SANTA ROSA SUBREGIONAL LONG-TERM WASTEWATER PROJECT, ANADROMOUS FISH MIGRATION STUDY PROGRAM, 1991-1994

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for

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Chapter I.
SUMMARY

THE STUDY PROGRAM

The passage of steelhead trout through the Laguna de Santa Rosa system to their spawning grounds in Santa Rosa Creek and Mark West Creek was monitored during the winters of 1990-91, 1991-92, and 1992-93 to evaluate potential effects of reclaimed water discharged to Santa Rosa Creek by the Santa Rosa Subregional Reclamation System. The study program was expanded prior to the 1993-94 spawning season to include not only fyke netting of upstream-migrating adult steelhead, but also fyke netting of any coho salmon that might ascend these streams to spawn earlier in the winter, fyke netting of downstream migrating adults and smolts, and surveys of habitat quality and numbers of juvenile salmonids in representative portions of each watershed where reproduction occurs. The expanded study program also included fyke netting and surveys of habitat and juvenile abundance in a reference stream (Maacama Creek) which does not receive reclaimed water, as well as habitat and juvenile abundance surveys in a fourth stream (Green Valley Creek) which does receive reclaimed water discharged by another sanitary district. The four-year study period included both normal and unusually dry rainfall seasons. Figure 1-1 shows the locations of wastewater discharges, anadromous fish migration corridors, and fyke nets within the study area.

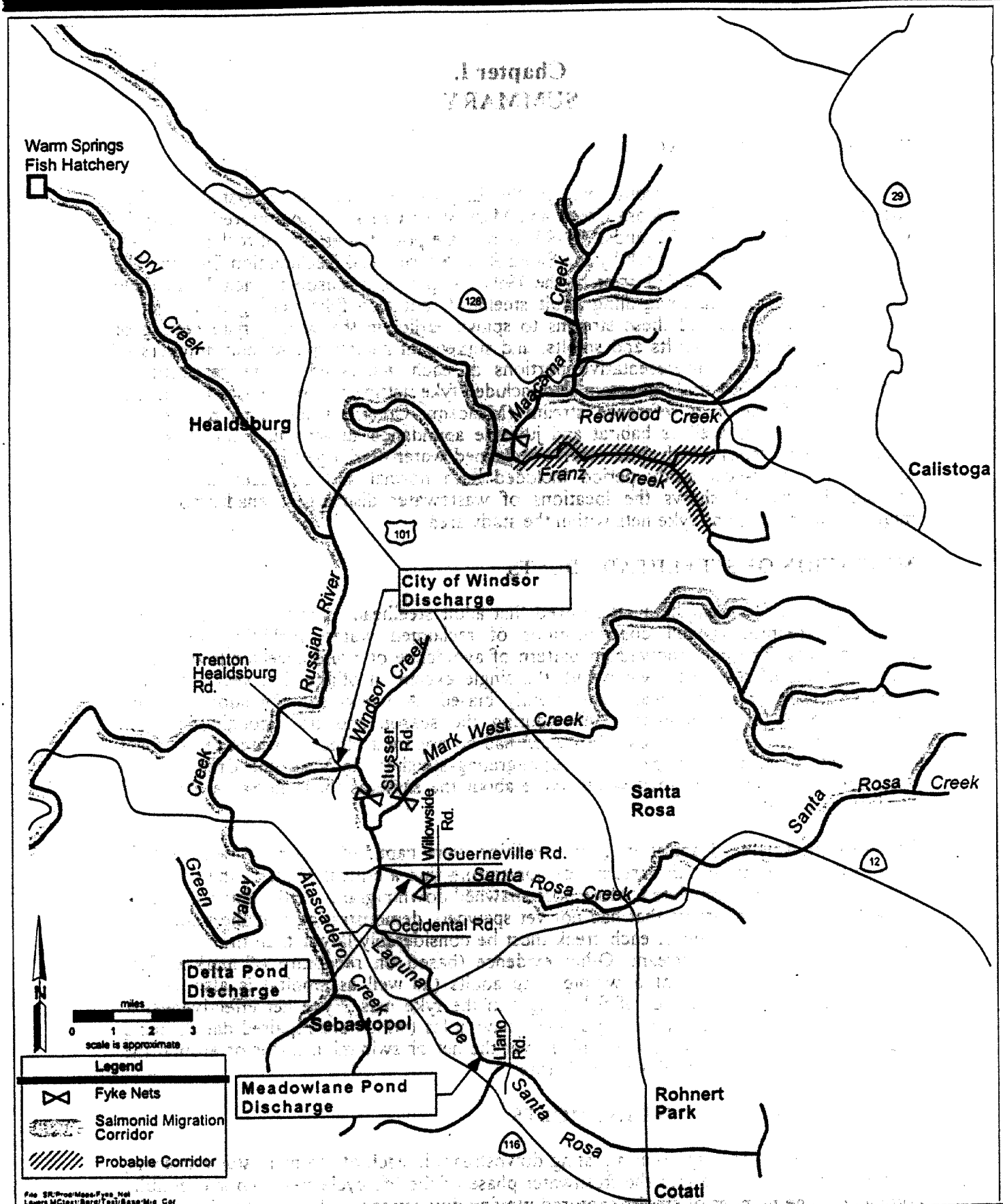
MIGRATION OF STEELHEAD ADULTS

Analysis of the four-year data set showed that adult steelhead migrated through a wide range of streamflows and concentrations of reclaimed water, including very high concentrations. The data showed no pattern of avoidance or preference for low or high concentrations of reclaimed water with the single exception of the first year’s catches, when the sampling effort was inadvertently biased. A week-long, "window" of no-discharge provided in February 1994 (during the season and flow conditions when steelhead are most likely to move upstream) had no apparent effect on catch rates. Total fish caught and fish caught per day of upmigrating steelhead in Maacama Creek, which does not receive any reclaimed water, were about the same as those in Santa Rosa and Mark West Creeks.

Spawned-out steelhead adults in good condition were captured moving downstream in each of the three main study streams, demonstrating that a critical phase in the life cycle (spawning) has been completed. More post-spawned downmigrants were captured in each creek than were upmigrants that had not yet spawned, demonstrating that the number of adults in the spawning run of each creek must be considerably larger than the number of fish captured moving upstream. Other evidence (based on recapture of marked fish) indicated that the number of downmigrating adults (as well as smolts) is also greatly underestimated by the number of fish caught in the fyke nets. Fyke net effectiveness is affected by several factors including animal gnaw holes (which are repaired daily), being overwhelmed by high flows, fish jumping over the net or swimming under or around the net at higher flows, and possibly other factors.

MIGRATION OF STEELHEAD SMOLTS

Steelhead smolts were captured migrating downstream in each of the main study streams, which is strong evidence that the freshwater phase of the life cycle has been successfully completed. The number of smolts captured moving downstream in Santa Rosa Creek was



Santa Rosa Subregional Long-Term Wastewater Project

Anadromous Fish Migration Study Area

Figure 1-1

slightly greater than the number captured in Maacama Creek, and about twice as great as the number of smolts captured in Mark West Creek. Evidence obtained by recapture of marked smolts lower in the Laguna system indicated that smolt numbers were greatly underestimated by fyke net catches, even in relatively low-flow periods. Maacama Creek had a less diverse smolt age structure than the other two streams, but there was a remarkable similarity among the three streams in mean length of smolts in each year class.

HABITAT SURVEYS

Surveys of spawning and rearing habitat indicate that each of the study streams has suffered loss of salmonid habitat, which is typical of small streams throughout the western United States. The lower reach of Santa Rosa Creek has been greatly modified by channelization and removal of riparian vegetation, resulting in low habitat diversity and summer water temperatures that are lethal to salmonids. In contrast, the middle and upper reaches of Santa Rosa Creek have relatively high-quality habitat compared to the other study streams. Water diversions by agricultural and other users appear to have severe impacts in dry years on juvenile salmonid survival in the upper reaches of Mark West and Maacama Creeks, whereas the water supply in upper Santa Rosa Creek is relatively stable because of low-intensity land development and the protection provided by Hood Mountain Regional Park.

JUVENILE DENSITY SURVEYS

The presence of large numbers of young-of-the-year steelhead in the middle and upper reaches of Santa Rosa and Mark West Creeks in early summer 1994 indicates that reclaimed water discharged in the previous winter did not prevent steelhead from successfully spawning in these streams. Recruitment of young-of-the-year steelhead was less successful in Maacama Creek, and there was no coho recruitment in the index zones surveyed. In stream reaches most affected by summer water diversions (upper Mark West Creek, upper, middle and lower Maacama) most of the juveniles present in July 1994 had disappeared (presumably died) by October. In upper and middle Santa Rosa Creek and middle Mark West Creek (less affected by water diversion), summer mortality was less severe, with the result that mean abundance in these areas was about the same in fall 1994 as it had been in fall 1993.

Juvenile coho were found during the fall 1994 juvenile abundance surveys in Green Valley Creek and Maacama Creek, but not in Santa Rosa Creek nor Mark West Creek. In the summer 1994 surveys, no young-of-the-year coho were found in any of the streams, indicating that coho reproduction was poor in the 1993-94 winter.

OVERALL CONCLUSIONS

The hypothesis that discharge of reclaimed water into the migration corridor in Santa Rosa and Mark West Creeks constitutes any impairment of these streams with respect to migration, reproduction, or rearing of steelhead is not supported by the data gathered through four years of study. Expansion of the study in the fourth year to include all freshwater phases of the life cycle has shown that these creeks have self-sustaining steelhead populations whose numbers are limited by habitat factors such as drought and water diversions in the rearing areas, not by reclaimed water. The carrying capacity of rearing habitat probably limits steelhead production in these streams considerably.

Coho may also be limited by habitat and by depressed stock coast-wide. The number of coho salmon found in the Laguna system is low relative to steelhead, and this makes

conclusions about relationships between wastewater and coho migration and reproduction difficult. Therefore, the possibility that low coho numbers in the Laguna system are related to reclaimed water cannot be ruled out. The inflexible life history of coho (i.e., no repeat spawning, isolated year classes), makes coho populations more vulnerable to extinction as a result of habitat changes than steelhead populations.

Chapter II.
INTRODUCTION

Steelhead trout and coho salmon stocks indigenous to the study area migrate from the Pacific Ocean, up the Russian River, and into its tributaries to reproduce (see Figure 1-1). The Laguna de Santa Rosa is one of the Russian River tributaries through which these anadromous fish migrate. The Santa Rosa Subregional Reclamation System (Subregional System) and the City of Windsor (CW) discharge reclaimed water (i.e., tertiary treated wastewater) to the Laguna de Santa Rosa system at the locations shown in Figure 2-1. This report summarizes the City of Santa Rosa's Anadromous Fish Migration Study Program, which has included studies of the effects of reclaimed water and other environmental factors on the migration and reproductive success of anadromous fishes in the Laguna de Santa Rosa system. This section of the report describes the project background, salmonid life histories and habitat requirements, the study area, and the scope of the field studies.

HISTORY OF ANADROMOUS FISH MONITORING

The Anadromous Fish Migration Study Program has been conducted in the Laguna system in three phases as follows:

- **Visual Monitoring.** Anadromous fish (primarily steelhead trout) migrate into the Laguna system to spawn during the winter. At the request of the California Department of Fish And Game (CDFG), the City of Santa Rosa (which operates the Subregional System) visually monitored anadromous fish migration during the winters of 1988-89 and 1989-90. The objective of the study was to characterize the timing and approximate size of the anadromous fish populations migrating through the Laguna. This phase of the study program produced no useful results in terms of run size or timing because of the low numbers of fish observed. Many fish presumably passed the observation points unseen, either at night or during turbid, high-water conditions.

- **Upstream Fyke Netting.** During the winters of 1990-91, 1991-92 and 1992-93, nets were deployed in the Laguna system to capture and count the number of adult salmonids migrating into the two Laguna tributaries believed to have reproducing populations (Mark West Creek and Santa Rosa Creek). The number of anadromous fish caught was compared to stream flow and wastewater concentration in the Laguna system. Fyke nets are effective only when stream flows are relatively low, and wastewater concentration tends to be highest when stream flows are low. Thus, any effect of the reclaimed water on fish passage would be most likely to be observed during relatively low flow conditions.

  Watershed-wide Monitoring. The City of Santa Rosa initiated the preparation of an Environmental Impact Report and Environmental Impact Statement in 1993 to evaluate alternatives for the management of wastewater through 2010. Because alternatives potentially involve increasing the rate of wastewater discharges (and thus the concentration of wastewater in the Laguna) and removing the discharge from the Laguna, the scope of the Phase 2 Anadromous Fish Migration Study Program was reviewed and modified. The review process involved key agencies (CDFG, Regional Water Quality Control Board, and National Marine Fisheries Service) and interested public. The Phase 3 study program was expanded to include not only fyke netting of upstream migrating salmonids, but also of downstream migrating adults and juveniles.

  Figure 2-1

In addition, surveys of habitat quality and numbers of juvenile salmonids in representative portions of each watershed where reproduction occurs were included in the Phase 3 study. This report summarizes the results of the Phase 2 and 3 studies.

SALMONID LIFE HISTORIES AND HABITAT REQUIREMENTS

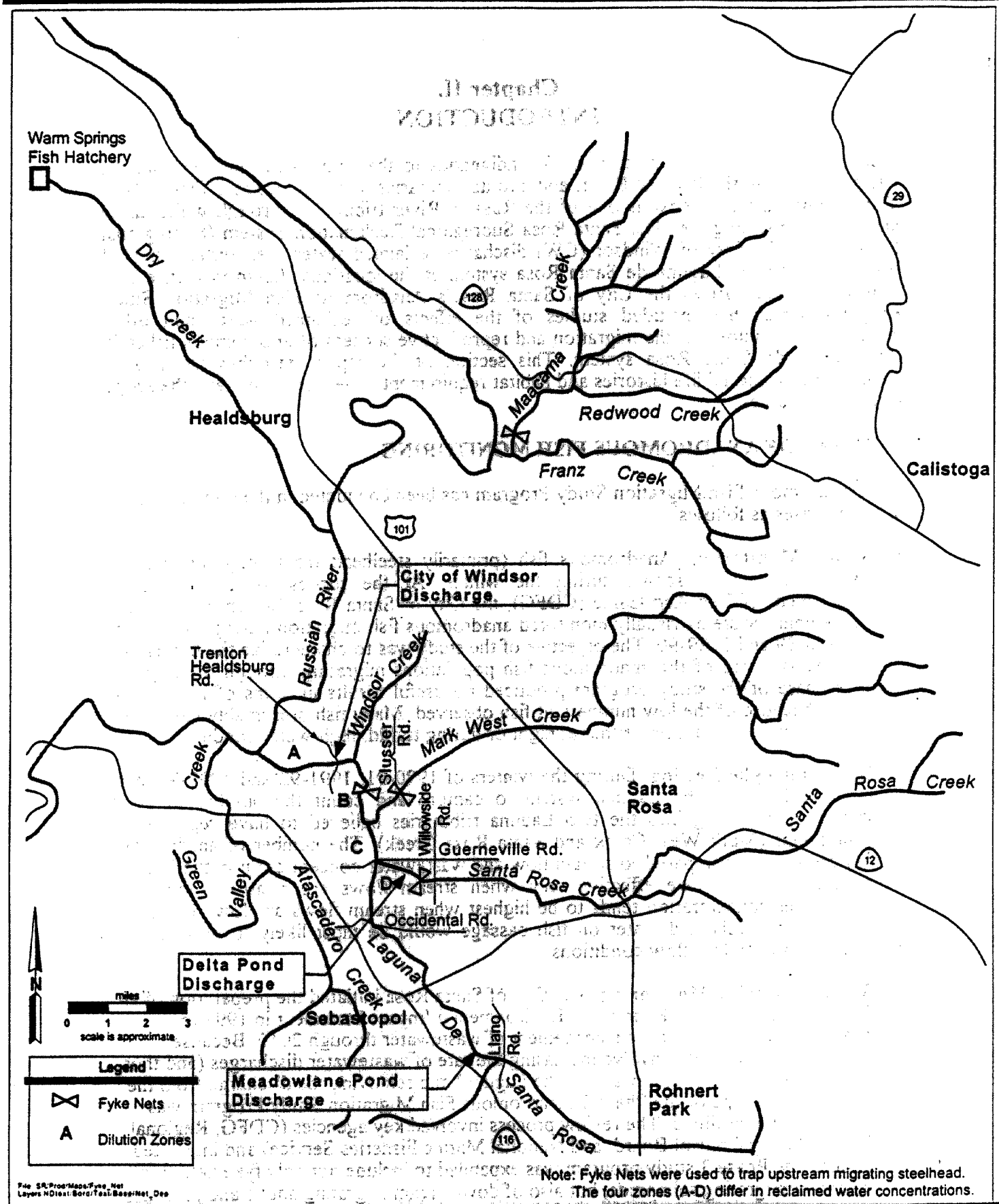
Steelhead are an anadromous (sea-run) strain of rainbow trout (long known as *Salmo gairdneri*, but recently renamed *Oncorhynchus mykiss* and now considered one of six species of Pacific salmon). Like other salmon, steelhead migrate from the ocean to freshwater streams to spawn. Unlike the other salmon, many steelhead survive and return to the sea after spawning, and may spawn again in subsequent years. Juveniles spend from one to three or more years in their natal streams before going to sea as smolts (smoltification is a process of adaptive physiological change that occurs as the juvenile fish migrate downstream on their way to the sea). After entering the sea, steelhead grow rapidly to adult size (the abundant food in the ocean is the presumed advantage of anadromy). Most steelhead return to freshwater streams to spawn after spending two or three years at sea, although some, usually males, return as "half-pounders" after only one year at sea. In the Laguna system the steelhead spawning run occurs between December and the end of April. Fish movements are determined by an interplay of their physiological readiness and winter rainfall patterns.

Studies by CDFG indicate that most steelhead enter the Russian River in January and February, but usually remain there for some time and do not enter smaller streams such as the Laguna until runoff events occur. Rainstorms cause the water to rise and turbidity to increase. Shortly thereafter, as flow and turbidity in the swollen creeks begin to decrease, the fish typically move upstream. This pattern may be considerably modified, for example, by lack of rainfall at the appropriate time, in which case fish may take advantage of any rise in stream flow, however minor, that might occur (W Cox, CDFG, pers. comm.). The 1991, 1992 and 1994 steelhead migration studies were conducted during extreme drought conditions and steelhead captures were sometimes associated with very minor flow increments. A generalized diagram of the life cycle of coho salmon and steelhead trout is shown in Figure 2-2.

Coho salmon (*Oncorhynchys kisutch*) historically spawned in many of the same small coastal streams in California that are used by steelhead, but have disappeared from many streams as the stocks have greatly declined in recent decades throughout the northwestern United States (Nehlsen, et al, 1991). A petition is now being reviewed by federal agencies to list the coho stocks remaining in California, Oregon, and Washington under the Endangered Species Act. Coho most likely spawned annually in Laguna tributaries such as Mark West Creek and Santa Rosa Creek in the past, but it is doubtful that self-sustaining populations now exist in these streams.

Coho adults usually enter the Russian River and its tributaries to spawn earlier than steelhead, primarily from October through December. Nearly all juvenile coho go to sea as smolts in late spring after spending one year in freshwater (Shapovalov and Taft, 1954). Most of the adults return to spawn after spending two years in the sea (as three year-old fish), although some males return after only one year at sea. A generalized diagram of the life history of coho salmon is presented in Figure 2-2.

Steelhead and coho both require certain types of habitat for nest-building and spawning, for successful incubation of the eggs, and for feeding and rearing of the young fish prior to their becoming smolts and making their downstream migration to the sea. The water



Note: Fyke Nets were used to trap upstream migrating steelhead.
The four zones (A-D) differ in reclaimed water concentrations.

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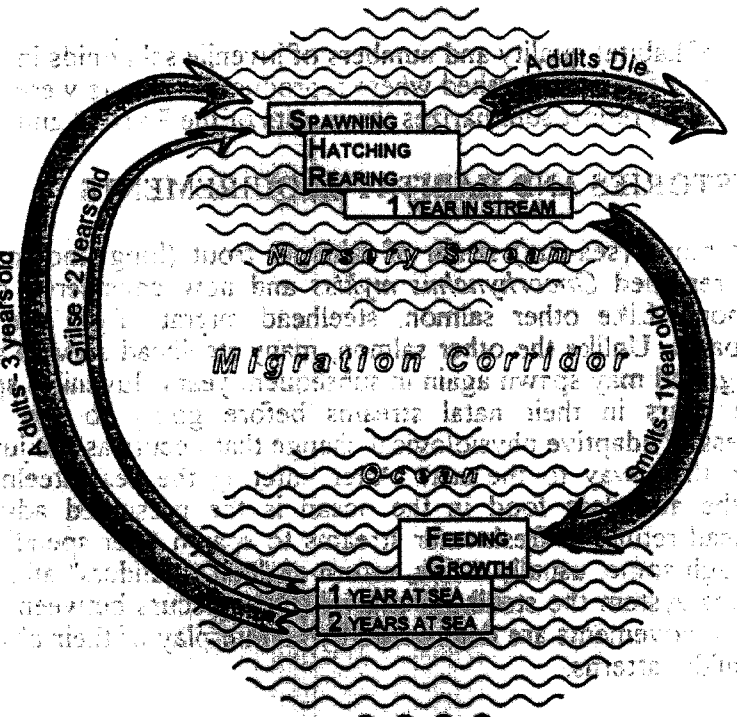
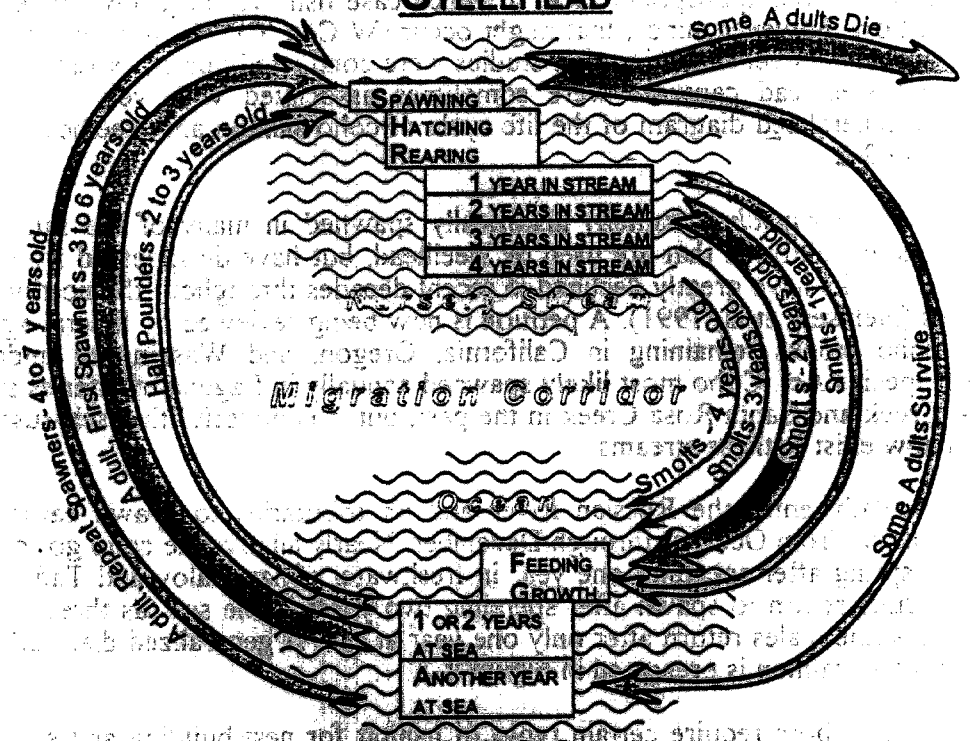
Fyke Net Deployment and Reclaimed Water Dilution Zones

Figure 2-1

COHO



STEELHEAD



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Life Cycles of Coho Salmon and Steelhead Trout

Figure 2-2

depths reported for spawning sites for coho in California range from 10-54 cm (Moyle, et al 1989) and 10 -70 cm for steelhead (Barnhart 1986). The general requirements for both species include coarse, clean, well-oxygenated gravel for making redds and spawning, where the embryos will be allowed to develop undisturbed, at appropriate temperatures and with ample water movement to supply oxygen and remove metabolic wastes. The optimal temperature range for spawning and incubation of both species in northern California is approximately 4-14° C (Reiser and Bjornn 1979, Barnhart 1986, Moyle, et al 1989). Incubation time decreases with increasing temperature, but higher temperatures also increase the virulence of pathogens and the toxicity of any harmful contaminants in the water. Water temperatures above about 18° C are generally unfavorable, and sustained temperatures above 22-25° C are lethal to embryos and juveniles of both species.

Developing embryos require high dissolved oxygen levels (near saturation) within the redd (Reiser and Bjornn 1979, Barnhart 1986, Moyle, et al 1989). Maintenance of high oxygen levels depends on a continuous flow of well-oxygenated water through the gravel; thus, the gravel must be fairly coarse (usually 2-10 cm diameter), stream velocity above the gravel in the range of 20-90 cm/second, and the gravel must be free from excessive quantities of suspended or deposited sediment. Accumulations of fine sediment (< 2 mm particle size) resulting from erosion, logging, poor agricultural practices, reduced stream velocity, etc., directly affect viability of embryos, emerging fry, and juveniles. In addition, sedimentation reduces the carrying capacity of the stream by reducing invertebrate food production and available shelter in crevices beneath cobble and boulders (Shapovalov and Taft 1954, Allen 1969, Hall and Lantz 1969, Barnhart 1986, Bratovich and Kelley 1988).

After emerging from the gravel, juvenile steelhead and coho continue to require well-aerated, cool, clean water free from excessive loads of sediment. A supply of invertebrate food is required and shelter is needed for resting and protection from predators. All else being equal, juvenile coho tend to prefer deep, shady pools with lots of woody debris and overhead cover (Moyle, et al 1989), whereas, steelhead fry are more inclined to occupy riffles (Barnhart 1986). However, in small California streams such as the ones in this study, riffle surface areas are greatly diminished during the dry season relative to pools, and both species are found mainly in pools (Cross 1975, cited in Barnhart 1986; and this report).

STUDY AREA

Migration Corridor

Under the terms of its current discharge permit, the Subregional System releases reclaimed water to the Laguna de Santa Rosa during winter months, when volumes released are limited to one percent of the flow in the Russian River, except in unusual hydrologic conditions when discharges are limited to five percent of river flow. The Laguna de Santa Rosa is a tributary of the Russian River, and itself has several tributaries, including Mark West Creek and Santa Rosa Creek (Figure 1-1). Mark West Creek and Santa Rosa Creek are believed to be the only Laguna tributaries presently supporting salmonid spawning runs (W. Cox, CDFG, *pers. comm.*). Figure 1-1 depicts the known salmonid migration pathway within the study area.

Reclaimed water releases from the Subregional System are made at various times from several points, including Meadowlane Pond adjacent to the treatment plant on Llano Road, Delta Pond on Santa Rosa Creek near Willowside Road, and from irrigation storage reservoirs along the Laguna between Llano Road and Occidental Road (Figure 2-1). In addition, the City of Windsor (CW) releases reclaimed water to the Laguna at

Trenton-Healdsburg Road at a maximum rate of one percent of Laguna flow at that location. Although reclaimed water concentrations resulting from Santa Rosa discharges to the Laguna are limited to between one and five percent of Russian River flow, the concentrations in the Laguna system can be much higher.

Fish migrating through the Laguna system experience different reclaimed water concentrations in each of several reaches (zones) within the Laguna, as presented in Figure 2-1. Between the Russian River and the CW discharge at Trenton-Healdsburg Road (Zone A, 2.9 miles), the Laguna carries all discharges from both CW and the Subregional System, diluted by the combined flows of all tributaries. Between Trenton-Healdsburg Road and the confluence with Mark West Creek (Zone B, 2.0 miles), the Laguna carries all discharges from the Subregional System (none from CW), diluted by combined flows from all tributaries except Windsor Creek (Windsor Creek flows further dilute discharges in the final 0.2-mile stretch of Zone B). Between the confluence with Mark West Creek and the confluence with Santa Rosa Creek (Zone C, 1.6 miles), the Laguna carries the same amount of discharge as in Zone B, but is diluted only by flows from Santa Rosa Creek and the Laguna upstream of its confluence with Santa Rosa Creek. Santa Rosa Creek, between its confluence with the Laguna and the Delta Pond discharge (Zone D, 0.6 miles), carries only the Delta Pond discharge, diluted only by flow in Santa Rosa Creek.

Thus, fish migrating from the Russian River to Mark West Creek must pass through Zones A and B (a distance of 4.9 miles), and fish en route to Santa Rosa Creek must pass through Zones A, B, C, and D (7.1 miles).

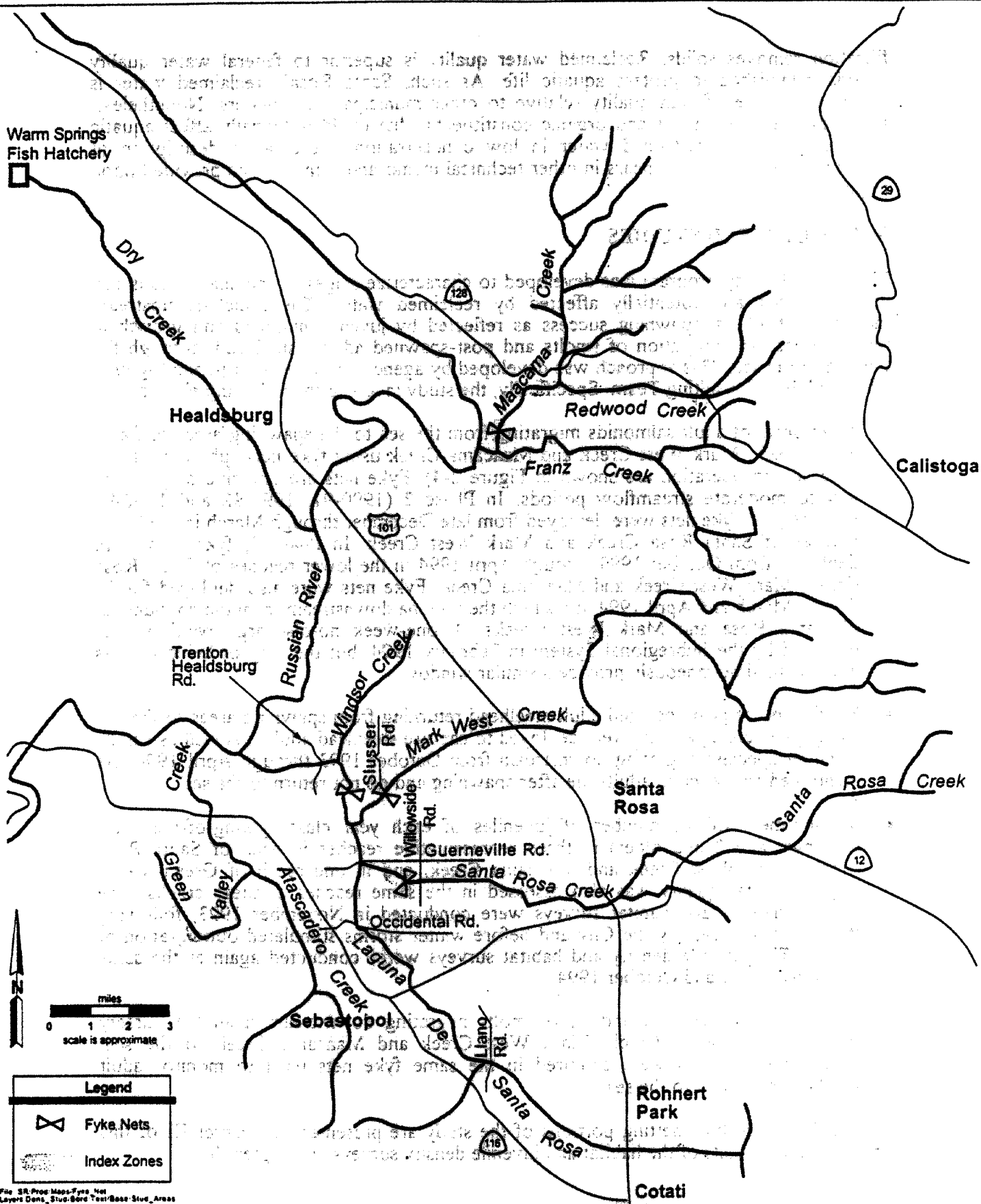
Headwaters and Watersheds

The headwaters of the study streams are shown in Figure 2-3, which also shows the locations of Maacama Creek and Green Valley Creek. Maacama Creek, which does not receive any reclaimed water, flows into the Russian River east of Healdsburg, draining the watershed on the east side of the Russian River immediately north of the area drained by Mark West Creek. Maacama Creek is similar in size and other respects to Santa Rosa Creek and Mark West Creek, and was selected as a control or reference stream for this study. If reclaimed water has any effect on anadromous salmonids in these streams, such effect(s) should be most pronounced in Santa Rosa Creek, less so in Mark West Creek, and even less so or non-existent in Maacama Creek. Fyke nets were set in Maacama Creek just upstream from its confluence with Franz Creek. Areas where habitat evaluations and juvenile salmonid density studies (Chapter IV) were conducted are also shown in Figure 2-3.

Green Valley Creek is a small stream system that enters the Russian River about a mile downstream from the mouth of the Laguna de Santa Rosa (Figure 2-3). Green Valley Creek has small runs of steelhead and coho (W. Cox, CDFG, *pers. comm*., and this study), but also receives reclaimed water discharged by the Forestville/Graton wastewater treatment plant. Thus, Green Valley Creek serves in this study as an analog of the Laguna system.

Reclaimed Water Discharges

Reclaimed water is discharged to the Laguna de Santa Rosa system by the Subregional System between October 1 and May 14 at rates of up to five percent of Russian River flow. Reclaimed water consists of tertiary treated municipal sewage from the greater Santa Rosa area. Reclaimed water is produced at the Laguna treatment plant, where extended aeration converts ammonia (potentially toxic) to nitrate (not toxic to aquatic life), and



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Habitat and Juvenile Density Index Zones

Figure 2-3

filtration removes solids. Reclaimed water quality is superior to federal water quality criteria established to protect aquatic life. As such, Santa Rosa's reclaimed water is considered to be of high quality relative to other municipal wastewaters. Nonetheless, pollutants (such as metals and organic constituents) that could potentially affect aquatic life are present in reclaimed water in low concentrations. A detailed description of reclaimed water quality appears in other technical memoranda, and can be provided upon request.

SCOPE OF FIELD STUDIES

The Phase 3 study program was developed to characterize stages of the anadromous fish life cycle that are potentially affected by reclaimed water. These include upstream migration of adults, spawning success as reflected by juvenile numbers and growth in rearing areas, and migration of smolts and post-spawned adults (steelhead) through the Laguna to the sea. This approach was developed by agency and interested public together with the HBA Consulting Team. Specifically, the study involved the following elements:

- Monitoring of adult salmonids migrating from the sea to the spawning areas of Santa Rosa Creek, Mark West Creek and Maacama Creek using fyke nets (photographs of fyke nets in operation are shown in Figure 2-4). Fyke nets are effective only during low to moderate streamflow periods. In Phase 2 (1990-91, 1991-92 and 1992-93 seasons), the fyke nets were deployed from late December through March in the lower reaches of Santa Rosa Creek and Mark West Creek. In Phase 3, fyke nets were deployed from October 1993 through April 1994 in the lower reaches of Santa Rosa Creek, Mark West Creek and Maacama Creek. Fyke nets were also deployed for 33 days in March and April 1994 at a site in the Laguna downstream from the confluences of Santa Rosa and Mark West Creeks. A one-week no-discharge window was provided by the Subregional System in February 1994, but the City of Windsor was not able to simultaneously provide a similar window.

- Monitoring of post-spawned adult steelhead returning from spawning areas to the sea using fyke nets. Fyke nets were deployed to capture steelhead adults (as well as smolts of either species) migrating downstream from October 1993 through April 1994. As mentioned above, coho adults die after spawning and do not return to the sea.

- Measurement of the number of juveniles of each year class (young-of-the year, yearlings, age 2 and older) in three representative reaches in each of Santa Rosa Creek, Mark West Creek and Maacama Creek, and in one reach of Green Valley Creek. Habitat quality was also assessed in the same reaches of these creeks. The juvenile density and habitat surveys were conducted in November 1993, following study plan approval by the City and before winter storms stimulated outmigration of smolts. The juvenile density and habitat surveys were conducted again at the same locations in July and October 1994.

- Monitoring of steelhead and coho smolts migrating downstream from the nursery areas in Santa Rosa Creek, Mark West Creek and Maacama Creek to the sea. Outmigrating smolts were captured in the same fyke nets used to monitor adult steelhead returning to the sea.

The results of the fyke netting portions of the study are presented in Chapter III of this report, and the results of the habitat and juvenile density surveys in Chapter IV.

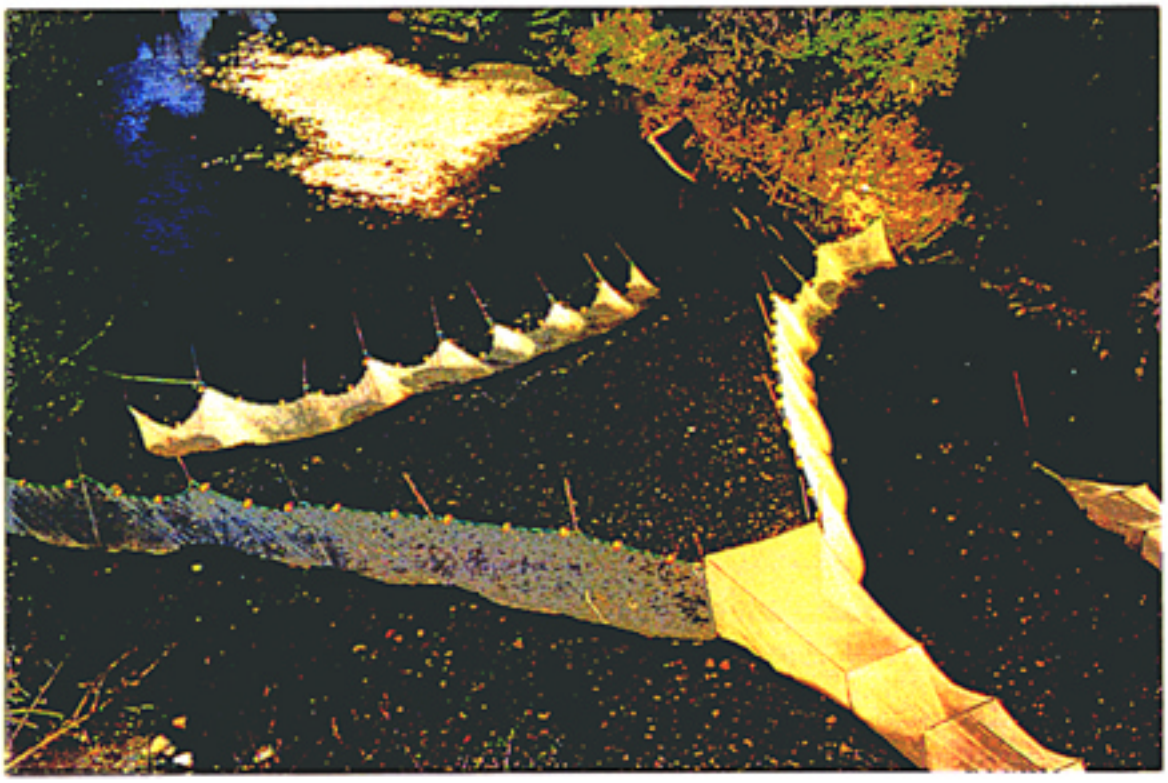


Figure 2-4. Above: Deployment of fyke nets in Santa Rosa Creek. Mr. Maddox is shown carrying the portable fish holding pen. Below: Deployment of fyke net in Maacama Creek, showing debris trap placed upstream of fyke net.

Chapter III.
FYKE NET MONITORING

The upstream passage of steelhead through the Laguna de Santa Rosa into Mark West Creek and Santa Rosa Creek relative to reclaimed water releases has been studied with fyke nets during January through March for three winters prior to this study. Studies conducted in 1991, 1992, and 1993 showed that adult steelhead migrated through the reclaimed water zone in Santa Rosa Creek when reclaimed water concentrations were high (up to 70 percent of the Laguna flow). Fish caught in Mark West Creek were captured after migrating through reclaimed water concentrations of up to 40 percent. Catches appeared to be related to season, rainfall patterns, and streamflow. The number of fish caught was low, probably because the netting method cannot be employed following rains that create high flows when most adult steelhead tend to migrate.

The 1993-1994 fyke netting season was expanded to include trapping of downstream migrants and trapping in a control stream without reclaimed water (Maacama Creek). Trapping duration was extended, a no-discharge “window” in February was evaluated, and other Laguna trap locations were added to evaluate trapping effectiveness and Laguna residence time of migrants. The expanded program was designed to evaluate movements of coho that may use these streams as well as steelhead.

METHODS

Net Construction

Fyke nets (see Figure 2-4), were used to trap migrating fish and retain them alive. The traps were deployed in pairs at each site, with one trap facing upstream (to capture fish moving downstream), and the other facing downstream (to capture upmigrants). The trap (fyke) is a long nylon-mesh funnel kept open by a series of square steel frames. The fyke nets used have a square opening four feet on a side, with the remaining five frames 2.5 feet on each side. Inside the fyke are two conical throats (i.e., smaller funnels) which direct the fish toward the cod end (the narrow closed end furthest from the entrance) and prevent their escape. Attached to the fyke are two wing nets which are angled across the stream to direct migrating fish into the fyke. The wings are four feet high and equipped with cork floats at the top and lead lines at the bottom. They are held in place by 5/8-inch iron reinforcing bars ("rebar") driven into the stream bed. Rebar stakes pass through metal rings at the top and bottom of the wing every five feet along its length. The top ring is fastened to the stake, but the bottom ring is free to slide up and down the stake. The trap is usually placed in a nearshore pool, so that one long (40 or 60 feet) and one short (20 feet) wing are needed to reach across the stream. Fyke nets are constructed of 1/2 x 3/8 inch delta-mesh nylon netting; wings are made of 1/2 inch square-mesh netting.

The net design is appropriate for stream flows up to about 150 cubic feet per second (cfs) at the net site in the creeks studied. As water rises and the current becomes more swift and carries more debris, forces on the wing increase (largely because the small-mesh net becomes occluded with leaves and other debris). This causes the rebar stakes to bend downstream, permitting water to flow over the wing. At still higher flows, the bottom rings slide up the stakes, which protects the wing from damage by swift currents and entrained debris but causes the wing to stop fishing effectively since water is now able to flow both under and over it. The limitation of being able to fish efficiently only at flows under 150 cfs is discussed further under "sampling strategy" below.

The upstream-facing net is particularly vulnerable to occlusion and damage from stream-borne debris, which greatly increases during storm runoff events. For this reason, an additional section of netting similar to the wing nets was placed upstream from the mouth of the upstream-facing net as a debris collector.

Net Locations

Fyke nets were located in Santa Rosa Creek and Mark West Creek at the same sites used during the first three years, and at a new site in Maacama Creek. Beginning in late March, nets were also placed in the lower Laguna, to investigate outmigrant residence time and to evaluate trapping efficiency. For a few days in late March and early April, nets were also placed at sites in the upper Laguna, in an attempt to verify that none of the upper Laguna tributaries are a source of salmonid smolts. The locations of fyke netting sites are shown in Figure 2-1 and listed below:

- Mark West Creek-- just east of Slusser Road, 1.9 miles upstream from the confluence of Mark West Creek and the Laguna)

- Santa Rosa Creek--0.3 miles above the Delta Pond discharge, 0.6 miles west of Willowside Road.

- Maacama Creek--0.3 miles upstream from the Chalk Hill Road bridge (later moved to a site 0.4 miles downstream from the bridge).

- Laguna de Santa Rosa--0.2 miles downstream from River Road. This is about 3.5 miles downstream from the Santa Rosa Creek site, and 3 miles downstream from the Mark West Creek site.

- Laguna de Santa Rosa--at Llano Road (not shown in Figure 2-1).

- Laguna de Santa Rosa--on Brown Farm, upstream from Highway 12 (not shown in Figure 2-1).

Net Deployment

The 1993-1994 fyke net fishing season began in October 1993 to include possible capture of coho adults and to determine when outmigration of smolts begins. Nets were deployed in Mark West Creek and Santa Rosa Creek for two days after the season's first rains (October 14-15 and November 10). Following the first major rainstorm (November 28-29) nets were deployed in these creeks and Maacama Creek, and were fished continuously thereafter in all three creeks unless high water made net deployment impossible (this occurred six times, for periods from one to eight days). Fishing was continued as long as significant numbers of smolts were outmigrating (until May 1).

Handling, Marking, and Releasing Fish

The nets were checked once each day, when all captured fish were transferred from the fyke net to a small holding pen where they could be identified, counted, and measured (salmonids only) before being released to continue in the direction they had been moving prior to capture. All fish (as well as other vertebrates such as frogs and turtles) were identified and counted. All salmonids were measured (fork length), and notes were made on gender and condition of adults, and on condition of juveniles. Mature salmonids were classified as "ripe" if they released eggs or milt when gently squeezed, and "green" if they

did not but appeared to have not yet spawned. Post-spawned fish were usually slender, somewhat scarred and bruised, and usually did not release eggs or milt. Males attempt to mate with as many females as possible, and may sometimes be found in apparent post-spawned condition, yet still exuding milt which has been retained in case another ready-to-spawn female is located.

Dorsal fins were examined for deformities which are typical of hatchery-raised fish. Adult steelhead were marked by punching a small hole with a paper punch in the membranous part of the caudal (tail) fin; on the upper lobe if upmigrating and on the lower lobe if downmigrating. Recaptured fish were not punched further upon recapture. During the deployment of the downstream Laguna nets in March, downmigrating steelhead adults captured in Mark West Creek were punched on the adipose fin, so they could be distinguished from Santa Rosa Creek fish if recaptured downstream. During the same period steelhead smolts captured in Santa Rosa Creek were marked by clipping the tip from the dorsal lobe of the caudal fin, and Mark West Creek smolts were adipose fin-clipped.

Sampling Strategy

The sampling strategy used for the placement of nets to study passage through the reclaimed water discharge zone was determined by the configuration of the discharge setting as well as by features of salmonid life history.

Migrating salmonids often move during the night and rest in sheltered locations, such as overhanging stream banks, by day. Since fish ordinarily move several miles per night, they could be expected to travel from the Russian River to a point upstream of the discharges in one night. In that event, a fish captured at a point immediately upstream from a discharge can be assumed to have been exposed to reclaimed water concentrations that occurred in the Laguna the previous night. This assumption was made in the interpretation of data presented in this report.

The main focus of these studies was not to count all migrants, but to investigate migration during potentially worst-case (high) reclaimed water concentrations, which occur during periods of relatively low stream flow. Placing the nets just upstream of the discharge zones allows the capture of fish that have moved through a known reclaimed water exposure. However, since fyke net sites near the discharges are located in downstream reaches of the streams (70 - 80 square miles of drainage area upstream of traps), rising water following major storms often exceeds 150 cfs, and will often overwhelm the nets. This means that upstream fyke net catches in the lower reaches of the streams cannot be used to estimate the total number of fish in a spawning run. Many (probably most) fish will migrate during periods when flow is too great for the fyke nets to fish effectively or be deployed. Flows too high for the nets to fish typically dilute reclaimed water concentrations to low (and presumably ecologically insignificant) levels.

ESTIMATING RECLAIMED WATER CONCENTRATION

Estimates of reclaimed water concentration in the Laguna discharge Zones A through D are based on daily reclaimed water discharge data and daily estimates of stream flow in each zone. Reclaimed water discharge data were provided by the Subregional System staff and by the City of Windsor.

The stream flow estimates for 1993-1994 are based on data from stream stage (depth) recording equipment located in Santa Rosa Creek at Willowside Road, Mark West Creek

at Slusser Road, the upper Laguna at Occidental Road, and the lower Laguna at Trenton-Healdsburg Road. The gages were installed and maintained as part of the Anadromous Fish Migration Project. Stream stage data were converted to flow using a curve that was developed empirically for each gage location using an electronic flow meter; details are given for Trenton-Healdsburg Road in Roth et al. (1992). The regression equations that were used to convert 1994 stage data to estimates of flow are summarized in Table 3-1.

Table 3-1. Regression Equations Used to Convert Stage Heights During 1993-1994 to Flow Rates.

Location	Regression Equation
Laguna at Trenton-Healdsburg Road	$y = 0.0746 - 6.39x + 17.9x^2 - 0.570x^3$
Laguna at Occidental Road	$y = 104 - 84.5x = 18.7x^2$
Mark West Creek	$y = -6.22 + 15.1x + 26.8x^2$
Santa Rosa Creek	$y = -9.89 + 12.5x + 48.2x^2$
where y = flow in cfs, and x = water depth in feet	

The regression equations given above for the Laguna at Trenton-Healdsburg Road, Mark West Creek, and Santa Rosa Creek are different than those used in 1993 because of changes in channel geometry reflected in the velocity profiles that were made in 1993-94. A regression equation was developed for the Laguna at Occidental Road. However, flow data at Occidental Road were available for only part of the study period. For this reason baseline flow in the upper Laguna was estimated by a regression between flow in the Laguna at Occidental Road and flow in the Laguna at Trenton-Healdsburg for the days when data were available at both locations ($y = -2.85 + 0.254x$; where y = flow at Occidental Road, and x = flow at Trenton-Healdsburg Road. $r^2 = 0.96$).

Flow and reclaimed water concentration in each of the zones (Zones A through D) were calculated according to Table 3-2.

Flows during the 1993-1994 discharge season were often unusually low, and it was necessary to refine the estimations of reclaimed water concentrations. Refinements were necessary to account for the longer travel time for discharge into the upper Laguna to reach Zones A, B, and C relative to discharge from Delta Pond and CW. Based on a hydraulic and water quality model (RMA, 1990), the travel time for reclaimed water in the Laguna from Guerneville Road to the Russian River is estimated to be less than half a day when flow is greater than about 125 cfs. Reclaimed water travel time from Meadowlane Pond to Guerneville Road (where stream gradient is very low) may take several days at lower flows. Estimates were based on flow-dependent running averages of previous discharge volumes as shown in Table 3-3.

Table 3-2. Calculation of stream flow and reclaimed water concentration in each discharge zone.

Zone	Stream Flow	Reclaimed Water Concentration
A	Flow in Laguna at Trenton-Healdsburg Road plus CW discharge	Total Subregional System and CW discharges divided by stream flow in Zone A
B	Baseline flow in the upper Laguna plus Santa Rosa Creek flow plus Mark West Creek flow plus Subregional System discharge	Total Subregional System discharge divided by stream flow in Zone B
C	Baseline flow in the upper Laguna plus Santa Rosa Creek flow plus Subregional System discharge	Total Subregional System discharge divided by stream flow in Zone C
D	Santa Rosa Creek flow	Delta Pond discharge divided by the sum of Delta Pond discharge and Santa Rosa Creek flow measured at Willowside Road

Table 3-3. Travel time of upper Laguna discharge at low flows.

Stream Flow at Trenton-Healdsburg Road	Upper Laguna Discharge Used to Calculate Reclaimed Water Concentration
greater than 125 cfs	upper Laguna discharge on the same day
greater than 100 cfs but less than 125 cfs	upper Laguna discharge from the previous day
greater than 75 cfs but less than 100 cfs	average upper Laguna discharge from the two previous days
greater than 50 cfs but less than 75 cfs	average upper Laguna discharge from the three previous days
greater than 25 cfs but less than 50 cfs	average upper Laguna discharge from the four previous days
greater than 0 cfs but less than 25 cfs	average upper Laguna discharge from the five previous days

1993-1994 MONITORING RESULTS

The results of the fyke net monitoring program are described in the following sections:

- Stream Flow
- Reclaimed Water Discharges
- Fish Catch
- Adult Steelhead Migrating Upstream in Santa Rosa and Mark West Creeks
- Relationships Between Steelhead Migrating Upstream, Streamflow, and Reclaimed Water Concentration
- Adult Steelhead Migrating Upstream in Maacama Creek
- Steelhead Adults Migrating Downstream
- Steelhead Smolts
- Coho Salmon
- Fish Catch in Upper and Lower Laguna sites
- Fyke Net Effectiveness

Stream Flow

Estimated average daily flows from October 15, 1993 to May 2, 1994, are shown in Appendix 3-1. Figure 3-1 shows the estimated average daily flow at the gage locations in the upper Laguna, Santa Rosa Creek, Mark West Creek and the lower Laguna at Trenton-Healdsburg Road. Field observations show that water consistently rises more quickly following rainfall events in Santa Rosa Creek than in Mark West Creek, probably because of the relatively large amount of impermeable surface (e.g. pavement) in the Santa Rosa Creek watershed. This difference between the creeks is apparent when hourly flows are considered, but is not obvious in Figure 3-1 because the data have been reduced to average daily flows.

The 1993-1994 season was very dry. Only four storms occurred which resulted in flows greater than 1000 cfs at Trenton-Healdsburg Road (one each in December and January, two in February). Rainfall data as recorded at the Llano Road Treatment Plant is shown with the fish catches in Appendix 3-2. Storm flows in 1993-1994 never reached 2000 cfs, in contrast to the previous year, when flows remained above 2000 cfs for extended periods. Table 3-4 compares the minimum and mean flows from January through March at Trenton-Healdsburg Road for the past four years.

Figure 3-1. Streamflow in the Laguna de Santa Rosa and its tributaries, 1993-1994

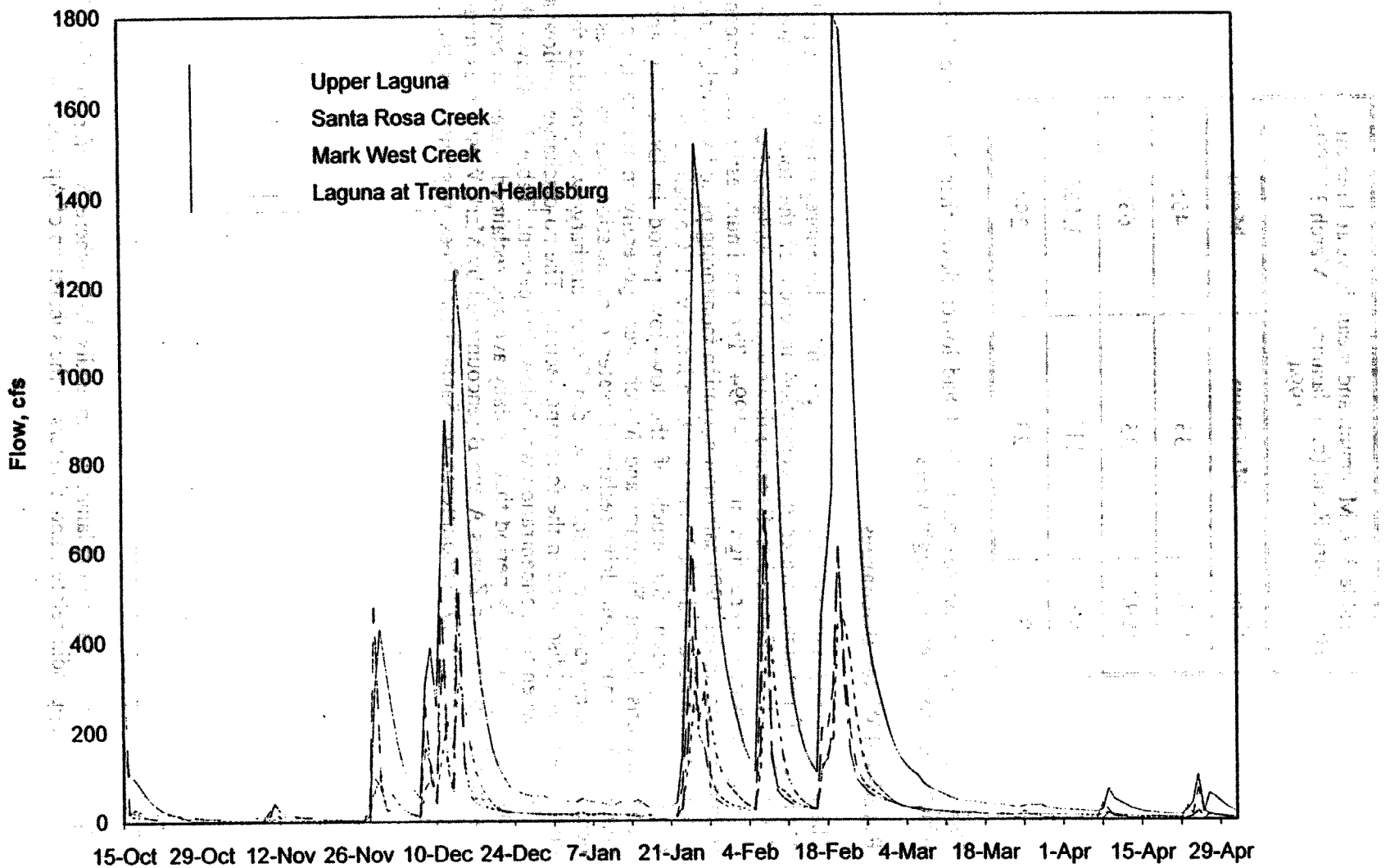


Table 3-4. Minimum and mean flows at Trenton Healdsburg Road (cfs), January 1 - March 31 1991-1994.		
Year	**Minimum**	**Mean**
1991	33	455
1992	35	630
1993	115	1,168
1994	23	294

The steelhead migration season in 1994 had lower flows than 1991 and 1992, both of which were considered drought years.

Reclaimed Water Discharges

The location and daily volume of discharges from the Subregional System and CW, and estimates of reclaimed water concentration in each of the four zones are shown in Appendix[1] 3-1 and Figure 3-2. Because flows were low, reclaimed water concentrations in the Laguna system were high in 1993-1994. The maximum estimated concentration of reclaimed water in the 1993 salmonid migration monitoring period was calculated to be 92 percent, which occurred briefly in zone A on January 11. Concentrations were in the range of 50 to 60 percent for much of the low-flow period in December and January. Concentrations during February and March were generally in the range of 20 to 35 percent. The maximum daily reclaimed water concentration was rarely less than five percent in the migration corridor. A "window" of no discharge was provided for this study during February (discussed in the following section). The no-discharge window accounted for 10 days when the concentration was below five percent. Table 3-5 shows the number of days during the study period that the daily average reclaimed water concentration was less than five percent in Zones A and B (encountered by Mark West Creek migrants) and in Zones A through D (encountered by Santa Rosa Creek migrants) for the four study years.

[1] Appendix nomenclature explanation: Appendix X-Y where X refers to the Chapter to which the appendix relates, and Y refers to the subsection of Appendix X.

Figure 3-2. Santa Rosa Creek, 1993-1994: Fishing effort, Upmigrating Steelhead Catch and Reclaimed water concentration

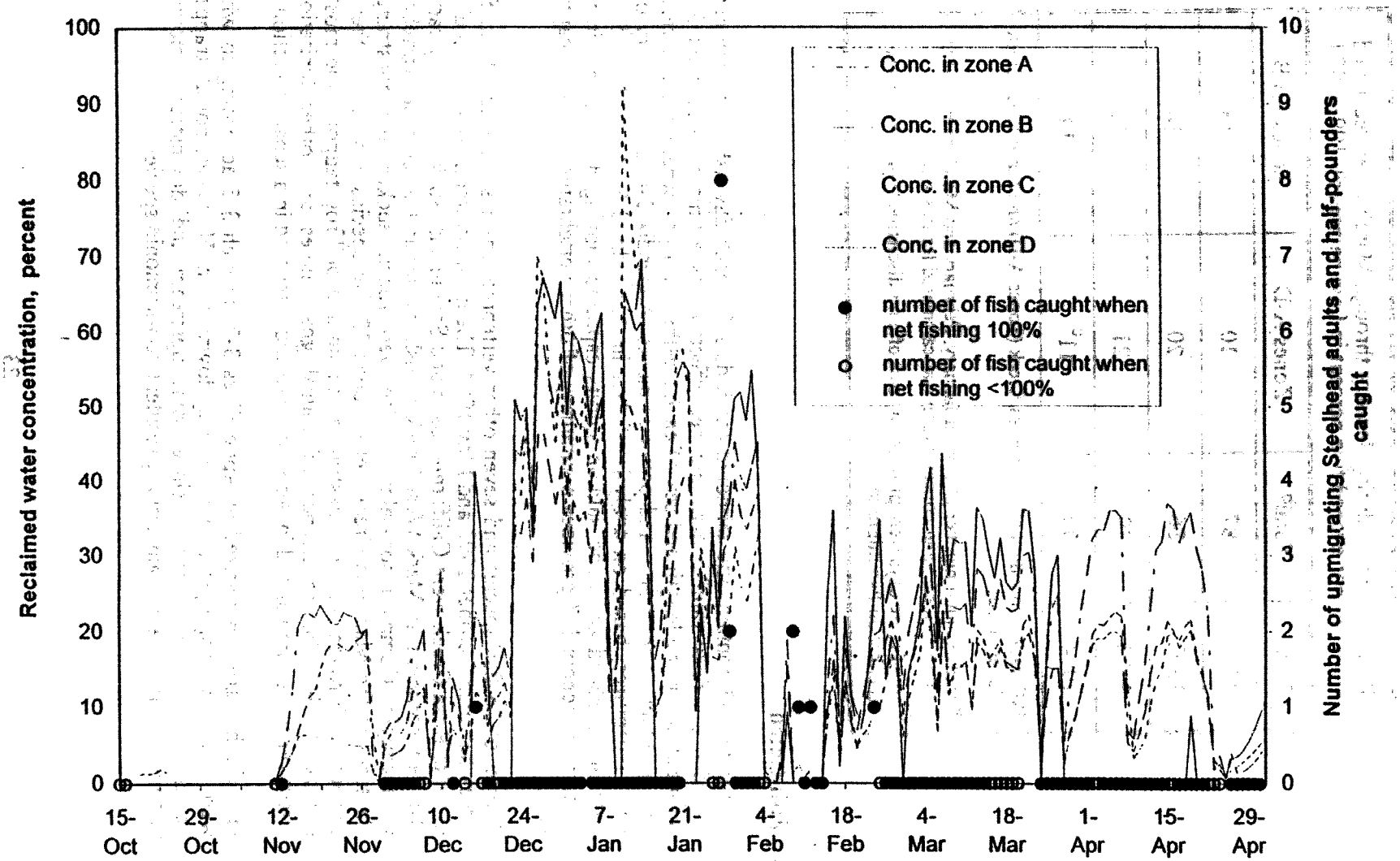


Table 3-5. Days during January through March when reclaimed water did not exceed five percent in Laguna zones[a], 1991-1994.

Year	Total[b]	Zones A-D	Zones A&B
1991	87	10	15
1992	86	20	18
1993	89	21	35
1994	90	11[c]	14[c]

[a]Migration corridors of Santa Rosa Creek (Zones A-D) and Mark West Creek (Zones A&B).

[b]Indicates total number of days in January, February and March of each year that reclaimed water concentration was calculated for this study.

[c]Ten of these days were provided as part of a no-discharge "window" to test its effect on fish migration.

Fish Catch

Appendix 3-2 contains the salmonid catch data for each day fished at each net site. Also included are daily rainfall data and net effectiveness estimates. Appendix 3-3 provides information on the length and sex of each steelhead caught, whether it was marked, notes on reproductive condition, and previous marks. Appendix 3-4 is a summary of steelhead adult recaptures, based on analysis of data in Appendix 3-3. Appendix 3-5 summarizes data on steelhead and coho salmon smolts captured moving downstream in the Laguna system. Appendix 3-7 provides a summary of other vertebrates that were captured in the nets.

A total of 25 fish species and seven other vertebrate species were caught in Santa Rosa Creek between October 1993 and May 1994. The most common non-salmonid fish species in Santa Rosa Creek were California roach and Sacramento sucker; bullfrog tadpoles were also very common. In Mark West Creek 13 fish species and seven other vertebrate species were caught. Common non-salmonid fish were roach, sucker, and coastrange sculpin. Captures in the Maacama Creek net included 12 fish species and seven other vertebrate species, with roach, sucker, coastrange sculpin and bullfrog tadpoles the most abundant non-salmonids. The occurrence of animal gnaw holes and other limitations to net effectiveness is summarized in Appendix 3-6 and discussed in a separate section below.

Fish catches are summarized in Appendices 3-2 through 3-5 according to whether they were caught moving upstream or moving downstream. However, not all trapped fish can be assumed to be migrating, since some upstream and downstream movements are undoubtedly local, especially among resident non-salmonid species.

Adult Steelhead Migrating Upstream in Santa Rosa and Mark West Creeks

The catch of upstream migrating adults and the relationship of catch to flow and reclaimed water concentrations in Santa Rosa Creek and Mark West Creek are discussed in the following sections. Salmonid catches from habitats not containing reclaimed water releases (upmigrating adults in Maacama Creek, adults migrating downstream, and salmonid juvenile catches), are presented in later sections.

Table 3-6 summarizes the total salmonid catch in all nets in Santa Rosa Creek and Mark West Creek during the 1993-1994 fishing season.

Table 3-6. Salmonid catches in Santa Rosa and Mark West Creeks, 1993-1994.

	Santa Rosa Creek		**Mark West Creek**	
	Moving downstream (128 days fished)	**Moving upstream (129 days fished)**	**Moving downstream (123 days fished)**	**Moving upstream (125 days fished)**
Steelhead adults	21	15	19	11
Steelhead half-pounders	2	1	0	4
Steelhead juveniles	653	218	317	104
Coho salmon adults	0	0	0	0
Coho salmon juveniles	1	3	4	0

In 1993-1994 a total of 129 days were fished for upmigrants in Santa Rosa Creek. The first steelhead (a male) was caught on December 16. A total of 16 adult steelhead and steelhead half-pounders were caught in 1993-1994. Half of these (8) were caught on a single night, January 28. The others were caught one or two at a time, in late January and February. As in previous years, the capture of upmigrating adults was closely tied to rainfall (see Figure 3-9). Ten of the upmigrants were females. None appeared to be of hatchery origin, judging by the appearance of the dorsal fin (erect in wild fish, often compressed in hatchery fish); none appeared to have spawned (see Appendix 3-3-1)

A total of 125 days were fished for upmigrants in Mark West Creek. Fifteen steelhead adults and half-pounders were caught in Mark West Creek. No coho adults were caught during the 1993-1994 season. The earliest fish were half-pounders caught on 21 and 22 December. A maximum of three fish per day were caught. Most catches were one or two fish per day. Unlike in Santa Rosa Creek, nearly half (7) of the upmigrating adult steelhead in Mark West Creek were caught in April. None of the fish appeared to have spawned; none appeared to be of hatchery origin (see Appendix 3-3-2)

Relationships Between Steelhead Migrating Upstream, Stream Flow and Reclaimed Water Concentration

The estimated concentration of reclaimed water in each of the four zones was calculated as a percentage of estimated stream flow, and is tabulated for each day in Appendix 3-1.

The presence of steelhead in Santa Rosa Creek and in Mark West Creek is described in this section in relation to the streamflow and reclaimed water concentration through which the fish are assumed to have migrated.

Santa Rosa Creek. Figure 3-2 shows the estimated concentration of reclaimed water in each of the four zones through which steelhead captured in Santa Rosa Creek must migrate, fishing days, and the number of fish caught each day.

A six-day "window" during which no reclaimed water was released from the Santa Rosa Subregional System was requested during rains in the first half of February, since this has been the most likely time and condition to catch steelhead based on the last 3 years of study. The window began on February 4, but was aborted when rain forced the removal of the nets. The window was begun again on February 9, when nets could be reset. The concentration of reclaimed water during the windows, as shown in Figure 3-2 and Appendix 3-1, dropped to zero in Zones B, C, and D, but remained at 1-2 percent in Zone A (downstream from Trenton Healdsburg Bridge) because CW releases continued during the windows. Two adult steelhead were caught on the first day of the window; one on the second day, and one half-pounder was caught on the fourth day. None were caught on the third, fifth or sixth days. These catches are similar to catches after rains in early February in previous years; conclusions regarding the relationship between the window and fish catch would be strengthened by conducting additional trials.

The catch of upmigrant steelhead in Santa Rosa Creek is presented in Figure 3-3 to show the number of fish caught each day as a function of flow and maximum reclaimed water concentration through which the fish are assumed to have migrated. In Figure 3-3, each day fished in Santa Rosa Creek is shown as a point on a scatter plot of flow versus reclaimed water concentration. Each open circle represents a day that the nets were fishing but no fish were caught. Each filled circle represents a day that fish were caught (with number of fish shown if more than one).

The seven days on which fish were caught in 1994 occurred at flows from 272 cfs to nearly 1000 cfs; a few days were fished at higher flows and many days were fished at lower flows. The four fish caught on three days during the no-discharge window occurred at less than 2 percent reclaimed water. The other twelve fish were caught at reclaimed water concentrations of 25 to 45 percent; many days were fished at higher reclaimed water concentrations, but most of these were at low flows. All but one of the fish were caught between January and March, and most of the high-flow days fished occurred during that period. These data show that in Santa Rosa Creek in 1994 adult steelhead were captured over a wide range of reclaimed water concentrations but mostly at flows over 500 cfs.

Mark West Creek. Figure 3-4 shows the estimated concentration of reclaimed water in Zones A and B, which are the two zones through which fish captured in Mark West Creek must migrate. Figure 3-4 also shows fishing days and the number of fish caught each day. Reclaimed water concentrations were slightly lower in zones A and B (mostly less than 20 percent in February and March) than in Zones C and D. The first eight fish were caught during roughly the same period (December through February) as upmigrants in Santa Rosa Creek. No steelhead upmigrants were caught during the no-discharge window in February. As mentioned above, the last seven fish were caught in April. Both December and April fish migrated during low discharge concentrations (0.8 to 15.4 percent), and at low flows (5 to 100 cfs).

Figure 3-3. Santa Rosa Creek, 1993-1994 (all dates)

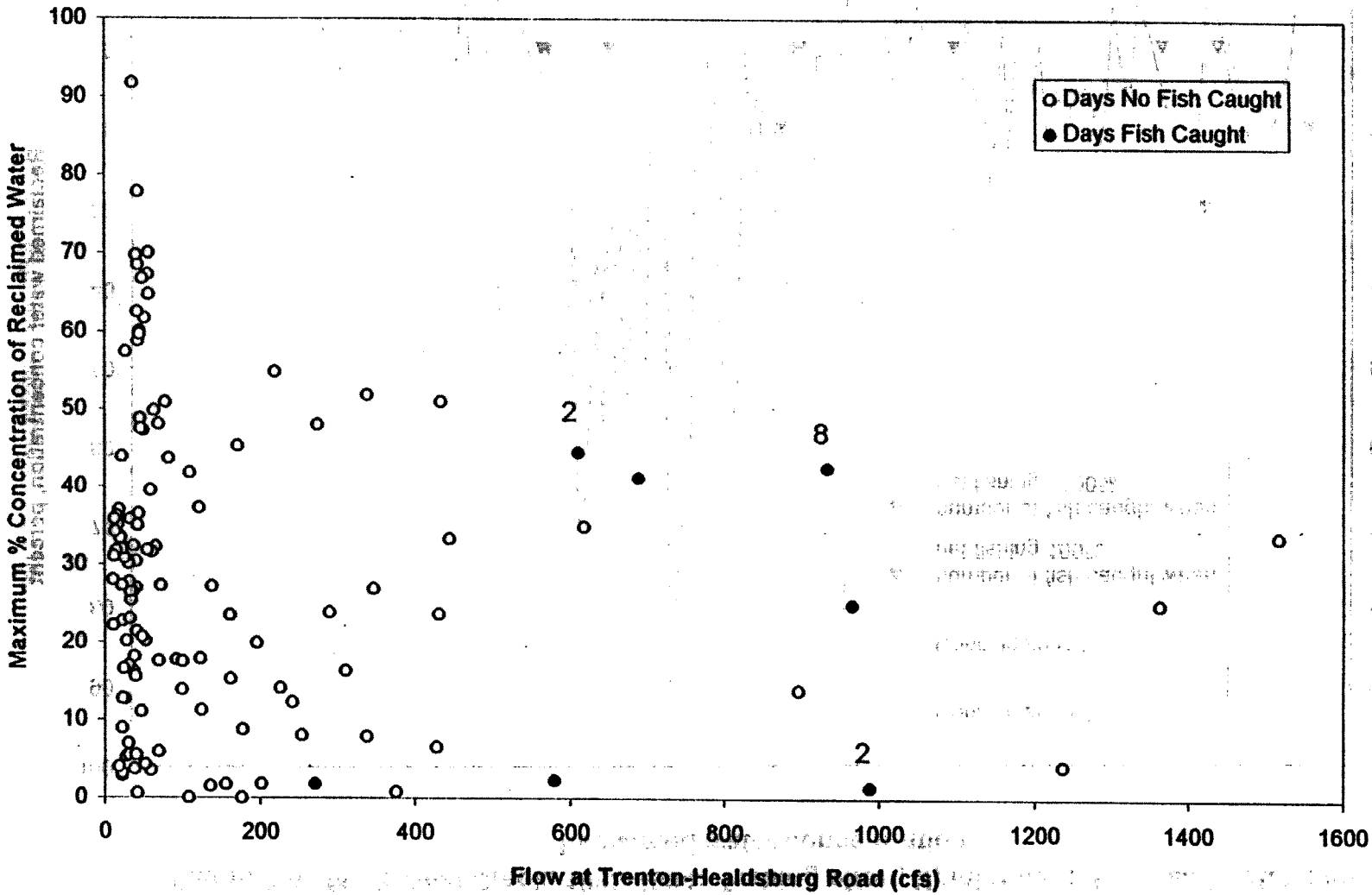
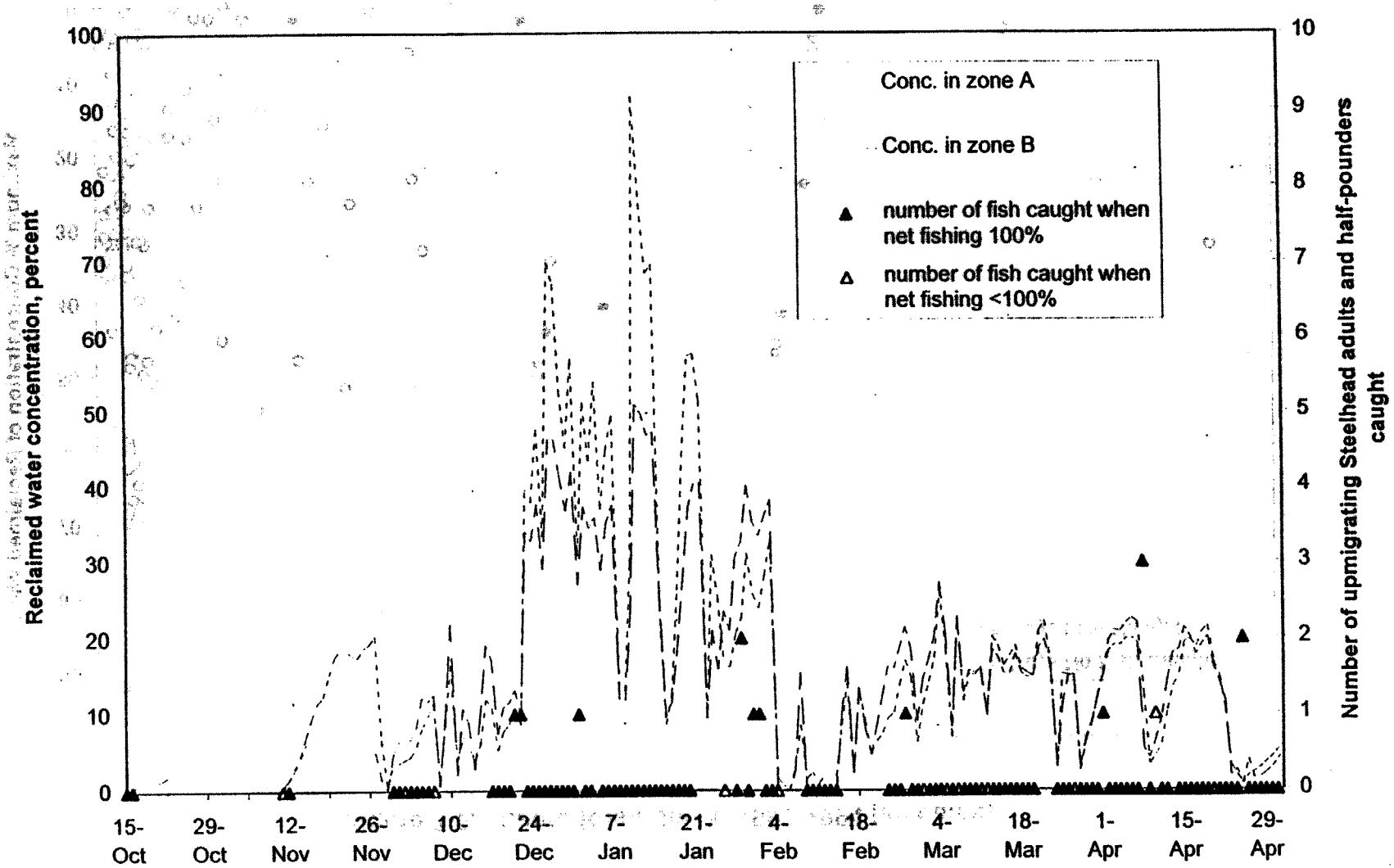


Figure 3-4. Mark West Creek, 1993-1994: Fishing effort, Upmigrating Steelhead Catch and Reclaimed water concentration



The Mark West Creek upmigrant data are arranged in Figure 3-5 to show the number of fish caught each day as a function of flow and maximum concentration of reclaimed water through which the fish migrated. Fish captured in January through March occurred over a fairly wide range of flows and at reclaimed water concentrations between 20 and 35 percent, whereas the fish catches in December and April occurred at both low flows and low concentrations of reclaimed water.

Evaluation of Four Years of Data

Monitoring of upstream steelhead migration was conducted during the migration seasons of 1991, 1992, 1993, and 1994. Table 3-7 reviews the catches. More days were fished in January through March 1994 than any of the earlier years. This is because fewer storms occurred in 1994 and because nets were deployed continuously during low-flow conditions.

Table 3-7. Upmigrant adult salmonid fishing effort, successful fishing days, and total fish caught, January through March 1991 - 1994.

	Mark West Creek			Santa Rosa Creek		
Year	Days fished	Days with steelhead	Total steelhead	Days fished	Days with steelhead	Total steelhead
1991	18[a]	7	33	29	4	6
1992	44	5	5	44	7	12
1993	39	12	20[b]	39	5	8
1994[c]	68	5	5	69	6	15
TOTAL	169	29	63	181	22	41

[a]Does not include four days when nets were set but when tampering was suspected (Feb. 6, 7) or confirmed (Feb. 14, 16).
[b]Includes two coho salmon.
[c]January through March only.

Figure 3-6 shows the successful and unsuccessful fishing days in Santa Rosa Creek as a function of streamflow and reclaimed water concentration for the January through March period of all four years studied. Fish were caught over a wide range of flows and reclaimed water concentrations, and no pattern of avoidance or preference for low or high reclaimed water concentrations is evident from these data.

A similar plot for Mark West Creek (Figure 3-7) shows that reclaimed water values were lower in its migration corridor, but that successful fishing days again were spread over a wide range of flows and concentrations, without an obvious pattern of avoidance or preference.

Figure 3-5. Mark West Creek, 1993-1994 (all dates)

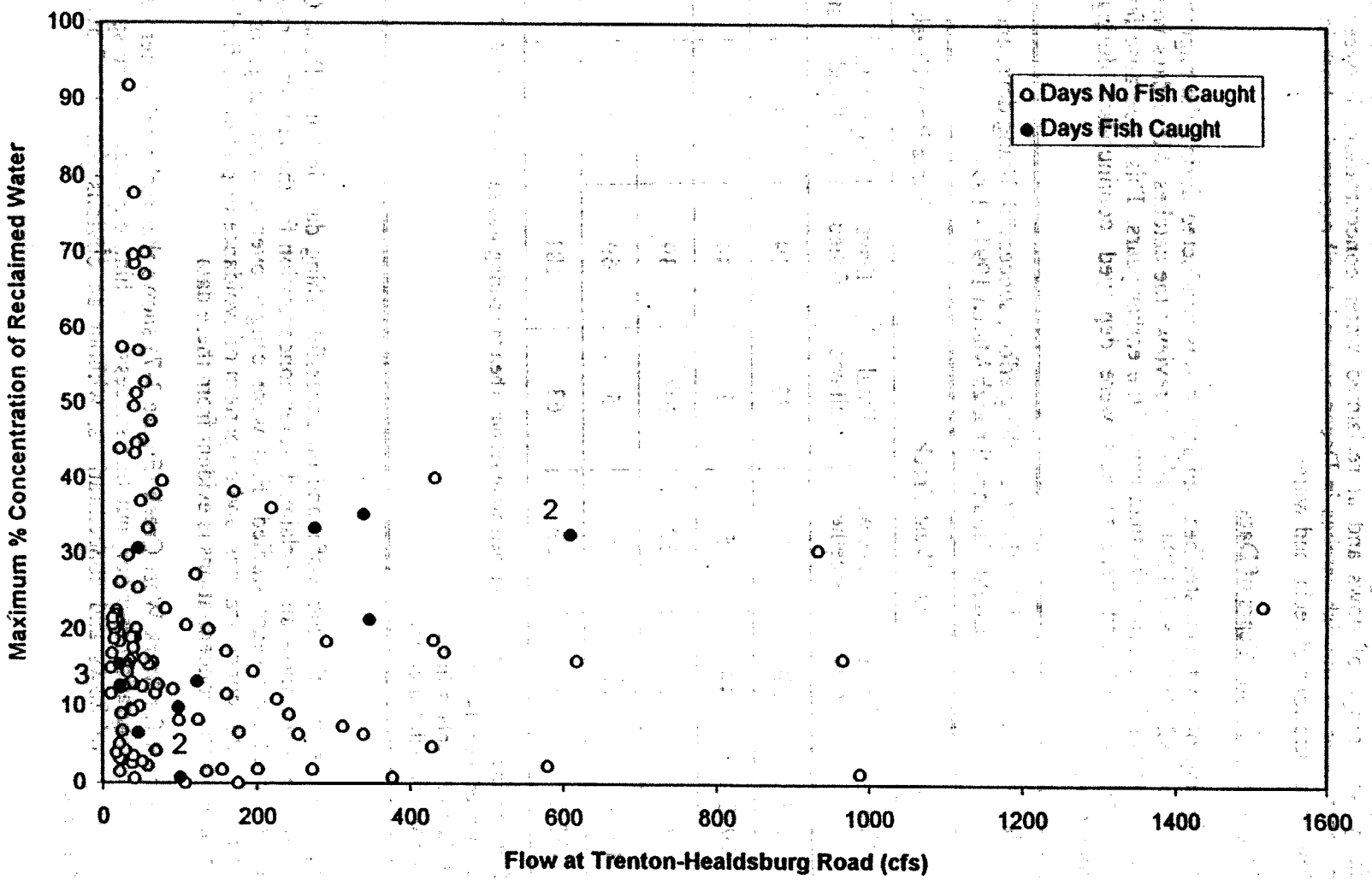


Figure 3-6 . Santa Rosa Creek, January - March 1991-1994

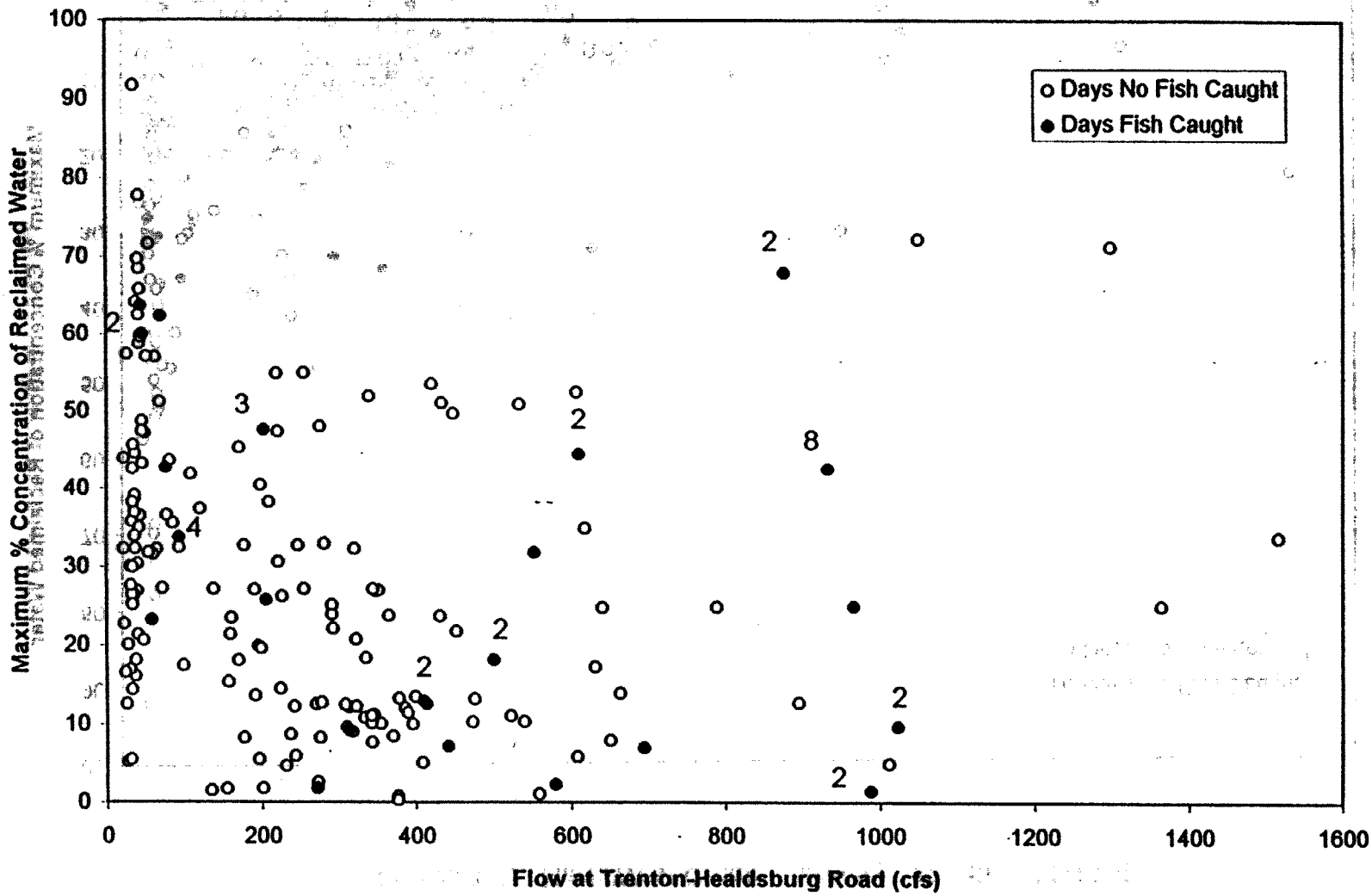
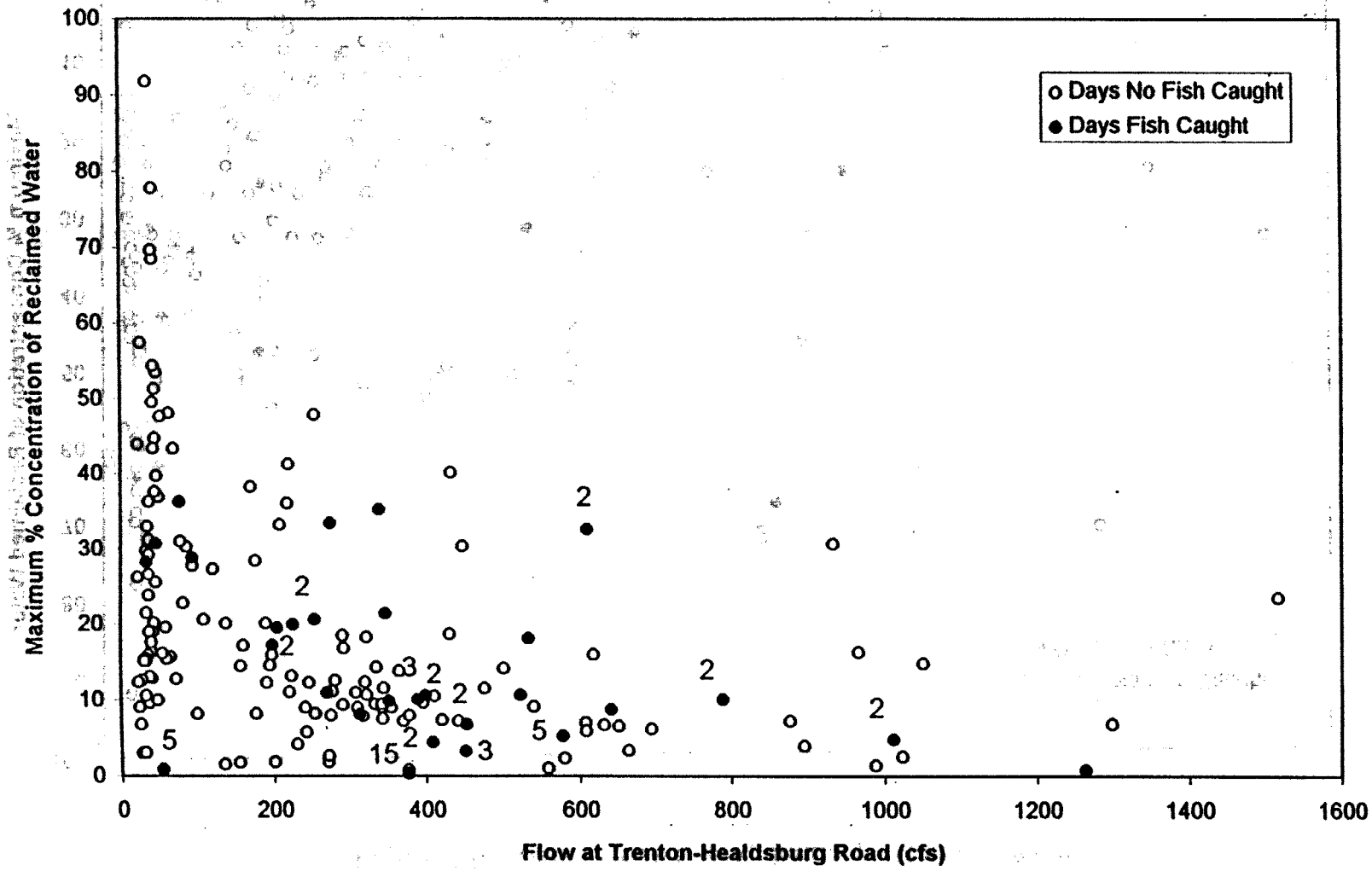


Figure 3-7. Mark West Creek, January - March 1991-1994



Previous Analysis of Three Years of Data

An analysis of the catch and concentration data for the first three years combined (Roth, et al., 1993) concluded that fish in the two creeks differed in their response to reclaimed water. In Mark West Creek catch rates were significantly higher at low reclaimed water concentrations, whereas in Santa Rosa Creek there was no such tendency. Unfortunately, this analysis neglected to examine the data from each of the years separately. When this is done, it becomes apparent that the evidence for these differences rests solely on the 1991 sampling program. Correlation coefficients between fish catches and reclaimed water concentration in each of the four years are significant only for the 1991 Mark West Creek data, and are not significant for any of the subsequent years (see Appendix 3-11).

Review of the 1991 data show that nets were not always set in the two creeks on the same days. In subsequent years a greater effort was made to ensure that sampling effort was comparable in both creeks. Statistical analysis requires unbiased samples. Examining the sequence of events influencing net deployment in 1991 suggests that there may have been an inadvertent sampling bias that gave rise to significant but probably spurious correlations between fish catch and reclaimed water concentrations. In Mark West Creek, several fish were captured at low concentrations during high flows in early February 1991. Over the next few days, poachers tampered with the net on four occasions during diminishing flows of higher concentration. In Santa Rosa Creek during this period, nets were not set due to high flows on several of the days when fish were caught in Mark West Creek. On days when nets were fishing in Santa Rosa Creek, fish were caught during periods of higher concentrations when the Mark West Creek nets were poached.

Sampling effort was also unequal during the storm in late February 1991. At that time, 20 steelhead were captured in Mark West Creek on two days when no nets could be set in Santa Rosa Creek. Immediately thereafter, the nets were irretrievably buried by a major storm. When fishing could be resumed, only one replacement net was available, and this was deployed in Santa Rosa Creek (whenever possible) through March. Four fish were caught in early March at high reclaimed water concentrations; no others were caught later in March, although concentrations were usually lower at that time. Since only one net was available, no fishing was done in March in Mark West Creek.

Thus the sampling effort in 1991 was inadvertently biased toward low reclaimed water concentration days in Mark West Creek and toward higher concentrations in Santa Rosa Creek. In subsequent years when net deployment was similar in each creek, no significant correlations were found. This is not surprising, because fish migration is the result of an interplay between many factors, and fish numbers are unlikely to be strongly, statistically correlated with any one of them (see Chapter IV Discussion).

Adult Steelhead Migrating Upstream in Maacama Creek

Table 3-8 summarizes the total salmonid catch in Maacama Creek. The capture of upmigrating steelhead are discussed in this section.

Table 3-8. Salmonid Catches in Maacama Creek, 1993-1994.		
	Moving downstream (119 days fished)	Moving upstream (122 days fished)
Steelhead adults	23	32
Steelhead half-pounders	3	0
Steelhead juveniles	601	204
Coho adults	8	1
Coho juveniles	163	4

Figure 3-8 shows steelhead adults captured in Maacama Creek as well as rainfall for the study period. Fish caught moving upstream are shown as solid bars; fish caught moving downstream (discussed in the following section) are shown as open bars. A total of 122 days were fished for upmigrants in Maacama Creek. Thirty-two (32) adult steelhead and one coho salmon were caught (Table 3-8). The coho catch is discussed separately below. No steelhead half-pounders were caught moving upstream in Maacama creek. The earliest steelhead were caught on 28 January. A maximum catch of four fish per day occurred once; 3 fish were caught on two occasions; all other catches were one or two fish per day. In general the timing of the catches was similar to that in Mark West Creek (see Figure 3-10), except that more fish were caught in March in Maacama Creek. Two of the fish caught moving upstream in Maacama Creek appeared to have already spawned when caught (Appendix 3-3-3). Neither fish had been captured earlier (recaptures of marked fish are discussed in the section on downstream adult movements below). Seven of the 32 fish (22 percent) had deformed dorsal fins which are typical of fish raised in hatcheries. Several of these fish were distinguished by a lighter color on the back and fewer but larger spots on the back.

Steelhead Adults Migrating Downstream

Unlike salmon, steelhead do not always die after spawning; many survive and return to sea, and may return in subsequent years to spawn again. Post-spawning mortality rates in the streams are unknown but post-spawning survivorship has been shown to be higher for females than males (Barnhart, 1986). Catches of adults moving downstream are presented in this section, along with an account of recapture of fish marked when moving upstream.

Santa Rosa Creek. Twenty-three steelhead adults and half-pounders were caught moving downstream in Santa Rosa Creek (Table 3-6). The catches of steelhead adults are shown in Figure 3-9**.** Half-pounders are shown in Appendix 3-8**.** Adults moving downstream tended to be associated with rainfall events, which indicates that both upstream and downstream migrants tend to move after rain. The first fish caught moving downstream were half-pounders caught on 19 and 20 December; these did not appear to have spawned (Appendix 3-3-1). Fish caught in the upstream-facing net are not always spawned-out fish returning to sea, but may be adults that wander upstream only to return downstream. These fish may return to the same stream or another stream to spawn later. None of the fish caught before 27 February appeared to be spawned-out (steelhead may not release all their gametes on the first spawning), so some of these fish may have spawned but had the

Figure 3-8. Maacama Creek: Steelhead adults

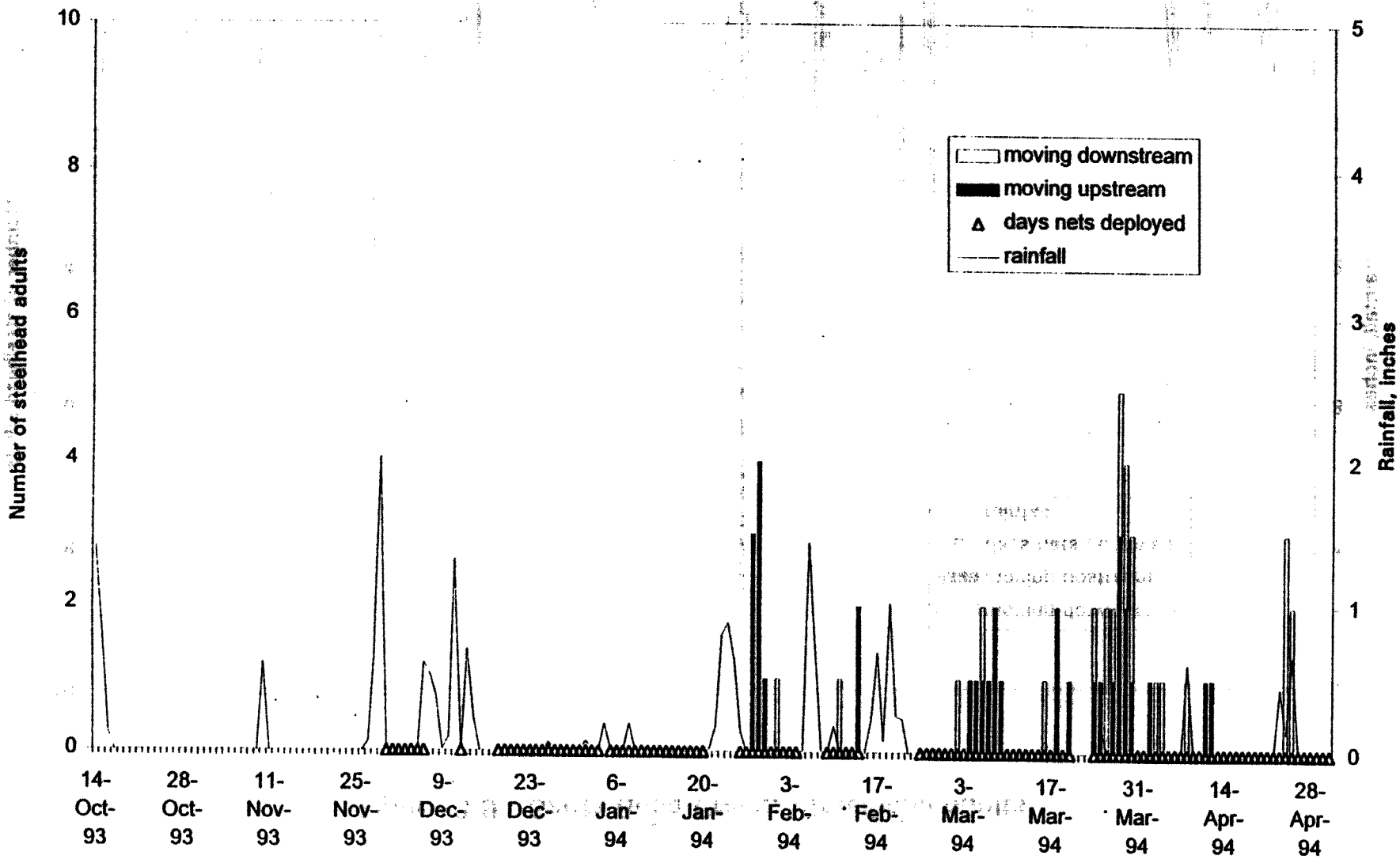


Figure 3-9. Santa Rosa Creek: Steelhead adults

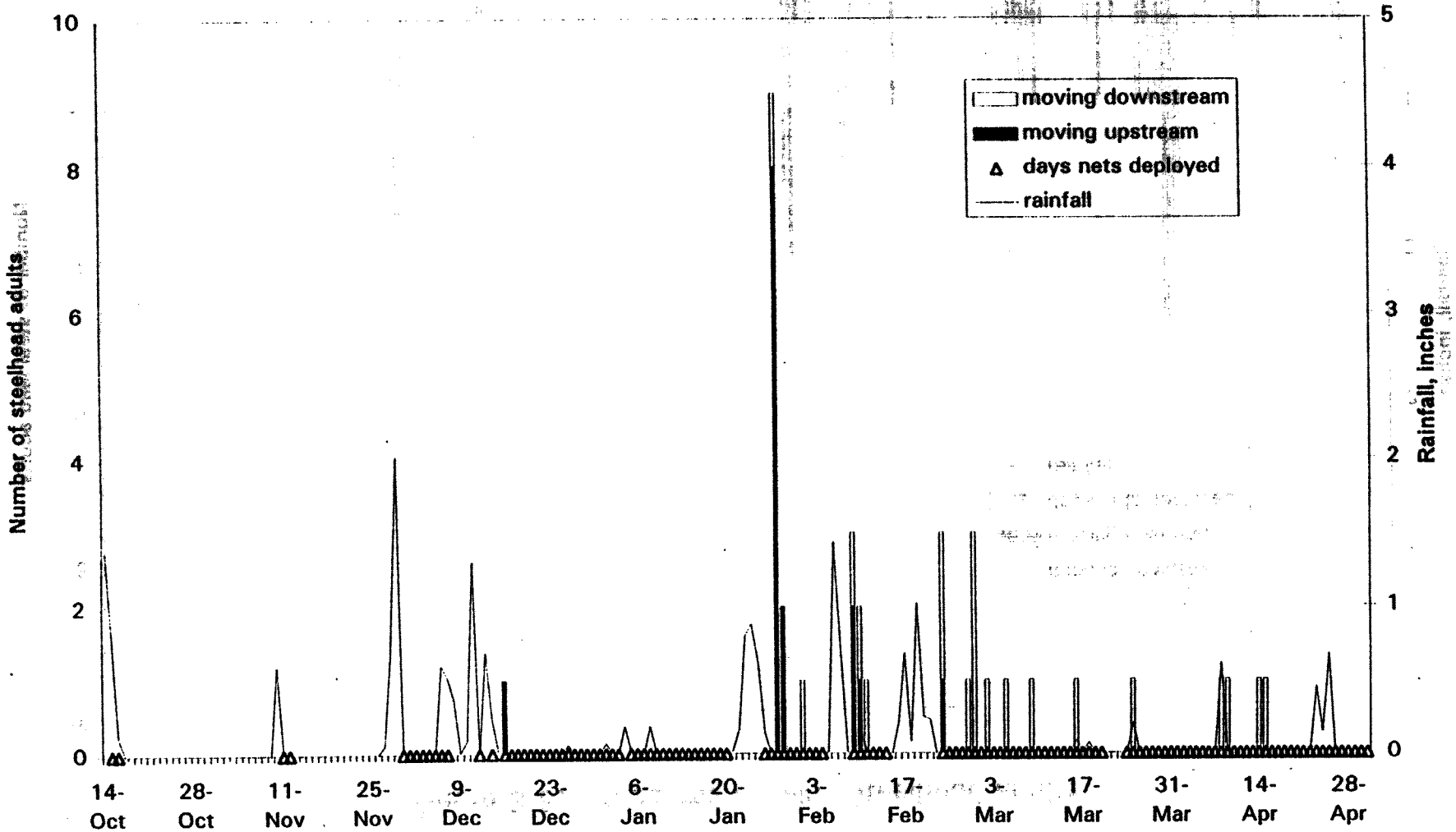
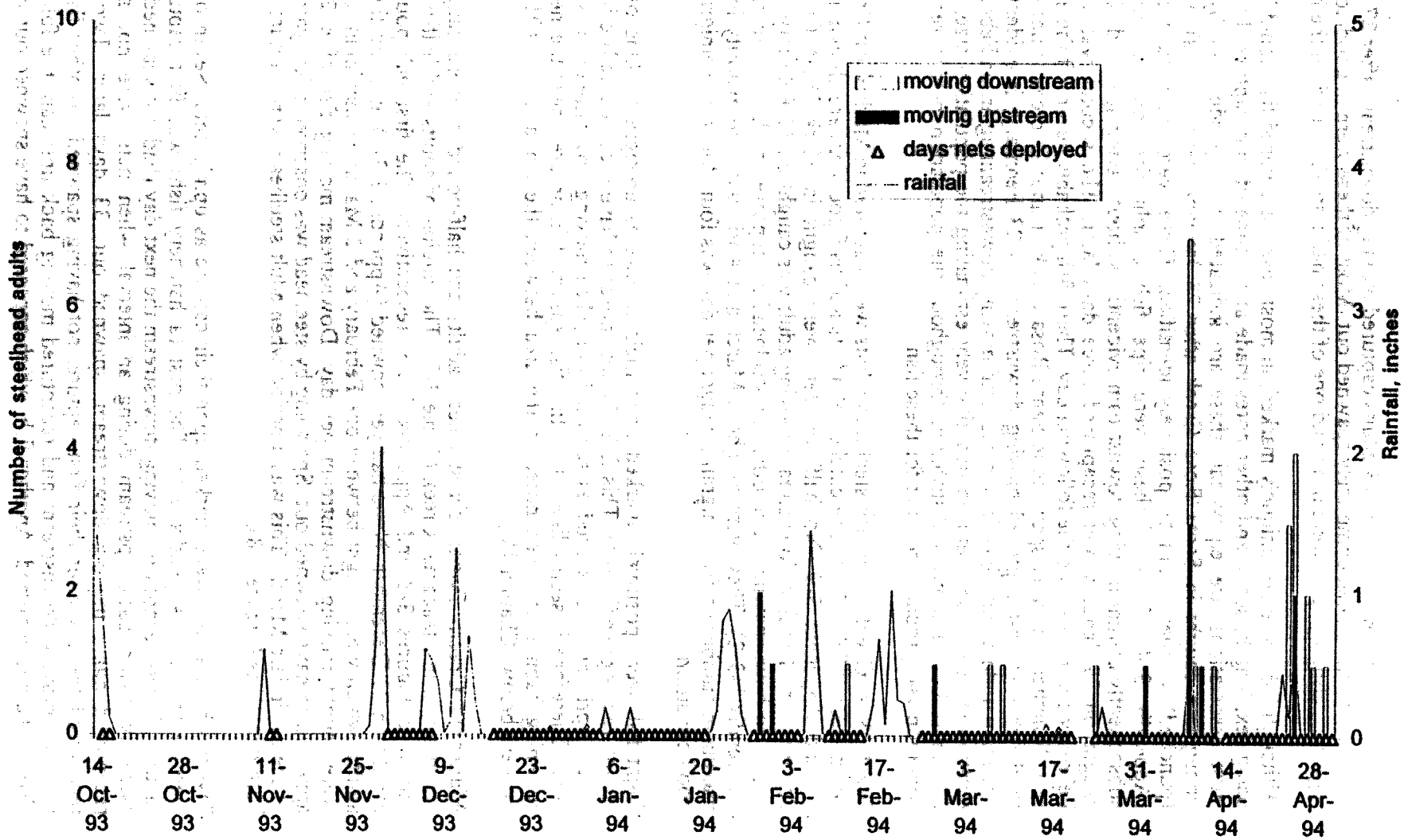


Figure 3-10. Mark West Creek: Steelhead adults



potential to spawn again. The 13 adults captured moving downstream after 27 February all appeared to have been completely spawned out. Most of these were in good condition and vigorous, although two were dead and one of these had a small wound on the head.

Although fish were not uniquely marked, in most cases recaptured fish could be identified using sex, length, scars, and other notes made at the time of first capture. In a few cases such associations are equivocal; these are indicated in Appendix 3-4 by "?". Only upmigrants caught in Santa Rosa Creek after 28 January (seven adults) were marked (punched) so they could be positively identified. Three were captured a second time (Appendix 3-4). Two of these were ripe fish caught first moving upstream and subsequently caught moving downstream evidently without having spawned. The first was caught on 29 January and recaptured three days later. The second was caught on 9 February and recaptured the following day. These fish probably never left the area near the nets. Whether they later spawned in Santa Rosa Creek or another creek is not known. The third fish was first captured moving downstream on 23 February; it evidently returned upstream undetected, since it was captured moving downstream again on February 28. For recaptured fish to be useful in quantitatively estimating the population size, the marked fish must be randomly redistributed throughout the population before recapture; this condition was probably not met for these fish.

Mark West Creek. Nineteen steelhead adults were captured in Mark West Creek moving downstream (Table 3-6). The catches of adults and half-pounders are shown in Figures 3-10 and Appendix 3-9. No half-pounders were caught in Mark West Creek moving downstream. The first downstream-moving adult was caught on 12 February, and did not appear to have spawned. The other 18 steelhead all appeared to have been spawned out (Appendix 3-3-2). They were caught in March and April, with the majority in April. The maximum number of downmigrants caught per day was four. Most downmigrants were in good condition.

Eight fish were positively marked upon their capture as upmigrants. One of these was recaptured (Appendix 3-4). This fish did not appear to have spawned before being caught on 25 April, but was scored as spawned out when moving downstream only three days later. Therefore it seems likely that this fish spawned in an area near the net. Potential spawning habitat has been noted in the area between the net and US 101 (see Redd Surveys below, Chapter IV).

Maacama Creek. Twenty-six steelhead adults and half-pounders were caught moving downstream in Maacama Creek (Table 3-8). The catches of adults and half-pounders are shown in Figures 3-8 and Appendix 3-2-3, respectively. The first half-pounders were caught on 23 December. None had yet spawned (Appendix 3-3-3), nor had the first three adults, which were caught between one February and 2 March. A maximum of three fish were caught moving downstream per day. Downstream-moving fish after 2 March all appeared to have spawned out. Spawning by steelhead was observed a few yards upstream of the net in late March. This was a period when adult steelhead were captured moving in both directions (Figure 3-8).

Twenty-three adults were marked upon their capture as upmigrants. Seven of these fish were recaptured (Appendix 3-4). The first (a hatchery fish) was first captured on 28 January; it was recaptured moving downstream the next day (had not spawned). This fish evidently swam back upstream during an interval when nets were not set. It was recaptured again moving downstream, spawned out, 33 days later. Two fish were recaptured the day after their first capture, not having spawned. Another fish was first captured moving downstream and recaptured moving back upstream the following day, also not having spawned. Another fish, which appeared to have spawned out when it was

first caught moving upstream, was recaptured moving downstream 10 days later. A hatchery fish was first caught moving downstream, not having spawned; then was recaptured moving upstream, still not having spawned, 26 days later. Another adult was first caught moving upstream on 29 January (not having spawned), and was recaptured 56 days later, spawned out.

Out of seven recaptured fish only two went up ripe and came down spawned out. The interval between the two events was 56 days and 33 days.

Conclusions Concerning Catches of Downmigrating Steelhead The capture of post-spawned steelhead returning downstream in the three creeks demonstrates that a critical phase in the life cycle is being successfully completed. More fish were captured moving downstream than upstream, which demonstrates that the number of adults in the spawning run of each creek is larger than the number captured moving upstream. The number of downmigrants is likely also underestimated by data collected in this study since these fish (like upmigrants) tended to move during high-flow periods, when fyke nets usually could not be deployed. Fyke nets deployed in the Lower Laguna (see below) showed that even in low-flow periods these nets do not capture all adults (or smolts) which pass.

Steelhead Smolts

Capture of steelhead smolts migrating to the sea for the first time is good evidence that the freshwater phase of the life cycle has been successfully completed. Fyke net counts of juvenile salmonids cannot be assumed to represent the whole population of juveniles passing through the stream. Smolts, like adults, move during high flows associated with rain when fyke nets often cannot be deployed. Inferences drawn from recapture of smolts in the lower Laguna (discussed below) suggest that fyke net catches underestimate smolt numbers even in relatively low-flow periods.

Santa Rosa Creek. A total of 653 juvenile steelhead were captured in the Santa Rosa Creek fyke net moving downstream, and 218 juveniles were captured moving upstream (Table 3-6). Figure 3-11 shows the juvenile steelhead catch for each day; rainfall is plotted on the same figure. In Figure 3-11, juveniles moving downstream are shown as solid bars, and those moving upstream as open bars. Catches of juvenile steelhead tended to be largest just after rains, as was the case with adults and half-pounders. Some juveniles were captured in Santa Rosa Creek virtually every fishing day. A net movement in the downstream direction was nearly always observed. Fish caught moving upstream early in the season are probably not traveling from very far downstream, since little summer habitat is available downstream (see Chapter IV). Such fish were probably displaced downstream by high flows following rains, and if these fish were not ready to smolt, they moved back upstream. Catches of downmigrants following rains in mid-December were about three dozen fish per day. Later on it was more typical to trap one to two dozen per day after rains.

During December and January, only one-half to two-thirds of the juveniles had clearly developed into smolts. By mid-February, nearly all juveniles had the appearance of typical smolts (i.e., slender body shape, no parr marks, silvery deciduous scales). By early March capture of juveniles in the upstream trap was negligible.

Mark West Creek. A total of 317 juvenile steelhead were captured moving downstream in Mark West Creek; 104 were captured moving upstream (Table 3-6). Figure 3-12 shows the juvenile catch in Mark West Creek. Unlike in Santa Rosa Creek, in Mark West Creek most of the juveniles caught before mid-February were moving upstream. These were probably fish not ready to smolt which had been displaced downstream by rains and

Figure 3-11. Santa Rosa Creek: Steelhead Smolts

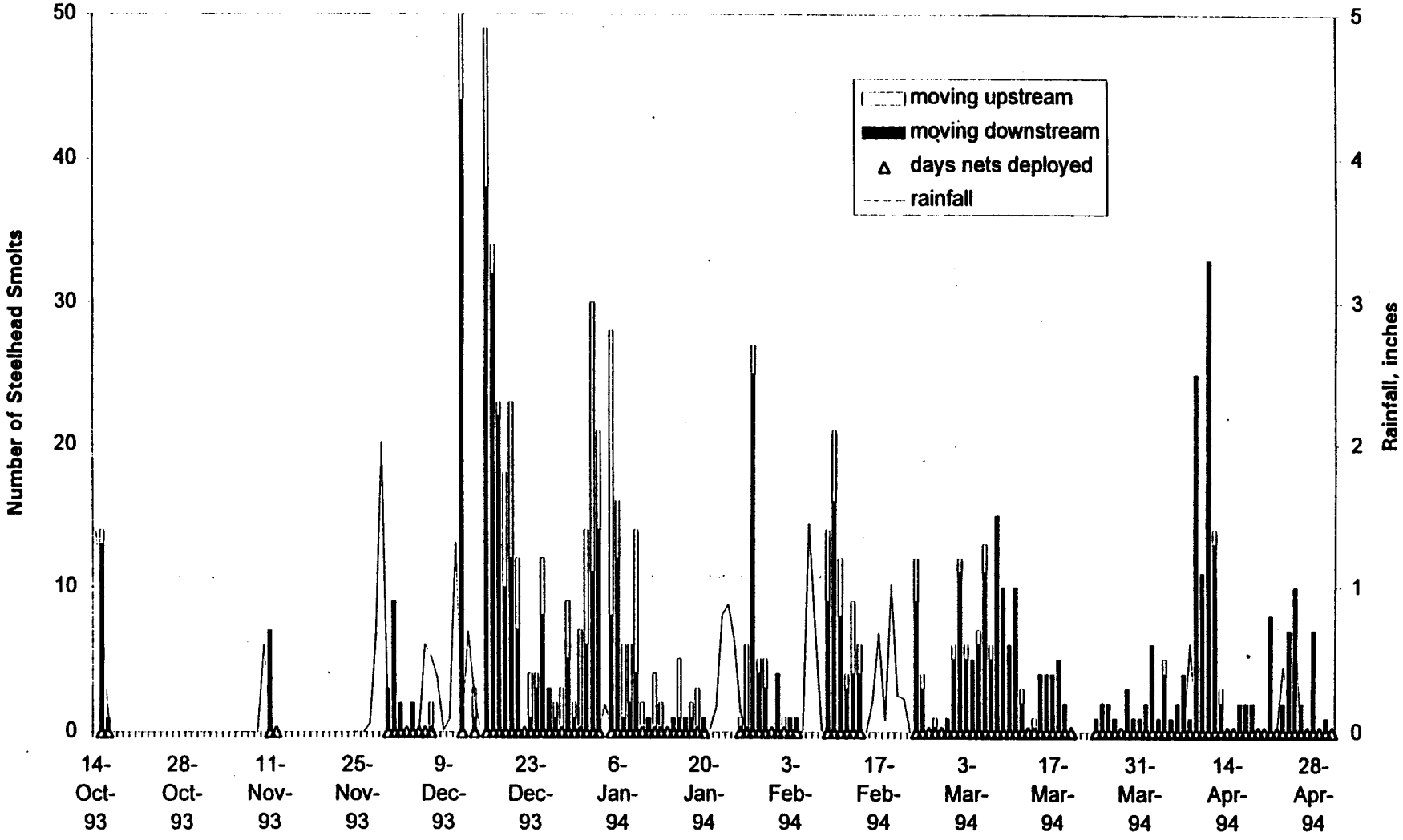
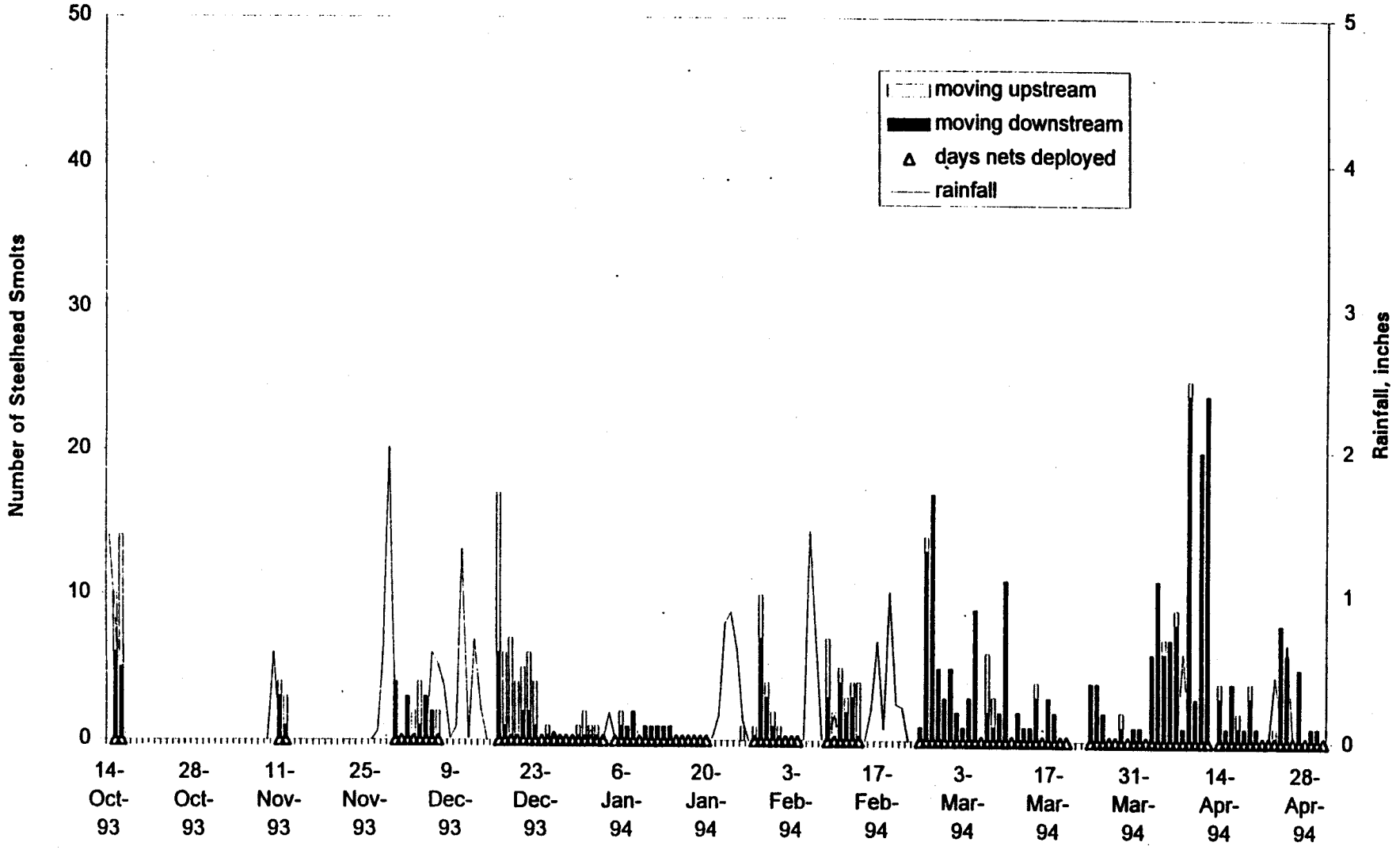


Figure 3-12. Mark West Creek: Steelhead Smolts



attempted to delay their downstream movement. On many days no salmonid juveniles were caught. A true net movement of smolts downstream in Mark West Creek (as defined by numbers caught in upstream versus downstream nets) did not begin until 25 February. Catches thereafter were roughly a dozen per day just after rains, and fewer as flows dropped between rains. Juvenile catches diminished after mid-April.

Maacama Creek. A total of 601 juvenile steelhead were trapped moving downstream in Maacama Creek; 204 were trapped moving upstream (Table 3-8). These totals are roughly similar to the number of juveniles caught in Santa Rosa Creek. However, the temporal pattern of the appearance of steelhead juveniles in Maacama Creek (Figure 3-13) was more like that in Mark West Creek. As in Mark West Creek, a significant net movement of smolts downstream did not begin until early March. Thereafter, smolt catches were 1-2 dozen per day, and were sustained for several days after each rain. Smolt catches dropped after 18 April

Length and Age of Steelhead Smolts An analysis of steelhead smolt length data from the three creeks is given in Appendix 3-5-1 through 3-5-3. Measured fork lengths are tabulated by two-week intervals, and the smolt age composition is deduced from the length-frequency data. Typically, one year-old fish were less than 130 mm, two year-olds were between 130 and 200 mm, three year-olds 200-250 mm, and four year-olds 250-300 mm. The actual separation between year classes for each interval is determined by length-frequency patterns, and is shown in the Appendices as a heavy horizontal line. Mean lengths are calculated for each age class in each interval.

The overall smolt year class composition for the whole study period is shown for the three creeks in Figure 3-14. In all three creeks the largest smolt age class was two year-old fish. Two year-olds comprised nearly 80 percent of the smolts in Maacama Creek, with most of the others one year-old. In Santa Rosa Creek and Mark West Creek the domination of the two year-old class was less complete. Nearly one-third of smolts in Santa Rosa Creek were one year-old. Over ten percent of Mark West Creek, and nearly four percent of Santa Rosa Creek steelhead smolts were over two years old.

There was a tendency for the younger fish to migrate earlier in the season, and for smaller individuals within an age class to migrate earlier than larger individuals. Individual growth during the smolt season does not entirely explain the pattern of increase in mean lengths within the one and two year-old age classes as the season progresses. Considering the mean lengths of each year class for the whole study period, the three creeks were very similar, as Figure 3-15 shows.

Coho Salmon

Santa Rosa Creek. No adult coho were trapped in Santa Rosa Creek. Four coho juveniles were trapped in the Santa Rosa Creek fyke nets (Table 3-6, Appendix 3-5-4); three were captured moving upstream (16 and 31 December, and 12 January), and one moving downstream (23 February). These appeared to be wild fish (no fin clips or tags). Fork lengths ranged from 102-139 mm. No coho juveniles were found during Santa Rosa Creek juvenile density surveys (see Chapter IV). It is not clear whether the fish captured in fyke nets were reared in Santa Rosa Creek or strayed up from another creek, such as nearby Green Valley Creek.

Mark West Creek. No adult coho were trapped in Mark West Creek in the 1993-1994 season (two were trapped in January-February 1993). Four coho juveniles were trapped in Mark West Creek, all moving downstream (Table 3-6, Appendix 3-5-4). These fish were captured between 12 and 24 April; they ranged in fork length from 115-125 mm, and

Figure 3-13. Maacama Creek: Steelhead Smolts

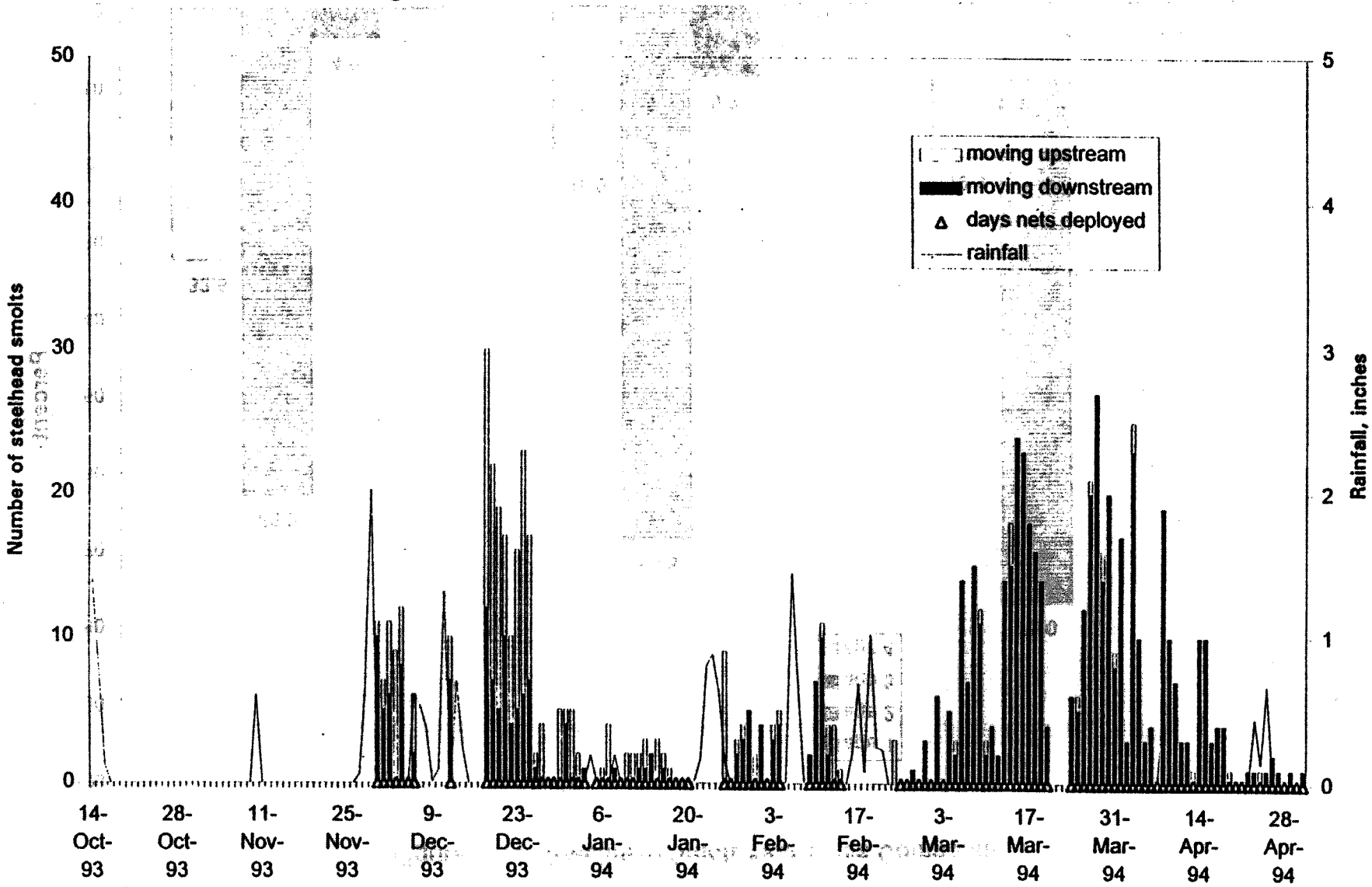


Figure 3-14. Steelhead Smolt Year-class Composition

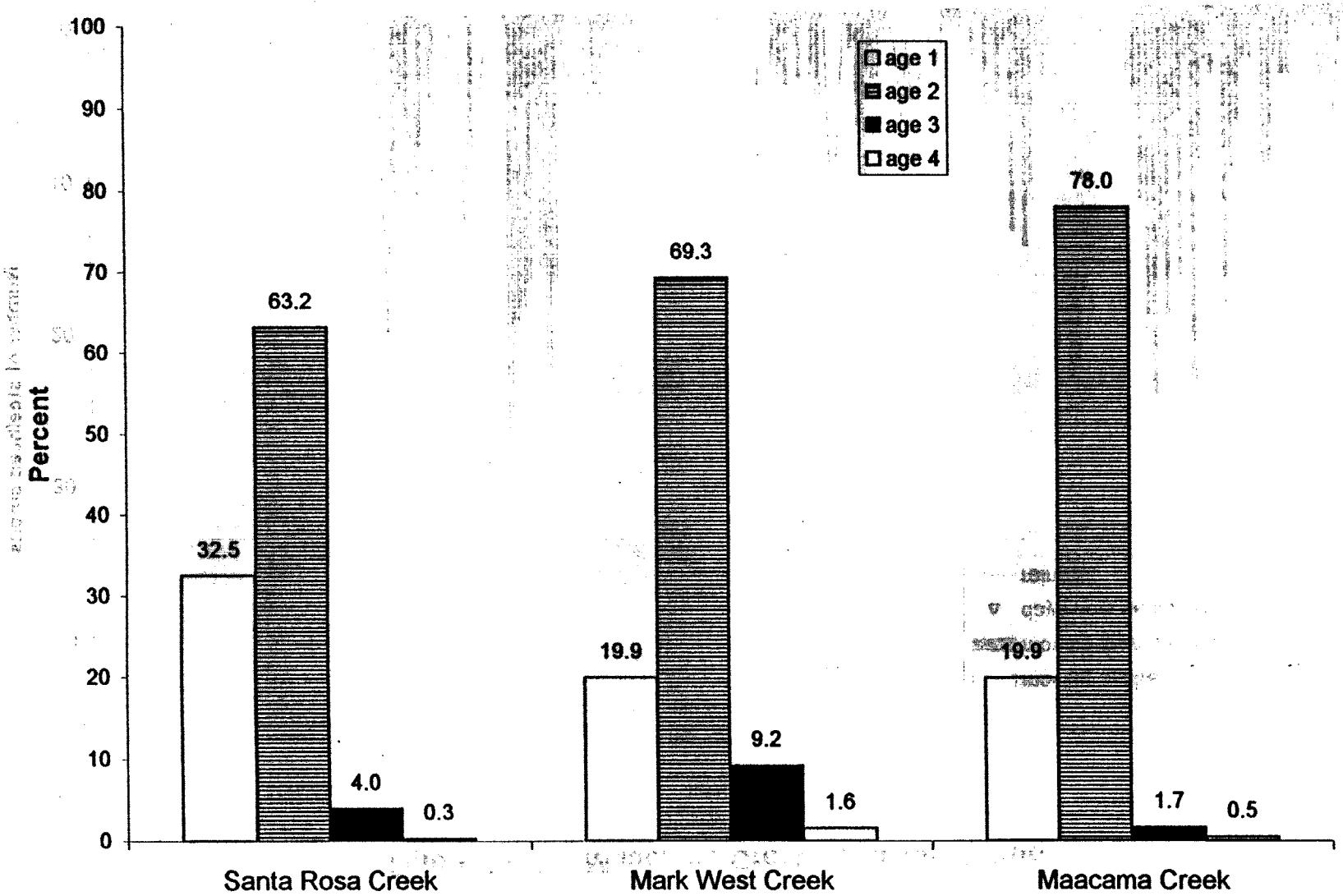
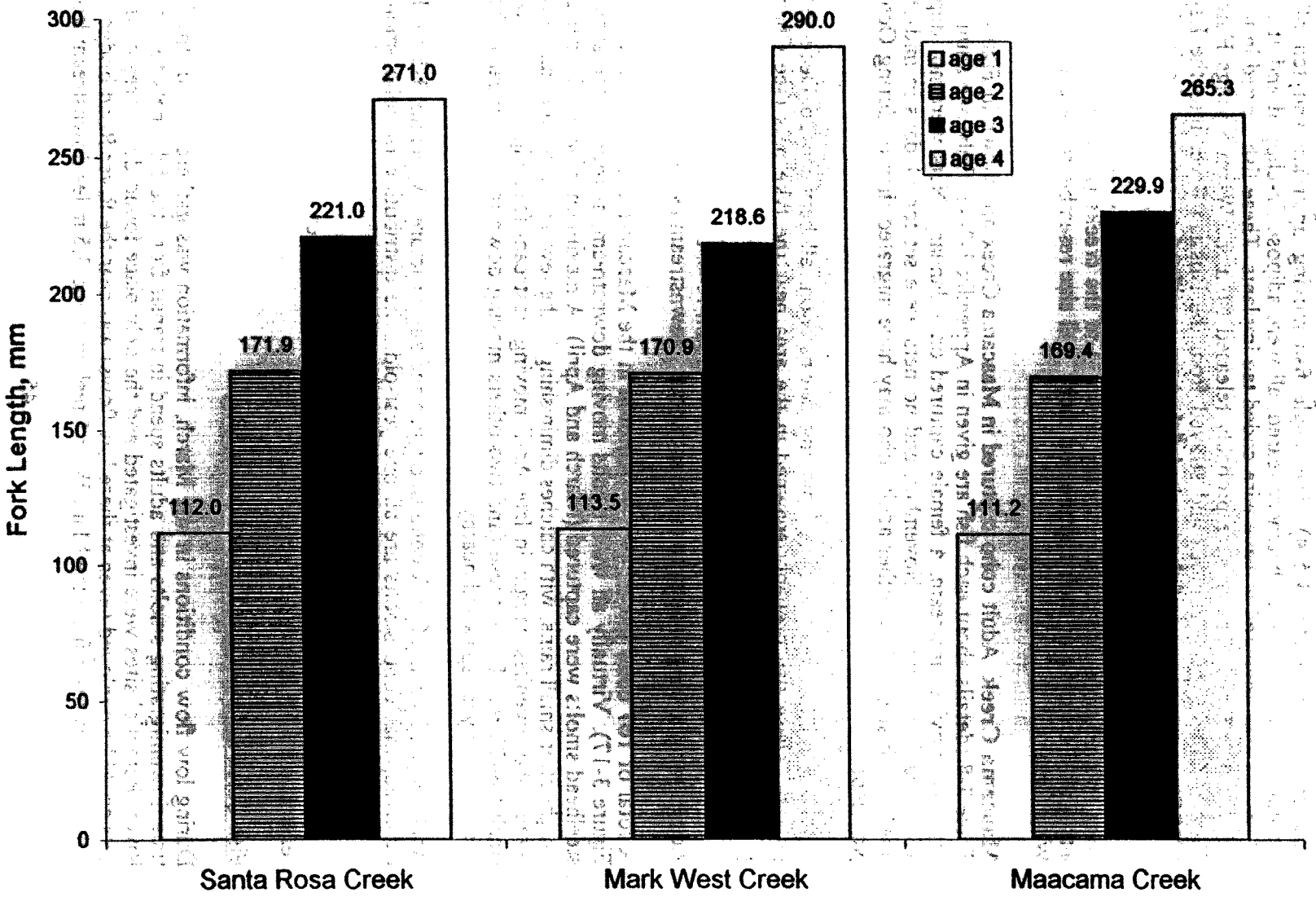


Figure 3-15:
Steelhead Smolt Mean Fork Lengths by Year Class



appeared to be wild fish. No coho juveniles were found during Mark West Creek juvenile density surveys (see Chapter IV).

Lower Laguna. The steelhead catches in the Lower Laguna are discussed in the following section. No adult coho were trapped in the Lower Laguna (Table 3-9). Nineteen coho juveniles were trapped in the Lower Laguna, one moving upstream and 18 moving downstream (Appendix 3-5-4). The single fish moving upstream and ten of the fish moving downstream were hatchery reared; all were adipose fin-clipped and at least three of the ten also appeared to have wire-coded tag implants. These fish ranged in fork length from 139-185 mm. These were probably released from the Warm Springs Hatchery (R. Gunter, CDFG, pers. comm.) and strayed from the Russian River into the Laguna. At CDFG's request, none of the marked fish were sacrificed to retrieve the implants. The remaining seven coho smolts were captured moving downstream on 13-14 April; all of these were wild fish, ranging in fork length from 110-135 mm. Since none of these seven were marked, it is not possible to say in which of the creeks (if either) they originated, although the timing of their capture and their small size resemble those captured in Mark West Creek.

Maacama Creek. Adult coho captured in Maacama Creek are shown in Figure 3-16 and Table 3-8 (details about each fish are given in Appendix 3-3-4). Only one adult coho was captured moving upstream, a female captured on 1 January. Nets were not deployed in Maacama Creek until 29 November, and no nets were set for 11 days in mid-December due to high streamflow; other adult coho may have migrated then or during October and November.

Eight adult coho were captured moving downstream, all between 26 December and 9 January. These fish probably spawned in the area near the fyke nets (see Chapter IV), since these fish deteriorate rapidly after spawning. Most appeared to have spawned. Four were dead (these probably died after swimming into the net, since dead adults do not seem to drift far). Any adults which spawned in upstream reaches of Maacama Creek probably did not survive long enough to travel as far back downstream as the fyke net site.

A total of 167 coho juveniles were captured in the Maacama Creek fyke net (Table 3-8, Figure 3-17). Virtually all were smolts moving downstream, at roughly the same time as steelhead smolts were captured (March and April). A maximum of about 10 per day were caught after small rains, with catches diminishing in the few days after the rain. Two of the three coho juveniles caught in late April moving upstream (see Figure 3-17) were very small (69-72 mm F.L.); these (and two others moving downstream) appear to have been young of the year spawned nearby.

Analysis of Maacama Creek coho smolt size and age structure (Appendix 3-5-5) shows, as expected, that coho smolts are all one year-old. The distribution of coho smolt lengths between 28 March and 24 April was bimodal, but this is probably not due to hatchery fish (which tend to be larger, as shown in Appendix 3-5-4) because these fish were not adipose clipped. As with steelhead smolts, the larger individuals tended to migrate later in the season.

Fish Catch in Upper and Lower Laguna Sites

During low flow conditions in late March, information was gathered about the length of time downmigrating smolts and adults spend in transit from the fyke nets to the Russian River. Potential sites were investigated and the only place found downstream where fyke nets could be deployed (even at these low flows) was near the River Road bridge, which is 3 miles downstream from the Mark West Creek nets and 3.5 miles downstream from the

Figure 3-16. Maacama Creek: Coho salmon adults

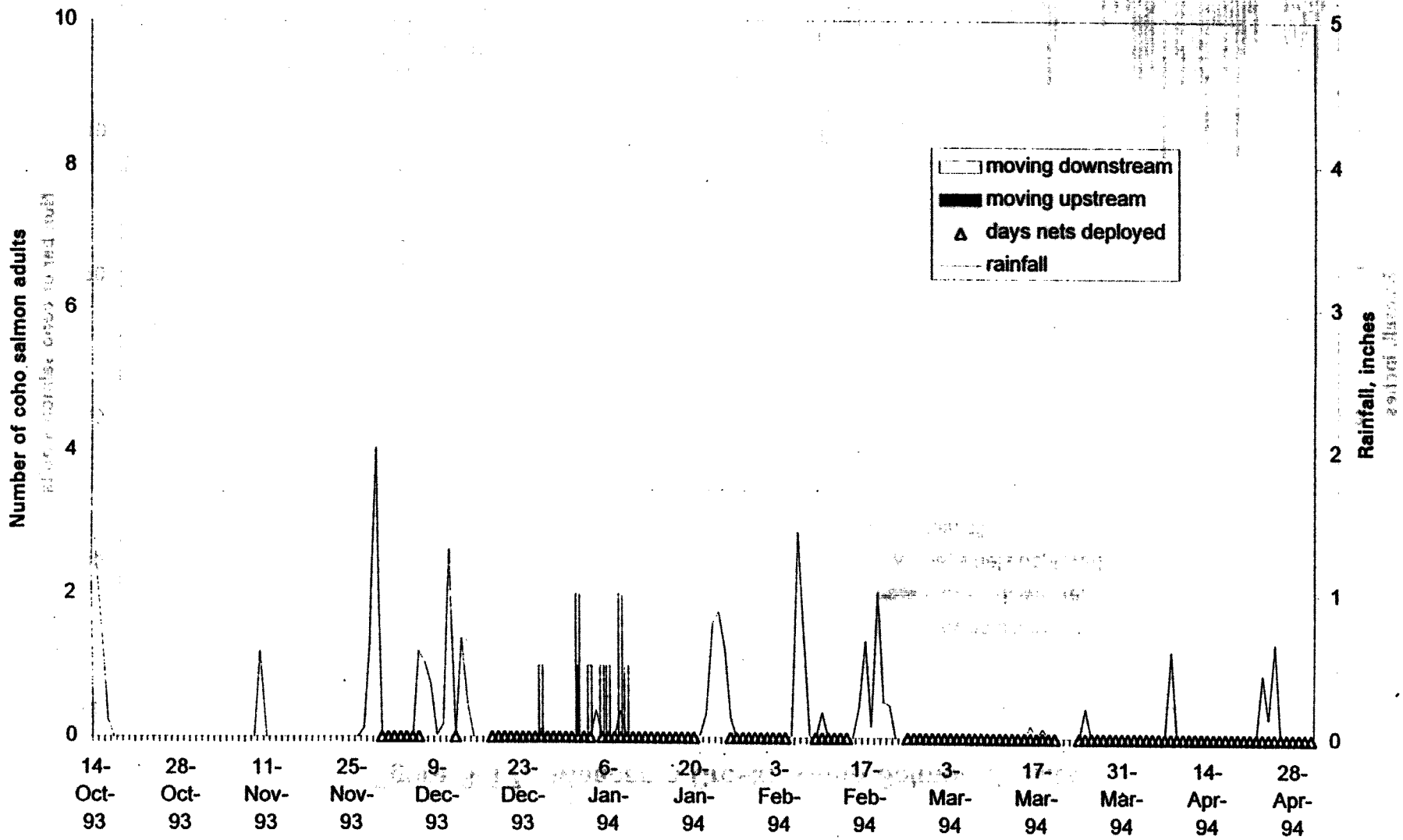
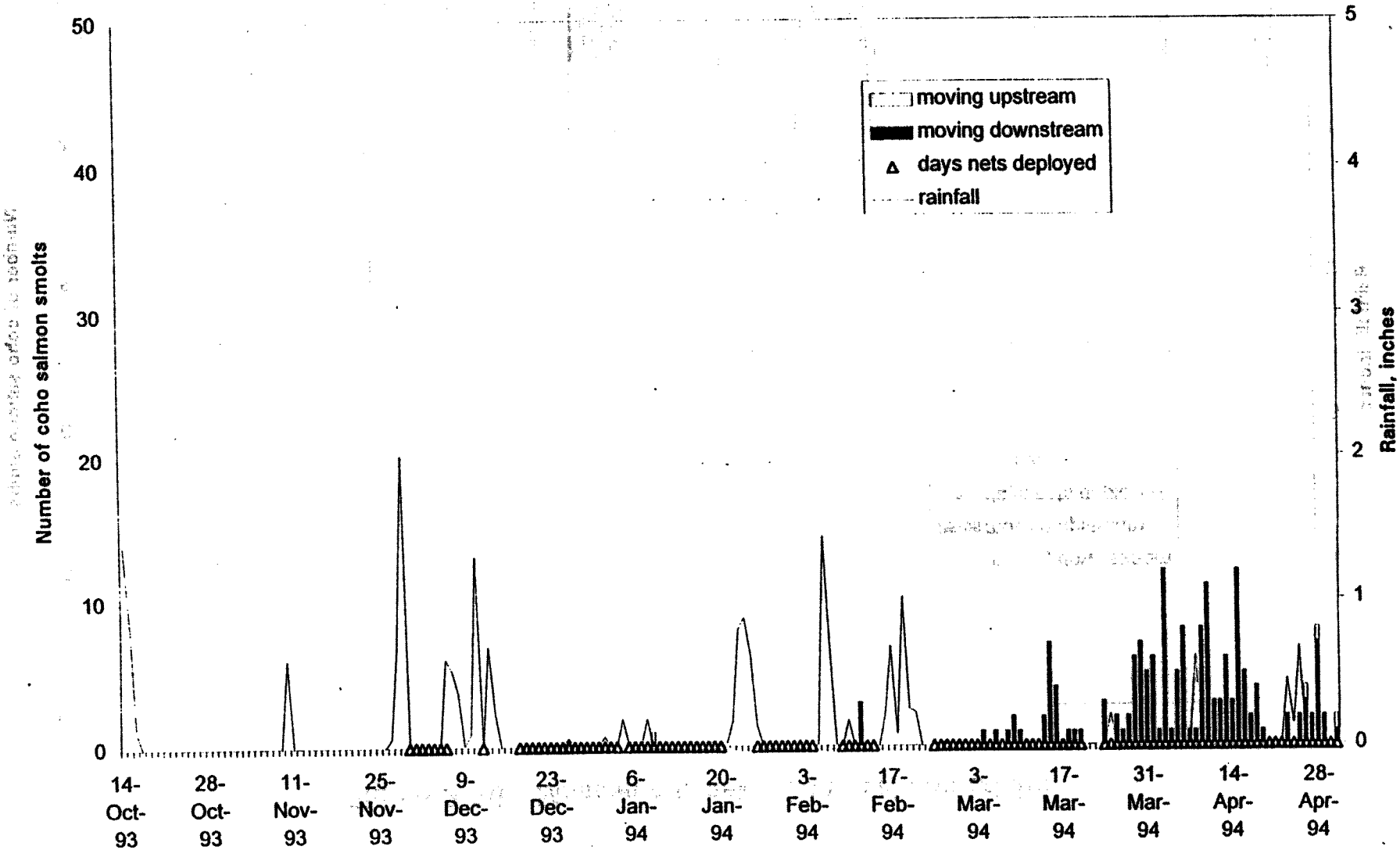


Figure 3-17. Maacama Creek: Coho Salmon Smolts



Santa Rosa Creek nets (i.e., roughly half the distance from the nets to the Russian River). This site proved to be particularly difficult to fish effectively, as is discussed in the following section. During the period when the Laguna nets were deployed (33 days, from 19 March through 23 April), smolts and adults trapped in the nets upstream were marked so that fish from Santa Rosa Creek could be distinguished from those originating in Mark West Creek, should either be recaptured in the Laguna nets. In addition to elucidating fish travel time, the downstream nets also proved useful in evaluating fyke net trapping effectiveness. The lower Laguna salmonid catches are summarized in Table 3-9.

Table 3-9. Salmonid Catches in the Lower Laguna at River Road, 1994

	Moving downstream (33 days fished)	**Moving upstream (33 days fished)**
Steelhead adults	10	5
Steelhead half-pounders	0	0
Steelhead juveniles	175	14
Coho salmon adults	0	0
Coho salmon juveniles	18	1

Travel Time of Fish. Ten adult steelhead and 175 juveniles were trapped moving downstream. During the time that the Lower Laguna nets were deployed, four steelhead adults were captured, marked and released downstream in Santa Rosa Creek. Seven more steelhead adults were captured, marked, and released downstream in Mark West Creek (Table 3-10). Four of these eleven fish were recaptured in the Laguna net. Details of the recaptures are given in Appendix 3-4. Three of the four fish were recaptured on the day following when they were marked, indicating a transit time of one day or less (nets were checked once each day). The fourth fish was recaptured 17 days after it was marked in Santa Rosa Creek.

Table 3-10. Steelhead adults marked upstream and recaptured in the Lower Laguna fyke net.

Where Marked	**Steelhead Adults Marked Upstream**	**Marked Steelhead Adults Recaptured**	**Unmarked Adults Caught in Laguna**
SRC	4	3	
MWC	7	1	
LAG	4	1	5

Smolts marked upstream and recaptured in the Laguna are listed in Table 3-11 (steelhead) and 3-12 (coho salmon).

Table 3-11. Steelhead smolts marked upstream and recaptured in the Laguna.

Where Marked	Steelhead Smolts Marked Upstream	Marked Steelhead Smolts Recaptured	Unmarked Smolts Caught in Laguna
SRC	119	10	
MWC	97	6	
LAG			157

Table 3-12. Coho smolts marked upstream and recaptured in the Laguna.

Where Marked	Coho Smolts Marked Upstream	Marked Coho Smolts Recaptured	Unmarked Coho Smolts Caught in Laguna
SRC	0	0	
MWC	4	0	
LAG	1	0	18

A total of 216 steelhead smolts were marked at upstream fyke nets; only 16 were recaptured in the Laguna. Associations between marked and recaptured smolts are more equivocal than adults because many smolts are similar in length. In a few cases, smolts with unique markings (e.g., bruises) permitted us to positively associate recaptured fish. Of the 16 smolts recaptured, eight were caught the day after they were marked upstream. The other eight were recaptured from two to five days later (Table 3-13).

Table 3-13. Travel time of steelhead smolts.

Days between marking at upstream net and recapture in Lower Laguna	Frequency (Number of Fish)
1	8
2	3
3	2
4	2
5	1

None of the four coho smolts marked in Mark West Creek were recaptured in the Laguna. These observations on travel time can be summarized as follows: during low flow conditions most adults and smolts traveled from the upstream nets in one day or less, but some evidently remained in the area for several days. Travel time during high flows is probably much shorter, as observations in the following section suggest.

Fyke Net Efficiency

Only 36 percent of marked adults and 7 percent of marked smolts were recaptured in the Laguna nets; some of the difficulties of trapping effectively at the Laguna site are discussed in the following section. However, five unmarked steelhead adults and 157 unmarked steelhead smolts were captured during the same period in the Laguna (Tables 3-10 and 3-11). This could either mean that other tributaries to the Laguna have steelhead runs, or that the upstream fyke nets failed to catch these fish. Steelhead are unlikely to be found in other Laguna tributaries, but fyke nets were set for six days in late March at Llano Road (downstream from Crane Creek, Copeland Creek, and Gossage Creek) and for five days in early April on Brown Farm near Sebastopol (downstream from these creeks and Blucher Creek). No salmonids were caught (see Appendices 3-7-5 and 3-7-6).

The second possibility, that fyke nets underestimate fish numbers, can be examined. Considering first the unmarked fish captured in the Laguna, three of the five were caught on 24-25 March. Nets were not set in Santa Rosa Creek or Mark West Creek on 21-23 March, so these fish could have passed through unmarked then. Of the other two fish, one was caught on 6 April--one day after a gnaw hole (which could allow fish to escape) was found in the Santa Rosa Creek net, and the other was caught on 9 April--one day after both upstream nets were overwhelmed by high flows. Similarly, there are plausible explanations for the seven marked fish which were *not* caught in the Laguna trap. All three nets were partially overwhelmed and did not fish correctly on 8 April; three of the four adults marked in Mark West Creek were not picked up by the Laguna nets that day. (There is a likelihood of fish passing both upstream and downstream nets undetected on that day). Similarly, gnaw holes were found in the Laguna net within 1-3 days after each of the other four fish were marked upstream.

That most of the smolts move down during high flows is supported by the catches of 157 smolts in the Laguna that had not been intercepted upstream, most of which occurred on a few days following rains which overwhelmed the upstream nets (68 smolts on 9 April, 32 smolts on 23 April).

Half of the adults and nearly 90 percent of the smolts captured during the Laguna trapping period were not intercepted in either of the upstream traps. Since the Laguna trap only captured 36 percent of marked adults and 7 percent of marked smolts, it can be assumed that unmarked adults and smolts were similarly underestimated. The Laguna trap was fishing effectively less than 60 percent of the time (see below), so these estimates are conservative. The number of adults and smolts that pass through the system during high flows cannot be quantitatively estimated, but it is probably considerably larger than the number caught during lower flows.

Fyke Net Effectiveness

Fyke nets can be deployed effectively only at low to moderate streamflows, so cannot count fish which pass at higher flows. Appendix 3-2 shows that during the five month period (December through April) nets were not set for a total of approximately 30 days (depending upon the creek) typically just before, during and just after rains. Thus, no data are available for the 20 percent of days when fish are most likely to pass. This is the

biggest limitation to fyke net effectiveness; but even when nets are deployed, they are unable to intercept every fish that passes, as the previous section showed. In many cases, it was apparent that the net(s) were not functioning effectively. The most common problems were nets overwhelmed by high flows and animal gnaw holes. The incidence of such problems is listed for each net on each day in Appendix 3-2, and these data are summarized in Appendix 3-6.

Animal gnaw holes were typically made by mink and river otters, although there was evidence that raccoons and muskrats also frequented the net sites, and may have gotten into the nets at times. Mink and otter holes were most frequent early in the season, and again during low water in spring. Continuous fishing during low water in spring exacerbated this problem. Gnaw holes may indicate that some fish were eaten or escaped. It is unlikely that an adult salmonid would be completely eaten; on two occasions during the four years of study an adult steelhead was killed in or around the nets. Both occurrences were in Mark West Creek, the first in 1991 and the other in 1994. In the recent occurrence, an upmigrant evidently became entangled in the net wing and was then attacked and partially eaten, probably by an otter.

Adult steelhead are probably little affected by predators (except for occasional human poachers) during their migration through the Laguna system, but smolts are heavily preyed upon by various birds. In the creeks of the Laguna system, the primary avian predators are great blue heron, great egret, snowy egret, black-crowned night heron, common merganser, and belted kingfisher. Fish passing through the lower reach of Santa Rosa Creek are more vulnerable to attacks by birds than in other reaches of the study streams, owing to the lack of riparian cover and instream shelter in that reach (see Chapter IV). The lack of cover makes it harder for fish to hide, and also makes the reach more attractive to wading birds, which seem to feel safer in open areas than in densely vegetated habitat. During low water in April bird peck holes began to appear in the net cod ends at all the fyke net sites (probably the work of herons which were sometimes seen standing on the nets), and many of the captured fish had wounds characteristic of bird pecks. Opaque tarpaulins were attached to the fyke traps beginning in mid-April, and this action effectively ended bird attacks on fish in the nets. However, many fish coming into the nets already bore such wounds, and many others were seen during the juvenile density surveys (Chapter IV). Presumably, many other smolts were successfully captured and eaten by birds during their outmigration.

Tampering with the traps occurred twice in 1994, both in Santa Rosa Creek. On one occasion (2 April) the downstream-facing net was opened and its catch of several large carp were allowed to escape between the nets. It is unlikely that any adult salmonids were in the net. One of the carp was evidently stabbed. On the other occasion (26 April) a section of one of the wing nets was cut off and removed.

The net location in the Lower Laguna was particularly difficult to fish effectively, as Appendix 3-6 shows. Here the net was scored as fishing effectively only 58 percent of the time, and the occurrence of holes may have been underestimated because the water was both deep and turbid. Nets appeared to be fishing effectively at the other sites from 67 to 90 percent of the time.

Chapter IV.
HABITAT, SPAWNING, AND JUVENILE ABUNDANCE MONITORING

In addition to the fyke net studies of upmigrating adult steelhead trout and coho salmon, the 1993-1994 Anadromous Fish Migration Study Program included efforts to study other aspects of reproduction and ecology of these populations during the freshwater phases of their life cycles in the study streams. The objective of this part of the study was to evaluate spawning success, juvenile production, and how many of the juveniles survive to become smolts and go to sea. The study program included surveys of the quality and quantity of habitat available for spawning and rearing, surveys of juvenile density, visual surveys of redd sites and spawning activity, and counts of outmigrating smolts captured by downstream fyke nets operating side-by-side with the fyke nets designed to intercept adult fish moving upstream. This program, in conjunction with the fyke net studies of adult migration, helps to complete a picture of the relative success of all of the key links in the life cycles of these fishes in the study area, with exception of the time spent at sea. The smolt trapping program is described above in Chapter III. This chapter describes the surveys of habitat condition, juvenile density, redds and spawning activity.

The focus of this investigation is Santa Rosa Creek, and, to a lesser extent, Mark West Creek, and the potential impacts of the City's reclaimed water discharges on migratory salmonids that utilize these streams for spawning and rearing through the juvenile phases of their life cycles. It was known at the outset of the study that numerous other human activities (channelization, diversions and de-watering, dam construction, riparian forest clearing, trash dumping, runoff of agricultural and urban wastes, exotic species introductions, etc.) had historically affected, and continue to affect, habitat conditions in these streams, as in most of the streams in the region. It is also well known that all of these activities can have detrimental effects on fish populations, especially salmonids (Barnhart 1986, Moyle et al 1989, Nehlson et al 1991). The task, then, was to identify and separate the possible impacts of the City's reclaimed water discharges from the other factors, and to assess the City's contribution, if any, to the cumulative impacts of all the factors on the populations of steelhead (and possibly coho) using these streams.

METHODS

Habitat Characterization

In each of the principal study streams (Santa Rosa Creek, Mark West Creek, and Maacama Creek), "index zones" were established for periodic surveys of habitat condition and juvenile density. An index zone is a particular reach or portion of stream that is surveyed in some way and then re-surveyed periodically in the same manner, as a means of documenting seasonal or other types of change. After making habitat observations in most reaches of all study area streams, the index zones were selected to be representative of the larger system. Each stream was divided into upper, middle, and lower reaches, based on elevation and distance from the Russian River (Table 4-1), and an index zone was selected for surveys within each reach. One index zone was also established in Green Valley Creek, which is known to support small runs of steelhead and coho (W. Cox, CDFG, *pers. comm*.). In the latter case, most of the stream was found to be highly degraded, and the index zone was established in the only reach (middle) that appeared to have any habitat suitable for salmonids.

Figure 2-1 shows the study area and locations of the index zones. The designation of upper, middle, and lower reaches in these streams was not intended to have any universal significance to other stream classification systems; it was a convenience adopted for this study to improve the comparability of the surveys. Some of the study streams are known to have fish habitat at elevations greater than 700 feet (the upper limit of the index zones used in this study), but most of those upper areas were not accessible to the study team.

Table 4-1. Habitat and Juvenile Density Index Zones

Creek	Reach	Elevation (ft)[a]	Location
Santa Rosa Creek	Upper	600-640	Cougar Lane
	Middle	310-320	Fish ladder to Hwy 12 Bridge
	Lower	60-80	Delta Pond to Fulton Rd.
Mark West Creek	Upper	600-640	Alpine Rd. to St. Helena Rd.
	Middle	400-440	Downstream from MWC Lodge
	Lower	50-60	River Rd. Bridge to Cunningham ranch
Maacama Creek	Upper	500-520	Hwy 128 Bridge to Peter Michael Winery
	Middle	200-240	Downstream from Camp Maacama, along 128
	Lower	140-160	Chalk Hill Road
Green Valley Creek	Upper	150-180[b]	[none]
	Middle		Allen Ranch
	Lower		[none]

[a]feet above sea level
[b]stream lower in Russian River Watershed; distance from river corresponds to middle reaches of other streams

The index zone approach (Nielsen and Johnson 1983) is based on the ecological premise that the best way to account for the distribution and abundance of a population of organisms at the present point in time is to know something about the population's history, through repeated observations, counts, or measurements over a period of time that is long relative to the life spans or generation times of the organisms (Connell and Sousa 1983). The main reason this approach provides a better account for the present status of a population than methods involving a one-time assessment of the population and its environment, is that historical events in the environment that may occur in a very short period of time (e.g., one severe storm, heat wave, or one unusually dry season) may profoundly affect a population for years afterward, and such an event often cannot be accounted for by any one-time assessment.

In the initial surveys (October-November 1993), the entire length of each index zone was rapidly surveyed by a team of two people. The stream habitat was classified by the habitat unit approach (Bisson, et al 1982, Hankin 1986), in which a unit is defined as a continuous portion of the stream of variable length, within which only one habitat type is

present or is dominant. Habitat types have generally been classified by many researchers into three broad categories: pools, runs (or glides), and riffles, with numerous finer distinctions within each category (e.g., lateral scour pools, plunge pools, secondary channel pools, rootwad enhanced pools, etc.,), depending on the authors. The approach used in this study was to classify each unit as either pool or riffle, with glides being assigned to whichever category (pool or riffle) they most closely resembled, as no unequivocal way was found to distinguish glides from the other categories in these small streams. (For example, a slight drop in water level can change a glide to a riffle, and most glides begin with a pool at the upper end and end with a riffle at the lower end).

For each habitat unit, a sketch was made and a data form was filled out (example shown in Figure 4-1). The length of each unit was measured by tape or rangefinder, or in the case of a few very long units in lower Santa Rosa Creek, estimated by odometer. The mean width, depth, and maximum depth of each unit was estimated, and observations made about stream gradient, bank cover, shade, instream shelter, substrate, spawning potential, and other relevant physical features. Biotic factors, such as the quality and quantity of food available, or the presence or absence of potential competitors or predators, were not evaluated, although such factors may be of great importance to fish populations. The primary objective of these surveys was to compare the densities of juvenile salmonids in different reaches of the Santa Rosa Creek drainage with those of nearby similar reference streams, as part of an effort to evaluate potential effects of reclaimed water discharges into lower Santa Rosa Creek. What was needed for this study was simply a robust and rapid way of describing major habitat features, largely so that comparable units could be selected for fish sampling.

After the habitat surveys were completed for all of the index zones, the data forms were reviewed again by the survey team, and each unit was assigned a "Salmonid Habitat Score" from one to 3, as follows:

- 1 = unsuitable for salmonids,
- 2 = marginally suitable,
- 3 = suitable.

Instream shelter, bank cover (and/or shade), and depth were the features that were weighted most heavily in assigning suitability scores. A score of one does not mean that there can be no salmonids in that unit, but simply that the absence of shelter or other critical features makes it unlikely that any salmonid would take up residence in that unit. The "suitable" category could clearly be further subdivided into divisions such as "good", "excellent", and so on, if such refinement was required, say, to attempt to explain differences in micro-habitat utilization within a stream reach, but, as discussed above, that was not the objective of this study.

It should also be noted that the kind of habitat used by very small fry just after emergence from the gravel (tiny shallow pools and riffle edges) was not evaluated, as this type of habitat was abundant in all of the streams, and had already been abandoned by the growing juveniles, in favor of bigger, deeper habitat by the time of the sampling. The timing of the sampling ensured that all of the young-of-the-year fish had had at least a month (for the July sampling) to grow since emergence, by which time the smallest surviving individuals were over 30 mm in length (fork length), and had all moved into the deeper habitat necessary for continued growth and survival. The absence of fry from the shallow, post-emergence habitat described above was confirmed at the time of sampling by searching such habitat with dipnets and miniature seines while overturning cobble and other objects upstream from the nets.

Merritt Smith Consulting

STREAM HABITAT INVENTORY FORM

Date 4 Nov 93 Stream Name SRC Reach upper Time 1135

Habitat Unit No. 1 Habitat Type glide/pool Unit Length 97'

Mean Width 6' Mean Depth 1/2' Max. Depth 2'

Stream Gradient low

Bank Cover or shade south bank is rock cliff, trees both sides

Substrate gravel over bedrock, scattered boulders.

Instream Shelter boulders, cut banks under cliff

Other Habitat Features or comments Many leaves & twigs in all units

Salmonid Habitat Score (1-3)* 3

Revisit Date 23 June, 20 July 94

Revisit Comments water slightly lower than Nov, structure the same, few leaves
checked again aug 16th

Revisit Salmonid Habitat Score 3

* 3 = Habitat suitable for salmonids
2 = Marginally suitable
1 = Unsuitable

Figure 4-1. Example of Habitat Inventory Form

In surveys following the initial (October-November 1993) surveys (July 1994 and October 1994) all of the habitat units in each index zone were examined again, and any changes in the descriptions of each unit were noted, with emphasis on differences that would affect the habitat score.

Juvenile Abundance Surveys

After completing the habitat surveys, fish were collected in selected units within each index zone by repeated passes through the unit with a beach seine of appropriate length for the unit, after blocking both ends of the unit with blocking nets. The selection of which units to sample in each index zone was based on the goal of being sure that some units representative of each habitat type (pools vs. riffles) were sampled, that some of the best units in each index zone were sampled, and that only a small amount of time was spent in units unlikely to contain any fish or likely to be the first units to go dry before the next summer's surveys. While this approach biases the sampling in favor of the better habitat, the vast majority of the juvenile fish occupying these streams occupy a relatively small portion of the habitat, which is found in the best units. These streams are small, and during much of the year many of the riffles and pools are too tiny and shallow to support salmonids. In fact, many of the units are dry in summer, and the surviving fish are concentrated in a few of the deepest and shadiest pools. Since the stratagem was to sample the same units in different seasons and years, the best pools, which are also the most likely to remain wet during the dry season, were favored for sampling.

The best pools have structural complexity, especially in the form of woody debris and cutbanks or ledges. Such pools can also be the most difficult to seine effectively, but results can be greatly improved by first blocking both ends of the unit (with nylon seine netting), then temporarily removing some of the instream structure that is moveable, e.g., loose treetops and prominent sharp-edged boulders, then replacing the removed items before releasing the fish after seining is completed in that unit. In other cases, e.g., where a large boulder, log, or islet is in the middle of the unit, the fish may be chased away from one side of the object, and then that section is blocked off with blocking nets from the rest of the unit before seining begins. These techniques were used in this study.

Seining was selected as the preferred sampling technique for juveniles in these streams based on the team's previous experience with electrofishing, seining, gillnetting, trapping, and other methods in the Laguna system and similar small streams elsewhere. All of the streams in this study have two features that dictate what sampling methods are effective: small size and low flow for most of the year, and a substantial amount of fine sediment in all reaches. Most of the juvenile steelhead and coho (except for a short period immediately after emerging from the redds) are found in the larger pools and glides through which water moves slowly. The deposited sediment in these units is re-suspended in the water column on the first pass through the unit, and the water clarity may remain near zero for a considerable time afterward. The increased turbidity enhances the effectiveness of the seining technique (possibly by making it harder for the fish to see the net or the operators); typically, more fish are captured on the second or third passes than on the first pass.

The seines used were made of nylon mesh, four feet deep by 10, 15, or 25 feet long, with a float line at the top and a lead line at the bottom. In the October-November 1993 surveys the mesh size of the nets used was 1/4 inch (square), except for the 10-foot seine, which was 1/8-inch mesh and was used in very small riffles, where some of the smallest fish might be found. The initial surveys were conducted as soon as possible (November 1993) after the study plan was approved by the City and before winter storms stimulated smolt migration. Of necessity, existing available equipment (and a rapid habitat assessment technique) were employed. In subsequent surveys, new and improved seines were used;

these were of the same lengths as the ones used in the first surveys, but all consisted of 3/16-inch mesh and included a square bag in the center of the net, which makes them more efficient at retaining fish. The main effect of adding the bags to the nets is that fewer passes are required to capture most of the fish in a unit. The smaller mesh size was chosen because it was anticipated that smaller young-of-the-year fish would be found in the summer surveys than in the initial fall survey.

After each pass with the seine, captured fish were placed in one or more shaded 5-gallon buckets filled with clean, continuously aerated stream water. The fish were sorted to species, and the salmonids were measured (fork length) and retained in separate aerated containers while subsequent passes were performed. Repeated seining of each unit was conducted until only a few salmonids were captured in consecutive passes relative to the numbers captured in earlier passes. Usually, seining was halted after capturing one or zero specimens in consecutive passes, but in cases where a unit contained hundreds of salmonids, seining was sometimes discontinued after reaching a point where only 6 or 8 specimens were being captured, which was small relative to the 50 or more being captured in each of the earlier passes. In structurally complex units this sometimes required 9 or 10 passes, but typically 2 to five passes were sufficient in most units. After completing the sampling in a unit, blocking nets were removed, any instream objects that had been relocated were replaced, the fish were examined again for any signs of stress, damage, or mortality (insignificant in all cases), and then returned to the unit.

In the summer 1994 surveys, a few units in upper Santa Rosa Creek were sampled in June and then sampled again three weeks later; nearly identical numbers of fish were captured the second time, and their average size was greater than in June; as expected (Figure 4-2). This observation adds support to the belief that the seining technique is repeatable and consistent, and not harmful to the fish.

SURVEYS OF REDDS AND SPAWNING ACTIVITY

Information about potential spawning areas in the study streams was obtained during the October-November 1993 habitat and juvenile density surveys. Fyke netting began with the first rains in October, and upmigrating adult male steelhead began appearing in the fyke nets in December. In January adult steelhead of both sexes were captured in the fyke nets, as well as a few coho (in Maacama Creek, beginning 26 December), so periodic surveys for redds and spawning activity were begun in January and continued through April, at likely spawning areas in each of the principal streams.

The redd surveys consisted of one person walking quietly up the stream while searching for redds or any signs of spawning or pre-spawning activity (such as fish fighting with each other near likely redd sites). Females construct nests by excavating large depressions in the gravel, using vigorous thrashing of their tails with the aid of the water current to move the excavated material downstream. The resulting pit may be a foot deep by 2 feet wide and 2 to 4 feet long, depending on the size and persistence of the female. After eggs are laid and simultaneously fertilized by a male, the female again uses tail-thrashing and the water current to knock gravel from the sides and upstream area into the pit to cover the eggs, usually while in the process of excavating a second nest just upstream of the first. The female continues making nests until all, or nearly all, of her eggs have been laid. When finished, the redd (all the nests constructed by a single female) appears as a series of round or oval regions of disturbed gravel, usually lighter colored than the surrounding substrate with its undisturbed *aufwuchs* (film of bacteria and algae). Typically, each nest is still

Figure 4-2

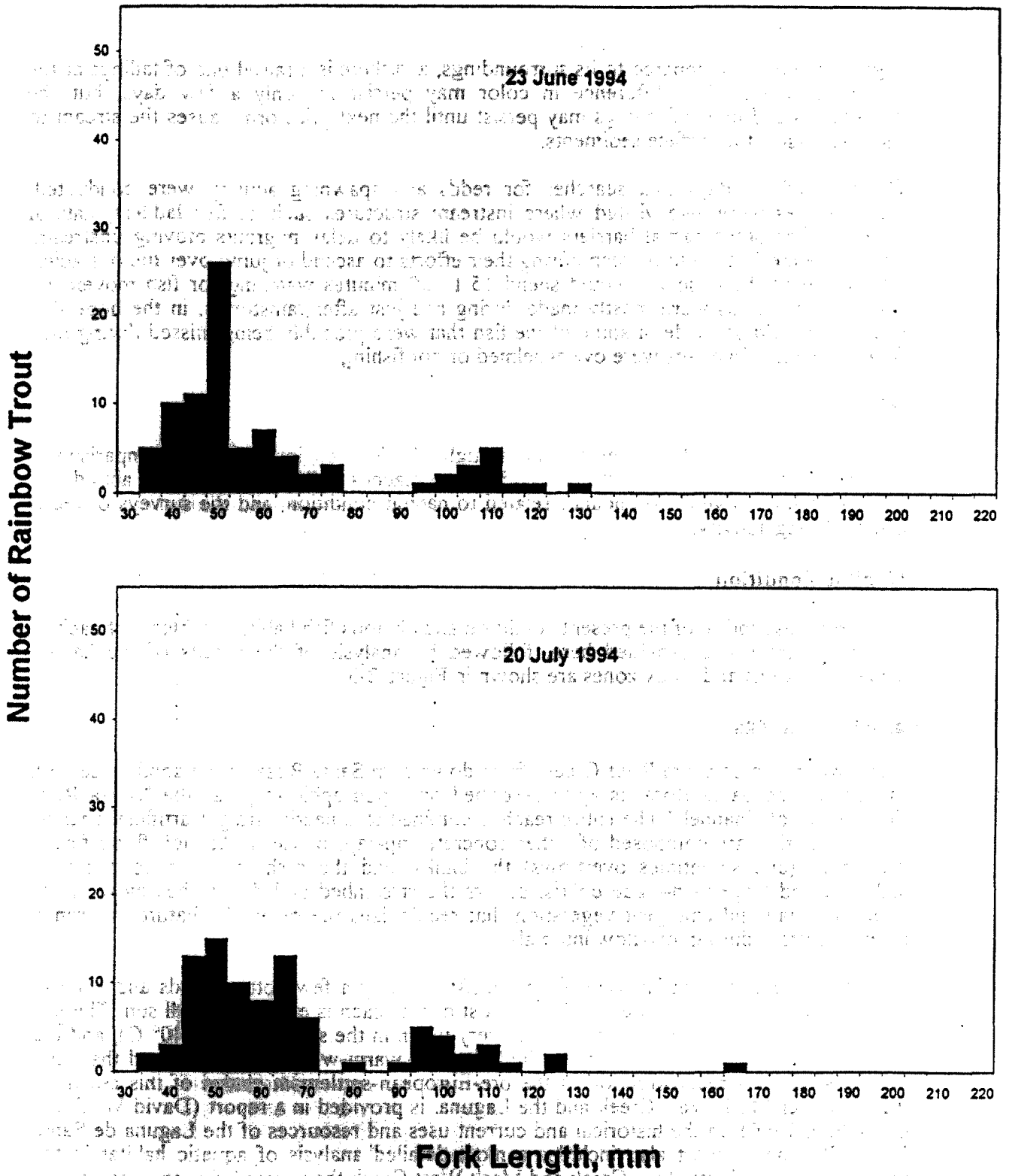


Figure 4-2. Length Frequency Distribution of Juvenile Steelhead Upper Santa Rosa Creek, June vs. July 1994 – Units 1 and 3

slightly depressed compared to its surroundings, and there is a raised pile of tailings at the downstream end. The difference in color may persist for only a few days, but the depressions and piles of tailings may persist until the next rainstorm causes the stream to rise and re-sort the surface sediments.

On most of the days that searches for redds and spawning activity were conducted, selected sites were also visited where instream structures such as fish ladders, natural waterfalls, or other partial barriers would be likely to delay migrants moving upstream, and where the fish could be seen during their efforts to ascend or jump over the obstacles. At these sites the observer would spend 15 to 30 minutes watching for fish movement. These observations were mostly made during and just after rainstorms, in the hope that sightings would be made of some of the fish that were probably being missed during high flows when the fyke nets were overwhelmed or not fishing

RESULTS

This section presents the survey results through fall 1994, beginning with a comparison of the habitat conditions among streams and stream reaches, followed by juvenile abundance and size results, juvenile abundance related to habitat condition, and the surveys of redds and spawning activity.

Habitat Condition

A general description of the present condition and obvious fish habitat problems of each of the study streams is provided here, followed by analysis of the results of the habitat surveys. Streams and index zones are shown in Figure 2-3.

Santa Rosa Creek

The lower reach of Santa Rosa Creek (from downtown Santa Rosa to the confluence with the Laguna de Santa Rosa) is aptly described on topographic maps as the "Santa Rosa Flood Control Channel." The entire reach is confined to a nearly straight artificial channel with banks that are composed of either concrete, rip-rap, or earth. At high flood flows, water fills (and sometimes overflows) the banks, and the rushing water, loaded with sediment and large man-made debris, scours the streambed and demolishes most of the young riparian and emergent vegetation that recolonizes the relatively featureless, sandy channel bottom during low-flow intervals.

As a result, mature riparian vegetation consists of only a few cottonwoods and willows downstream from Willowside Road, and most of the reach is exposed to full sun. There is little habitat diversity, the water becomes very warm in the summer (over 30° C), and the general nature of the reach has more similarity to a warm-water slough or pond than to a coastal stream. A reconstruction of the pre-European-settlement nature of this reach, as well as lower Mark West Creek and the Laguna, is provided in a report (David W. Smith Consulting 1990) on the historical and current uses and resources of the Laguna de Santa Rosa. The same report also includes a more-detailed analysis of aquatic habitat in the lower reaches of Santa Rosa Creek and Mark West Creek than provided in this report.

Habitat in the middle and upper reaches of Santa Rosa Creek is in much better condition than in the lower reach. Although the middle reach along Montgomery Drive and up to the Highway 12 bridge has houses along both sides, there is still dense riparian vegetation providing shade and overhanging and/or instream shelter for fish. The streambed is in a relatively natural state, with boulders, bedrock, cobble, and some gravel suitable for

spawning. There is more embeddedness, i.e., fine sediments among the larger particles, than would be expected in a pristine stream of similar size, but not as much as in the other study streams, nor so much as to prevent successful spawning. Downed trees, rootwads, and cutbanks contribute significantly to instream shelter for juvenile salmonids. Surface flow was continuous in this reach during the July 1994 survey, but was intermittent when examined again in mid-August (after an unusually dry winter and spring). Continuous flow was restored prior to the October 1994 survey.

Upper Santa Rosa Creek, from the valley floor up into Hood Mountain Regional Park, is structurally similar to the middle reach, except that there are steeper portions including long cataracts and vertical bedrock walls. Very few houses are near the stream, and the Regional Park status protects much of the drainage from development, diversions, or logging. Embeddedness of the streambed is moderate, and similar to that in the middle reach, and may be related to erosion resulting from a cattle operation north of the Regional Park (M. Fawcett, *pers. obs.*). Surface flow in this reach was continuous throughout summer 1994, although it was only a trickle or seepage in some of the riffles.

Mark West Creek

Lower Mark West Creek, from the River Road Crossing downstream to the Laguna, is an unbroken deep glide, similar to some of the long glides in lower Santa Rosa Creek, but, unlike lower Santa Rosa Creek, lower Mark West Creek is mostly shaded by a mature tree canopy. Upstream, from the River Road crossing to U.S. 101, most of the stream is deeply shaded by large trees, with the resultant summer water temperature maxima never approaching those reached in lower Santa Rosa Creek.

Lower Mark West Creek has also been subjected to re-routing and other modification in historical times, but the present course and condition of this reach is much more similar to that of a natural stream than either lower Santa Rosa Creek, Lower Maacama Creek, or lower Green Valley Creek. The streambed includes bedrock, boulders, and cobble, but is dominated by gravel and sand. The streambed is moderately embedded, but several areas of gravel that appear suitable for salmonid spawning occur between Slusser Road and the freeway. Instream shelter is enhanced by rootwads, downed trees, cutbanks, and riparian vines hanging in the water. Surface flow was intermittent in parts of this reach by mid-August 1994, but numerous deep glides and pools provided adequate habitat for juvenile salmonids throughout the dry period. Cool water temperatures were maintained in these units by subsurface flow and deep shade provided by the mature tree canopy. Mid-afternoon water temperatures in this reach on 16 August 1994, were uniformly 16° C, while ranging from 27-31° C on the same afternoon in lower Santa Rosa Creek.

Middle Mark West Creek, the reach that runs through the redwoods along Mark West Springs Road below the Mark West Springs Lodge, appears to be in a relatively natural state, except that embeddedness is higher than would be expected in a pristine stream, and the reach (at least that within the index zone) has few deep pools. However, many of the existing pools have instream shelter provided by rootwads and large boulders. The reach is well shaded by alder, willow, and redwood trees, and in general, appears to provide fairly good habitat for juvenile salmonids. There are few homes or other developments near this portion of the stream, and no extensive water diversions. Surface flow was intermittent in this reach by mid-August, 1994, and it appears likely that many of the shallow glides and pools went dry between then and the first major fall rains in October.

The index zone designated for Upper Mark West Creek is part of the reach alongside Calistoga Road between Alpine Road and St. Helena Road. The stream in this reach is greatly influenced by agricultural water diversions further upstream. When the stream is

flowing in this reach, it provides structurally complete habitat for juvenile salmonids, including a rocky streambed, diverse riffles, pools, and glides, dense riparian cover, rootwads, cutbanks, and downed trees. Embeddedness is similar to that in the middle reach of Mark West Creek. However, in late spring and summer, dewatering by upstream water users causes the stream to become intermittent, and the surviving fish are concentrated in a few isolated pools. According to some local residents, this has happened every summer in recent years, and is often manifested at the Alpine Road crossing as stream flowing one day, then completely dry for several days, then flowing again as water users adjust their diversions throughout the dry season.

Undoubtedly, many fish are stranded in parts of the stream as it goes dry and are either asphyxiated or become easy prey for wading birds and other predators. Drying also kills most of the aquatic invertebrates needed for food by juvenile salmonids, so that each time the stream is finally re-wetted in the fall, fish food is probably in short supply for several more months until invertebrate populations increase again. The majority of the habitat units in this reach were completely dry by 18 July 1994. It is probable that only a single deep pool in this index zone remained filled through the rest of the summer.

Maacama Creek

The lower index zone of Maacama Creek is part of the reach between the mouth at the Russian River and the Chalk Hill Road Bridge near Young Road. Mature riparian cover (cottonwood, alder, and willow trees) occurs along the banks of the wide flood channel in this reach, but much of the streambed at normal stages of flow is exposed to the sun most of the year, as the stream meanders along the wide channel. Where the present streambed approaches one or the other of the other banks, shade, rootwads, and cutbanks provide cover for salmonids, but where the streambed passes near the center of the wide channel, riparian cover is less abundant. The substrate throughout most of the index zone is gravel and cobble, and many areas appear suitable for spawning. However, both this reach and the middle reach of Maacama Creek are adversely affected by water diversions during the dry season. In 1994, vineyards were pumping irrigation water from the lower reach in April and May, and the entire reach was dry by mid-summer.

The middle zone of Maacama Creek, which parallels Highway 128, appears to be better salmonid habitat than the lower reach, with more abundant riparian and emergent vegetation, greater diversity of pool and riffle types, and more boulders, rootwads, and cutbanks. However, much of this reach was completely dry in summer 1994, and one water user was observed in August pumping water from a large pit he had dug in the middle of the dry streambed (Fawcett, *pers. obs.*). During the July survey a large portion of the index zone appeared to have been dry earlier, and then re-wetted prior to the survey, even though there was no precipitation during the summer. (This scenario was suggested by the presence of white, decaying algae on the bottom, the absence of live fish or invertebrates, and accumulations of shriveled, rotting threespine sticklebacks in depressions in the streambed--sticklebacks are highly tolerant of environmental extremes, and the depressions would have been the last bits to go dry). During the October 1994 surveys, much of this reach was still dry, and most of the rest appeared to have again been only recently re-wetted (the lower reach was still completely dry at this time).

Upper Maacama Creek is represented in this study by Redwood Creek where it crosses Highway 128 in Knight's Valley. Redwood Creek is one of the major tributaries of Maacama Creek, but not necessarily the best one for salmonids. Other tributaries that may have salmonid populations include McDonnell Creek, Ingalls Creek, Bear Creek, and Briggs Creek, but none of these were accessible to the study team. Redwood Creek upstream from Highway 128 is similar in size and in other respects to upper Mark West

Creek and upper Santa Rosa Creek, but is somewhat steeper, has more abundant boulders and cobble, and less silty, less embedded substrate. The stream is heavily shaded by dense, overhanging riparian cover of alder, cottonwood, and willow trees. Most of the units in this index zone were completely dry by mid-August, 1994, but a few deep, shady pools retained cool water and shelter throughout the dry season.

Green Valley Creek

Green Valley Creek drains part of the eastern slope of the mountains just west of Graton, and then, after being joined by Atascadero Creek, flows north to enter the Russian River near Rio Dell. The lower reach of Green Valley Creek, downstream from the confluence of Atascadero Creek, is heavily laden with silt, to the extent that whatever rock and gravel comprised the original streambed is completely buried. Although some shelter for salmonids is provided by overhanging blackberries and other vegetation and by rootwads and woody debris in the water, the habitat is generally very poor and different from the other study streams, so it was decided not to do any surveys in this reach. The upper reach of Green Valley Creek, i.e., everything above about 300-foot elevation, appears to be too small and ephemeral to support salmonids (the upper reach was dry when first examined in fall 1993), and so was also not surveyed. However, the main portion of the creek lying within Green Valley (this portion is the equivalent of the middle reaches of the other study streams) does have some habitat suitable for salmonids and was surveyed in the vicinity of the Fred Allen property.

Green Valley Creek in its middle reach flows through a narrow, steep-sided channel that is heavily populated with riparian trees and shrubs, which form a nearly complete canopy over most of the reach. Parts of the reach include large bedrock formations through which the stream plunges in a series of cataracts and pools. The bedrock ledges, rootwads of large trees, and woody debris provide instream shelter for fish, partially offsetting the paucity of boulders, cobble, or gravel on the surface of the streambed. The streambed contains a lot of silt, although not as much as in the lower reach. Excessive silt probably limits the production of invertebrate prey for fish, and may thereby limit the stream's carrying capacity for salmonids. A shortage of suitable spawning areas could also limit fish production in this stream. Surface flow was intermittent in this reach on 28 July 1994. This site was not visited again until after the first fall rains in early October. At the time of the fall survey (31 October 1994), some of the units were completely dry and others partially filled with stagnant water and showing signs of having been dry earlier, so conditions were probably severe in August and September.

Habitat Survey Results

Habitat information for each stream surveyed is summarized by habitat unit for each index zone in the tables in Appendix 4-1 and by index zone in Appendix 4-2. Figure 4-3 compares the percent of all the habitat units within each index zone rated as "suitable" in each of the three surveys: fall 1993 (29 October-20 November), summer 1994 (18-28 July), and fall 1994 (20 October-3 November). The results of the initial fall surveys can be summarized as follows: Each of the study streams had a considerable amount of habitat rated as "suitable". in each reach, with Maacama appearing to be the best overall, and the lower reach of Santa Rosa Creek rated worst. However, substantial declines are apparent in the suitability ratings for summer 1993.

In the summer survey, many of the units changed from "suitable" or "marginal" to "unsuitable" for salmonids. In the cases of upper Mark West Creek and all three reaches of

Figure 4-3

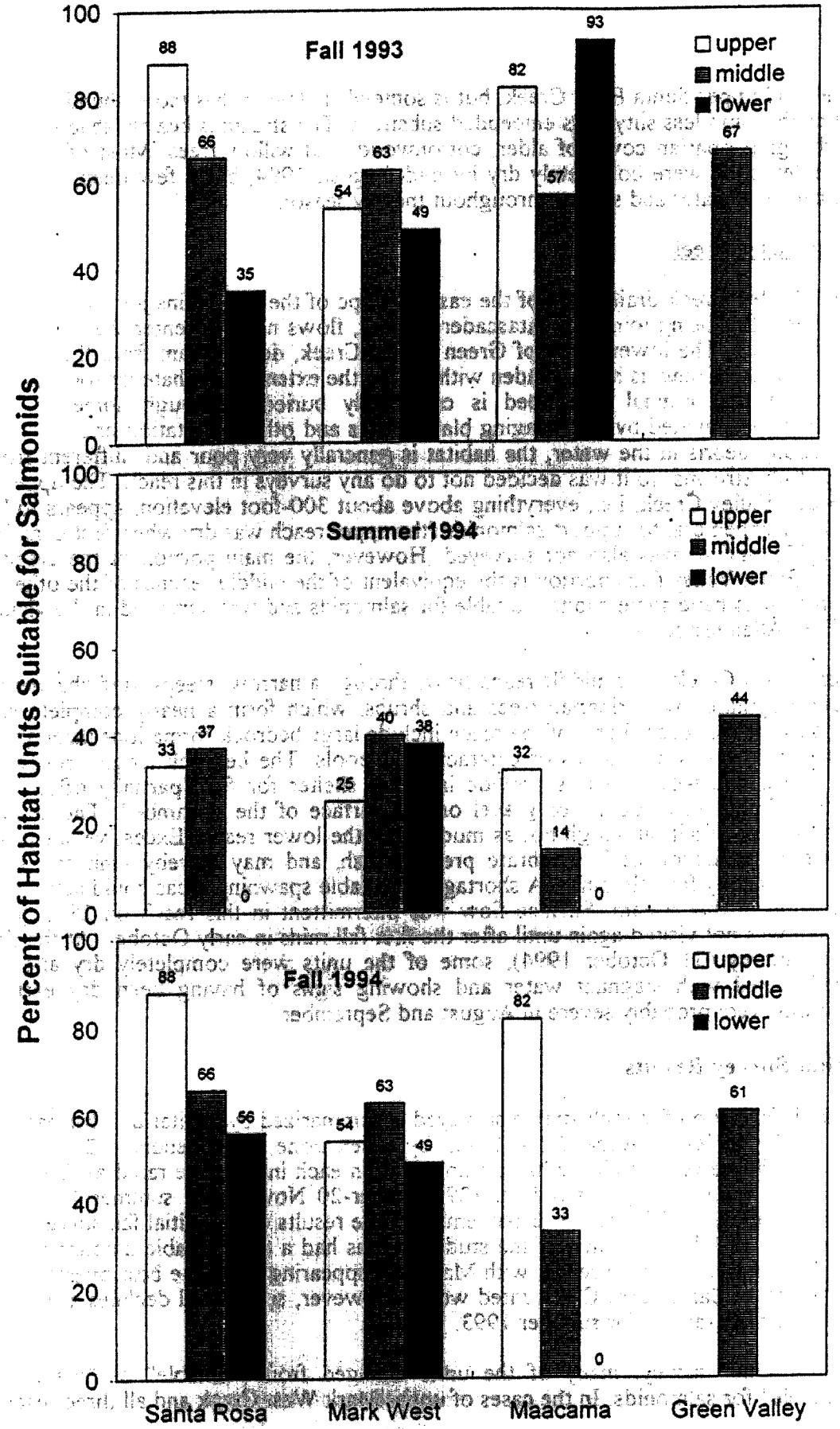


Figure 4-3. Habitat Suitability Scores

Maacama Creek, the changes are nearly all due to drought; many of the units were completely dry. In lower Santa Rosa Creek, the habitat structure and flow was similar to what it had been the previous fall, but the water temperatures ranged from 17° C in the morning to 22° C in the afternoon, which is approaching the upper level of tolerance for steelhead and coho. Temperatures at all other index zones during this survey period ranged only from 14-16° C. All of the units in lower Santa Rosa Creek were examined again on 16 August, when the temperatures ranged from 27-31° C, well above the lethal limit for these fishes, and many of the pools were stagnant. On the same afternoon, the water temperature in lower Mark West Creek was only 16°C (middle and lower Maacama Creek were completely dry by this time, and so could not be compared), and upper Santa Rosa Creek was 15° C.

The middle and upper reaches of all of the streams have a lot of shade from riparian cover, as does lower Mark West Creek, whereas most of lower Santa Rosa Creek has no shade at all. It is unlikely that the water temperature ever exceeds about 17-18° C in any of the index zones other than lower Santa Rosa Creek (and possibly lower Maacama Creek, which also has less riparian cover than the remaining zones). Because of the high temperatures, all of the units in lower Santa Rosa Creek were rated as "unsuitable" for summer 1994.

By the time of the October 1994 surveys, the habitat ratings in all reaches except middle and lower Maacama Creek were close to, or identical to, those of the previous fall (Figure 4-3). A substantial rainstorm occurring in early October 1994 resulted in restoration of continuous streamflow in most units except those in middle and lower Maacama Creek. The summer declines in habitat suitability already noted suggest some likely explanations for why some of the seemingly suitable reaches surveyed in fall 1993 had almost no salmonids in them (see below), especially lower Santa Rosa Creek.

Juvenile Abundance and Population Age Structure

The actual numbers of juvenile steelhead and coho collected in each unit sampled in each of the three surveys are provided in Appendix 4-3-1 to 4-3-4. Appendix 4-4-1 to 4-4-4 lists the non-salmonid fish and other vertebrate species collected. Juvenile steelhead data are summarized by age class as the mean number per habitat unit for each index zone in Appendix 4-3-5. The total number of fish captured in all passes of the seine in each unit is used as a conservative estimate of the true number of fish in the unit.

Figure 4-4 shows the mean number of juvenile steelhead of all age classes per habitat unit for each index zone sampled in the three surveys. In general, the upper reaches of the principal streams supported the highest densities of juveniles. Substantially higher densities of juveniles were found in the summer survey than in the previous fall survey (with exception of Maacama Creek), which indicates that successful reproduction occurred during the previous spawning season, as the increased densities were nearly entirely due to recruitment of young-of-the-year fish, as discussed below. Of particular interest are the high densities observed in July at middle and upper reaches of Santa Rosa and Mark West Creeks, the two streams of most concern with regard to potential discharge effects on returning adult salmonids. Evidently, reclaimed water discharged in 1993-94 did not prevent adult steelhead from successfully spawning in these streams. In fact, the carrying capacity of the rearing habitat available in summer may have been exceeded, as most of the juveniles present in July had disappeared by October 1994. Juvenile survivorship in summer 1993 is unknown, but the densities of juveniles observed in October 1994 were quite similar to those found in October-November 1993. Averaging the mean densities for

Figure 4-4

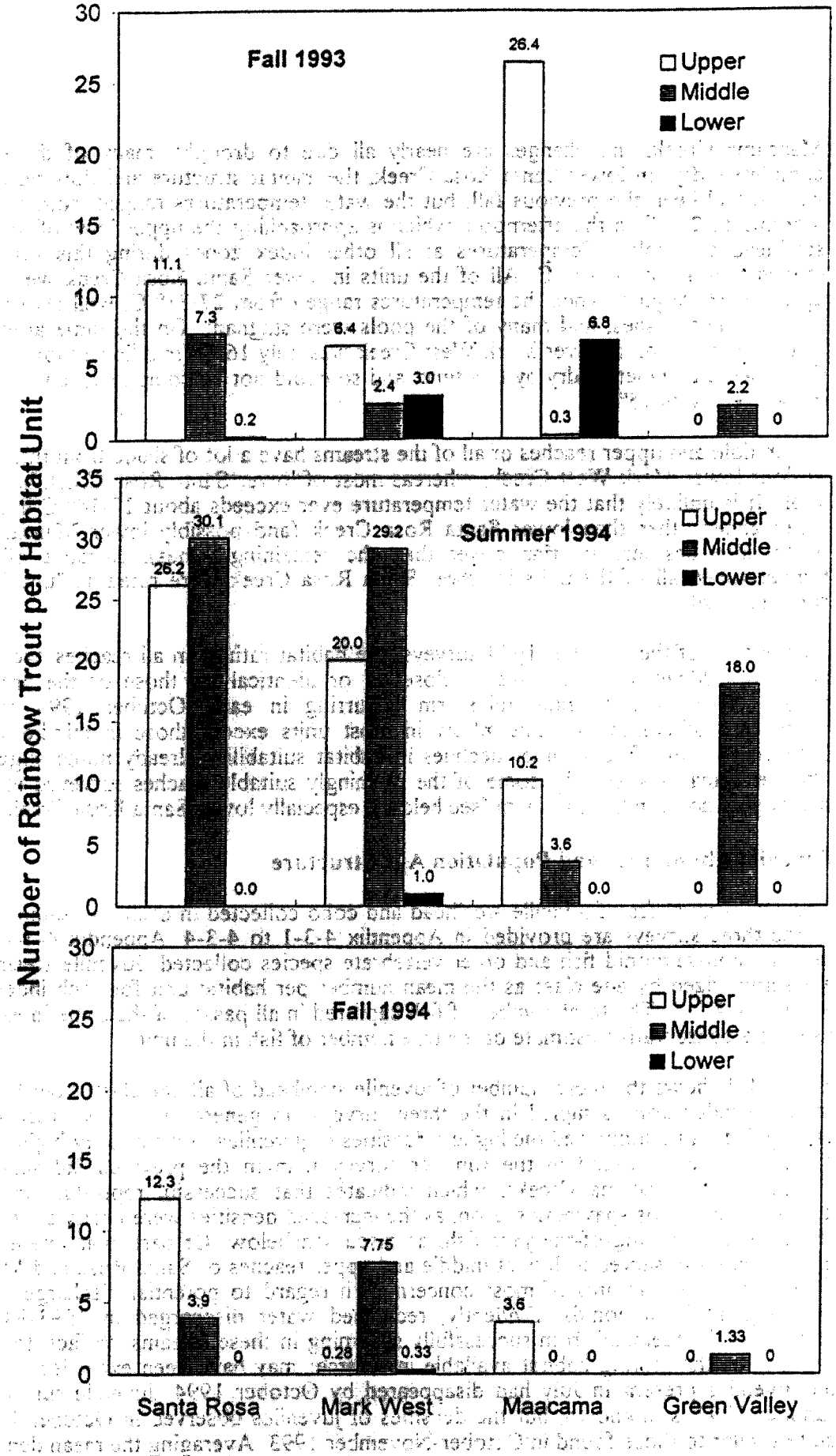


Figure 4-4. Juvenile Steelhead Abundance

both upper and middle index zones of these two streams shows that, for middle and upper Santa Rosa Creek, the mean abundance in October-November 1993 was 9.2 fish per unit, vs. 8.1 in October 1994. For Mark West Creek, the grand mean was 4.4 fish per unit in October-November 1993, vs. 4.0 in October 1994.

Reproduction in Maacama Creek during 1993-94 was evidently poor, as suggested by Figure 4-4, and by the fact that the July and October 1994 surveys revealed very few young-of-the-year fish.

Examination of the size distribution of the sampled fish is useful in allowing us to identify age (or year) classes of fish in the population, which helps in analysis of the strength of reproduction each year, as well as survivorship and growth of the fish from year to year, and among streams and reaches within a stream. Length-frequency histograms of juvenile steelhead are provided in Figures 4-5 to 4-8, for each stream reach and sampling period. Young-of-the-year steelhead (i.e., those produced in the preceding spawning season) are those in the 30-100 mm (approximate) size class in the fall surveys, with slight variation among streams. The young-of-the-year fish are always those represented by the clusters furthest to the left in the figures. All other age classes (2, 3, 4 years old, etc.), are represented by smaller and less distinct clusters further to the right. The mean length of young-of-the-year steelhead at each index zone is shown in Appendix 4-3-6, and mean abundance at each zone is shown in Appendix 4-3-7. The mean abundance of juvenile steelhead over one year old is shown in Appendix 4-3-8.

Viewing the length frequency histograms from top to bottom of the page for each index zone allows the reader to follow the fate of a cohort (age class) through time. Figure 4-5 illustrates the growth of the young-of-the-year cohort in the upper reach of Santa Rosa Creek from fall 1993 to summer 1994. This cohort (the cluster on the far left in fall 1993) had, by summer 1994, grown into the size range of 90-130 mm. A new cohort of young-of-the-year fish, from about 30-80 mm in length, represents eggs spawned in spring 1994. Also, Figure 4-5 shows clearly that there was massive attrition of juvenile steelhead in the middle reach of Santa Rosa Creek between the summer and the fall survey (owing to drought-related loss of habitat), whereas attrition in the same period was much less in the upper reach, which maintained continuous flow throughout the dry period. The same general patterns are evident in Mark West Creek (Figure 4-6), although there the late summer attrition was most severe in the upper reach. The effects of drought (or diversions) on juvenile steelhead are also evident for Maacama Creek (Figure 4-7) and Green Valley Creek (Figure 4-8).

Juvenile coho were relatively abundant in the fall 1993 survey in upper Maacama Creek (Appendix 4-3-3). These were young-of-the-year fish ranging from 65-90 mm in length (Figure 4-9), the products of spawning that occurred in the winter of 1992-93. At the next survey in July 1994, three individuals of this same cohort were found, by then having grown to 110-120 mm, and by then being stranded in that unit at least until the fall rains in 1994. The remainder of this cohort (along with most of the juvenile steelhead present in fall 1993) presumably moved downstream following the fall rains, and may have been among the coho smolts captured while outmigrating in March and April 1994 at the lower Maacama fyke net station (Figure 3-17).

In the summer 1994 survey, no young-of-the-year coho were found in any of the Maacama Creek index zones, nor in the fall 1994 surveys, which leads to the conclusion that coho spawning (or fry survivorship) in winter-spring 1994 was poor in the Maacama system, at least in the Redwood Creek drainage and the mainstem downstream from Redwood Creek. Some young-of-the-year coho (60-80 mm) were captured in the lower Maacama fyke nets in April and May 1994, demonstrating that some spawning had

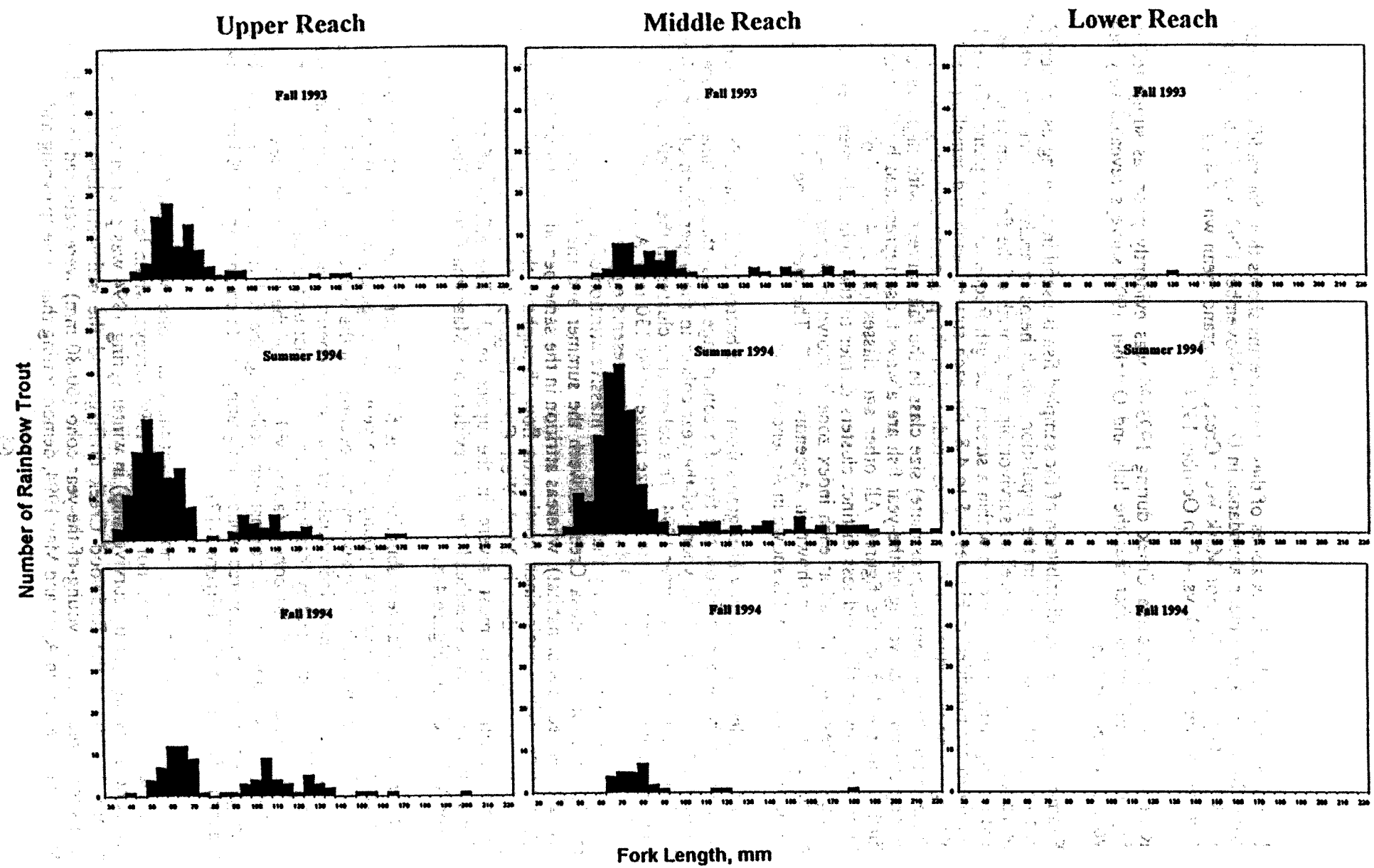


Figure 4-5. Length Frequency Distribution of Juvenile Steelhead Santa Rosa Creek

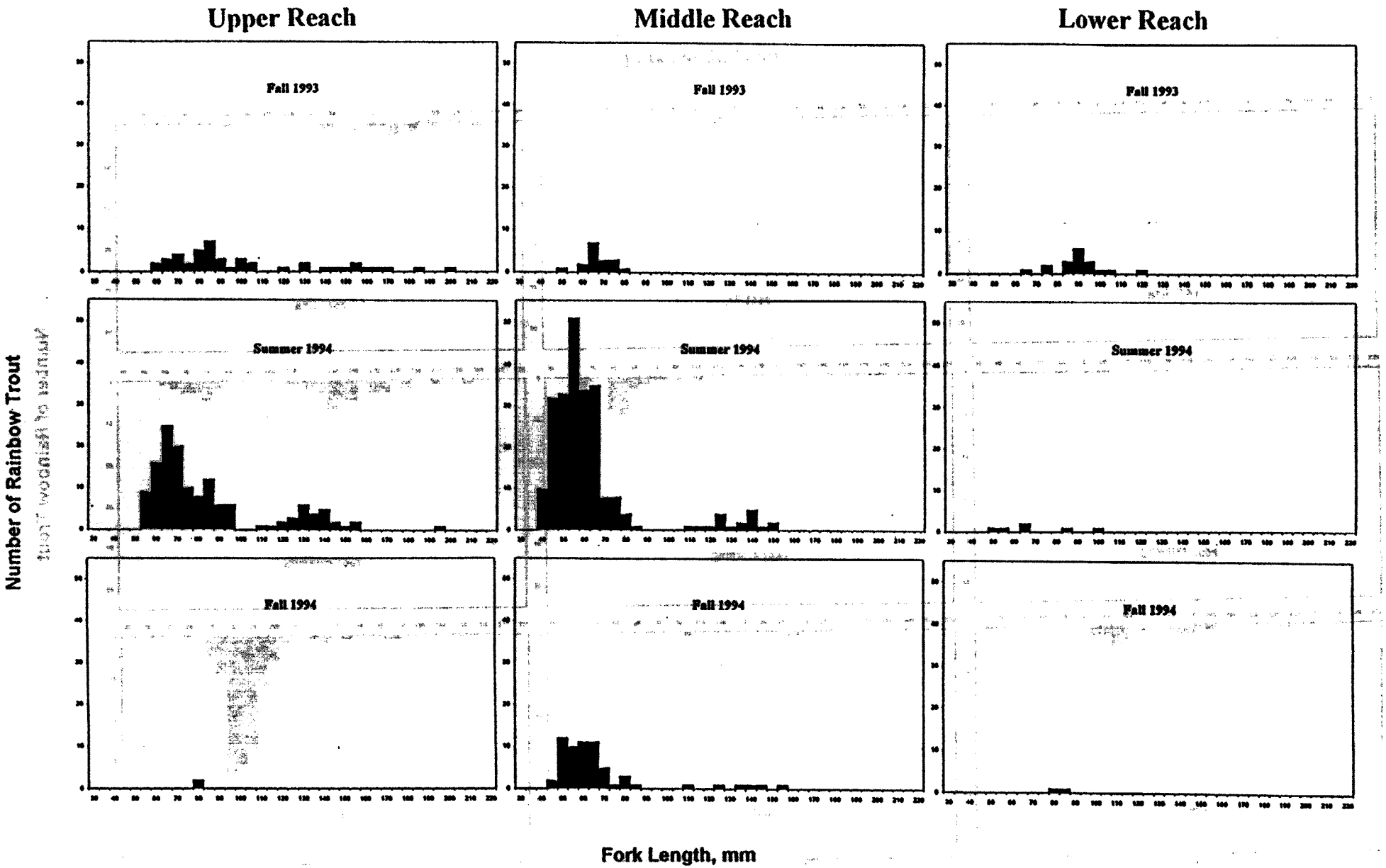


Figure 4-6. Length Frequency Distribution of Juvenile Steelhead Mark West Creek

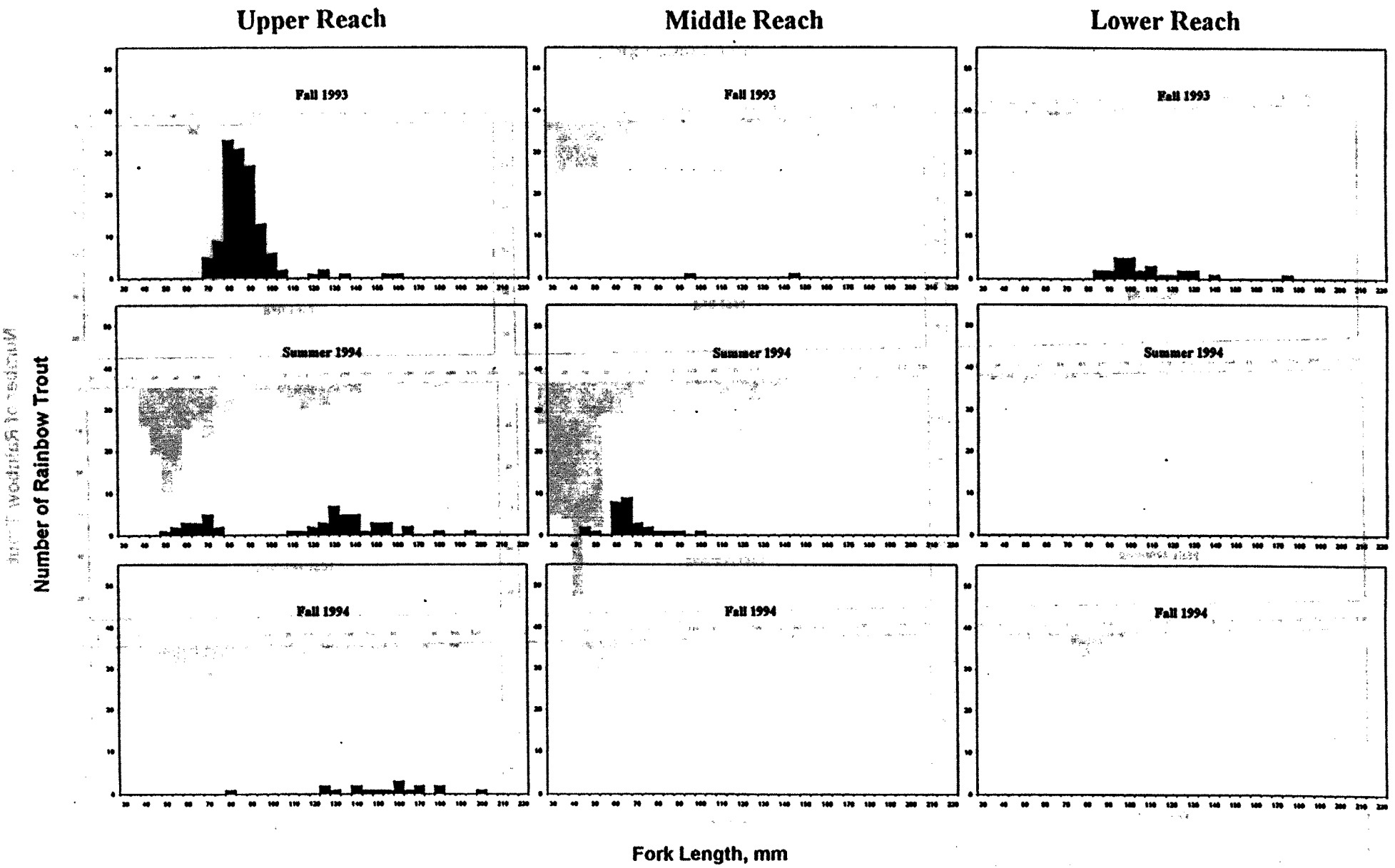


Figure 4-7. Length Frequency Distribution of Juvenile Steelhead Maacama Creek

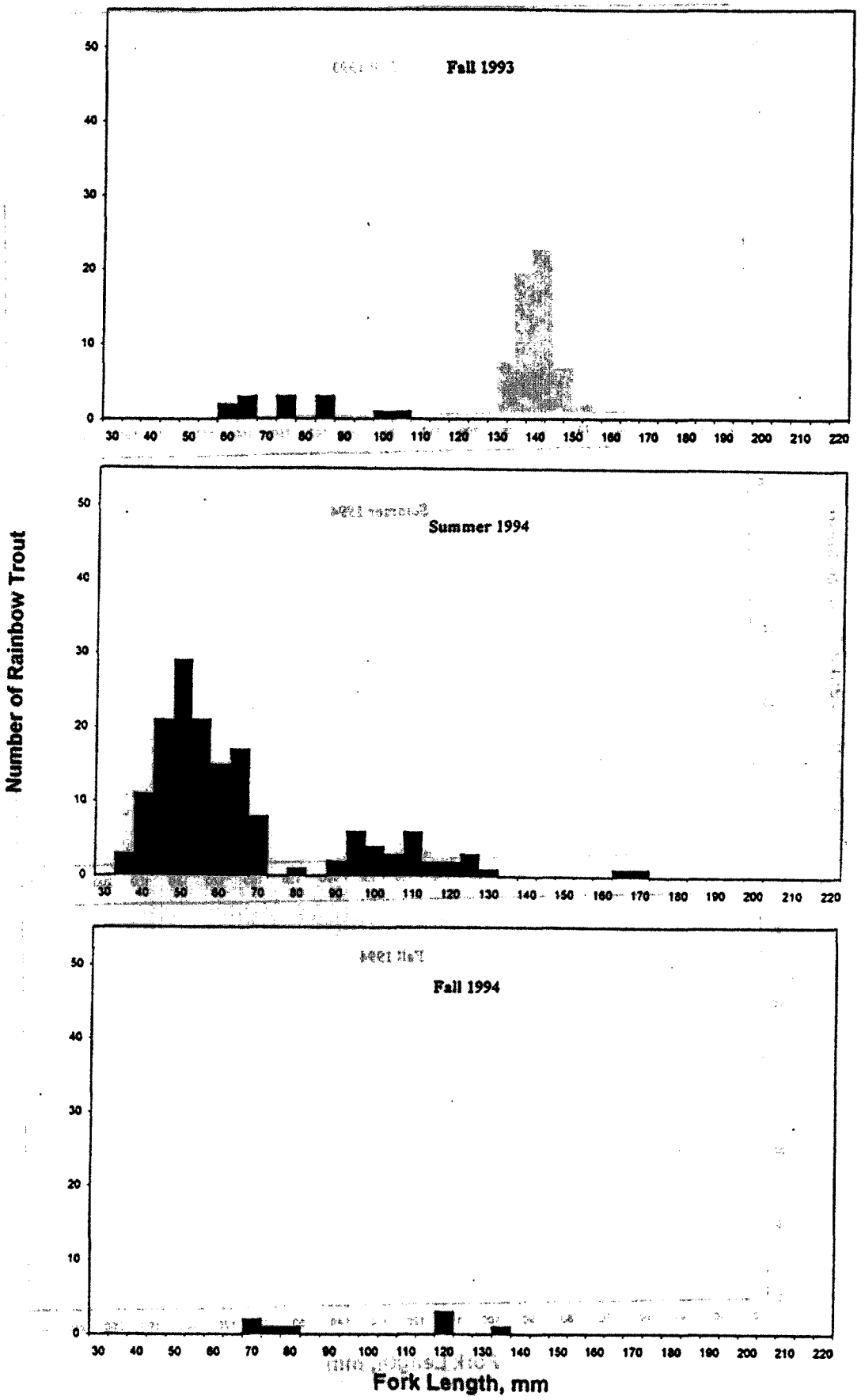


Figure 4-8. Length Frequency Distribution of Juvenile Steelhead Green Valley Creek

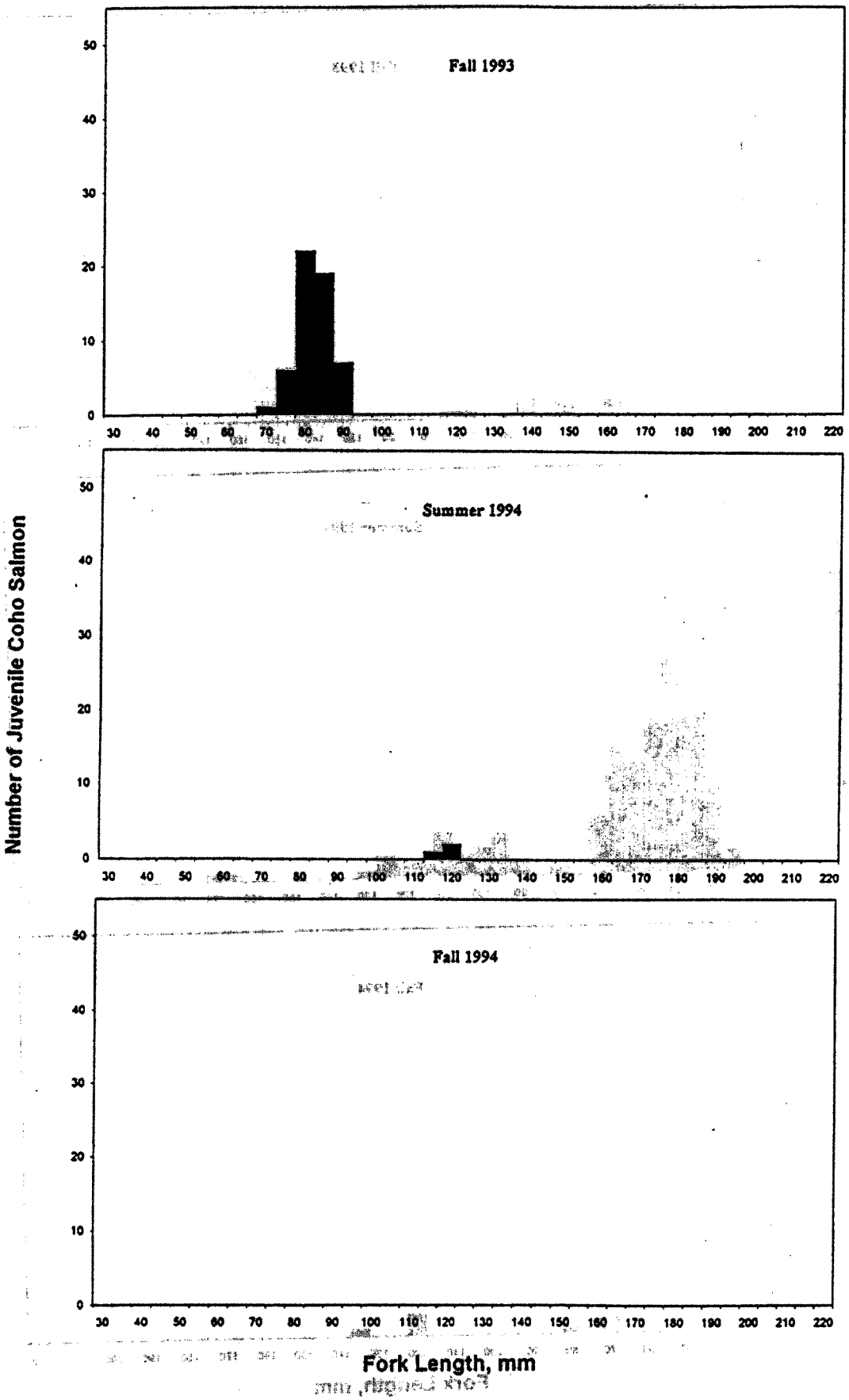


Figure 4-9. Length Frequency Distribution of Juvenile Coho Upper Maacama (Redwood Creek)

occurred. However, unless those young-of-the-year fish migrated downstream and found their way to some other suitable rearing stream via the Russian River, they probably died as Maacama Creek dried up. Several spawned-out coho adults of both sexes were observed just above the Maacama fyke nets in late December 1993-early January 1994 Those fish could have spawned anywhere in the Maacama system, but probably spawned not far from where they were found, as the females usually do not move far from their redds before dying, once spawning is completed (Moyle, et al 1989). Since the entire reach from the Russian River up to several miles above the fyke net site went dry in summer 1994, it is unlikely that there were any survivors from redds produced by those particular adults.

Coho have a relatively inflexible life history, compared to steelhead (Shapovalov and Taft 1954, Moyle, et al 1989). Nearly all juveniles go to sea after spending one full year in freshwater, and then return to spawn after two years at sea (the three juveniles mentioned above that did not smolt after their first year are exceptions, and probably died before the fall 1994 survey, as there was nowhere for them to go in late summer). The result of such a reproductive pattern is that each year class acts essentially as a separate population from other year classes. The juvenile coho observed in Redwood Creek in fall 1993 presumably came from eggs spawned in winter 1992-93 by adults that were themselves spawned in Redwood Creek in winter 1989-90. Thus, it might be expected to see adults returning to Redwood Creek in winter 1996-97, even if spawning was a complete failure in 1994 and 1995.

In Green Valley Creek, a total of four young-of-the-year coho were found in the fall 1993 survey (Figure 4-10). The cohort to which those juveniles belonged should have gone to sea in spring 1994. However, a single coho measuring 110 mm fork length was found in the same unit in summer 1994. At that size, the fish was probably too large to have resulted from a winter 1993-94 spawning, and thus may represent another of the minority of coho that does not outmigrate after one year in freshwater. The same specimen (presumably) was found in the same unit again in fall 1994, still 110 mm.

No coho juveniles were found in any of the surveys in Mark West Creek or Santa Rosa Creek, even though a few juveniles were captured in fyke nets in both creeks during the 1993-94 trapping season (Appendix 3-5-4), and two male adults were intercepted moving upstream to spawn in Mark West Creek in the 1992-93 season. The timing and other features of the captures of juvenile coho in Santa Rosa Creek, Mark West Creek, and the Laguna fyke station suggest the possibility that there may have been some coho spawning in Mark West Creek in 1992-93 (less likely in Santa Rosa Creek), but, if so, a small number of redds were produced, and the juveniles may have been reared in a part of the system not near the index zones (see Discussion, below).

Juvenile Abundance Related to Habitat Condition

The habitat and juvenile abundance results presented above show clearly that habitat assessment conducted in the fall has little or no explanatory value with respect to the distribution and abundance of juvenile salmonids observed at the same time in the study streams, because the habitat conditions obtaining in the preceding summer may have critical effects on fish survival. Knowing which reaches of streams have become completely dry or excessively warm in summer simplifies prediction of where juvenile salmonids are likely to be found in the fall, after streamflow and continuity has been restored. Stream reaches that appear to be suitable for juvenile rearing in the fall may have no fish in them because all the fish died during the preceding summer "bottleneck" in

Figure 4-10

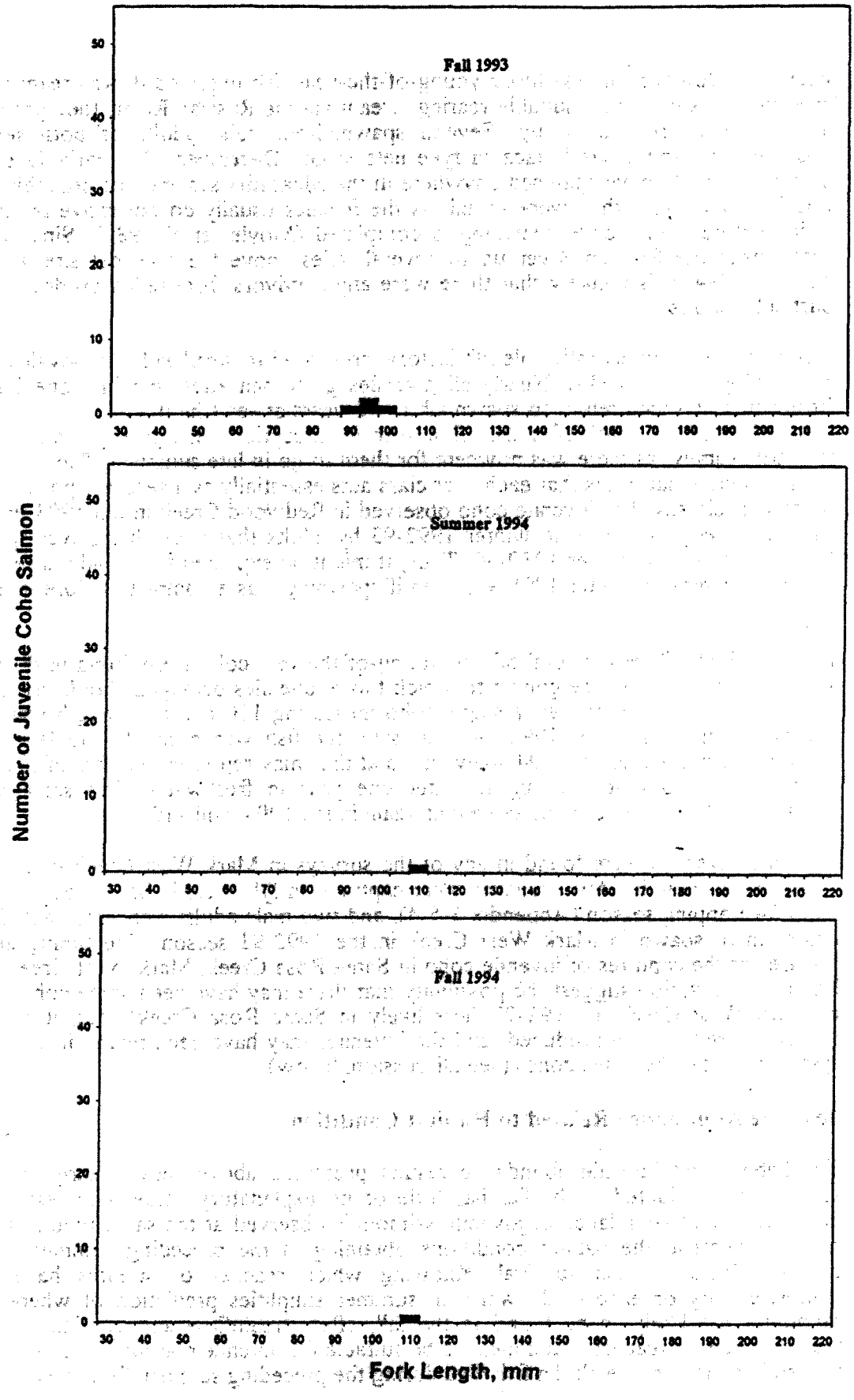


Figure 4-10. Length Frequency Distribution of Juvenile Coho Green Valley Creek

habitat condition. Thus, a more meaningful relationship might be found by comparing summer habitat ratings (i.e., worst case) with fall abundance data. Figure 4-11 compares the percentage of all habitat units ranked as "suitable" in the summer 1994 surveys with the mean number of juvenile steelhead per unit for the fall 1994 surveys. Since, as explained above in the Methods section, the selection of units to sample for fish favored the better habitat units, the percentage of the units *fished* that ranked as "suitable" is also shown (lightly shaded areas) in Figure 4-11. The figure can be read either from top to bottom or from left to right, and it shows no consistent relationship between perceived habitat quality and juvenile abundance among streams, nor among reaches within streams. Similar results have often been found in other studies (e.g., Emig's 1981, survey of steelhead and coho in Walker Creek, Marin County). The results suggest that factors not seen at the time of the surveys may overwhelm any effects due to local differences in habitat quality.

The present distribution of useable rearing habitat for salmonids within the watersheds surveyed in this study is depicted in Figure 4-12, which shows the reaches of each principal stream and its tributaries believed, on the basis of the surveys and information provided by W. Cox (CDFG, *pers. comm.*) to have habitat that is at least marginally suitable throughout most years for spawning and rearing. Excluded are reaches that are known or thought to be unsuitable or inaccessible (e.g., downstream barriers now prevent migratory fish from ascending Matanzas Creek, a tributary of Santa Rosa Creek), as well as other reaches which may have suitable habitat but were not accessible to the study team, and about which no anecdotal or other information has come to light. The linear stream miles represented by the shaded areas in Figure 4-12 are listed in Table 4-2.

Table 4-2. Estimated Length of Suitable Spawning and Rearing Habitat

Santa Rosa Creek	17.2 miles
Mark West Creek	24.0 miles
Maacama Creek	16.3 miles
Green Valley Creek	5.2 miles

Surveys of Redds and Spawning Activity

The dates, locations, and observations made during the redd and spawning surveys are summarized in Table 4-3. The main result is that not very many sightings of redds or of spawning activity were made. Redds were observed in upper Santa Rosa Creek (1), lower Mark West Creek (2), and lower Maacama (3-4 redds plus spawning steelhead at one site just above the fyke nets, and another one redd and a nearby steelhead at another site further upstream). Adult migrant steelhead were seen jumping weirs in middle Santa Rosa Creek in January and again in February 1994, and several adult steelhead were seen on two occasions in February attempting to ascend a nearly impassable barrier in upper Santa Rosa Creek. Several spawned-out coho were seen near the Maacama fyke site in late December 1993-early January 1994, but no redds were found. Finally, several steelhead (at least 6-8 different individuals) were seen spawning over a period of several days near

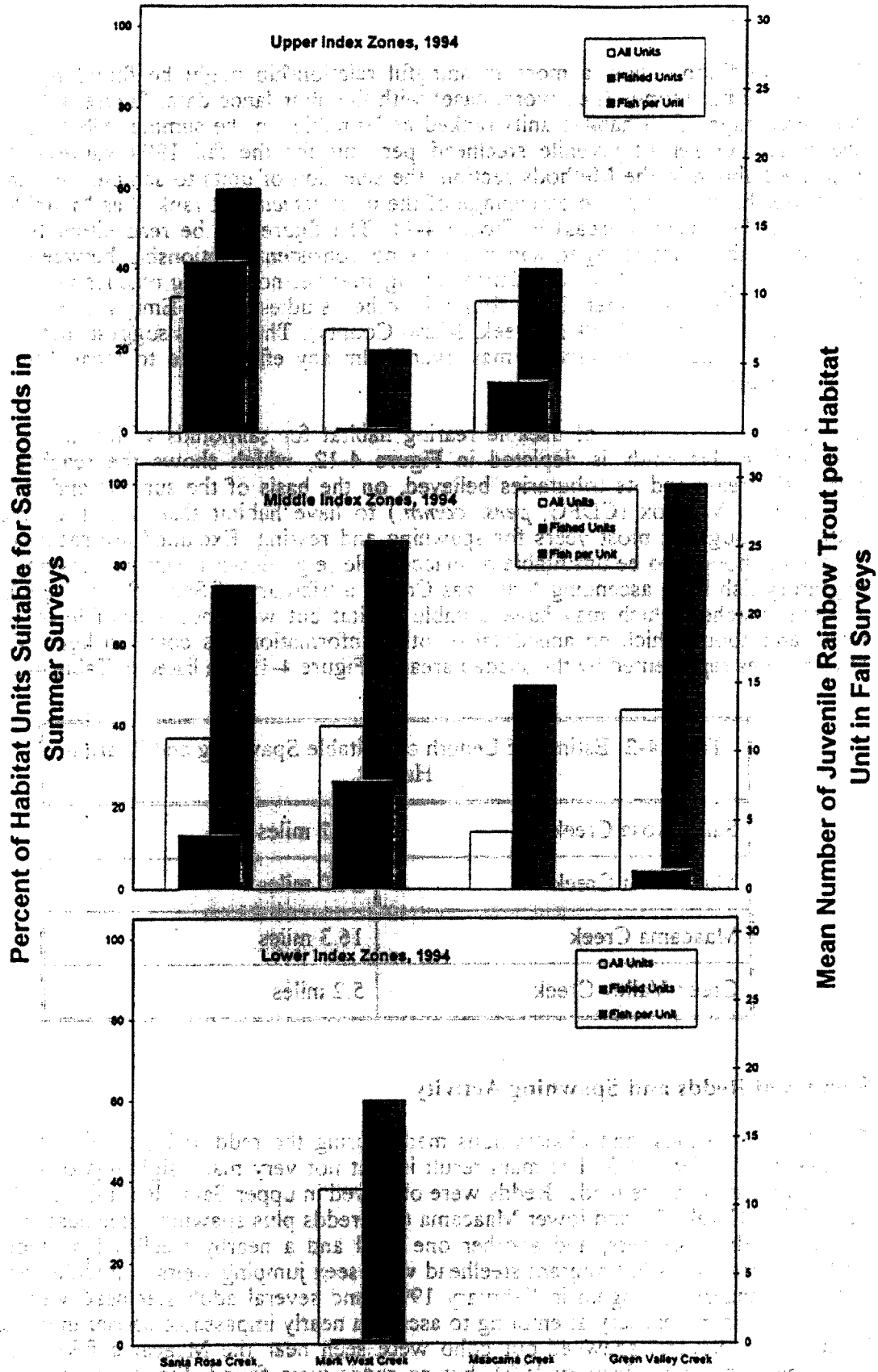
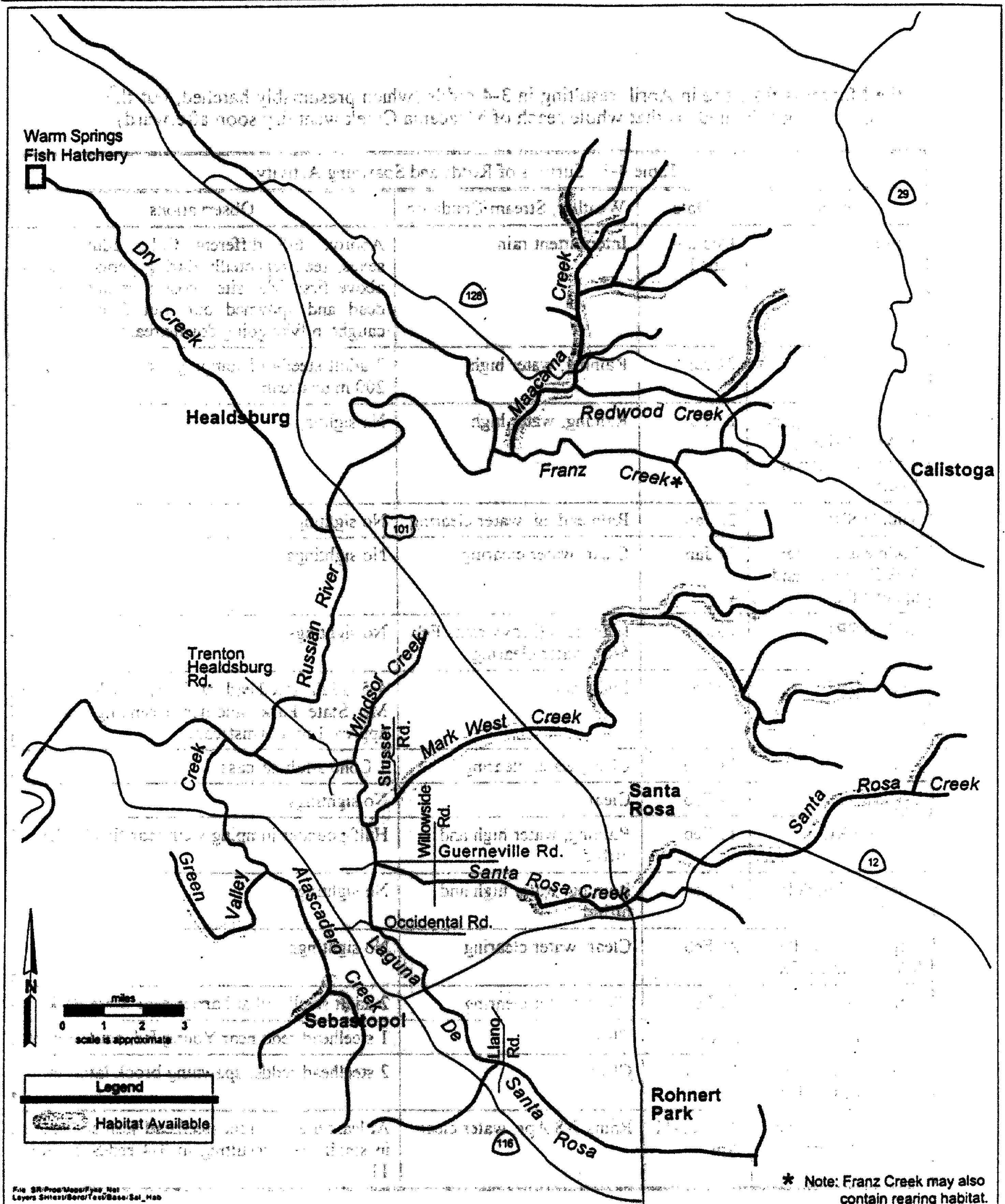


Figure 4-11. Summer Habitat vs. Fall Steelhead Abundance



Santa Rosa
Subregional Long-Term Wastewater Project

Habitat Available for Juvenile Salmonid Rearing

Figure 4-12

the Maacama fyke site in April, resulting in 3-4 redds (which presumably hatched, but the offspring probably died, as that whole reach of Maacama Creek went dry soon afterward).

Table 4-3. Surveys of Redds and Spawning Activity

Location	Date	Weather, Stream Condition	Observations
Lower Maac	Dec 26-Jan11	Intermittent rain	Approx. 6-8 different Coho adults, both sexes, seen repeatedly during period in glide above first fyke site--most eventually found dead and spawned out, but 3 ripe males caught in fyke going downstream
Middle SRC	24 Jan	Raining, water high	2 adult steelhead jumping weir; another seen 200 m upstream
Upper SRC, Upper MWC (2 sites), Upper and Lower Maac	24 Jan	Raining, water high	No sightings
Middle SRC	26 Jan	Rain ending, water clearing	No sightings
Middle and upper MWC, middle and upper SRC	27 Jan	Clear, water clearing	No sightings
Middle SRC	10 Feb	Light rain (heavy rains Feb 5-6), water clearing	No sightings
Upper SRC	10 Feb	Light rain	4-5 adult steelhead at barrier below Hood Mt. State Park; another ascending cataract approx 1 mi downstream
Lower Maac	11 Feb	Clear, water clearing	1 Coho adult carcass
Upper Maac,	11 Feb	Clear	No sightings
Middle SRC	21 Feb	Raining, water high and turbid	Half-pounder jumping weir near fish ladder
Upper and middle MWC	21 Feb	Raining, water high and turbid	No sightings
Upper and middle MWC, middle SRC	25 Feb	Clear, water clearing	No sightings
Upper SRC	25 Feb	Clear, water clearing	2 adult steelhead at barrier near State Park
Lower Maac	5 Apr	Clear	1 steelhead redd near Young Rd, adult nearby
Lower MWC (Hwy 101 to Slusser Rd)	10 Apr	Clear	2 steelhead redds; spawning brook lamprey
Lower Maac (50 m above fyke site)	29 Mar-11 Apr	Rains 7-8 Apr, water clear	At least 6-8 different steelhead seen spawning in small area, resulting in 3-4 redds by Apr 11

Chapter V.
DISCUSSION

OVERALL CONCLUSIONS

The hypothesis that discharge of reclaimed water into the migration corridor in Santa Rosa and Mark West Creeks constitutes any impairment of these streams with respect to migration, reproduction, or rearing of steelhead is not supported by the data gathered through four years of study. Expansion of the study in the fourth year to include all freshwater phases of the life cycle has shown that these creeks have self-sustaining steelhead populations whose numbers are limited by habitat factors such as drought and water diversions in the rearing areas, not by reclaimed water. The carrying capacity of rearing habitat probably limits steelhead production in these streams considerably.

Coho may also be limited by habitat and by depressed stock coast-wide. The number of coho salmon found in the Laguna system is low relative to steelhead, and this makes conclusions about relationships between wastewater and coho migration and reproduction difficult. Therefore, the possibility that low coho numbers in the Laguna system are related to reclaimed water cannot be ruled out. The inflexible life history of coho (i.e., no repeat spawning, isolated year classes), makes coho populations more vulnerable to extinction as a result of habitat factors relative to steelhead populations.

ADULT UPMIGRATION IN RELATION TO FLOW AND RECLAIMED WATER

The four-year study focused on testing the most testable, and likely, predictions that follow from the hypothesis that reclaimed water impairs steelhead migrations. No evidence of impairment has been found. Indeed, Figures 3-6 and 3-7 show that fish migrate through a wide range of reclaimed water concentrations, including high concentrations, and do not indicate that upmigrating adult steelhead tended to occur at low concentrations, as would be expected if the fish were inhibited in some way by reclaimed water.

Rainfall, and the resulting changes in streamflow, are known to be major determinants of anadromous fish migration, but the importance of any single parameter such as streamflow cannot necessarily be identified by statistical tests such as regression analysis. In a seminal 9-year study of steelhead and coho use of Waddell Creek in Santa Cruz County, California, Shapovolov and Taft (1954) described this problem:

> ". . . an unsuccessful attempt was made . . . to establish a correlation between water volume and temperature and the spawning migration of silver salmon at Waddell Creek. Yet poachers and other interested local residents and biologists who have an intimate field acquaintance with the various species of anadromous salmonids usually know rather definitely at what times a particular species is going to enter and ascend a particular stream. Certainly, water volume and temperature (there is a general correlation between the two, since rainfall creates a water temperature of approximately 50 to 55 degrees F.) do exercise an influence on the spawning migration, but the extent of their influence is greatly altered by other complicating factors (variables), such as the time of year, the number of fish that have already entered and ascended the stream, the length of time that it has been raining and consequently the length of time that the stream has been high, the condition of the tides, etc. The existence of homing . . . limits the

> potential total number of fish that may enter the stream. Obviously, if most of this number have already entered the stream, comparatively few more will enter even with optimal physical conditions of water height, temperatures, tides, etc. This approach seems so obvious that it would not be necessary to mention it, except for the fact that biologists so often have tended to disregard it, by ignoring influencing factors if they could not be graphed to show correlation, or conversely by considering their graphs in error if exceptions occurred." (Shapovalov and Taft, 1954, p.32).

Migrating steelhead captured in this study do not appear to avoid reclaimed water, but the possibility exists that another part of the population avoids reclaimed water. This probably can never be completely addressed, but two lines of evidence based on this study suggest that the existence of such a subpopulation is unlikely. The first is the week-long experimental no-discharge “window”, which did not result in conspicuously large catches at the season and flow level where catches have been most likely to occur. The “window” experiment would, of course, have to be repeated a number of times to strengthen or refute this conclusion, but the results suggest that any "avoiders" (if they exist) are probably not a large fraction of the total migratory population. The second line of evidence is a comparison with daily catches in Maacama Creek, which does not receive reclaimed water. Catches of steelhead in Santa Rosa and Mark West Creeks were usually one or two fish per day when fish were moving, which is about the same as the catch rate in Maacama Creek.

The subject of whether steelhead ascending the Laguna de Santa Rosa incorporate the olfactory signature of reclaimed water (i.e., use it as a homing cue) has been raised. It was not addressed directly in this study, but some speculations can be made based on the data at hand. The apparent absence of hatchery adults in Santa Rosa and Mark West Creeks in 1994 could be an indication that hatchery fish avoided the Laguna because they were not imprinted with the signature of reclaimed water. If the signature of reclaimed water prevents the introgression of hatchery genes into the genetic pool of Santa Rosa and Mark West Creek steelhead populations, then reclaimed water could be regarded as an asset. However, the greater frequency of hatchery fish in Maacama Creek may also be related to the proximity of the hatchery (Dry Creek).

The sequential imprinting hypothesis (Harden Jones 1968) predicts that migrants homing to tributaries further up a watershed should have more olfactory signals in common than migrants whose natal tributaries are nearer to the mouth of the main stream; thus, migrants returning to the hatchery on Dry Creek would be more likely to stray into Maacama Creek than into the Laguna system. Whether or not these data imply a greater genetic diversity, or higher proportion of wild genes in the Laguna steelhead populations compared to Maacama steelhead, there are some other aspects of the data that suggest that the Santa Rosa and Mark West Creek steelhead populations may be better adapted to project area conditions than the Maacama Creek population(s). The outmigration of smolts over a longer time period in Santa Rosa Creek and the more diverse smolt age structure (year-class composition) in Santa Rosa and Mark West Creeks are examples.

SMOLT DOWNMIGRATION IN RELATION TO RAINFALL AND FLOW

Downmigrating steelhead adults and smolts in Santa Rosa, Mark West, and Maacama Creeks were usually captured following rainfall events. This may have been due to the small size of these creeks and the lack of rainfall during the spring of 1994. Outmigrating

smolts in Waddell Creek were not associated with rain (Shapovalov and Taft, 1954), nor were those in Lagunitas Creek, Marin County (Bratovich and Kelley, 1988, Kelley and Entrix, Inc., 1992). Both of these creeks had higher base flows during spring than the creeks studied in this project.

TIMING OF UPMIGRANTS IN RELATION TO HATCHERY RETURNS

The timing of the appearance of upmigrating coho and steelhead adults at the fyke nets can be compared to the returns of hatchery-reared fish to Warm Springs Hatchery. The hatchery returns are summarized by week for the past four years in Appendix 5-1. Steelhead fyke net catches in general have coincided with the first half of the hatchery return period (mid-December to mid-February), but three out of four years studied were drought years. Fyke net catches in 1994 extended into late March in both Santa Rosa and Mark West Creeks, although hatchery returns typically continue through April (Appendix 5-1). Coho returns to the hatchery occur throughout December and January; the few coho netted in Maacama Creek were in early January, but sampling effort was limited in December.

ESTIMATING THE NUMBER OF ADULTS IN THE SPAWNING RUN

Estimating the total number of steelhead migrants from the fyke net catch data is difficult because the number moving during high water, when nets were not set, is unknown. Fyke nets were out of service in Santa Rosa and Mark West Creeks for about 18 days during the three storms between 21 January and 22 February 1994. This is the period when most adults have been caught in this and other studies (Shapovolov and Taft 1954), as well as the period of peak returns at Warm Springs Hatchery. Based on patterns of steelhead returns to Waddell Creek (Shapovalov and Taft's Figure 23), it is reasonable to estimate that half or more of the fish could have passed during this period. If the total number of adults trapped (upstream and downstream) was underestimated by a factor of two to four (see fyke net efficiency, above), then a rough estimate would be that approximately 100 fish (using 36 fish and an underestimation factor of 3) upmigrated in each creek while traps were set and another 100 upmigrated in each creek during the three storms when no traps were set.

Two other approaches can be used to corroborate this estimate. In the Waddell Creek study, the fish traps were claimed to capture both up- and downstream migrants with equal efficiency (except when fish jumped over the dam during floods). Over the 9-year study, Shapovolov and Taft counted an average of 432 upmigrants, but only 47 downmigrants each year. Thus, each downmigrant they captured represented nine upmigrants. The present study was probably more efficient in the capture of downmigrants than upmigrants, but clearly did not capture all downmigrants. About 20 downmigrants were intercepted in each of Santa Rosa and Mark West Creeks. If each of these represented several upmigrants, an estimate in the low hundreds of individuals would result.

Another estimate of adult numbers can be made based on smolt numbers. Downmigrating smolts were probably underestimated in fyke nets by a factor of ten or more (see fyke net efficiency, above), but the number of fish that were not counted when nets were not set in January and February is probably a smaller fraction of the total since smolt migration is not concentrated during that period. If the 650 smolts that were actually counted in Santa Rosa Creek represent 6,500, and the survivorship at sea is comparable to that found by Shapovalov and Taft (1954) for Waddell Creek (2.4 percent for 1-year-old smolts, 5.8 percent for 2-year-old smolts) then the observed smolts outmigrating from Santa Rosa

Creek in 1994 (based on observed smolt age composition) would produce 6,500 x 0.052 = 338 adults returning in 1996.

The earlier estimates for survivorship at sea are likely to be too high to apply to this study, because sport fishing in the Russian River undoubtedly removes some of the returning adults on their way to the Laguna system (Waddell Creek had no equivalent sport fishing pressure). Even if survivorship is now only half as much, the resulting estimate is roughly similar to the estimated size of the 1994 upmigrant population given above, which is based on fyke net catches of adults.

An estimated total adult population size of around 200 individuals in Santa Rosa Creek is probably fewer than the number which ran in Santa Rosa Creek before the habitat was altered by human activities. For example, the average number of adult steelhead returning to Waddell Creek each year was 432 (Shapovalov and Taft 1954), even though that stream is considerably shorter (approximately 5.4 miles) than Santa Rosa Creek (17.2 miles estimated useable habitat now, more earlier).

Other researchers who have studied anadromous salmonid populations in California and elsewhere in the western United States have shown a general trend of diminishing populations as the stream habitat has been lost or its quality reduced by logging, loss of riparian vegetation, siltation, water diversions, and other factors (Allen, 1969, Burns 1971, Nehlson, et al, 1991). The streams studied in this project typify many of these alterations: The lower sections of Santa Rosa and Maacama Creeks have undergone severe loss of riparian vegetation, as well as channelization. Siltation in all of the streams has reduced carrying capacity. The largest single "bottleneck" in the salmonid life cycle in these streams, however, appears from this study to be lack of water in the streams in summer, due at least in part to diversion.

SUMMER JUVENILE MORTALITY

The apparent summer (1994) mortality of juvenile steelhead was severe in all of the study streams, and was probably 100 percent in lower and middle Maacama Creek (although it is conceivable that some early outmigration could have occurred, and that some of the migrants found their way to the estuary or to more suitable tributaries). In studies of Lagunitas Creek, summer mortality was estimated to be a minor factor in limiting salmonid populations, following implementation of an agreement whereby minimum streamflows are maintained by controlled releases of water from Kent Dam (Kelley and Entrix, 1992). A similar agreement was reached with respect to water releases to Walker Creek from Soulajule Reservoir, but results have been unclear in terms of improvement of salmonid runs (Emig 1981).

STATUS OF COHO SALMON POPULATIONS

Coho spawning was apparently successful in 1993, but in the project index zones no young-of-the-year were found in 1994 in either Maacama Creek or Green Valley Creek. Both juvenile steelhead and coho rearing appear to be imperiled by lack of water in the lower and middle reaches in summer, due primarily to diversions in the case of Maacama Creek. Evidence from this study suggests the existence of a small population of coho in Mark West Creek, and possibly in Santa Rosa Creek. Two wild adult upmigrants (both males) were trapped in Mark West Creek in 1993, (at reclaimed water concentrations of 8.8 and 20.6 percent). The eleven wild smolts trapped in fyke nets in Mark West Creek and the lower Laguna in 1994 may have been spawned by members of that returning group. Since no juveniles were found in the seining surveys, any successful coho

reproduction that took place was likely not near the surveyed index zones. In Santa Rosa Creek, one coho smolt was caught moving downstream and three coho smolts were caught moving upstream. No adult coho have been captured in fyke nets in Santa Rosa Creek, and no juveniles have been found in seining surveys.

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APPENDICES

NOTE ON APPENDIX NUMBERS: The first digit indicates the chapter in the report to which the data refer. The second digit indicates the subject. A third digit is used in cases where similar data are presented for each creek or zone separately.

Appendix 3-1. Daily Stream Flow and Reclaimed Water Discharge, 1993-1994

	Stream Flow (cfs)				Reclaimed Water Discharge (cfs) Santa Rosa			Reclaimed Water Conc. (percent)			
Date	Upper Laguna	SRC	MWC	TH	Upper Laguna	Delta Pond	CW	zone A	zone B	zone C	zone D
15-Oct-93	41.9	467.9	28.4	176.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16-Oct-93	24.5	19.9	14.8	107.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17-Oct-93	21.5	29.2	13.0	95.7	0.0	0.0	1.3	1.4	0.0	0.0	0.0
18-Oct-93	17.2	24.0	11.1	78.9	0.0	0.0	0.9	1.2	0.0	0.0	0.0
19-Oct-93	12.4	22.7	10.9	60.2	0.0	0.0	0.8	1.3	0.0	0.0	0.0
20-Oct-93	8.7	20.1	10.5	45.3	0.0	0.0	0.6	1.3	0.0	0.0	0.0
21-Oct-93	5.9	19.3	9.7	34.4	0.0	0.0	0.5	1.4	0.0	0.0	0.0
22-Oct-93	3.7	19.3	9.5	25.7	0.0	0.0	0.5	1.9	0.0	0.0	0.0
23-Oct-93	2.6	18.0	9.1	21.5	0.0	0.0	0.3	1.6	0.0	0.0	0.0
24-Oct-93	1.6	16.6	9.1	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-Oct-93	0.5	15.3	8.9	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26-Oct-93	0.0	13.9	8.9	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27-Oct-93	0.0	12.6	8.2	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28-Oct-93	0.0	11.3	8.7	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29-Oct-93	0.0	9.9	8.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30-Oct-93	0.0	8.6	7.4	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31-Oct-93	0.0	7.2	7.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-Nov-93	0.0	5.9	8.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2-Nov-93	0.0	4.6	8.7	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-Nov-93	0.0	4.6	8.8	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4-Nov-93	0.0	4.4	9.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-Nov-93	0.0	4.3	9.7	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-Nov-93	0.0	3.9	9.7	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7-Nov-93	0.0	3.8	10.4	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8-Nov-93	0.0	3.8	11.2	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-Nov-93	0.0	3.8	11.2	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-Nov-93	0.0	22.0	15.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11-Nov-93	7.9	37.3	16.1	42.2	0.2	0.0	0.0	0.5	0.4	0.5	0.0
12-Nov-93	3.0	8.8	11.3	23.1	0.3	0.0	0.0	1.5	1.4	2.8	0.0
13-Nov-93	1.9	5.5	12.6	18.9	0.6	0.0	0.0	2.9	2.7	6.9	0.0
14-Nov-93	1.3	3.9	11.0	16.5	0.7	0.0	0.0	4.5	4.3	12.3	0.0
15-Nov-93	0.5	3.1	10.4	13.0	0.9	0.0	0.0	7.1	6.2	20.6	0.0
16-Nov-93	0.0	3.3	10.7	10.1	1.0	0.0	0.0	9.5	6.4	22.3	0.0
17-Nov-93	0.0	3.4	10.9	8.6	1.0	0.0	0.0	11.4	6.5	22.4	0.0
18-Nov-93	0.0	3.4	11.1	7.8	1.0	0.0	0.0	12.3	6.2	21.9	0.0
19-Nov-93	0.0	3.1	11.1	6.3	1.0	0.0	0.0	15.2	6.3	23.5	0.0
20-Nov-93	0.0	3.3	11.3	5.5	1.0	0.0	0.0	17.5	6.1	22.2	0.0
21-Nov-93	0.0	3.5	11.2	5.0	0.9	0.0	0.0	18.5	5.9	21.1	0.0
22-Nov-93	0.0	3.3	11.3	4.7	0.9	0.0	0.0	18.4	5.6	20.9	0.0
23-Nov-93	0.0	2.8	11.5	4.5	0.8	0.0	0.0	17.8	5.3	22.5	0.0
24-Nov-93	0.0	2.7	11.8	4.4	0.8	0.0	0.0	17.4	5.0	22.1	0.0
25-Nov-93	0.0	2.8	11.9	4.1	0.8	0.0	0.0	18.7	5.0	21.9	0.0
26-Nov-93	0.0	3.0	12.3	3.9	0.7	0.0	0.0	19.2	4.6	19.8	0.0
27-Nov-93	0.0	3.1	12.2	3.9	0.8	0.0	0.0	20.3	5.0	20.3	0.0
28-Nov-93	0.3	40.4	18.1	12.4	0.8	0.0	0.0	6.7	1.4	2.0	0.0
29-Nov-93	71.6	479.7	97.1	292.9	0.9	0.0	0.2	0.4	0.1	0.2	0.0
30-Nov-93	106.1	90.2	78.1	429.0	13.9	0.0	2.2	3.7	4.8	6.6	0.0
1-Dec-93	83.3	27.5	28.9	339.2	9.5	0.0	2.6	3.6	6.4	7.9	0.0
2-Dec-93	61.9	16.9	21.6	254.8	6.9	0.0	3.3	4.0	6.4	8.1	0.0
3-Dec-93	42.3	12.3	18.9	177.6	5.2	0.0	2.7	4.4	6.7	8.8	0.0

Appendix 3-1. Daily Stream Flow and Reclaimed Water Discharge, 1993-1994

Date	Stream Flow (cfs)				Reclaimed Water Discharge (cfs) Santa Rosa			Reclaimed Water Conc. (percent)			
	Upper Laguna	SRC	MWC	TH	Upper Laguna	Delta Pond	CW	zone A	zone B	zone C	zone D
4-Dec-93	28.8	12.5	17.2	124.5	5.2	0.0	2.0	5.7	8.2	11.2	0.0
5-Dec-93	20.6	8.8	16.1	92.2	6.3	0.0	1.3	8.1	12.2	17.7	0.0
6-Dec-93	14.7	11.6	16.0	69.0	5.6	0.0	1.2	9.7	11.7	17.5	0.0
7-Dec-93	10.6	10.2	15.6	53.0	5.2	0.0	1.0	11.5	12.6	20.1	0.0
8-Dec-93	75.8	260.2	165.2	309.5	3.1	0.0	0.7	1.2	0.6	0.9	0.0
9-Dec-93	95.6	95.8	124.3	387.8	33.3	0.0	0.5	8.7	9.5	14.8	0.0
10-Dec-93	62.4	40.6	38.4	256.9	39.6	0.0	4.1	16.7	21.9	27.8	0.0
11-Dec-93	149.3	522.8	342.9	599.2	20.9	0.0	2.4	3.9	2.0	3.0	0.0
12-Dec-93	225.1	136.3	119.5	897.4	57.9	0.0	6.3	7.1	10.7	13.8	0.0
13-Dec-93	164.6	75.4	62.9	659.2	29.7	0.0	8.9	5.8	8.9	11.0	0.0
14-Dec-93	311.5	588.0	500.0	1237.6	39.9	0.0	9.0	3.9	2.8	4.2	0.0
15-Dec-93	275.3	134.5	120.5	1095.0	56.8	0.0	9.7	6.0	9.7	12.2	0.0
16-Dec-93	172.3	72.6	58.2	689.7	20.8	51.0	12.2	12.0	19.1	22.7	41.2
17-Dec-93	110.5	51.2	40.4	446.1	16.3	25.6	7.5	10.9	17.2	20.6	33.3
18-Dec-93	76.4	39.5	33.7	311.8	4.3	7.7	4.5	5.2	7.4	9.4	16.3
19-Dec-93	54.8	32.7	29.3	226.9	14.3	0.0	3.5	7.7	10.9	14.1	0.0
20-Dec-93	38.2	28.0	24.8	161.7	11.9	0.0	2.3	8.6	11.5	15.2	0.0
21-Dec-93	28.4	26.4	23.0	123.0	11.9	0.0	1.7	10.9	13.2	17.8	0.0
22-Dec-93	22.3	23.1	21.5	99.2	7.3	0.0	1.3	8.6	9.8	13.9	0.0
23-Dec-93	16.9	21.5	20.3	77.9	8.0	22.3	0.8	39.6	34.0	44.1	50.9
24-Dec-93	14.8	19.3	19.2	69.3	8.1	17.9	0.5	37.9	32.8	43.3	48.1
25-Dec-93	13.3	18.1	18.4	63.6	12.1	18.0	0.3	47.7	37.7	48.9	49.8
26-Dec-93	12.2	17.7	17.9	59.2	11.0	8.5	0.4	33.4	29.0	39.5	32.4
27-Dec-93	11.4	16.6	17.5	56.1	10.4	28.8	0.3	70.0	46.3	58.4	63.5
28-Dec-93	11.4	15.4	16.8	56.0	5.7	31.7	0.3	67.1	46.3	58.3	67.3
29-Dec-93	11.5	14.8	16.2	56.6	2.7	27.1	0.2	52.8	41.2	53.1	64.7
30-Dec-93	10.3	14.0	15.8	51.7	0.7	22.6	0.0	45.2	36.8	49.0	61.7
31-Dec-93	9.4	13.4	15.4	48.3	0.7	26.8	0.0	57.0	41.9	54.7	66.7
1-Jan-94	8.8	14.1	15.3	46.0	0.7	13.4	0.0	30.7	27.0	38.2	48.8
2-Jan-94	8.5	14.8	15.2	44.7	0.7	22.2	0.0	51.3	37.3	49.6	60.0
3-Jan-94	8.1	12.5	14.8	43.0	0.8	17.9	0.0	43.4	34.5	47.5	58.7
4-Jan-94	8.0	17.9	15.4	42.8	0.8	22.3	0.0	54.0	35.9	47.2	55.5
5-Jan-94	9.9	19.7	15.8	50.0	0.8	17.7	0.0	36.9	28.9	38.4	47.3
6-Jan-94	8.5	13.0	15.3	44.8	0.8	19.3	0.0	44.8	35.2	48.2	59.6
7-Jan-94	7.8	12.0	14.8	42.0	0.8	20.0	0.0	49.5	37.6	51.2	62.5
8-Jan-94	7.6	16.5	14.8	41.1	0.8	4.5	0.0	12.8	12.0	18.0	21.3
9-Jan-94	7.0	15.9	15.0	38.7	5.0	0.0	0.0	13.0	11.8	18.1	0.0
10-Jan-94	5.6	12.2	14.8	33.2	9.9	0.0	0.0	29.8	23.3	35.8	0.0
11-Jan-94	6.4	11.3	14.3	36.3	13.7	19.6	0.0	91.7	51.0	65.3	63.4
12-Jan-94	8.0	11.5	14.1	42.7	13.8	19.4	0.0	77.8	49.7	63.0	62.7
13-Jan-94	8.1	11.5	13.9	43.0	9.9	19.6	0.0	68.5	46.8	60.1	63.0
14-Jan-94	7.6	10.5	13.8	41.0	5.2	23.4	0.0	69.7	47.3	61.3	69.1
15-Jan-94	9.0	10.4	13.7	46.5	1.9	9.4	0.0	24.3	25.5	36.9	47.5
16-Jan-94	6.7	10.1	13.5	37.7	3.2	0.0	0.0	8.6	9.6	16.1	0.0
17-Jan-94	4.4	10.0	13.3	28.6	3.6	0.0	0.0	12.6	11.5	20.1	0.0
18-Jan-94	3.0	9.7	13.2	23.2	6.1	0.0	0.0	26.2	18.9	32.3	0.0
19-Jan-94	2.9	9.9	13.2	22.6	9.9	0.0	0.0	43.9	27.7	43.7	0.0
20-Jan-94	4.1	9.4	13.1	27.4	15.7	0.0	0.0	57.4	37.2	53.8	0.0
21-Jan-94	5.4	9.3	12.9	32.4	18.7	0.0	0.0	57.8	40.4	56.0	0.0
22-Jan-94	7.1	9.6	13.0	39.2	20.2	0.0	0.0	51.5	40.5	54.8	0.0

Appendix 3-1. Daily Stream Flow and Reclaimed Water Discharge, 1993-1994

Date	Stream Flow (cfs)				Reclaimed Water Discharge (cfs) Santa Rosa			Reclaimed Water Conc. (percent)			
	Upper Laguna	SRC	MWC	TH	Upper Laguna	Delta Pond	CW	zone A	zone B	zone C	zone D
23-Jan-94	34.4	78.4	27.0	146.5	14.5	0.0	0.0	9.9	9.4	11.4	0.0
24-Jan-94	120.4	266.3	174.3	485.1	69.1	80.4	1.0	31.0	21.0	27.9	23.2
25-Jan-94	247.7	655.3	411.0	986.3	136.8	110.7	3.6	25.4	15.9	21.5	14.5
26-Jan-94	382.6	222.0	192.5	1517.7	132.1	113.2	7.5	16.6	23.5	28.9	33.8
27-Jan-94	343.8	288.0	162.0	1364.6	137.1	73.8	12.3	16.2	21.0	25.0	20.4
28-Jan-94	234.4	102.9	73.0	933.9	105.2	76.4	12.9	20.5	30.7	35.0	42.6
29-Jan-94	152.3	65.6	47.5	610.9	75.9	52.7	11.2	22.5	32.6	37.1	44.5
30-Jan-94	107.5	49.3	36.6	434.3	78.4	51.4	7.7	31.1	40.2	45.3	51.0
31-Jan-94	83.5	39.9	31.2	339.8	41.0	43.1	4.7	25.8	35.2	40.5	51.9
1-Feb-94	67.2	32.9	26.7	275.8	33.3	30.5	2.9	23.9	33.4	38.9	48.1
2-Feb-94	53.0	29.5	24.3	219.9	24.3	35.9	2.2	28.1	36.1	42.2	54.9
3-Feb-94	40.6	25.7	22.5	171.0	37.0	18.0	2.1	33.0	38.2	45.3	41.2
4-Feb-94	31.6	25.3	21.0	135.6	0.0	0.0	2.1	1.5	0.0	0.0	0.0
5-Feb-94	24.8	23.2	19.8	108.9	0.0	0.0	0.8	0.7	0.0	0.0	0.0
6-Feb-94	116.2	289.2	166.7	468.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7-Feb-94	362.3	674.9	769.6	1437.5	41.9	0.0	0.0	2.9	2.3	3.9	0.0
8-Feb-94	390.4	141.5	146.5	1548.3	109.5	14.6	8.8	8.5	15.5	18.9	9.4
9-Feb-94	248.2	74.1	65.4	988.4	0.0	0.0	14.3	1.4	0.0	0.0	0.0
10-Feb-94	144.6	65.8	50.2	580.5	0.0	0.0	13.9	2.3	0.0	0.0	0.0
11-Feb-94	92.9	54.0	41.0	377.1	0.0	0.0	3.1	0.8	0.0	0.0	0.0
12-Feb-94	66.2	39.8	32.8	272.0	0.0	0.0	5.0	1.8	0.0	0.0	0.0
13-Feb-94	48.4	33.3	29.0	201.6	0.0	0.0	3.7	1.8	0.0	0.0	0.0
14-Feb-94	36.6	29.7	26.6	155.3	0.0	0.0	2.7	1.7	0.0	0.0	0.0
15-Feb-94	29.2	26.6	24.4	126.2	0.0	8.9	2.0	8.5	10.0	13.8	25.2
16-Feb-94	24.2	24.6	22.9	106.6	0.0	13.9	1.4	14.1	16.2	22.1	36.1
17-Feb-94	113.8	207.1	121.5	459.3	0.0	9.9	0.9	2.3	2.2	3.0	4.5
18-Feb-94	148.8	207.7	137.6	597.0	18.3	58.5	0.9	13.0	13.5	17.7	22.0
19-Feb-94	184.9	295.9	224.5	739.3	23.4	38.7	6.1	9.1	8.1	11.4	11.6
20-Feb-94	453.8	609.2	606.2	1797.7	18.0	61.3	7.8	4.8	4.5	6.9	9.1
21-Feb-94	445.5	350.3	301.9	1765.3	69.8	31.4	11.2	6.3	8.4	11.3	8.2
22-Feb-94	373.1	202.2	150.1	1480.2	63.3	39.1	7.2	7.4	12.4	15.1	16.2
23-Feb-94	242.6	121.4	91.8	966.5	48.0	40.3	2.3	9.4	16.2	19.5	25.0
24-Feb-94	154.2	91.2	77.6	618.5	12.6	48.8	1.2	10.1	16.0	20.0	34.9
25-Feb-94	106.9	73.6	63.0	432.2	44.0	11.9	4.5	13.8	18.7	23.6	13.9
26-Feb-94	85.6	65.4	53.3	348.1	39.9	15.7	4.5	17.0	21.4	26.9	19.4
27-Feb-94	71.2	57.4	49.4	291.4	28.5	11.9	3.2	14.8	18.5	23.9	17.1
28-Feb-94	58.8	48.4	44.6	242.6	14.9	0.0	0.0	6.2	9.0	12.2	0.0
1-Mar-94	47.0	41.2	40.6	196.2	14.8	7.1	0.0	11.1	14.5	19.9	14.7
2-Mar-94	38.1	36.2	35.8	161.3	14.9	7.9	0.0	14.1	17.2	23.5	17.8
3-Mar-94	32.2	31.8	31.1	138.1	14.8	9.1	0.0	17.3	20.0	27.1	22.2
4-Mar-94	27.9	28.2	27.9	121.0	14.8	16.8	0.0	26.1	27.3	36.0	37.3
5-Mar-94	24.8	26.8	26.3	108.9	0.9	19.3	0.0	18.5	20.6	28.1	41.8
6-Mar-94	22.5	27.7	26.0	99.7	0.9	5.9	0.0	6.8	8.2	11.9	17.4
7-Mar-94	17.9	22.8	23.3	81.7	0.9	17.7	0.0	22.8	22.5	31.4	43.7
8-Mar-94	15.5	20.1	21.7	72.4	0.9	7.5	0.0	11.6	12.8	19.1	27.3
9-Mar-94	13.9	19.4	20.3	65.9	0.8	9.2	0.0	15.2	15.7	23.1	32.2
10-Mar-94	12.5	18.4	19.4	60.6	0.7	8.5	0.0	15.1	15.4	22.8	31.6
11-Mar-94	11.1	17.5	18.5	54.7	0.7	8.2	0.0	16.1	15.8	23.6	31.8
12-Mar-94	9.5	15.4	17.2	48.7	0.7	4.0	0.0	9.6	10.0	15.9	20.6
13-Mar-94	8.3	14.2	16.7	44.1	0.7	8.2	0.0	20.2	18.5	28.3	36.5

Appendix 3-1. Daily Stream Flow and Reclaimed Water Discharge, 1993-1994

Date	Stream Flow (cfs)				Reclaimed Water Discharge (cfs)			Reclaimed Water Conc. (percent)			
					Santa Rosa						
	Upper Laguna	SRC	MWC	TH	Upper Laguna	Delta Pond	CW	zone A	zone B	zone C	zone D
14-Mar-94	8.1	13.8	16.7	42.9	0.8	7.4	0.0	19.0	17.5	27.2	34.9
15-Mar-94	7.5	13.4	16.1	40.9	0.8	5.9	0.0	16.4	15.3	24.2	30.4
16-Mar-94	7.4	16.7	15.4	40.5	1.0	6.2	0.0	17.6	15.3	22.8	26.9
17-Mar-94	6.8	12.9	13.4	38.1	1.1	6.2	0.0	19.0	17.9	26.9	32.3
18-Mar-94	6.4	12.8	12.7	36.3	1.2	4.6	0.0	15.9	15.3	23.1	26.5
19-Mar-94	5.9	12.2	12.3	34.3	1.1	4.2	0.0	15.4	14.8	22.6	25.4
20-Mar-94	5.7	11.1	11.3	33.5	1.0	4.0	0.0	14.9	15.1	23.0	26.4
21-Mar-94	5.6	10.6	13.8	33.2	0.9	6.0	0.0	20.9	18.8	30.0	36.1
22-Mar-94	5.0	10.7	12.2	30.9	0.8	6.0	0.0	22.2	19.7	30.4	36.0
23-Mar-94	4.5	10.2	10.4	29.1	0.8	4.0	0.0	16.6	16.0	24.6	28.1
24-Mar-94	4.1	10.5	11.4	27.5	0.8	0.0	0.0	2.9	3.0	5.2	0.0
25-Mar-94	5.1	19.7	12.6	31.2	0.8	4.0	0.0	15.3	11.3	16.2	16.9
26-Mar-94	5.3	10.9	11.4	32.2	0.7	4.2	0.0	15.1	15.0	23.1	27.7
27-Mar-94	5.2	9.3	12.3	31.6	0.8	4.0	0.0	15.1	15.1	24.8	30.1
28-Mar-94	5.2	8.6	11.7	31.9	0.8	0.0	0.0	2.5	3.1	5.5	0.0
29-Mar-94	3.8	8.0	11.4	26.1	1.7	0.0	0.0	6.5	6.8	12.6	0.0
30-Mar-94	3.4	7.4	10.8	24.8	2.2	0.0	0.0	8.7	9.0	16.5	0.0
31-Mar-94	3.1	6.7	11.0	23.5	2.9	0.0	0.0	12.3	12.2	22.7	0.0
1-Apr-94	2.9	6.4	10.4	22.7	3.5	0.0	0.0	15.4	15.1	27.3	0.0
2-Apr-94	2.8	6.4	10.3	22.1	4.3	0.0	0.0	19.6	18.3	32.2	0.0
3-Apr-94	2.6	6.3	10.2	21.6	4.5	0.0	0.0	21.0	19.1	33.5	0.0
4-Apr-94	2.5	6.2	9.8	20.9	4.3	0.0	0.0	20.8	19.0	33.3	0.0
5-Apr-94	2.0	5.4	9.3	18.9	4.1	0.0	0.0	21.8	19.9	36.0	0.0
6-Apr-94	1.8	5.5	9.2	18.3	4.1	0.0	0.0	22.5	20.0	36.0	0.0
7-Apr-94	1.7	5.6	9.1	17.8	3.9	0.0	0.0	22.0	19.3	35.1	0.0
8-Apr-94	3.2	37.7	12.4	23.8	3.0	0.0	0.0	12.7	5.4	6.9	0.0
9-Apr-94	14.8	21.9	16.0	69.5	2.3	0.0	0.0	3.3	4.2	5.9	0.0
10-Apr-94	9.0	7.7	12.9	46.8	2.1	0.0	0.0	4.4	6.6	11.1	0.0
11-Apr-94	7.3	5.5	9.9	39.9	2.3	0.0	0.0	5.9	9.4	15.5	0.0
12-Apr-94	5.6	5.9	8.8	33.1	3.4	0.0	0.0	10.4	14.4	23.0	0.0
13-Apr-94	3.8	4.2	8.2	26.4	3.6	0.0	0.0	13.6	18.0	30.8	0.0
14-Apr-94	2.9	4.4	7.8	22.6	3.4	0.0	0.0	15.1	18.4	31.8	0.0
15-Apr-94	2.0	4.3	7.3	19.0	3.7	0.0	0.0	19.4	21.3	37.0	0.0
16-Apr-94	1.3	4.4	7.2	16.4	3.2	0.0	0.0	19.8	20.0	36.2	0.0
17-Apr-94	1.2	5.2	7.3	15.8	3.0	0.0	0.0	18.8	17.8	31.7	0.0
18-Apr-94	0.8	4.9	6.9	14.5	3.0	0.0	0.0	20.6	19.1	34.2	0.0
19-Apr-94	0.7	4.7	6.5	13.9	2.5	0.5	0.0	21.5	20.1	35.8	9.0
20-Apr-94	0.4	4.4	6.3	12.8	2.2	0.0	0.0	16.9	16.3	31.0	0.0
21-Apr-94	0.1	4.4	6.1	11.8	1.8	0.0	0.0	14.9	14.2	28.0	0.0
22-Apr-94	0.0	4.1	4.8	11.1	1.2	0.0	0.0	10.5	11.6	22.2	0.0
23-Apr-94	3.0	30.9	5.7	23.1	0.7	0.0	0.0	3.2	1.8	2.1	0.0
24-Apr-94	7.0	12.2	8.5	38.9	0.7	0.0	0.0	1.9	2.6	3.7	0.0
25-Apr-94	22.8	71.3	17.8	100.9	0.8	0.0	0.0	0.8	0.7	0.8	0.0
26-Apr-94	1.9	19.5	18.7	18.6	0.7	0.0	0.0	4.0	1.8	3.3	0.0
27-Apr-94	12.1	10.4	13.0	58.9	0.8	0.0	0.0	1.4	2.3	3.5	0.0
28-Apr-94	10.3	8.1	10.3	51.8	0.8	0.0	0.0	1.6	2.8	4.3	0.0
29-Apr-94	7.5	7.1	8.7	40.6	0.8	0.0	0.0	2.1	3.5	5.5	0.0
30-Apr-94	4.9	6.4	7.9	30.4	0.8	0.0	0.0	2.8	4.2	7.0	0.0
1-May-94	2.9	5.8	7.2	22.7	0.9	0.0	0.0	3.8	5.1	9.0	0.0
2-May-94	1.5	5.6	6.8	17.1	0.9	0.0	0.0	5.0	5.8	10.9	0.0

Appendix 3-2-1. Santa Rosa Creek, Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
14-Oct-93	1.4										
15-Oct-93	0.82	3	3	13	1	0	0	0	0	0	0
16-Oct-93	0.12	3	3	1	0	0	0	0	0	0	0
17-Oct-93	0										
18-Oct-93											
19-Oct-93											
20-Oct-93											
21-Oct-93											
22-Oct-93											
23-Oct-93											
24-Oct-93											
25-Oct-93											
26-Oct-93											
27-Oct-93											
28-Oct-93											
29-Oct-93											
30-Oct-93											
31-Oct-93											
1-Nov-93											
2-Nov-93											
3-Nov-93											
4-Nov-93											
5-Nov-93											
6-Nov-93											
7-Nov-93											
8-Nov-93											
9-Nov-93	0										
10-Nov-93	0.6										
11-Nov-93	0	1	3	7	0	0	0	0	0	0	0
12-Nov-93		1	1	0	0	0	0	0	0	0	0
13-Nov-93											
14-Nov-93											
15-Nov-93											
16-Nov-93											
17-Nov-93											
18-Nov-93											
19-Nov-93											
20-Nov-93											
21-Nov-93											
22-Nov-93											
23-Nov-93											
24-Nov-93											
25-Nov-93											
26-Nov-93	0										
27-Nov-93	0.06										
28-Nov-93	0.66										
29-Nov-93	2.02										
30-Nov-93	0.01	3	1	3	0	0	0	0	0	0	0

Appendix 3-2-1. Santa Rosa Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
1-Dec-93	0	1	1	9	0	0	0	0	0	0	0
2-Dec-93		1	1	2	0	0	0	0	0	0	0
3-Dec-93		3	1	0	0	0	0	0	0	0	0
4-Dec-93		1	1	2	0	0	0	0	0	0	0
5-Dec-93	0	1	1	0	0	0	0	0	0	0	0
6-Dec-93	0.6	1	3	0	0	0	0	0	0	0	0
7-Dec-93	0.52	2	2	0	2	0	0	0	0	0	0
8-Dec-93	0.37										
9-Dec-93	0.01										
10-Dec-93	0.09										
11-Dec-93	1.31										
12-Dec-93	0.01	1	1	44	6	0	0	0	0	0	0
13-Dec-93	0.69										
14-Dec-93	0.23	2	2	1	2	0	0	0	0	0	0
15-Dec-93	0										
16-Dec-93		1	1	38	11	0	0	0	1	0	1
17-Dec-93		1	3	32	2	0	0	0	0	0	0
18-Dec-93		1	1	22	1	0	0	0	0	0	0
19-Dec-93		1	3	10	8	1	0	0	0	0	0
20-Dec-93		1	3	12	11	1	0	0	0	0	0
21-Dec-93		1	1	7	5	0	0	0	0	0	0
22-Dec-93		1	1	0	0	0	0	0	0	0	0
23-Dec-93		3	3	1	3	0	0	0	0	0	0
24-Dec-93		1	1	3	1	0	0	0	0	0	0
25-Dec-93	0	1	1	8	4	0	0	0	0	0	0
26-Dec-93	0.06	1	1	3	0	0	0	0	0	0	0
27-Dec-93	0	1	1	1	1	0	0	0	0	0	0
28-Dec-93		1	1	0	3	0	0	0	0	0	0
29-Dec-93	0	1	1	5	4	0	0	0	0	0	0
30-Dec-93	0.02	1	1	1	1	0	0	0	0	0	0
31-Dec-93	0	1	1	0	7	0	0	0	0	0	1
1-Jan-94	0.07	1	1	6	8	0	0	0	0	0	0
2-Jan-94	0	1	1	11	19	0	0	0	0	0	0
3-Jan-94	0	1	1	14	7	0	0	0	0	0	0
4-Jan-94	0.19										
5-Jan-94	0.01	1	1	8	20	0	0	0	0	0	0
6-Jan-94	0	1	1	12	4	0	0	0	0	0	0
7-Jan-94	0	1	1	1	5	0	0	0	0	0	0
8-Jan-94	0.19	2	2	2	4	0	0	0	0	0	0
9-Jan-94	0	1	1	4	10	0	0	0	0	0	0
10-Jan-94		1	1	0	2	0	0	0	0	0	0
11-Jan-94		1	1	1	0	0	0	0	0	0	0
12-Jan-94		1	1	0	4	0	0	0	0	0	1
13-Jan-94		1	1	0	2	0	0	0	0	0	0
14-Jan-94		2	2	0	0	0	0	0	0	0	0
15-Jan-94		1	1	1	0	0	0	0	0	0	0
16-Jan-94		1	1	1	4	0	0	0	0	0	0
17-Jan-94		1	1	1	0	0	0	0	0	0	0

Appendix 3-2-1. Santa Rosa Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
18-Jan-94		1	1	1	1	0	0	0	0	0	0
19-Jan-94		1	1	0	3	0	0	0	0	0	0
20-Jan-94	0	1	1	1	0	0	0	0	0	0	0
21-Jan-94	0.02										
22-Jan-94	0.17										
23-Jan-94	0.8										
24-Jan-94	0.88										
25-Jan-94	0.62										
26-Jan-94	0.14		2		1		0		0		0
27-Jan-94	0.00		2		6		0		0		0
28-Jan-94		1	1	25	2	0	0	1	8	0	0
29-Jan-94		1	1	4	1	0	0	0	2	0	0
30-Jan-94		3	1	3	2	0	0	0	0	0	0
31-Jan-94		1	1	0	0	0	0	0	0	0	0
1-Feb-94		3	3	4	0	0	0	1	0	0	0
2-Feb-94		1	1	0	1	0	0	0	0	0	0
3-Feb-94		1	2,3	1	0	0	0	0	0	0	0
4-Feb-94	0.00	3	3	1	0	0	0	0	0	0	0
5-Feb-94	0.01										
6-Feb-94	1.44										
7-Feb-94	0.71										
8-Feb-94	0.01										
9-Feb-94	0.00	1	1	9	5	0	0	1	2	0	0
10-Feb-94	0.18	1	1	16	5	0	0	1	1	0	0
11-Feb-94	0.00	1	1	8	4	0	0	1	0	0	0
12-Feb-94		1	1	3	1	0	1	0	0	0	0
13-Feb-94		1	1	4	5	0	0	0	0	0	0
14-Feb-94		1	1	4	2	0	0	0	0	0	0
15-Feb-94	0.00										
16-Feb-94	0.21										
17-Feb-94	0.68										
18-Feb-94	0.08										
19-Feb-94	1.02										
20-Feb-94	0.25										
21-Feb-94	0.23										
22-Feb-94	0.00										
23-Feb-94		1	1	9	3	0	0	2	1	1	0
24-Feb-94	0.00	1	3	3	1	0	0	0	0	0	0
25-Feb-94	0.02	1	1	0	0	0	0	0	0	0	0
26-Feb-94	0.03	1	1	0	1	0	0	0	0	0	0
27-Feb-94	0.03	1	1	0	0	0	0	1	0	0	0
28-Feb-94	0.00	1	1	1	0	0	0	3	0	0	0
1-Mar-94		1	1	5	1	0	0	0	0	0	0
2-Mar-94		1	1	11	1	0	0	1	0	0	0
3-Mar-94	0.00	3	1	5	1	0	0	1	0	0	0
4-Mar-94	0.01	1	1	5	0	0	0	0	0	0	0
5-Mar-94	0.02	1	3	6	1	0	0	1	0	0	0
6-Mar-94	0.00	3	1	11	2	0	0	0	0	0	0

Appendix 3-2-1. Santa Rosa Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
7-Mar-94		1	1	5	1	0	0	0	0	0	0
8-Mar-94		3	3	15	0	0	0	0	0	0	0
9-Mar-94		1	1	10	0	0	0	1	0	0	0
10-Mar-94		1	3	6	0	0	0	0	0	0	0
11-Mar-94		1	1	10	0	0	0	0	0	0	0
12-Mar-94		1	3	2	1	0	0	0	0	0	0
13-Mar-94		1	1	0	0	0	0	0	0	0	0
14-Mar-94		1	1	0	1	0	0	0	0	0	0
15-Mar-94	0.00	3	3	4	0	0	0	0	0	0	0
16-Mar-94	0.09	1	3	4	0	0	0	1	0	0	0
17-Mar-94	0.00	1	3	4	0	0	0	0	0	0	0
18-Mar-94	0.07	1	3	5	0	0	0	0	0	0	0
19-Mar-94	0.00	1	3	2	0	0	0	0	0	0	0
20-Mar-94		1	3	0	0	0	0	0	0	0	0
21-Mar-94											
22-Mar-94											
23-Mar-94											
24-Mar-94	0.00	1	1	1	0	0	0	0	0	0	0
25-Mar-94	0.21	1	3	2	0	0	0	1	0	0	0
26-Mar-94	0.00	1	1	2	0	0	0	0	0	0	0
27-Mar-94		1	3	1	0	0	0	0	0	0	0
28-Mar-94		1	1	0	0	0	0	0	0	0	0
29-Mar-94		1	1	3	0	0	0	0	0	0	0
30-Mar-94		1	1	1	0	0	0	0	0	0	0
31-Mar-94		1	3	1	0	0	0	0	0	0	0
1-Apr-94		1	1	2	0	0	0	0	0	0	0
2-Apr-94		3	4	6	0	0	0	0	0	0	0
3-Apr-94		1	3	1	0	0	0	0	0	0	0
4-Apr-94		1	1	4	1	0	0	0	0	0	0
5-Apr-94		3	3	1	0	0	0	0	0	0	0
6-Apr-94		1	1	2	0	0	0	0	0	0	0
7-Apr-94	0.00	3	1	4	0	0	0	0	0	0	0
8-Apr-94	0.61	2	2	1	0	0	0	1	0	0	0
9-Apr-94	0.00	1	1	25	0	0	0	1	0	0	0
10-Apr-94		1	1	11	0	0	0	0	0	0	0
11-Apr-94		1	1	33	0	0	0	0	0	0	0
12-Apr-94		1	1	13	1	0	0	0	0	0	0
13-Apr-94		1	3	2	1	0	0	0	0	0	0
14-Apr-94		1	1	0	0	0	0	1	0	0	0
15-Apr-94		3	3	0	0	0	0	1	0	0	0
16-Apr-94		1	3	2	0	0	0	0	0	0	0
17-Apr-94		1	1	2	0	0	0	0	0	0	0
18-Apr-94		1	3	2	0	0	0	0	0	0	0
19-Apr-94		1	1	0	0	0	0	0	0	0	0
20-Apr-94		1	1	0	0	0	0	0	0	0	0
21-Apr-94		1	1	8	0	0	0	0	0	0	0
22-Apr-94	0.00	1	3	0	0	0	0	0	0	0	0
23-Apr-94	0.45	2	2	2	0	0	0	0	0	0	0

Appendix 3-2-1. Santa Rosa Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
24-Apr-94	0.14	2	2	7	0	0	0	0	0	0	0
25-Apr-94	0.67	1		10		0		0		0	
26-Apr-94	0.00	4	1	2	0	0	0	0	0	0	0
27-Apr-94		1	1	0	0	0	0	0	0	0	0
28-Apr-94		1	1	7	0	0	0	0	0	0	0
29-Apr-94		1	1	0	0	0	0	0	0	0	0
30-Apr-94		1	1	1	0	0	0	0	0	0	0
1-May-94		1	1	0	0	0	0	0	0	0	0

Appendix 3-2-2. Mark West Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
14-Oct-93	1.4										
15-Oct-93	0.82	1	1	6	4	0	0	0	0	0	0
16-Oct-93	0.12	1	1	5	9	0	0	0	0	0	0
17-Oct-93	0										
18-Oct-93											
19-Oct-93											
20-Oct-93											
21-Oct-93											
22-Oct-93											
23-Oct-93											
24-Oct-93											
25-Oct-93											
26-Oct-93											
27-Oct-93											
28-Oct-93											
29-Oct-93											
30-Oct-93											
31-Oct-93											
1-Nov-93											
2-Nov-93											
3-Nov-93											
4-Nov-93											
5-Nov-93											
6-Nov-93											
7-Nov-93											
8-Nov-93											
9-Nov-93	0										
10-Nov-93	0.6										
11-Nov-93	0	3	3	3	1	0	0	0	0	0	0
12-Nov-93		1	1	1	2	0	0	0	0	0	0
13-Nov-93											
14-Nov-93											
15-Nov-93											
16-Nov-93											
17-Nov-93											
18-Nov-93											
19-Nov-93											
20-Nov-93											
21-Nov-93											
22-Nov-93											
23-Nov-93											
24-Nov-93											
25-Nov-93											
26-Nov-93	0										
27-Nov-93	0.06										
28-Nov-93	0.66										

Appendix 3-2-2. Mark West Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
29-Nov-93	2.02										
30-Nov-93	0.01	1	1	4	0	0	0	0	0	0	0
1-Dec-93	0	3	1	0	0	0	0	0	0	0	0
2-Dec-93		1	3	3	0	0	0	0	0	0	0
3-Dec-93		1	1	0	2	0	0	0	0	0	0
4-Dec-93		1	1	1	3	0	0	0	0	0	0
5-Dec-93	0	1	1	3	0	0	0	0	0	0	0
6-Dec-93	0.6	1	1	2	0	0	0	0	0	0	0
7-Dec-93	0.52	2	2	0	2	0	0	0	0	0	0
8-Dec-93	0.37										
9-Dec-93	0.01										
10-Dec-93	0.09										
11-Dec-93	1.31										
12-Dec-93	0.01										
13-Dec-93	0.69										
14-Dec-93	0.23										
15-Dec-93	0										
16-Dec-93											
17-Dec-93		1	1	6	11	0	0	0	0	0	0
18-Dec-93		1	1	1	5		0	0	0	0	0
19-Dec-93		1	1	0	7	0	0	0	0	0	0
20-Dec-93		1	1	0	4	0	0	0	0	0	0
21-Dec-93		1	1	2	3	0	1	0	0	0	0
22-Dec-93		1	1	2	4	0	1	0	0	0	0
23-Dec-93		1	1	1	3	0	0	0	0	0	0
24-Dec-93		1	1	0	0	0	0	0	0	0	0
25-Dec-93	0	1	1	0	1	0	0	0	0	0	0
26-Dec-93	0.06	1	1	0	0	0	0	0	0	0	0
27-Dec-93	0	1	1	0	0	0	0	0	0	0	0
28-Dec-93		1	1	0	0	0	0	0	0	0	0
29-Dec-93	0	1	1	0	0	0	0	0	0	0	0
30-Dec-93	0.02	1	1	0	1	0	0	0	0	0	0
31-Dec-93	0	1	1	0	2	0	0	0	0	0	0
1-Jan-94	0.07	1	1	0	1	0	1	0	0	0	0
2-Jan-94	0	1	1	0	1	0	0	0	0	0	0
3-Jan-94	0	1	1	0	0	0	0	0	0	0	0
4-Jan-94	0.19										
5-Jan-94	0.01	1	1	0	0	0	0	0	0	0	0
6-Jan-94	0	1	1	1	1	0	0	0	0	0	0
7-Jan-94	0	1	1	1	0	0	0	0	0	0	0
8-Jan-94	0.19	1	1	2	0	0	0	0	0	0	0
9-Jan-94	0	1	1	0	0	0	0	0	0	0	0
10-Jan-94		1	1	1	0	0	0	0	0	0	0
11-Jan-94		1	1	1	0	0	0	0	0	0	0
12-Jan-94		1	1	1	0	0	0	0	0	0	0
13-Jan-94		1	1	1	0	0	0	0	0	0	0

Appendix 3-2-2. Mark West Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
14-Jan-94		1	1	1	0	0	0	0	0	0	0
15-Jan-94		1	1	0	0	0	0	0	0	0	0
16-Jan-94		1	1	0	0	0	0	0	0	0	0
17-Jan-94		1	1	0	0	0	0	0	0	0	0
18-Jan-94		1	1	0	0	0	0	0	0	0	0
19-Jan-94		1	1	0	0	0	0	0	0	0	0
20-Jan-94	0	1	1	0	0	0	0	0	0	0	0
21-Jan-94	0.02										
22-Jan-94	0.17										
23-Jan-94	0.8										
24-Jan-94	0.88										
25-Jan-94	0.62										
26-Jan-94	0.14		2		1		0		0		0
27-Jan-94	0.00										
28-Jan-94		1	1	0	1	0	0	0	0	0	0
29-Jan-94		1	1	7	3	0	0	0	2	0	0
30-Jan-94		1	1	3	1	0	0	0	0	0	0
31-Jan-94		1	1	1	1	0	0	0	1	0	0
1-Feb-94		1	1	0	1	0	1	0	0	0	0
2-Feb-94		1	1	0	0	0	0	0	0	0	0
3-Feb-94		1	1	0	0	0	0	0	0	0	0
4-Feb-94	0.00	3	3	0	0	0	0	0	0	0	0
5-Feb-94	0.01										
6-Feb-94	1.44										
7-Feb-94	0.71										
8-Feb-94	0.01										
9-Feb-94	0.00	2	1	3	4	0	0	0	0	0	0
10-Feb-94	0.18	3	1	0	2	0	0	0	0	0	0
11-Feb-94	0.00	1	1	4	1	0	0	0	0	0	0
12-Feb-94		1	1	2	1	0	0	1	0	0	0
13-Feb-94		1	1	3	1	0	0	0	0	0	0
14-Feb-94		1	1	0	4	0	0	0	0	0	0
15-Feb-94	0.00										
16-Feb-94	0.21										
17-Feb-94	0.68										
18-Feb-94	0.08										
19-Feb-94	1.02										
20-Feb-94	0.25										
21-Feb-94	0.23										
22-Feb-94	0.00										
23-Feb-94			1		0		0		0		0
24-Feb-94	0.00	1	1	1	0	0	0	0	0	0	0
25-Feb-94	0.02	1	1	13	1	0	0	0	0	0	0
26-Feb-94	0.03	1	1	17	0	0	0	0	1	0	0
27-Feb-94	0.03	1	1	5	0	0	0	0	0	0	0
28-Feb-94	0.00	1	1	3	0	0	0	0	0	0	0

Appendix 3-2-2. Mark West Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
1-Mar-94		1	2	5	0	0	0	0	0	0	0
2-Mar-94		1	1	2	0	0	0	0	0	0	0
3-Mar-94	0.00	1	1	1	0	0	0	0	0	0	0
4-Mar-94	0.01	1	1	3	0	0	0	0	0	0	0
5-Mar-94	0.02	1	3	9	0	0	0	0	0	0	0
6-Mar-94	0.00	1	1	0	0	0	0	0	0	0	0
7-Mar-94		3	3	2	4	0	0	1	0	0	0
8-Mar-94		3	1	1	2	0	0	0	0	0	0
9-Mar-94		3	1	2	0	0	0	1	0	0	0
10-Mar-94		1	1	11	0	0	0	0	0	0	0
11-Mar-94		3	3	0	0	0	0	0	0	0	0
12-Mar-94		1	3	2	0	0	0	0	0	0	0
13-Mar-94		1	1	1	0	0	0	0	0	0	0
14-Mar-94		1	1	1	0	0	0	0	0	0	0
15-Mar-94	0.00	1	1	3	1	0	0	0	0	0	0
16-Mar-94	0.09	1	1	0	0	0	0	0	0	0	0
17-Mar-94	0.00	1	1	3	0	0	0	0	0	0	0
18-Mar-94	0.07	1	1	2	0	0	0	0	0	0	0
19-Mar-94	0.00	1	1	0	0	0	0	0	0	0	0
20-Mar-94		1	1	0	0	0	0	0	0	0	0
21-Mar-94											
22-Mar-94											
23-Mar-94											
24-Mar-94	0.00	1	1	4	0	0	0	1	0	0	0
25-Mar-94	0.21	1	1	4	0	0	0	0	0	0	0
26-Mar-94	0.00	1	1	2	0	0	0	0	0	0	0
27-Mar-94		3	3	0	0	0	0	0	0	0	0
28-Mar-94		3	1	0	0	0	0	0	0	0	0
29-Mar-94		1	1	1	1	0	0	0	0	0	0
30-Mar-94		1	1	0	0	0	0	0	0	0	0
31-Mar-94		1	1	1	0	0	0	0	0	0	0
1-Apr-94		2	1	1	0	0	0	0	1	0	0
2-Apr-94		1	1	0	0	0	0	0	0	0	0
3-Apr-94		1	1	6	0	0	0	0	0	0	0
4-Apr-94		1	1	11	0	0	0	0	0	0	0
5-Apr-94		1	1	6	1	0	0	0	0	0	0
6-Apr-94		1	1	7	0	0	0	0	0	0	0
7-Apr-94	0.00	1	1	8	1	0	0	0	0	0	0
8-Apr-94	0.61	2	1	1	0	0	0	4	3	0	0
9-Apr-94	0.00	1	1	24	1	0	0	1	0	0	0
10-Apr-94		3	3	3	0	0	0	0	1	0	0
11-Apr-94		3	1	20	0	0	0	0	0	0	0
12-Apr-94		3	1	24	0	0	0	1	0	1	0
13-Apr-94											
14-Apr-94		1	1	3	1	0	0	0	0	0	0
15-Apr-94		1	1	1	0	0	0	0	0	0	0

Appendix 3-2-2. Mark West Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
16-Apr-94		1	1	4	0	0	0	0	0	0	0
17-Apr-94		1	1	1	1	0	0	0	0	0	0
18-Apr-94		1	1	1	0	0	0	0	0	0	0
19-Apr-94		1	1	3	1	0	0	0	0	0	0
20-Apr-94		1	3	1	0	0	0	0	0	1	0
21-Apr-94		1	1	0	0	0	0	0	0	0	0
22-Apr-94	0.00	1	1	0	0	0	0	0	0	0	0
23-Apr-94	0.45	1	1	0	1	0	0	0	0	0	0
24-Apr-94	0.14	1	1	8	0	0	0	3	0	2	0
25-Apr-94	0.67	1	1	6	0	0	0	2	2	0	0
26-Apr-94	0.00	1	1	0	0	0	0	0	0	0	0
27-Apr-94		1	1	5	0	0	0	2	0	0	0
28-Apr-94		1	1	0	0	0	0	1	0	0	0
29-Apr-94		1	1	1	0	0	0	0	0	0	0
30-Apr-94		1	1	1	0	0	0	1	0	0	0
1-May-94		1	1	0	0	0	0	0	0	0	0

Appendix 3-2-3. Maacama Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon			
				Juveniles		Half-pounders		adults		Juveniles		adults	
date	rain, inches	net fishing? down	net fishing? up	down	up	down	up	down	up	down	up	down	up
26-Nov-93	0												
27-Nov-93	0.06												
28-Nov-93	0.66												
29-Nov-93	2.02												
30-Nov-93	0.01	1	1	10	1	0	0	0	0	0	0	0	0
1-Dec-93	0	1	1	5	2	0	0	0	0	0	0	0	0
2-Dec-93		1	1	6	5	0	0	0	0	0	0	0	0
3-Dec-93		1	1	0	9	0	0	0	0	0	0	0	0
4-Dec-93		1	1	8	4	0	0	0	0	0	0	0	0
5-Dec-93	0	1	1	0	0	0	0	0	0	0	0	0	0
6-Dec-93	0.6	1	1	2	4	0	0	0	0	0	0	0	0
7-Dec-93	0.52												
8-Dec-93	0.37												
9-Dec-93	0.01												
10-Dec-93	0.09												
11-Dec-93	1.31												
12-Dec-93	0.01	2	2	7	3	0	0	0	0	0	0	0	0
13-Dec-93	0.69												
14-Dec-93	0.23												
15-Dec-93	0												
16-Dec-93													
17-Dec-93													
18-Dec-93		1	1	12	18	0	0	0	0	0	0	0	0
19-Dec-93		1	1	7	15	0	0	0	0	0	0	0	0
20-Dec-93		1	1	5	14	0	0	0	0	0	0	0	0
21-Dec-93		1	1	10	7	0	0	0	0	0	0	0	0
22-Dec-93		1	1	4	7	0	0	0	0	0	0	0	0
23-Dec-93		1	1	5	11	2	0	0	0	0	0	0	0
24-Dec-93		1	1	6	17	0	0	0	0	0	0	0	0
25-Dec-93	0	1	1	7	10	0	0	0	0	0	0	0	0
26-Dec-93	0.06	1	1	1	1	0	0	0	0	0	0	1	0
27-Dec-93	0	1	1	0	4	0	0	0	0	0	0	0	0
28-Dec-93		1	1	0	0	0	0	0	0	0	0	0	0
29-Dec-93	0	1	1	0	0	0	0	0	0	0	0	0	0
30-Dec-93	0.02	1	1	0	5	0	0	0	0	0	0	0	0
31-Dec-93	0	1	1	4	1	0	0	0	0	0	0	0	0
1-Jan-94	0.07	1	1	0	5	0	0	0	0	0	0	1	1
2-Jan-94	0	1	1	0	2	0	0	0	0	0	0	0	0
3-Jan-94	0	1	1	1	0	0	0	0	0	0	0	1	0
4-Jan-94	0.19												
5-Jan-94	0.01	1	1	0	0	0	0	0	0	0	0	1	0
6-Jan-94	0	1	1	0	1	0	0	0	0	0	0	1	0
7-Jan-94	0	1	1	0	4	0	0	0	0	0	0	0	0
8-Jan-94	0.19	1	1	1	0	0	0	0	0	0	0	2	0
9-Jan-94	0	1	1	0	0	0	0	0	0	0	1	1	0
10-Jan-94		1	1	0	2	0	0	0	0	0	0	0	0

Appendix 3-2-3. Maacama Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon			
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles		adults	
date	inches	down	up	down	up	down	up	down	up	down	up	down	up
11-Jan-94		1	1	0	2	0	0	0	0	0	0	0	0
12-Jan-94		1	1	1	1	0	0	0	0	0	0	0	0
13-Jan-94		1	1	1	2	0	0	0	0	0	0	0	0
14-Jan-94		1	3	2	0	0	0	0	0	0	0	0	0
15-Jan-94		1	1	0	3	0	0	0	0	0	0	0	0
16-Jan-94		1	1	1	1	0	0	0	0	0	0	0	0
17-Jan-94		1	1	0	1	0	0	0	0	0	0	0	0
18-Jan-94		1	1	0	0	0	0	0	0	0	0	0	0
19-Jan-94		1	1	0	0	0	0	0	0	0	0	0	0
20-Jan-94	0	1	1	0	0	0	0	0	0	0	0	0	0
21-Jan-94	0.02												
22-Jan-94	0.17												
23-Jan-94	0.8												
24-Jan-94	0.88												
25-Jan-94	0.62												
26-Jan-94	0.14		2		9		0		0		0		0
27-Jan-94	0.00		2		0		0		0		0		0
28-Jan-94		1	1	2	1	0	0	0	3	0	0	0	0
29-Jan-94		1	1	3	1	0	0	0	4	0	0	0	0
30-Jan-94		1	1	5	0	0	0	0	1	0	0	0	0
31-Jan-94		1	1	0	2	0	0	0	0	0	0	0	0
1-Feb-94		1	1	4	0	0	0	1	0	0	0	0	0
2-Feb-94		1	1	0	0	0	0	0	0	0	0	0	0
3-Feb-94		1	1	3	1	0	0	0	0	0	0	0	0
4-Feb-94	0.00	1	1	4	1	1	0	0	0	0	0	0	0
5-Feb-94	0.01												
6-Feb-94	1.44												
7-Feb-94	0.71												
8-Feb-94	0.01												
9-Feb-94	0.00	2	1	2	0	0	0	0	0	0	0	0	0
10-Feb-94	0.18	2	1	7	0	0	0	0	0	0	0	0	0
11-Feb-94	0.00	1	2	10	1	0	0	1	0	0	0	0	0
12-Feb-94		1	1	2	2	0	0	0	0	3	0	0	0
13-Feb-94		1	1	0	4	0	0	0	0	0	0	0	0
14-Feb-94		1	1	0	1	0	0	0	2	0	0	0	0
15-Feb-94	0.00												
16-Feb-94	0.21												
17-Feb-94	0.68												
18-Feb-94	0.08												
19-Feb-94	1.02												
20-Feb-94	0.25												
21-Feb-94	0.23												
22-Feb-94	0.00												
23-Feb-94			2		3		0		0		0		0
24-Feb-94	0.00	2	1	0	0	0	0	0	0	0	0	0	0
25-Feb-94	0.02	2	1	0	0	0	0	0	0	0	0	0	0

Appendix 3-2-3. Maacama Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon			
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles		adults	
date	inches	down	up	down	up	down	up	down	up	down	up	down	up
26-Feb-94	0.03	1	1	1	0	0	0	0	0	0	0	0	0
27-Feb-94	0.03	1	1	0	0	0	0	0	0	0	0	0	0
28-Feb-94	0.00	1	1	3	0	0	0	0	0	0	0	0	0
1-Mar-94		3	1	0	0	0	0	0	0	0	0	0	0
2-Mar-94		1	3	6	0	0	0	1	0	0	0	0	0
3-Mar-94	0.00	3	1	0	0	0	0	0	0	0	0	0	0
4-Mar-94	0.01	1	3	5	0	0	0	0	1	1	0	0	0
5-Mar-94	0.02	2	2	2	1	0	0	0	1	0	0	0	0
6-Mar-94	0.00	1	3	14	0	0	0	1	1	1	0	0	0
7-Mar-94		1	1	7	0	0	0	0	1	0	0	0	0
8-Mar-94		3	3	15	0	0	0	0	2	1	0	0	0
9-Mar-94		1	3	11	1	0	0	0	1	2	0	0	0
10-Mar-94		1	1	2	1	0	0	0	0	1	0	0	0
11-Mar-94		3	3	4	0	0	0	0	0	0	0	0	0
12-Mar-94		1	3	2	0	0	0	0	0	0	0	0	0
13-Mar-94		1	3	14	0	0	0	0	0	0	0	0	0
14-Mar-94		1	3	15	3	0	0	0	0	2	0	0	0
15-Mar-94	0.00	1	1	24	0	0	0	0	0	7	0	0	0
16-Mar-94	0.09	1	1	23	0	0	0	1	0	4	0	0	0
17-Mar-94	0.00	1	1	18	0	0	0	0	0	0	0	0	0
18-Mar-94	0.07	1	1	16	0	0	0	0	2	1	0	0	0
19-Mar-94	0.00	1	1	14	0	0	0	0	0	1	0	0	0
20-Mar-94		1	1	4	0	0	0	0	1	1	0	0	0
21-Mar-94													
22-Mar-94													
23-Mar-94													
24-Mar-94	0.00	1	3	6	0	0	0	1	1	3	0	0	0
25-Mar-94	0.21	1	1	5	1	0	0	0	1	0	0	0	0
26-Mar-94	0.00	1	3	12	0	0	0	2	0	2	0	0	0
27-Mar-94		3	1	20	1	0	0	1	1	1	0	0	0
28-Mar-94		1	1	27	0	0	0	2	3	2	0	0	0
29-Mar-94		1	1	14	2	0	0	2	0	6	0	0	0
30-Mar-94		3	1	20	0	0	0	2	1	7	0	0	0
31-Mar-94		3	3	8	1	0	0	0	0	5	0	0	0
1-Apr-94		1	3	17	0	0	0	0	0	6	0	0	0
2-Apr-94		3	3	3	0	0	0	0	1	1	0	0	0
3-Apr-94		1	1	23	2	0	0	1	0	12	0	0	0
4-Apr-94		3	1	10	0	0	0	1	0	1	0	0	0
5-Apr-94		1	1	3	0	0	0	0	0	5	0	0	0
6-Apr-94		1	1	4	0	0	0	0	0	8	0	0	0
7-Apr-94	0.00	1	1	0	0	0	0	0	0	1	0	0	0
8-Apr-94	0.61	1	1	19	0	0	0	1	0	1	0	0	0
9-Apr-94	0.00	1	1	10	0	0	0	0	0	8	0	0	0
10-Apr-94		1	3	7	0	0	0	0	0	11	0	0	0
11-Apr-94		1	1	3	0	0	0	0	1	3	0	0	0
12-Apr-94		1	3	3	0	0	0	0	1	3	0	0	0

Appendix 3-2-3. Maacama Creek: Fyke Net Salmonid Catch, 1993-1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon			
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles		adults	
date	inches	down	up	down	up	down	up	down	up	down	up	down	up
13-Apr-94		1	1	0	1	0	0	0	0	6	0	0	0
14-Apr-94		3	1	10	0	0	0	0	0	3	0	0	0
15-Apr-94		1	3	10	0	0	0	0	0	12	0	0	0
16-Apr-94		1	3	3	0	0	0	0	0	5	0	0	0
17-Apr-94		1	1	4	0	0	0	0	0	2	0	0	0
18-Apr-94		3	3	4	0	0	0	0	0	4	0	0	0
19-Apr-94		1	1	0	1	0	0	0	0	1	0	0	0
20-Apr-94		3	1	0	0	0	0	0	0	0	0	0	0
21-Apr-94		1	1	0	0	0	0	0	0	0	0	0	0
22-Apr-94	0.00	1	1	1	0	0	0	0	0	0	0	0	0
23-Apr-94	0.45	1	1	1	0	0	0	0	0	2	0	0	0
24-Apr-94	0.14	1	1	0	1	0	0	3	0	0	0	0	0
25-Apr-94	0.67	3	1	1	0	0	0	2	0	2	0	0	0
26-Apr-94	0.00	1	1	2	0	0	0	0	0	3	1	0	0
27-Apr-94		1	1	1	0	0	0	0	0	2	0	0	0
28-Apr-94		1	1	0	0	0	0	0	0	7	1	0	0
29-Apr-94		1	1	1	0	0	0	0	0	2	0	0	0
30-Apr-94		1	3	0	0	0	0	0	0	0	0	0	0
1-May-94		1	1	1	0	0	0	0	0	1	1	0	0

Appendix 3-2-4. Laguna de Santa Rosa at River Road: Fyke Net Salmonid Catch, 1994.

down = fish moving downstream; up = fish moving upstream
Fishing? codes: 1 = OK; 2 = net overwhelmed or wings not down; 3 = hole(s) in net; 4 = tampering

				Steelhead Trout						Coho Salmon	
	rain,	net fishing?		Juveniles		Half-pounders		adults		Juveniles	
date	inches	down	up	down	up	down	up	down	up	down	up
16-Mar-94	0.09										
17-Mar-94	0.00										
18-Mar-94	0.07										
19-Mar-94	0.00	1	3	8	0	0	0	0	0	1	0
20-Mar-94		3	1	1	0	0	0	0	0	0	0
21-Mar-94											
22-Mar-94											
23-Mar-94											
24-Mar-94	0.00	1	3	1	1	0	0	2	1	0	0
25-Mar-94	0.21	1	1	2	0	0	0	1	1	1	1
26-Mar-94	0.00	1	1	3	0	0	0	2	0	0	0
27-Mar-94		3	3	0	1	0	0	0	0	1	0
28-Mar-94		1	1	0	0	0	0	1	0	0	0
29-Mar-94		1	3	1	0	0	0	0	0	0	0
30-Mar-94		1	1	1	0	0	0	0	0	2	0
31-Mar-94		3	3	0	1	0	0	0	0	0	0
1-Apr-94		1	3	5	0	0	0	0	0	2	0
2-Apr-94		3	1	1	1	0	0	0	0	0	0
3-Apr-94		1	3	2	3	0	0	0	0	3	0
4-Apr-94		3	1	0	0	0	0	0	0	0	0
5-Apr-94		1	3	2	0	0	0	0	0	0	0
6-Apr-94		1	1	1	0	0	0	1	0	1	0
7-Apr-94	0.00	3	3	2	0	0	0	0	0	0	0
8-Apr-94	0.61	2	2	2	1	0	0	0	1	0	0
9-Apr-94	0.00	1	1	68	1	0	0	3	1	0	0
10-Apr-94		1	1	10	3	0	0	0	0	0	0
11-Apr-94		3	1	4	0	0	0	0	0	0	0
12-Apr-94		3	1	0	1	0	0	0	0	0	0
13-Apr-94		1	1	21	0	0	0	0	0	6	0
14-Apr-94		1	1	5	0	0	0	0	0	1	0
15-Apr-94		3	3	0	0	0	0	0	0	0	0
16-Apr-94		3	3	2	0	0	0	0	0	0	0
17-Apr-94		3	3	0	0	0	0	0	0	0	0
18-Apr-94		3	3	0	0	0	0	0	0	0	0
19-Apr-94		1	1	1	0	0	0	0	0	0	0
20-Apr-94		1	1	0	0	0	0	0	0	0	0
21-Apr-94		1	1	0	0	0	0	0	0	0	0
22-Apr-94	0.00	3	1	0	0	0	0	0	0	0	0
23-Apr-94	0.45	1	1	32	1	0	0	0	1	0	0
24-Apr-94	0.14										
25-Apr-94	0.67										
26-Apr-94	0.00										
27-Apr-94											
28-Apr-94											
29-Apr-94											
30-Apr-94											

Appendix 3-3-1. Santa Rosa Creek: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
SRu1	16-Dec-93	m	620	clip	caudal fin eroded dorsal side
SRu2	28-Jan-94	m	690		caudal fin eroded ventral side
SRu3	28-Jan-94	f			did not measure
SRu4	28-Jan-94	f	650		split dorsal fin
SRu5	28-Jan-94	m	675	clip	
SRu6	28-Jan-94	f	630		caudal fin eroded ventral side
SRu7	28-Jan-94	f	640	clip	
SRu8	28-Jan-94	f	760		
SRu9	28-Jan-94	f	600	clip	
SRu10	29-Jan-94	f	678	punch	
SRu11	29-Jan-94	f	738	punch	
SRu12	9-Feb-94	m	615	punch	
SRu13	9-Feb-94	m	585	punch	small (bird?) wound
SRu14	10-Feb-94	f	520	punch	
SRu15	12-Feb-94	m	380	punch	half-pounder
SRu16	23-Feb-94	f	775	punch	caudal fin eroded ventral side

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
SRd1	19-Dec-94	m	335		half-pounder
SRd2	20-Dec-93	m	350		half-pounder
SRd3	28-Jan-94	m	650	clip	not spawned out
SRd4	1-Feb-94	f	738		this is SRu11; not spawned out
SRd5	9-Feb-94	f	660	punch	
SRd6	10-Feb-94	m	590		this is SRu13; not spawned out
SRd7	11-Feb-94	f	680	punch	caudal fin eroded dorsal side
SRd8	23-Feb-94	f	440	punch	not spawned out
SRd9	23-Feb-94	f	658	punch	not spawned out
SRd10	27-Feb-94	f	640	punch	spawned out
SRd11	28-Feb-94	f	750	punch	
SRd12	28-Feb-94	f	475		
SRd13	28-Feb-94	f	435		dead; spawned out; recapture of SRd8?
SRd14	2-Mar-94	f	755	punch	spawned out; caudal fin eroded dorsal side
SRd15	3-Mar-94	f	690	punch	spawned out; caudal fin eroded dorsal side
SRd16	5-Mar-94	m	630	punch	spawned out; kype broken off
SRd17	9-Mar-94	f	630	punch	spawned out
SRd18	16-Mar-94	f	550		small wound on caudal peduncle
SRd19	25-Mar-94	m	648	punch	spawned out
SRd20	8-Apr-94	m	640	punch & a.c.	spawned out; kype broken off
SRd21	9-Apr-94	m	540	a.c.	spawned out
SRd22	14-Apr-94	m	500		dead; spawned out; small wound on head
SRd23	15-Apr-94	f	550	a.c.	spawned out

Appendix 3-3-2. Mark West Creek: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
MWu1	21-Dec-93	m	300		half-pounder; wound on head
MWu2	22-Dec-93	m	312	clip	half-pounder
MWu3	1-Jan-94	m	243	clip	half-pounder
MWu4	29-Jan-94	f	570	clip	wound on peduncle
MWu5	29-Jan-94	m	680	clip	bruises
MWu6	31-Jan-94	f	669	punch	caudal fin eroded dorsal side; bird pecks
MWu7	1-Feb-94	m	310	punch	half-pounder
MWu8	26-Feb-94	m	660		poor cond; 3 fins missing
MWu9	1-Apr-94	m	678	punch	ripe
MWu10	8-Apr-94	f	548	a.c.	ripe
MWu11	8-Apr-94	f	722	a.c.	ripe
MWu12	8-Apr-94	f	550	a.c.	ripe
MWu13	10-Apr-94	f	500		dead; partially eaten
MWu14	25-Apr-94	f	565	a.c.	ripe
MWu15	25-Apr-94	m	525	a.c.	ripe; dorsal lobe of caudal fin deformed

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
MWd1	12-Feb-94	m	690	punch	
MWd2	7-Mar-94	m	640		spawned out; poor cond.
MWd3	9-Mar-94	f	680		spawned out; dead
MWd4	24-Mar-94	f	575	punch	spawned out
MWd5	8-Apr-94	f	669	punch & a.c.	spawned out; dorsal and caudal fins eroded
MWd6	8-Apr-94	f	520	punch & a.c.	spawned out
MWd7	8-Apr-94	f	671	punch & a.c.	spawned out
MWd8	8-Apr-94	f	630	punch & a.c.	spawned out
MWd9	9-Apr-94	f	575	punch & a.c.	spawned out
MWd10	12-Apr-94	m	710	punch & a.c.	spawned out
MWd11	24-Apr-94	m	565	punch & a.c.	spawned out
MWd12	24-Apr-94	f	678	punch & a.c.	spawned out
MWd13	24-Apr-94	f	640	punch & a.c.	spawned out; wound on snout
MWd14	25-Apr-94	f	715	punch & a.c.	spawned out
MWd15	25-Apr-94	m	665	punch & a.c.	spawned out
MWd16	27-Apr-94	f	640	punch & a.c.	spawned out
MWd17	27-Apr-94	?	700		spawned out?
MWd18	28-Apr-94	m	530		this is MWu15; spawned out; left eye ruptured
MWd19	30-Apr-94	?			not measured; spawned out?

Appendix 3-3-3. Maacama Creek: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
MAu1	28-Jan-94	f	650		
MAu2	28-Jan-94	m	710		hatchery fin
Mau3	28-Jan-94	m	640		
MAu4	29-Jan-94	m	620		bruises
MAu5	29-Jan-94	m	740	punch	
MAu6	29-Jan-94	f	660	punch	mark on right side
MAu7	29-Jan-94	f	650	punch	
MAu8	30-Jan-94	f	659		notch in dorsal lobe of caudal fin; rt eye distended
MAu9	14-Feb-94	f	680	punch	
MAu10	14-Feb-94	f	645	punch	
MAu11	4-Mar-94	?			escaped
MAu12	5-Mar-94	m	550	punch	
MAu13	6-Mar-94	m	745	punch	caudal fin eroded on ventral lobe
MAu14	7-Mar-94	f	492	punch	not spawned out
MAu15	8-Mar-94	f	670	punch	not spawned out
MAu16	8-Mar-94	m	547		hatchery fin; not spawned out
MAu17	9-Mar-94	m	660		previously punched lower; is this MAd5? hatchery fin; not spawned
MAu18	18-Mar-94	f	514	punch	not spawned out
MAu19	18-Mar-94	m	517	punch	not spawned out
MAu20	20-Mar-94	f	645	punch	hatchery fin; not spawned out
MAu21	24-Mar-94	m	585	punch	not spawned out
MAu22	25-Mar-94	f	700	punch	spawned out
MAu23	27-Mar-94	f	648	punch	spawned out
MAu24	28-Mar-94	f	520	punch	ripe; eggs eyed
MAu25	28-Mar-94	m	571	punch(2)	ripe
MAu26	28-Mar-94	m	459	punch	ripe
MAu27	29-Mar-94	m	480		this is MAd13; not spawned out
MAu28	29-Mar-94	m	482	punch	ripe
MAu29	30-Mar-94	f	560	punch	ripe
MAu30	2-Apr-94	f	590	punch	hatchery fin; ripe
MAu31	11-Apr-94	m	505	punch	hatchery fin; ripe
MAu32	12-Apr-94	m	540	punch(2)	hatchery fin; ripe

Appendix 3-3-2. Mark West Creek: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
MWu1	21-Dec-93	m	300		half-pounder; wound on head
MWu2	22-Dec-93	m	312	clip	half-pounder
MWu3	1-Jan-94	m	243	clip	half-pounder
MWu4	29-Jan-94	f	570	clip	wound on peduncle
MWu5	29-Jan-94	m	680	clip	bruises
MWu6	31-Jan-94	f	669	punch	caudal fin eroded dorsal side; bird pecks
MWu7	1-Feb-94	m	310	punch	half-pounder
MWu8	26-Feb-94	m	660		poor cond; 3 fins missing
MWu9	1-Apr-94	m	678	punch	ripe
MWu10	8-Apr-94	f	548	a.c.	ripe
MWu11	8-Apr-94	f	722	a.c.	ripe
MWu12	8-Apr-94	f	550	a.c.	ripe
MWu13	10-Apr-94	f	500		dead; partially eaten
MWu14	25-Apr-94	f	565	a.c.	ripe
MWu15	25-Apr-94	m	525	a.c.	ripe; dorsal lobe of caudal fin deformed

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
MWd1	12-Feb-94	m	690	punch	
MWd2	7-Mar-94	m	640		spawned out; poor cond.
MWd3	9-Mar-94	f	680		spawned out; dead
MWd4	24-Mar-94	f	575	punch	spawned out
MWd5	8-Apr-94	f	669	punch & a.c.	spawned out; dorsal and caudal fins eroded
MWd6	8-Apr-94	f	520	punch & a.c.	spawned out
MWd7	8-Apr-94	f	671	punch & a.c.	spawned out
MWd8	8-Apr-94	f	630	punch & a.c.	spawned out
MWd9	9-Apr-94	f	575	punch & a.c.	spawned out
MWd10	12-Apr-94	m	710	punch & a.c.	spawned out
MWd11	24-Apr-94	m	565	punch & a.c.	spawned out
MWd12	24-Apr-94	f	678	punch & a.c.	spawned out
MWd13	24-Apr-94	f	640	punch & a.c.	spawned out; wound on snout
MWd14	25-Apr-94	f	715	punch & a.c.	spawned out
MWd15	25-Apr-94	m	665	punch & a.c.	spawned out
MWd16	27-Apr-94	f	640	punch & a.c.	spawned out
MWd17	27-Apr-94	?	700		spawned out?
MWd18	28-Apr-94	m	530		this is MWu15; spawned out; left eye ruptured
MWd19	30-Apr-94	?			not measured; spawned out?

Appendix 3-3-3. Maacama Creek: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
MAd1	23-Dec-94	m	330	clip	half-pounder
MAd2	23-Dec-94	m	275	clip	half-pounder
MAd3	1-Feb-94	m	700	punch	this is MAu2; not spawned out
MAd4	4-Feb-94	m	266		half-pounder
MAd5	11-Feb-94	m	644	punch	
MAd6	2-Mar-94	m	540	punch	
MAd7	6-Mar-94	m	718		this is MAu2/MAd3; spawned out
MAd8	16-Mar-94	f	630	punch	spawned out
MAd9	24-Mar-94	m	620	punch	spawned out; kype worn off
MAd10	26-Mar-94	m	810		previously punched upper lobe; is this MAu4? spawned out
MAd11	26-Mar-94	m	681	punch	spawned out
MAd12	27-Mar-94	f	545	punch	spawned out?
MAd13	28-Mar-94	m	475	punch	not spawned out
MAd14	28-Mar-94	m	535	punch	spawned out; poor cond
MAd15	29-Mar-94	m	460		this is MAu26; not spawned out
MAd16	29-Mar-94	m	690		spawned out; poor condition
MAd17	30-Mar-94	m	480		this is MAu28; ripe
MAd18	30-Mar-94	m	678	punch	spawned out
MAd19	3-Apr-94	f		punch	not measured; spawned out
MAd20	4-Apr-94	f	690		previously punched upper; is this MAu22? spawned out
MAd21	8-Apr-94	f	555		spawned out?
MAd22	24-Apr-94	?			not measured; spawned out?
MAd23	24-Apr-94	?			not measured; spawned out?
MAd24	24-Apr-94	?			not measured; spawned out?
MAd25	25-Apr-94	m	630	punch	spawned out
MAd26	25-Apr-94	f	618	punch	spawned out

Appendix 3-3-4. Maacama Creek: Coho Salmon Adults Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
MAuc1	1-Jan-94	f	710		ripe?

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
MAdc1	26-Dec-93	f	610		spawned out; dead
MAdc2	1-Jan-94	f	615		spawned out; alive
MAdc3	3-Jan-94	m	565		spawned out; dead
MAdc4	5-Jan-94	m	535		spawned out? dead
MAdc5	6-Jan-94	m	670		ripe; alive
MAdc6	8-Jan-94	m	550		ripe; alive
MAdc7	8-Jan-94	m	710		ripe; alive
MAdc8	9-Jan-94	m	680		spawned out; dead

Appendix 3-3-5. Laguna de Santa Rosa at River Road: Steelhead Adults and Half-pounders Captured, 1993-1994.

Fish moving upstream					
#	Date	sex	F.L.	Marked?	Remarks
LAu1	24-Mar-94	?	550	punch	
LAu2	25-Mar-94	m	669	punch(2)	spawned out
LAu3	8-Apr-94	m	478	punch	ripe
LAu4	9-Apr-94	m	515	punch	
LAu5	23-Apr-94	f	572		green; notch in adipose fin

Fish moving downstream					
#	Date	sex	F.L.	Marked?	Remarks
LAd1	24-Mar-94	f	680		spawned out
LAd2	24-Mar-94	f	545		spawned out
LAd3	25-Mar-94	f	685	punch(2)	spawned out
LAd4	26-Mar-94	f	650		prev. punched lower;is this SRd17? spawned out
LAd5	26-Mar-94	m	648		prev. punched lower; this is SRd19; spawned out
LAd6	28-Mar-94	m	665		this is LAu2; spawned out
LAd7	6-Apr-94	f	640		spawned out; damaged tail
LAd8	9-Apr-94	f	510		spawned out
LAd9	9-Apr-94	m	640		prev. punched lower & adipose; this is SRd20; spawned out
LAd10	9-Apr-94	m	525		prev. punched lower & adipose; is this MWd6? (sexed wrong?)

Appendix 3-4. Adult Steelhead Recapture Summary.

Capture Date	#	sex	capture		recapture		Days elapsed	Remarks
			site	direction	site	direction		
Marked in Santa Rosa Creek, Recaptured in Santa Rosa Creek								
29-Jan	SRu11	f	SRC	up	SRC	down	3	came up ripe, went down ripe
9-Feb	SRu13	m	SRC	up	SRC	down	1	came up ripe, went down ripe
23-Feb	SRd8	f	SRC	down	SRC	down	5	went down ripe; not caught going back up; went down spent
Marked in Mark West Creek, Recaptured in Mark West Creek								
25-Apr	MWu15	m	MWC	up	MWC	down	3	came up ripe, went down spent
Marked in Maacama Creek, Recaptured in Maacama Creek								
28-Jan	MAu2	m	MAAC	up	MAAC	down	1	hatchery fish; came up ripe, went down ripe
					MAAC	down	33	not caught going back up; went down spent
29-Jan	MAu4	m	MAAC	up	MAAC	down	56	?;came up ripe, went down spent
11-Feb	MAd5	m	MAAC	down	MAAC	up	26	?; hatchery fish; went down ripe; came back up ripe
25-Mar	MAu22	f	MAAC	up	MAAC	down	10	came up spent, went down spent
28-Mar	MAu26	m	MAAC	up	MAAC	down	1	came up ripe, went down ripe
28-Mar	MAd13	m	MAAC	down	MAAC	up	1	went down ripe; came back up ripe
29-Mar	MAu28	m	MAAC	up	MAAC	down	1	came up ripe, went down ripe
Marked in Lower Laguna, Recaptured in Lower Laguna								
25-Mar	LAu2	m	LAG	up	LAG	down	3	came up spent, went down spent
Marked in Santa Rosa Creek, Recaptured in Lower Laguna								
9-Mar	SRd17	f	SRC	down	LAG	down	17	?; went down spent, continued down spent
25-Mar	SRd19	f	SRC	down	LAG	down	1	went down spent, continued down spent
8-Apr	SRd20	m	SRC	down	LAG	down	1	went down spent, continued down spent
Marked in Mark West Creek, Recaptured in Lower Laguna								
8-Apr	MWd6	?	MWC	down	LAG	down	1	went down spent, continued down spent

Appendix 3-5-1. Santa Rosa Creek: Fork length-frequency (mm) of steelhead smolts captured moving downstream in fyke nets, by two-week intervals, 1993-1994.

interval	11-Oct 24-Oct	25-Oct 7-Nov	8-Nov 21-Nov	22-Nov 5-Dec	6-Dec 19-Dec	20-Dec 2-Jan	3-Jan 16-Jan	17-Jan 30-Jan	31-Jan 13-Feb	14-Feb 27-Feb	28-Feb 13-Mar	14-Mar 27-Mar	28-Mar 10-Apr	11-Apr 24-Apr	25-Apr 8-May
days fished	2	0	2	4	7	14	13	7	10	6	14	11	14	14	7
total fish	14	0	7	16	146	58	44	35	48	16	92	25	59	71	20
fish per day	7		3.5	4.0	20.9	4.1	3.4	5.0	4.8	2.7	6.6	2.3	4.2	5.1	2.9
50-54															
55															
60					1										
65					2										
70				1	1										
75		AGE 1			3										
80					5		1				1				
85					2	1		1							
90				1	4	1	4		2						
95					6		5	1	1		2				
100				1	9	5	4	4	1						
105					5	5	7	7	3	1					
110				1	2	5	2	4	1				1		
115	1			2	1	1	4	2			1				
120			4	1	7	4	2	2			1		1		
125	3			2	4	7	2	2	3	1	1	2			
130	1			1	5	5	2	2	3		4	1	1		1
135	4				3	1	1		6	1	3		1	1	
140	2		1	2	4		3	1	1	1	1	1	1	2	
145	2				2	4	1	1		2	3	1	3	3	
150					7	2	1	1	6	1	4		5	1	
155				1	3	4			2		2	2	4	9	2
160			1	1	9	1	1	1	2	1	5	1	2	3	3
165				1	12	3	1	1		1	6	1	7	13	5
170	1				9	2			3	1	3	7	8	9	3
175		AGE 2			7	2	2		1	1	3	1	3	9	
180				1	9			2	1	1	7	4	6	5	3
185					8				4		3		2	7	1
190					6		1		2	2	7	2	3	5	1
195					3	1					6		4	1	
200					3	1		2	1	1	6	1	2	2	1
205					1			1			8		1		
210					2	1			1	1	6	1		1	
215					1	2			1		4				
220											2		2		
225		AGE 3							1				1		
230									1		1		1		
235															
240															
245											1				
250											1				
255															
260															
265															
270			1						1						
275		AGE 4													
280															
285															
290															
295															
300															
age 1 mean	122.5		121.0	109.2	102.7	116.4	107.7	111.5	120.6	124.7	121.4	127.7	125.5	135.0	134.0
age 2 mean	141.7		151.5	154.4	171.3	162.5	158.2	170.6	170.1	170.6	183.8	172.5	172.9	172.3	172.1
age 3 mean					211.8	215.3		206.0	221.5	214.0	227.0		226.3		
age 4 mean			270.0						272.0						

Appendix 3-5-2. Mark West Creek: Fork length-frequency (mm) of steelhead smolts captured moving downstream in fyke nets, by two-week intervals, 1993-1994.

interval	11-Oct 24-Oct	25-Oct 7-Nov	8-Nov 21-Nov	22-Nov 5-Dec	6-Dec 19-Dec	20-Dec 2-Jan	3-Jan 16-Jan	17-Jan 30-Jan	31-Jan 13-Feb	14-Feb 27-Feb	28-Feb 13-Mar	14-Mar 27-Mar	28-Mar 10-Apr	11-Apr 24-Apr	25-Apr 8-May
days fished	2	0	3	6	5	14	13	7	10	5	14	11	14	13	7
total fish	11	0	7	11	7	9	9	10	12	36	42	19	64	66	13
fish per day	5.5		2.3	1.8	1.4	0.6	0.7	1.4	1.2	7.2	3.0	1.7	4.6	5.1	1.9
50-54															
55															
60															
65															
70															
75		AGE 1													
80															
85	1				1										
90	1		1	3				1	1	1					
95	1		1	1		1			2						
100	1		1		1	1		1			1				
105	2			4			2	2			1				
110				1			1	1		3					
115													1	1	
120										1				1	
125							1			1	1				
130				1					1		1	1		1	
135							1			1	1		1	1	
140			1		1				1	1			2	9	
145					1	1	1				1	1	1	1	
150					1					2	4	4	5	7	2
155						1				1	3	3	8	4	1
160		AGE 2							1	1	2	1	7	1	4
165	1									1	1	1	9	7	1
170								1		4	5	2	8	11	2
175	1					1		1	1	4	1		5	4	1
180			1			1			1	4	6	2	3	5	
185											1	3	4	1	
190							2		1	1	4		3	5	
195										3	3	1	4	2	1
200	1		1					1		1	1		1		
205						1	1		2	2	2				
210											1			1	
215						1		1		2				1	
220	1				1	1		1	1		2		1	2	
225		AGE 3											1		
230										1					
235															
240										1					
245														1	
250															
255															
260															
265															1
270		AGE 4													
275															
280															
285	1														
290															
295			1	1											
300					1										
age 1 mean	97.8		96.7	100.6	95.5	100.0	112.8	104.0	96.0	112.0	121.2	132.0	136.3	135.8	
age 2 mean	180.0		175.7	131.0	147.0	166.3	168.0	183.7	164.7	174.8	174.4	168.6	170.8	170.8	166.4
age 3 mean	220.0				223.0	216.0	208.0	220.5	212.0	220.5	213.2		225.0	224.6	
age 4 mean	286.0		296.0	295.0	300.0										273.0

Appendix 3-5-3. Maacama Creek. Fork length-frequency (mm) of steelhead smolts captured moving downstream in fyke nets, by two-week intervals, 1993-1994

interval	11-Oct 24-Oct	25-Oct 7-Nov	8-Nov 21-Nov	22-Nov 5-Dec	6-Dec 19-Dec	20-Dec 2-Jan	3-Jan 16-Jan	17-Jan 30-Jan	31-Jan 13-Feb	14-Feb 27-Feb	28-Feb 13-Mar	14-Mar 27-Mar	28-Mar 10-Apr	11-Apr 24-Apr	25-Apr 8-May
days fished	0	0	0	6	5	14	13	7	10	5	14	11	14	14	7
total fish	0	0	0	29	28	43	7	10	33	1	84	157	164	37	6
fish per day				4.8	5.6	3.1	0.5	1.4	3.3	0.2	6.0	14.3	11.7	2.6	0.9
50-54					1										
55															
60															
65															
70															
75					1										
80		AGE 1			2	1									
85				1	1	1		2							
90				3	2	1		1	1						
95				5	3	4			1						
100				1	1	1					2	3			
105				4	3	2		1				3			
110				3	1	1		1	2		1	6			
115				4	1	1		2	1				1		
120				1	2	2			2		4		1		
125				2	1	2	1		1		4	4	2		
130				1					1		3	3	1		
135				1		1		1	2		3	1	3	1	
140				1	1						1	7	7	2	
145					1	1			2		9	6	8	1	
150					1			2	3		3	13	12	3	
155				1					3		7	21	21	2	
160						3			1	1	5	16	17	4	
165		AGE 2				1	1		2		7	19	13	5	2
170					4	1			2		8	11	15	8	
175						5	1				9	14	18	3	
180				1		5			1		8	9	7	6	
185						3					5	8	11	1	
190					1	1			1		1	3	7	1	1
195						3	1		1			5	9		
200					1	1						2	4		3
205											3	1	2		
210									3				2		
215									1			1	1		
220						1	1								
225															
230		AGE 3					1						1		
235						1			1				1		
240															
245											1				
250															
255												1			
260															
265									1						
270															
275		AGE 4				1									
280															
285															
290															
295															
300															
age 1 mean				106.2	99.0	106.1	120.0	102.9	115.0		124.9	117.0	123.6	138.0	
age 2 mean				150.6	169.6	177.8	180.7	147.3	169.2	163.0	169.5	167.2	170.3	168.5	187.5
age 3 mean						230.0	226.0		228.5		245.0	215.0	235.0		
age 4 mean						275.0			266.0			255.0			

Appendix 3-5-4. Juvenile Coho Salmon Captured in Fyke Nets in the Laguna de Santa Rosa and its Tributaries, 1993-1994.

Fish Caught in Santa Rosa Creek moving upstream			
#	date	F.L.	remarks
c1	16-Dec-93	120*	wild
c2	31-Dec-93	102	wild
c3	12-Jan-93	116	wild

Fish Caught in Santa Rosa Creek moving downstream			
c4	23-Feb-94	139	wild

Fish Caught in Mark West Creek moving downstream			
c5	12-Apr-94	120	wild
c6	20-Apr-94	121	wild
c7	24-Apr-94	125	wild
c8	24-Apr-94	115	wild

Fish Caught in Lower Laguna moving upstream			
c9	25-Mar-94	139	hatchery; adipose fin clipped

Fish Caught in Lower Laguna moving downstream			
c10	19-Mar-94	150	hatchery; adipose fin clipped
c11	25-Mar-94	169	hatchery; adipose fin clipped
c12	27-Mar-94	153	hatchery; adipose fin clipped
c13	30-Mar-94	178	hatchery; adipose fin clipped
c14	30-Mar-94	166	hatchery; adipose fin clipped
c15	1-Apr-94	168	hatchery; adipose fin clipped, nose tag
c16	1-Apr-94	164	hatchery; adipose fin clipped, nose tag
c17	3-Apr-94	185	hatchery; adipose fin clipped
c18	3-Apr-94	175	hatchery; adipose fin clipped
c19	3-Apr-94	160	hatchery; adipose fin clipped
c20	6-Apr-94	160	hatchery; adipose fin clipped, nose tag
c21	13-Apr-94	120	wild
c22	13-Apr-94	115	wild
c23	13-Apr-94	110	wild
c24	13-Apr-94	126	wild
c25	13-Apr-94	134	wild
c26	13-Apr-94	140*	wild
c27	14-Apr-94	135	wild

*length estimated

Appendix 3-5-5. Maacama Creek: Fork length-frequency (mm) of coho smolts captured moving downstream in fyke nets, by two week intervals, 1993-1994.

interval	11-Oct 24-Oct	25-Oct 7-Nov	8-Nov 21-Nov	22-Nov 5-Dec	6-Dec 19-Dec	20-Dec 2-Jan	3-Jan 16-Jan	17-Jan 30-Jan	31-Jan 13-Feb	14-Feb 27-Feb	28-Feb 13-Mar	14-Mar 27-Mar	28-Mar 10-Apr	11-Apr 24-Apr	25-Apr 8-May
days fished	0	0	0	6	5	14	13	7	6	5	14	11	14	14	7
total fish	0	0	0	0	0	0	0	0	3	0	4	21	74	40	14
fish per day									0.5		0.3	1.9	5.3	2.9	2.0
50-54															
55													AGE 0	1	
60															
65															1
70															
75															
80															
85															
90									1		1				
95									1				1		
100									1		1	4	2		
105												1	3	1	
110												4	9	2	2
115											1	3	5	2	2
120												2	9	7	3
125								AGE 1				3	9	7	2
130												3	5	5	2
135												1	6	1	1
140													1	2	
145													9		1
150													3	2	
155											1		1		
160													1		
165													1	1	
170															
175															
180															
185															
190															
195															
200															
205															
210															
215															
220															
225															
230															
235															
240															
245															
250															
255															
260															
265															
270															
275															
280															
285															
290															
295															
300															
age 0 mean														56.0	66.0
age 1 mean									97.7		116.8	116.9	130.2	130.6	125.3

Appendix 3-6. Fyke Net Fishing Effectiveness Summary.

	Santa Rosa Creek				Mark West Creek			
	moving downstream		moving upstream		moving downstream		moving upstream	
	no.	%	no.	%	no.	%	no.	%
days fishing OK	104	81	87	67	106	86	112	90
days overwhelmed	7	5	9	7	4	3	3	2
days with holes	16	13	31	24	13	11	10	8
days over & holes	0	0	1	1	0	0	0	0
days tampering	1	1	1	1	0	0	0	0
total	128	100	129	100	123	100	125	100

	Maacama Creek				Lower Laguna			
	moving downstream		moving upstream		moving downstream		moving upstream	
	no.	%	no.	%	no.	%	no.	%
days fishing OK	100	84	95	78	19	58	19	58
days overwhelmed	6	5	6	5	1	3	1	3
days with holes	13	11	21	17	13	39	13	39
days over & holes	0	0	0	0	0	0	0	0
days tampering	0	0	0	0	0	0	0	0
total	119	100	122	100	33	100	33	100

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Oct-93				Nov-93					Dec-93								
		15		16		11		12		30	1	2	3	4	5	6	7	12	14
		up	dn	up	dn	up	dn	up	dn	up dn	up dn	up dn	up dn	up dn	up dn	up dn	up dn	up dn	up dn
Petromyzontidae																			
Pacific lamprey	*Lampetra tridentata*																		
Salmonidae																			
Coho salmon juvenile	*Onchorhynchus kisutch*																		
Steelhead adult	*Onchorhynchus mykiss*																		
Steelhead half-pounder	*Onchorhynchus mykiss*																		
Steelhead juvenile	*Onchorhynchus mykiss*	1	13		1		7			3	9	2		2			2	6 44	2 1
Cyprinidae																			
California roach	*Hesperoleucus symmetricus*	88	206	1	65	84	530	1	5	4 512	14 103	1	14		1		1 1	2	3 190	2 1
Sacramento blackfish	*Orthodon microlepidotus*	12	24			1	5			4	31		1						2
Sacramento squawfish	*Ptychocheilus grandis*																		
Hitch	*Lavinia exilicauda*																		
Carp	*Cyprinus carpio*	1																	
Goldfish	*Carassius auratus*									1									
Golden shiner	*Notemigonus crysoleucas*				1														
Fathead minnow	*Pimephales promelas*									2									
Catostomidae																			
Sacramento sucker	*Catostomus occidentalis*	40	80		3	5	42	1	7	37	63	4		1		1 1	3	88	
Ictaluridae																			
Black bullhead	*Ictalurus melas*									1									
Brown bullhead	*Ictalurus nebulosus*																		
White catfish	*Ictalurus catus*									1									
Yellow bullhead	*Ictalurus natalis*	4	10		5		6				1								
Poeciliidae																			
Mosquitofish	*Gambusia affinis*																		
Gasterosteidae																			
Threespine stickleback	*Gasterosteus aculeatus*																		
Centrarchidae																			
Bluegill	*Lepomis macrochirus*	11	17		5	9	23		2	1 25	1 22		8		2		1	15	1
Green sunfish	*Lepomis cyanellus*	10	21	3	5		12		1	2 18	6		1					1	
Largemouth bass	*Micropterus salmoides*		3				1												
Black crappie	*Pomoxis nigromaculatus*																	1	
Embiotocidae																			
Tule perch	*Hysterocarpus traski*	2	4				3			1									
Cottidae																			
Coastrange sculpin	*Cottus aleuticus*			1					1										
Prickly sculpin	*Cottus asper*																		
Other Vertebrata																			
Mallard	*Anas platyrhynchos*																		
Black-crowned night heron	*Nycticorax nycticorax*														1				
Western pond turtle	*Clemmys marmorata*				1				1				1						
Pond slider	*Pseudemys scripta*																		
Bullfrog	*Rana catesbeiana*		1																
Bullfrog tadpole	*Rana catesbeiana*	1	35	6	5	3	1	3	5	7		10	7	5 18	1 5		1	3	
Foothill yellow-legged frog	*Rana boylii*																		
Mink	*Mustela vison*																		

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Dec-93																							
		16		17		18		19		20		21		22		23		24		25		26		27		28		29	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*									1																	
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*	1																									
Steelhead adult	*Onchorhynchus mykiss*	1																									
Steelhead half-pounder	*Onchorhynchus mykiss*								1		1																
Steelhead juvenile	*Onchorhynchus mykiss*	11	38	2	32	1	22	8	10	11	12	5	7			3	1	1	3	1			3	1	1	3		4	5
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	5	35	1	7		11	1	11		7		3						1	2	1		3		2		3		2
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*																										
Goldfish	*Carasslus auratus*																										
Golden shiner	*Notemigonus crysoleucas*										1																
Fathead minnow	*Pimephales promelas*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*	2	44		9		3		2		6		1						2				1						
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*																										
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*								1																		
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*																			1							
Centrarchidae																											
Bluegill	*Lepomis macrochirus*		8						1				1														
Green sunfish	*Lepomis cyanellus*																			1							
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*																										
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*		1		3		16		3				4				1						7		9		11	2	5
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Dec-93				Jan-94																			
		30		31		1		2		3		5		6		7		8		9		10		11		12		13	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*			1																				1			
Steelhead adult	*Onchorhynchus mykiss*																										
Steelhead half-pounder	*Onchorhynchus mykiss*																										
Steelhead juvenile	*Onchorhynchus mykiss*	1	1	7		8	6	19	11	7	14	20	8	4	12	5	1	4	2	10	4	2		1	4		2	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*		1		1		6	4	23		2	6		1	6	1	2		3	1	1	7	3		2	18			4
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*																										
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*						1		1						2	1	1											
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*																										
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*																										
Centrarchidae																											
Bluegill	*Lepomis macrochirus*							1																			
Green sunfish	*Lepomis cyanellus*													1													
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*						1									1		1									
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*		3	1	5	1	1	1	4			1			1				1		2			1			5
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94																								Feb-94			
		14		15		16		17		18		19		20		26	27	28		29		30		31		1		2	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	up	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																												
Salmonidae																													
Coho salmon juvenile	*Onchorhynchus kisutch*																												
Steelhead adult	*Onchorhynchus mykiss*																	8	1	2						1			
Steelhead half-pounder	*Onchorhynchus mykiss*																												
Steelhead juvenile	*Onchorhynchus mykiss*				1	4	1		1	1	1	3			1	1	6	2	25	1	4	2	3				4	1	
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*		1			1	2		1		2	1	2		1	1	2		13	1	2		1			1			1
Sacramento blackfish	*Orthodon microlepidotus*																		1										
Sacramento squawfish	*Ptychocheilus grandis*																												
Hitch	*Lavinia exilicauda*																												
Carp	*Cyprinus carpio*																												
Goldfish	*Carassius auratus*																												
Golden shiner	*Notemigonus crysoleucas*																		1										
Fathead minnow	*Pimephales promelas*																		5										
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*		3						1						1	1	3	4	33										1
Ictaluridae																													
Black bullhead	*Ictalurus melas*						1																						
Brown bullhead	*Ictalurus nebulosus*																												
White catfish	*Ictalurus catus*																												
Yellow bullhead	*Ictalurus natalis*																												
Poeciliidae																													
Mosquitofish	*Gambusia affinis*																												
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*												1																
Centrarchidae																													
Bluegill	*Lepomis macrochirus*														1				3		1								
Green sunfish	*Lepomis cyanellus*																												
Largemouth bass	*Micropterus salmoides*																				1								
Black crappie	*Pomoxis nigromaculatus*																												
Embiotocidae																													
Tule perch	*Hysterocarpus traski*																												
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*						1	3											3										
Prickly sculpin	*Cottus asper*																												
Other Vertebrata																													
Mallard	*Anas platyrhynchos*																												
Black-crowned night heron	*Nycticorax nycticorax*																												
Western pond turtle	*Clemmys marmorata*																												
Pond slider	*Pseudemys scripta*																												
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*	2	2	1	3	1	6	1	36	16	19	6	15	8	27				4		1		1	1	2			1	2
Foothill yellow-legged frog	*Rana boylii*																												
Mink	*Mustela vison*																												

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Feb-94																							
		3		4		9		10		11		12		13		14		23		24		25		26		27		28	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*									2																	
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																	1									
Steelhead adult	*Onchorhynchus mykiss*					2	1	1	1		1							1	2						1		3
Steelhead half-pounder	*Onchorhynchus mykiss*											1															
Steelhead juvenile	*Onchorhynchus mykiss*		1		1	5	9	5	16	4	8	1	3	5	4	2	4	3	9	1	3			1			1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*			1	2	2	3	1	7	6	3	2	2	1	2	3	3	4	3					1	2		1
Sacramento blackfish	*Orthodon microlepidotus*						4	3	3		1								1					1			
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*						1																				
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*					1		2											1	1							
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*				1	5	6	1	18		7				1		2	2	14						1		
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*						1																				
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*					1																					
Centrarchidae																											
Bluegill	*Lepomis macrochirus*						2		1									1	3								
Green sunfish	*Lepomis cyanellus*						1												1								
Largemouth bass	*Micropterus salmoides*															1			1								
Black crappie	*Pomoxis nigromaculatus*																		1								
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*						1	1								1											
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*										1																
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*		6		2		5		4	1	8	1	2		6		8		10		158		17		19	4	50	1	23
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*					1																					

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Dec-93				Jan-94																			
		30		31		1		2		3		5		6		7		8		9		10		11		12		13	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*			1																				1			
Steelhead adult	*Onchorhynchus mykiss*																										
Steelhead half-pounder	*Onchorhynchus mykiss*																										
Steelhead juvenile	*Onchorhynchus mykiss*	1	1	7		8	6	19	11	7	14	20	8	4	12	5	1	4	2	10	4	2		1	4		2	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*		1		1		6	4	23		2	6		1	6	1	2		3	1	1	7	3		2	18		4
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*																										
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*						1		1						2	1	1											
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*																										
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*																										
Centrarchidae																											
Bluegill	*Lepomis macrochirus*							1																			
Green sunfish	*Lepomis cyanellus*													1													
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*						1									1		1									
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*		3	1	5	1	1	1	4			1			1				1		2				1		5
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94																						Feb-94			
		14		15		16		17		18		19		20		26	27	28		29		30		31		1		2	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	up	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																												
Salmonidae																													
Coho salmon juvenile	*Onchorhynchus kisutch*																												
Steelhead adult	*Onchorhynchus mykiss*																	8	1	2						1			
Steelhead half-pounder	*Onchorhynchus mykiss*																												
Steelhead juvenile	*Onchorhynchus mykiss*			1		4	1		1	1	1	3			1	1	6	2	25	1	4	2	3			4		1	
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*		1			1	2		1		2	1	2		1	1	2		13	1	2		1			1			1
Sacramento blackfish	*Orthodon microlepidotus*																		1										
Sacramento squawfish	*Ptychocheilus grandis*																												
Hitch	*Lavinia exilicauda*																												
Carp	*Cyprinus carpio*																												
Goldfish	*Carassius auratus*																												
Golden shiner	*Notemigonus crysoleucas*																		1										
Fathead minnow	*Pimephales promelas*																		5										
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*		3						1						1	1	3	4	33										1
Ictaluridae																													
Black bullhead	*Ictalurus melas*						1																						
Brown bullhead	*Ictalurus nebulosus*																												
White catfish	*Ictalurus catus*																												
Yellow bullhead	*Ictalurus natalis*																												
Poeciliidae																													
Mosquitofish	*Gambusia affinis*																												
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*												1																
Centrarchidae																													
Bluegill	*Lepomis macrochirus*														1				3		1								
Green sunfish	*Lepomis cyanellus*																												
Largemouth bass	*Micropterus salmoides*																				1								
Black crappie	*Pomoxis nigromaculatus*																												
Embiotocidae																													
Tule perch	*Hysterocarpus traski*																												
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*						1	3											3										
Prickly sculpin	*Cottus asper*																												
Other Vertebrata																													
Mallard	*Anas platyrhynchos*																												
Black-crowned night heron	*Nycticorax nycticorax*																												
Western pond turtle	*Clemmys marmorata*																												
Pond slider	*Pseudemys scripta*																												
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*	2	2	1	3	1	6	1	36	16	19	6	15	8	27				4		1		1	1	2			1	2
Foothill yellow-legged frog	*Rana boylii*																												
Mink	*Mustela vison*																												

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Feb-94																							
		3		4		9		10		11		12		13		14		23		24		25		26		27		28	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*									2																	
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																	1									
Steelhead adult	*Onchorhynchus mykiss*					2	1	1	1		1							1	2						1		3
Steelhead half-pounder	*Onchorhynchus mykiss*											1															
Steelhead juvenile	*Onchorhynchus mykiss*		1		1	5	9	5	16	4	8	1	3	5	4	2	4	3	9	1	3			1				1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*			1	2	2	3	1	7	6	3	2	2	1	2	3	3	4	3					1	2		1	
Sacramento blackfish	*Orthodon microlepidotus*						4	3	3		1								1					1				
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*						1																				
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*					1		2											1	1							
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*				1	5	6	1	18		7				1		2	2	14						1		
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*						1																				
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*					1																					
Centrarchidae																											
Bluegill	*Lepomis macrochirus*						2		1									1	3								
Green sunfish	*Lepomis cyanellus*						1									1			1								
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																		1								
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*						1	1								1											
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*										1																
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*		6		2		5		4	1	8	1	2		6		8		10		158		17		19	4	50	1	23
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*					1																					

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94																							
		1		2		3		4		5		6		7		8		9		10		11		12		13		14	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																		1								
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss*				1		1				1							1									
Steelhead half-pounder	*Onchorhynchus mykiss*																										
Steelhead juvenile	*Onchorhynchus mykiss*	1	5	1	11	1	5		5	1	6	2	11	1	5		15		10		6		10	1	2		1	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	2		1	1			7	7	6	14	2	4	7	7	15	7	5	6	4	7	16	10		15	54	12	8	2
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																			1							
Carp	*Cyprinus carpio*											1										1		1			
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*	1																				1				2	
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*	16	1	9	7	5	3	2			1		1				2		1		1		3				1		2
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*																1										
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*								1																		
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*																										
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																						1				
Green sunfish	*Lepomis cyanellus*																					1					
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																1										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	1														1						1		1			1	2
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*				1		1					1	1														1	2	1
Pond slider	*Pseudemys scripta*																												1
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*	9	35	5	17	4	5	5	7	4	22	4	5	4	23	3	63	5	52	5	69	3	52	1	119	14	85	8	104
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94																					
		15		16		17		18		19		20		24		25		26		27		28		29		30		31	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss*				1											1											
Steelhead half-pounder	*Onchorhynchus mykiss*																										
Steelhead juvenile	*Onchorhynchus mykiss*		4		4		4		5		2				1		2		2		1				3		1		1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	6		18	2		11	5	19	4	2	2			7		5	37	7	40	2	26	6	9	2	121	7	4	3
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*				1									3													
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*															1											
Fathead minnow	*Pimephales promelas*													2		2								1		1	
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*				2		1							1						2	18	14	14		4	2	2		2
Ictaluridae																											
Black bullhead	*Ictalurus melas*																										
Brown bullhead	*Ictalurus nebulosus*																								1		
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*	1																1									
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																		1	1							
Green sunfish	*Lepomis cyanellus*																				1				1		
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*																								1		
Prickly sculpin	*Cottus asper*														1												
Other Vertebrata																											
Mallard	*Anas platyrhynchos*										1																
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*		3				1						1	1					1				2		1		1
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*	3	9	1	22	2	19	1	20	4	3	3	4	2	14	6	5	5	21	6	42	1	35		58	11	33	24	130
Foothill yellow-legged frog	*Rana boylii*																										
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94																							
		1		2		3		4		5		6		7		8		9		10		11		12		13		14	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																	1									
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss*															1			1								1
Steelhead half-pounder	*Onchorhynchus mykiss*																										
Steelhead juvenile	*Onchorhynchus mykiss*		2		6		1	1	4		1		2		4		1				11		33	1	13	1	2		
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	3	3	28	4	32	3	8	13	13		7	8	40				16	13	19	7	5	15	13	7	8	2	4	2
Sacramento blackfish	*Orthodon microlepidotus*																	1	2				1		1		1		
Sacramento squawfish	*Ptychocheilus grandis*																										
Hitch	*Lavinia exilicauda*																										
Carp	*Cyprinus carpio*				2	1				1	1												1	2	1	9			
Goldfish	*Carassius auratus*																										
Golden shiner	*Notemigonus crysoleucas*																										
Fathead minnow	*Pimephales promelas*			5				9												4		1							1
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*		4		6	1	7		6				8	2	8			1	66	1	6	1	9				2		
Ictaluridae																											
Black bullhead	*Ictalurus melas*																		1								
Brown bullhead	*Ictalurus nebulosus*															1		1	1		1						
White catfish	*Ictalurus catus*																										
Yellow bullhead	*Ictalurus natalis*																										
Poeciliidae																											
Mosquitofish	*Gambusia affinis*																										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*									1				1													
Centrarchidae																											
Bluegill	*Lepomis macrochirus*	1						1										7	2	2	2	6	1	3	2	2	1		
Green sunfish	*Lepomis cyanellus*				1			1		1				1				9	12		5	5		1	5		1	2	1
Largemouth bass	*Micropterus salmoides*																										
Black crappie	*Pomoxis nigromaculatus*																					1				1			
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*		2										1						2								
Prickly sculpin	*Cottus asper*																										
Other Vertebrata																											
Mallard	*Anas platyrhynchos*																										
Black-crowned night heron	*Nycticorax nycticorax*																										
Western pond turtle	*Clemmys marmorata*	1	1	1					1				1						2		1						
Pond slider	*Pseudemys scripta*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*	28	118	25	66	41	101	14	105	23	65	9	120	29	183		4		61	14	82	21	62	18	250	17	337	50	150
Foothill yellow-legged frog	*Rana boylii*						1																				
Mink	*Mustela vison*																										

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94																									
		15		16		17		18		19		20		21		22		23		24		25	26		27		28		29
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	dn	up	dn	up	dn	up	dn	up
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																												
Salmonidae																													
Coho salmon juvenile	*Onchorhynchus kisutch*																												
Steelhead adult	*Onchorhynchus mykiss*		1																										
Steelhead half-pounder	*Onchorhynchus mykiss*																												
Steelhead juvenile	*Onchorhynchus mykiss*				2		2		2						8				2		7	10		2				7		
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*	6		1	4	9	5	11	4	8	8	6	4	6	5	2		2	4			11	12	4	3	11	5	5	1
Sacramento blackfish	*Orthodon microlepidotus*											1	2		1							3							
Sacramento squawfish	*Ptychocheilus grandis*																						1						
Hitch	*Lavinia exilicaude*																												
Carp	*Cyprinus carpio*																					1				1	1		
Goldfish	*Carassius auratus*																												
Golden shiner	*Notemigonus crysoleucas*																					2							
Fathead minnow	*Pimephales promelas*			4		1	2	5			2			1		2			1		4	13		5	1				
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*							5	2			1	1	1	5		1		1		1	11	5	1	2	2		12	2
Ictaluridae																													
Black bullhead	*Ictalurus melas*		1																										
Brown bullhead	*Ictalurus nebulosus*								1								1												
White catfish	*Ictalurus catus*																												
Yellow bullhead	*Ictalurus natalis*																												
Poeciliidae																													
Mosquitofish	*Gambusia affinis*																								1				
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*																												
Centrarchidae																													
Bluegill	*Lepomis macrochirus*	2		1				1			1											2	1		2		2	1	
Green sunfish	*Lepomis cyanellus*	6	1	1	1		10	8	5	1	1	1	1		2	2	6	1	2		2	13	7	3	2	1	4	3	
Largemouth bass	*Micropterus salmoides*																												1
Black crappie	*Pomoxis nigromaculatus*																					3	2	2		1		3	
Embiotocidae																													
Tule perch	*Hysterocarpus traski*																												
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*																												
Prickly sculpin	*Cottus asper*																												
Other Vertebrata																													
Mallard	*Anas platyrhynchos*																												
Black-crowned night heron	*Nycticorax nycticorax*																												
Western pond turtle	*Clemmys marmorata*								1						1				1										
Pond slider	*Pseudemys scripta*										1																		
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*	37	150	50	200	60	200	32	80	45	125	75	250	18	135	50	200	1	8		12		7	57	18	240	31	155	26
Foothill yellow-legged frog	*Rana boylii*																												
Mink	*Mustela vison*																												

Appendix 3-7-1. Santa Rosa Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94			May-94	
		29	30		1	
		dn	up	dn	up	dn
Petromyzontidae						
Pacific lamprey	*Lampetra tridentata*					
Salmonidae						
Coho salmon juvenile	*Onchorhynchus kisutch*					
Steelhead adult	*Onchorhynchus mykiss**					
Steelhead half-pounder	*Onchorhynchus mykiss**					
Steelhead juvenile	*Onchorhynchus mykiss**			1		
Cyprinidae						
California roach	*Hesperoleucus symmetricus*	6	9	5	9	1
Sacramento blackfish	*Orthodon microlepidotus*					
Sacramento squawfish	*Ptychocheilus grandis*					
Hitch	*Lavinia exilicauda*					
Carp	*Cyprinus carpio*				4	
Goldfish	*Carassius auratus*					
Golden shiner	*Notemigonus crysoleucas*					
Fathead minnow	*Pimephales promelas*		2	3		
Catostomidae						
Sacramento sucker	*Catostomus occidentalis*	1	2	2		1
Ictaluridae						
Black bullhead	*Ictalurus melas*					
Brown bullhead	*Ictalurus nebulosus*					
White catfish	*Ictalurus catus*					
Yellow bullhead	*Ictalurus natalis*					
Poeciliidae						
Mosquitofish	*Gambusia affinis*			2		
Gasterosteidae						
Threespine stickleback	*Gasterosteus aculeatus*					
Centrarchidae						
Bluegill	*Lepomis macrochirus*		1	1	3	
Green sunfish	*Lepomis cyanellus*	1	1	1	2	4
Largemouth bass	*Micropterus salmoides*					
Black crappie	*Pomoxis nigromaculatus*					
Embiotocidae						
Tule perch	*Hysterocarpus traski*					
Cottidae						
Coastrange sculpin	*Cottus aleuticus*		1			
Prickly sculpin	*Cottus asper*					
Other Vertebrata						
Mallard	*Anas platyrhynchos*					
Black-crowned night heron	*Nycticorax nycticorax*					
Western pond turtle	*Clemmys marmorata*		1			
Pond slider	*Pseudemys scripta*					1
Bullfrog	*Rana catesbeiana*					
Bullfrog tadpole	*Rana catesbeiana*	230	30	244	45	325
Foothill yellow-legged frog	*Rana boylii*					
Mink	*Mustela vison*					

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Oct-93				Nov-93						Dec-93													
		15		16		11		12		30		1		2		3		4		5		6		7		17		18	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																							1			
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**																										
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**	4	6	9	5	1	3	2	1		4				3	2		3	1		3		2	2		11	6	5	1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	46	49	58	38	27	10	6	14	18	14	10	1	1		7	9	11	8	8		21	3	5	4	42	1	16	
Sacramento blackfish	*Orthodon microlepidotus*									3	3	1												1					
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*	13	3		4	2	2			116	9	12	10			4		2	4	1		5		44		6		5	
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*					4		3												1						1		1	
Centrarchidae																											
Bluegill	*Lepomis macrochirus*	12	30	5	12					1	3		1		2		2		1	1				2		1			
Green sunfish	*Lepomis cyanellus*	141	29	36	32	13		6	7	6	2	2				2	3	3	3		1	1		8	1	1	1		
Embiotocidae																											
Tule perch	*Hysterocarpus traski*	1	1		4				1										1							1			
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	6	14	6	16	5	9	2	5	3		5				3		2		1	1	1		1		5		1	
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*		1																								
Bullfrog tadpole	*Rana catesbeiana*																										
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*												1																

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Dec-94																				Jan-94	
		19		20		21		22		23		24		25		26		27		28		29		30		31		1	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**																										
Steelhead half-pounder	*Onchorhynchus mykiss**					1		1																		1	
Steelhead juvenile	*Onchorhynchus mykiss**	7		4		3	2	4	2	3	1			4	8								1	2		1	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	5		3		1		2	1	1	5	39	1		5	2				1					1	18	1
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*	1				1																					
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*		1			1						1	1					1						1			
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																										
Green sunfish	*Lepomis cyanellus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	1		2	1	1		1	1	2	1					1				1		3		2		3	
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																							1			
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*													4													
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94																					
		2		3		5		6		7		8		9		10		11		12		13		14		15		16	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**																										
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**	1						1	1		1		2				1		1		1		1				
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*				2		11		7		3		3	2	13		8		3		4		3	3	9		17		9
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*								1				3		2						1		2				1		2
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*						1	1		1																	
Centrarchidae																											
Bluegill	*Lepomis macrochirus*			1																							
Green sunfish	*Lepomis cyanellus*				1				1														1					1
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*					1	1						1		3		1						1				1		
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*																					1					
Bullfrog tadpole	*Rana catesbeiana*																										
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94																				Feb-94									
		17		18		19		20		26	28		29		30		31		1		2		3		4		9	
		up	dn	up	dn	up	dn	up	dn	up	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																															
Pacific lamprey	*Lampetra tridentata*																														
Pacific brook lamprey	*Lampetra pacifica*																														
Ammocete larva	*Lampetra sp.*																														
Salmonidae																															
Coho salmon juvenile	*Onchorhynchus kisutch*																														
Steelhead adult	*Onchorhynchus mykiss**												2				1														
Steelhead half-pounder	*Onchorhynchus mykiss**																		1												
Steelhead juvenile	*Onchorhynchus mykiss**									1	1		3	7	1	3	1	1	1								4	3			
Cyprinidae																															
California roach	*Hesperoleucus symmetricus*	1	9		9		5		1	1	1		4	1	2				1				5								
Sacramento blackfish	*Orthodon microlepidotus*																														
Catostomidae																															
Sacramento sucker	*Catostomus occidentalis*				1				1	1		1	3		2		1		1				5				1			
Gasterosteidae																															
Threespine stickleback	*Gasterosteus aculeatus*				1														1												
Centrarchidae																															
Bluegill	*Lepomis macrochirus*											1		1																	
Green sunfish	*Lepomis cyanellus*																														
Embiotocidae																															
Tule perch	*Hysterocarpus traski*																														
Cottidae																															
Coastrange sculpin	*Cottus aleuticus*				2				2					1	1		1	1	2				2					1			
Other Vertebrata																															
Wood duck	*Aix sponsa*																														
Western pond turtle	*Clemmys marmorata*																														
Pond slider	*Pseudemys scripta*																														
Western toad	*Bufo boreas*																														
Bullfrog	*Rana catesbeiana*																														
Bullfrog tadpole	*Rana catesbeiana*																														
Opossum	*Didelphis marsupialis*																														
River otter	*Lutra canadensis*																														

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Feb-94																		Mar-94					
		10		11		12		13		14		23	24		25		26		27		28		1		2		3	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**						1										1										
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**	2		1	4	1	2	1	3	4				1	1	13		17		5		3	5		2		1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*		1			1												1				1	1		1		
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*				2		1		1	1						1			1									
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*										1		1														
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																										
Green sunfish	*Lepomis cyanellus*						2												1								
Embiotocidae																											
Tule perch	*Hysterocarpus traski*												1														
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*		1	1	2			1	4	2	8		2					2	1		1			1			
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*																										
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*		1																1		1						1
Bullfrog tadpole	*Rana catesbeiana*																										
Opossum	*Didelphis marsupialis*				1																						
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94																					
		4		5		6		7		8		9		10		11		12		13		14		15		16		17	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**								1				1														
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		3		9			4	2	2	1		2		11				2		1		1	1	3		3
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*			2						2	5	1		23	3	4	2	1	4	1	2	2	7	4	3	2	2
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*							4																			
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*		1			1																1				1	
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																										
Green sunfish	*Lepomis cyanellus*															1											
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																		1								
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*							1	3	1		2		16	3			5	4	2	2	12	4	4	1		1
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*		1					1			1					1				1							
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*				1								1														
Bullfrog tadpole	*Rana catesbeiana*																										
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94																		Apr-94					
		18		19		20		24		25		26		27		28		29		30		31		1		2		3	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																										
Steelhead adult	*Onchorhynchus mykiss**							1														1					
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		2					4		4		2						1	1			1				6	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	10	2	1	4			1	2	3	2	1	5	1	6		1	1				4	1	11	1	6	1	5	1
Sacramento blackfish	*Orthodon microlepidotus*									1																	
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*																			1						1	
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*				1	1	1					1	1				1				1						
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																										
Green sunfish	*Lepomis cyanellus*													1				1									
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										1
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	1					1	3	6		2	6	1	2			2	11	5		2	2		4			4	1
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*		1	1																							
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*							2																			
Bullfrog	*Rana catesbeiana*							1		1																	
Bullfrog tadpole	*Rana catesbeiana*																										
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94																							
		4		5		6		7		8		9		10		11		12		13		14		15		16		17	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*													1													1
Pacific brook lamprey	*Lampetra pacifica*																						1				
Ammocete larva	*Lampetra sp.*			1																							
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*																	1									
Steelhead adult	*Onchorhynchus mykiss**									3	4		1	1				1									
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		11	1	6		7	1	8		1	1	24		3		20		24			1	3		1		4	1	1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	7	3	4		1	4	3	1	7	2	4	1	22		10	8	4				2	2	5		4	1	8	6
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*		1							1	3		2		2				1								6	1
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*				1				1		1					1	1											3
Centrarchidae																											
Bluegill	*Lepomis macrochirus*												1						1						1				
Green sunfish	*Lepomis cyanellus*												2														
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	1	1	3	6	2	1	4	2	1		1				1	2	1				2	3			3		1	
Other Vertebrata																											
Wood duck	*Aix sponsa*			1																							
Western pond turtle	*Clemmys marmorata*																							1		1	1
Pond slider	*Pseudemys scripta*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*																	1									
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-2. Mark West Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94																								May-94	
		18		19		20		21		22		23		24		25		26		27		28		29		30		1	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*				2																						
Pacific brook lamprey	*Lampetra pacifica*																										
Ammocete larva	*Lampetra sp.*																										
Salmonidae																											
Coho salmon juvenile	*Onchorhynchus kisutch*						1								2												
Steelhead adult	*Onchorhynchus mykiss**														3	2	2				2		1			1	
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		1	1	3		1						1		8		6				5			1		1	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*		1	5	3	2	7	1			1	22		7	6	1	5	1		1	3	3	5	1		1	3	8
Sacramento blackfish	*Orthodon microlepidotus*																										
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*													10	16		2										
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*						2		1								2	1			4	1					
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																		2	1	1	1	2				
Green sunfish	*Lepomis cyanellus*		1				1							3		2	4										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*			1	1		1		1		1	8		2	2	2	3	1	1	1	2	2	1	1	2			1
Other Vertebrata																											
Wood duck	*Aix sponsa*																										
Western pond turtle	*Clemmys marmorata*				1			1												1							
Pond slider	*Pseudemys scripta*																			1							
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*								1												1		1	1	3		1
Opossum	*Didelphis marsupialis*																										
River otter	*Lutra canadensis*																										

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Nov-93		Dec-93																					
		30		1		2		3		4		5		6		12		18		19		20		21		22		23	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																												
Salmonidae																													
Coho salmon adult	*Onchorhynchus kisutch*																												
Coho salmon juvenile	*Onchorhynchus kisutch*																												
Steelhead adult	*Onchorhynchus mykiss**																												
Steelhead half-pounder	*Onchorhynchus mykiss**																												2
Steelhead juvenile	*Onchorhynchus mykiss**	1	10	2	5	5	6	9		4	8			4	2	3	7	18	12	15	7	14	5	7		7	4	11	5
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*	4	7	4	8	8	13	8		2	3	4		4	1	9	44		30	6	10	4	5	3	1	3	1		
Hardhead	*Mylopharodon conocephalus*																											2	1
Sacramento blackfish	*Orthodon microlepidotus*															1				2									
Sacramento squawfish	*Ptychocheilus grandis*															17	3	12	3	1	3	3	1	1	3	1	1		
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*		4	2	4	1	1			3		1	1	3		10	7		9		6		1	5		1	11	1	1
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*	1								1																			
Centrarchidae																													
Bluegill	*Lepomis macrochirus*	1	22	1	6	2	5										11		1										
Embiotocidae																													
Tule perch	*Hysterocarpus traski*																2						1						
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*		18	3	9	1	6			1	2		3		4		6				1								2
Other Vertebrata																													
Western pond turtle	*Clemmys marmorata*																												
Western toad	*Bufo boreas*																												
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*																10		1		2						4		
Foothill yellow-legged frog	*Rana boylii*																												
Red-legged frog tadpole	*Rana aurora*																								1				
Mink	*Mustela vison*																												

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Dec-93														Jan-94											
		24		25		26		27		28		29		30		31		1		2		3		5		6		7	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																												
Salmonidae																													
Coho salmon adult	*Onchorhynchus kisutch*						1											1	1				1		1		1		
Coho salmon juvenile	*Onchorhynchus kisutch*																												
Steelhead adult	*Onchorhynchus mykiss**																												
Steelhead half-pounder	*Onchorhynchus mykiss**																												
Steelhead juvenile	*Onchorhynchus mykiss**	17	6	10	7	1	1	4						5		1	4	5		2			1			1		4	
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*	1	1	3	1	1		2		1	1	3		4	7	1		1		3		4		2	2	4		1	
Hardhead	*Mylopharodon conocephalus*														2									1					
Sacramento blackfish	*Orthodon microlepidotus*																												
Sacramento squawfish	*Ptychocheilus grandis*			2									1									1		1					
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*								1									3		1	1		1	5		1	1		
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*																												
Centrarchidae																													
Bluegill	*Lepomis macrochirus*																												
Embiotocidae																													
Tule perch	*Hysterocarpus traski*					1	1																						
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*	1																				1	1					1	
Other Vertebrata																													
Western pond turtle	*Clemmys marmorata*																												
Western toad	*Bufo boreas*																												
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*		2		1		1																						
Foothill yellow-legged frog	*Rana boylii*																												
Red-legged frog tadpole	*Rana aurora*																												
Mink	*Mustela vison*																												

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94																									
		8		9		10		11		12		13		14		15		16		17		18		19		20		26	27
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	up
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*																										
Salmonidae																											
Coho salmon adult	*Onchorhynchus kisutch*		2		1																						
Coho salmon juvenile	*Onchorhynchus kisutch*			1																							
Steelhead adult	*Onchorhynchus mykiss**																										
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		1			2		2		1	1	2	1		2	3		1	1	1						9	
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	3	4	4	5	2				2	1	2	2	3	1	4	2	1	1	4	3		3	1	2	1	4	1	1
Hardhead	*Mylopharodon conocephalus*												1	1	1	14		1	2			1	1					
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*									1																1	
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*	1	1		1										1	22		41	5	3	1	3					1
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*																										
Centrarchidae																											
Bluegill	*Lepomis macrochirus*																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*			1		1	1			1	1	2				1		2		1				1	2	1	1		
Other Vertebrata																											
Western pond turtle	*Clemmys marmorata*																										
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*																										
Bullfrog tadpole	*Rana catesbeiana*													1		1											
Foothill yellow-legged frog	*Rana boylii*									1																	
Red-legged frog tadpole	*Rana aurora*																										
Mink	*Mustela vison*																										

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Jan-94								Feb-94													
		28		29		30		31		1		2		3		4		9		10		11		12		13		14	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																													
Pacific lamprey	*Lampetra tridentata*																					1							
Salmonidae																													
Coho salmon adult	*Onchorhynchus kisutch*																												
Coho salmon juvenile	*Onchorhynchus kisutch*																							1	3				
Steelhead adult	*Onchorhynchus mykiss**	3		4		1				1												1					2		
Steelhead half-pounder	*Onchorhynchus mykiss**															1													
Steelhead juvenile	*Onchorhynchus mykiss**	1	2	1	3		5	2			4			1	3	1	4		2		7	1	10	2	2	4		1	
Cyprinidae																													
California roach	*Hesperoleucus symmetricus*		2	1						1					4						3			1	3		1		
Hardhead	*Mylopharodon conocephalus*																					3				2		1	
Sacramento blackfish	*Orthodon microlepidotus*																												
Sacramento squawfish	*Ptychocheilus grandis*			2						1				1			1			1				1	1				
Catostomidae																													
Sacramento sucker	*Catostomus occidentalis*		1	1	1	1	1		1					2				1		1	2			1	1	3		3	
Gasterosteidae																													
Threespine stickleback	*Gasterosteus aculeatus*				1			1	1													1				1			1
Centrarchidae																													
Bluegill	*Lepomis macrochirus*	1																											
Embiotocidae																													
Tule perch	*Hysterocarpus traski*																												
Cottidae																													
Coastrange sculpin	*Cottus aleuticus*				1		2	1								1		1		1				1	3		4	1	3
Other Vertebrata																													
Western pond turtle	*Clemmys marmorata*					1														1									
Western toad	*Bufo boreas*																												
Bullfrog	*Rana catesbeiana*																												
Bullfrog tadpole	*Rana catesbeiana*																												
Foothill yellow-legged frog	*Rana boylii*																												
Red-legged frog tadpole	*Rana aurora*																												
Mink	*Mustela vison*																												

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Feb-94										Mar-94													
		23	24		25		26		27		28	1		2		3		4		5		6		7		8	
		up	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																										
Pacific lamprey	*Lampetra tridentata*																		1							
Salmonidae																										
Coho salmon adult	*Onchorhynchus kisutch*																									
Coho salmon juvenile	*Onchorhynchus kisutch*																1					1			1	
Steelhead adult	*Onchorhynchus mykiss**																		1		1	1	1		2	
Steelhead half-pounder	*Onchorhynchus mykiss**																									
Steelhead juvenile	*Onchorhynchus mykiss**	3					1				3			5			5		1	2		14		7		15
Cyprinidae																										
California roach	*Hesperoleucus symmetricus*	1	1						2					6			8		1	5	1	4	1			
Hardhead	*Mylopharodon conocephalus*								1					1							1					
Sacramento blackfish	*Orthodon microlepidotus*																									
Sacramento squawfish	*Ptychocheilus grandis*						1		2		1								1	1			2			
Catostomidae																										
Sacramento sucker	*Catostomus occidentalis*	1												1			4		10		3	1	9	1	4	
Gasterosteidae																										
Threespine stickleback	*Gasterosteus aculeatus*				1							1									3					
Centrarchidae																										
Bluegill	*Lepomis macrochirus*								1								1			3		37		12		1
Embiotocidae																										
Tule perch	*Hysterocarpus traski*																									
Cottidae																										
Coastrange sculpin	*Cottus aleuticus*	2			1												1		3				1		6	1
Other Vertebrata																										
Western pond turtle	*Clemmys marmorata*																									
Western toad	*Bufo boreas*																									
Bullfrog	*Rana catesbeiana*																1						1			
Bullfrog tadpole	*Rana catesbeiana*				3		3		1	2	1	2		2			2					2		1		2
Foothill yellow-legged frog	*Rana boylii*																									
Red-legged frog tadpole	*Rana aurora*																									
Mink	*Mustela vison*				1																					

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94																							
		9		10		11		12		13		14		15		16		17		18		19		20		24		25	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*													2				2		1		1		1			
Salmonidae																											
Coho salmon adult	*Onchorhynchus kisutch*																										
Coho salmon juvenile	*Onchorhynchus kisutch*		2		1								2		7		4				1		1		3		
Steelhead adult	*Onchorhynchus mykiss**	1															1			2				1		1	
Steelhead half-pounder	*Onchorhynchus mykiss**																								1		
Steelhead juvenile	*Onchorhynchus mykiss**	1	11	1	2		4		2		14	3	15		24		23		18		16		14		4		6	1	5
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*			6	1	1	2		1	1		3	1	7	1	3	3	6			2	1		2		2			2
Hardhead	*Mylopharodon conocephalus*						1																				
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*	5		5		6		2		2	1	4	2	1	1	1		4		1		2					
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*		1			2			1	2	1	1		7	2	3	3		1			1	1		1			
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*											2		2					1									
Centrarchidae																											
Bluegill	*Lepomis macrochirus*		6		5		1							1	1													
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Coltus aleuticus*	1	5	6	5	8	5	8	7		4	6	3	5	9	7	2	5	5	4		2	4	4	3		1	2	1
Other Vertebrata																											
Western pond turtle	*Clemmys marmorata*								1		1	2	1		4	1	1		2	1	1				2	1	1
Western toad	*Bufo boreas*																										
Bullfrog	*Rana catesbeiana*				1				1	1			2														
Bullfrog tadpole	*Rana catesbeiana*		5	1	4	1	1		2		2	1	3		5		14		4		1		5		2		5		7
Foothill yellow-legged frog	*Rana boylii*																										
Red-legged frog tadpole	*Rana aurora*																										
Mink	*Mustela vison*																										

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Mar-94												Apr-94											
		26		27		28		29		30		31		1		2		3		4		5		6		7		8	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*				2	1		1																			
Salmonidae																											
Coho salmon adult	*Onchorhynchus kisutch*																										
Coho salmon juvenile	*Onchorhynchus kisutch*		2		1		2		6		7		5		6		1		12		1		5		8		1		1
Steelhead adult	*Onchorhynchus mykiss**		2	1	1	3	2	2	2	1	2					1			1		1							1
Steelhead half-pounder	*Onchorhynchus mykiss**																												
Steelhead juvenile	*Onchorhynchus mykiss**		12	1	20		27	2	14		20	1	8		17		3	2	23		10		3		4				19
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	10	9	16	14	14	5	5	2	20	13	25	8	14	16	1	4	21	17	27	7	4	7	6	2	1	1	2	1
Hardhead	*Mylopharodon conocephalus*																												
Sacramento blackfish	*Orthodon microlepidotus*																												
Sacramento squawfish	*Ptychocheilus grandis*					15	1			5	1	2		4	2	1	1			4								2	
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*		14	1	6	29	14	9	2	6	9	2		6	5		3		13		4		2	1	1			1	1
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*		1															1						2				
Centrarchidae																											
Bluegill	*Lepomis macrochirus*		1																										
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																												
Cottidae																											
Coastrange sculpin	*Cottus aleuticus*	4	2	4	1	2	1		1	5		3	1		1			6		3		4		7		1			
Other Vertebrata																											
Western pond turtle	*Clemmys marmorata*	2		2		1	1	1		1			2						1				1	1			1		
Western toad	*Bufo boreas*				1												1						1						
Bullfrog	*Rana catesbeiana*																					1							
Bullfrog tadpole	*Rana catesbeiana*		2		7	1	3			1	2		1		2				2		1						2		1
Foothill yellow-legged frog	*Rana boylii*																												
Red-legged frog tadpole	*Rana aurora*																												
Mink	*Mustela vison*																												

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94																					
		9		10		11		12		13		14		15		16		17		18		19		20		21		22	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																											
Pacific lamprey	*Lampetra tridentata*				1		1																				
Salmonidae																											
Coho salmon adult	*Onchorhynchus kisutch*																										
Coho salmon juvenile	*Onchorhynchus kisutch*		8		11		3		3		6		2		12		5		2		4		1				
Steelhead adult	*Onchorhynchus mykiss**					1		1																			
Steelhead half-pounder	*Onchorhynchus mykiss**																										
Steelhead juvenile	*Onchorhynchus mykiss**		10		7		3		3	1			8		10		3		4		4	1					1
Cyprinidae																											
California roach	*Hesperoleucus symmetricus*	2	3	76	2	7	7	1	4	14		1	11	1	11		1		14		3	2		11			2	8
Hardhead	*Mylopharodon conocephalus*																										
Sacramento blackfish	*Orthodon microlepidotus*																										
Sacramento squawfish	*Ptychocheilus grandis*			7	1										2							1			2		6
Catostomidae																											
Sacramento sucker	*Catostomus occidentalis*		3	1	3		3				3		1		14		1	1			3				1		10
Gasterosteidae																											
Threespine stickleback	*Gasterosteus aculeatus*		1					1					1					1	1			1		1		3	
Centrarchidae																											
Bluegill	*Lepomis macrochirus*						1				1				1		1		1		1				1		1
Embiotocidae																											
Tule perch	*Hysterocarpus traski*																										
Cottidae																											
Coastrange sculpin	*Coltus aleuticus*			8	2	1	2		1	1		5			2	3		2	2		1	1		6		1	8	2
Other Vertebrata																											
Western pond turtle	*Clemmys marmorata*			1		2	1		1						1		2				1				1		2
Western toad	*Bufo boreas*												1		1												
Bullfrog	*Rana catesbeiana*																				1						
Bullfrog tadpole	*Rana catesbeiana*		2		1		3		6		3		6	1	5	2	4		6		1	2	5	1	1		6		5
Foothill yellow-legged frog	*Rana boylii*																										
Red-legged frog tadpole	*Rana aurora*																										
Mink	*Mustela vison*																										

Appendix 3-7-3. Maacama Creek: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1993-1994. up = moving upstream; dn = moving downstream.

		Apr-94														May-94	
		23		24		25		26		27		28		29		30		1	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																			
Pacific lamprey	*Lampetra tridentata*																		
Salmonidae																			
Coho salmon adult	*Onchorhynchus kisutch*																		
Coho salmon juvenile	*Onchorhynchus kisutch*		2				2	1	3		2	1	7		2			1	1
Steelhead adult	*Onchorhynchus mykiss*[a]				3		2												
Steelhead half-pounder	*Onchorhynchus mykiss*[a]																		
Steelhead juvenile	*Onchorhynchus mykiss*[a]		1	1			1		2		1				1				1
Cyprinidae																			
California roach	*Hesperoleucus symmetricus*		1				1	29			6	7	1	1	1			7	1
Hardhead	*Mylopharodon conocephalus*																		
Sacramento blackfish	*Orthodon microlepidotus*																		
Sacramento squawfish	*Ptychocheilus grandis*																	1	
Catostomidae																			
Sacramento sucker	*Catostomus occidentalis*			2			4		13			1					1	12	
Gasterosteidae																			
Threespine stickleback	*Gasterosteus aculeatus*															1			
Centrarchidae																			
Bluegill	*Lepomis macrochirus*						3		26		12		6	1	5				1
Embiotocidae																			
Tule perch	*Hysterocarpus traski*																		
Cottidae																			
Coastrange sculpin	*Cottus aleuticus*							9			1					2		10	1
Other Vertebrata																			
Western pond turtle	*Clemmys marmorata*			1		1	1			1									
Western toad	*Bufo boreas*																		
Bullfrog	*Rana catesbeiana*																		
Bullfrog tadpole	*Rana catesbeiana*		11		14	1	65	3	59		36	2	11	1	17		14		9
Foothill yellow-legged frog	*Rana boylii*																		
Red-legged frog tadpole	*Rana aurora*																		
Mink	*Mustela vison*																		

Appendix 3-7-4. Laguna de Santa Rosa at River Road: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1994. up = moving upstream; dn = moving downstream.

		Mar-94																	
		19		20		24		25		26		27		28		29		30		31	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																					
Pacific lamprey	*Lampetra tridentata*																				
Salmonidae																					
Coho salmon juvenile	*Onchorhynchus kisutch*	1						1	1			1						2			
Steelhead adult	*Onchorhynchus mykiss**					1	2	1	1	2				1							
Steelhead juvenile	*Onchorhynchus mykiss**	8		1		1	1		2	3		1				1		1		1	
Cyprinidae																					
California roach	*Hesperoleucus symmetricus*			1	1					1											
Sacramento blackfish	*Orthodon microlepidotus*											2		1							
Sacramento squawfish	*Ptychocheilus grandis*																			1	
Hitch	*Lavinia exilicauda*																			1	
Carp	*Cyprinus carpio*	1										1		2							2
Golden shiner	*Notemigonus crysoleucas*																				
Fathead minnow	*Pimephales promelas*					1										2					
Catostomidae																					
Sacramento sucker	*Catostomus occidentalis*			1		1	1		1	1								1			
Ictaluridae																					
Brown bullhead	*Ictalurus nebulosus*									1											
White catfish	*Ictalurus catus*																				
Yellow bullhead	*Ictalurus natalis*																				
Gasterosteidae																					
Threespine stickleback	*Gasterosteus aculeatus*																				
Centrarchidae																					
Bluegill	*Lepomis macrochirus*																				
Green sunfish	*Lepomis cyanellus*											1									
Largemouth bass	*Micropterus salmoides*																				
Black crappie	*Pomoxis nigromaculatus*																				
Embiotocidae																					
Tule perch	*Hysterocarpus traski*																				
Cottidae																					
Prickly sculpin	*Cottus asper*			1						1											
Other Vertebrata																					
Western pond turtle	*Clemmys marmorata*	4								1						2		1		1	
Pond slider	*Pseudemys scripta*																				
Bullfrog	*Rana catesbeiana*																				
Bullfrog tadpole	*Rana catesbeiana*	2										2				1					
Mink	*Mustela vison*																				

Appendix 3-7-4. Laguna de Santa Rosa at River Road: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1994. up = moving upstream; dn = moving downstream.

		Apr-94																	
		1		2		3		4		5		6		7		8		9		10	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																					
Pacific lamprey	*Lampetra tridentata*																	2			
Salmonidae																					
Coho salmon juvenile	*Onchorhynchus kisutch*		2				3						1								
Steelhead adult	*Onchorhynchus mykiss**												1			1		1	3		
Steelhead juvenile	*Onchorhynchus mykiss**		5	1	1	3	2				2		1		2	1	2	1	68	3	10
Cyprinidae																					
California roach	*Hesperoleucus symmetricus*		1		1	1					2										1
Sacramento blackfish	*Orthodon microlepidotus*					1					5							15	56		42
Sacramento squawfish	*Ptychocheilus grandis*							1									2		4		
Hitch	*Lavinia exilicauda*																				
Carp	*Cyprinus carpio*						1				5					3			4	1	4
Golden shiner	*Notemigonus crysoleucas*																1				
Fathead minnow	*Pimephales promelas*					1													3		
Catostomidae																					
Sacramento sucker	*Catostomus occidentalis*		4									1	3			6	17	2	27		2
Ictaluridae																					
Brown bullhead	*Ictalurus nebulosus*																			1	
White catfish	*Ictalurus catus*																				
Yellow bullhead	*Ictalurus natalis*					1															
Gasterosteidae																					
Threespine stickleback	*Gasterosteus aculeatus*																		1		2
Centrarchidae																					
Bluegill	*Lepomis macrochirus*						1											1	20	1	1
Green sunfish	*Lepomis cyanellus*									2				1						1	1
Largemouth bass	*Micropterus salmoides*						1														
Black crappie	*Pomoxis nigromaculatus*																1	1	20	2	17
Embiotocidae																					
Tule perch	*Hysterocarpus traski*																				
Cottidae																					
Prickly sculpin	*Cottus asper*																				
Other Vertebrata																					
Western pond turtle	*Clemmys marmorata*		2				1						2		1				2		
Pond slider	*Pseudemys scripta*																				
Bullfrog	*Rana catesbeiana*																				
Bullfrog tadpole	*Rana catesbeiana*																		10		1
Mink	*Mustela vison*																				

Appendix 3-7-4. Laguna de Santa Rosa at River Road: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1994. up = moving upstream; dn = moving downstream.

		Apr-94																					
		11		12		13		14		15		16		17		18		19		20		21		22		23	
		up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn	up	dn
Petromyzontidae																									
Pacific lamprey	*Lampetra tridentata*					1				1															
Salmonidae																									
Coho salmon juvenile	*Onchorhynchus kisutch*					6		1																	
Steelhead adult	*Onchorhynchus mykiss**																							1	
Steelhead juvenile	*Onchorhynchus mykiss**		4	1		21		5				2						1						1	32
Cyprinidae																									
California roach	*Hesperoleucus symmetricus*		3					2										1		2				1	5
Sacramento blackfish	*Orthodon microlepidotus*	2	19		1		1	1										1		6					18
Sacramento squawfish	*Ptychocheilus grandis*															2		2				1			2
Hitch	*Lavinia exilicauda*																								
Carp	*Cyprinus carpio*	1	28	1	15	2	20	2		9		1						4		3					42
Golden shiner	*Notemigonus crysoleucas*			1														3		1				2	
Fathead minnow	*Pimephales promelas*		2				2		1			1	1				2								
Catostomidae																									
Sacramento sucker	*Catostomus occidentalis*	2	1				2		1		1					1			2				1	2		3	24
Ictaluridae																									
Brown bullhead	*Ictalurus nebulosus*		1														2								3
White catfish	*Ictalurus catus*						1												1						
Yellow bullhead	*Ictalurus natalis*		1				1																		
Gasterosteidae																									
Threespine stickleback	*Gasterosteus aculeatus*							2				2		1		1		2					1		
Centrarchidae																									
Bluegill	*Lepomis macrochirus*	1		1		2		4				1		2		1	2	1	5		1		2		1		5
Green sunfish	*Lepomis cyanellus*		2		1	1		3	4	2								2	2			1	1			7
Largemouth bass	*Micropterus salmoides*						1																			
Black crappie	*Pomoxis nigromaculatus*	1	11	2			15	1	9		10	2	8	1	2		9		15	1	27	1	24	2	10		55
Embiotocidae																									
Tule perch	*Hysterocarpus traski*	1																					1		
Cottidae																									
Prickly sculpin	*Cottus asper*										1						1				1				
Other Vertebrata																									
Western pond turtle	*Clemmys marmorata*		1		2						2		1										1		
Pond slider	*Pseudemys scripta*										1											1			
Bullfrog	*Rana catesbeiana*								1																
Bullfrog tadpole	*Rana catesbeiana*		3				2		3								8				1		2		12
Mink	*Mustela vison*																					1			

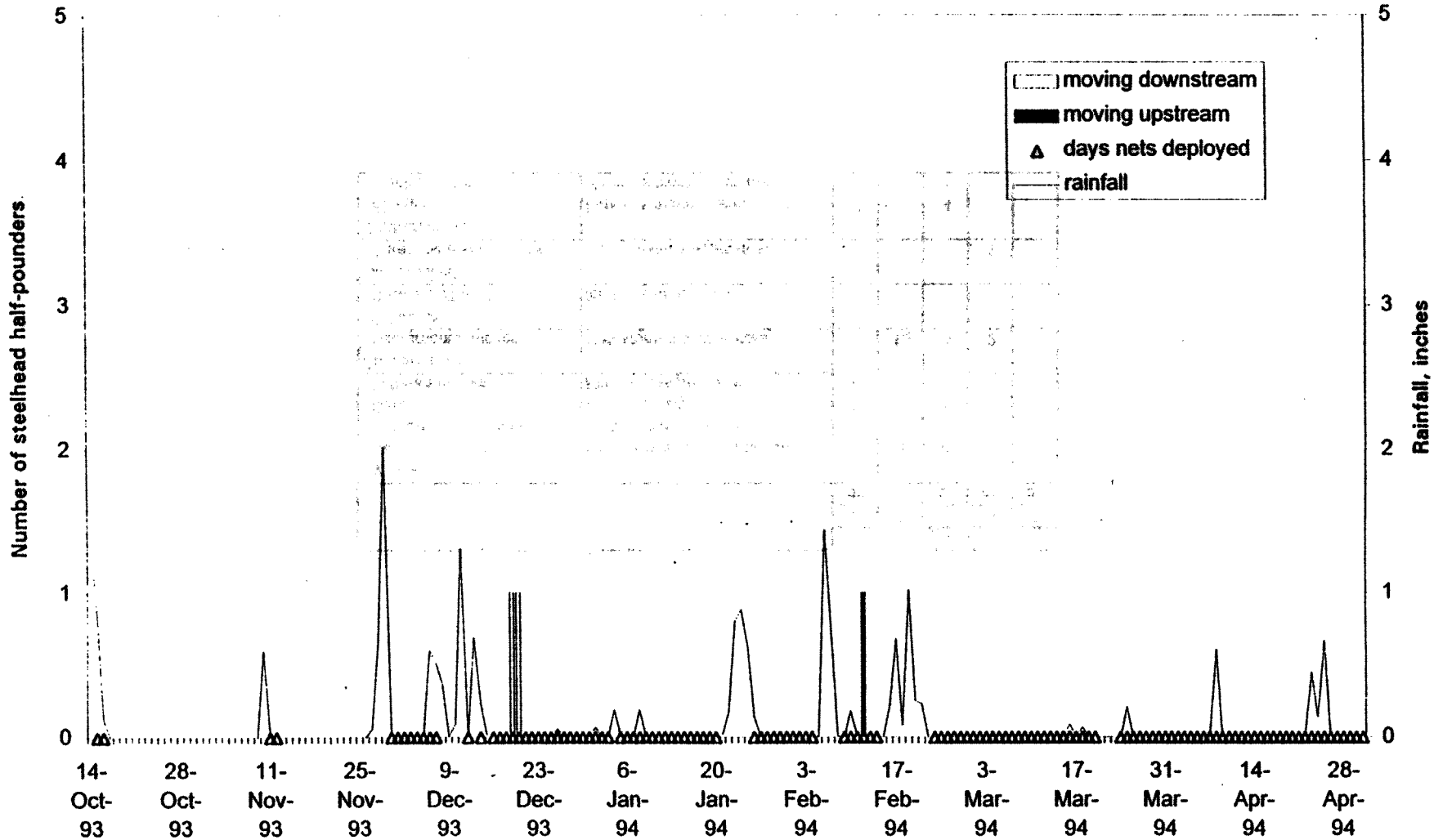
Appendix 3-7-5. Laguna de Santa Rosa at Llano Road: Fyke Net Catches of Various Species of Fish and Other Vertebrates, 1994. up = moving upstream; dn = moving downstream.

		Mar-94					
		26		27		28	
		up	dn	up	dn	up	dn
Cyprinidae							
California roach	*Hesperoleucus symmetricus*	1					
Sacramento squawfish	*Ptychocheilus grandis*					1	
Carp	*Cyprinus carpio*				2		
Fathead minnow	*Pimephales promelas*	27	5	4			1
Catostomidae							
Sacramento sucker	*Catostomus occidentalis*	2		6	5	2	
Ictaluridae							
Brown bullhead	*Ictalurus nebulosus*	5		1	1		
Centrarchidae							
Bluegill	*Lepomis macrochirus*	4					
Green sunfish	*Lepomis cyanellus*	29	3	4		23	2
Other Vertebrata							
Western pond turtle	*Clemmys marmorata*	12	1	4	10	3	4
Bullfrog	*Rana catesbeiana*			1			
Bullfrog tadpole	*Rana catesbeiana*	7	7	14		6	6

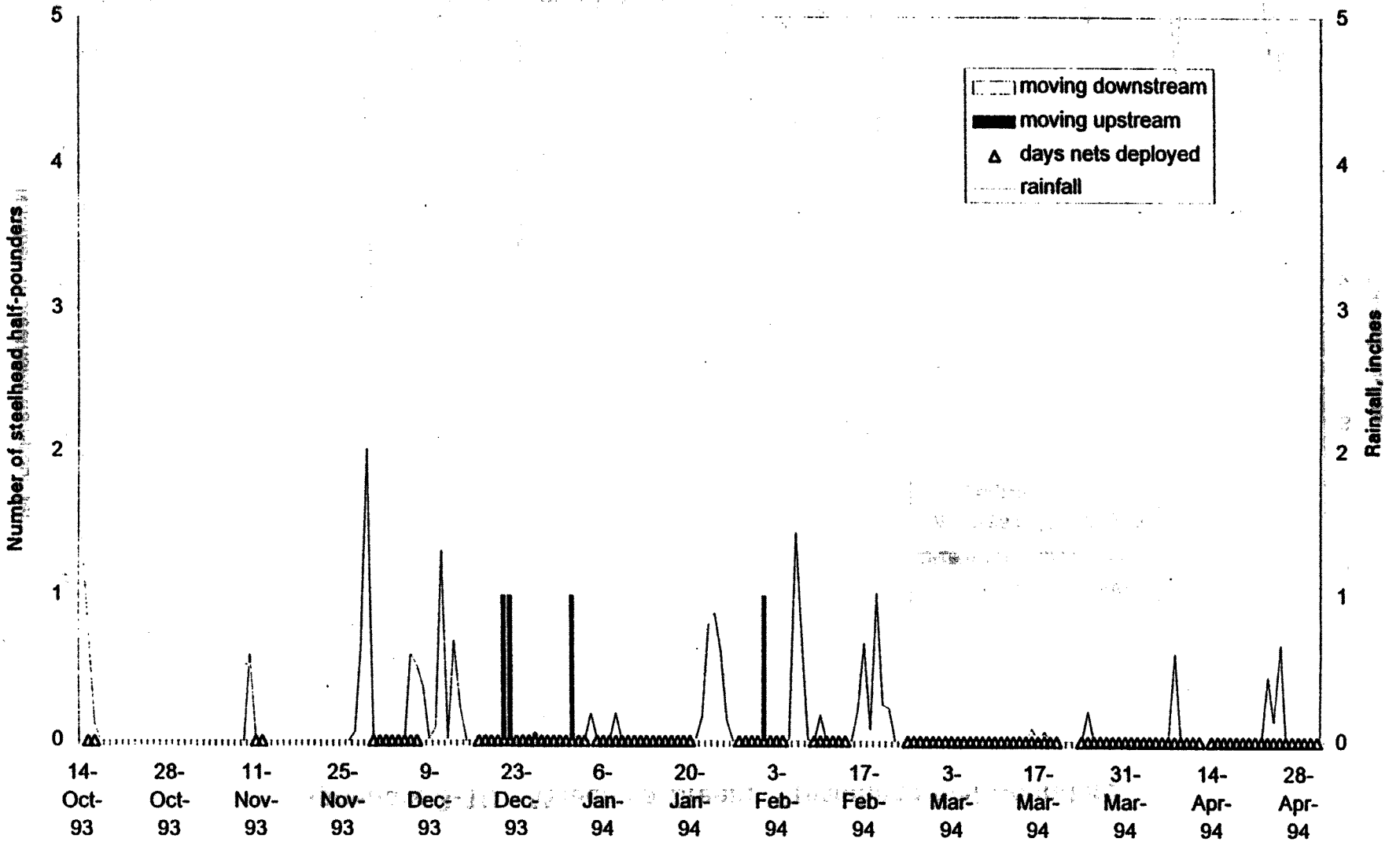
Appendix 3-7-6. Laguna de Santa Rosa at Brown Farm: Fyke Net Catches of Various Species of Fish Moving Downstream, 1994.

		Apr-94				
		2	3	4	5	6
		dn	dn	dn	dn	dn
Cyprinidae						
California roach	*Hesperoleucus symmetricus*	5	2	3		1
Sacramento blackfish	*Orthodon microlepidotus*	1				
Carp	*Cyprinus carpio*	8	12	5		
Fathead minnow	*Pimephales promelas*	6			2	
Catostomidae						
Sacramento sucker	*Catostomus occidentalis*	2	15	6	2	
Ictaluridae						
Brown bullhead	*Ictalurus nebulosus*		1			
Gasterosteidae						
Threespine stickleback	*Gasterosteus aculeatus*				1	
Centrarchidae						
Bluegill	*Lepomis macrochirus*	2		4		
Black crappie	*Pomoxis nigromaculatus*			1		

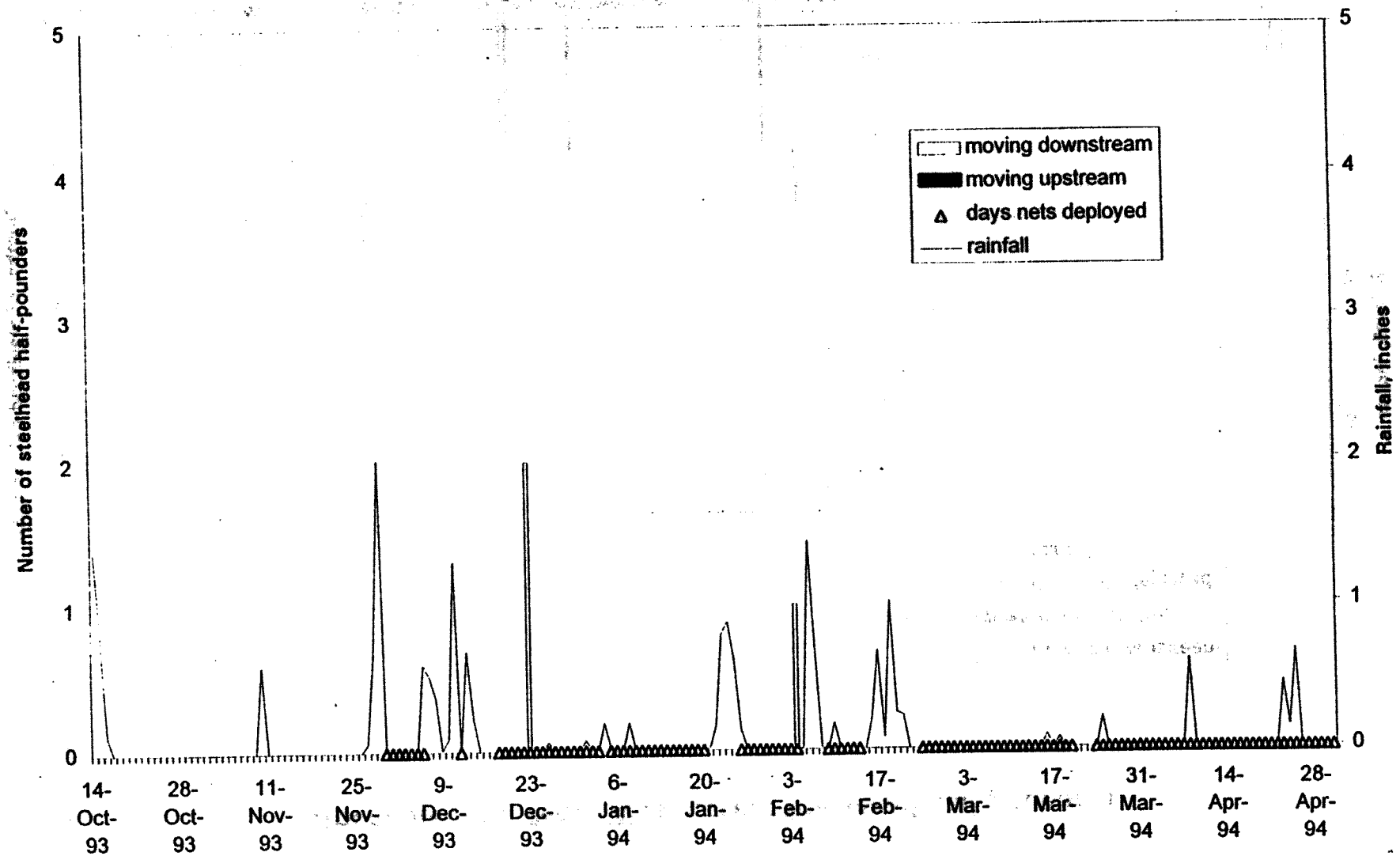
Appendix 3-8. Santa Rosa Creek: Steelhead half-pounders



Appendix 3-9. Mark West Creek: Steelhead half-pounders



Appendix 3-10. Maacama Creek: Steelehead half-pounders



Appendix 3-11. Spearman Rank Order Correlation Coefficients For Steelhead Adult Catch vs. Reclaimed Water Concentration and Flow, And for Flow vs. Recalaimed Water Concentration, For Each Year Studied.

	MWC fish vs. conc			MWC fish vs. flow			MWC flow vs. conc		
year	P	r	r-sq	P	r	r-sq	P	r	r-sq
1991	0	-0.769	0.591	0.011	0.586	0.343	0	-0.54	0.292
1992	0.487 ns	0.107	0.011	0.927 ns	0.014	0.000	0	-0.861	0.741
1993	0.840 ns	0.033	0.001	0.601 ns	0.086	0.007	0	-0.855	0.731
1994*	0.856 ns	0.016	0.000	0.106 ns	0.145	0.021	0.074 ns	0.126	0.016
1994**	0.058 ns	0.231	0.053	0.026	0.27	0.073	0.065 ns	-0.196	0.038

	SRC fish vs. conc			SRC fish vs. flow			SRC flow vs. conc		
year	P	r	r-sq	P	r	r-sq	P	r	r-sq
1991	0.028	0.408	0.166	0.379 ns	0.168	0.028	0	-0.506	0.256
1992	0.607 ns	0.079	0.006	0.637 ns	-0.073	0.005	0	-0.667	0.445
1993	0.398 ns	-0.139	0.019	0.293 ns	0.172	0.030	0	-0.718	0.516
1994*	0.495 ns	-0.06	0.004	0	0.357	0.127	0.104 ns	0.115	0.013
1994**	0.164 ns	-0.169	0.029	0	0.432	0.187	0.009	-0.275	0.076

* all dates

**January through March only

Appendix 4-1-1. Habitat Suitability Scores, Upper Santa Rosa Creek. **Boldface** scores denote units where fish were sampled.

Santa Rosa Creek Upper Reach					
			Habitat Score*		
Unit #	Habitat Type	Unit Length, ft	Fall 1993	Summer 1994	Fall 1994
1	glide/pool	97	**3**	**3**	**3**
2	riffle	25	**1**	1	**2**
3	pool	48	**3**	**3**	**3**
4	riffle	100	**3**	**2**	**3**
5	riffle	50	3	2	3
6	pool	90	**3**	**3**	**3**
7	riffle	30	3	2	3
8	pools & riffle	25	3	2	3
9	riffle & glide	30	3	2	3
10	pool	80	3	3	3
11	glide	50	3	2	3
12	riffle	40	3	2	3
13	glide	30	3	2	3
14	braided riffle	80	3	2	3
15a	side pool	25	3	2	3
15	pool	125	3	3	3
16	pool	50	3	3	3
17	glide w/ short riffle	50	3	2	3
18	riffle	15	1	1	1
19	glide/pool	70	3	2	3
20	braided riffle	40	2	1	2
21	glide & riffles	50	3	2	3
22	pool/glide	80	3	3	3
23	glide/riffle	35	3	3	3

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-2. Habitat Suitability Scores, Middle Santa Rosa Creek. **Boldface** scores denote units where fish were sampled.

Santa Rosa Creek Midddle Reach					
			Habitat Score*		
Unit #	Habitat Type	Length, ft	Fall 1993	Summer 1994	Fall 1994
1	pool	166	**3**	**3**	**3**
2	riffle & small pools	60	**3**	**3**	**3**
3	riffle & tiny pools	106	**3**	**2**	**3**
4	pool	75	3	3	3
5	pool	97	**3**	**3**	**3**
6	pool	93	**3**	**3**	**3**
7	riffle	30	2	1	2
8	glide/pool	60	1	1	2
9	pool	60	3	3	3
10	pool	10	2	1	2
11	riffle	15	1	1	1
12	pool/glide	120	3	3	3
13	braided riffle	30	2	1	2
14	pool	100	3	2	3
15	pool	50	3	1	3
16	riffle	35	3	1	3
17	glide	25	2	1	2
18	riffle	100	2	1	2
19	pool	55	**3**	**3**	**3**
20	riffle	20	2	1	2
21	pool	77	3	2	3
22	riffle & cascade	35	3	2	3
23	pool/glide	125	3	3	3
24	riffle	35	2	1	2
25	glide	110	3	2	3
26	riffle & small pools	35	2	1	2
27	pool/glide	80	3	3	3
28	riffle	70	3	1	3
29	pool	75	3	3	3
30	riffle	25	3	1	3
31	pool/glide	100	3	3	3
32	riffle	20	2	1	2
33	glide	45	2	2	2
34	riffle & tiny pools	105	**3**	**1**	**3**
35	pool	52	**3**	**3**	**3**

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-3. Habitat Suitability Scores, Lower Santa Rosa Creek. **Boldface** scores denote units where fish were sampled.

Santa Rosa Creek Lower Reach					
			Habitat Score*		
Unit #	Habitat Type	Length, ft	Fall 1993	Summer 1994	Fall 1994
1	pool	40	**3**	**1**	**3**
2	riffle	15	2	1	2
3	glide/pool	110	2	1	2
4	riffle	15	2	1	2
5	glide	60	2	1	2
6	glide	800	3	1	3
7	riffle	90	2	1	3
8	glide/pool	350	**3**	1	**3**
9	riffle	40	2	1	2
10	backwater pool	50	1	1	1
11	riffle	20	2	1	2
12	riffle w/ glide	80	3	1	3
13	pool/glide	2000	3	1	3
14	riffle	100	2	1	3
14a	pool	130	2	1	3
15	glide	400	3	1	3
16	riffle	50	2	1	2
17	pool/glide	500	3	1	3
18	riffle	35	1	**1**	**1**
19	glide/pool	300	3	1	3
20	riffle	50	2	1	3
21	glide	100	2	1	2
22	riffle w/glides	120	**2**	**1**	**2**
23	glide/riffle	120	3	1	3
24	braided riffle	80	**3**	**1**	**3**
24a	riffle (secondary)	80	**1**	**1**	**1**
25	glide/pool	200	2	1	3
26	glide	700	3	1	3
27	riffle	90	3	1	3
27a	side-channel pool	90	1	1	1
28	glide	400	2	1	2
29	riffle	70	1	1	3
30	glide/pool	350	3	1	3
31	riffle	36	2	1	2
32	glide	1200	3	**1**	**3**
33	riffle	60	2	1	3
34	glide	105	**2**	**1**	**3**
35	riffle	20	1	1	2
36	glide & riffle	125	2	1	3
37	riffle	100	2	1	2
38	glide & riffle	50	2	1	2
39	riffle	40	2	1	2
40	glide/pool	130	3	1	3

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-4. Habitat Suitability Scores, Upper Mark West Creek. **Boldface** scores denote units where fish were sampled.

Mark West Creek Upper Reach					
			Habitat Score*		
Unit #	Habitat Type	Length, ft	Fall 1993	Summer 1994	Fall 1994
1	glide	110	**3**	**1**	**3**
2	riffles/small pools	90	**2**	**1**	**2**
3	pool/glide	105	**3**	**2**	**3**
4	riffle	30	2	1	2
5	pool/glide	40	**3**	**2**	**3**
6a	braided riffle/cascade	15	2	1	2
6	braided riffle/cascade	20	2	1	2
7	pool/glide	30	**3**	**1**	**3**
7a	pool/glide	30	**2**	**1**	**2**
8	pool/glide	90	**3**	**3**	**3**
9	riffles/small pools	50	2	1	2
10	pool/glide	125	3	3	3
10a	glide	130	2	1	2
10b	riffle/small pools	75	2	1	2
10c	pool	40	3	1	3
11	riffles & pools	100	2	1	2
12	pool	170	3	3	3
13	riffle	40	2	1	2
14	pool	150	3	1	3
15	glide/riffle	30	2	1	2
16	pool	100	3	3	3
17	pool/glide	40	3	3	3
18	pool	10	3	1	3
19	pool	35	3	3	3

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-5. Habitat Suitability Scores, Middle Mark West Creek. **Boldface** scores denote units where fish were sampled.

Mark West Creek Middle Reach					
			Habitat Score*		
Unit #	Habitat Type	Length, ft	Fall 1993	Summer 1994	Fall 1993
1	pool	60	3	3	3
2	riffle & tiny pools	70	3	2	3
3	glide/pool	70	3	3	3
4	riffle	30	1	1	1
5	glide	50	3	2	3
6	braided riffle	40	2	1	2
7	glide/pool	40	3	3	3
8	pool	30	2	1	2
9	riffle & tiny pools	50	3	2	3
10	glide	100	3	3	3
11	riffle & tiny pools	30	3	2	3
12	glide/pool	95	**3**	**3**	**3**
13	riffle	25	2	1	2
14	glide	40	3	2	3
15	riffle & small pools	40	2	2	2
16	pool	150	3	3	3
17	riffle & tiny pools	50	2	2	2
18	pool/glide	80	**3**	**3**	**3**
19	riffle	80	2	1	2
20	glide	100	**3**	**3**	**3**
21	braided riffle	20	1	1	1
22	glide/pool	100	3	**3**	**3**
23	riffle	40	2	1	2
24	pool/glide	20	**3**	**3**	**3**
25	riffle/glide	30	2	1	2
26	pool/glide	220	**3**	**3**	**3**
26a	side pool	15	**2**	**1**	**2**
27	riffle	45	3	2	3
28	glide	25	1	1	1
28a	glide	100	3	1	3
29	glide	50	3	2	3
30	pool	50	3	3	3
30a	pool	45	3	3	3
31	pool/glide	90	3	3	3
32	glide/pool	150	2	1	2

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-6. Habitat Suitability Scores, Lower Mark West Creek. **Boldface** scores denote units where fish were sampled.

Mark West Creek Lower Reach					
			Habitat Score*		
Unit #	Habitat Type	Length, ft	Fall 1993	Summer 1994	Fall 1994
1	riffle	53	2	2	2
2	pool	300	3	3	3
2b	pool	100	3	3	3
3	riffle	15	2	2	2
4	glide	35	3	3	3
5	riffle	20	3	2	3
6	glide	45	2	2	2
7	riffle	20	2	2	2
8	pool	60	3	3	3
9	riffle	15	1	1	1
10	pool	30	3	3	3
11	riffle	20	1	1	1
12	pool/glide	135	3	3	3
13	riffle	45	2	2	2
14	pool	100	3	3	3
15	glide	20	2	2	2
16	pool	30	2	2	2
17	riffle	15	1	1	1
18	pool	225	3	3	3
19	riffle	30	1	1	1
20	pool	300	3	3	3
21	riffle	20	1	1	1
22	pool	65	3	3	3
23	riffle	20	1	1	1
24	riffle	40	1	1	1
25	pool	40	2	1	2
26	riffle	30	1	1	1
27	pool	113	**3**	**3**	**3**
28	riffle	125	**3**	**1**	**3**
29	riffle	40	1	1	1
30	pool/glide	300	3	3	3
31	pool	75	3	3	3
32	glide/pool	60	**3**	**3**	**3**
33	riffle	15	1	1	1
34	pool/glide	120	**3**	**3**	**3**
35	riffle	30	1	1	1
36	pool	100	**3**	**2**	**3**
37	riffle	40	1	1	1
38	pool	140	3	1	3

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-7. Habitat Suitability Scores, Upper Maacama Creek (Redwood Creek). **Boldface** scores denote units where fish were sampled.

Maacama Creek Upper Reach					
			Habitat Score*		
Unit #	Habitat Type	Unit Length, ft	Fall 1993	Summer 1994	Fall 1994
1L	pool	18	**3**	**1**	**3**
2l	glide	60	**3**	**1**	**3**
3L	pool	45	**3**	**3**	**3**
4L	glide	30	3	1	3
5L	riffle	60	3	1	3
6L	pool	40	3	3	3
7L	riffle & cascade	120	3	1	3
1	glide	90	**3**	**1**	**3**
2	riffle/glide	110	3	2	3
3	pool	45	**3**	**3**	**3**
4	riffle	65	3	1	3
5	glide	42	3	3	3
6	riffle	40	2	1	2
7	glide	25	3	1	3
8	riffle	18	2	1	2
9	pool	20	3	1	3
10	glide	83	3	1	3
11	riffle	25	2	1	2
12	glide	80	3	3	3
13	riffle & cascade	35	2	1	2
14	pool	23	3	3	3
15	pool formed by dam	115	3	3	3

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix4-1-8. Habitat Suitability Scores, Middle Maacama Creek. **Boldface** scores denote uints where fish were sampled.

Maacama Creek Middle Reach					
			Habitat Score*		
Unit #	Habitat Type	Unit Length, ft	Fall 1993	Summer 1994	Fall 1994
1	riffle & glides	50	3	2	2
2	glide	73	**3**	**3**	**3**
3	glide	50	**2**	**2**	**2**
4	riffle	20	1	1	1
5	pool/glide	105	**3**	**3**	**3**
6	glide & riffle	60	2	1	1
7	glide	75	2	1	1
8	riffle	30	1	1	1
9	glide	145	3	1	1
9a	side pool	75	**3**	**1**	**1**
10	glide	360	**3**	**1**	**2**
11	riffle, cascades	40	3	1	1
12	glide	85	2	1	1
13	riffle & cascade	25	2	1	2
14	glide	50	2	1	2
15	glide	170	3	1	3
16	glide	40	3	1	3
17	glide	125	3	2	3
18	riffle	30	1	1	1
19	glide	90	3	2	3
20	pool/glide	190	**3**	**3**	**3**

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-9. Habitat Suitability Scores, Lower Maacama Creek. **Boldface** scores denote units where fish were sampled.

Maacama Creek Lower Reach					
			Habitat Score*		
Unit #	Habitat Type	Unit Length, ft	Fall 1993	Summer 1994	Fall 1994
1	pool	146	**3**	**1**	**1**
2	riffle	50	1	1	1
3	pool	60	3	1	1
4	glide	728	3	1	1
5	riffle & glide	90	3	1	1
6	pool/glide	300	3	1	1
7	pool/glide	110	**3**	**1**	**1**
8	pool/glide	65	**3**	**2**	**1**
9	glide	60	**3**	**2**	**1**
10	pool	50	3	1	1
11	glide	120	3	1	1
12	riffle/glide	230	3	1	1
13	pool/glide	90	**3**	**2**	**1**
14	riffle	100	3	1	1
15	glide	150	3	1	1

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-1-10. Habitat Suitability Scores, Middle Green Valley Creek. **Boldface** scores denote units where fish were sampled.

Green Valley Creek Middle Reach					
			Habitat Score*		
Unit #	Habitat Type	Unit Length, ft	Fall 1993	Summer 1994	Fall 1994
1	pool	25	2	2	3
2	glide/riffle	50	3	2	3
3	pool	35	3	3	3
4	pool	45	3	3	3
5	glide	55	3	2	3
6	bedrock pool	20	**3**	**3**	**3**
7	cascades/pools	20	3	2	3
8	cascades	70	3	2	2
9	pool	20	2	1	1
10	glide/riffle	50	2	2	1
11	glide/pool	15	2	1	1
12	riffle	30	1	1	1
13	pool	100	**3**	**3**	**3**
14	pool	75	**3**	**3**	**3**
15	pool	60	**3**	**3**	**3**
16	cascades	20	2	2	2
17	pool/glide	65	**3**	**3**	**3**
18	glide	110	3	3	2

*3 = suitable; 2 = marginal; 1 = unsuitable

Appendix 4-2-1. Habitat Suitability Summary, Santa Rosa Creek

Upper Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	24	100	1315	100	24	100	1315	100	24	100	1315	100
Suitable	21	88	1235	94	8	33	605	46	21	88	1235	93
Marginal	1	4	40	3	13	54	630	48	2	8	65	5
Unsuitable	2	8	40	3	3	13	80	6	1	4	15	1

Middle Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	35	100	2296	100	35	100	2296	100	35	100	2296	100
Suitable	23	66	1871	81	13	37	1158	50	23	66	1158	50
Marginal	10	29	350	15	6	17	473	21	11	31	473	21
Unsuitable	2	6	75	3	16	46	665	29	1	3	665	29

Lower Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units				Habitat Units			
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	43	100	9501	100	43	100	9501	100	43	100	9501	100
Suitable	15	35	7140	75	0	0	0	0	24	56	8070	85
Marginal	22	51	2016	21	0	0	0	0	15	35	1176	12
Unsuitable	6	14	345	4	43	100	9501	100	4	9	255	3

Appendix 4-2-2. Habitat Suitability Summary, Mark West Creek

Upper Mark West Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	24	100	1655	100	24	100	1655	100	24	100	1655	100
Suitable	13	54	1045	63	6	25	335	20	13	54	1045	63
Marginal	11	46	610	37	2	8	130	8	11	46	610	37
Unsuitable	0	0	0	0	16	67	1190	72	0	0	0	0

Middle Mark West Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	35	100	2230	100	35	100	2230	100	35	100	2230	100
Suitable	22	63	1655	74	14	40	1220	55	22	63	1655	74
Marginal	10	29	500	22	9	26	425	19	10	29	500	22
Unsuitable	3	9	75	3	12	34	585	26	3	9	75	3

Lower Mark West Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	39	100	2986	100	39	100	2986	100	39	100	2986	100
Suitable	19	49	2403	80	15	38	2018	68	19	49	2403	80
Marginal	8	21	268	9	9	23	348	12	8	21	268	9
Unsuitable	12	31	315	11	15	38	620	21	12	31	315	11

Appendix 4-2-3. Habitat Suitability Summary, Maacama Creek

Upper Maacama Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	22	100	1189	100	22	100	1189	100	22	100	1189	100
Suitable	18	82	1071	90	7	32	390	33	18	82	1071	90
Marginal	4	18	118	10	1	5	110	9	4	18	118	10
Unsuitable	0	0	0	0	14	64	689	58	0	0	0	0

Middle Maacama Creek												
	Fall 1993				Summer 1994				Fall 1993			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	21	100	1888	100	21	100	1888	100	21	100	1888	100
Suitable	12	57	1463	77	3	14	368	19	7	33	793	42
Marginal	6	29	345	18	4	19	315	17	5	24	535	28
Unsuitable	3	14	80	4	14	67	1205	64	9	43	560	30

Lower Maacama Creek												
	Fall 1993				Summer 1994				Fall 1993			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	15	100	2349	100	15	100	2349	100	15	100	2349	100
Suitable	14	93	2299	98	0	0	0	0	0	0	0	0
Marginal	0	0	0	0	3	20	215	9	0	0	0	0
Unsuitable	1	7	50	2	12	80	2134	91	15	100	2299	100

Appendix 4-2-4. Habitat Suitabililty Summary, Green Valley Creek

Middle Green Valley Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Surveyed	18	100	865	100	18	100	865	100	18	100	865	100
Suitable	12	67	705	82	8	44	510	59	11	61	550	64
Marginal	5	28	130	15	7	39	290	34	3	17	200	23
Unsuitable	1	6	30	3	3	17	65	8	4	22	115	13

Appendix 4-2-5. Habitat Suitability Summary (Fished Units Only), Santa Rosa Creek.

Upper Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	5	100	360	100	5	100	360	100	5	100	360	100
Suitable	4	80	335	93	3	60	235	65	4	80	335	93
Marginal	0	0	0	0	1	20	100	28	1	20	25	7
Unsuitable	1	20	25	7	1	20	25	7	0	0	0	0

Middle Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	8	100	734	100	8	1	734	100	8	100	734	100
Suitable	8	100	734	100	6	75	523	71	8	100	734	100
Marginal	0	0	0	0	1	13	106	14	0	0	0	0
Unsuitable	0	0	0	0	1	13	105	14	0	0	0	0

Lower Santa Rosa Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units			
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	6	100	775	100	7	100	1660	100	8	100	2010	100
Suitable	3	50	470	61	0	0	0	0	5	63	1775	88
Marginal	2	33	225	29	0	0	0	0	1	13	120	6
Unsuitable	1	17	80	10	7	100	0	100	2	25	115	6

Appendix 4-2-6. Habitat Suitability Summary (Fished Units Only), Mark West Creek.

Upper Mark West Creek												
	Fall 1993				Summer 1994				Fall 1993			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	7	100	495	100	5	100	375	100	7	100	495	100
Suitable	5	71	375	76	1	20	90	24	5	71	375	76
Marginal	2	29	120	24	2	40	145	39	2	29	120	24
Unsuitable	0	0	0	0	2	40	140	37	0	0	0	0

Middle Mark West Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	6	100	530	100	7	100	630	100	7	100	530	100
Suitable	5	83	515	97	6	86	615	98	6	86	515	97
Marginal	1	17	15	3	0	0	0	0	1	14	0	0
Unsuitable	0	0	0	0	1	14	15	2	0	0	15	3

Lower Mark West Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	5	100	518	100	5	100	518	100	5	100	518	100
Suitable	5	100	518	100	3	60	293	57	5	100	518	100
Marginal	0	0	0	0	1	20	100	19	0	0	0	0
Unsuitable	0	0	0	0	1	20	125	24	0	0	0	0

Appendix 4-2-7. Habitat Suitability Summary (Fished Units Only), Maacama Creek.

Upper Maacama Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	5	100	258	100	5	100	258	100	5	100	258	100
Suitable	5	100	258	100	2	40	90	35	5	100	258	100
Marginal	0	0	0	0	0	0	0	0	0	0	0	0
Unsuitable	0	0	0	0	3	60	168	65	0	0	0	0

Middle Maacama Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	6	100	853	100	6	100	853	100	6	100	853	100
Suitable	5	83	803	94	3	50	368	43	3	50	368	43
Marginal	1	17	50	6	1	17	50	6	2	33	410	48
Unsuitable	0	0	0	0	2	33	435	51	1	17	75	9

Lower Maacama Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	4	100	411	100	5	100	471	100	5	100	411	100
Suitable	4	100	411	100	0	0	0	0	0	0	0	0
Marginal	0	0	0	0	3	60	215	46	0	0	0	0
Unsuitable	0	0	0	0	2	40	256	54	5	100	411	100

Appendix 4-2-8. Habitat Suitability Summary (Fished Units Only), Green Valley Creek.

Middle Green Valley Creek												
	Fall 1993				Summer 1994				Fall 1994			
	Habitat Units		Length, feet		Habitat Units		Length, feet		Habitat Units		Length, feet	
	Units	%	Feet	%	Units	%	Feet	%	Units	%	Feet	%
Fished	5	100	320	100	5	100	320	100	5	100	320	100
Suitable	5	100	320	100	5	100	320	100	5	100	320	100
Marginal	0	0	0	0	0	0	0	0	0	0	0	0
Unsuitable	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4-3-1. Santa Rosa Creek Juvenile Abundance Data.

Upper Santa Rosa Creek (Cougar Lane)									
		Fall 1993 survey		Summer 1994 survey				Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
1(lower)	pool	11-Nov-93	22	23-Jun-94	32	20-Jul-94	27	24-Oct-94	20
1(upper)	pool	11-Nov-93	19	23-Jun-94	31	20-Jul-94	30	24-Oct-94	16
2	riffle	11-Nov-93	0					24-Oct-94	0
3	pool	11-Nov-93	17	23-Jun-94	24	20-Jul-94	33	24-Oct-94	14
4	riffle	11-Nov-93	0			20-Jul-94	2	24-Oct-94	1
6(upper)	pool	11-Nov-93	13			20-Jul-94	25	24-Oct-94	14
6(lower)	pool	11-Nov-93	7			20-Jul-94	40	24-Oct-94	21

Middle Santa Rosa Creek (fish ladder to Hwy 12 bridge)							
		Fall 1993 survey		Summer 1994 survey		Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
1	pool	8-Nov-93	19	21-Jul-94	141	28-Oct-94	15
2+3	riffle/pool	8-Nov-93	3	21-Jul-94	12	28-Oct-94	1
5	pool	8-Nov-93	0	21-Jul-94	1	28-Oct-94	4
6	pool	8-Nov-93	12	21-Jul-94	24	28-Oct-94	3
19	pool	8-Nov-93	4	21-Jul-94	9	28-Oct-94	2
34	riffle/pool	9-Nov-93	0	21-Jul-94	0	28-Oct-94	0
35	pool	9-Nov-93	13	21-Jul-94	24	28-Oct-94	2

Lower Santa Rosa Creek (above and below Willowside bridge)							
		Fall 1993 survey		Summer 1994 survey		Fall 1994 survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
1	glide/pool	3-Nov-93	0	27-Jul-94	0	26-Oct-94	0
8(upper)	pool	13-Nov-93	0			26-Oct-94	0
18	riffle			27-Jul-94	0	26-Oct-94	0
22	riffle/glide	2-Nov-93	0	27-Jul-94	0	26-Oct-94	0
24A	riffle/glide	2-Nov-93	0	27-Jul-94	nh	26-Oct-94	0
24	riffle/glide	2-Nov-93	0	27-Jul-94	0	26-Oct-94	nh
32(upper)	glide/pool			27-Jul-94	0	26-Oct-94	0
34	glide/pool	2-Nov-93	1	27-Jul-94	0	26-Oct-94	0

Appendix 4-3-2. Mark West Creek Juvenile Abundance Data.

Upper Mark West Creek (Alpine Road)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
1	glide	12-Nov-93	0	18-Jul-94	nh	26-Oct-94	0
2	riffle	12-Nov-93	0	18-Jul-94	nh	26-Oct-94	0
3	pool	12-Nov-93	5	18-Jul-94	42	26-Oct-94	0
5	pool/glide	13-Nov-93	1	18-Jul-94	22	26-Oct-94	0
7	pool	13-Nov-93	1	18-Jul-94	nh	26-Oct-94	0
7A	pool	13-Nov-93	1	18-Jul-94	nh	26-Oct-94	0
8	pool	13-Nov-93	37	18-Jul-94	76	26-Oct-94	2

Middle Mark West Creek (downstream from Mark West Lodge)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
12	pool/glide	9-Nov-93	1	25-Jul-94	25	21-Oct-94	10
18	glide	9-Nov-93	7	25-Jul-94	55	21-Oct-94	11
20	pool	10-Nov-93	1	25-Jul-94	20	21-Oct-94	2
22	pool			25-Jul-94	55	21-Oct-94	13
24	pool/glide	10-Nov-93	1	25-Jul-94	28	21-Oct-94	8
26(middle)	glide	10-Nov-93	6	25-Jul-94	17	21-Oct-94	1
26(upper)	pool	10-Nov-93	1	25-Jul-94	34	21-Oct-94	17
26A	pool	10-Nov-93	0	25-Jul-94	nh	21-Oct-94	0

Lower Mark West Creek (River Road Bridge to Cunningham Ranch)							
		Fall 1993 Survey		Summer 1994 Survey		Fall 1994 Survey	
Habitat Unit	Habitat Type	Date Sampled	Total Trout	Date Sampled	Total Trout	Date Sampled	Total Trout
27	pool	30-Oct-93	6	26-Jul-94	2	20-Oct-94	2
28 (lower)	riffle	30-Oct-93	0	26-Jul-94	1	20-Oct-94	0
28 (upper)	riffle	30-Oct-93	2	26-Jul-94	0	20-Oct-94	0
32	glide	30-Oct-93	2	26-Jul-94	3	20-Oct-94	0
34	glide	30-Oct-93	2	26-Jul-94	0	20-Oct-94	0
36	pool	30-Oct-93	6	26-Jul-94	0	20-Oct-94	0

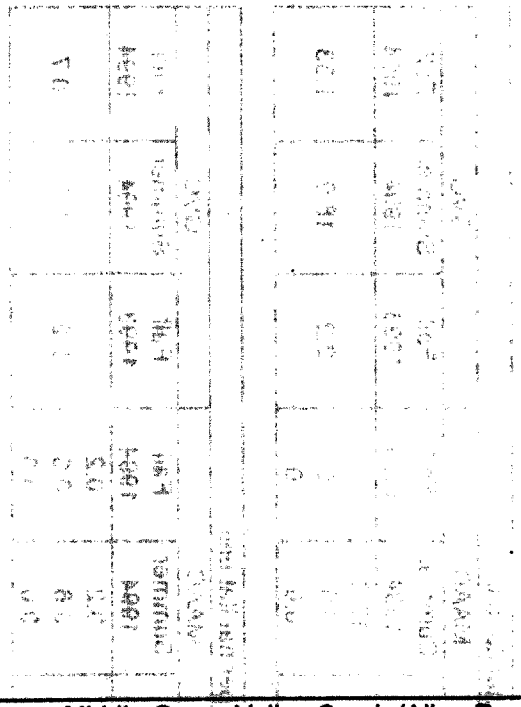
Appendix 4-3-3. Maacama Creek Juvenile Abundance Data.

Upper Maacama/Redwod Creek (Redwood Cr., Hwy 128 to Yellowjacket)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout
1L	pool	19-Nov-93	0	14	19-Jul-94	0	4	27-Oct-94	0	0
2L	glide	19-Nov-93	0	5	19-Jul-94	0	1	27-Oct-94	0	1
3L	pool	19-Nov-93	43	101	19-Jul-94	3	18	27-Oct-94	0	10
1	glide	19-Nov-93	1	2	19-Jul-94	0	2	27-Oct-94	0	0
3	pool	19-Nov-93	11	10	19-Jul-94	0	26	27-Oct-94	0	7

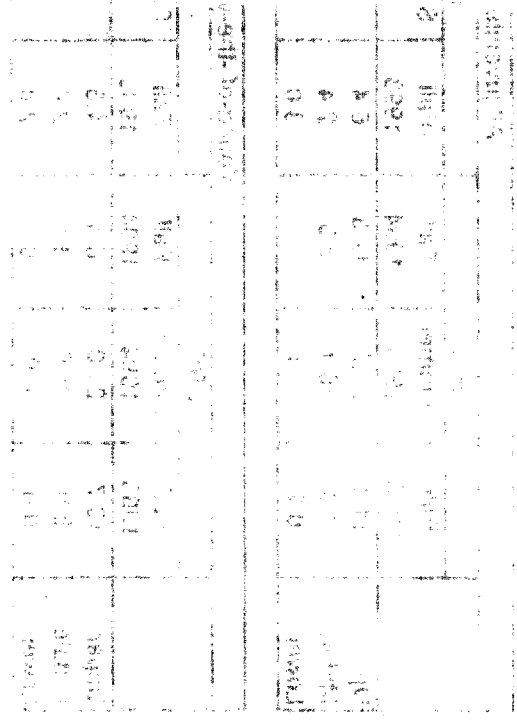
Middle Maacama/Redwood Creek (Camp Maacama)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout
2(lower)	pool	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
2(upper)	pool	20-Nov-93	0	1	22-Jul-94	0	22	27-Oct-94	0	0
3	glide	20-Nov-93	0	0	22-Jul-94	0	7	27-Oct-94	0	0
5	pool	20-Nov-93	0	1	22-Jul-94	0	0	27-Oct-94	0	0
9A	pool	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
10(upper)	glide	20-Nov-93	0	0	22-Jul-94	nh	nh	27-Oct-94	0	0
20(lower)	pool	20-Nov-93	0	0	22-Jul-94	0	0	27-Oct-94	0	0
20(upper)	pool	20-Nov-93	0	0	22-Jul-94	0	0	27-Oct-94	0	0

Lower Maacama/Redwood Creek (Chalk Hill Road)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout
1	pool	17-Nov-93	0	2	22-Jul-94	nh	nh	27-Oct-94	nh	nh
7	pool/glide	17-Nov-93	0	1	22-Jul-94	0	0	27-Oct-94	nh	nh
8(upper)	pool	18-Nov-93	0	3	22-Jul-94	nh	nh	27-Oct-94	nh	nh
9	pool				22-Jul-94	0	0	27-Oct-94	nh	nh
13	pool/glide	18-Nov-93	0	21	22-Jul-94	0	0	27-Oct-94	nh	nh

Appendix 4-3-4,.Green Valley Creek Juvenile Abundance Data.



Middle Green Valley Creek (Allen Ranch)										
		Fall 1993 survey			Summer 1994 survey			Fall 1994 survey		
Habitat Unit	Habitat Type	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout	Date Sampled	Total Coho	Total Trout
6	pool	22-Nov-93	1	0	28-Jul-94	1	12	31-Oct-94	1	2
13(lower)	pool	22-Nov-93	0	2	28-Jul-94	0	15	31-Oct-94	0	0
13(upper	pool	22-Nov-93	3	0	28-Jul-94	0	16	31-Oct-94	0	0
14	pool	22-Nov-93	0	0	28-Jul-94	0	5	31-Oct-94	0	6
15	pool	22-Nov-93	0	11	28-Jul-94	0	20	31-Oct-94	0	0
17(lower)	pool	22-Nov-93	0	0	28-Jul-94	0	40	31-Oct-94	0	0



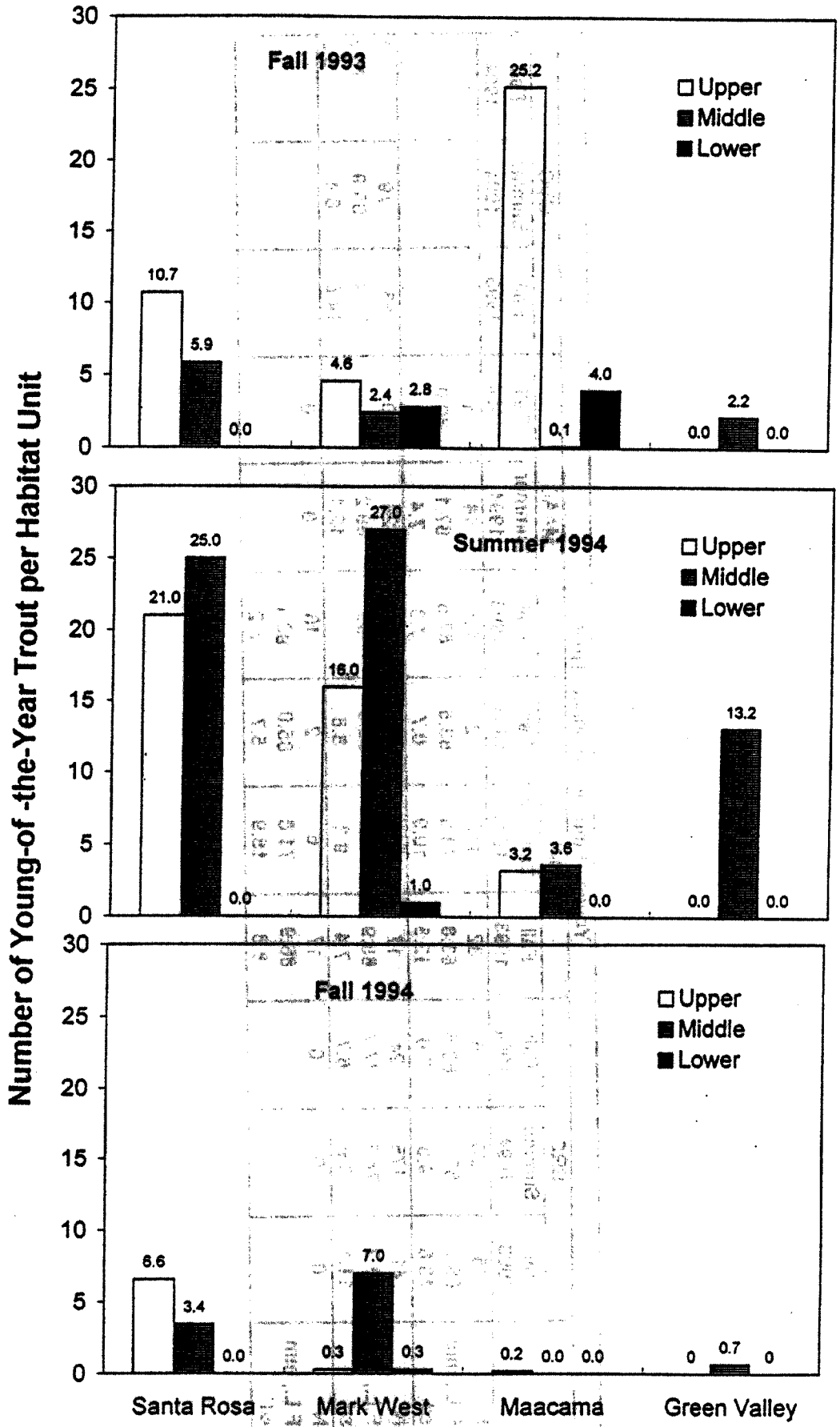
Appendix 4-3-5. Summary of Juvenile Rainbow Trout Abundance by Stream Reach and Age Class, Fall 1993, Summer 1994, and Fall 1994.

All juvenile Rainbow Trout, number per habitat unit												
	SRC			MWC			MAAC			GVC		
	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	11.1	26.2	12.3	6.4	20.0	0.28	26.4	10.2	3.6			
Middle	7.3	30.1	3.9	2.4	29.3	7.75	0.3	3.6	0	2.2	18.0	1.33
Lower	0.2	0.0	0	3.0	1.0	0.33	6.8	0.0	0			

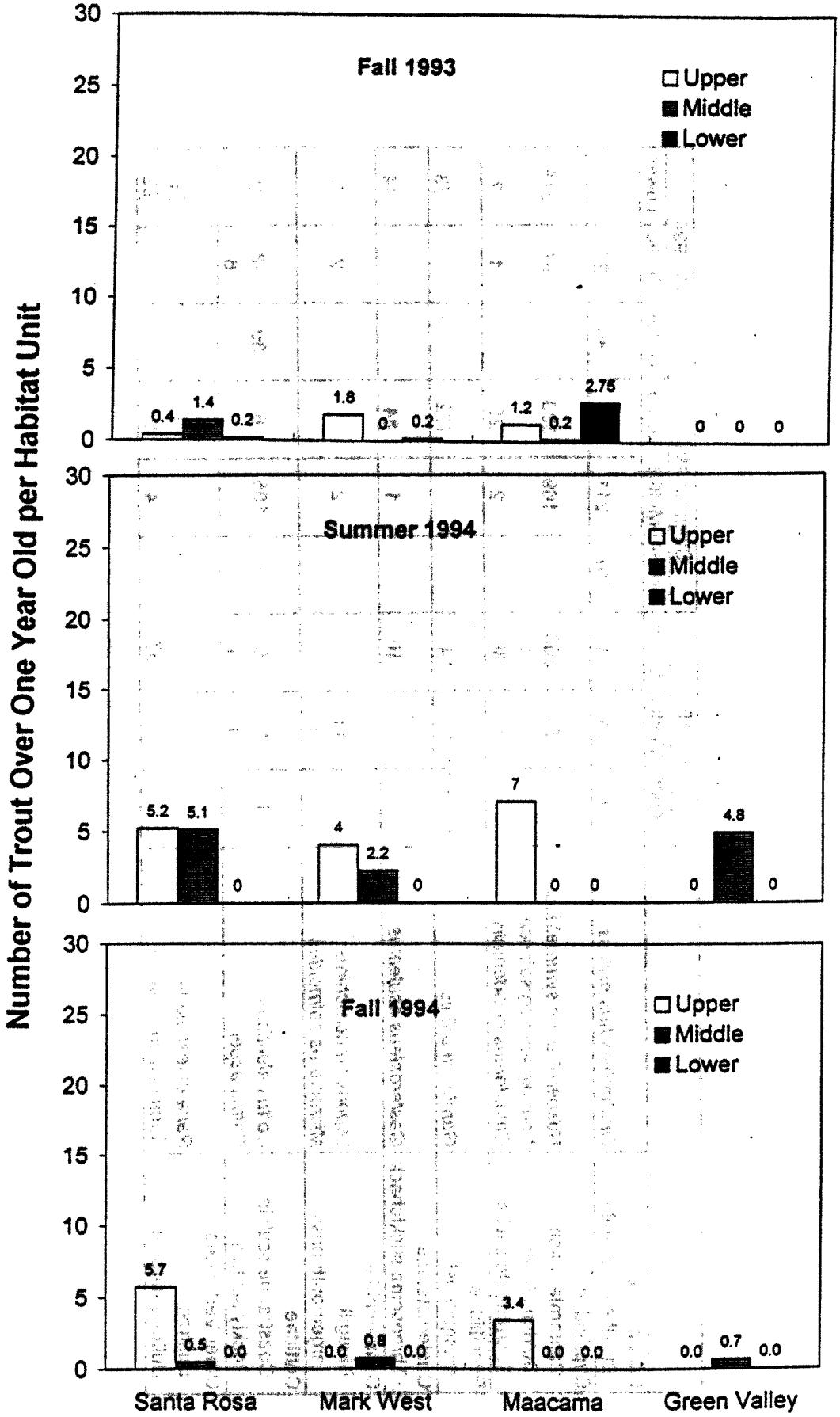
Young-of -the-year Rainbow Trout, number per habitat unit												
	SRC			MWC			MAAC			GVC		
	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	10.7	21.0	6.6	4.6	16.0	0.3	25.2	3.2	0.2			
Middle	5.9	25.0	3.4	2.4	27.0	7.0	0.1	3.6	0.0	2.2	13.2	0.7
Lower	0.0	0.0	0.0	2.8	1.0	0.3	4.0	0.0	0.0			

Appendix 4-3-6. Fork Lengths of Young-of-the-Year Rainbow Trout, Fall 1993, Summer 1994 and Fall 1994

		Young-of-the-year Rainbow Trout											
		SRC			MWC			MAAC			GVC		
		Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994	Fall 1993	Summer 1994	Fall 1994
Upper	N	75	126	46	32	112	2	126	16	1			
	F.L., mm	66.7	55.7	63.5	83.8	73.8	83.5	87.5	67.1	80.0			
	sd	10.6	9.3	7.0	12.3	10.9	0.7	7.3	7.4				
Middle	N	41	175	24	17	216	56	1	29	0	13	79	4
	F.L., mm	83.2	74.7	77.7	68.9	58.4	62.3	95	68.2		78.4	65.9	75.8
	sd	11.1	8.9	6.7	7.4	9.3	8.8		12.1		14.6	6.4	6.2
Lower	N	0	0	0	17	6	2	16	0	0			
	F.L., mm				86.9	71.8	85.0	98.1					
	sd				8.8	18.9	5.7	6.2					



Appendix 4-3-7. Young-of-the-Year Steelhead Abundance



Appendix 4-3-8. Abundance of Juvenile Steelhead Over One Year Old

Appendix 4-4-1. Santa Rosa Creek: Seine Catches of Various Species of Fish and Other Vertebrates, 1993-1994.

		Fall 1993			Summer 1994			Fall 1994		
		Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Salmonidae										
Steelhead juvenile	*Onchorhynchus mykiss*	78	51	1	157	211		86	27	
Cyprinidae										
California roach	*Hesperoleucus symmetricus*		74	803		169	330		97	215
Golden shiner	*Notemigonus crysoleucas*			1						
Sacramento sucker	*Catostomus occidentalis*		1	36		2	29		1	7
Poeciliidae										
Mosquitofish	*Gambusia affinis*			4			182			73
Gasterosteidae										
Threespine stickleback	*Gasterosteus aculeatus*			40		1	84			14
Centrarchidae										
Bluegill	*Lepomis macrochirus*		11			2			2	6
Largemouth bass	*Micropterus salmoides*		1						1	
Cottidae										
Coastrange sculpin	*Cottus aleuticus*	1	13	9	17	105	6	39	48	2
Prickly sculpin	*Cottus asper*		1	1					6	
Other Vertebrata										
Bullfrog	*Rana catesbeiana*						1			1
Bullfrog tadpole	*Rana catesbeiana*			57		4	94			92

Appendix 4-4-2. Mark West Creek: Seine Catches of Various Species of Fish and Other Vertebrates, 1993-1994.

		Fall 1993			Summer 1994			Fall 1994		
		Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Petromyzontidae										
Ammocete larva	*Lampetra sp.*									1
Salmonidae										
Steelhead juvenile	*Onchorhynchus mykiss*	45	17	18	140	234	6	2	62	2
Cyprinidae										
California roach	*Hesperoleucus symmetricus*	96	52	286	308	118	274	47	112	273
Catostomidae										
Sacramento sucker	*Catostomus occidentalis*			6						1
Poeciliidae										
Mosquitofish	*Gambusia affinis*			1						1
Gasterosteidae										
Threespine stickleback	*Gasterosteus aculeatus*			501			574			830
Centrarchidae										
Bluegill	*Lepomis macrochirus*				1	3		1		
Embiotocidae										
Tule perch	*Hysterocarpus traski*			1			14			3
Cottidae										
Coastrange sculpin	*Cottus aleuticus*	8	3	63	23	12	142	2	14	26
Other Vertebrata										
Bullfrog tadpole	*Rana catesbeiana*	1				45			60	

Appendix 4-4-3. Maacama Creek: Seine Catches of Various Species of Fish, 1993-1994.

		Fall 1993			Summer 1994			Fall 1994		
		Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
Salmonidae										
Coho salmon juvenile	*Onchorhynchus kisutch*	55			3					
Steelhead adult	*Onchorhynchus mykiss*				1			1		
Steelhead juvenile	*Onchorhynchus mykiss*	132	2	27	51	29		18	n	n
Cyprinidae									o	o
California roach	*Hesperoleucus symmetricus*		122	117		335	50			
Sacramento squawfish	*Ptychocheilus grandis*		1				8		c	c
Catostomidae									a	a
Sacramento sucker	*Catostomus occidentalis*		16	73		10	10		t	t
Gasterosteidae									c	c
Threespine stickleback	*Gasterosteus aculeatus*		178	521		360	25		h	h
Centrarchidae										
Bluegill	*Lepomis macrochirus*	2			41			54		
Smallmout bass	*Micropterus dolomieui*							1		
Embiotocidae										
Tule perch	*Hysterocarpus traski*					3				
Cottidae										
Coastrange sculpin	*Cottus aleuticus*	16		2	30	42	20	11		
Prickly sculpin	*Cottus asper*	1								

Appendix 4-4-4. Green Valley Creek: Seine Catches of Various Species of Fish and Other Vertebrates, 1993-1994.

		Fall 1993	Summer 1994	Fall 1994
Petromyzontidae				
Ammocete larva	*Lampetra sp.*		2	1
Salmonidae				
Coho salmon juvenile	*Onchorhynchus kisutch*	4	1	1
Steelhead juvenile	*Onchorhynchus mykiss*	13	108	8
Cyprinidae				
Golden shiner	*Notemigonus crysoleucas*		1	1
Gasterosteidae				
Threespine stickleback	*Gasterosteus aculeatus*	7	13	3
Centrarchidae				
Bluegill	*Lepomis macrochirus*	488	7	2
Green sunfish	*Lepomis cyanellus*	2	3	7
Largemouth bass	*Micropterus salmoides*	4	1	1
Cottidae				
Coastrange sculpin	*Cottus aleuticus*		79	16
Other Vertebrata				
Bullfrog tadpole	*Rana catesbeiana*	2	76	37
Rough-skinned newt	*Taricha granulosa*		1	

Appendix 5-1. Summary of Coho Salmon and Steelhead Trout Returns to the Warm Springs Hatchery, 1990-1994.

Month	Days	Coho Salmon				Steelhead Trout			
		1990-1991	1991-1992	1992-1993	1993-1994	1990-1991	1991-1992	1992-1993	1993-1994
November	1st-7th			1					
	8th-14th			1					
	15th-21st			1	10				
	22nd-30th	1	2	15	0				
December	1st-7th	1	7	120	68			1	2
	8th-14th	5	17	151	89			6	5
	15th-21st	58	18	33	25			0	4
	22nd-31st	7	99	60	47		5	1	32
January	1st-7th	2	8	145	10	1	13	116	47
	8th-14th	106	6	34	6	1	16	137	25
	15th-21st	27	2	10	25	4	14	110	20
	22nd-31st	2	0	6	123	7	69	153	201
February	1st-7th	65	0	0	5	45	71	334	37
	8th-14th	1	1	1	23	67	253	474	208
	15th-21st	2	1	0	5	28	178	279	188
	22nd-28th	0	0		11	22	166	274	185
March	1st-7th	1			2	101	198	184	123
	8th-14th					43	183	202	137
	15th-21st					38	211	68	192
	22nd-31st					29	96	112	148
April	1st-7th					19	77	37	67
	8th-14th					11	22	56	53
	15th-21st					2	17	99	34
	22nd-30th					5	5	29	52