PEER REVIEW DRAFT

Appendix 4

Fish and Fishery Resources of the Klamath River Basin

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1.1 Introduction

The Klamath River basin contains 83 species of fish, 45 of which are native to the Klamath drainage and 38 that have been introduced and are non-native. Fourteen of the native fish species in the basin have been granted special federal and/or state status (Table 1).

Table 1: Native Fish Species in the Klamath River Basin with Special Federal and/or State Status

SPECIES	STATUS
Shortnose sucker, *Chasmistes brevirostris*	Endangered-OR, CA, and Federal
Lost River sucker, *Deltistes luxatus*	Endangered-OR, CA, and Federal
Coho salmon, *Oncorhynchus kisutch*	Critical -OR; Threatened-CA and Federal;
Bull trout, *Salvelinus confluentus*	Critical-OR; Endangered-CA; Threatened-Federal
Delta Smelt, *Hypomesus transpacificus*	Threatened-CA and Federal
Coastal cutthroat trout, *Oncorhynchus clarki clarki*	Special Concern-CA
Eulachon, *Thaleichthys pacificus*	Special Concern-CA
Longfin smelt, *Spirinchus thaleichthys*	Special Concern-CA
Redband/Rainbow trout, *Oncorhynchus mykiss gairdneri*	Vulnerable-OR
Chum Salmon, *Oncorhynchus keta*	Special Concern-CA
Klamath largescale sucker, *Catostomus snyderi*	Special Concern-Federal
Slender sculpin, *Cottus tenuis*	Special Concern-Federal
Pacific Lamprey, *Lampetra tridentata*	Vulnerable-OR; Special Concern-Federal
Green sturgeon, *Acipenser medirostris*	Special Concern- CA and Federal

Sources: California Department of Fish and Game (CDFG) 2006b, p.4-6; National Research Council (NRC) 2004, p.181, 251, & 252; Oregon Natural Heritage Information Center (ONHIC) 2004, p.8-11.

The following discussion of fish species and resources in the basin is divided into three parts: fish species found above Iron Gate Dam in California and Oregon, fish species found from Iron Gate Dam to the Ocean in California, and Chinook, steelhead, and coho salmonids from Iron Gate Dam to the Ocean in California.

1.2 Fish above Iron Gate Dam in the Klamath River Basin, California and Oregon

The Klamath River basin above Iron Gate Dam hosts 18 native and 19 non-native fish species (Table 2). Native fish persisting in this area of the basin include lamprey, trout, and sucker species including the endangered shortnose and Lost River suckers. Introduced fish include various sunfish, catfish, and perch species.

Table 2: Fish Found Above Iron Gate Dam in the Klamath River Basin

NATIVE	
Klamath River lamprey, *Lampetra similis*	Klamath largescale sucker, *Catostomus snyderi*
Miller Lake Lamprey, *Lampetra milleri*	Klamath smallscale sucker, *Catostomus rimiculus*
Pit-Klamath brook lamprey, *Lampetra lethophaga*	Redband/Rainbow trout, *Oncorhynchus mykiss gairdneri*
Klamath tui chub, *Siphatales bicolor bicolor*	Bull trout, *Salvelinus confluentus*
Blue chub, *Gila coerulea*	Klamath Lake sculpin, *Cottus princeps*
Klamath speckled dace, *Rhinichthys osculus klamathensis*	Slender sculpin, *Cottus tenuis*
Shortnose sucker, *Chasmistes brevirostris*	Upper Klamath marbled sculpin, *Cottus klamathensis klamathensis*
Lost River sucker, *Deltistes luxatus*	

Table 2 (continued): Fish Found Above Iron Gate Dam in the Klamath River Basin

NON-NATIVE	
Goldfish, *Carassius auratus*	Brown trout, *Salmo trutta*
Golden shiner, *Notemigonus chrysoleucas*	Sacramento perch, *Archoplites interruptus*
Fathead minnow, *Pimephales promelas*	White crappie, *Pomoxis annularis*
Yellow bullhead, *Ameiurus natalis*	Black crappie, *Pomoxis nigromaculatus*
Brown bullhead, *Ameiurus nebulosus*	Green sunfish, *Lepomis cyanellus*
Black bullhead, *Ameiurus melas*	Bluegill, *Lepomis macrochirus*
Channel catfish, *Ictalurus punctatus*	Pumpkinseed, *Lepomis gibbosus*
Kokanee salmon, *Oncorhynchus nerka*	Largemouth bass, *Micropterus salmoides*
Brook trout, *Salvelinus fontinalis*	Yellow perch, *Perca flavescens*

Source: NRC 2004, p.181, 189; PacifiCorp 2004, p.4-5 to 4-7.

1.2.1 Distribution and Status of Native Fish

The following information on fish distribution and status is mainly derived from NRC 2004, p.181-193, with additional information taken from Behnke 1992, p.19, 20 and PacifiCorp 2004, p. 4-12, 4-13, and 4-33.

Four species of suckers inhabit the Klamath River basin above Iron Gate Dam. The shortnose and Lost River suckers are large, long-lived, late-maturing and live in lakes but spawn primarily in streams. Shortnose and Lost River suckers have been found in the reservoirs between Keno and Iron Gate Dam. The Klamath Tribes refer to the shortnose and Lost River suckers as qapdo and c'waam, respectively. These fish were a primary food source for the Klamath and Modoc Indians from historic times until the 1980s when severe declines in the fish populations caused the Klamath Tribes to close their fishery. Historically, Lost River and shortnose suckers were present in the Lost River and Klamath River above Iron Gate Dam and their tributaries (Moyle 2002, USFWS 2002 Appendix D as cited by NRC 2004, p.190, 191). Their current distribution and numbers have decreased from a combination of extirpations and redistribution through water management (NRC p.191). The Klamath Tribes historically harvested tens of thousands of pounds of c'waam and qapdo. Now they are restricted to a single fish each year for ceremonial purposes. Both species are currently on the federal, Oregon, and California endangered species list. Klamath smallscale suckers are considered to be rare in the Klamath River basin. The status of Klamath largescale suckers is poorly understood although it is surmised that lake populations are probably declining in abundance while river populations are probably abundant. Periodicity information for all four sucker species within the Klamath River basin in Oregon is presented in Figure 1.

Ancestors of the redband trout (resident rainbow trout) entered the Klamath River basin when it was connected to the Columbia basin via the Snake River, and coastal rainbow trout (steelhead) later entered the basin from the ocean. Redband/rainbow trout have persisted in the basin above Iron Gate Dam because of their ability to thrive in lake and stream conditions that would be lethal to most salmonids. Currently, redband/rainbow trout numbers are high in both lakes and rivers of the basin above Iron Gate Dam, and these trout support a strong summer fishery. Redband/rainbow trout are currently present in both Copco and Iron Gate Reservoir (Pacificorp 2004, p.4-53 – 4-55, 4-58).

The redband/rainbow trout population in the J.C. Boyle peaking reach (J.C. Boyle Dam to Copco 1 reservoir) supports a high quality recreational fishery and has been described by the National Park Service as highly productive and self-sustaining. In 1984 the adult population in the upper 6 miles of the reach was estimated as 890 fish per mile, and in the 5 miles below this area (near the Oregon-California border) the population was estimated to be 1,911 fish per mile. Populations in Shovel Creek are healthy according to CDFG surveys in the early 1990's. Periodicity information for redband/rainbow trout within the Klamath River basin in Oregon is presented in Figure 1.

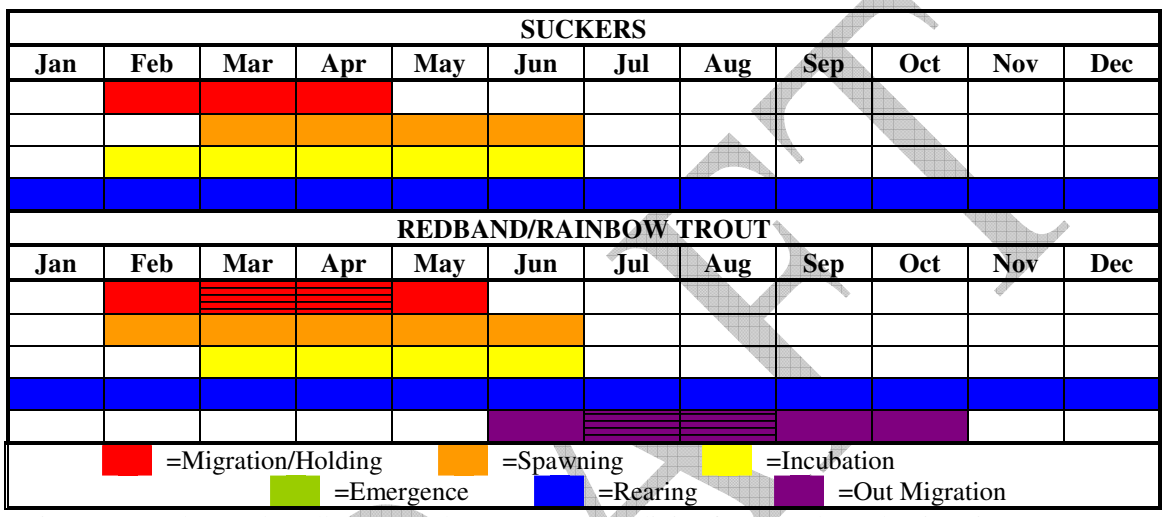

Figure 1: Sucker and Redband/Rainbow Trout Periodicity for the Klamath River in Oregon

= Lesser Use =Lesser Use

Source: FISHPRO 2000

Bull trout have been extirpated, or are at risk of extirpation, from most of the areas they once existed in the Klamath River basin. Bull trout are known to be or have been present in 10 creeks in the basin above Iron Gate Dam: four tributaries to the Sprague River, four tributaries to the Sycan River, and two tributaries to Upper Klamath Lake. The current distribution of bull trout is limited to the headwaters upstream of Upper Klamath Lake. Populations are listed as threatened by the federal government, critical by Oregon, and endangered by California.

The abundance of Klamath Lake sculpin in the basin above Iron Gate Dam is estimated to be in the millions. The presence of these sculpin has not changed from historical distributions and they are found in springs and creeks flowing into the west side of Upper Klamath Lake, Upper Klamath Lake, and Agency Lake. Upper Klamath marbled sculpin are the most widely distributed sculpin present in the basin. They are found in most streams and rivers in the Klamath River basin above Iron Gate Dam, and common in Upper Klamath Lake although they are largely absent from the reservoirs in California. Although slender sculpin were historically common in Upper Klamath Lake and the Williamson, Sprague, Sycan, and Lost Rivers, a survey conducted during the mid 1990's

found them to be present only in Upper Klamath Lake and the Lower Williamson River. Overall, the slender sculpin have disappeared from much of their native range, are uncommon in areas where they are present today, and are listed as a species of concern by the federal government.

Klamath River and Pit-Klamath brook lamprey are abundant and widespread in small streams of the basin above Iron Gate Dam. Klamath tui chub have decreased in abundance in the Lost River over the last 30 years, but are typically among the most abundant species found during fish kills in Upper Klamath Lake. Blue chub populations throughout the basin are in decline, however they are probably the most abundant native fish in Upper Klamath Lake. The status of Klamath speckled dace is currently unknown although it appears to be common in the basin with the exception of the Lost River.

1.2.2 Distribution and Status of Non-Native Fish

The following information on fish distribution and status is mainly derived from NRC 2004, p.188-189, with additional information taken from PacifiCorp 2004, p.4-30, 4-31.

Fifteen of the non-native species in the Klamath River basin above Iron Gate Dam were introduced for sport fishing or for bait. Most of these species are not common in the basin, although some are abundant and widespread. The effect of these fish on native fishes is poorly understood.

Yellow perch, brown bullhead, and pumpkinseed are abundant in the reservoirs, sloughs and ponds of the basin above Iron Gate Dam. Brook trout, brown trout, and non-native strains of rainbow trout are common in streams above Iron Gate Dam and have replaced native redband/rainbow trout and bull trout in many areas. Bullhead and perch are the most abundant non-native species found in Copco Reservoir, while Iron Gate Reservoir hosts large populations of perch, bass, and crappie. Non-native trout are also found in Iron Gate and Copco reservoirs. Fathead minnows are often the most abundant species encountered during fish sampling, and are common in Upper Klamath Lake and the Lost River system. Declines in tui and blue chub numbers have been associated with the increased presence of fathead minnows. Sacramento perch is also present in the Klamath River in the area from below Upper Klamath Lake to Iron Gate Reservoir and throughout the Lost River, although its numbers are not particularly high where present.

1.3 Fish below Iron Gate Dam in the Klamath River Basin, California

A total of 46 fish species (27 native and 19 non-native) are found in the Klamath River basin below Iron Gate Dam (Table 3). Native fish currently present in this region of the Klamath River include lamprey, sturgeon, sculpin, and salmonids including the state and federally listed coho salmon. Introduced fish include bass, bullheads, and several species of sunfish.

Table 3: Fish Found Below Iron Gate Dam in the Klamath River Basin

NATIVE	
Pacific Lamprey, *Lampetra tridentata**	Eulachon, *Thaleichthys pacificus**
River lamprey, *Lampetra ayersi**	Surf smelt, *Hypomesus pretiosus*
Klamath River lamprey, *Lampetra similes*	Longfin smelt, *Spirinchus thaleichthys**
Green sturgeon, *Acipenser medirostris**	Prickly sculpin, *Cottus asper*
White sturgeon, *Acipenser transmontanus**	Sharpnose sculpin, *Clinocottus acuticeps*
Klamath speckled dace, *Rhinichthys klamathensis osculus*	Coastrange sculpin, *Cottus aleuticus*
Klamath smallscale sucker, *Catostomus rimiculus*	Pacific staghorn sculpin, *Leptocottus armatus*
Shiner perch, *Cymatogaster aggregata*	Lower Klamath marbled sculpin, *Cottus klamathensis polyporus*
Starry flounder, *Platichthys stellatus*	Threespine stickleback, *Gasterosteus aculeatus***
Pacific herring, *Clupea pallasi*	Arrow goby, *Clevelandia ios*
Topsmelt, *Atherinops affinis*	Pink salmon, *Oncorhynchus gorbuscha**
Coho salmon, *Oncorhynchus kisutch**	Steelhead (rainbow trout), *Oncorhynchus mykiss**
Chinook salmon, *Oncorhynchus tshawytscha**	Coastal cutthroat trout, *Oncorhynchus clarki clarki**
Chum salmon, *Oncorhynchus keta**	
NON-NATIVE	
American shad, *Alosa sapidissima**	Sockeye salmon, *Oncorhynchus nerka*
Goldfish, *Carassius auratus*	Bluegill, *Lepomis macrochirus*
Fathead minnow, *Pimephales promelas*	Pumpkinseed, *Lepomis gibbosus*
Golden shiner, *Notemigonus chrysoleucas*	Largemouth bass, *Micropterus salmoides*
Brown bullhead, *Ameiurus nebulosus*	Spotted bass, *Micropterus punctulatus*
Yellow bullhead, *Ameiurus natalis*	Smallmouth bass, *Micropterus dolomieui*
Wakasagi, *Hypomesus nipponensis*	Yellow perch, *Perca flavescens*
Green sunfish, *Lepomis cyanellus*	Delta smelt, *Hypomesus transpacificus*
Brook trout, *Salvelinus fontinalis*	Brown trout, *Salmo trutta***

*Anadromous.
**Some anadromous, some non-migratory
Source: NRC 2004, p.251-253; PacifiCorp 2004, p.4-5 to 4-7.

1.3.1 Distribution and Status of Native Fish

Unless otherwise noted, the following information on fish distribution and status is derived from NRC 2004, p.252-277. Chinook and coho salmon, and steelhead trout habitat and distribution, populations, and periodicity are discussed in great detail in section 1.4.

Anadromous species present in the Klamath River basin below Iron Gate Dam include Chinook, coho, pink, and chum salmon, steelhead and coastal cutthroat trout, eulachon, white and green sturgeon, and Pacific lamprey.

Chum salmon are periodically observed in the basin, and maintain a small population in the Klamath River. Historically chum were more abundant, although their numbers were never very large. Coastal cutthroat trout mainly occur in smaller tributaries in the lower 22 miles of the Klamath River, and have been observed in tributaries to the Trinity River. Pink salmon probably once existed in the Klamath River, although they appear to be extirpated from all areas in California and only occasionally stray into streams along the California coast. In 2003, 2 pink salmon fry were found in the Klamath River between Iron Gate Dam and the Interstate 5 bridge (Corum 2006).

Spring/summer steelhead were once widely distributed in the Klamath River and Trinity River basins and were present in the headwaters of most larger tributaries. Their

numbers have declined from historic levels, and NMFS considers stocks depressed and in danger of extinction. Fall and winter steelhead are currently widely distributed in the basin below Iron Gate Dam. Their numbers are believed to be declining from historic levels although past and present estimates of abundance are not readily available. NMFS considers winter steelhead to be in low abundance and at some risk of extinction (Busby et al. 1994 as cited by NRC 2004, p.233), but has not listed them under the ESA (NRC 2004, p.274).

Spring and fall run Chinook populations and distribution have decreased dramatically since the early 1900's. Historically, spring Chinook were found in tributaries throughout the basin, although they are now only present in the Salmon and Trinity Rivers. Large numbers of fall Chinook used to spawn in the basin above Iron Gate Dam, but no longer have access to these areas. In the early 1900's as many as 100,000 spring Chinook were found in the basin, but current populations range from 100 to 1000 fish. Fall Chinook populations have also declined as is evidenced by the Shasta River run which were around 80,000 fish in the 1930's and in the last 10 years have generally been well below 10,000 fish.

Coho were once abundant and widely distributed in the Klamath River and its tributaries at least as far up as Spencer Creek in Oregon (Hamilton et. al. 2005, p.16). Trinity River wild coho stocks have experienced a 96% decline in numbers from historic levels. Coho in the Klamath River basin are currently on the state and federal endangered species lists due to the long-term decline in numbers and distribution.

Eulachon were historically present in large numbers in the lower 8 miles of the river, however since the 1970's their numbers have been too low to support the once flourishing tribal fishery. It is estimated that 70-80% of all green sturgeon are produced in the lower Klamath and Trinity Rivers where several hundred are taken every year by the tribal fishery. There is some evidence that green sturgeon numbers in the basin below Iron Gate Dam have decreased in recent years, although a proposal to list them as threatened was declined by the NMFS in 2003. At the present time they are listed as a species of special concern by the federal government. The historic distribution of Pacific lamprey is unknown, however it is certain that they entered the area above Klamath Falls, Oregon in the basin above Iron Gate Dam at least occasionally. Today Pacific lamprey populations are declining in all coastal rivers, and they are listed as a species of concern by the federal government.

Non-anadromous species common in the Klamath River below Iron Gate Dam and its low gradient tributaries include speckled dace, Klamath smallscale suckers, lower Klamath marbled sculpin, threespine stickleback, and Klamath River lamprey. Dace, stickleback, sculpin, and suckers probably utilize nutrients brought into the streams by anadromous species, and may suffer heavy predation by juvenile salmonids.

1.3.2 Distribution and Status of Non-Native Fish

The following information on non-native fish distribution and status is derived from NRC 2004, p.236-237.

The Klamath River basin below Iron Gate Dam is dominated by native fish, although non-native species have a stronger presence in highly altered areas such as reservoirs and ponds. Large populations of brown bullhead and other non-natives are present in the Shasta River due to introductions and the warmth of these waters. Non-native fish continually enter the Klamath River below Iron Gate Dam from the basin above the Dam where they are extremely abundant (NRC 2004, p.277).

1.4 Chinook salmon, steelhead trout, and coho salmon below Iron Gate Dam in the Klamath River Basin, California

Anadromous salmonids in the Klamath River basin are limited to the area of the basin within California below Iron Gate Dam, which is a barrier to anadromy. Anadromous salmonid runs currently utilizing this portion Klamath River basin include spring and fall Chinook, coho salmon, and spring/summer, fall, and winter steelhead trout. Some authors recognize three runs of steelhead in the basin based on the timing of their entrance to the estuary and tributaries (Hopelain 1998; Shaw et al. 1998; Trihey and Associates, Inc. 1996; USFWS 1979), while others recognize two runs based on sexual maturity at the time of entrance to the river (Hardy 1999; Hardy and Addley 2006; KRBFTF 1991; Moyle 2002). This appendix discusses steelhead based on three runs: spring/summer, fall, and winter. All six salmonid runs in the Klamath River basin have experienced declines in populations and distribution since the early 1900's. The decline of anadromous species in the basin can be attributed to a variety of factors including over harvest, land-use practices, mining, stream habitat alterations, agriculture, and changes in water quality and temperature (Hardy and Addley 2006, p.7). Significant effects are also attributed to water allocation practices and dam construction, which has altered flow regimes (Hardy and Addley 2006, p.7). The following discussion reviews the habitat and distribution, status, and periodicity of these six salmonid runs.

1.4.1 Habitat and Distribution

The information in this section was synthesized from the following sources: CDFG 1965, p.369; Hamilton et al. 2005; Hardy 1999, p.19, 20; Hardy and Addley 2006, p.3, 5, 10-20; and NRC 2004, p.289, 290, 295, & 296.

The continued survival and persistence of sustainable populations of salmonids in the Klamath River basin depends on the amount and suitability of the habitat. Historically, anadromous species within the basin extended above Upper Klamath Lake in Oregon, and into the Sprague and Williamson River systems and other tributaries. Chinook salmon historically migrated into tributaries of Upper Klamath Lake, and steelhead trout were found in the Klamath River basin above Iron Gate Dam as well. Coho salmon distribution extended at least to the vicinity of Spencer Creek.

In 1918, the completion of Copco No.1 Dam on the Klamath River became the first migration barrier for anadromous species and eliminated over 100 miles of potential anadromous fish habitat in the basin. However, reduced access to tributaries in the upper areas of the Klamath River basin likely occurred as early as 1912-1914 when the Lost River diversion canal and Chiloquin Dam were constructed (Hardy and Addley 2006, p.5). The final barrier to upstream migration in the mainstem Klamath River occurred in 1962 with the completion of Iron Gate Dam. The construction of Lewiston and Trinity dams on the Trinity River in 1963 blocked access to over 109 miles of salmonid spawning habitat. Dwinnell dam was constructed on the Shasta River in 1926 and created a barrier to migration, blocking access to 22% of the historical salmonid spawning habitat.

A habitat survey published by the CDFG in 1965 found that there were 805 miles of habitat in the Klamath River basin below Iron Gate Dam suitable for Chinook, 813 miles of habitat suitable for coho, and 1,616 miles of habitat suitable for steelhead. More current information from Hardy and Addley estimate that there are about 701 miles of Chinook, 786 miles of coho, and 1121 miles of steelhead habitat in the basin below Iron Gate Dam.

The following figures show the current distribution of Chinook (Figure 2), steelhead (Figure 3), and coho (Figure 4) runs in the Klamath River basin as well as the areas where these species have been extirpated in the basin. These figures are based on readily available data and thus do not necessarily reflect all locations of presence or areas of extirpation. Rather, the figures show the general decrease in the distribution of salmonids in the basin from historic levels. Locations at which fish presence is not indicated on the map do not necessarily indicate the absence of fish in these areas, as surveys to determine presence/absence may not have been conducted at all locations within the basin.

"Spring Chinook have been known to occupy the lower reaches of many mid-Klamath tributaries during their adult migration (Cyr 2006)." In addition to those areas shown in Figure 2, spring Chinook are occasionally found in very small numbers in the following locations: Beaver Creek, Lower Scott River, and Bogus Creek (Brucker 2006; USFS 2006). The occasional presence of spring Chinook in tributaries of the Klamath River above the Salmon River in very low, dwindling numbers, reflects the fact that they are at high risk of extirpation from these areas.

It is believed that fall and spring Chinook and coho, in addition to steelhead, were once present above Dwinnell Dam on the Shasta River. Hardy and Addley (2006, p.12) report that Dwinnell Dam blocked access to habitat that was historically utilized by steelhead in the headwaters of the Shasta River, and thus Figure 3 reflects steelhead extirpation above Dwinnell Dam. The NRC (2004, p.289) state that the construction of Dwinnell Dam blocked access to 22% of the historical salmonid habitat above the dam. However, to date no reference was found which specifically stated the historic presence of Chinook or coho above Dwinnell Dam, though the habitat was suitable for their presence in many tributaries above the dam.

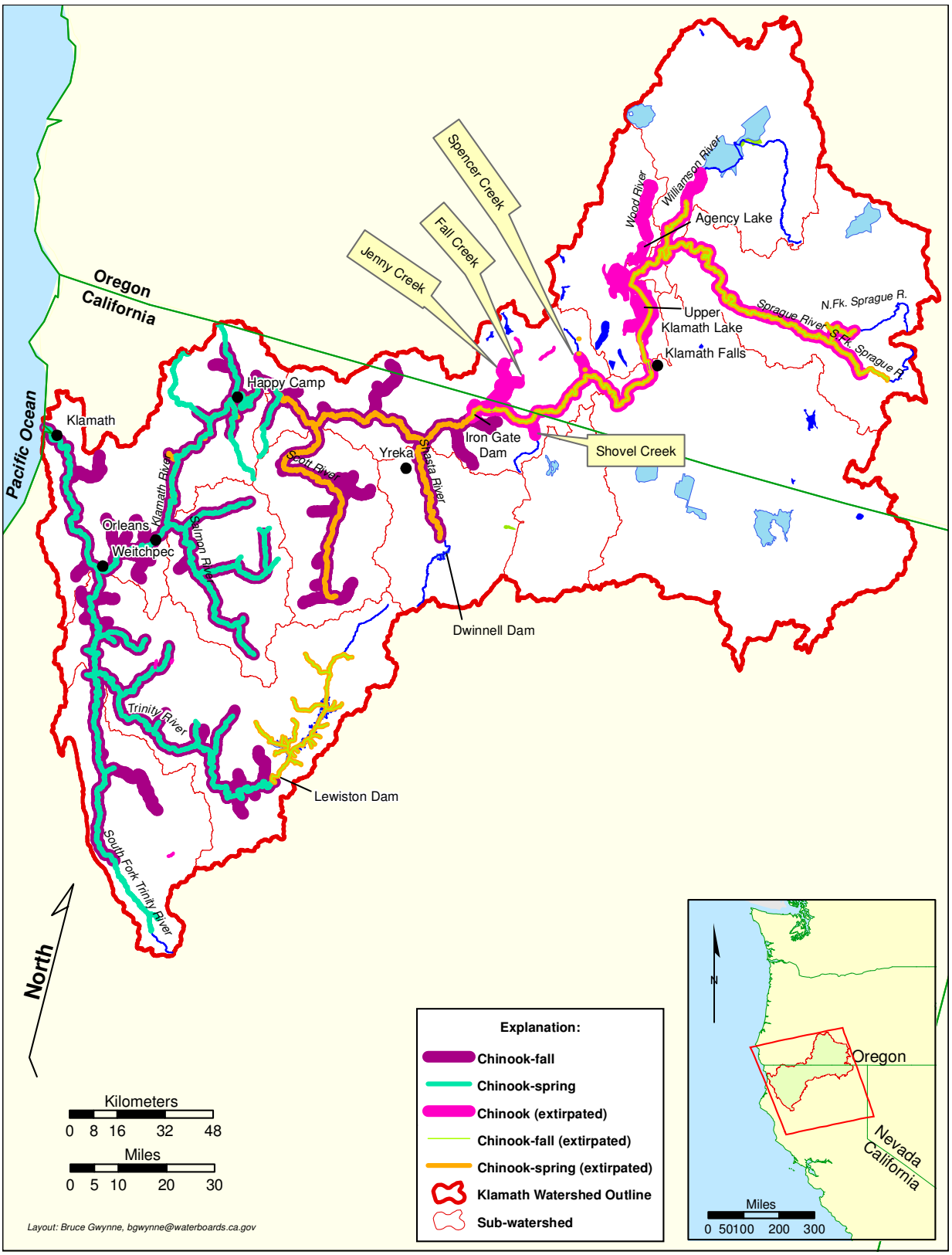

Figure 2: Current Distribution and Areas of Extirpation of Chinook Salmon Runs in the Klamath River Basin
Note: The data for "Chinook (extirpated)" did not differentiate between fall and spring Chinook runs.
Sources: Hamilton et al. 2005, p.12; Moffett and Smith 1950, p.23 & 27; Moyle 2002, p.259; USFS 1996; USFS 2006.

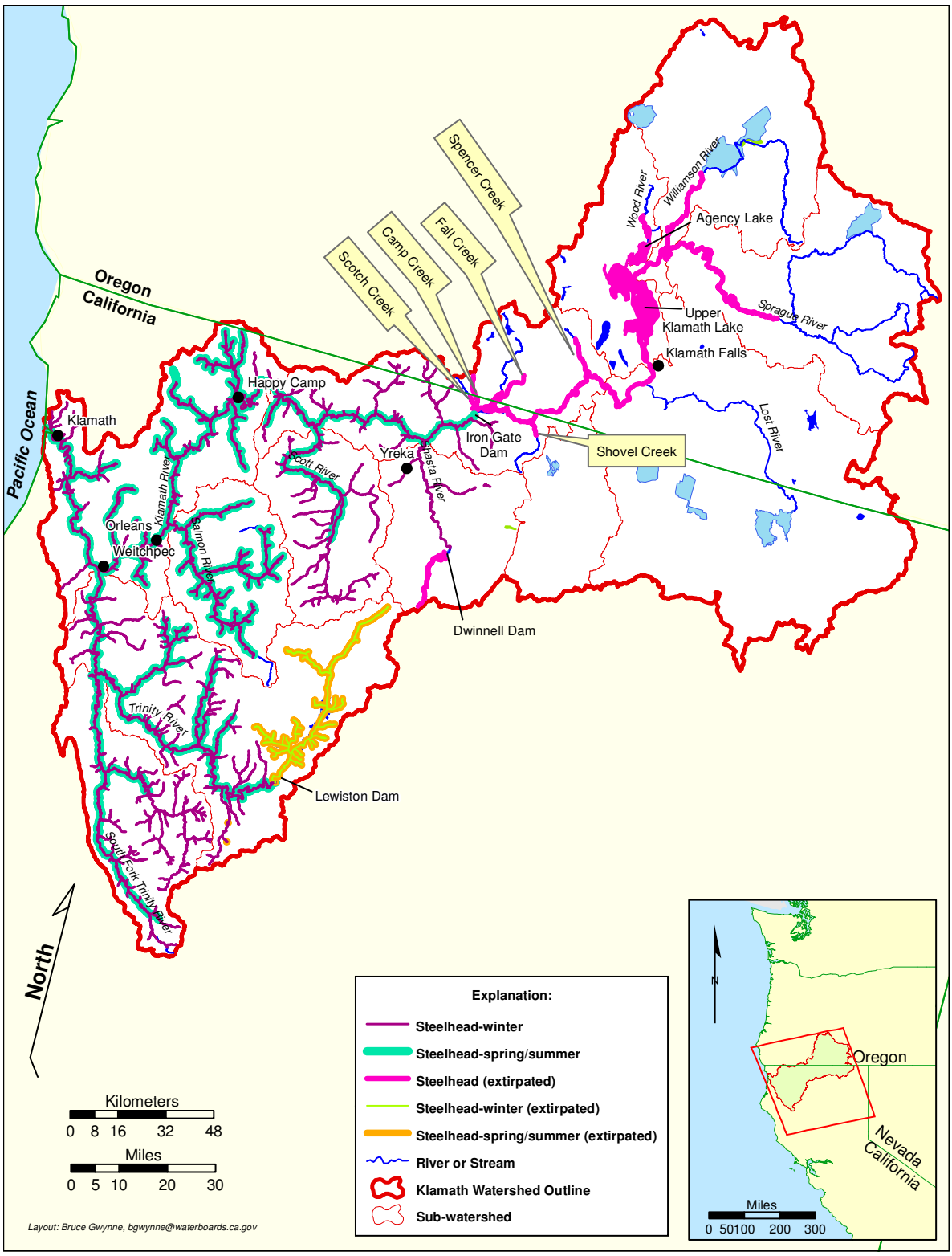

Figure 3: Current Distribution and Areas of Extirpation of Steelhead Trout Runs in the Klamath River Basin
Note: The data for "Steelhead (extirpated)" did not differentiate between spring/summer, fall, and winter runs. The USFS recognizes only winter steelhead (as opposed to fall and winter) and thus information for "Steelhead-winter" and "Steelhead-winter (extirpated)" included data on both fall and winter steelhead runs.
Sources: Hamilton et al. 2005, p.12; Hardy and Addley 2006, p.12; Rushton 2005, p.16 & 17; USFS 1996.

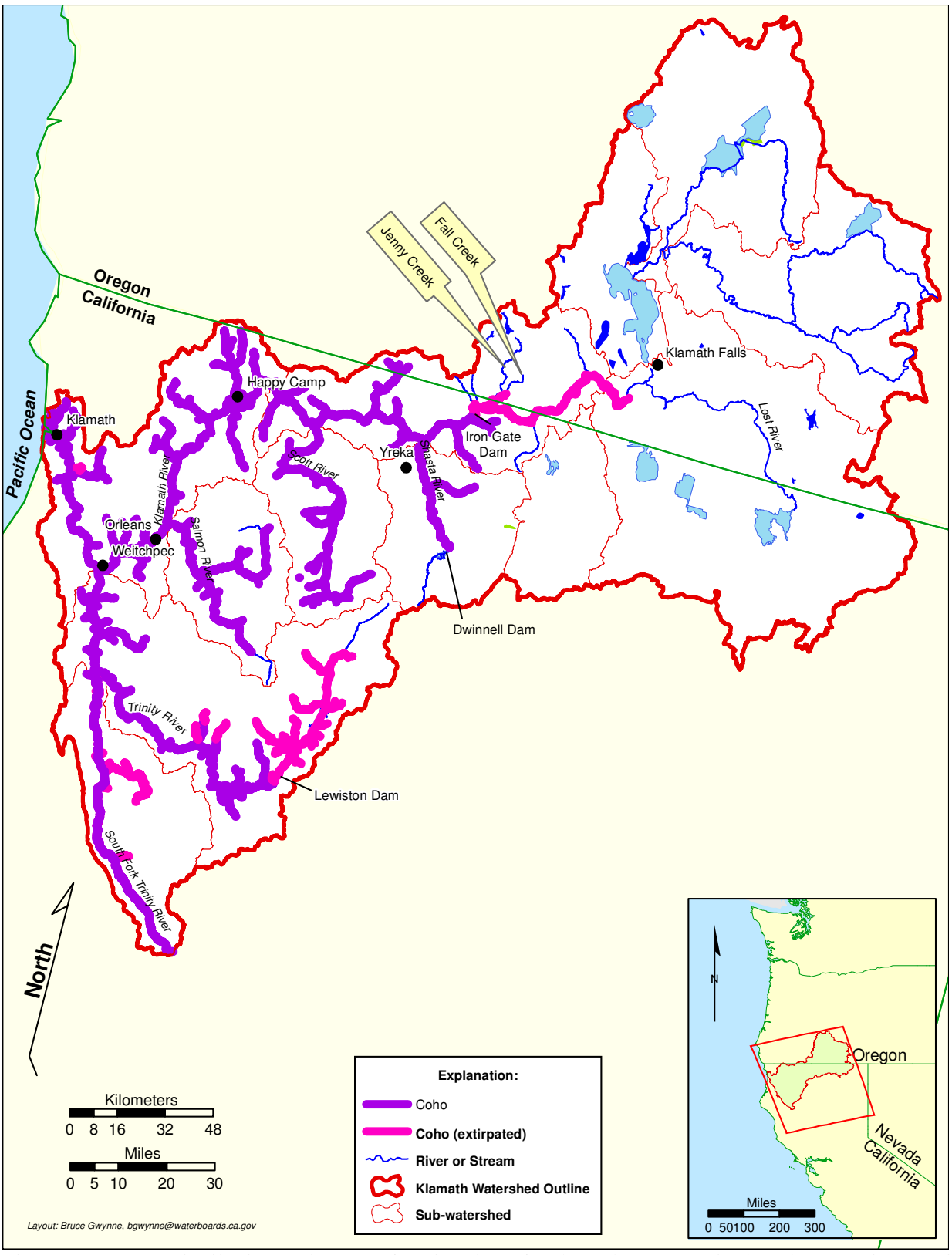

Figure 4: Current Distribution and Areas of Extirpation of Coho Salmon Runs in the Klamath River Basin
Sources: Brown and Moyle 1991, p.14; Brown et al. 1994, p.243; CDFG 2002, p.42; Cyr 2006; Hamilton et al. 2005, p.12; USFS 1996.

1.4.2 Populations

Salmonid populations in the Klamath River basin have declined since the early 1900s. During the period from 1876 to 1933 the salmon runs entering the Klamath River supported a large commercial fishery and several canneries near the mouth of the river (Moyle 2002, p.258). In 1931, Snyder wrote that the fishery of the Klamath River basin is very important because with proper management it can be maintained, although he also states that depletion of the Klamath salmon is apparent and occurring at an "alarming rate" which artificial propagation alone may not remedy (Snyder 1931, p.9, 121). Utilizing information from Snyder (1931), the NRC (2004, p.267, 268) estimated that the annual total catch in the Klamath River basin during the period from 1916-1927 was probably 120,000 to 250,000 fish, and thus the number of potential spawners was considerably higher. Although historically there were large runs of salmonids in the basin, data indicate that current populations are much lower than historic levels.

1.4.2.1 Chinook Salmon

Historic and current records reflect that Chinook salmon were, and continue to be, the most abundant anadromous species in the Klamath River basin. An approximation of total annual catch plus escapement for the period from 1915-1928 estimated there were 300,000 to 400,000 Chinook in the basin (Rankle 1982 as cited by Hardy and Addley 2006, p.7). An estimate of spawner abundance from CDFG in 1965 estimated that on average there were 168,000 Chinook per year in the Klamath River basin (CDFG 1965, p.369). In 1972, Coots estimated that 148,000 Chinook entered the basin (Coots 1973 as cited by Hardy and Addley 2006, p.7).

1.4.2.2 Fall Chinook Salmon

Overall, fall Chinook numbers in the Klamath River basin have dramatically declined during the past century (Hardy and Addley 2006, p.7). The fall Chinook run once totaled as many as 500,000 fish annually (Moyle 2002, p.258). Fall Chinook numbers in the Shasta River watershed alone, historically numbered 20,000-80,000 fish per year (Regional Water Board 2006, p.1-25). Fall Chinook population estimates in the Klamath River basin for the period from 1978-2007 have ranged from a high of 239,559 fish in 1987 to fewer than 35,000 fish in 1991 (Figure 5). In 2002 it was estimated that the fall Chinook population in the basin was 170,014 fish, of which approximately 32,533 were killed (97.1% of the total fish killed) in mid to late September due to a combination of factors including disease, high water temperatures, and low river flow (CDFG 2004, p.III; USFWS 2003a, p.ii; USFWS 2003b, p.ii). This conservative estimate of the number of fall Chinook killed in 2002 is figured from the number of dead fish observed in the area of the fish kill and does not included dead fish that were washed out of the estuary or settled too deep in the water to be visible during surveys (USFWS 2003b, p.1-7). Thus, the estimate of 32,533 dead fall Chinook (19% of the estimated population in 2002) is very conservative and it is likely the actual number of fall Chinook killed was much higher (CDFG 2004, p.III, 158; USFWS 2003b, p.13). Information for 2007 reflect a total estimated run size of 132,167 fall Chinook in the Klamath River basin (CDFG 2008). NRC (2004, p.268) states that in some respects, "…it is remarkable that fall-run Chinook salmon in the Klamath River are doing as well as they seem to be. Both adults migrating

upstream and juveniles moving downstream face water temperatures that are bioenergetically unsuitable or even lethal."

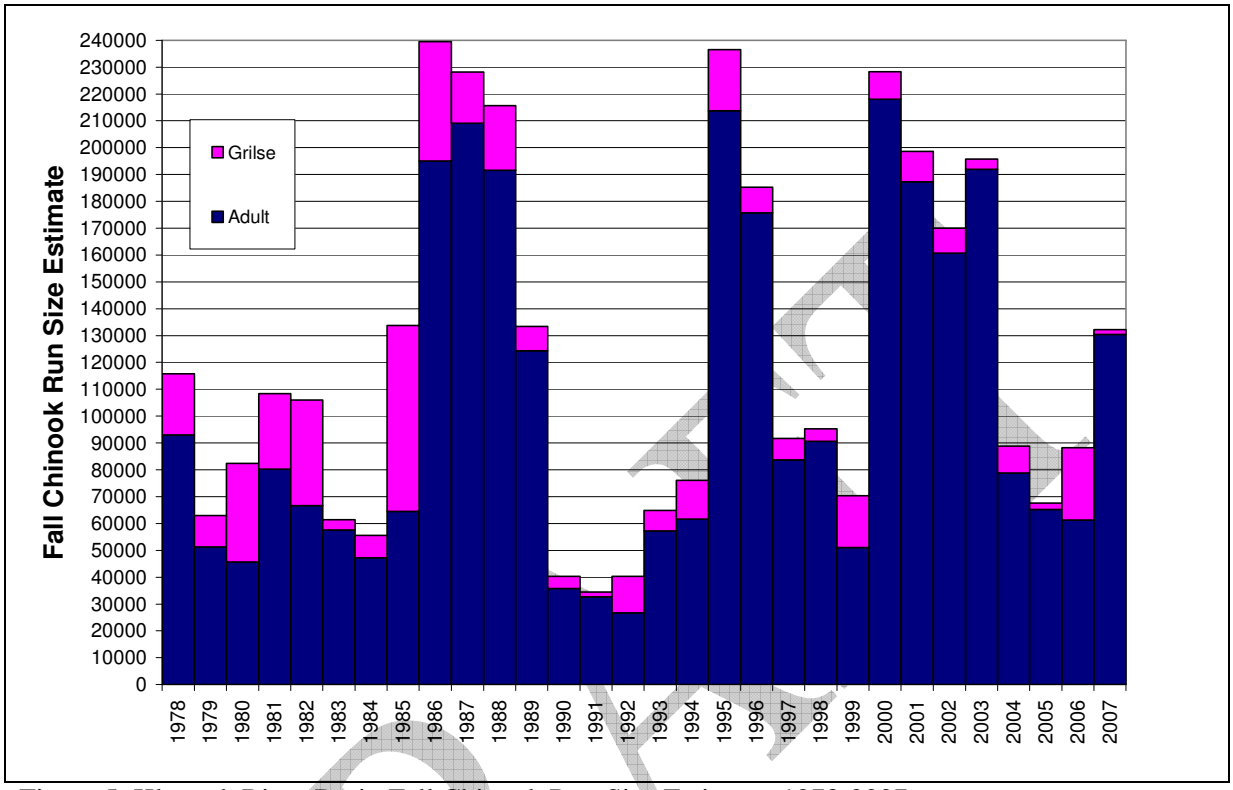

Figure 5: Klamath River Basin Fall Chinook Run Size Estimate, 1978-2007
Note: Run size estimate includes hatchery spawners, natural spawners, and in-river harvest totals. Data from 2007 is preliminary. Grilse are Chinook that return to freshwater to spawn after spending only one year in the ocean.
Source: CDFG 2008

Hatchery returns to Iron Gate and Trinity River hatcheries comprised 6-44% of the fall Chinook populations during the period from 1978-2007 (CDFG 2008). Natural spawners in the Klamath River and its tributaries comprised and estimated 13-39% (Figure 6) of the population during 1991-2007 (CDFG 2008). During 2004 and 2005 the estimated number of fall Chinook natural spawners in the basin has fallen below the Pacific Fishery Management Council goal of a minimum of 35,000. Natural spawning numbers in the basin during these years was estimated to be 28,516 and 27,857 respectively.

In 2006, the National Marine Fishery Service expected the number of natural spawners to be below 35,000 and established an emergency management measure, which closed a majority of the commercial fisheries and greatly reduced the recreational fishery from Cape Falcon, OR, to Point Sur, CA during the period from May 1 through August 31, 2006 (Federal Register 2006, p.26254, 26257). The actual number of natural spawners returning to the Klamath River basin in 2006 (as estimated by CDFG) was 44,546.

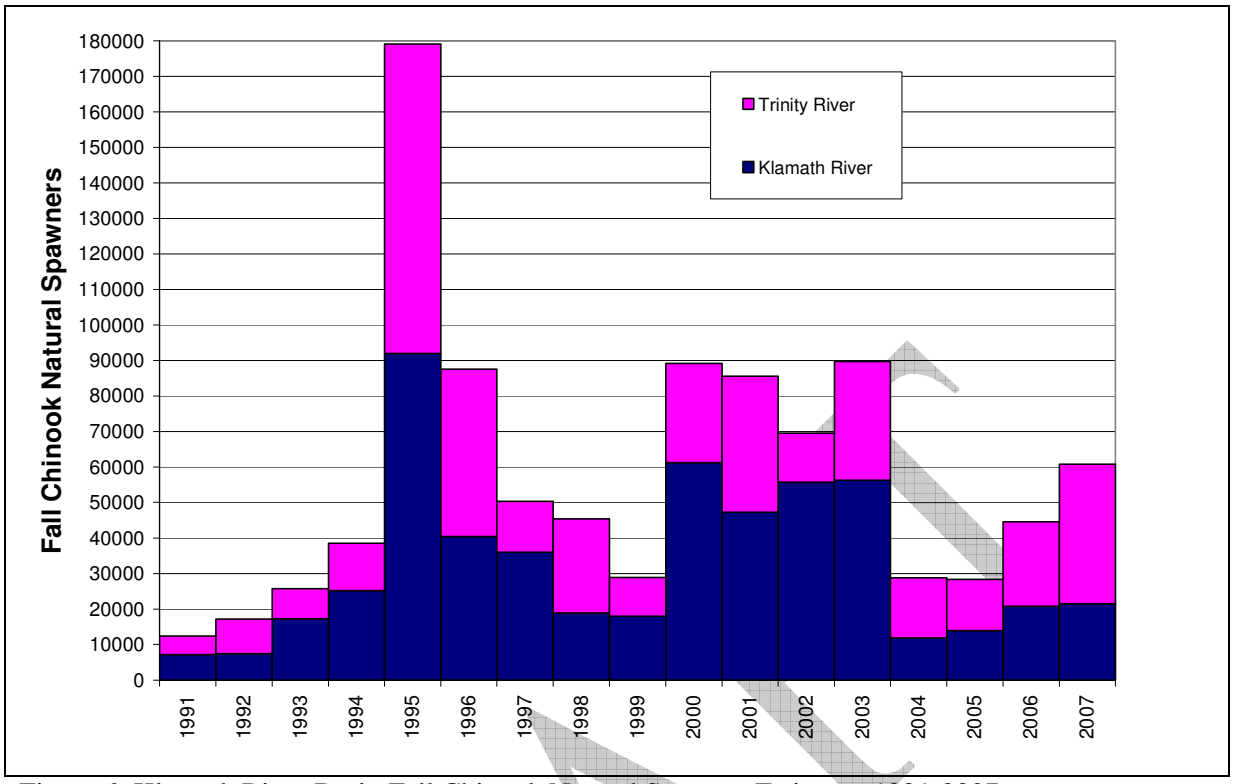

Figure 6: Klamath River Basin Fall Chinook Natural Spawner Estimate, 1991-2007
Note: Data from 2007 is preliminary.
Source: CDFG 2008

The following text on hatchery fall Chinook is from NRC (2004, p.267):

> Hatcheries for Chinook salmon have been operating continuously since 1917. Both the Iron Gate Hatchery and the Trinity River Hatchery produce large numbers of spring-run (13%) and fall-run (87%) juvenile Chinook of native stock (Myers et al. 1998). The hatcheries release 7-12 million juveniles into the river each year (about 70% from the Iron Gate Hatchery, all fall run). The fish generally have been released over a 2-3 days in late May or early June and take 1-2 mo (mean, 31 days) to reach the estuary (M. Wallace, CDFG, unpublished data, 2002), although some fish probably remain in pools for most of summer. Smaller fish take longer than larger fish to reach the estuary, but because they are feeding and growing on the way downstream, all juveniles are about the same size when they reach it. About 40% of the juvenile fish in the estuary in 2000 were of hatchery origin (CDFG, unpublished data, 2000); this is presumably a fairly typical figure. Adult Chinook returning to the hatcheries are roughly one third of the total run—30% in 1999, 44% in 2000, and 28% 2001 (CDFG, unpublished data, 2001). There has been an increase in the percentage of hatchery fish in the run in recent years—up from 18% in 1978-1982, and 26% in 1991-1995 (Meyers et al. 1998). Their contribution to natural spawning is not known, but estimates for the

> Trinity River suggest that it is roughly the same as the percentage of hatchery returns (Myers et al. 1998).

1.4.2.3 Spring Chinook Salmon

The Klamath River basin was known historically for its large run of spring Chinook salmon, which is currently a vestige of its former self (West 1991, p.3). In 1931, Snyder wrote that the spring Chinook migration in the basin, while once very pronounced, "has now come to be limited as to the number of individuals, and is of relatively little economic importance" (Snyder 1931, p.19). A population of more than 100,000 spring-run Chinook was once present in the basin, although this estimate is probably low because spring-run fish were the main run of Chinook in the Klamath River in the 1800's (Moyle 2002, p.259). Access to prime coldwater habitat in the headwaters of the Shasta, Klamath, and Trinity Rivers has been blocked by the construction of dams thus contributing to the decline of spring Chinook. Spring Chinook runs above Trinity Dam historically included an estimated 5,000 fish in the mainstem Trinity and 1,000-5,000 fish in each of four tributaries above Lewiston Dam (Moyle et al. 1995, p.40). Historic run size estimates in each of the Sprague River, Williamson River, Shasta River, and Scott River alone were at least 5,000 fish (CDFG 1990 as cited by Moyle 2002, p.259).

> Runs in the Sprague and Williamson Rivers were probably extirpated before 1900 as the result of dams constructed in Oregon; if any fish remained, they were eliminated with the construction of Copco Dam across the main river in California in 1917. The run in the Shasta River, probably the largest tributary run in the Klamath drainage, disappeared in the early 1930s as a result of habitat degradation and increased summer water temperatures caused by Dwinnell Dam. The smaller Scott River run was extirpated in the early 1970s by a variety of causes (Moyle 2002, p.259).

By the 1980's, habitat alterations had reduced or eliminated much of the cold water habitat and deep pools that spring-run Chinook require resulting in their elimination from much of their former habitat (NRC 2004, p.269). It is estimated that only 3% of the historic habitat available to spring Chinook is currently used by this run (Spring Salmon Summit 2005, p.10). Extant spring run Chinook populations in the Klamath River basin only remain in the Trinity and the Salmon Rivers. Population estimates for spring Chinook during the period from 1980-2006 have ranged from a high of 69,004 fish to fewer than 1,945 (Figure 7). Trinity River Hatchery returns have made up 14-68% of these populations during 1980-2006, and on average comprise 28% of the population.

An average of 10,320 natural spring Chinook spawners have returned to the Klamath River basin annually during the period from 1990-2006, and estimates have ranged from 1,618-35,719 fish (Figure 8). The only substantial wild populations still persisting in the basin are found in the Salmon River (Campbell and Moyle 1991 as cited by Moyle et al. 1995, p.40). Monitoring records of spring Chinook adults in the Salmon River during this period reflect an average of 601 fish returning to the stream annually, with a range from 90 (2005) to 1,485 (1995).

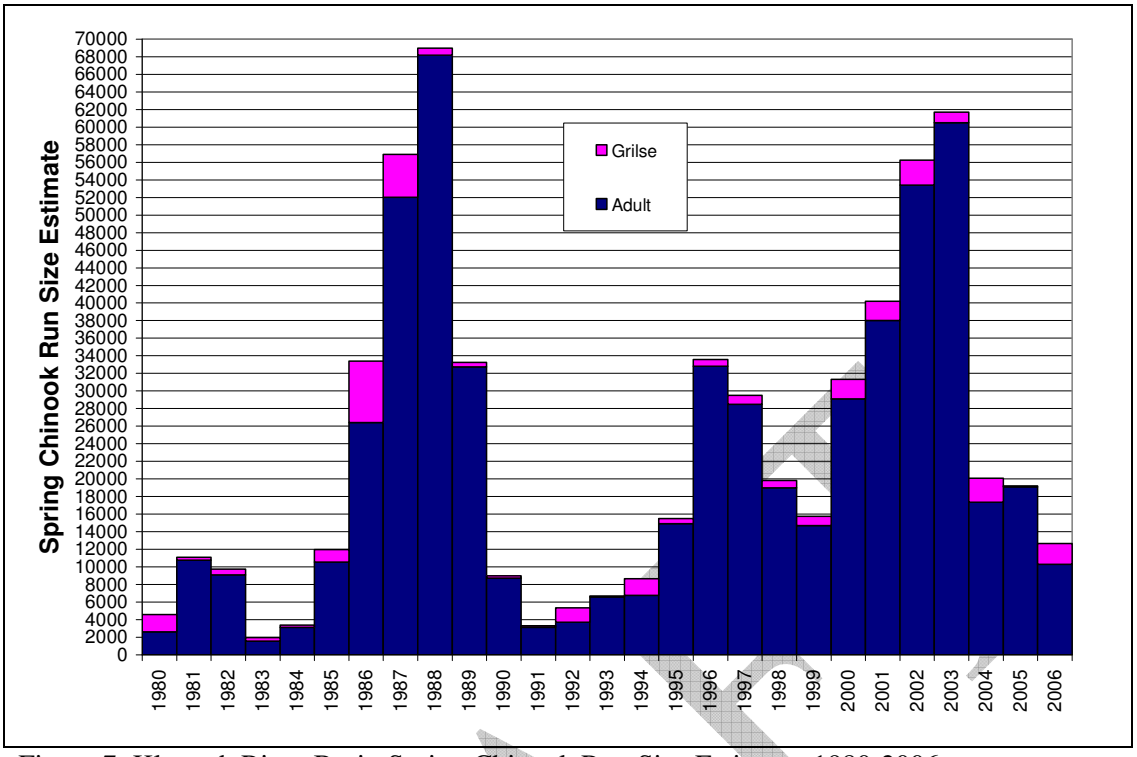

Figure 7: Klamath River Basin Spring Chinook Run Size Estimate, 1980-2006
Note: Run size estimate includes hatchery spawners, natural spawners, and in-river harvest totals. Grilse are Chinook that return to freshwater to spawn after spending only one year in the ocean.
Source: CDFG 2006a

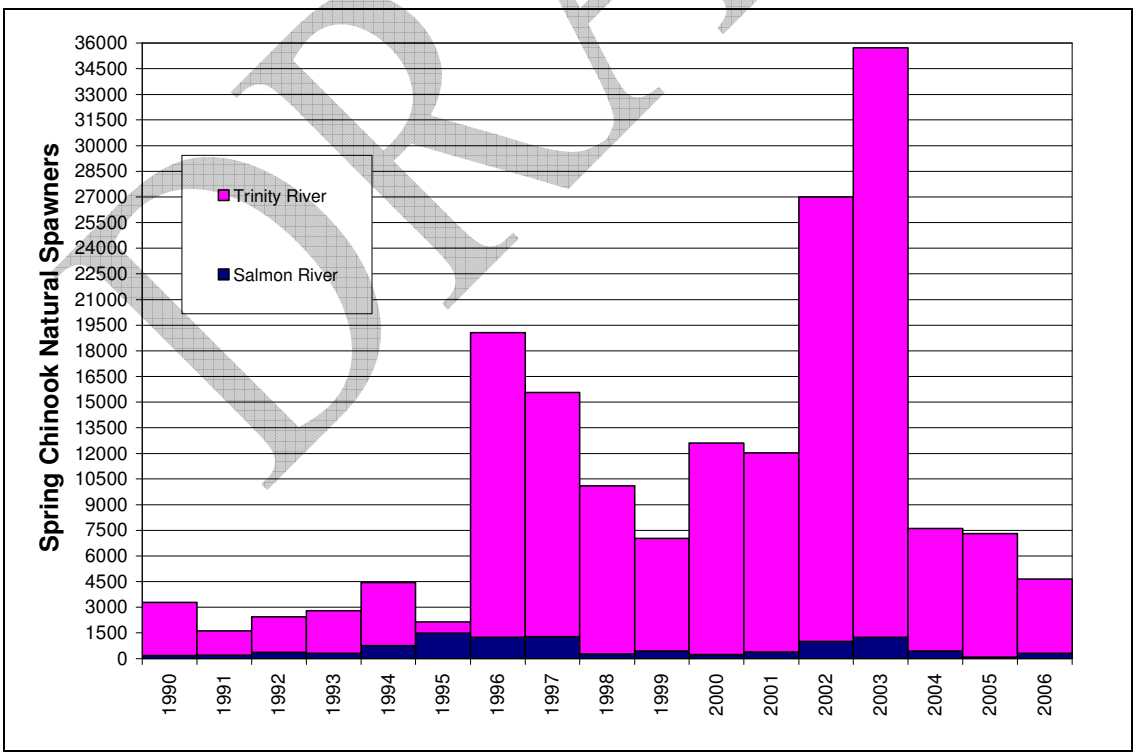

Figure 8: Klamath River Basin Spring Chinook Natural Spawner Estimates, 1990-2006
Source: CDFG 2006a

1.4.2.4 Steelhead Trout

Steelhead are common in the Klamath River basin below Iron Gate Dam where three runs are known to occur: spring/summer, fall, and winter. All three of these runs have a life-history stage called the half-pounder, which is an immature fish that migrates to the sea in the spring but returns to freshwater in the late summer. Fall and winter run steelhead are fairly common in the basin, although they are less abundant than historical levels, while spring/summer steelhead are in danger of extinction (Moyle 2002, p.280). It is likely that steelhead runs exceeded several million fish prior to the 1900s (Hardy and Addley 2006, p.6). An estimate of steelhead spawner abundance by CDFG (1965, p.369) estimated an average of 221,000 steelhead in the Klamath River basin annually.

Hardy and Addley (2006, p.6) state:

> The best quantitative historical run sizes in the Klamath and Trinity river systems were estimated at 400,000 fish in 1960 (USFWS 1960, cited in Leidy and Leidy 1984), 250,000 in 1967 (Coots 1967), 241,000 in 1972 (Coots 1972) and 135,000 in 1977 (Boydston 1977). Busby et al., (1994) reported that the hatchery influenced summer/fall-run in the Klamath Basin (including the Trinity River stocks) during the 1980's numbered approximately 10,000 while the winter-run component of the run was estimated to be approximately 20,000. Monitoring of adult steelhead returns to the Iron Gate Hatchery have shown wide variations since monitoring began in 1963. However, estimates during the 1991 through 1995 period have been extremely low and averaged only 166 fish per year compared to an average of 1935 fish per year for 1963 through 1990 period (Hiser 1994). In 1996, only 11 steelhead returned to Iron Gate Hatchery. The National Marine Fisheries Service (NMFS) considers that based on available information, Klamath Mountain Province steelhead populations are not self-sustaining and if present trends continue, there is a significant probability of endangerment (NMFS 1998); however, steelhead were not listed under the Endangered Species Act of 1973 (ESA).

Annual counts of spring/summer steelhead in holding areas throughout the Klamath River basin have ranged from 500 to 3,000 fish (Roeloffs 1983, as cited by Hopelain 1998, p.1). In the 1990's it was estimated that there were 1000-1500 spring/summer steelhead adults divided among eight populations in the basin (Barnhart 1994, Moyle et al. 1995, Moyle 2002 as cited by NRC 2004, p.274). NMFS considers spring/summer steelhead stocks depressed and in danger of extinction (Busby et al. 1994 as cited by NRC 2004, p.274).

Fall steelhead represent the largest of the three steelhead runs and were estimated to include 55,000-75,000 spawning adults and 150,000-225,000 half-pounders during the period from 1980-1982 (D.P. Lee, CDFG, pers. comm. as cited by Hopelain 1998, p.1).

Run size estimates for winter steelhead were 170,000 in the 1960s, 129,000 in the 1970s, and 100,000 in the 1980s (Busby et al. 1994 as cited by NRC 2004, p.273). Current population estimates for winter steelhead have not been conducted, although Hopelain (1998, p.1) estimated a run-size of about 5,000 to 25,000 during 1980-1982. It is presumed that winter steelhead abundance is still declining although estimates, both past and present, are not very reliable (NRC 2004, p.273).

The following text on hatchery winter steelhead is from NRC (2004, p.272, 273):

> The Iron Gate Hatchery produces about 200,000 and the Trinity River Hatchery about 800,000 winter steelhead smolts per year (Busby et al. 1994). The fish are released into the rivers in the last 2 wk of March, and most reach the estuary about a month later (M. Wallace, CDFG, personal communication), coincident with the emigration of wild smolts. Diets of outmigrating smolts are similar to those of wild smolts, although the consumption of a greater variety of taxa and fewer organisms by the hatchery fish than by wild fish suggests that they have lower feeding efficiency than wild fish (Boles 1990). Otherwise, the interactions between hatchery and wild fish in the Klamath are not known, although hatchery steelhead released into a stream will dominate the wild steelhead (McMichael et al. 1999), potentially increasing the mortality in wild fish from predation, injury, or reduced feeding. Hatchery steelhead also can have adverse effects on juveniles of other salmonids, especially Chinook and coho salmon, through aggressive behavior and predation (Kelsey et al. 2002).
>
> In the 1970s and early 1980s, adults of hatchery origin made up about 8% of the run of Klamath River steelhead and 20-34% of the run in the Trinity River (Busby et al. 1994). As numbers of wild steelhead decline, the percentage of hatchery fish in the population presumably will increase. There is some indication that the runs most heavily influenced by hatchery steelhead in the Trinity River have a lower frequency of half-pounders in the population than do wild populations (Hopelain 1998).

Although steelhead population estimates for the Klamath River basin have not been conducted on a regular basis, adult steelhead return numbers to the Iron Gate Hatchery, Trinity River Hatchery, and Shasta River Fish Counting Facility are available and are presented for the period from 1970-2005 in Figure 9. Adult steelhead returns to these three locations in the basin have ranged from a high of 10,837 fish in 2004 to a low of 529 fish in 1999, with an average return of 3,328 fish over the last 36 years.

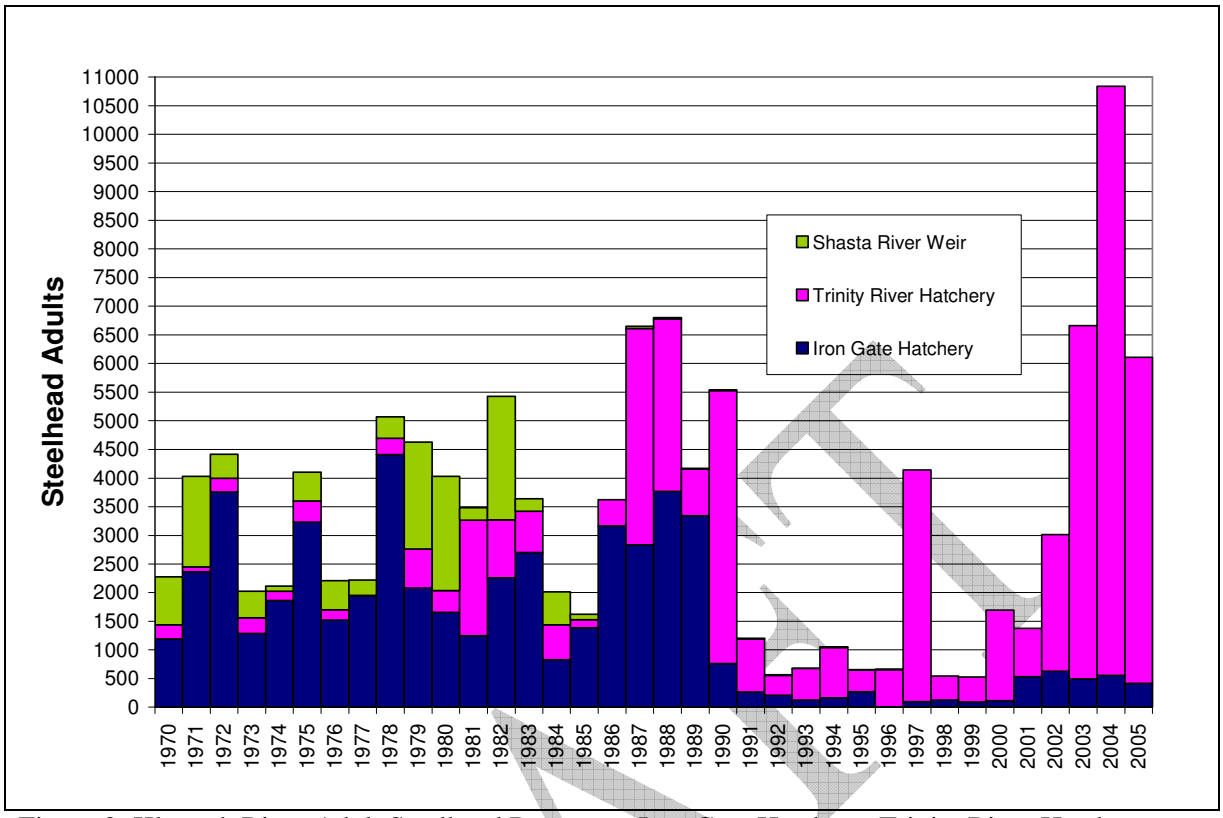

Figure 9: Klamath River Adult Steelhead Returns to Iron Gate Hatchery, Trinity River Hatchery, and the Shasta River Fish Counting Facility, 1970-2005
Note: Steelhead data were not available from the Shasta River Fish Counting Facility for the period of 1997-2005 and thus information is only presented for Iron Gate and Trinity River Hatchery Returns.
Sources: Klamath River Information System (KRIS) 2006; Marshall 2005; and Rushton 2005.

1.4.2.5 Coho Salmon

It is clear from the information available that coho salmon populations statewide have undergone a dramatic decline from historic levels (Brown and Moyle 1991, p.8; Brown et al. 1994; CDFG 2002, p.1). The Southern Oregon/Northern California Coast Evolutionary Significant Unit (SONCC ESU), which encompasses Klamath River basin stocks, has been listed as threatened by the State of California and the federal government. Coho salmon occupy only 61% of the SONCC ESU streams that were previously identified as historical coho salmon streams (CDFG 2002, p.2).

Maximum estimates for coho spawners in California during the 1940's range from 200,000-500,000 fish (Sagar and Glova 1988 as cited by Moyle 2002, p.250). Brown et al. (1994) state that California coho populations are probably less than 6% of what they were in the 1940s, and there has been at least a 70% decline since the 1960s. In 1994, Brown et al. estimated the coho salmon population in California to be 30,000 fish, with natural spawners comprising 43% of the total population or 13,240 fish. This figure is said to be "optimistic because we assumed coho salmon still occur in streams for which there are no current data; it is likely, therefore, that we have underestimated the magnitude of decline (Brown et al. 1994)."

Historical spawning escapement estimates for the Klamath River basin approximate 15,400-20,000 coho, with 8,000 of these fish originating in the Trinity River (USFWS 1979, App. as cited by Brown et al. 1994). In 1965, CDFG estimated 15,400 coho spawners per year in the basin (CDFG 1965, p.369). In 1994, Brown et al. estimated a total abundance of 18,125 coho in the basin, including 1,860 native and naturalized fish. Brown et al. (1994) published the results of presence and absence counts for coho salmon in the basin. Of the 41 tributaries monitored (113 tributaries where they were known to have existed historically), coho were detected in only 21 and absent in the other 20 (Brown et al. 1994). Current population estimates for coho in the Klamath River basin have not been conducted, although adult coho return numbers to the Iron Gate Hatchery, Trinity River Hatchery, and Shasta River Fish Counting Facility are available and are presented for the period from 1964-2005 in Figure 10. Adult coho returns from these combined locations during the last 42 years averaged 5949 fish.

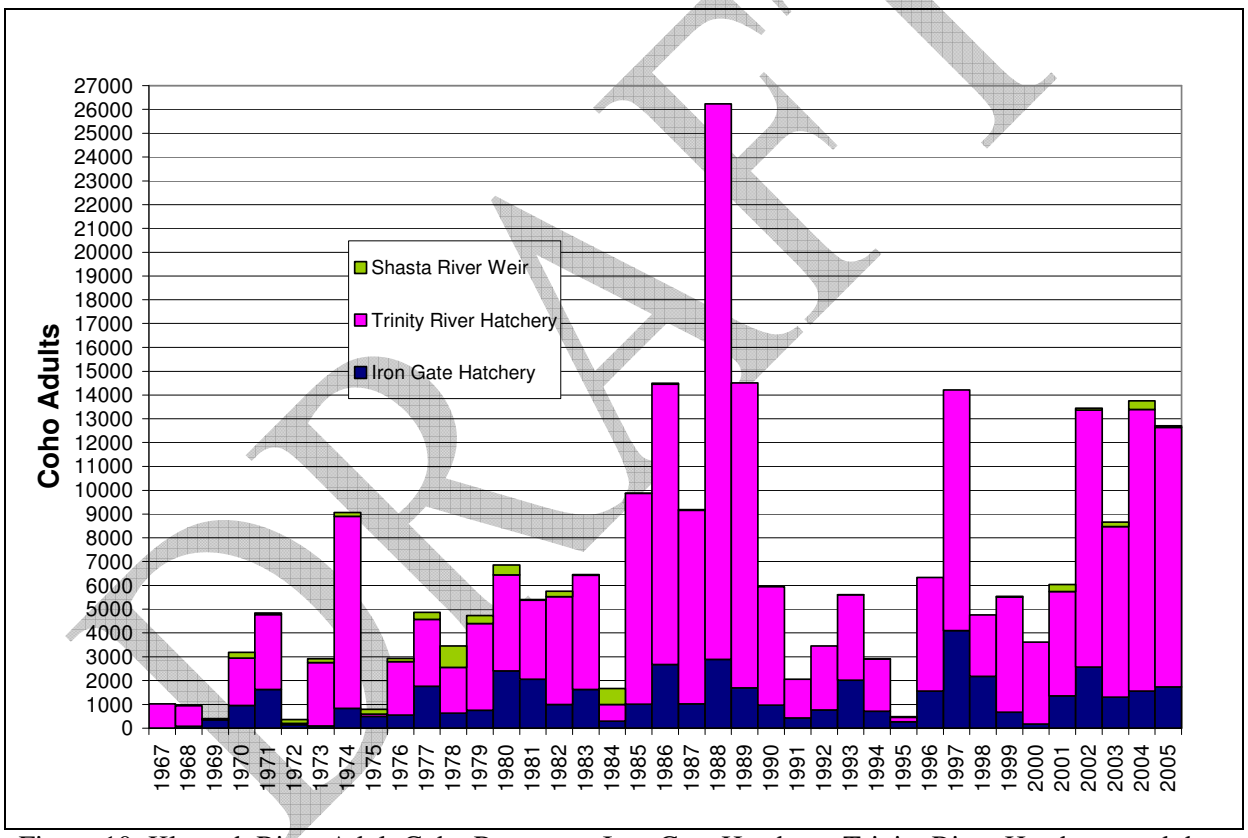

Figure 10: Klamath River Adult Coho Returns to Iron Gate Hatchery, Trinity River Hatchery, and the Shasta River Fish Counting Facility, 1964-2005
Sources: Hampton 2004, p.1; Hampton 2005a, p.1; Hampton 2005b; KRIS 2006; Marshall 2005; and Rushton 2005.

Natural production of coho salmon in the Klamath River basin is considered minimal, with Iron Gate and Trinity River Hatcheries the major sources of most coho salmon in the basin (KRFMC 1991, App. as cited by Brown et al. 1994). The following text from NRC (2004, p.262, 263) discusses hatchery coho in the Klamath River basin:

Coho salmon have been an important part of the Klamath basin fish fauna since prehistoric times (CDFG 2002), and many attempts have been made to augment their populations in the Klamath basin. The first attempt occurred in 1895, when 460,000 fish from Redwood Creek—part of the same evolutionarily significant unit (ESU) as Klamath River coho—were stocked in the Trinity River. It is not known whether these fish, which were taken from a small stream, survived and contributed to later populations. Hatchery production of coho salmon in the Klamath basin began in the 1910-1911 season and continued for another 5 yr. From 1919 to 1942, six additional plants of hatchery-reared fish, all apparently of local origin, were conducted (CDFG 2002). The principal hatcheries today are the Iron Gate Hatchery (operating since 1966) on the Klamath and the Trinity River Hatchery (operating since 1963) on the Trinity River. Faced with a declining egg supply, operators of the two hatcheries at various times brought in fertilized eggs from the Eel and Noyo rivers in California and the Cascade and Alsea rivers in Oregon (CDFG 2002). Thus, present hatchery stocks probably are of mixed origin. Although a few hatchery fish have been planted in tributaries, hatchery fish are for the most part released as smolts into the main stem on the assumption that they will head directly to the sea.

Genetic studies of the contribution of hatchery coho to wild populations in the Klamath basin are not available. Brown et al. (1994) inferred that most wild coho stocks in the basin were partially mixed with hatchery stocks because the two hatcheries are at the far upstream end of coho distribution and produce large numbers of fish. In recent years, the Trinity River Hatchery has released an average of 525,000 coho per year and the Iron Gate Hatchery about 71,000 per year (CDFG 2002), although historically the Iron Gate Hatchery has released about 500,000 coho per year (CDFG, unpublished data, 2002). The coho typically are reared to the smolt stage and marked with a maxillary clip before release, which occurs between March 15 and May 1. They reach the estuary in concert with wild smolts, which peak in late May and early June, but typically are longer than the wild fish—about 170-185 mm vs 135-145 mm (M. Wallace, CDFG, unpublished data, 2002). Although the effect of large numbers of hatchery coho on wild coho is not known for the Klamath, hatchery fish may dominate wild fish when the two are together (Rhodes and Quinn 1998). In any event, hatchery fish are apparently more numerous than their wild counterparts. In 2000 and 2001, 61% and 73%, respectively, of the smolts captured in the estuary were of hatchery origin (M. Wallace, CDFG, unpublished data, 2002).

The percentage of hatchery fish in the spawning population has not been estimated directly, but Brown et al. (1994) estimated that 90% of the adult coho in the system returned directly to the hatcheries or spawned in the rivers in their immediate vicinity. Other hatchery coho no doubt stray into

other streams, but the percentage is not known (CDFG 2002). In a survey of spawning coho in the Shasta River in 2001, individuals from the Iron Gate and Trinity River hatcheries were identified; seven of 23 carcasses examined were hatchery fish (CDFG, unpublished data, 2001). Regardless of origin, natural-spawning coho in the basin's tributaries have managed to maintain timing of runs and other life-history features that fit the basin's hydrologic cycle well.

1.4.3 Periodicity

Adult and juvenile Chinook and steelhead are present year round in the Klamath River basin below Iron Gate Dam (Figures 11 and 13), and mainstem Klamath River below the Dam (Figures 12 and 14). Adult coho are present in the basin from August to February (Figure 15) and in the mainstem Klamath River from September through January (Figure 16), while juvenile coho are present year round. The following sections discuss the presence of salmonids in the Klamath River basin at various life stages throughout the year, known as "periodicity." Data on individual Chinook and steelhead runs in Figures 11, 12, 13, 14 below, are based on readily available information and do not necessarily reflect the entire use period for that run/species. The "All" information rows for Chinook and steelhead represent periods where one or more of the runs are utilizing the basin, and thus is a summary of all information on the individual runs and run timing information for the species in general.

Unless otherwise noted, the text in the following section is primarily from Hardy 1999 (p.5-7), Hardy and Addley 2006 (p.14), NRC 2004 (p.254-258, 264-266, 270-274), and USFWS 1979 (p.16, 27, 29, 30), with additional information from Moyle (2002, p.254), and Salmon River Restoration Council (SRRC) and Klamath Tribe Department of Natural Resources (KTDNR) 2006.

1.4.3.1 Chinook Salmon

Chinook periodicity information for the Klamath River basin below Iron Gate Dam is presented in Figure 11, and information for Chinook periodicity in the mainstem Klamath River is presented in Figure 12.

Fall Chinook are generally slower in their upstream migration than spring Chinook. It takes approximately 2-4 weeks for fall Chinook to reach upstream spawning grounds (USGS 1998 as cited by NRC 2004, p.265). Fall Chinook spawn in the lower reaches of tributaries and in the mainstem Klamath River, although less than 33% spawn in the mainstem. Half of the spawning that occurs in the mainstem takes place in the 13 miles of the river below Iron Gate Dam, although significant spawning occurs as far down as Happy Camp and limited spawning occurs as far downstream as Orleans. Eggs generally incubate for 50-60 days when water temperatures range from 5-14.4 C. Fry move downstream after emergence and often take up residence in shallow water on the edges of the stream in flooded vegetation, where they remain for various lengths of time, although some outmigrate directly to the estuary. The NRC (2004, p.265) reports that juveniles rearing in the Klamath River or larger tributaries reside there for 3-9 months but move

downstream continuously. Shaw et. al. (1998, p.29) state that juvenile rearing in the mainstem between Iron Gate Dam and Seiad Creek is likely to occur year round. Belchik (1997) reports that rearing juvenile salmonids reside in pockets of cool water, thermal refugia, in the Klamath River when mainstem water temperatures become unsuitable during the summer. Type I, II, and III Chinook exist in the Klamath River basin and thus outmigration occurs year round. Juvenile fall Chinook move into the estuary at a smaller size and reside there longer when conditions in the river are unfavorable, such as times of warm water temperatures. It appears that many juveniles leave the estuary after only a few weeks, and outmigrate to the ocean (Wallace 2000 as cited by NRC 2004, p.265).

Spring Chinook are thought to migrate more deliberately and further upstream than fall Chinook. Spring Chinook migrate as far upstream as they can go in larger tributaries, which allows them to access habitat often inaccessible to fall Chinook due to low flows and high temperatures during the summer and fall. Spring Chinook are persistent in their upstream migration and don't rest until they have reached holding areas where they remain until they spawn. Migrating spring Chinook hold in deep pools for 2-

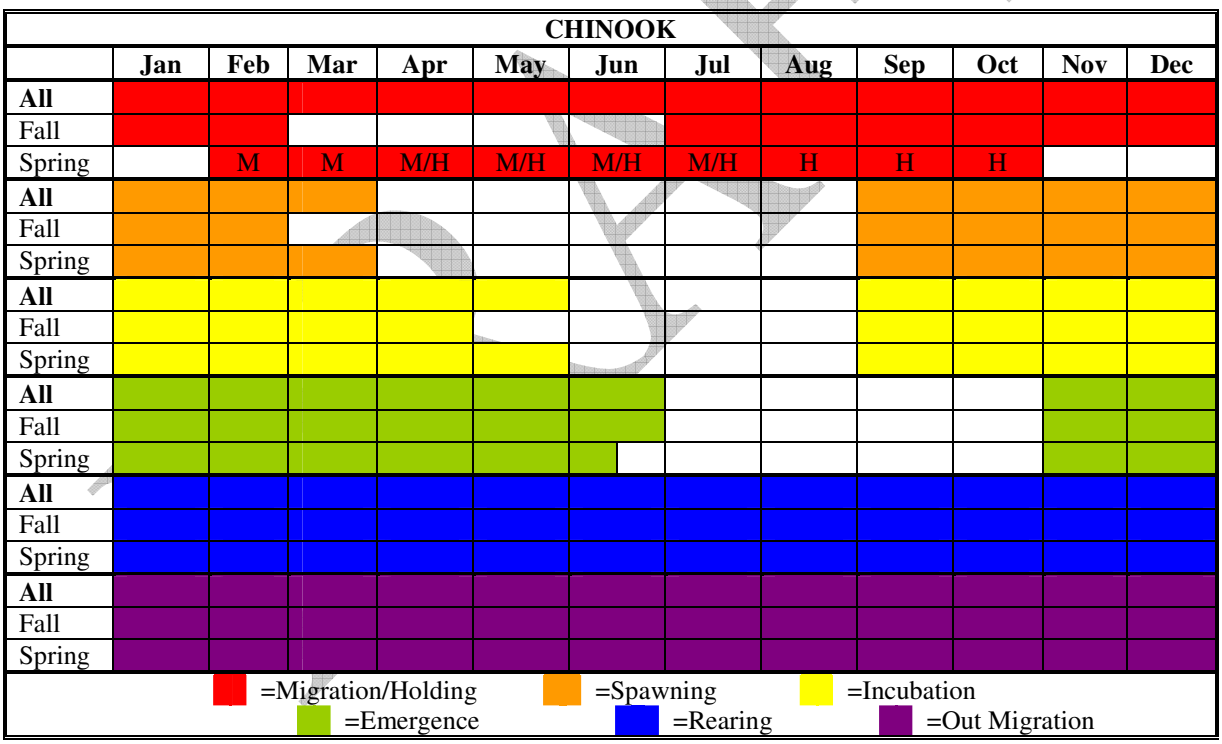

Figure 11: Chinook Periodicity in the Klamath River Basin
M=Migration, M/H=Migration and Holding, H=Holding
Sources: Hardy 1999, p.6, 7, & 34; Hardy and Addley 2006, p.96; KRBFTF 1991, p.4-8, 4-9, 4-12; Leidy and Leidy 1984; NRC 2004, p.269; Olson per comm., as cited by West 1991, p.9; PacifiCorp 2004, p.4-25; Shaw et al. 1998; Snyder 1931, p.19; SRRC and KTDNR 2006; Scott River Watershed Council (SRWC) 2004, p.6-17; Trihey and Associates, Inc. 1996, p.12, 17; USFWS 1979, p.16; USFWS 1999, p.19, 38; USFWS 2001, p. 13, 22; West 1991, p.9.

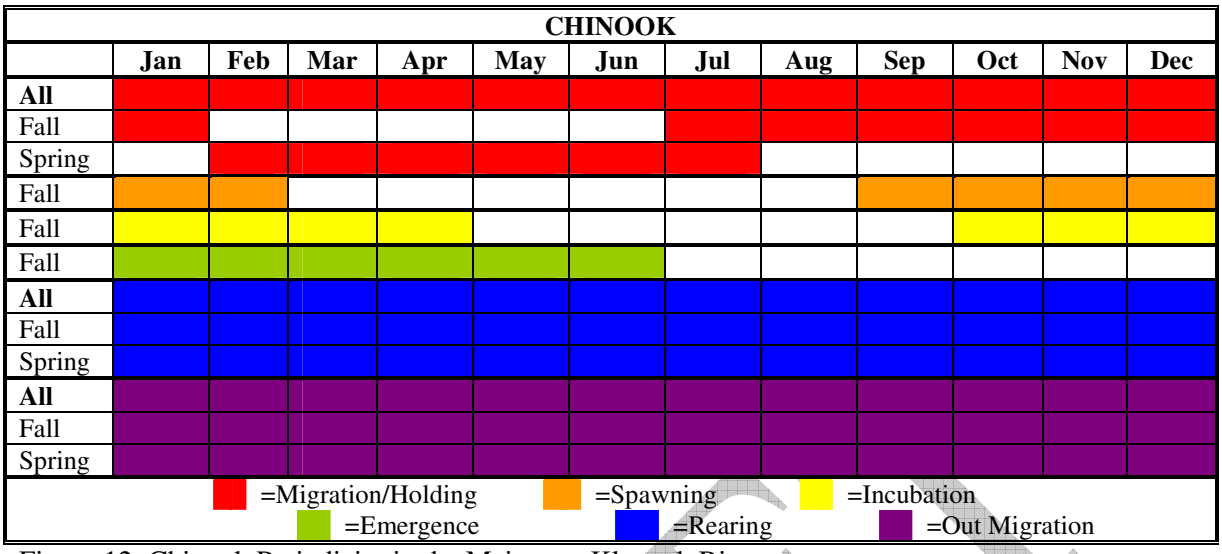

Figure 12: Chinook Periodicity in the Mainstem Klamath River
Sources: Hardy 1999, p.34; Hardy and Addley 2006, p.96; NRC 2004, p.264-267; Rushton 2005; Shaw et al. 1998; USFWS 1979, p.16; USFWS 1999, p.16; USFWS 2001, p. 59, 62, 65, & 68

4 months (throughout the summer) as their gonads fully develop, and then spawn the following fall and winter. Spring Chinook are susceptible to high water temperatures that can result in decreased fecundity of females (decreases egg viability) as they hold throughout the summer (McCullough 1999 as cited by NRC 2004, p.269). Incubation takes approximately 40-60 days, and alevin and fry remain in the gravel for 2-4 weeks before emergence. Spring Chinook will typically rear in freshwater for a year after emergence before heading to the ocean (Healey 1991 as cited by NRC 2004, p.268).

1.4.3.2 Steelhead Trout

Information on steelhead periodicity in the Klamath River basin below Iron Gate Dam is presented in Figure 13, and steelhead periodicity in the mainstem Klamath River is presented in Figure 14.

With the exception of half-pounders, steelhead remain in the ocean for 1-3 years before initiating their spawning run and may spawn 3-4 times during their life. Incidence of repeat spawning reported by Hopelain (1998, p.21) were 17.6-47.9% for fall steelhead, 40-63.3% for spring/summer steelhead, and 33.1% for winter steelhead. Although steelhead generally use the mainstem Klamath River as a migration corridor, some spawning does occur in the mainstem. The mainstem is also very important to the juvenile rearing life stage of steelhead. Fall run steelhead typically enter the Klamath River basin during the summer and hold for several months before moving to spawning areas in smaller tributaries. The early part of the fall steelhead run consists primarily of half-pounders. Franklin (2006) notes that half-pounders have entered the Klamath River as early as July, although most references cite migration beginning in August. Spring/summer steelhead enter the Klamath River in early spring and hold in deep pools until they spawn the following winter. High water temperatures can decrease the

viability of eggs in female spring/summer steelhead holding throughout the summer and fall. Steelhead eggs typically incubate for 4 –7 weeks, although the length of time for incubation is a function of water temperature, taking longer in cooler temperatures.

STEELHEAD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All												
Spring/summer	H	H	H	M/H	M/H	M/H	M/H	H	H	H	H	H
Fall	H						M	M/H	M/H	M/H	M/H	H
Winter												
Half-pounder												
All												
Spring/summer												
Fall												
Winter												
All												
winter												
All												
Winter												
All												
Winter												
Half-pounder												
All												
Spring/summer												
Fall/winter												

=Migration/Holding =Spawning =Incubation
=Emergence =Rearing =Out Migration

Figure 13: Steelhead Periodicity in the Klamath River Basin
M=Migration, M/H=Migration and Holding, H=Holding
Sources: Barnhart 1994 as cited by NRC 2004, p.271; Hardy 1999, p.5, 6 & 34; Hardy and Addley 2006, p.96 ; Hopelain 1998, p.1; Leidy and Leidy 1984; NRC 2004, p.271, 272; Shaw et al. 1998; Trihey and Associates, Inc. 1996, p.13; USFWS 1979, p.29, 30; USFWS 1999, p.28, 49; USFWS 2001, p.36, 44.

STEELHEAD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All												
Spring/summer												
Fall												
Winter												
Half-pounder												
All												
All												
All												
All												
All												

=Migration/Holding =Spawning =Incubation
=Emergence =Rearing =Out Migration

Figure 14: Steelhead Periodicity in the Mainstem Klamath River
Sources: Hardy 1999, p.34; Hardy and Addley 2006, p.96; Hopelain 1998, p.12; NRC 2004, p.271-273; Rushton 2005; Shaw et al. 1998; USFWS 1979, p.29 & 30; USFWS 1999, p.27; USFWS 2001, p. 61, 64, 67, & 70.

After emergence, fall and winter steelhead juveniles distribute themselves widely throughout the basin, and many move out of the tributaries and into the mainstem to rear (NRC 2004, p.271). Juvenile spring/summer steelhead typically occupy the same upper stream reaches where they were spawned. Shaw et al. (1998, p.31) report that young of the year steelhead emigrate to the mainstem and most likely rear there for a year before emigrating as two year olds. Cool water areas, thermal refugia, of the mainstem Klamath River are utilize by rearing juvenile salmonids during the summer once mainstem temperatures become unsuitably warm (Belchik 1997). Juvenile steelhead normally spend 2 years in freshwater before they enter the ocean, although some emigrate after 1 or 3 years.

1.4.3.3 Coho Salmon

Coho periodicity information for the Klamath River basin below Iron Gate Dam is presented in Figure 15, and information on coho periodicity in the mainstem Klamath River is presented in Figure 16.

In the Klamath River basin, coho salmon have a 3-year lifecycle during which they spend 1-1½ years in freshwater before moving to the ocean, and then return to the river to spawn at age 3. Occasionally males, called "jacks", will return to the river to spawn as 2-year-olds. Coho upstream migrations are typically linked to pulse flows associated with rain events in the basin. They generally spawn in tributaries, however they have been observed spawning at tributary confluences, in side channels, and along the shoreline of the mainstem Klamath River. Eggs incubate for approximately 7 weeks and alevins remain in the gravel for 2-3 weeks before emerging.

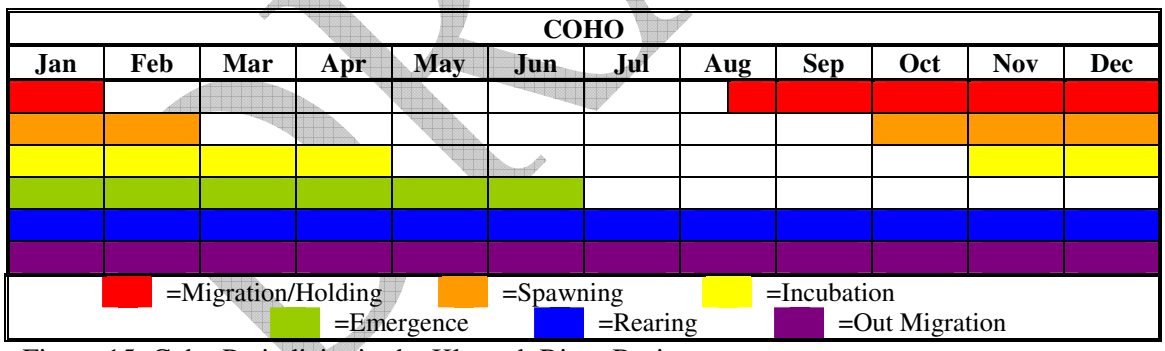

Figure 15: Coho Periodicity in the Klamath River Basin

Sources: Hardy 1999, p.6 & 34; Hardy and Addley 2006, p.96; Leidy and Leidy 1984; NRC 2004, p.7, 8; Shaw et al. 1998; Snyder 1931, p.16, 23; SRRC and KTDNR 2006; SRWC 2004, p.6-17; Trihey and Associates, Inc. 1996, p.13, 17; USFWS 1979, p.27; USFWS 1999, p.26, 43; USFWS 2001p.32, 40.

Upon emergence from the gravels coho juveniles seek areas of low velocity with an abundance of food, such as the stream margins. The NRC reports that coho juveniles live in the mainstem Klamath River despite temperatures that regularly exceed 24C (M. Rhode, CDFG, personal communication, USFWS, unpublished data, 2002 as cited by NRC 2004, p.257). These juveniles are mainly found in pools at the mouths of tributaries where temperatures are 2-6C lower than in the mainstem. Belchik (1997) reports that

cool water areas, thermal refugia, of the mainstem Klamath River are utilize by rearing juvenile salmonids, including coho, during the summer once mainstem temperatures become unsuitably warm. The Karuk tribe have collected data which shows that coho use the mainstem Klamath River even during the hottest periods of the year if suitable thermal refugia is available (Corum 2006). Shaw et. al. (1998, p.30) states that coho likely rear in the mainstem Klamath River between Iron Gate Dam and Seiad Creek year round, although they do not necessarily inhabit the mainstem on a continuous basis due to the high bioenergetic demands. Coho juveniles typically rear in freshwater for 1 year before outmigration occurs.

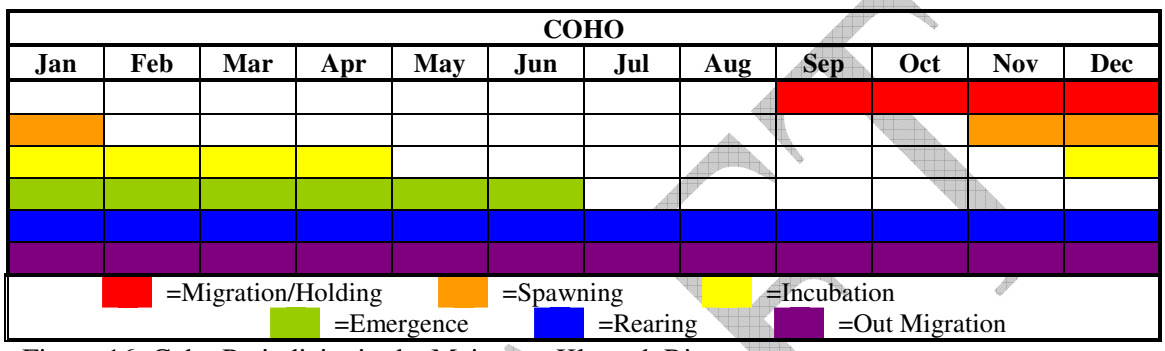

Figure 16: Coho Periodicity in the Mainstem Klamath River
Sources: Hardy 1999, p.34; NRC 2004, p.254, 255, 258, & 259; Rushton 2005; Shaw et al. 1998; USFWS 1979, p.27, USFWS 1999, p.23; USFWS 2001, p. 60, 63, 66, & 69.

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