitats in the Redwood Creek basin, northwestern California. U. S. Geol. Surv. Prof. Pap. 1454-P.

Keller, E.A. and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Sci. Pro. 4: 361-380.

Keller, E.A. and T. Tally. 1979. Effects of large organic debris on channel form and fluvial processes in the coastal redwood environment. Pages 169-197 in Adjustments of the fluvial system. D.D. Rhodes and G.P. Williams, editors. Kendall/Hunt, Dubuque, Iowa.

Kelley, F.R. 1984. Geology and Geomorphic Features Related to Landsliding, Lincoln Ridge, Hales Grove, Piercy, Arcata North and Arcata South 7.5-minute Quadrangles, Calif. Div. of Mines and Geology, Open File Reports, 84-14, 84-15, 84-16, 84-38 and 84-39, San Francisco Office.

Kelsey, H.M. 1982. Hillslope evolution and sediment movement in a forested headwater basin, Van Duzen River, north coastal California. PNW-141, Pacific Northwest Forest and Range Experiment Station.

Kelsey, H.M., Coghlan, M., Pitlick, J., and Best, D., 1995, Geomorphic analysis of streamside landslides in Redwood Creek basin, northeastern California, Geomorphic processes and aquatic habitat in the Redwood Creek basin, northwestern California, U.S. Geological Survey Professional Paper 1454, p. J1-J12.

Kelsey, H.M., M. Coghlan, J. Pitlick, and D. Best. 1995, Geomorphic analysis of streamside landslides in Redwood Creek basin, northeastern California, Geomorphic processes and aquatic habitat in the Redwood Creek basin, northwestern California, U.S. Geological Survey Professional Paper 1454, p. J1-J12.

Kelsey, H.M., M.A., Madej, J.C. Pitlic, T.M.Coghlan, D.W. Best, R. Belding, and P. Stroud. 1981. Sediment sources and sediment transport in the Redwood Creek Basin, a progress report, RNP Technical report No. 3, National Park Service, Arcata, CA.

Keppeler, E., and D. Brown, 1998. Subsurface Drainage Processes and Management Impacts.USDA Forest Service Gen. Tech. Rep. PSW-GTR-168. 1998.

Keppeler, E. T. 1998. The summer flow and water yield response to timber harvest. In: Ziemer, Robert R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 6 May 1998; Ukiah, California. General Tech. Rep. PSW GTR-168. Albany, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 35-43.Keppeler, E. T., and Robert R. Ziemer. 1990. Logging effects on streamflow: water yields and summer flows at Caspar Creek in northwestern California. Water Resources Research 26(7): 1669-1679.

Kilbourne, R.T. 1983-85. Geology and Geomorphic Features Related to Landsliding, Sherwood Peak, Cahto Peak, Longvale, Willits NW, Willits SW, Iron Peak, Laytonville, Fortuna, Hydesville, McWhinney Creek, Korbel and Blue Lake 7.5-minute Quadrangles, Calif. Div. of Mines and Geology, Open File Reports 83-38, 83-39, 84-18, 84-19, 84-20, 84-40, 84-41, 85-1, 85-2, 85-3, 85-5 and 85-6, San Francisco Office.

King, J.G., and L.C. Tennyson. 1984. Alteration of streamflow characteristics following road construction in north central Idaho. Water Res. Research 20(8): 1159-1163.

Konecki, J. T., C. A. Woody, and T. P. Quinn. 1995. Critical thermal maxima of coho salmon (Oncorhynchus kisutch) fry under field and laboratory acclimation regimes. Can. J. Zool. 73:993-996.

LaHusen, R.G., 1984, Characteristics of management related debris flows, northwestern California., Symposium on the Effects of Forest Land Use on Erosion and Slope Stability: Honolulu, HI, May 7-11, 1984, p. 139-145.

Larse, R.W. 1971. Prevention and Control of Erosion and Stream Sedimentation from Forest Roads. In *Proceedings of the Symposium of Forest Land Uses and the Stream Environment*, pp. 76-83. Oregon State University.

Ledwith, T. 1996. The effects of buffer strip width on air temperature and relative humidity in a stream riparian zone. Watershed Management Council Networker, Summer.

Lewis, Jack. 1998. Evaluating the impacts of logging activities on erosion and sediment transport in the Caspar Creek watersheds. In: Ziemer, Robert R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 6 May 1998; Ukiah, California. General Tech. Rep. PSW GTR-168. Albany, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 55-69.

Lisle, T. E. 1989. Sediment transport and resulting deposition in spawning gravels, north coastal California. Water Resources Research 25(6): 1303-1319. [Caspar Creek]

Lisle, T. E., 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, southeast Alaska. North American Journal of fisheries Management 6:538-550

Lisle, T. E., 1990. The Eel River, northwestern California; high sediment yields from a dynamic landscape. Pages 311-314, in: M.G. Wolman and H.C. Riggs (ed.), Surface Water Hydrology, v. O-1, The Geology of North America, Geological Society of America.

Lisle, T. E., and S.Hilton. 1999. Fine bed material in pools of natural gravel bed channels. Water Resources Research 35(4): 1291-1304

Lisle, T. E., J. E. Pizzuto, H. Ikeda, F. Iseya, and Y. Kodama. 1997. Evolution of a sediment wave in an experimental channel. Water Resources Research 33(8): 1971-1981.

Lisle, T.E. 1987. Using residual depths to monitor pool depths independently of discharge. USDA For. Ser. Res. Note PSW-394.

Louisiana-Pacific Corporation (LP). 1986. Estuary Seining information 1985-86. File from LP archives. Provided by Simpson Timber Company.

Marron, D.C., Nolan, K.M. and Janda, R.J., 1995. Surface erosion by overland flow in the Redwood Creek basin, northwestern California, effects of logging and rock type. 1454, USGS.

McCashion, J.D., and Rice, R.M., 1983, Erosion on logging roads in northwestern California: How much is avoidable?: Journal of Forestry, v. 81, p. 23-26.

McCuddin, M. E. 1977. Survival of salmon and trout embryos and fry in gravel-sand mixtures. Master's thesis. University of Idaho, Moscow.

McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. Van Sickle. 1990. Source Distances For Coarse Woody Debris Entering Small Streams in Western Oregon and Washington. Canadian Journal of Forest Research. 20:326-330.

McKenzie, D.P. and Morgan, W.J. 1969, Evolution of triple junctions, Nature, 224, 5125 p. 124-133

McLaughlin, R.J., S.D. Ellen, M.C. Blake, Jr., A.S. Jayko, W.P. Irwin, K.R. Aalto, G.A. Carver, and S.H. Clarke, Jr., 2000, Geology of the Cape Mendocino, Eureka, Garberville, and Southwestern part of the Hayfork 30 x 60 Minute Quadrangles and Adjacent Offshore Area, Northern California. U.S. Geological Survey Pamphlet to accompany Miscellaneous Field Studies MF-2336, p. 2-26.

Montgomery and Buffington, 1993, Channel classification, prediction of channel response, and assessment of channel condition. Report TFW-SH10-93-002 prepared for the SHAMW committee of the Washington State Timber/Fish/Wildlife Agreement, 84 pgs.

Montgomery, D.R., and Dietrich, W.E., 1994, A physically-based model for topographic control on shallow landsliding: Water Resources Research, v. 30, p. 1153-1171.

Moore, K. M. S. and S. V. Gregory. 1988. Summer habitat utilization and ecology of cutthroat trout fry (*Samo clarki*) in Cascade Mountain streams. Canadian Journal of Fisheries and Aquatic Sciences. 45:1921-1930.

Moyle, P.B. 1976. Inland fishes of California. University of California Press, Berkeley, California. 405 pp.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish sepcies of special concern in California. IFD, CDFG, Sacramento, CA. 272 pp.

Murphy and Koski 1989. Input and depletion of woody debris in Alaska streams and Implications for streamside management. North American Journal of Fisheries Management 9: 427-436.

Murphy M. L. and W. R. Meehan. 1991. Stream Ecosystems. American Fisheries Society Special Publication 19:139-179.

Murphy, M.L., Heifetz, J., Johnson, S.W., Koski, K.V. and Thedinga, J.F., 1986. Effects of clear-cut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Canadian Journal of Fisheries and Aquatic Sciences, 43: 1521-151533.

Murphy. M.L. and W.R. Meehan. 1991. Stream ecosystems. Pages 17-46 in Influences in forest and rangeland management on salmonid fishes and their habitats. W.R. Meehan, editor. Amer. Fish Soc. Spec. Pub. 19.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Naiman, R. editor. 1992. Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag. 148 pp

National Marine Fisheries Service. 1997. Aquatic properly functioning condition matrix. NMFS, Southwest Region, Northern California Area Office, Santa Rosa and USFWS, Arcata, California.

National Marine Fisheries Service. 1999. Generic Salmonid Conservation Measures for Forestry Activities for a Short-Term HCP, National Marine Fisheries Service, July 1999

National Marine Fisheries Service (NMFS). 2001. Status review update for coho salmon (Oncorhynchus kisutch) from the central California coast and the California portion of the southern Oregon/northern California coasts evolutionarily significant units. Southwest Fisheries Science Center, Santa Cruz Laboratory. 12 April 2001 revision.

NCASI (National Council of the Paper Industry for Air and Stream Improvement, Inc.). 1999. Scale considerations and the detectability of sedimentary cumulative watershed effects. Technical Bulletin No. 776. Research Triangle Park, N.C., National Council of the Paper Industry for Air and Stream Improvement, Inc.

Nehlsen, W., J.E. Williams and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho and Washington. Fisheries, Am. Fish. Soc. 16(2): 4-21.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. North American Journal of Fisheries Management. 11: 72-82.

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16: 693-727.

Nickelson, T.E., J.D. Rogers, S.L. Johnson and M.F. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (Oncorhynchus kisutch) in Oregon coastal streams. Can. J. Fish. Aq. Sci. 49: 783-789.

Nickelson, T. E. and P.W. Lawson, 1998. Population viability of coho salmon, Oncorhynchus kisutch, in Oregon coastal basins: application of a habitat-based life cycle model Canadian Journal of Fisheries and Aquatic Sciences, 55: 2383-2392.

Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Portland, Oregon.

Nussbaum, R. A. and C. K. Tait. 1977. Aspects of the life history and ecology of the Olympic salamander, Rhyacotriton olympicus (Gaige). Am. Midl. Nat. 98:176-199.

O'Connor, M.D. and Harr, R.D. 1994. Bedload transport and large organic debris in steep mountain streams in forested watersheds on the Olympic Peninsula, Washington. Final Report to Washington Department of Natural Resources and Timber/Fish/Wildlife, Olympia, Washington. TFW-SH7-94-001.

Ogle, B.A. 1953. Geologic Map of the Eel River Valley Area, California, Div. of Mines, Bulletin 164.

PWA, 1998, Sediment source investigation and sediment reduction plan for the North Fork Elk River watershed, Humboldt County, CA., Unpublished technical report for Pacific Lumber Company.

PWA, 1999a, Sediment Source Investigation and Sediment Reduction Plan for Freshwater Creek Watershed, Humboldt County, CA, Technical report prepared for Pacific Lumber Company, Scotia, CA, by Pacific Watershed Associates, p. 94.

PWA, 1999b, Sediment Source Investigation and Sediment Reduction Plan for the Jordan Creek Watershed, Humboldt County, CA, Pacific Watershed Associates, Technical report prepared for The Pacific Lumber Company, Scotia, CA, January, 1999, 63p p.

Pyles, M. R.; K. Mills and G. Saunders, 1987. Mechanics and stability of the Lookout Creek earth flow. Bulletin of the Association of Engineering Geologists. 24(2): 267-280.

Raines, M.A., and Kelsey, H.M., 1991, Sediment budget for the Grouse Creek basin, Humboldt County, CA., USDA, USDA Forest Service, Six Rivers National Forest, Eureka, CA.

Raudkivi, A.J., 1990, Loose Boundary Hydraulics, Pergamon Press, Elmsford, NY.

Redwood National and State Parks (RNSP). 1994. Field data of revisit of 1981 Redwood Creek thesis sites. In files of Redwood National and State Parks, South Operations Center, Orick, California. Project funded by USFS Redwood Sciences Laboratory.

Redwood National and State Parks (RNSP). 1995-1996. Field data of barrier survey of Redwood Creek tributaries. In files of Redwood National and State Parks, South Operations Center, Orick, California. Project funded by USFS Redwood Sciences Laboratory.

Reeves, G.H., F.H. Everest, and J.D. Hall. 1987. Interactions between the redside shiner (Richardsonius balteatus) and the steelhead trout (Salmo gairdneri) in western Oregon: the influence of water temperature, Can. J. Fish. Aq. Sci. 44: 1603-1613.

Reid L. M. and S. Hilton.,, 1998, Buffering the Buffer. USDA Forest Service Gen. Tech. Rep. PSW-GTR-168.

Reid, L.M., and T. Dunne, 1984. Sediment production from forest road surfaces. Water Resources Research 20: 1753-1761.

Reiser, D. W. and R. G. White. 1988. Effects of two sediment-size classes on steelhead trout and Chinook salmon egg incubation and juvenile quality. North American Journal of fisheries Management 8:432-437.

Rice, R. M., and P. A. Datzman. 1981. Erosion associated with cable and tractor logging in northwestern California. In: Timothy R. H. Davies and Andrew J. Pearce (eds.), Erosion and Sediment Transport in Pacific Rim Steeplands, Proceedings of the Christchurch Symposium, 25-31 January 1981, Christchurch, New Zealand. Int. Assn. Hydrol. Sci. Pub. No. 132: 362-374.

Rice, R.M., and Lewis, J., 1991, Estimating erosion risks associated with logging and forested roads in northwestern California.: Water Resources Bulletin, v. 27, p. 809-818.

Rice, Raymond M., Forest B. Tilley, and Patricia A. Datzman. 1979. A watershed's response to logging and roads: South Fork of Caspar Creek, California, 1967-1976. USDA Forest Service Research Paper PSW-146. Berkeley, California: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture. 12 p.

Richards, K.S., 1982. Rivers: form and process in alluvial channels. Methuen. London.

Ristau, Donn. 1979. Geologic Maps of Twenty-six 15-minute Quadrangles in Del Norte, Humboldt, Trinity and Siskiyou Counties, Calif. Dept of Forestry Title II Geologic Data Compilation Project. Scale 1:62,500.

Robards, T., 1999. Instructions for WLPZ canopy/surface cover compliance sampling under Forest Practice Rules. Calif. Dept. of Forestry and Fire Protection – Forest Practices, Sacramento, CA. 2 pages.

Schmidt, K.M. Roering, J.J., Stock, J.D., Dietrich, W.E., Montgomery, D.R., and Schaub, T. (in press) Root cohesion variability and susceptibility to shallow landsliding in the Oregon Coast Range. Canadian Geotechnical Journal.

Sedell, J.R., F. J. Swanson, and S.V. Gregory. 1984. Evaluating fish responses to woody debris. Pages 222-245 in Proceedings, symposium on propagation, enhancement and rehabilitation of anadromous salmonid populations and habitat in the Pacific Northwest, T.J, T.J. Hassler, editor. Ca. Coop. Fish Res. Unit, Humboldt State University, Arcata, California.

Shaw T. A. and C. L. Jackson. 1994. Little River juvenile salmonid outmigration monitoring 1994. U. S. Fish and Wildlife Service, Coastal California Fish and Wildlife Office, Arcata, California.

Shirvell, C. S. 1994. Effect of changes in streamflow on the microhabitat use and movements of sympatric juvenile coho (Oncorhynchus kisutch) and chinook salmon (O. tshawytscha) in a natural stream. Can. J. Fish. Aquat. Sci. 51:1644-1652.

Sidle, R.C., Pearce, A.J., and O'Loughlin, C.L., 1985, Hillslope stability and land use, Am. Geophysical Union, 140 p.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113:142-150.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, R. P. Novitzki, 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. Corvallis, OR. Man Tech Environmental Research Services Corporation.

Steele, J. and G. Stacey, 1994, 1994. Coho salmon habitat impacts: a qualitative assessment technique for registered professional foresters. CDFG, Draft #2. 31 pp.

Strand, R.G., 1963, Geologic Map of California, Weed Sheet, scale 1:250,000: California Division of Mines and Geology.

Stuart, J.D. 1987. Fire history of an old-growth forest of *Sequoia sempervirens* (Taxodiaceae) in Humboldt Redwoods State Park, California. Madrono 34(2):128-141.

Stuart, J.D. and L. Fox. 1993. Humboldt Redwoods State Park unit prescribed fire management plan. Arcata, CA: California Department of Parks and Recreation. 239 p.

Sullivan, K., J. Tooley, K. Doughty, J.E. Caldwell, and P. Knudsen. 1990. Evaluation of prediction models and characterization of stream temperature regimes in Washington. Timber/Fish/Wildlife Rep. No. TFW-WQ3-90-006. Washington Dept. Nat. Resources, Olympia, Washington. 224 pp.

Sullivan, K., T. E. Lisle, C. A. Dolloff, G. E. Grant, and L.M. Reid. 1987. Stream channels; the link between forests and fishes. Pages 39-97 in Salo and Cundy (1987).

Swanson, F. J., T. K. Kratz, N. Caine, and R. G. Woodmansee. 1988. Landform effects on ecosystem patterns and processes. Bioscience 38: 92-98.

Swanson, F.J., and Dryness, C.T., 1975, Impact of clearcutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon.: Geology, v. 3, p. 393-396.

Swanston, D. N. 1981. Creep and earthflow erosion from undisturbed andmanagement impacted slopes of the Coast and Cascade Ranges of the Pacific Northwest, U.S.A. In: Erosion and Sediment Transport in Pacific Rim Steeplands. I.A.H.S. Publ. No. 132:76-94.

Swanston, D. N. and F. J. Swanson, 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. In: Coates, Donald R., ed. Geomorphology and engineering. Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc.: 199-221.

Swanston, D.N. 1971. Principal mass movement processes influenced by roadbuilding, logging and fire. Pages 29-40 in Krygier and Hall (1971).

Swanston, D.N. 1991. Natural processes. Pp. 139-179 In: W.R. Meehan (editor), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. Am. Fish. Soc. Special Publication No. 19.

Tagart, J. V. 1976. The survival from egg deposition to emergence of coho salmon in the Clearwater River, Jefferson County, Washington. Master's thesis. University of Washington, Seattle.

Tappel, P. D. and T. C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management 3: 123-135.

Taylor, A.H. and C.N. Skinner. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management 111:285-301.

Transportation Research Board. 1996. Landslides: Investigation and Mitigation, Special Report 247. Turner, A.K. and Schuster, R.L. (Eds.) National Research Council, National Academy Press, Washington D.C., 673 p.

Triska, F.J., V.C. Kennedy, R.J. Avanzino and B.N. Reilly. 1983. Effect of simulated canopy cover on regulation of nitrate uptake and primary production by natural periphyton assemblages. pp 129-159 In: T. Fontaine and S. Bartell (eds.), Dynamics of L otic Ecosystems, Ann Arbor Science Publishers, Michigan.

U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-37. 292 p.

US Fish and Wildlife Service. 1967. Letter to District Engineer, San Francisco District, Corps of Engineers. San Francisco, CA. 1967.

Van Sickle, J. and S.V. Gregory. 1990. Modeling Inputs of Large Woody Debris to Streams from Falling Trees. Canadian Journal of Forest Research. 20:1593-1601.

Voight, H. N. and D. B. Gale. 1998. Distribution of fish species in tributaries of the lower Klamath River: an interim report for FY 1996 Yurok Tribal Fisheries Program, Klamath, CA. 71 p. plus appendices.

Waananen A. O. and J. R. Crippen. 1997. Magnitude and frequency of floods in California. U. S. Geological Survey, Water-Resources Investigations 77-21.

Wagner, D.L. and G.J. Saucedo. 1987. Geologic Map of the Weed Quadrangle, Regional Geologic Map Series, Map No. 4A, Calif. Div. of Mines and Geology.

Walters, C. 1986. Adaptive management of renewable resources. Macmillan, New York.

Weaver, W.E. and D.K. Hagans, 1994. Handbook for forest and ranch roads; a guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads. Pacific Watershed Associates, Arcata, California. 190 pp.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-24, 258 pp.

Welch. E. J. M. Jacoby & C. W. May. 1998. Stream quality. In R. J. Naiman 8r R. E. Bilhy teds). River Ecology and Management: Lessons from the Paatic Coastal Ecoregion. Springer-Verlag. New York: 67-92.

Welsh, H. H., Jr., and A. J. Lind. 1996. Habitat correlates of the southern torrent salamander, Rhyacotriton variegates (Caudata: Rhyacotritonidae) in northwestern California. Journal of Herpetology 30:385-398.

Welsh, H.H., Jr. 1990. Relictual amphibians and old-growth forests. Conservation Biology 4: 309-319.

Welsh, H.H., Jr. 1992. Population ecology of two relictual salamanders from the Klamath Mountains of Northwestern California, pp. 419-437, In McCullough, D.R., and R.H. Barrett (eds.), Wildlife 2001: Populations. Elsevier Applied Science, New York.

Welsh, H.H., Jr., G. R. Hodgson, and B. C. Harvey, 2001. Distribution of jevenile coho salmon in relation to water temperatures in tributaries of the Mattole River, California. North American Journal of Fisheries Management 21:464-470.

Weseloh, T. 1999. California Trout. Interview, November 2, 1999.

Wood, P.J. and Armitage, P.D. (1997). Biological effects of fine sediment in the lotic environment Environmental Management, 21, 203-217.

Woodward-Clyde Consultants, 1980, Evaluation of the potential for resolving the geologic and seismic issues at Humboldt Bay Power Plant Unit No. 3, Report prepared for Pacific Gas and Electric Company, summary report and appendices.

Wright, K.A., K.H. Sendek, R.M. Rice, and R.B. Thomas. 1990. Logging effects on streamflow: storm runoff at Caspar Creek in northwestern California. Water Res. Research 26(7):1657-1667.

Yang, C.T. 1996. Sediment Transport: Theory and Practice. McGraw Hill, 396 p.

Yoshinori, T., and Osamu, K. 1984. Vegetative influences on debris slide occurrences on steep slopes in Japan In Symposium on effects of forest land use on erosion and slope stability. East-West Center, Honolulu. pp. 63-72.

Young, J.C. 1978. Geology of the Willow Creek Quadrangle, Humboldt and Trinity Counties, California, Calif. Div. of Mines and Geology, Map Sheet 31.

Young, K.A., S. G. Hinch and T. G. Northcote. 1999. Status of resident coastal cutthroat trout and their habitat twenty-five years after riparian logging. North American Journal of Fisheries Management 19:901-911.

Ziemer, Robert R. 1998. Flooding and stormflows. In: Ziemer, Robert R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 6 May 1998; Ukiah, California. General Tech. Rep. PSW GTR-168. Albany, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 15-24.

Section 10. Glossary

10.1 ABBREVIATIONS

AHCP	Aquatic Habitat Conservation Plan
AMRA	Adaptive Management Reserve Account
BACI	Before-After-Control-Impact
CCAA	Candidate Conservation Agreement with Assurances
CCR	California Code of Regulations
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CI	Confidence Interval
CMZ	Channel Migration Zone
CWA	Clean Water Act
dbh	diameter at breast height
DPS	Distinct Population Segment
DSL	Deep-Seated Landslide
EEZ	Equipment Exclusion Zone
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESP	Enhancement of Survival Permit
ESU	Evolutionarily Significant Unit
FFFC	Fish, Farms, and Forestry Communities (Coalition)
FPRs	Forest Practice Rules
FRIS	Forest Resources Information System
FSAs	Fully Stocked Acres
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HPA	Hydrographic Planning Area
HRA	Habitat Retention Area
HW	Headwater Depth
IA	Implementation Agreement
ITP	Incidental Take Permit
LWD	Large Woody Debris
MSP	Maximum Sustained Production
MWPZ	Mass Wasting Prescription Zones
MWAT	Maximum Weekly Average Temperature
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NSO	Northern Spotted Owl
PI	Prediction Interval
PG	Professional Geologist
RPF	Registered Professional Forester

RSMZ	Riparian Slope Stability Management Zone
RWQCB	Regional Water Quality Control Board
RWU	Road Work Unit
SMZ	Slope Stability Management Zone
SSS	Steep Streamside Slope
THP	Timber Harvesting Plan
TMDL	Total Maximum Daily Load
USFWS	U.S. Fish and Wildlife Service
WLPZ	Watercourse and Lake Protection Zone
7DMAVG	highest 7-day moving mean of water temperature
7DMMX	highest 7-day moving mean of the maximum daily temperature

10.2 DEFINITIONS

Adaptive Management: As defined by the Services for purposes of their HCP program, a method for examining alternative strategies for meeting measurable biological goals and objectives, and then, if necessary, adjusting future conservation management actions according to what is learned (65 Federal Register 106, 36245).

Adjustment Area: Commercial timberland acreage within the 11 HPAs that is not within Green Diamond's ownership on any given date during the term of the Plan. This includes lands that are eligible for addition to the Plan Area through acquisition or that may be removed from the Plan Area through sale, subject to the limitations imposed by the Plan and IA.

Aerial yarding: Movement of logs to a landing by use of helicopters, or balloons, often used where roads cannot be constructed to provide access to a harvesting unit.

Age class: One of the intervals into which the age range of trees is divided for classification or use in management.

Aggradation: Deposition in one place of material eroded from another. Aggradation raises the elevation of streambeds, floodplains, and the bottoms of other water bodies.

Alevin: Larval salmonid that has hatched but has not fully absorbed its yolk sac and has not yet emerged from the spawning gravel.

Alluvial (*alluvium*): Referring to the process of sediment transport and depositions resulting from flowing water (sediments laid down in river beds, flood plains, lakes, fans at the foot of mountain slopes, and estuaries).

Anadromous: A life history strategy in which fish are born and rear in freshwater, move to the ocean to grow, and return to freshwater to reproduce; an example is Chinook salmon (*Oncorhynchus tschawytscha*).

Approach velocity: The velocity of water perpendicular to the face of a screen (e.g. water drafting intake).

Bankfull channel width: Channel width between the tops of the most pronounced bank on either side of a stream reach where water would just begin to flow out onto the floodplain.

Basal area: The cross sectional area of a single stem, including the bark, measured at breast height (4.5 feet above the ground).

Bedload: Sand, silt and gravel, or soil and rock debris rolled along the bottom of a stream by moving water.

Before-After-Control-Impact (BACI): An experimental approach that utilizes a paired design with treatment and control sites. Data are collected from both experimental sites before and after the treatment and an analysis is done to determine if the relationship of the response variable(s) between the treatment and control sites differs following the treatment.

Beneficial use: One of several uses of streams and lakes that may include drinking, fish habitat, and recreation. This phrase has a specific technical connotation because the federal Clean Water Act requires states to adopt standards and procedures that protect designated beneficial uses of public waters.

Bog: A peat-accumulating wetland that has no significant inflows or outflows and supports acidophilic mosses, particularly sphagnum.

Boulders: Substrate particles greater than 256 mm in diameter. Often subclassified as small (256-1,024) and large (>1,024 mm) boulders.

Break-in-slope: See Qualifying Slope Break.

Broadcast burn: A prescribed fire allowed to burn over a designated area with well-defined boundaries to achieve some land management objective.

Bucking: Use of a saw to remove log lengths from a tree after it has been felled.

Buffer: A vegetation strip or management zone of varying size, shape, and character maintained along a stream, lake, road, or different vegetation zone to minimize the impacts of actions on sensitive resources.

Cable yarding: Taking logs from the stump area to a landing using an overhead system of winch-driven cables to which logs are attached with chokers.

California Forest Practice Rules (CFPRs): Rules promulgated by the California Board of Forestry and administered by the California Department of Forestry and Fire Protection governing the conduct of commercial timber operations on state and private land in California.

Candidate Conservation Agreement with Assurances (CCAA): An agreement between a non-federal property owner and the Service(s), in which the property owner commits to implement conservation measures for a proposed or candidate species or a species likely to become a candidate or proposed in the near future. The property owner also receives assurances from the Service(s) that additional conservation measures will not be required and additional land, water, or resource use restrictions will not be imposed should the currently unlisted species become listed in the future (64 Federal Register 116, 32727). The agreement accompanying with an enhancement of survival permit issued under section 10(a)(1)(A) of the ESA.

Canopy closure: The ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area.

Canopy cover: The proportion of ground or water covered by a vertical projection of the outermost perimeter of the natural spread of foliage or plants, including small openings within the canopy.

Changed Circumstances: Changes in circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the Services and that can be planned for (e.g. the listing of a new species, or a fire or other natural catastrophic event in areas prone to such events.). 50 CFR §§ 17.3, 222.102. Changes that will constitute Changed Circumstances, and the responses to those circumstances, are described in Plan Section 6.2. Changed Circumstances are not Unforeseen Circumstances.

Channel: Natural or artificial waterway of perceptible extent that periodically or continuously contains moving water.

Channel migration: A natural process in which streams shift position laterally on their floodplain or valley floor.

Channel Migration Zones (CMZs): Current boundaries of bankfull channel along the portion of the floodplain that is likely to become part of the active channel in the next 50 years. The area of the channel defined by a boundary that generally corresponds to the modern floodplain, but may also include terraces that are subject to significant bank erosion.

Class I watercourses: All current or historical fish-bearing watercourses and/or domestic water supplies that are on site and/or within 100 feet downstream of the intake.

Class II watercourses: As used in the Plan, watercourses containing no fish, but support or provides habitat for aquatic vertebrates. Seeps and springs that support or provide habitat for aquatic vertebrates are also considered Class II watercourses with respect to the conservation measures.

Class II-1 watercourse: A subset of Class II watercourses, as illustrated in Figure 6-2 of the Plan.

Class II-2 watercourse: A subset of Class II watercourses, as illustrated in Figure 6-2 of the Plan

Class III watercourses: Small seasonal channels which do not support aquatic species, but have the potential to transport sediment to Class I or II watercourses.

Clearcutting: Even-aged regeneration method where all the merchantable trees in the stand are removed in one harvest. Regeneration is accomplished by natural or artificial means.

Cobble: Substrate particles 64-256 mm in diameter. Often subclassified as small (64-128 mm) and large (128-256 mm).

Co-dominant tree: A tree whose crown helps to form the general level of the main canopy in even-aged stands or in uneven-aged stands, the main canopy of the tree's immediate neighbors, receiving full light from above and comparatively little from the sides.

Commercial harvest: Removal of merchantable trees from a stand.

Convergent slopes: Slopes that drain toward one another.

Covered Activities: Certain activities carried out by Green Diamond in the Plan Area that may result in incidental take of Covered Species and all those activities necessary to carry out the commitments reflected in the Plan's Operating Conservation Program and IA.

Covered Species: The species identified in Table 1-4 of this Plan, which the Plan addresses in a manner sufficient to meet all of the criteria for issuing an incidental take permit under ESA Section 10(a)(1)(B) and all of the criteria for issuing an enhancement of survival permit under ESA Section 10(a)(1)(A), as applicable.

Critical dip: A dip in the road constructed on the downhill side of a stream crossing to intercept and prevent a stream from flowing down the road if the crossing is overtopped.

Cull: A tree or log that does not meet merchantable specifications.

Culvert: Buried pipe structure that allows streamflow or road drainage to pass under a road.

Cumulative effect: As defined in the Services' HCP Handbook and Draft CCAA Handbook: Under NEPA regulations, the incremental environmental impact or effect of the action together with the impacts of past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR 1508.7). Under ESA section 7 regulations, the effects of future state or private activities not involving federal activities, that are reasonably certain to occur with the action area of the federal action subject to consultation (50 CFR 402.02).

Daylighting: Harvesting of trees within 25' of the edge of an existing road to speed drying of the road surface and provide better visibility for save travel.

Debris flow: A landslide with mixed particle size and a high water content that acts in a fluid or plastic motion.

Debris slide: A landslide of mixed particle size, predominantly dry unconsolidated material. May move fast or slow.

Debris torrent: A fast moving, channelized debris flow.

Deep-seated landslide: Landslides that have a basal slip plane that is relatively deep and commonly extends into bedrock. These are typically vegetated with trees and/or grass and typically move incrementally.

Degradation (habitat): To degrade or lessen the habitat value of a stream.

Degradation (streambed): Erosional removal of materials from one place to another. Degradation lowers the elevation of streambeds and floodplains.

Diameter at breast height (DBH): The diameter of a tree 4.5 feet above the ground on the uphill side of the tree.

Dissolved oxygen: Oxygen found in solution with water in streams and lakes. Solubility is generally measured in mg/l and varies with temperature, salinity, and atmospheric pressure.

Ditch relief culvert: A drainage structure or facility which will move water from an inside road ditch to an outside area.

Divergent slopes: Slopes that drain away from one another.

Dominant tree: A tree whose crown extends above the general level of the main canopy of even-aged stands or, in uneven-aged stands, above the crowns of the tree's immediate neighbors and receiving full light from above and partly from the sides.

Drainage: An area (basin) mostly bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed.

Drainage area: Total land area draining to any point in a stream, as measured on a map, aerial photo, or other horizontal, two-dimensional projection.

Early spring drying: The period from May 1st through May 14th where no measurable rainfall has occurred within the last 5 days and no rain is forecasted by the National Weather Service for the next 5 days.

Earthflow: A landslide with predominantly fine grained material and high water content that acts in a fluid or plastic motion.

Effective date: The date(s) upon which the ITP and ESP are issued by the Services.

Eleven (11) HPAs: The area encompassed by the eleven Hydrographic Planning Areas identified in Figure 1-1 and Table 1-1 of the Plan and described in Section 1.3.2.4.

Eligible Plan Area: All privately owned commercial timberlands within the 11 HPAs that, over the life of the Plan, are either included within the Plan Area or are eligible for inclusion in the Plan Area. This is the entire commercial timberland acreage analyzed in the Plan to support the Plan's provisions allowing for additions and deletions of lands from the Plan Area of the term of the Plan and Permits.

Embeddedness: The extent to which large streambed particles (boulders, cobbles, rubble, and gravel) are surrounded or covered by fine sediments, usually assessed by visual examination of spawning riffles and pool tailouts and measured in classes according to percent coverage.

Endangered: The classification given to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

Enhancement of Survival Permit (ESP): A permit issued by the Service(s) pursuant to ESA Section 10(a)(1)(A) for any act that enhances the propagation or survival of a listed species that would otherwise be prohibited by ESA Section 9. The permit that authorizes incidental take of species covered by a CCAA.

Equipment Exclusion Zone (EEZ): An area where use of heavy equipment is not allowed.

Equipment Limitation Zone (ELZ): An area where the use of heavy equipment associated with timber operations is partially restricted for the protection of water quality, the beneficial uses of water, and/or other forest resources.

ESP Species: The species for which Green Diamond is seeking an ESP from USFWS ; the species named on the ESP.

Estuary: Semi-enclosed body of water that has a free connection with the open ocean and within which seawater is measurably diluted with fresh water derived from land drainage.

Evapotranspiration: The conversion of water, whether open or as soil moisture (both by evaporation) or within plants (by transpiration), into water vapor that is released into the atmosphere.

Even-aged stand: A stand of trees composed of a single age class in which the range of tree ages is usually +/- 20 percent of rotation.

Even-aged management: The application of a combination of actions that results in the creation of even-aged stands. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Evolutionarily Significant Unit (ESU): A population (or group of populations) that is substantially reproductively isolated from other population units of the same species, and represents an important component in the evolutionary legacy of the species.

Extirpate: The elimination of a species from a particular area.

Feasible: Capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, operational, and technological factors, and considering what is allowable under the law.

Fine sediment: Sediment with particle size of 2 mm and less, including sand, silt, and clay.

Fish-friendly structure: Culvert or other structure that will provide upstream and downstream passage for all life stages of fish and not restrict the active channel flow.

Floodplain: The area adjacent to the stream constructed by the river in the present climate and inundated during periods of high flow.

Fluvial. Describes a condition that is produced by the action of a stream. Also describes a fish or plant species living in a stream or river.

Forest management: The practical application of biological, physical, quantitative, managerial, economic, social, and policy principles to the regeneration, management, utilization, and conservation of forests to meet specified goals and objectives while maintaining the productivity of the forest.

Front-end loader: A machine with special forks, lifts, or grapples for loading logs onto trucks, pallets, or railcars.

Fry: Life stage of trout and salmon between full absorption of the yolk sac and a somewhat arbitrarily defined fingering or parr stage (generally reached by the end of the first summer).

Geomorphic processes: Landscape modifying processes such as surface erosion, mass wasting, and stream flow.

Gradient: Average change in vertical elevation per unit of horizontal distance.

Gravel: Substrate particles between 2 and 64 mm in diameter.

Green Diamond's ownership: Commercial timberlands that Green Diamond owns in fee and lands owned by others subject to Green Diamond harvesting rights.

Ground-based yarding: Movement of logs to a landing by use of tractors, either tracked or rubber tired (rubber tired skidders) or shovels (hydraulic boom log loaders).

Habitat: The place, natural or other wise, (including climate, food, cover, and water) where an animal, plant, or population naturally or normally lives and develops.

Habitat Conservation Plan (HCP). As defined in the Services' HCP Handbook, a planning document that is a mandatory component of an application for an incidental take permit under ESA Section 10(a)(1)(B); also known as a conservation plan. The document that, among other things, identifies the operating conservation program that will be implemented to minimize, mitigate, and monitor the effects of incidental take on the species covered by a Section 10(a)(1)(B) permit.

Harass: A form of take under the ESA. Defined in ESA implementing regulations promulgated by the Department of Interior as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The Department of Commerce/NMFS has not defined "harass" by regulation.

Harm: A form of take under the ESA. Defined in federal regulations as an act which actually kills or injures fish and wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR part 222.102; also see 50 CFR part 17.3).

Harvesting: All activities necessary to cut, remove, and transport timber products from the Plan Area.

Harvesting Rights: The rights to conduct timber operations on lands owned in fee by another. Short-term harvesting rights generally expire upon the conclusion of timber operations, upon a date certain, or a combination of the two. Perpetual harvesting rights pertain to existing and subsequent crops of timber and continue without expiration.

Headwall swales: Areas of narrow, steep, convergent topography (swales or hollows) located at the heads of Class III watercourses that have been sculpted over geologic time by repeated debris slide and debris flow events.

Headwater depth: The vertical distance from the bottom of the culvert at the inlet to the water surface of the pool.

Heel-boom loader: A stationary piece of log loading equipment located on roads and landings, similar to a construction crane, that uses a crane-like grapple to deck, move, and load logs onto log trucks from one central pivot point.

Historically active landslide scarp: Any ground crack that exhibits at least 3 inches of horizontal displacement or at least 6 inches of vertical displacement with movement within the past 100 years.

Historically active landslide toe: An area below the inflection point of the convex, lobate landform at the downslope end of the landslide.

Hot-loading: (See hot-logging).

Hot-logging: A logging operation in which the logs are not decked and stored but loaded onto a truck as soon as they are skidded to a landing.

HPA Group: HPAs that have been grouped together based on their geologic and geomorphic characteristics for purposes applying slope stability measures.

Hydrographic Area: An HPA that encompasses either multiple watersheds or a fraction of one watershed.

Hydrographic Planning Area (HPA): The hydrographic areas and hydrologic units mapped in the AHCP/CCAA which encompass the Eligible Plan Area and surrounding lands in common watersheds.

Hydrologic Unit: An HPA that encompasses an entire drainage.

Hydrologically disconnected: Isolation of the road network such that drainage will not directly enter into watercourses.

Hyporehic zone: The hyporehic zone is the interstitial area within a stream that occurs beneath the surface of the streambed and is the interface between surface water and the underlying groundwater.

Implementation Agreement (IA): An agreement between the Service(s) and the incidental take permittee(s) that identifies the obligations of the parties, identifies remedies if parties fail to meet their obligations, provides assurances to the Service(s) that the conservation plan will be implemented, and provides assurances to the permittee(s) that implementation of the plan satisfies ESA requirements for the species and activities covered by the plan and permit.

Incidental take: The taking of a federally listed species, if such taking is incidental to, and not the purpose of, carrying out otherwise lawful activities.

Incidental Take Permit (ITP): A permit issued by the Services pursuant to ESA Section 10(a)(1)(B) authorizing incidental take of federally listed species named on the permit.

Initial Plan Area: Green Diamond's ownership within the 11 HPAs as of the effective date of the Permits, as depicted in Figure 1-1 of the Plan.

Inner Gorge: A geomorphic feature formed by coalescing scars originating by coalescing scars originating from landsliding and erosisonal processes caused by historically active stream erosion. The feature is identified as that area beginning immediately adjacent to the stream channel below extending up slope to the first break in the slope. Inner gorge is a subset of Steep Streamside Slopes.

Insloping: Describes a road where the inner edges of the road surface are lower than the outer edges of the road, and consequently runoff is directed into an “inside” ditch between the road surface and the adjacent uphill sideslope.

Intermediate tree: A tree whose crown extends into the lower portion of the main canopy of even-aged stands or, in uneven-aged stands, into the lower portion of the canopy formed by the tree’s immediate neighbors, but shorter in height than the co-dominants and receiving little direct light from above and none from the sides.

Intermittent stream: A stream that flows only at certain times of the year and/or when it receives water from springs or from a surface source. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available streamflow.

Issuance criteria: The criteria specified in the ESA and federal regulations for issuance of an ITP or ESP; also, the criteria specified in the CCAA policy for an ESP.

Iteroparous: Species in which individuals may survive to spawn more than once (eg. steelhead).

ITP Species: The Covered Species for which Green Diamond is seeking an ITP; the species named on the ITP.

Jack: Young salmon, usually a male, that mature precociously. The small males with mature gonads migrate upstream with other mature salmon and spawn by sneaking into redds to release sperm simultaneously with a spawning pair.

Landings: The areas where harvested trees are gathered (through skidding or yarding) for subsequent transport out of the forest.

Landslide headscarp: The uppermost scarp of a landslide below the landslide crown, but above any secondary scarps; may also be referred to as crown scarp, main scarp, or primary scarp.

Landslide prone terrain: Potentially higher risk areas for producing shallow landslides compared to adjacent slopes.

Large woody debris (LWD): Larger pieces of wood in stream channels or on the ground, including logs, root wads, and large chunks of wood that provide important biological and physical functions.

Listed species: A species, subspecies, or qualifying distinct population segment of a vertebrate species on the lists of threatened and endangered wildlife and plants in 50 CFR 17.11 and 17.12. Also, a species, subspecies, or variety of plant or animal on the lists of the endangered, threatened, and rare species maintained by the California Fish and Game Commission.

Mainline roads: Roads that support significant amounts of traffic annually from major tracts of timber or provide the main access into a tract for non-harvest management activities.

Mainstem: Principal stem of channel of a drainage system.

Management roads: Roads that are needed to either support long term management activities in the Plan Area or provide access to timber that will be harvested within the next 20 years.

Mass soil movement (mass wasting): All geologic processes in which masses of earth materials move downslope by gravitational forces. Includes, but is not limited to, landslides, rock falls, and debris avalanches. It does not, however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).

Mass Wasting Prescription Zones (MWPZs): Steep streamside slopes, deep-seated landslides, and headwall swales where slope stability measures will be applied.

Maximum extent practicable. Term used in the ESA and federal regulations to describe the level of impact minimization and mitigation required for incidental take of a listed species to be authorized under ESA Section 10(a)(1)(B).

Maximum sustained timber production: Harvest levels planned under CFPRs to balance forest growth and timber harvest over a 100-year period and to achieve maximum sustained production of high quality timber products while protecting resource values such as water quality and wildlife.

Maximum Weekly Average Temperature (MWAT) Threshold: A calculated value, based on experimental data, which is the upper temperature recommended for a specific life stage of a species.

Merchantable: Trees or stands having the size, quality, and condition suitable for marketing under a give economic condition, even if not immediately accessible for logging.

Mesic: Pertaining to or adapted to an area that has a balanced supply of water; neither wet nor dry.

Microclimate: The climate of small areas, such as under a plant or other cover, differing in extremes of temperature and moisture from the climate outside that cover.

Microhabitat: Specific combination of habitat elements in the place occupied by an organism for a specific purpose.

Minor forest products: Secondary forest materials including tree burls, stump products, boughs and greenery for wreaths and floral arrangements or similar purposes.

National Marine Fisheries Service (NMFS): A division of the U.S. Department of Commerce that is responsible for the stewardship of the nation's marine resources, the protection and recovery of listed marine species, and the authorization of incidental take of listed marine species.

Old growth: A forest stand with moderate-to-high canopy closure; a multi-layered canopy dominated by large overstory trees; a high incidence of large trees with large, broken tops, and other indications of decadence; numerous large snags; and heavy accumulations of logs and other woody debris on the ground.

Operating Conservation Program: As defined in 50 CFR §§ 17.3, 222.102, those conservation management activities which are expressly agreed upon and described in a conservation plan or its implementing agreement, if any, and which are to be undertaken for the affected species when implementing an approved conservation plan, including measures to respond to changed circumstances. In this Plan and the IA, the conservation management activities and specific measures (including provisions for changed circumstances, funding, monitoring, reporting, adaptive management, and dispute resolution) as set forth in Section 6.2.

Original Assessed Ownership: That portion of Green Diamond's ownership that was assessed at the time the Plan was prepared.

Out-migration: The downstream movement of juvenile salmonid fish in streams toward the ocean during which a physiological adaptation termed smoltification occurs thus allowing the young fish to survive in a saline environment.

Outsloping: Describes a road where the inner edges of the road surface are higher than the outer edges of the road. Consequently, runoff is directed onto the sideslope downhill of the road.

Overstory: That portion of the trees, in a forest of more than one story, forming the upper or uppermost canopy layer.

Parr: Young salmonid, in the stage between alevin and smolt, that has developed distinctive dark "parr marks" on its sides and is actively feeding in fresh water.

Permanently decommissioned roads: Decommissioned roads that will not be needed for future management activities.

Permit or Permits: The incidental take permit (ITP) issued by NMFS to Green Diamond pursuant to ESA Section 10(a)(1)(B) or the enhancement of survival permit (ESP) issued by USFWS to Green Diamond pursuant to ESA Section 10(a)(1)(A) ("ESP"), or both the ITP and the ESP.

Physiographic regions: Geographical areas that are delineated according to common physical characteristics relating to their geology, and geomorphology.

Plan: The Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances prepared by Green Diamond, dated October 2006.

Plan Area: All commercial timberland acreage within eleven Hydrographic Planning Areas (HPAs) on the west slopes of the Klamath Mountains and the Coast Range of California where Green Diamond owns fee lands and Harvesting Rights (Green Diamond's ownership), during the period of such ownership within the term of the Permits, subject to the limitations described in Section 1.3.2.3 and in the IA, and up to 100 miles of roads on lands where Green Diamond owns and exercises Road Access Rights within its approved Timber Harvesting Plan (THP) areas in the Eligible Plan Area during the term of the Plan and Permits. This is the geographic area where incidental take will be authorized, the Covered Activities will occur, and the Operating Conservation Program will be implemented. Except where stated otherwise in the Plan, references to lands, commercial timberlands, and Green Diamond's ownership in the context of the Plan Area include lands owned in fee and lands subject to harvesting rights.

Pond: A body of water smaller than a lake, sometimes artificially formed.

Pools: Pools are impoundments of flowing water in streams which are formed by structures such as bedrock, boulders, or woody debris in or adjacent to the stream channel. Velocity conditions within pools generally result in the deposition of finer sediment types.

Population: A collection of individuals that share a common gene pool.

Precommercial thinning: Thinning or pruning dense young forest trees to achieve optimum diameter growth and increase the eventual product value of the tree.

Prescribed burning: Introduction of fire under controlled conditions to remove unwanted brush, logging slash, and/or woody debris or specified forest elements.

Professional Geologist (PG): A person who holds a valid California license as a professional geologist pursuant to California's Department of Consumer Affairs Geologist and Geophysicist Act.

Qualifying slope break: A decline in slope gradient (below the specified minimum slope gradient for the given HPA) and of sufficient distance that it may be reasonably expected to impede sediment delivery to watercourses from shallow landslides originating above the slope break.

Recovery: The process by which the decline of an endangered or threatened species is arrested or reversed, or threats to its survival are neutralized so that the species' long-term survival in nature can be ensured.

Red light threshold: A threshold triggered by multiple negative monitoring responses (a series of yellow light triggers) indicating a more serious condition than the yellow light threshold.

Redd: A shallow excavated depression in a stream bottom in which fish deposit, then rebury their fertilized embryos following the spawning act. In this "nest" embryos incubate and hatch following their development.

Regeneration: The renewal of tree cover by natural or artificial means. Also the young tree crop (seedlings and saplings).

Registered Professional Forester (RPF): A person who holds a valid license as a professional forester pursuant to Article 3, Section 2, Division 1 of the California Public Resources Code (as in effect on the date of issuance of the Permits).

Residual: A tree that remains standing after some event such as selection harvest.

Riffle: A stream segment characterized by swiftly flowing water with surface agitation and have bars of deposited sediments. Riffles typically occur in areas of increased channel gradient where hydraulic conditions sort transported sediments (gravel, cobble, and boulders).

Rill: One of the first and smallest channels formed by surface erosion; also, a very small brook or trickling stream of water.

Riparian: That portion of the watershed or shoreline influenced by surface or subsurface waters, including stream or lake margins, marshes, drainage courses, springs, and seeps. Riparian areas usually have visible vegetative or physical characteristics reflecting the influence of water. Riversides and lake borders are typical riparian areas.

Riparian buffer: A set-back or management zone of varying width that is used to protect riparian and water resources from impacts from adjacent activities.

Riparian Management Zone (RMZ): A riparian buffer zone on each side of Class I or Class II watercourses that receives special treatments to provide temperature control, nutrient inputs, channel stability, sediment control, and LWD recruitment.

Riparian Slope Stability Management Zone (RSMZ): A RMZ below an SMZ or where streamside slopes exceed the minimum Steep Streamside Slope gradients. This is the SSS inner zone.

Riparian vegetation: Vegetation growing on or near the banks of a stream or other body of water in soils that exhibit some wetness characteristics during some portion of the growing season.

RMZ inner zone: The first 30 to 70 feet of RMZ area (depending on stream class and side slopes), as measured from the first line of perennial vegetation.

RMZ outer zone: The remaining 45 to 100 feet of RMZ area (depending on stream class and side slopes) or the entire area extending to the edge of the floodplain from the RMZ inner zone edge.

Road Access Rights: The rights to construct and use roads on lands outside Green Diamond's ownership pursuant to an access agreement with the fee owner.

Road daylighting: Removal of trees within 25 feet slope distance of the shoulder or cut bank of a road.

Rotation: The planned number of years between the regeneration of an even-aged stands and its final cutting at a specified stage.

Rotation age: The age of a stand when it is harvested at the end of a rotation.

Run (fish): A group of fish migrating in a river (most often on a spawning migration) that may comprise one or many stocks.

Runs (stream): Runs are stream segments characterized by swift flowing water with little surface agitation and no major flow obstructions. The substrate composition of runs usually consists of gravel, cobbles, and boulders.

Salmonids: The taxonomic group of fishes belonging to the family Salmonidae including salmon, trout, char and graylings.

Salvage operations: The removal of dead trees or trees damaged or dying because of injurious agents other than competition, to recover economic value that would otherwise be lost.

Sand: Substrate particles 0.061-2 mm in diameter.

Secondary roads: Roads that support periodic traffic into portions of tracts with the level of use dependent upon location of harvest units.

Second growth: Timber stands established after natural or human-caused removal of the original stand or previous forest growth.

Sediment: Fragments of rock, soil, and organic material transported and deposited by wind, water, or other natural phenomena.

Sedimentation: Deposition of material suspended in water or air, usually when the velocity of the transporting medium drops below the level at which the material can be supported.

Seep: An area of minor ground water outflow onto the land surface or into a stream channel; flows that are too small to be a spring.

Semelparous: Species in which individuals die following spawning (e.g., chinook salmon).

Selection harvest: The removal or trees, individually or in small groups, from the forest.

Sensitive species: Generally, a species that is sensitive to impacts from human activities and/or natural events and may be in decline due to such impacts. Also, A species designated by the California Board of Forestry pursuant to 14 CCR 898.2(d).

Services: NMFS and USFWS.

Shallow-rapid landslide: Rapid landslide event that is confined to the overlying mantle of colluvium and weathered bedrock (in some instances competent bedrock) that commonly leave a bare unvegetated scar after failure. These landslides may include debris slides, debris flows, channel bank failures, and rock falls.

Shallow-seated landslides: Relatively shallow landslides, typically confined to the overlying mantle of colluvium and weathered bedrock (in some instances competent bedrock) that commonly leave a bare unvegetated scar after failure. These landslides may include debris slides, debris/flows/torrents, channel bank failures, and rock falls.

SHALSTAB: A GIS-based slope stability computer model that delineates the relative potential for shallow landslides across the landscape. SHALSTAB identifies potential unstable areas based on both slope steepness and contributing upslope drainage area.

Side channels: Side channels are stream channels that occur along stream margins or where water at elevated flows leaves the main channel and spreads over the floodplain.

Silt: Substrate particles 0.004-0.062 mm in diameter.

Silviculture: The specific methods by which a forest stand or area is harvested and regenerated over time to achieve the desired management objectives.

Single tree selection: Individual trees are harvested and new regeneration occurs in their place. All species represented in pretreatment stands will be represented post harvest where feasible. Retention standards in stands after harvest are as follows: Site I – 125 square feet basal area; Site II and III – 75 square feet basal area; and Site IV and V – 50 square feet basal area.

Site index: A species-specific measure of actual or potential forest productivity expressed in terms of the average height of trees included in a specified stand component (defined as a certain number of dominants, codominants, or the largest and tallest trees per unit area) at a specified index or base age

Site potential tree height: The height that a dominant tree may attain given the site conditions where it occurs.

Size class: The categorization of trees into one of the following four DBH classes: seedling (< 1"), sapling (1" to 4.9"), pole (5" to 11.9"), sawtimber (12" and larger),

Skid trail: An access cut through the woods for skidding logs with ground-based equipment. It is not a high enough standard for use by highway vehicles, such as a log truck, and is therefore not a road.

Slash: Woody residue left on the ground after trees are felled, or accumulated there as a result of a storm, fire, or silvicultural treatment.

Slope break: See Qualifying Slope Break.

Slope Stability Management Zone (**SMZ):** The outer zone of an SSS zone.

Smolt: Juvenile salmonid that is undergoing physiological changes to cope with a marine environment.

Snag: A standing dead tree.

Species: As defined in ESA Section 3(15), “the term ‘species’ included any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.” Also, a population of individuals that are more or less alike and that are able to breed and produce fertile offspring under natural conditions.

Species class: Refers to the categorization of tree species into the following four classes: redwood, Douglas-fir, other conifers, and hardwoods.

Species of concern: A term used by USFWS for species that are considered sensitive to impacts and may be in decline but which currently are not listed or proposed for listing.

Spring: An area of ground water outflow onto the land surface or into a stream channel; flows are greater than a seep.

Stand: A group of trees that possesses sufficient uniformity in composition, structure, age, spatial arrangement, or condition to distinguish it from adjacent groups.

Stand improvement: An intermediate treatment made to improve the composition, structure, condition, health, and growth of even- or uneven-aged stands.

Status: The classification of a species regarding its position in the listing process under the ESA or California Fish and Game Code.

Steep Streamside Slopes (SSS): Steep slopes located immediately adjacent to a stream channel; defined by: 1) a minimum slope gradient leading to a Class I or Class II watercourse, 2) a maximum distance from a Class I or Class II watercourse, and 3) a reasonable ability for slope failures to deliver sediment to a watercourse.

SSS zone: The area in which default prescriptions for SSS will be applied; consists of an inner zone (the RSMZ) and outer zone (the SMZ).

Stream: A natural watercourse with a well-defined channel with distinguishable bed and bank showing evidence of having contained flowing water indicated by deposit of rock, sand, gravel, or soil.

Stream order: A number from 1 to 6 or higher, ranked from headwaters to river terminus, that designated the relative position of a stream or stream segment in a drainage basin. First-order streams have no tributaries; the confluence of two first-order streams produces a second-order stream; the confluence of two second-order streams produces a third-order stream, etc. However, if a first-order stream joins a second-order stream, the latter remains a second-order stream. It is not until one stream combines with another stream of the same order that the resulting stream increases by an order of magnitude.

Substrate: Mineral or organic material that forms the bed of a stream.

Summer period: The period from May 15th through October 15th.

Suppressed tree: A tree whose crown is completely overtopped by the crown of one or more neighboring trees.

Surface erosion: Movement of soil particles down or across a slope, as a result of gravity and a moving medium such as rain or wind. The transport of sediment depends on the steepness of the slope, the texture and cohesion of the soil particles, the activity of rainsplash, sheetwash, gullying, and dry ravel processes, and the presence of vegetation.

Suspended sediment: Sediment suspended in a fluid by the upward components of turbulent currents or by colloidal suspension. That part of a stream's total sediment load carried in the water column.

Sustained yield: The yield of commercial wood that an area can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal.

Swamp: a wetland dominated by trees or shrubs.

Sweeping velocity: The velocity of water parallel to the face of a screen (e.g., water drafting intake).

Take: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." 16 USCA § 1532(19); 50 CFR § 222.102. "Harm" means an act that actually kills or injures fish or wildlife, which act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including for USFWS species breeding, feeding or sheltering and for NMFS species breeding, spawning, rearing, migrating, feeding or sheltering. 50 CFR §§ 17.3, 222.102.

Temporarily decommissioned roads: Decommissioned roads that may be used again in the future for management activities but typically not for at least 20 years.

Terrace: A valley bottom landform composed of glacial or alluvial fill that occurs at a higher elevation than the active floodplain or channel migration zone.

Thalweg: The deepest point of a stream along any channel cross section.

Thinning: A treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality.

Threatened: The classification given to a plant or animal species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Timber felling: Physically cutting a tree from its stump including cutting of the felled tree into predetermined log lengths.

Timber harvesting: All activities necessary to cut, remove, and transport timber products from an area.

Timber Harvesting Plan (THP): A plan describing a proposed timber harvesting operation pursuant to 14 CCR section 4582 (as in effect on the date of issuance of the Permits).

Tractor logging: Use of a tractor to carry logs from the harvest site to a landing.

Turbidity: An indicator of the amount of sediment that is suspended in water. It has been used as an expression of the optical properties of a water sample that causes light rays to be scattered and absorbed, rather than transmitted through the sample.

Undercut bank: A bank that has its base cut away by the water action along man-made or natural overhands in the stream.

Understory: Vegetation (trees or shrubs) growing under an overstory.

Uneven-aged: A stand with trees of three or more distinct age classes, either intimately mixed or in small groups.

Unforeseen Circumstances: Changes in circumstances affecting a species or geographic area covered by the Plan that could not reasonably have been anticipated by Green Diamond and the Services at the time of the Plan's development, and that result in a substantial and adverse change in the status of the covered species." 50 CFR §§ 17.3, 222.102.

Unlisted Species: A species (including a subspecies or a distinct population segment of a vertebrate species) that is not listed as endangered or threatened under the ESA.

Unseasonably dry fall: The period from October 16th through November 15th when less than 4 inches of cumulative rainfall occurs from September 1st through October 15th.

Waterbarring: A ditch or shallow gully used to divert flowing water off roads or trails in order to prevent erosion and sediment delivery to streams. Usually constructed across the road or trail at a diagonal angle to prevent water from flowing directly down them.

Watercourse: Any well-defined channel with distinguishable bed and bank showing evidence of having contained flowing water indicated by deposit of rock, sand, gravel, or soil. Watercourse also includes manmade watercourses.

Watercourse and Lake Protection Zone (WLPZ): A strip of land, along both sides of a watercourse or around the circumference of a lake or spring, where additional management practices may be required for erosion control and for protection of the quality and beneficial uses of water, fish, and riparian wildlife habitat. (14 CCR 895.1)

Watercourse transition line: That line closest to the watercourse where perennial vegetation is permanently established.

Water drafting: Direct removal of water from a watercourse or pond into a water truck or for storage in reservoirs or tanks for use in dust abatement or fire suppression.

Watershed: The catchment area of land draining into a river, river system, or body of water; the drainage basin contributing water, organic matter, dissolved nutrients, and sediments to a stream or lake.

Wetland: A transitional area between aquatic and terrestrial ecosystems that is inundated or saturated for periods long enough to produce hydric soils and support hydrophytic vegetation.

Windthrow: Trees blown down by wind; also called blowdown.

Winter period: The period from October 16th through May 14th.

Yarding: (Alternatively: skidding). The movement of forest products from the stump to the landing.

Yellow light threshold: An early warning indicator identifying and rapidly addressing a potential problem. This threshold typically can be exceeded by a single negative monitoring result.