COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION

DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE KLAMATH HYDROELECTRIC PROJECT
Docket No. P-2082-027

Section 3
Environmental Consequences
Pages 3-193 to 3-229
DEIS

3.3.3.1.2 Anadromous Fish Species

Fall Chinook Salmon

Historical records reviewed by Hamilton et al. (2005) indicate that large numbers of Chinook salmon spawned in the tributaries upstream of Upper Klamath Lake, including the Sprague, Williamson, and Wood rivers. Most accounts indicate that the spring run may have been the dominant run in the basin prior to development, but Hamilton, et al. (2005) also concluded that the runs to the upper basin must have included a fall-run component based on the size of the salmon harvested (up to 60 pounds) and the timing of spawning noted by Lane and Lane Associates (1981). The latter reference, which was based on 50 interviews with members of the Klamath Tribe conducted in the 1940s, documented tribal salmon fisheries on the Sprague River extending to its upstream limit within the reservation (near the town of Bly), on the Williamson River, and in Upper Klamath Lake. Hamilton et al. (2005) also cited several reports of Chinook spawning in tributaries between Upper Klamath Lake and Iron Gate dam including Spencer, Shovel, Fall, and Jenny creeks.

Huntington (2004) estimated that the Klamath River and its tributaries between Upper Klamath Lake and Iron Gate dam historically provided 68 miles of habitat for Chinook salmon, the Sprague River system provided 307 miles of Chinook habitat, the Williamson River system provided 47 miles of Chinook habitat, and the Wood River and other small tributaries to Upper Klamath Lake provided 148 miles of Chinook habitat. He also estimated pre-development returns of salmon and steelhead to the watershed upstream of Upper Klamath Lake based on production rates documented in the Shasta River Basin, expanded based on watershed area (which he considered to produce a low end estimate) and mean annual flow (which he considered to produce a high end estimate). Using this method, Huntington (2004) estimated that the historic returns of adult Chinook salmon to areas upstream of Upper Klamath Lake were between 149,734 and 438,023 fish per year, and were most likely in the lower end of this range.

The total escapement of fall Chinook salmon from 1978 to 2002 to the Klamath River and its tributaries, and to the two hatcheries in the basin (the Iron Gate and Trinity hatcheries) has averaged 85,855 fish over this time period, and returns to the hatcheries have constituted an average of 29.3 percent of returning fall Chinook (see table 3-47). Natural spawners, including stray fish from hatchery releases, constituted the remaining 70.7 percent of the fall Chinook escapement. Among naturally spawning fish, the greatest proportions have returned to the Trinity basin (35.5 percent of the total escapement) and Bogus Creek (11.0 percent of the total escapement). The mainstem Klamath River only accounted for 4.2 percent of the total escapement.

NMFS considers fall Chinook salmon present downstream of the Trinity River-Klamath River confluence to belong to the Southern Oregon and Northern California Coastal Chinook salmon ESU. Fall and spring Chinook upstream of the Trinity confluence are both considered to be part of the Upper Klamath-Trinity Rivers Chinook salmon ESU. Neither ESU is currently listed under the ESA.

Fall Chinook salmon in the Klamath River spend less than a year in freshwater, a life history strategy that allows them to take advantage of streams in which temperature conditions may become unfavorable by late summer (Moyle, 2002). Snyder (1931) referred to the run as a summer run, because fish started entering the estuary and lower river in early July and the run peaked in August before declining in September. Today, the run peaks in early September and continues through late October (NAS, 2004). The run timing reported by NAS is consistent with angler harvest rates reported in Hopelain (2001), which peaked between the last week in August and the first week in September from 1984 through 1987. NAS (2004) suggests that this shift in run timing may be a response to mainstem water temperatures becoming less favorable to adult salmon in the summer, or perhaps due to excessive harvest of early run fish.

Even with the current run timing, the temperature during the spawning run is probably stressful to the migrating salmon, and may result in increased mortality of spawning adults or reduced egg viability. Literature reviewed by Bartholow (1995) suggests that water temperatures between 6 and 14°C are optimal for adult migration and that chronic exposure of migrating adults to 17 to 20°C water can be lethal, although they can endure temperatures as high as 24°C for short periods. Spring Chinook typically migrate at 3.3 to 13.3°C, summer Chinook migrate at 13.9 to 20.0°C, and fall Chinook migrate at 10.6 to 19.4°C (Bell, 1991). In the lower portions of the Klamath River, water temperatures during the spawning migration typically approach a maximum of 21°C or higher in August and September, and occasionally exceed 26°C in the mid-reaches of the Klamath River (Cal Fish & Game, 2004a). High water temperatures appear to contribute to the incidence of disease outbreaks that may cause substantial mortality of migratory juvenile and adult fall Chinook, including the major kill of adult salmon that occurred in September 2002. Additional information on losses associated with fish diseases and their relation to water quality conditions is provided in section 3.3.3.1.4, *Diseases Affecting Salmon and Steelhead*.

Fall Chinook salmon reach their upstream spawning grounds within 2 to 4 weeks after they enter the river, after which they spawn and die. Spawning normally peaks during mid-October, and is complete by the middle of November (NAS, 2004). Time to emergence is dependent on the temperature regime. In the mainstem Klamath River, alevins can emerge from early February through early April, but peak times vary from year to year. After they emerge, fry disperse downstream, and many then take up residence in shallow water on the stream edges, often in flooded vegetation, where they may remain for various periods. As they grow larger, they move into faster water. Some fry, however, keep moving after emergence and reach the estuary for rearing.

Fall Chinook salmon fry rear in the mainstem at temperatures of 19 to 24°C (NAS, 2004). That pattern is consistent with the thermal tolerances of juvenile Chinook salmon, which can feed and grow at continuous temperatures up to 24°C when food is abundant and other conditions are not stressful (Myrick and Cech, 2001). Under constant laboratory conditions, optimal temperatures for growth are around 13 to 16°C. Continuous exposure to temperatures of 25°C or higher is invariably lethal, although the time until mortality depends on the acclimation temperature of the fish (McCullough, 1999). Juveniles can, however, tolerate higher temperatures (28 to 29°C) for short periods (NAS, 2004). Depending on their thermal history, fish in wild populations may experience high mortality at temperatures as low as 22 to 23°C (McCullough, 1999). In the lower Klamath River, the presence in late summer of refugia that are 1 to 4°C cooler than the mainstem and lower temperatures at night increase the ability of fry to grow and survive. The abundance of invertebrate food also makes the environment bioenergetically favorable, although intense competition for food and space may occur around the refuge pools (NAS, 2004).

Juvenile Chinook salmon are found in the Klamath estuary from March through September, over which time new fish constantly enter and older fish leave (NAS, 2004). Migrant sampling conducted from 1997 through 2000 at Big Bar on the Klamath River (RM 49.7) and at Willow Creek on the Trinity River (RM 21.1) indicates that the peak outmigration of fall Chinook salmon smolts occurs in June and July in the Klamath River (figure 3-47) and from June through August in the Trinity River (figure 3-48). In both rivers, the outmigration timing is similar for wild and hatchery subyearling (age 0+) smolts.

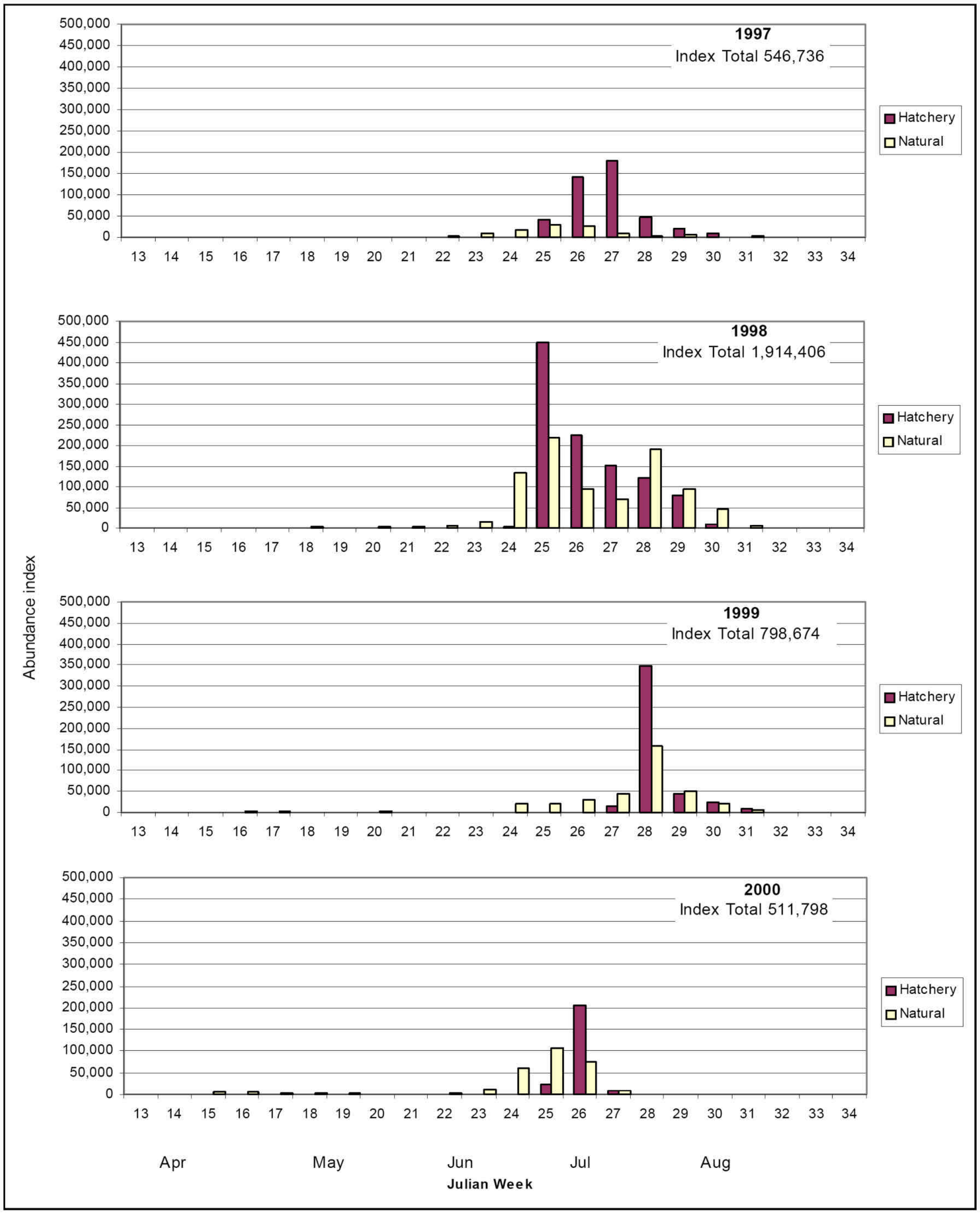

Figure 3-47. Weekly abundance index for natural and hatchery fall Chinook smolts during screw-trap sampling conducted at Big Bar (RM 49.7) on the Klamath River, 1997-2000. (Source: Scheiff et al., 2001)

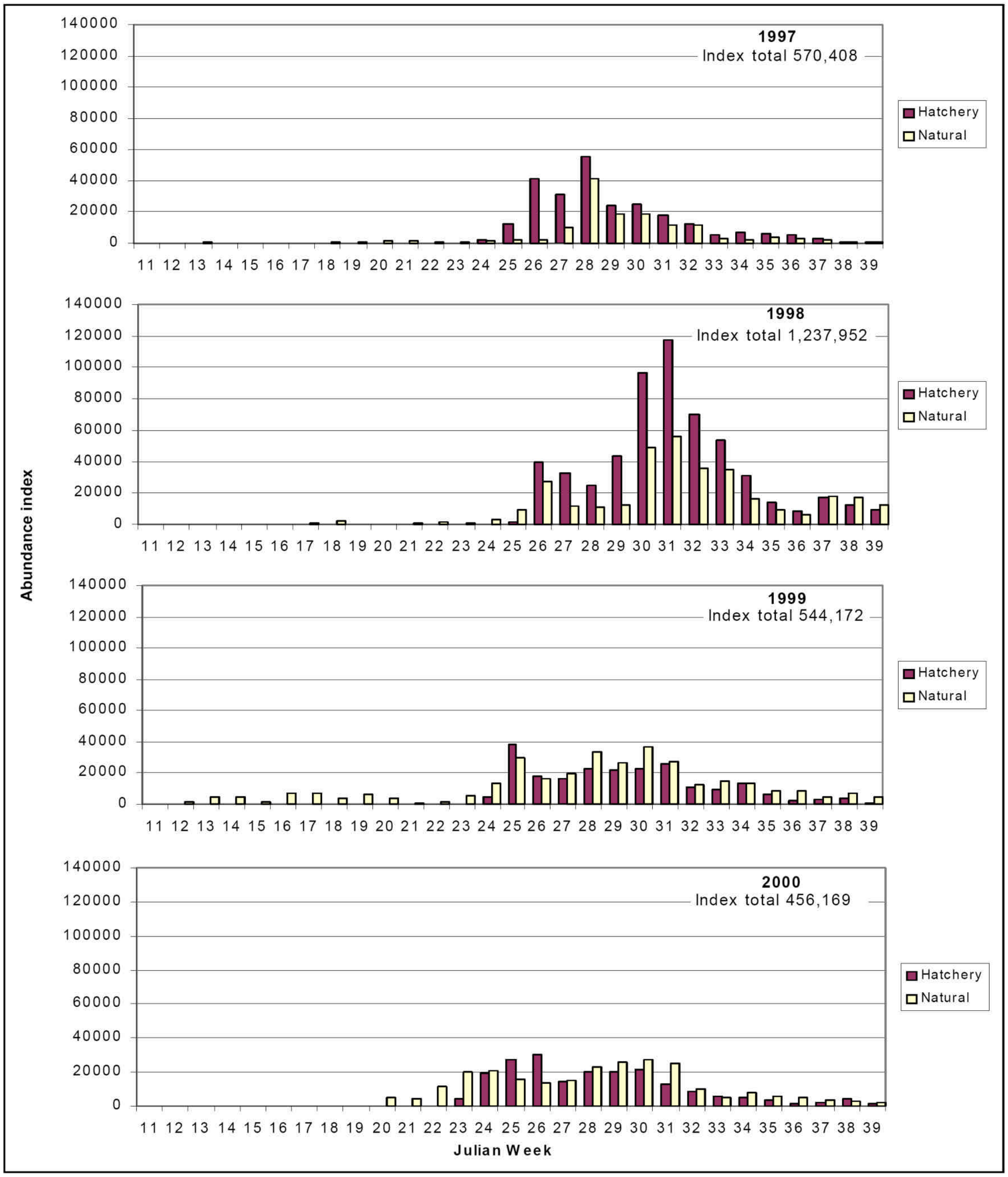

Figure 3-48. Weekly abundance index for fall Chinook smolts during screw-trap sampling conducted at Willow Creek (RM 21.1) on the Trinity River, 1997-2000. (Source: Scheiff et al., 2001)

Spring Chinook Salmon

As noted in the preceding section, spring Chinook salmon may have been the dominant run in the tributaries upstream of Upper Klamath Lake; NAS (2004) states that the spring run may have been nearly as abundant as the fall run in the basin overall. The Shasta, Scott, and Salmon rivers all supported large runs, but the spring runs suffered a precipitous decline in the 19th century due to the effects of hydraulic mining, dams, diversions, and fishing (Snyder, 1931). A large run in the Shasta River disappeared around the time that Dwinnell dam was constructed in 1926. In the Klamath River Basin upstream of the Trinity, only the Salmon River continues to support a run of spring Chinook salmon. As previously noted, returns to the Salmon River between 1980 and 2002 have ranged from 143 fish in 1983 to 1,443 fish in 1995 (see figure 3-43). Returns of spring Chinook salmon to the Trinity River between 1978 and 2002 have ranged from 1,315 fish in 1983 to 53,852 fish in 1988 (see figure 3-45). The Trinity run is supplemented by the annual release of approximately 1 million spring Chinook smolts each year from the Trinity hatchery. Although data shown in figure 3-45 indicate that returns to the hatchery constitute about a third of spring Chinook run in the Trinity River, NAS (2004) suggests that all of the Trinity River mainstem spawners may be of hatchery origin.

Spring Chinook salmon exhibit a stream-type life history, meaning that the juveniles remain in streams for a year or more before they migrate to the ocean. Adult spring Chinook salmon typically enter freshwater before they are sexually mature, and hold in deep pools for 2 to 4 months before spawning. In California, this strategy allows salmon to spawn and develop in upstream reaches of tributaries that may be inaccessible to fall Chinook because of low flows and higher temperatures in lower reaches during the summer and fall (Moyle, 2002).

Spring Chinook salmon enter the Klamath system from April through July (NAS, 2004). Ideal holding water temperatures for spring Chinook are between 6 and 14°C, as temperatures above 14°C can reduce egg viability, and susceptibility to disease is reported to increase when water temperature exceeds about 16°C (McCullough, 1999). However, spring Chinook salmon in the Salmon River hold in pools where water temperatures often exceed 20°C (West, 1991), indicating that they are capable of surviving at higher water temperatures for short time periods. Spawning peaks in October. Fry emerge from the redds from March to early June, and they reside through the summer in cool headwater streams. Some juveniles may move downstream to the estuary as temperatures decline in October, although most do not migrate until the following spring (Hardy and Addley, 2001).

Coho Salmon

Coho salmon are thought to have once been abundant and widely distributed in the Klamath River and its tributaries, although their historical numbers and the extent of their upstream distribution is unknown due to uncertainty regarding species identification in historical reports and the dominance of the fishery for Chinook salmon (Snyder, 1931; NAS, 2004). Snyder (1931) reported that coho may have migrated into the tributaries upstream of Upper Klamath Lake. Hamilton et al. (2005) concluded, based on historical accounts and knowledge of the types of habitat preferred by the species, that coho would probably have used Spencer Creek, and would have migrated upstream to at least this tributary, which now flows into the upper part of the J.C. Boyle reservoir at RM 227.6. NMFS (2002) have identified important coho habitat in the Shasta, Scott, Salmon, and Trinity rivers; in 6 creeks between Iron Gate dam and Seiad Valley; 13 creeks between Seiad Valley and Orleans; and 27 creeks between Orleans and the mouth of the Klamath.

Coho salmon populations in California in general and in the Klamath River Basin specifically have declined dramatically in the last 50 years (Cal Fish & Game, 2002a). Surveys in 2001 indicated that 17 (68 percent) of 25 historical coho streams in the Klamath River Basin contained small numbers of juvenile coho (Cal Fish & Game, 2002a). In the Trinity River, hatchery-produced coho have been estimated to comprise 97 percent of in-river spawners, with wild-produced fish comprising an average of only 200 fish out of a total average return of 10,190 adult coho salmon (FWS/HVT, 1999). The number of adult coho observed passing the Shasta fish counting weir have ranged from 0 to about 900 fish between 1930 and 2002, and less than 20 spawners were counted each year from 1985 through 1998 (see figure 3-41). More recently, counts at the Shasta weir have rebounded slightly, to 291 fish in 2001 and 86 fish in 2002. As noted previously, the counting facility is operated primarily during the Chinook spawning run, so these counts do not include the later portion of the coho run in most years.

NMFS considers naturally spawned coho salmon in the Klamath River Basin to be part of the Southern Oregon/Northern California Coasts coho salmon ESU. This ESU was listed as threatened on May 6, 1997 and critical habitat downstream of Iron Gate dam was designated on May 5, 1999. Additional information on the listing status and abundance trends within this ESU is provided in section 3.3.5, *Threatened and Endangered Species*.

Coho salmon in the Klamath River Basin spend the first 14 to 18 months of their lives in freshwater, after which the fish live in the ocean until they return to freshwater to spawn at the age of 3 years (NAS, 2004). Adults typically start to enter the river in September, peak migration occurs between late October and the middle of November, and a few fish continue to enter the river through the middle of December (NAS, 2004). Most spawning takes place in tributaries, but coho salmon have been observed spawning in side channels, tributary mouths, and shoreline margins of the mainstem Klamath River between Beaver Creek (RM 161) and Independence Creek (RM 94) (T. Shaw, M. Magnusen, A. Olsen, personal communication, as cited by Trihey & Associates, 1996). Fry start emerging in late February and typically reach peak abundance in March and April, although fry-sized fish appear into June and early July (Cal Fish & Game, 2002a). Fry are not territorial and have a tendency to move around; some fry are captured in outmigrant traps at the mouths of the Shasta and Scott rivers from March through May (Chesney and Yokel, 2003). Typical juvenile habitat consists of pools and runs in forested streams where there is dense cover in the form of logs and other large, woody debris.

Preferred coho rearing temperatures are from 12 to 14°C (Bell, 1991), although juvenile coho can, under some conditions, live at 18 to 29°C for short periods (McCullough, 1999; Moyle, 2002). Early laboratory studies in which juvenile coho were reared under constant temperatures indicated that exposure to temperatures over 25°C, even for short periods, should be lethal (Brett, 1952). In laboratory studies where temperatures were increased gradually (1°C/hr), lethal temperatures were found to range from 24 to 30°C, depending on the temperature to which the fish were originally acclimated (McCullough, 1999).

NAS (2004) reports that juvenile coho can survive and grow at high daily maximum temperatures provided that (1) food of high quality is abundant so that foraging uses little energy and maximum energy can be diverted to the high metabolic rates caused by high temperatures, (2) refugia areas of low temperature are available so that exposure to high temperatures is not constant, and (3) competitors or predators are largely absent so that the fish are not forced into physiologically unfavorable conditions or energetically expensive behavior (such as aggressive interactions). Snorkel surveys conducted at temperature refugia (tributary-mouth pools) in the Klamath River conducted in 2001, however, indicate that the proportion of refugia occupied by juvenile coho decreased from 16 percent in June to 3 percent (a single pool) in August and September (table 3-50). Most of the tributary mouth pools contained juvenile Chinook salmon, steelhead, or both. These fishes can compete with and prey on juvenile coho (and each other) and are somewhat more tolerant of high temperatures than coho.

Table 3-50. Pools containing juvenile coho salmon, Chinook salmon, and steelhead on the mainstem Klamath River in 2001, as determined in snorkeling surveys.[a] (Source: NAS, 2004)

Months of Survey	No. of Months Pools Surveyed	No. (%) of Pools with Juvenile Fish		
		Coho	**Chinook**	**Steelhead**
June	31	5 (16)	26 (84)	26 (84)
July	46	7 (15)	41 (89)	43 (93)
August	39	1 (3)	26 (67)	34 (87)
September	32	1 (3)	13 (41)	28 (88)

[a] The data are comprehensive in that they include all tributaries large enough to form a cool pool, and include some tributaries below the Trinity River (e.g., Blue Creek).

Juvenile coho transform into smolts and begin migrating downstream in the Klamath River Basin between February and the middle of June (NAS, 2004). Most smolts captured in the screw trap at Big Bar are taken between mid-April and mid-June (figure 3-49). Smolts may feed and grow in the estuary for a month or so before entering the ocean. Once at sea, they spend the next 18 months or so as immature fish that feed voraciously on shrimp and small fish, and grow rapidly.

Steelhead

Historically, the Klamath River supported large populations of steelhead, the anadromous form of rainbow trout. Steelhead were distributed throughout the mainstem and the principal tributaries such as the Shasta, Scott, Salmon, and Trinity River basins, and many of the smaller tributary streams. Steelhead also were likely distributed in the tributaries upstream of Upper Klamath Lake, but due to difficulty in differentiating steelhead from large resident rainbow trout, precise information on the upstream limit of their distribution is lacking. Hamilton et al. (2005) note that, in watersheds where both Chinook salmon and steelhead are present, the range of steelhead is usually the same, if not greater.

Hardy and Addley (2001) state that, before 1900, runs of steelhead in the Klamath River Basin may have exceeded several million fish. They cite more recent run size estimates of 400,000 fish in 1960; 250,000 in 1967; 241,000 in 1972; and 135,000 in 1977. In its most recent status review for the Klamath Mountains province steelhead ESU, NMFS (2001) indicates that most California populations showed a precipitous decline to very low abundance around 1990 and stayed at low levels through 1999, but a modest increase in abundance was noted in 2000. Escapement estimates of summer steelhead to the Salmon River (see figure 3-44) are consistent with the trend noted by NMFS, and in the Salmon River this increasing trend continued in 2002. The increased return of summer steelhead from 2000 to 2002 coincides with a period of strong returns of adult salmon and steelhead to the region caused by favorable ocean conditions that existed between 1998 and 2001. Information on the abundance of winter steelhead, which is considered to be the most abundant form, is very limited due to logistical difficulties in sampling adults during the winter season (NMFS, 2001).

NMFS considers all steelhead in the Klamath River Basin to be part of the Klamath Mountains province ESU. Moyle (2002) describes two life history forms within this ESU, a summer run and a winter run. Hopelain (1998), however, concluded that there are three distinct runs of steelhead in the Klamath River Basin: a winter run that enters the river from November through March, a spring run that enters the river from March through June, and a fall run that enters the river from July through October. Other reports appear to consider the fall run described by Hopelain to be a component of the winter run, based on a run timing of August through February given for winter-run steelhead by Barnhart (1994; as cited by NAS, 2004). After entering the river, winter-run steelhead disperse throughout the lower basin and spawn mainly in tributaries but also show some mainstem spawning. Spawning, which can take place any time from January through April, apparently peaks in February and March (NAS, 2004).

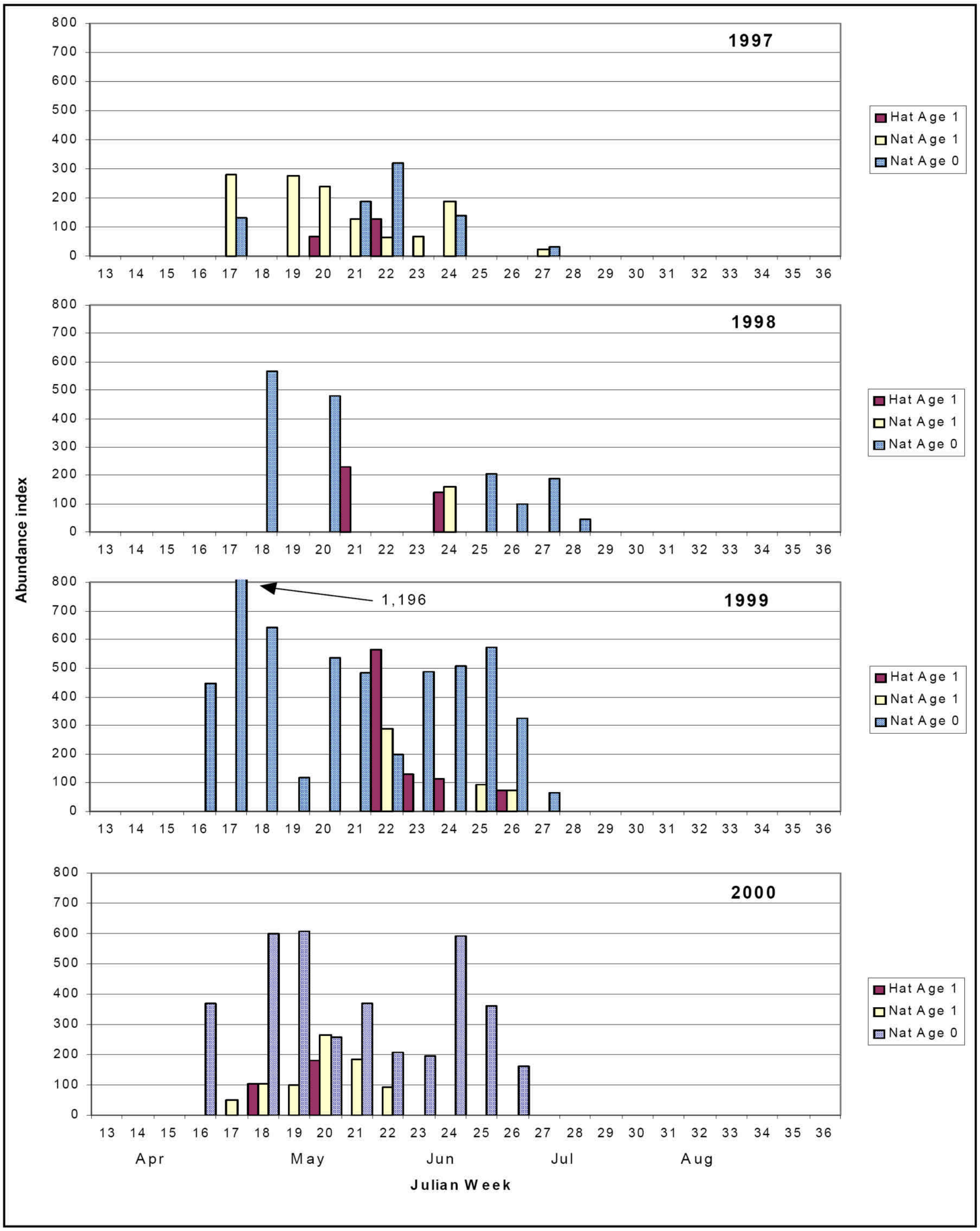

Figure 3-49. Weekly abundance index for natural and hatchery coho smolts during screw-trap sampling conducted at Big Bar (RM 49.7) on the Klamath River, 1997-2000. (Source: Scheiff et al., 2001).

According to Moyle (2002), summer-run steelhead migrate upstream to the cool waters of the larger tributaries from late April through June. They typically hold in deep pools until December, when they spawn. Maximum daytime temperatures of less than 16°C seem to be optimal (NAS, 2004), although Nakamoto (1994) reported steelhead holding in deep pools in the New River, California, in water temperatures that ranged from 16.8 to 24.6°C over a 27-day period during late July to early August.

Steelhead fry emerge from the gravel in the spring, and most spend 2 years in fresh water before going to sea. The rest spend either 1 or 3 years in fresh water (Hopelain, 1998). Juvenile steelhead occupy virtually all accessible habitats in which conditions are physiologically suitable. Although spawning occurs mainly in tributaries, the juveniles distribute themselves widely, and many move into the mainstem. Juveniles feed primarily on invertebrates, especially drifting aquatic and terrestrial insects, but fish (including small salmon) can be an important part of the diet of larger individuals. Aggressive 2-year-old steelhead (6 to 7 inches) often dominate in pools (NAS, 2004).

Both resident and anadromous forms of rainbow trout exhibit a high degree of thermal tolerance compared to most other salmonids. Preferred temperatures are usually from 15 to 18°C, but juvenile rainbow trout regularly persist in water where daytime temperatures reach 26 to 27°C (Moyle, 2002). Long-term exposure to temperatures that are continuously above 24°C, however, is usually lethal. Steelhead cope with high temperatures by finding thermal refugia or by living in areas where nocturnal temperatures drop below the threshold of stress (NAS, 2004). Persistence in thermally stressful areas requires abundant food. Smith and Li (1983, as cited by NAS, 2004) found that juvenile steelhead persisted in a small California stream in which daytime temperatures sometimes reached 27°C for short periods by moving into riffles where food was abundant.

Migrant sampling conducted from 1997 through 2000 at Big Bar on the Klamath River (RM 49.7) and at Willow Creek on the Trinity River (RM 21.1) indicates that the peak outmigration of steelhead smolts occurs from early April through mid- June in both rivers, with smaller numbers of steelhead smolts continuing to migrate through September, especially in the Trinity River (Scheiff et al., 2001). A majority of Klamath steelhead return to fresh water as “half-pounders,” 3 to 4 months after their initial entry into salt water. This life-history trait allows steelhead to consume eggs from the large numbers of Chinook salmon that enter the river in the fall (NAS, 2004). Half-pounders usually stay in the lower mainstem of the Klamath through March before they return to the sea to mature. Klamath steelhead spend 1 to 4 winters in the ocean before they return to spawn. About 30 percent of the steelhead in the Klamath spawn a second time after another year at sea, and about 5 percent survive to spawn a third time (Hopelain, 1998).

Green Sturgeon

Green sturgeon are an anadromous species that is known to range in nearshore marine waters from Mexico to the Bering Sea. NMFS has identified two distinct population segments: a northern coastal segment consisting of populations spawning in coastal watersheds northward of and including the Eel River[48] and a southern segment consisting of coastal or Central Valley populations spawning in watersheds south of the Eel River. The Klamath River Basin supports the largest spawning population of the species, which is included in the northern DPS and also includes fish that spawn in Umpqua, Rogue, and Eel rivers. On April 6, 2005, NMFS proposed to list the southern DPS as threatened and determined that the northern DPS does not warrant listing, but it maintained the northern DPS on the species of concern list due to remaining uncertainties about its status and threats.

Green sturgeon enter the Klamath River to spawn from March through July (NAS, 2004). Most spawning occurs from the middle of April to the middle of June. Spawning takes place in the lower mainstems of the Klamath and Trinity rivers in deep pools with strong bottom currents. As noted

[48] The Eel River enters the Pacific Ocean near Eureka, about 50 miles south of the Klamath River.

previously, green sturgeon have been observed migrating into the Salmon River, but they are not thought to ascend the Klamath River beyond Ishi Pishi Falls (RM 66)(Moyle, 2002; NMFS, 2005). Juveniles stay in the river until they are 1 to 3 years old, when they move into the estuary and then to the ocean. Optimal temperatures for juvenile growth appear to be from 15 to 19°C, and temperatures above 25°C have been reported to be lethal (Mayfield, 2002, as cited by NAS, 2004). Outmigrant juveniles are captured each year in screw traps at Big Bar (RM 49.7) on the Klamath River and at Willow Creek (RM 21.1) on the Trinity River (Scheiff et al., 2001). After leaving the river, green sturgeon spend 3 to 13 years at sea before returning to spawn, and they often move long distances along the coast (NAS, 2004).

Green sturgeon support small tribal fisheries by the Yurok Tribe in the Klamath River and the Hoopa Valley Tribe in the Trinity River (table 3-51). Although Yurok and Hoopa Valley tribal catch has remained relatively constant in recent years, commercial and sport harvest has been greatly reduced by newly imposed fishing regulations in Oregon and Washington. Commercial fisheries targeting sturgeon have not been allowed in the Columbia River or in Willapa Bay, Washington, since 2001. In California, commercial fisheries for sturgeon are prohibited and regulations prohibiting the recreational harvest of green sturgeon took effect in March 2006.[49]

Pacific Lamprey

Pacific lamprey are found in Pacific coast streams extending from Alaska to Baja California. They currently occur throughout the mainstem Klamath River and its major tributaries downstream of Iron Gate dam. The extent of their historical upstream distribution is uncertain due to the occurrence of several resident species of lamprey in the upper parts of the basin. Hamilton et al. (2005) note that Pacific lamprey are capable of migrating long distances, and generally show a similar distribution as anadromous salmon and steelhead. They conclude that the upstream distribution of Pacific lamprey would have likely extended upstream at least to Spencer Creek (RM 227.6).

Pacific lamprey are anadromous nest builders that, like salmon, die shortly after spawning. They enter the Klamath at all times of the year and cease feeding as they migrate upstream. They spawn at the upstream edge of riffles in sandy gravel. Lamprey eggs hatch in approximately 2 to 4 weeks, and then the larvae (ammocoetes) drift downstream to backwater areas where they burrow into the substrate and commence feeding, tail embedded and head exposed, on algae and detritus. Juveniles remain in fresh water for 5 to 7 years before they migrate to the sea at a length of about 6 inches and transform into adults (Moyle, 2002). They spend 1 to 3 years in the marine environment, where they parasitize a wide variety of ocean fishes, including Pacific salmon, flatfish, rockfish, and pollock. Their degree of fidelity to their natal streams is unknown (FWS, 2004a). Adult Pacific lamprey typically range between 30 and 76 centimeters (12 and 30 inches) in length (Moyle, 2002).

Larson and Belchik (1998) interviewed 20 Yurok tribal elders about the historic and current lamprey fishery in the Klamath River. Most of those interviewed reported daily catches as high as 300 to 1,500 lamprey per person per day before the run declined some time between the late 1960s and the late 1980s. Reported catches since the decline have not exceeded 100 fish, with most respondents indicating that a catch of 20 lamprey was considered an extremely good catch. Pacific lamprey are collected regularly in screw traps fished in the Klamath at Big Bar and in the Trinity River at Willow Creek (see table 3-50).

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[49]Cal Fish & Game News release on emergency sturgeon regulations http://www.dfg.ca.gov/news/news060630.html accessed on June 16, 2006.

Table 3-51. Harvest of green sturgeon from California, Oregon, and Washington from 1985 to 2003. (Source: NMFS, 2005)

		California			Oregon[c]					Washington[d]						
		Klamath[b]				Columbia River[c]			Willapa Bay			Greys Harbor				
Year	**SF Bay[a]**	**Yurok**	**Hoopa[f]**	**Sport**	**Trawl**	**Sport**	**Comm.**	**Comm.**	**Sport**	**Treaty[e]**	**Comm.**	**Sport**	**Treaty[e]**	**Trawl**	**Other Treaty[e]**	**Total**
1985	Few	351	10		726	533	1,600	1,289			227		5	348	67	5,156
1986	Few	421	30	153	190	407	6,000	925		1	626		3	142	167	9,065
1987	Few	171	20	170	124	228	4,900	877			770		8	52	349	7,669
1988	Few	212	20	258	120	141	3,300	1,598	4		609	4	1	34	213	6,514
1989	Few	268	30	202	210	84	1,700	461	4		870	12	2	133	91	4,067
1990	Few	242	20	157	143	86	2,200	953	2		734	4	9	66	120	4,736
1991	Few	312	11	366	242	22	3,190	957	0		1,527	0	3	99	59	6,788
1992	Few	212	3	197	94	73	2,160	1,002	0		737	0	3	66	4	4,551
1993	Few	417	36	293	250	15	2,220	290	32		542	112	3	37	20	4,267
1994	Few	293	6	160	154	132	240	268	13	6	17	25	22	5	1	1,342
1995	Few	131	6	78	29	21	390	78	8		374	96	7	3	65	1,286
1996	Few	119	8	210	182	63	610	129	24		137	70	132	1	7	1,692
1997	Few	306	16	158	400	41	1,614	16	4		316	105	198	6	19	3,199
1998	Few	335	10	103	77	73	894	65	12	2	25	28	55	0		1,692
1999	Few	204	28	73	21	93	967	9	5		0	29	58	4		1,491
2000	Few	162	31	15	12	32	1,224	224	5		0	38	50	3		1,796
2001	Few	268	10	NA	17	50	342	106	9		0	27	32	1		862
2002	Few	273	5	NA	14	51	163	0	48		7	0	131	4		696
2003	Few	287	16	NA	17	52	46	43	NA		2	NA	46	5		514
2004			12	NA												

Eulachon

The eulachon or candlefish is a smelt that reaches the southern extent of its range in the Mad River, Redwood Creek, and the Klamath River (Moyle, 2002). Historically, large numbers entered the river to spawn in March and April, but they rarely moved more than 8 miles inland (NAS, 2004). Spawning occurs in gravel riffles, and the embryos take about a month to develop before hatching. Upon hatching, the larvae are washed into the estuary. The eulachon in the Klamath River once was an important food of the Native Americans in the region (Trihey & Associates, 1996). Moyle (2002) states that eulachon have been scarce in the Klamath River since the 1970s, with the exception of 3 years: they were plentiful in 1988 and moderately abundant again in 1989 and 1999. Based on interviews with Yurok tribal elders, Larson and Belchik (1998) state that most tribal fishers perceived a decline in the mid to late 1970s, although a smaller number thought that it was in the 1980s. Similar declines have been noted elsewhere within the species range. Commercial landings in the Columbia River and its tributaries averaged between 1 and 3 million pounds prior to 1993, but declined ten-fold starting in 1994 (figure 3-50). A similar decline has occurred in the Fraser River, where landings decreased from about 100 metric tons (110 tons) prior to 1966 to about 20 metric tons (22 tons) in the early 1990s, leading to closure of the fishery in 1998, 1999, and 2000.[50]

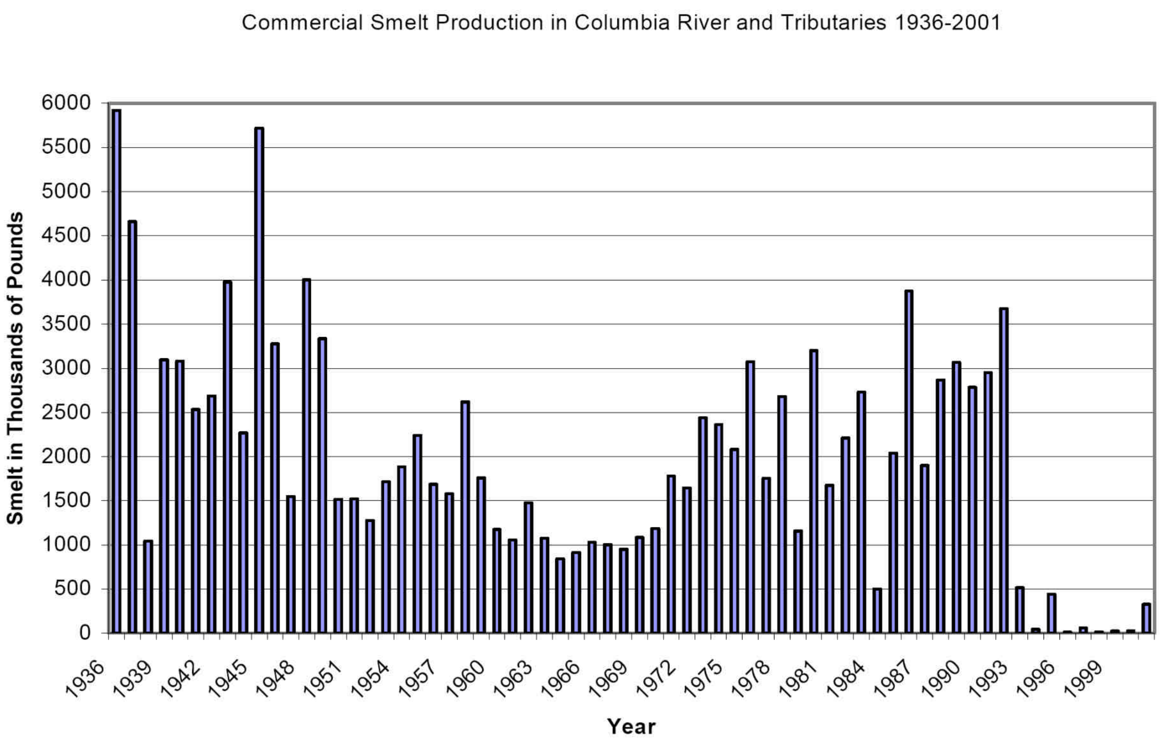

Figure 3-50. Eulachon commercial landings in the Columbia River and tributaries, 1936 to 2001. (Source: Accessed from http://www.nwcouncil.org/fw/subbasinplanning/lowerColumbia/plan/2004_05/TechnicalFoundation/VolumeIII/Vol.%20III%20Ch.%204--Eulachon.pdf on January 2, 2006)

[50] Fraser river catch records accessed from http://www.pac.dfo-mpo.gc.ca/ops/fm/herring/eulachon/default_e.htm on January 2, 2006.

Other Anadromous Species

NAS (2004) reports that coastal cutthroat trout occur mainly in the smaller tributaries of the Klamath River within about 22 miles of the estuary; this species also has been observed further upstream in tributaries to the Trinity River (Moyle et al., 1995). Sea-run adults enter the river for spawning in September and October, and juveniles rear in fresh water for 1 to 3 years before going to sea during April through June.

Other anadromous fish species that occur in the Klamath River Basin include chum salmon, white sturgeon, and American shad. NAS (2004) reports that periodic observations of adult chum salmon and regular collection of small numbers of young suggest that this species continues to maintain a small population in both the Klamath and Trinity rivers, though it has never been present in large numbers.

3.3.3.1.3 Trinity and Iron Gate Hatcheries

Trinity Hatchery

The Trinity River Hatchery, located at the base of Lewiston dam, began operation in 1963 to compensate for salmon and steelhead spawning and rearing habitat losses upstream of Lewiston dam and farther upstream above Trinity dam. Trinity River Hatchery produces spring and fall Chinook salmon, coho salmon, and steelhead.

Trinity River Hatchery releases approximately 1 million juvenile spring Chinook salmon and roughly 1 to 3 million juvenile fall Chinook salmon each year. Releases usually occur in late May to early June, with fish reaching the estuary 1 to 2 months later (NAS, 2004). The Trinity River run of up to several thousand adult spring Chinook salmon each year apparently consists primarily of returning Trinity River Hatchery fish (NAS, 2004). In addition, approximately one-third of the adult Chinook fall run in the Trinity River is reported to consist of returning Trinity River Hatchery fish (NAS, 2004).

The Trinity River Hatchery also produces coho salmon and winter steelhead. The hatchery has released an average of about 525,000 coho salmon smolts per year in recent years (NAS, 2004). Coho smolts are released between about mid-March and early May and reach the estuary at the same time as wild smolts, peaking in late May and early June. About 800,000 winter-run steelhead smolts are produced each year. Steelhead smolts are released in late March, and most of them reach the estuary in late April along with wild steelhead smolts (NAS, 2004). NAS (2004) suggests that the run of coho salmon to the Trinity River is likely dominated by hatchery-produced fish, while hatchery-produced steelhead have comprised from 20 to 34 percent of steelhead runs in the Trinity.

Iron Gate Hatchery

The Iron Gate Hatchery was built in 1961 as mitigation for the loss of spawning areas in the Klamath River and its tributaries between the Iron Gate and Copco developments. The adult salmon ladder, trap, and spawning facility were built at the base of the dam and put into operation in 1962. The hatchery complex, including egg incubation, rearing, maintenance, and administration facilities, as well as staff residences, was constructed about 400 yards downstream in March 1966. The current production goals and release dates for fall Chinook, coho, and steelhead are presented in table 3-52.

Table 3-52. Iron Gate Fish Hatchery production. (Source: Hampton, 2005, adapted by staff)

Species	Type	Number	Target Release Dates[a]	Adult Run Timing
Fall Chinook	Subyearling	4,920,000[b]	May-June	September-November
	Yearling	1,080,000[c]	November	September-November
Coho	Yearling	75,000	March	Late October-early January
Steelhead	Yearling	200,000	March-May	January-November

[a] If unusual circumstances dictate, releases may deviate from the target release dates on approval from the regional manager.

[b] In years when yearlings are not reared at the Fall Creek rearing facility, the smolt production will be 5,100,000.

[c] Approximately 900,000 shall be reared at Iron Gate Hatchery and 180,000 shall be reared at the Fall Creek ponds and released from Iron Gate fish hatchery. If the Fall Creek rearing facility is not operated, the production goal shall be 900,000 yearlings.

In response to recommendations by the Joint Hatchery Review Committee (2001), Cal Fish & Game implemented an early release strategy for Chinook, whereby subyearling smolts are released beginning in May in four groups, each separated by about 1 week. The benefits of such a release strategy are currently under investigation, but the premise is that it may reduce competition with natural salmonids, and possibly increase smolt survival due to the presence of lower temperatures and higher flows during the time of the release (Hampton, 2005).

Cal Fish & Game operates Iron Gate Hatchery, and PacifiCorp funds 80 percent of the total operating costs to satisfy its annual mitigation goals for fall Chinook fingerlings, coho yearlings, and steelhead yearlings. Beginning in 1979, portions of the fall Chinook fingerling production have been reared to the yearling stage for release in November. This yearling program was funded entirely by Cal Fish & Game, and has recently been terminated due to a lack of state funding.

Current production at Iron Gate Hatchery maximizes use of the facilities, with six of eight raceways dedicated to Chinook salmon production, and one each for coho salmon and steelhead. In years when Cal Fish & Game funds Chinook yearling production, the Fall Creek facility is used for rearing about 200,000 Chinook salmon to the yearling stage, with survival to release typically 180,000 fish at 8 fish/lb. Current production uses 30 cfs for incubation and rearing, with up to 50 cfs used on occasion, mostly when the fish ladders are operational. The 30 cfs in the rearing facility are fully used during subyearling smolt releases (and smolt transfer) and during yearling releases. Water used to support current production at Iron Gate comes from high and low-level intakes at Iron Gate reservoir. From late spring through early fall, water for the raceways and upper ladder is supplied from the 70-foot deep intake at Iron Gate. This supply of cool water from below the thermocline is limited, and in some years is depleted by late summer such that warm water temperatures have caused substantial mortalities of adult Chinook salmon in the pre-spawning holding ponds (PacifiCorp, 2005k). At the Fall Creek rearing facility, Cal Fish & Game diverts and uses 6 to 9 cfs from the Fall Creek bypassed reach. Flows are returned back to the creek.

For all species cultured, only fish that volitionally enter the hatchery are used as brood stock. Generally, this has been the practice since the hatchery began operation. However, there were 4 years when coho returns to the hatchery were low to the point where eggs were imported. In 1966, 1967, 1968, and 1970, the majority of coho production (60 to 70 percent) at Iron Gate was from eggs imported from the Cascade Hatchery on the Columbia River.

The annual egg allotment for all species is distributed throughout the duration of the spawning run in proportion to the instantaneous magnitude of the run. Maintaining genetic diversity by distributing the egg allotment throughout the spawning run takes precedence over meeting numeric production goals. Wild spawners are commonly integrated into the hatchery egg take to minimize genetic digression between hatchery and wild stocks. All adult steelhead processed in the hatchery are returned to the river, and all juvenile salmon and steelhead that are produced are released directly into the Klamath River from the hatchery.

Figures 3-51, 3-52, and 3-53 show the historical production of juvenile fish at Iron Gate Hatchery from 1965 to 2001 for fall Chinook salmon, coho salmon, and steelhead, respectively. Coho salmon and steelhead fingerling releases were discontinued for the most part in the early 1980s.

Chinook salmon production fluctuated substantially in the years preceding 1989. Numbers of Chinook salmon smolts ranged from 454,546 in 1965 to 12,727,288 in 1985. The period from 1977 through 1984 had relatively low production, well below production goals. Production exceeded goals from 1985 through 1988, and has been consistently at or close to goals since 1989.

Coho salmon production has varied from zero to 200,000 yearling smolts. The production goal of 75,000 yearlings has been met in 26 of the last 37 years, or 70 percent of the time. Production was frequently below the production goal during the 1970s. Production in the 1980s was usually above this target, with much greater numbers in the late 1980s. Since 1994, production has been maintained close to production goals. Fingerling releases were made periodically before 1984 and were relatively large in 1969 and 1982, corresponding to relatively large adult returns.

Steelhead production has varied widely through the years ranging from a high of 642,857 yearlings in 1970 to a low of 10,702 in 1997. Production has declined steadily since the peak year in 1970, and the production goal of 200,000 smolts has not been met since 1991. Fingerling releases have been made in past years, but not since 1988. During the 1980s, fingerling releases of 200,000 to 300,000 were common with a peak of one million fingerlings released in 1970.

Figure 3-54 shows returns of adult salmon and steelhead to the Iron Gate Hatchery from 1964 to 2002. The values shown do not include jacks (defined as fish less than 22 inches long). From 1963 to 1999, fall Chinook returns to the hatchery ranged from 954 in 1969 to 22,681 in 1995, with a generally increasing trend. In 2000 and 2001, record numbers of Chinook returned to Iron Gate Hatchery, with 71,151 returning in 2000.

Coho salmon returns have ranged from zero to 4,097, averaging 830 fish from 1963-2002 (see figure 3-54). Coho salmon returns to Iron Gate Hatchery have increased on average over the years, but with substantial variation between years. What has changed the most are the magnitude of the peak years, such as 1996/1997 when over 4,000 adult coho salmon returned to the hatchery. These peak years are interspersed with returns as low as a few hundred fish. Cal Fish & Game also reports (Hampton, 2005) that since 1997, the percentage of unmarked coho entering the hatchery has ranged from 43.2 percent (1998) to 7.6 percent, averaging 21 percent. The unmarked coho salmon include wild coho, unmarked hatchery coho, and unmarked hatchery coho from the Cole M. Rivers Hatchery on the Rogue River.

Steelhead returns have been erratic, but showed a precipitous decline in the early 1990s (see figure 3-54). Since 2000, the run has recovered somewhat. In 2003, the egg take met collection goals (200,000) for the first time in a decade with an adult return of 495 adult fish.

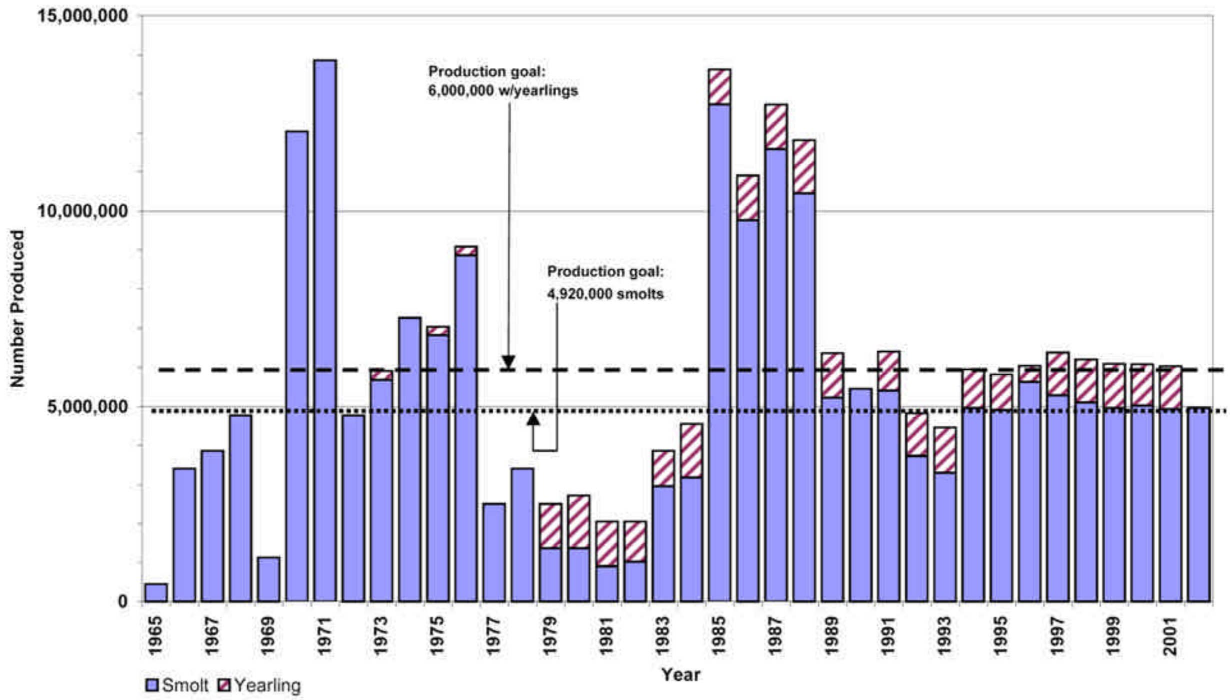

Figure 3-51. Fall Chinook production at Iron Gate Hatchery, 1965 to 2001. (Source: PacifiCorp, 2004a)

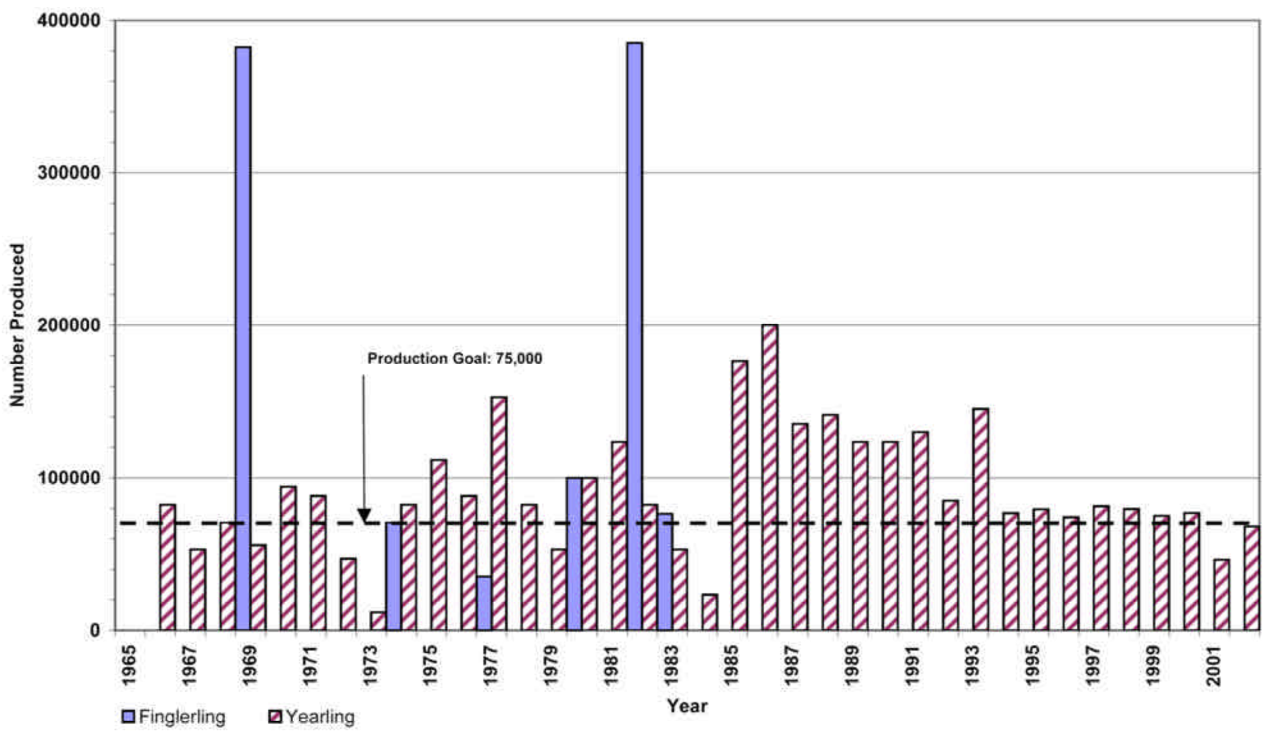

Figure 3-52. Coho salmon production at Iron Gate Hatchery, 1965 to 2001. (Source: PacifiCorp, 2004a)

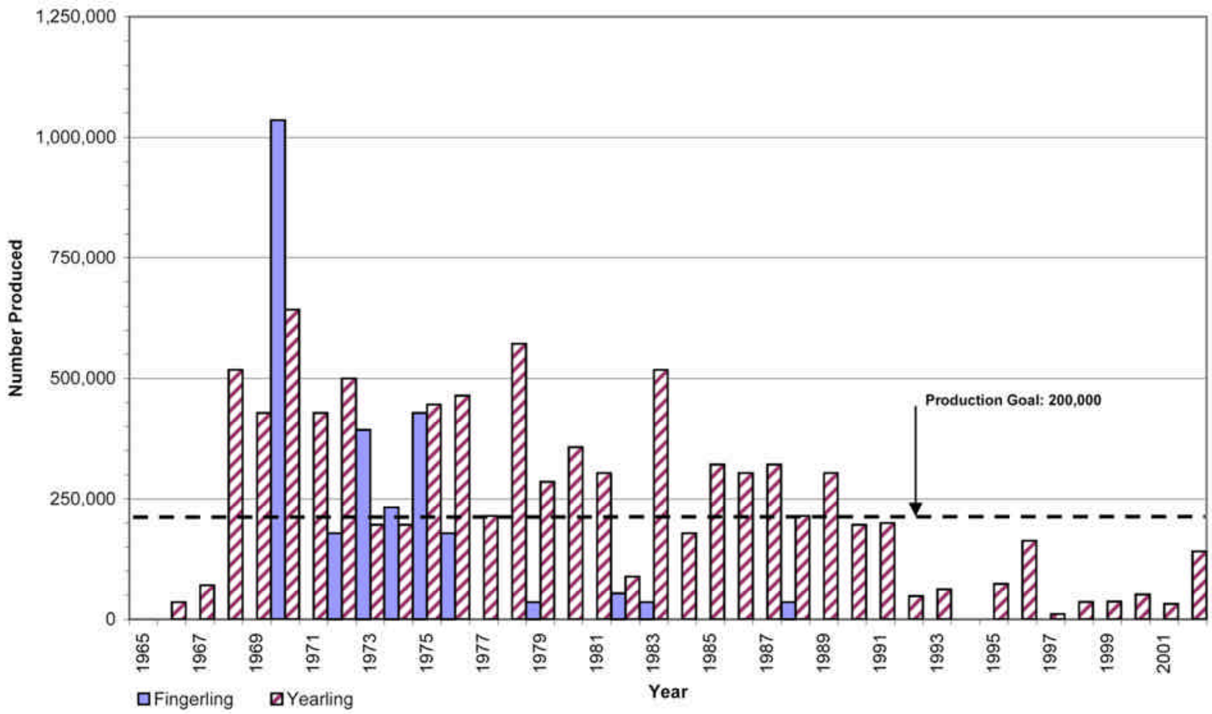

Figure 3-53. Steelhead production at Iron Gate Hatchery, 1965 to 2001. (Source: PacifiCorp, 2004a)

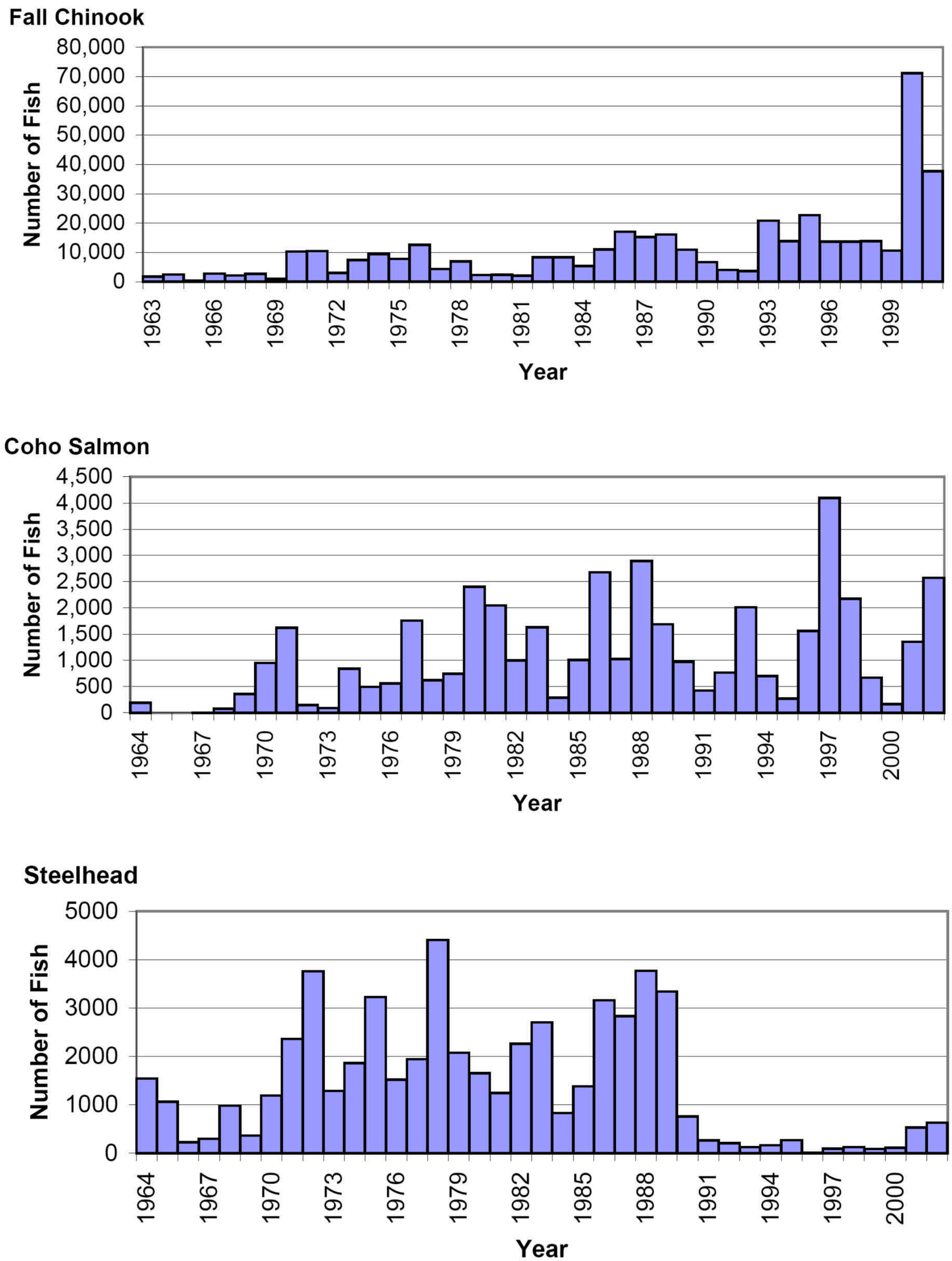

Figure 3-54. Adult salmon and steelhead returns to the Iron Gate Hatchery. (Source: PacifiCorp, 2004a).

3.3.3.1.4 Diseases Affecting Salmon and Steelhead

Juvenile Salmonids

Several pathogens have been identified that may contribute to losses of juvenile anadromous fish during their outmigration from the Klamath River Basin. Pathogens observed to cause disease in juvenile salmonids in the Klamath and Trinity rivers include *C. shasta*, *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis*. Ceratomyxosis, the disease caused by *C. shasta,* has been identified as the most significant disease for juvenile salmon in the basin (Nichols et al., 2003). Foott et al. (2002) found that over 40 percent of Chinook salmon smolts sampled from the lower Klamath River in 2001 were diagnosed with severe ceratomyxosis, and the incidence of *C. shasta* infection has ranged from 29 to 43 percent in juvenile Chinook salmon collected in the Klamath estuary (Foott et al., 2002; Nichols et al., 2003). Nichols and Foott (2005) estimated that 45 percent of the juvenile fall Chinook that outmigrated in 2004 were infected with *C. shasta*, and 94 percent of the population was infected with *P. minibicornis*. They concluded that the high incidence of fish infected with both pathogens suggests that the majority of the *C. shasta* infected juvenile Chinook would not survive. Monitoring results in 2005 reported by Nichols (2005) indicate that infection rates of juvenile fall Chinook with *C. shasta* increased to levels that exceeded 70 percent by late April, and infection rates for *P. minibicornis* ranged between 94 and 100 percent from late April through at least mid-May. Ceratomyxosis has been shown to persist in juvenile salmon after they enter salt water, and Foott et al. (2004) concluded that most smolts with detectable infection are likely to die from the disease.

Scheiff et al. (2001) noted that juvenile fish kills observed in 1997 and 2000 during screw-trap sampling occurred during periods of sustained high water temperatures, and past studies have indicated that resistance to ceratomyxosis may be reduced at higher water temperatures. Foott et al. (2004), however, found that the rate of mortality was not markedly different between Chinook salmon smolts held at 16°C and at 20°C in a hatchery setting after exposure, and concluded that the magnitude of parasite exposure may have a stronger influence on disease severity than rearing temperature.

Although infection with *C. shasta* does not appear to occur in the Trinity River, there is evidence that Chinook salmon smolts from the Trinity River become infected and diseased with ceratomyxosis after they enter the Klamath during their outmigration. In the summer of 2002, 19 percent of marked Trinity River hatchery Chinook salmon smolts collected in the estuary were found to be infected with *C. shasta* (Nichols et al., 2003). Klamath River steelhead appear to be resistant to ceratomyxosis, and the impact of this disease on coho salmon in the Klamath River is unknown, although at least one case of infection has been documented (Foott et al., 2004).

Oregon State University (2004) studied the prevalence of *C. shasta* within the project area extending from Keno reservoir downstream to the confluence with Beaver Creek, a tributary that enters the Klamath River near RM 161, 29 miles downstream of Iron Gate dam. Sentinel studies conducted by holding rainbow trout in live cages for 3 to 5 days at seven sites documented infection at all sites except for Keno reservoir (infections were observed in the Keno reach; in J.C. Boyle reservoir, bypassed reach, and peaking reach; in the Copco No. 2 bypassed reach; and in the Klamath River upstream of Beaver Creek). Mortality rates caused by *C. shasta* during a 70-day post-exposure holding period were less than 22 percent for most groups, with the exceptions of a 59 percent mortality rate observed for fish that were exposed during July in the J.C. Boyle bypassed reach and mortality rates of 75 and 90 percent for fish that were exposed in June and July, respectively, in the Klamath River upstream of Beaver Creek. Separate trials were conducted in April, June, July, September, and November at most sites.

Additional sampling was conducted using a recently developed assay technique called the Quantitative Polymerase Chain Reaction assay, which can measure *C. shasta* concentrations in water. Results from sampling at 19 locations generally mirrored the results of the sentinel studies, with *C. shasta* being detected at all sites except Keno reservoir, and the highest concentration found in the mainstem Klamath River upstream of Beaver Creek (Oregon State University, 2004). The assay sampling included several locations where sentinel studies had not been conducted, including one in the Williamson River (upstream of Upper Klamath Lake), which had the second-highest concentration of *C. shasta* of all sites sampled.

Oregon State University (2004) also conducted sampling to evaluate the abundance of *Manayunkia speciosa*, the polychaete that has been identified as an alternate host for both *C. shasta* and *P. minibicornis* (Bartholomew, 2006). Polychaetes were found to be most abundant in the river and in riverine sections of reservoirs. They were not associated with the very fine organic silt/mud substrate that occurs in reservoirs, and the microhabitat that was associated with the highest concentration of the polychaete was a periphytic algae (*Cladophora* spp.). This macro-algae has a competitive advantage in nutrient enriched waters, and can become the dominant species, frequently covering the entire stream bed and displacing other macrophytes where it occurs (Stocking and Bartholomew, 2004). Another microhabitat that was encountered less frequently but that also supported high concentrations of polychaetes was a loose, flocculent matrix of diatoms.

Adult Salmonids

During the last half of September 2002, a major fish kill occurred in the lower 36 miles of the Klamath River. The primary cause of the fish kill was a disease outbreak from the common pathogens *Ichthyopthirius multifilis* (Ich) and *Flavobacterium columnare* (columnaris) (Guillen, 2003; Cal Fish & Game, 2004a; NAS, 2004). The fish kill was unprecedented in that it was the first major adult mortality event ever recorded in the Klamath River (Cal Fish & Game, 2004a).

Based on surveys conducted by FWS during the 2002 fish kill, Guillen (2003) estimated that a total of 33,527 adult anadromous salmonids were killed, including 32,533 fall Chinook salmon, 629 steelhead, 344 coho salmon, and one coastal cutthroat trout. Approximately 21.7 percent of the fall Chinook, 38.7 percent of the steelhead, and 91.5 percent of the coho salmon were determined to be of hatchery origin. Guillen (2003) considered these estimates to be conservative, and Cal Fish & Game (2004a) suggest that the actual losses might have been twice as high as those reported above.

Based on an analysis of fish run timing, river flows, and water quality conditions that occurred in 2002, FWS concluded that a combination of factors resulted in conditions that lead to the fish kill (Guillen, 2003). These included an early peak in the return of a large run of fall Chinook salmon and low river discharges that apparently did not provide suitable attraction flows for migrating adult salmon, resulting in large numbers of fish congregating in the warm waters of the lower river. Guillen (2003) concluded that the high density of fish, low discharges, warm water temperatures, and possible extended residence time of salmon created optimal conditions for parasite proliferation and precipitated an epizootic of Ich and columnaris.

Cal Fish & Game (2004a) also concluded that a combination of factors contributed to create conditions in 2002 that were stressful to salmonids and were conducive to a disease outbreak. Factors identified by Cal Fish & Game included atypically low flows and low river volume coupled with an above average run of fall Chinook salmon, which peaked 1 week earlier than average, and seasonably warm water temperatures that normally occur in September in the lower Klamath River. Cal Fish & Game (2004a) also reported that low flows and changes in the river channel caused by high flow events in the late 1990s may have impeded fish passage due to shallow water at several riffles under the prevailing low flows, and this combined with an above average run, contributed to high fish densities. The lack of a sand spit constriction at the river mouth combined with low flows also resulted in a lower than normal water volume within the estuary, which contributed to higher than normal fish densities.

3.3.3.1.5 Salmon and Steelhead Harvest and Harvest Management

The Klamath Fishery Management Council (KFMC) formed in 1985, is a federal advisory committee made up of commercial and recreational fishermen, Yurok and Hoopa Valley tribal fisheries representatives, and state and federal agencies (Cal Fish & Game, Oregon Fish & Wildlife, NMFS, and Interior). The KFMC meets each spring to review the past year's salmon harvest and predictions, developed by its technical advisory team, of salmon ocean abundance and harvests in the upcoming year. The KFMC then makes specific recommendations to the agencies that regulate the harvest of Klamath River Basin anadromous fish. Oregon Fish & Wildlife and Cal Fish & Game manage harvest of resident fish in their respective portions of the river.

PFMC regulates ocean harvest in the area from 3 to 200 miles offshore by considering the KFMC recommendations and developing regulations to be established by the Department of Commerce for offshore fisheries, and the California Fish and Game Commission for nearshore and Klamath River harvests. The guiding document for PFMC's management of commercial and recreational fisheries is the Pacific Coast Salmon Fishery Management Plan (Salmon FMP) (PFMC, 2003a). The Salmon FMP covers Chinook and coho salmon and, in odd years, pink salmon. PFMC does not regulate ocean harvests for steelhead or cutthroat trout, or for runs of even-year pink salmon, as these species are rarely caught in ocean fisheries.

The Salmon FMP was developed to comply with the requirements of the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265, as amended through October 11, 1996), which states that "conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery." Optimum yield for a stock includes total salmon catch and mortality from fisheries within the exclusive economic zone[51] adjacent to Washington, Oregon, and California, and in waters of those states (including internal waters), and Idaho. PFMC must ensure that fishing regulations also meet or exceed the requirements of the ESA, and must manage fisheries to be consistent with NMFS conservation standards or recovery plans. To achieve optimum yield, PFMC developed fixed conservation objectives for Chinook and coho salmon stocks that are based either on achieving a specified number of adult spawners (spawner escapement) or a specified number of adult returns to a specific location (such as a dam or river) that would result in a target level of spawning adults.

The Yurok and Hoopa Valley tribes have a federally protected right to the fishery resource of their reservations sufficient to support a moderate standard of living or 50 percent of the total available harvest of Klamath-Trinity basin salmon, whichever is less. The in-river recreational harvest is set annually as a percentage of the non-tribal harvest allocation. The 50 percent tribal fisheries allocation for Klamath River Basin stocks is split further, with 80 percent going to the Yurok Tribe, and 20 percent to the Hoopa Valley Tribe. The Karuk Tribe fishing is limited to a spot at Ishi-Pishi Falls and is not limited to a specific allocation. Individual tribal members are assigned shares of the tribal allocation under the regulatory authority of the tribes.

Klamath River Fall Chinook

Klamath River fall Chinook stocks are a major contributor to the ocean fisheries from central Oregon to central California. The Salmon FMP conservation objective states that 33 to 34 percent of the natural run of fall Chinook must be allowed to escape all tribal, commercial, and recreational fisheries to spawn. In addition, there is a floor conservation requirement of no less than 35,000 natural spawners returning to Klamath River in any one year. If it is estimated that natural spawning escapement will exceed 35,000 fish, then harvest of fish in excess of 35,000 is allowed. If it is predicted that the floor level of 35,000 natural spawner escapement will not be met, PFMC must close all salmon fisheries within

[51] The exclusive economic zone is the area from 3 to 200 miles off the coast of the United States.

their jurisdiction that influence the stock, regardless of the status of other salmon stocks in the area. This includes the entire area from Pigeon Point in California to Florence, Oregon (PFMC, 2003) (figure 3-55).

The 2006 forecast for age-3 abundance is the lowest on record, and the spawning escapement floor of 35,000 naturally spawning Klamath River fall Chinook was not projected to be attained even with complete closure of ocean salmon fisheries between Cape Falcon, Oregon and Big Sur, California. Therefore, PFMC's management measures required implementation of "emergency rule" to allow harvest. NMFS advised PFMC to structure the 2006 salmon fishery management recommendations with an escapement limit of no less than 21,000 natural spawners. This resulted in complete closure of commercial ocean troll fisheries between Florence South Jetty to Horse Mountain (the Klamath Management Zone), and only a 15-day opening for Horse Mountain to Pt. Arena (PFMC, 2006a). Table 3-53 presents the harvest quotas established by PFMC for Klamath River fall Chinook for 2001 through 2006. Figure 3-56 presents historical fall Chinook landings by PFMC management zone, and table 3-54 presents harvest of age 3 and 4 Klamath River fall Chinook in the Klamath Management Zone from 1986 through 2005.

In June 2006, PFMC began analysis of a range of alternatives to amend the Salmon FMP in order to provide *de minimis* (minimum allowable) fishing opportunities during periods when the status of Klamath River fall Chinook is such that no fishing opportunities would be allowed under the current Salmon FMP.

PFMC is scheduled to review the analyses and adopt a preferred alternative for public review at its September 2006 meeting, and take final action at its November 2006 meeting (http://www.pcouncil.org/decisions/0606decisions.html#salmon, accessed June 21, 2006).

Table 3-47 presents historical spawning escapement and in-river harvest of fall Chinook in the Klamath River Basin. Preliminary data for 2005 show the natural spawning escapement to the Klamath River Basin was 27,305 adults compared to 2004 escapement of 24,246, and 2003 escapement of 87,647 (figure 3-57). The KFMC modeled the predicted natural escapement for 2006 and concluded that, if the restrictive 2005 fishing regulations were continued in 2006, natural escapement would again fall short of the 35,000 floor mandated by PFMC (Klamath River Technical Advisory Team, 2005).

During 2005, 383,500 natural and hatchery fall Chinook adults were estimated to have returned to the Sacramento River Basin for spawning. This value is approximately 39 percent of the pre-season expectation of 983,600, but with an in-river harvest rate of 25 percent, still exceeds PFMC's conservation escapement objective of 122,000 to 180,000 adults (figure 3-58). For 2006, the run forecast for adult Central Valley Chinook was 368,000 fish.[52]

[52]Records from 1970–2005 (PFMC, 2006, Preseason Report III).

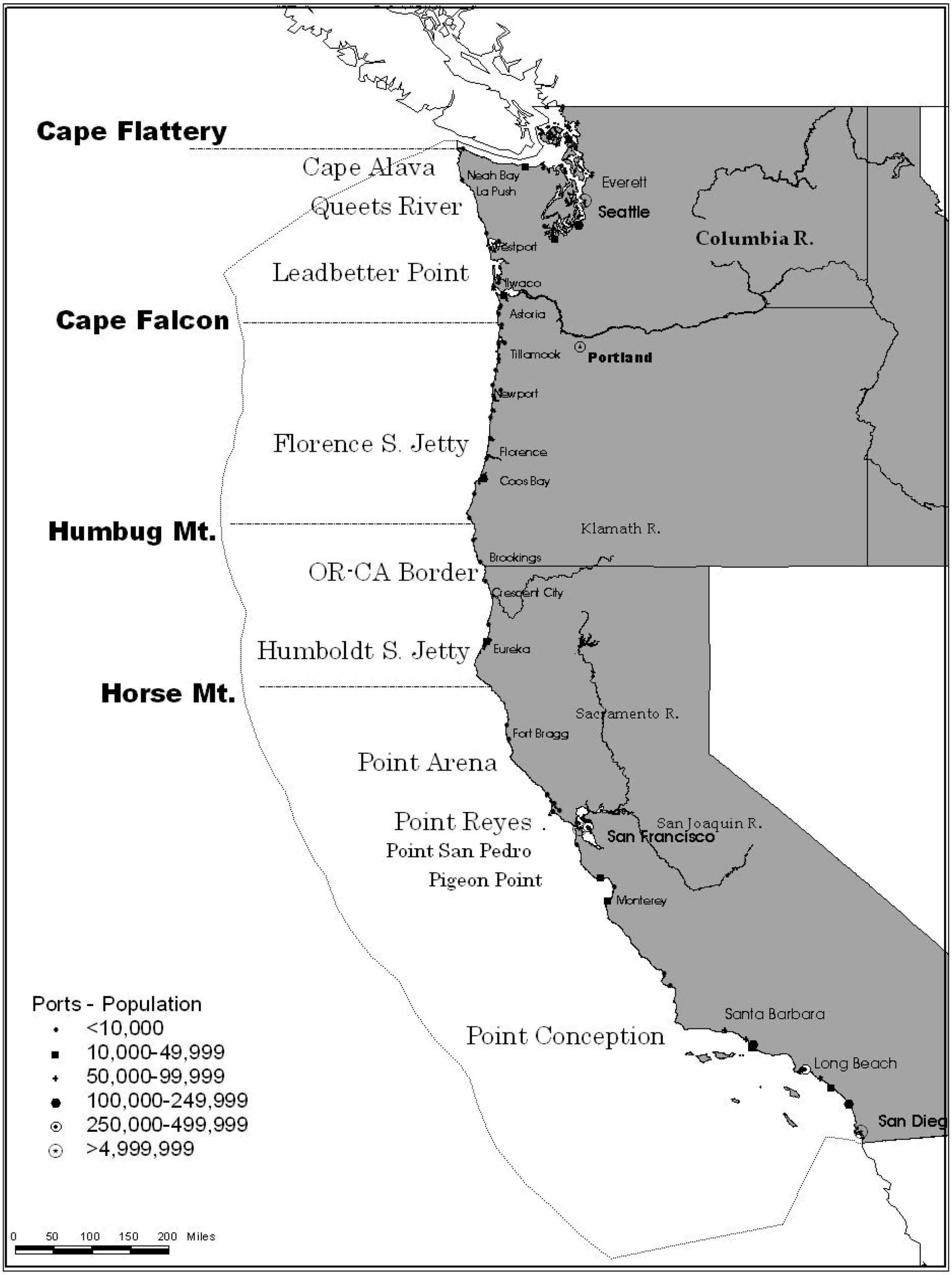

Figure 3-55. Pacific coast ports and management zones. (Source: PFMC, 2005a)

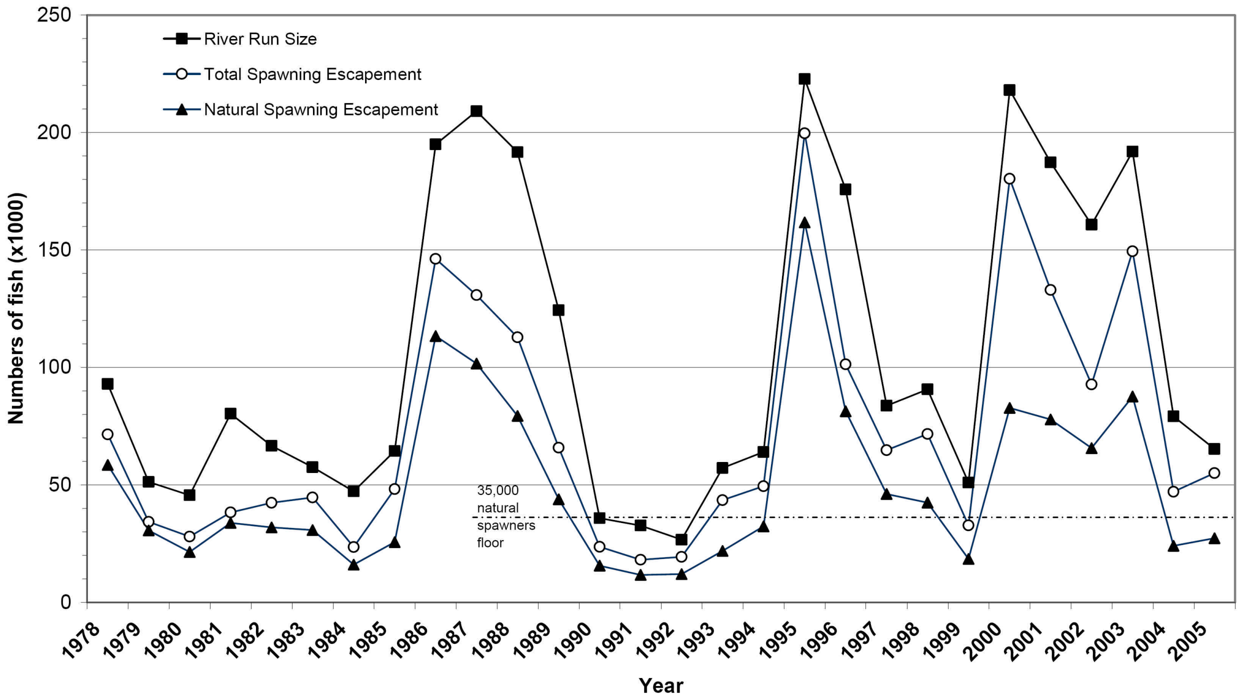

Figure 3-56. Klamath River adult fall Chinook salmon river return and spawning escapements, 1978 to 2005. (Source: PFMC, 2006b)

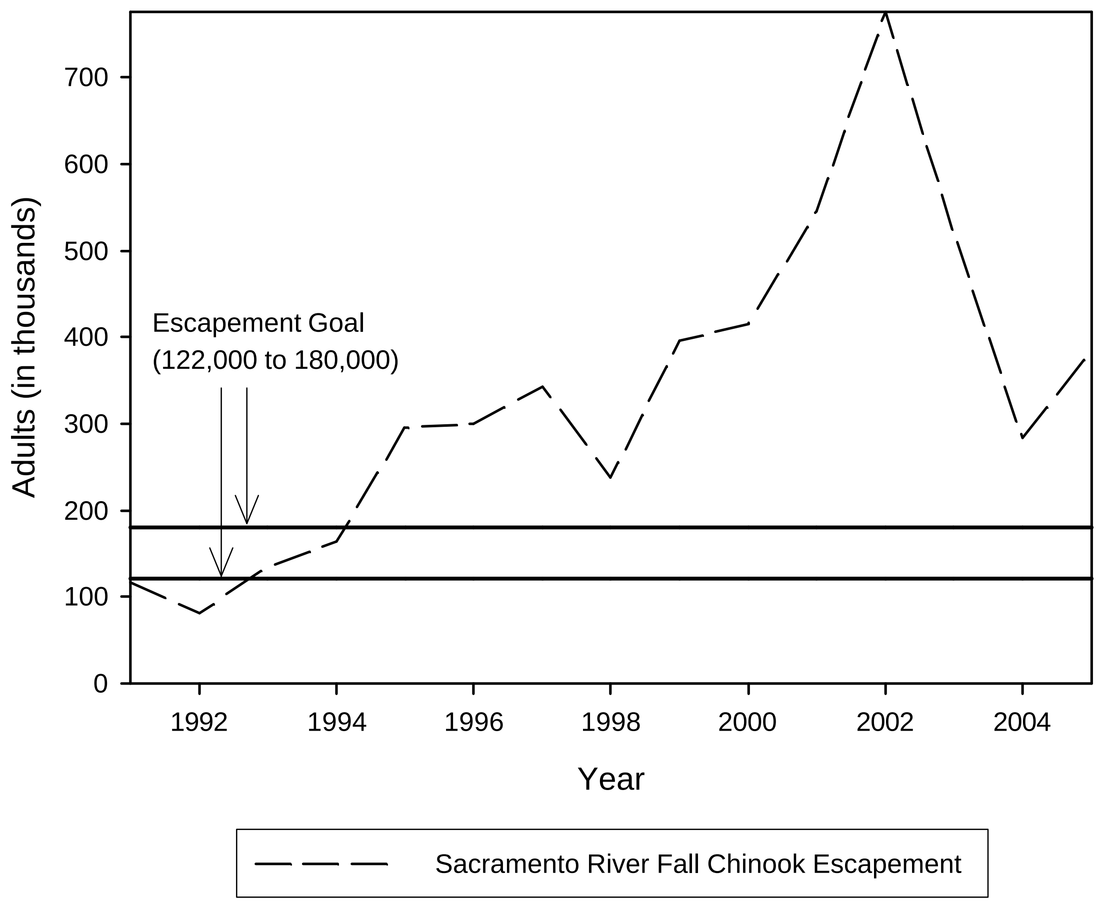

Figure 3-57. Natural and hatchery Sacramento River fall Chinook escapement to mouth of Sacramento River. (Source: PFMC, 2006b)

Table 3-53. PFMC stock management quotas for 2001-2005 for Klamath River fall Chinook. (Sources: PFMC, 2001, 2002a, 2003b, 2004b, 2005c, 2006)

	Allocation [a]	Quota
Klamath River Escapement	2001: 47,000 target natural spawning escapement [b]	
	2002-2005: Minimum 35,000 natural spawning escapement goal	
	2006: 21,100 target natural spawning escapement goal	
Federally recognized tribal harvest (to Yurok and Hoopa Valley tribal fisheries)/Non-tribal harvest	50% / 50%	2001: 75,500 adult fish each
		2002: 50,400 adult fish each
		2003: 41,400 adult fish each
		2004: 31,000 adult fish each
		2005: 8,300 adult fish each
		2006: 10,000 adult fish each
Non-tribal harvest:		
KMZ[c] ocean fishery	2001: 60.5%	2001: 45,600 adult fish
	2002: 59.5%	2002: 30,000 adult fish
	2003: 73.9%	2003: 30,600 adult fish
	2004: 85 %	2004: 26,500 adult fish
	2005: 85 %	2005: 7,100 adult fish
	2006: 100%	2006: 8,400 adult fish[d]
KMZ[b] ocean recreational fishery (percent of KMZ ocean fishery allocation in row above)	2001: 17.0%	2001: 7,700 adult fish
	2002: 11%	2002: 3,300 adult fish
	2003: 14.8%	2003: 4,500 adult fish
	2004: 14.1%	2004: 3,700 adult fish
	2005: 17.1%	2005: 1,200 adult fish
	2006: 8.8%	2006: 900 adult fish
Klamath River recreational fishery	2001: 39.5%	2001:. 29,800 adult fish
	2002: 40.7%	2002: 20,500 adult fish
	2003: 26.1%	2003: 10,800 adult fish
	2004: 15%	2004: 4,700 adult fish
	2005: 15%	2005: 1,200 adult fish
	2006: 0%	2006: 300 adult fish[e]

Notes: KMZ – Klamath Management Zone

[a] Percentages rounded.

[b] Escapement is the number of naturally spawning salmon escaping ocean fisheries and entering freshwater.

[c] The area between Humbug Mountain, Oregon, and Horse Mountain, California.

[d] Allocation for KMZ fish harvested outside the KMZ area.

[e] Closed to recreational fishing; allocation is for incidental mortality from catch and release fisheries.

Table 3-54. Harvest (# fish) of age-3 and age-4 Klamath River fall Chinook. (Source: PFMC, Preseason Report I, 2006)

	Ocean Fisheries (Sept. 1 -Aug. 31)							River Fisheries		
	KMZ									
Year	Troll	Sport	Subtotal	North of KMZ	South of KMZ	Subtotal	Ocean Total	Net	Sport	Total
1986	43,515	6,001	49,516	97,525	155,205	252,730	302,246	25,100	21,000	46,100
1987	39,308	9,590	48,898	114,677	106,255	220,932	269,830	52,400	19,900	72,300
1988	27,607	8,693	36,300	50,818	157,098	207,916	244,216	51,100	21,800	72,900
1989	12,232	21,378	33,610	47,187	39,718	86,905	120,515	43,700	8,600	52,300
1990	4,036	7,305	11,341	76,431	21,657	98,088	109,429	7,300	3,600	10,900
1991	0	2,038	2,038	1,879	4,996	6,875	8,913	9,716	3,293	13,009
1992	172	55	227	2,770	12	2,782	3,009	5,330	974	6,304
1993	0	812	812	1,669	7,965	9,634	10,446	9,212	3,160	12,372
1994	41	1,645	1,686	1,117	4,685	5,802	7,488	11,209	1,783	12,992
1995	0	1,209	1,209	13,614	16,180	29,794	31,003	14,797	6,017	20,814
1996	769	3,451	4,220	10,277	29,906	40,183	44,403	56,322	12,741	69,063
1997	3	403	406	1,071	4,185	5,256	5,662	10,900	5,322	16,222
1998	0	107	107	4,269	466	4,735	4,842	9,395	7,603	16,998
1999	76	552	628	2,907	1,128	4,035	4,,663	13,770	2,242	16,012
2000	520	4,137	4,657	11,188	25,946	37,134	41791	29,191	5,649	34,840
2001	1,418	1,698	3,116	8,551	9,932	18,483	21,599	38,644	12,113	50,757
2002	2,198	1,767	3,965	5,219	21,217	26,436	30,401	23,663	10,321	33,984
2003	1,375	2,510	3,885	14,062	85,655	99,717	103,602	29,750	9,653	39,403
2004	3,935	3,970	7,905	38,917	61,210	100,127	108,032	22,103	3,761	25,864

Notes: KMZ – Klamath Management Zone

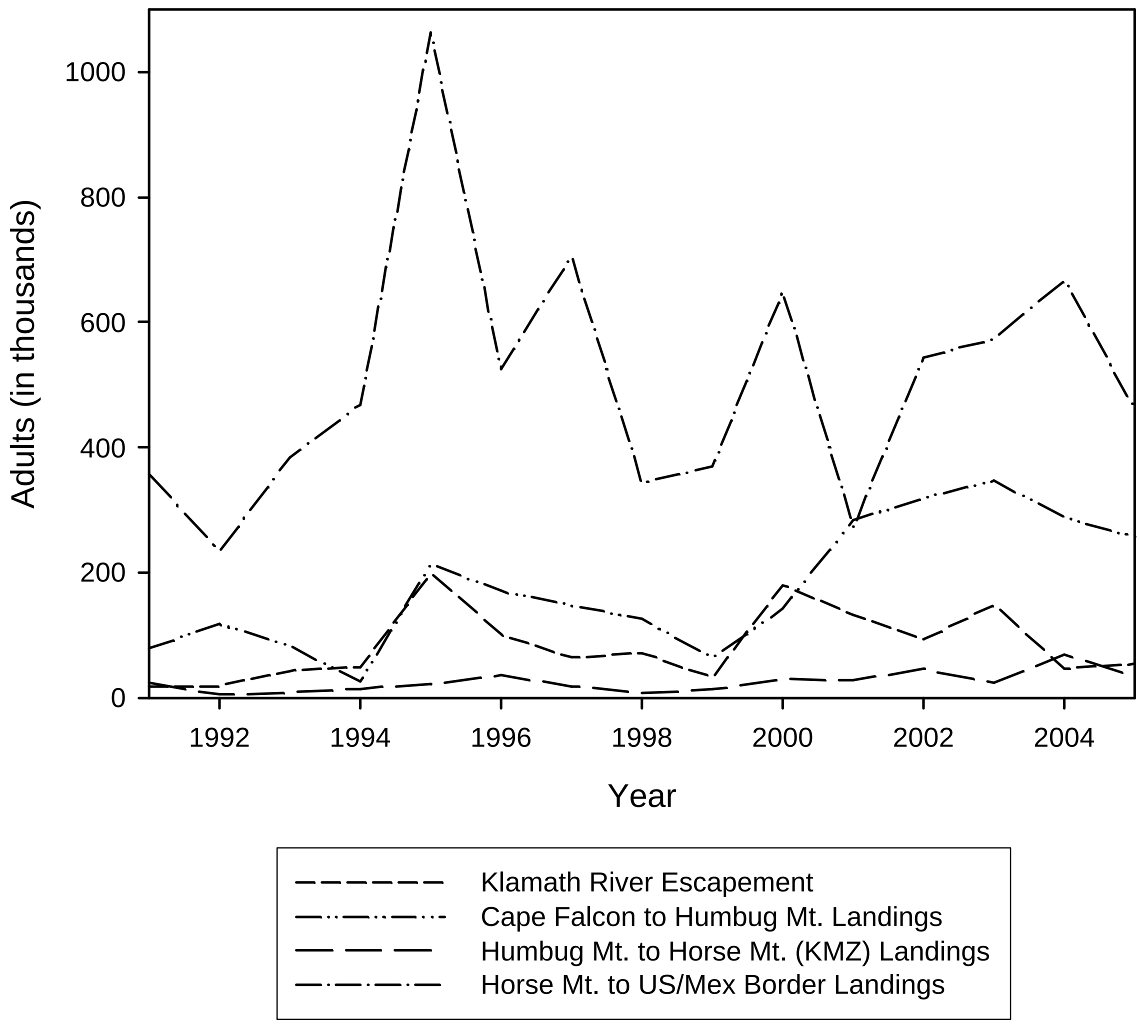

Figure 3-58. Klamath River total fall Chinook spawning escapement (hatchery and natural combined) and ocean landings by PFMC management zone. (Source: PFMC, 2005a)

The California Fish and Game Commission annually establishes regulations to manage the Klamath River sport harvest portion of the PFMC quota. To allow fishing opportunities throughout the Klamath River Basin, the quota allowance is typically evenly split, with 50 percent of the quota allocated to the Klamath River below the Highway 96 bridge at Weitchpec and 50 percent to the remainder of the Klamath River Basin above the Highway 96 bridge, including the Trinity River. In 2006, The California Fish and Game Commission ruled[53] that the fall Chinook quota for the entire Klamath River Basin is zero.

From 1987 through 1989, the Yurok and Hoopa Valley Reservation gillnet fisheries in the estuary averaged 27,500 Chinook annually, but from 1990 through 1998 there was no commercial harvest in the estuary except in 1996 (PFMC, 2005a). Table 3-55 presents the Yurok and Hoopa Valley Reservation

[53] California Fish and Game Commission regulations, accessed from http://www.fgc.ca.gov/2006/7_50b91_1pa.pdf on June 21, 2006

tribal gillnet harvest of Chinook for 1990 through 2004. From 1999 to 2002, the subsistence fishery has exceeded the commercial harvest, but this trend was reversed in 2003 and 2004, when the commercial harvest was more than double the subsistence fishery. Table 3-56 presents estimates of angler harvest from 1983 through 1987.

Table 3-55. Estimates of Yurok and Hoopa Valley Reservation gillnet harvest, 1990-2005.[a] (Sources: PFMC, 2006a, 2002a)

		Chinook Salmon (numbers of fish)					
		Spring Run			Fall Run		
Year	**Area**	**Jack**	**Adult**	**Total**	**Jack**	**Adult**	**Total**
1990	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	386	386	13	3,536	3,549
	Middle Klamath	0	521	521	36	1,116	1,152
	Upper Klamath	0	504	504	102	2,331	2,433
	Trinity	24	865	889	36	811	847
	Total	24	2,276	2,302	187	7,794	7,981
1991	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	70	70	7	3,902	3,909
	Middle Klamath	0	46	46	9	1,765	1,774
	Upper Klamath	3	167	170	16	3,251	3,267
	Trinity	0	263	263	30	1,310	1,342
	Total	3	546	549	62	10,228	10,290
1992	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	15	15	124	1,152	1,275
	Middle Klamath	0	97	97	62	1,107	1,159
	Upper Klamath	0	284	284	148	2,580	2,726
	Trinity	0	346	346	42	946	988
	Total	0	742	742	366	5,785	6,151
1993	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	19	19	62	3,017	3,079
	Middle Klamath	0	320	320	33	1,632	1,865
	Upper Klamath	0	211	211	47	3,495	3,542
	Trinity	0	228	226	33	1,492	1,525
	Total	0	778	778	175	9,636	9,811
1994	Commercial Estuary		-	-	-	-	-
	Subsistence Estuary	9	152	161	80	4,341	4,421
	Middle Klamath	14	110	124	4	1,448	1,452
	Upper Klamath	3	239	242	71	3,658	3,729
	Trinity	0	255	255	94	2,266	2,360
	Total	26	756	782	249	11,713	11,962
1995	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	656	656	117	5,200	5,317
	Middle Klamath	0	1,312	1,312	44	2,415	2,459
	Upper Klamath	0	824	624	47	4,610	4,657
	Trinity	93	1,175	1,268	268	3,383	3,651
	Total	93	3,767	3,860	476	15,608	16,084
1996	Commercial Estuary	16	3,113	3,129	127	40,020	40,147
	Subsistence Estuary	1	1,851	1,852	36	9,093	9,129
	Middle Klamath	9	673	682	7	1,570	1,577
	Upper Klamath	3	268	271	12	3,023	3,035
	Trinity	6	1,162	1,186	8	2,770	2,776
	Total	35	7,086	7,122	190	56,476	56,668
1997	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	0	2,919	2,919	21	5,574	5,596
	Middle Klamath	0	1,102	1,102	3	1,479	1,482

Year	Area	Chinook Salmon (numbers of fish) Spring Run Jack	Adult	Total	Fall Run Jack	Adult	Total
	Upper Klamath	0	1,416	1,419	5	3,796	3,801
	Trinity	1	1,250	1,251	6	1,238	1,244
	Total	1	8,690	6,691	35	12,087	12,122
1998	Commercial Estuary	-	-	-	-	-	-
	Subsistence Estuary	2	621	623	16	3,454	3,470
	Middle Klamath	0	937	937	9	1,324	1,333
	Upper Klamath	0	780	780	23	3,874	3,897
	Trinity	45	426	471	5	1,535	1,540
	Total	47	2,764	2,811	53	10,187	10,240
1999	Commercial Estuary	-	-	-	-	2,077	2,077
	Subsistence Estuary	2	456	456	127	2,315	2,442
	Middle	0	1,343	1,343	49	2,261	2,310
	Upper Klamath	0	593	593	237	4,784	5,021
	Trinity	13	776	769	96	2,978	3,074
	Total	15	3,188	3,183	509	14,415	14,924
2000	Commercial Estuary	-	33	33	-	4,104	4,104
	Middle Klamath	-	2	2	-	186	186
	Upper Klamath	-	1	1	-	813	813
	Subsistence Estuary	5	1,739	1,744	35	13,209	13,209
	Middle Klamath	0	509	509	29	1,049	1,078
	Upper Klamath	8	909	917	111	4,127	4,238
	Trinity	29	1,325	1,354	128	5,926	6,090
	Total	42	4,518	4,560	303	29,415	29,718
2001	Commercial Estuary	79	4,637	4,716	63	7,011	7,074
	Upper Klamath	1	58	59	1	51	52
	Subsistence Estuary	152	8,846	8,998	198	21,956	22,154
	Middle Klamath	0	134	134	28	1,697	1,725
	Upper Klamath	19	1,504	1,523	49	2,976	3,025
	Trinity	46	4,164	4,210	60	4,954	5,014
	Total	297	19,343	19,640	399	38,645	39,044
2002	Commercial Estuary	7	1,852	1,859	7	8,952	8,959
	Upper Klamath	-	-	-	-	-	
	Subsistence Estuary	25	6,551	6,576	10	11,197	11,207
	Middle Klamath	70	1,310	1,380	10	729	739
	Upper Klamath	24	2,205	5,229	31	2,528	2,559
	Trinity	40	3,052	3,062	68	1,168	1,236
	Total	166	14,970	15,136	126	24,574	24,700
2003	Commercial Estuary	4	779	783	12	17,083	17,095
	Upper Klamath	0	0	0	0	0	0
	Subsistence Estuary	10	1,800	1,810	4	5,604	5,608
	Middle Klamath	0	2,355	2,355	5	1,376	1,381
	Upper Klamath	0	1,730	1,730	11	3,200	3,211
	Trinity	7	2,380	2,387	12	2,771	2,783
	Total	21	9,044	9,065	44	30,034	30,078
2004[b]	Commercial Estuary	2	408	410	13	14,251	14,264
	Upper Klamath	0	0	0	13	540	554
	Subsistence Estuary	10	2,178	2,188	62	6,787	6,848
	Middle Klamath	6	2,346	2,352	14	577	591
	Upper Klamath	11	1,715	1,726	46	1,959	2,005
	Trinity	62	1,944	2,006	20	1,689	1,709
	Total	91	8,591	8,682	168	25,083	25,971
2005	Commercial Estuary	0	0	0	0	0	0
	Upper Klamath	16	3,113	3,129	0	0	0

Year	Area	Chinook Salmon (numbers of fish)					
		Spring Run			Fall Run		
		Jack	Adult	Total	Jack	Adult	Total
	Subsistence Estuary	1	430	430	21	2,233	2,254
	Middle Klamath	9	520	520	5	462	467
	Upper Klamath	3	1,232	1,232	33	2,851	2,884
	Trinity	17	1,858	1,858	11	2,409	2,420
	Total	46	7,153	7,169	70	7,955	8,025

[a] FWS generated estimates for Klamath River portion from 1983 to 1993. The Fisheries Department of the Hoopa Valley Business Council has monitored the Trinity River fishery since 1982. The Yurok Tribe Fisheries Program monitored the Klamath River portion in 1994 and 1995.

[b] Preliminary estimate.

- = Estimate not made.

Table 3-56. Klamath River angler harvest estimates for Chinook and coho salmon, and steelhead 1983 to 1987 seasons. (Source: Hopelain, 2001)

Harvest area	Angler trips	Angler hours	Chinook		Coho		Steelhead	
			grilse	adults	grilse	adult	halfpounders	adult
1983[a]								
Area 1[b]			60	750				
Area 2-3			175	1,125				
Total			**235**	**1,875**				
1984								
Area 1	2,2844	60614	175	548	57	0	260	88
Areas 2[c]	1,4938	49844	256	257	88	4	3165	1454
Area 3[d, e]	n/a	n/a	128	1,799				
Total	**37782**	**110498**	**559**	**2604**	**145**	**4**	**3425**	**1542**
1985								
Area 1	21,399	68,070	1,479	2,427	12	41	135	107
Area 2	18,761	70,171	2,331	438	35	4	3,626	3,184
Area 3	n/a	n/a	1,943	563				
Total	**40,160**	**138,241**	**5,753**	**3,428**	**47**	**45**	**3,761**	**3,291**
1986								
Area 1	28,274	89,092	704	2,456	0	4	124	85
Area 2	18,156	71,564	2,257	2,661	50	15	2,073	2,905
Area 3	n/a	n/a	3,009	3,871				
Total	**46,430**	**160,656**	**5,970**	**8,988**	**50**	**19**	**2,197**	**2,990**
1987								
Area 1	26,292	79,534	146	2,455	1	0	98	43
Area 2	24,972	99,047	2,980	5,648	80	152	2,160	1,753
Area 3	n/a	n/a	1,490	3,655				
Total	**51,264**	**178,581**	**4,616**	**11,758**	**81**	**152**	**2,258**	**1,796**

[a] Creel census not conducted in 1983. Estimates based on previous season's harvest levels.

[b] Area 1= estuary, mouth (RM 0) to Highway 101 Bridge (RM 3). Estimates based on creel data.

[c] Area 2 = Highway 101 Bridge (RM 3) to Johnson's (RM 24). Estimates based on creel data.

[d] Area 3 = Johnson’s (RM 24) to Iron Gate dam (RM 191). Angler interviews were not conducted in this area.

[e] Harvest estimates for coho and steelhead were not determined for Area 3.

Coho Salmon

The majority of coho harvested in the Oregon Production Index area (Leadbetter Point, Washington, to the U.S./Mexico border) originate from stocks produced in rivers located within that same area. These stocks include hatchery and natural production from the Columbia River, Oregon Coast, and northern California, including the Klamath River hatcheries.

The Salmon FMP allocates the allowable coho harvest between recreational and commercial fisheries with a preference towards recreational fisheries. If stocks are projected to be below 150,000 fish, all of the allowable ocean harvest of coho is allocated to recreational fishery. The overall abundance estimate for Oregon Production Index area stocks in 2005 was 593,600, down from 841,600 in 2004, and lower than the 10-year average of 677,600 (figure 3-59). Spawner estimates are not available for ESA-listed California Coastal coho stocks. Estimates are available for escapement to Klamath River Basin hatcheries, but not for coho spawning in natural areas. In 2005, a total of 16,268 coho returned to Trinity River Hatchery and 1,395 coho returned to Iron Gate Hatchery. These values exceed the combined goal of 2,000 adults (PFMC, 2006b). Retention of coho in all California fisheries is prohibited.

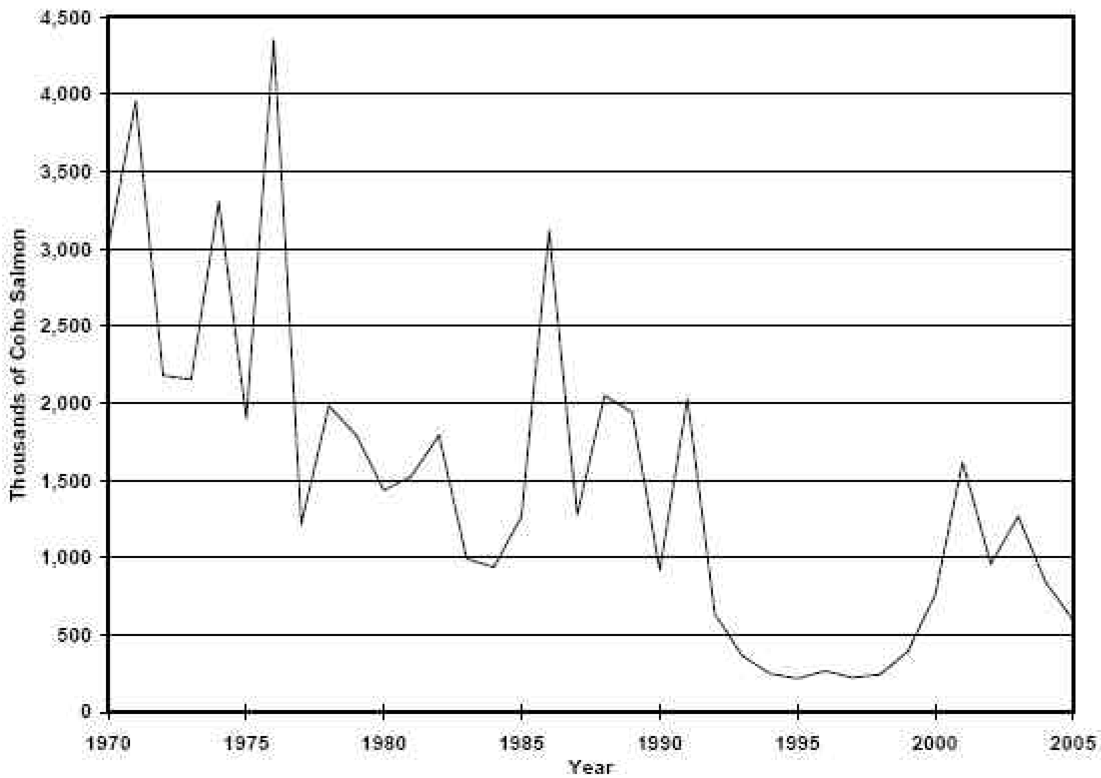

Figure 3-59. Oregon production index area salmon abundance estimates by stratified random survey (SRS) accounting methods, 1970 to 2005. (Source: PFMC, 2006b)

Commercial troll fisheries have been closed to retention of coho south of Cape Falcon since 1993, and recreational fisheries targeting coho were closed from 1994 through 2003. In 2004 and 2005, limited recreational harvest of hatchery coho was allowed from Cape Falcon to the California-Oregon border from June 18 until the earlier of July 31 or a landed quota of 40,000 marked fish. In 2006, coho may be caught from June 17 through the earlier of July 31 or when the landed catch reaches 20,000 marked coho. The area south of Humbug Mountain to Horse Mountain was closed to coho beginning July 5 during 2004, 2005, and 2006. The retention prohibition for coho south of Horse Mountain continues to be in place to protect Oregon coastal coho salmon stocks.

Harvest of coho salmon has been prohibited in the Klamath River since 1994, with the exception of sanctioned tribal harvest for subsistence, ceremonial, and commercial purposes by the Yurok, Hoopa Valley, and Karuk tribes. The Yurok Tribal Fisheries Program reported that annual harvest of coho salmon from reservation lands on the lower Klamath River averaged 244 fish (67 percent of which were marked hatchery fish) between 1997 and 2001, though this average was influenced by a harvest of almost 900 fish in 2001. In the other 4 years, harvest did not exceed 135 fish (Good et al., 2005).

Table 3-56 presents angler harvest estimates in the Klamath River for 1983 through 1987 (prior to the closure of the sport fishery for coho in 1994) based on creel census and tag returns. The angler catch of adult coho ranged from 4 to 152 fish, and the catch of coho grilse ranged from 47 to 145 fish (Hopelain, 2001).

Steelhead

The California Fish and Game Commission regulates steelhead fishing in the Klamath River Basin. Current regulations state that all wild trout and steelhead must be released immediately. One brown trout, and either one hatchery trout or hatchery steelhead may be retained in prescribed portions of the basin.[54] Table 3-56 presents angler harvest estimates in the Klamath River for steelhead from 1983 through 1987. The estimated catch of adult steelhead ranged from 1,542 to 3,291 adults, and from 2,197 to 3,761 half-pounders (Hopelain, 2001).

3.3.3.1.6 Resident Fish Species

Redband Rainbow Trout

Behnke (1992) considers the strains of rainbow trout that predominate inland of the Cascade range to be a separate subspecies from the coastal form. In the Klamath River Basin, he identifies the inland form as the Upper Klamath redband trout, *Oncorhynchus mykiss newberrii*, while he considers steelhead and resident rainbow trout downstream of Upper Klamath Lake to be primarily coastal rainbow trout, *Oncorhynchus mykiss irideus*. He indicates that there may be two distinct groups of redband trout in the upper basin, one that is adapted to lakes and another that is adapted to streams. Classification of resident rainbow trout populations in the lower part of the basin appears to be less distinct, as Behnke (1992) reports that trout in some of the small tributaries downstream of Upper Klamath Lake have characteristics that are typical of inland redband trout. Because some genetic mixing between the subspecies is likely to occur and the ancestry of specific populations cannot be determined without genetic testing, we refer to all resident *O. mykiss* in the basin as rainbow trout, and the anadromous form as steelhead.

Upper Klamath Lake supports a population of large rainbow trout, which appear to be adapted to harsh water quality conditions and resistant to the endemic protozoan *C. shasta*, which causes high rates of mortality in non-resistant strains of rainbow trout. This population supports a catch and release fishery for trophy-sized trout. Behnke (1992) reported seeing hundreds of 1 to 5 kilogram (2 to 11 pound) trout in clear-water sections of the lake that are influenced by spring inflows.

The free-flowing reach of the Klamath River downstream of Keno dam also supports a good rainbow trout fishery, although the fishing season in this reach is closed during the summer because high water temperatures cause excessive mortality in a catch-and-release fishery. Most of the trout in this reach spawn in Spencer Creek. In 1991, Oregon Fish & Wildlife collected 1,813 adult rainbow trout at a weir constructed across Spencer Creek, with peak upstream movement observed in April (Buchanan et al., 1991). During outmigrant trapping, a total of 4,218 fry and 25,618 juvenile rainbow trout were

[54] California Fish and Game Commission regulations, accessed from http://www.fgc.ca.gov/2006/7_50b91_1paregs.pdf on August 28, 2006.

collected. Peak downstream movement of fry occurred in August and September, while the peak movement of juveniles occurred in May (Buchanan et al., 1991).

The J.C. Boyle bypassed and peaking reaches also support good fisheries for rainbow trout. Most of the fish in these reaches spawn in Shovel Creek or in the bypassed reach. During two surveys conducted in the bypassed reach during 2003, PacifiCorp identified 66 trout redds. A single survey conducted in Shovel Creek in April 2003 revealed 43 redds between RM 0.6 and RM 0.9. In addition, 11 of 14 adult trout that were radio-tagged in the California segment of the peaking reach migrated into Shovel Creek during the spawning season, and 2 of the 14 adult trout radio-tagged in the Oregon segment moved downstream and entered Shovel Creek.

Resident Lampreys

In addition to the anadromous Pacific lamprey, there are at least three resident species of lampreys that are known to occur in the Klamath River Basin. Accurately determining the species composition and distribution of lampreys is complicated by a lack of distinguishing characteristics among ammocoetes, the life stage that is the most readily collected during field surveys. The parasitic Klamath River lamprey is believed to be widely distributed in the basin upstream of and downstream of Upper Klamath Lake (Moyle, 2002). Other species that are known to occur in the watershed upstream of Upper Klamath Lake are the parasitic Miller Lake lamprey, a landlocked form of the parasitic Pacific lamprey referred to as the “Klamath Lake lamprey,” and the non-parasitic Pit-Klamath brook lamprey.

All lamprey species have a similar early life history. After hatching, ammocoetes drift downstream to areas of low velocity and silt or sand substrate, where they burrow into the stream bottom and live as filter feeders for 2 to 7 years (FWS, 2004a). After they transform into adults, the nonparasitic species do not feed, while the parasitic species feed on a variety of fish species. Anadromous species migrate into the ocean to feed, while resident species remain in fresh water for their entire life cycle.

The Klamath River lamprey is reported to occur in the Klamath River downstream of Iron Gate dam, in the Trinity River, in the Klamath River upstream of Iron Gate dam, in Spencer Creek, and in Upper Klamath Lake. In Upper Klamath Lake, ammocoetes are reported to metamorphose in the fall, spend 12 to 15 months in Upper Klamath Lake where they exhibit parasitic feeding habits, then spawn in the spring (Kostow, 2002). Adult Klamath River lamprey range in length from approximately 6 to 11 inches, much smaller than the typical size range of 12 to 30 inches given for adult Pacific lamprey by Moyle (2002).

3.3.3.1.7 Aquatic Macroinvertebrates

In fall 2002, PacifiCorp conducted general macroinvertebrate sampling at 101 transects within 21 riverine study reaches between Link River dam and the Shasta River and at 18 transects within 6 study reaches in Fall Creek. In addition, 5 transects were sampled in each of the four main project reservoirs (Keno, J.C. Boyle, Copco reservoir, and Iron Gate). Seventeen of the riverine sites were sampled again in spring 2003. In addition, surveys focused on locating large bivalve species were conducted in Keno reach, J.C. Boyle peaking reach, and Klamath River downstream of Iron Gate dam.

The results of the general macroinvertebrate surveys indicate that invertebrates are abundant throughout the project area, with typical densities ranging between 4,000 and 8,000 invertebrates per square meter. Maximum densities were observed in the Keno reach (figure 3-60), while the number of species of mayflies, stoneflies, and caddisflies (important prey taxa for fish species) generally increased in the downstream direction (figure 3-61). Dominant species in riverine reaches included caddisflies (*Hydropsyche* spp., *Hydroptila* spp., and *Amiocentrus aspilus*), blackfly (*Simulium* spp.), midges (*Rheotanytarsus* spp. and *Cricotopus* spp.), beetle (*Zaitzevia* spp.), and mayflies (*Baetis tricaudatus* and *Acentrella* spp.). The invertebrate community in reservoirs was dominated by species that are more tolerant of impaired water quality conditions, especially in Keno reservoir, which showed a high abundance of invertebrates but low diversity, and the community was dominated by a few species.

PacifiCorp reported finding 11 species of bivalves during the general invertebrate sampling and the focused bivalve species sampling. Table 3-57 shows the sampling sites where each species was found. The only large bivalve species found were the Oregon floater and the western ridgemussel. The only species found that has a special management status was the montane peaclam, which is considered a federal species of concern and a Forest Service sensitive species. The montane peaclam is classified as an S1 (extremely endangered in known range) species in the California Natural Diversity Database and by the Oregon Natural Heritage Program.

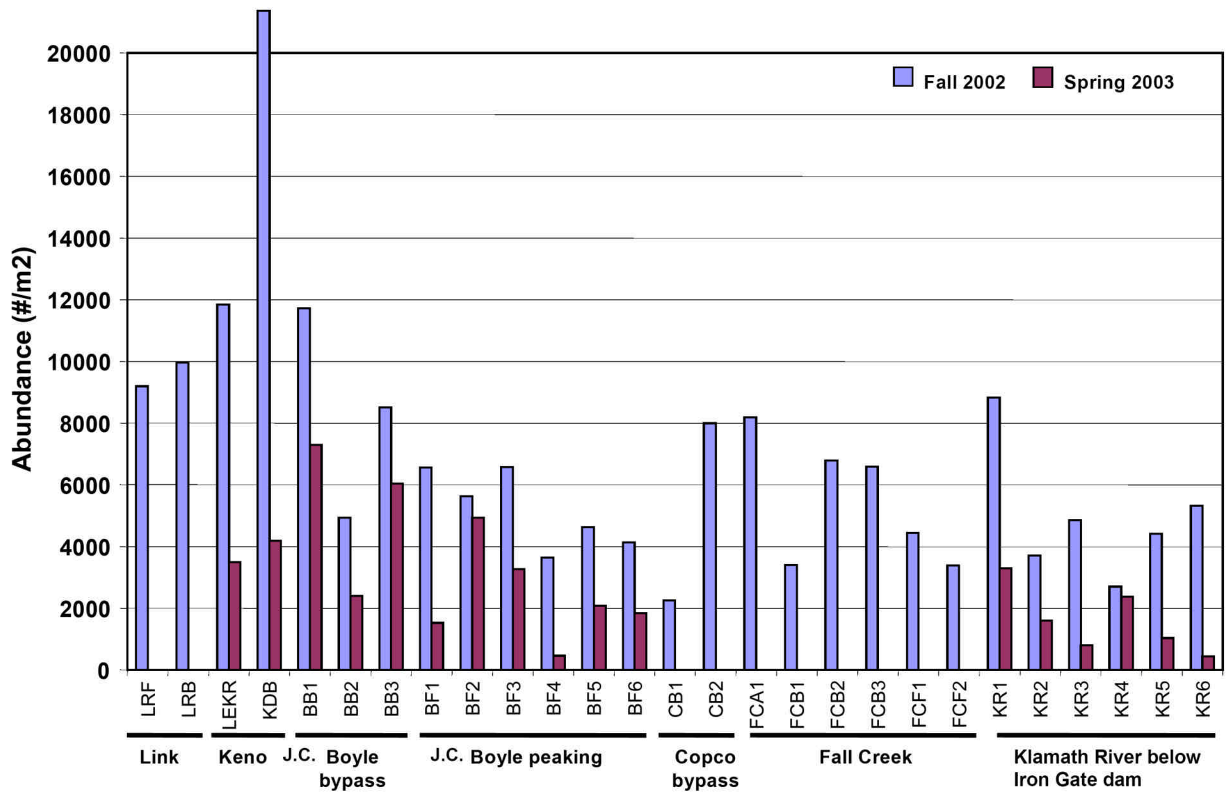

Figure 3-60. Total invertebrate density measured during fall 2002 and spring 2003 in the Klamath River between Link River and the confluence with the Shasta River. (Source: PacifiCorp, 2004f)

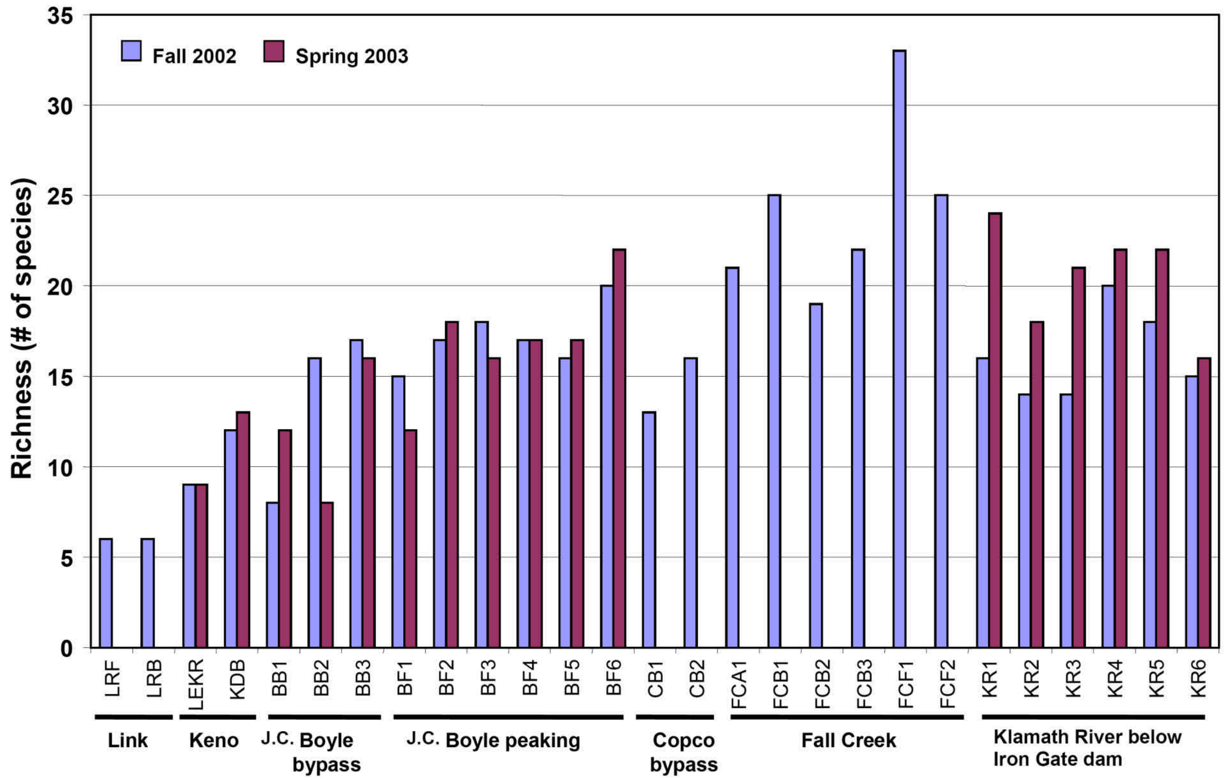

Figure 3-61. Number of species of mayflies, stoneflies and caddisflies (EPT richness) measured during fall 2002 and spring 2003 in the Klamath River between Link River and the confluence with the Shasta River. (Source: PacifiCorp, 2004f)

Table 3-57. Sampling sites where bivalve species were observed during macroinvertebrate sampling and focused bivalve surveys. (Source: PacifiCorp, 2004a, as modified by staff)

Scientific Name	**Common Name**	**Keno Reservoir**	**Keno Reach**	**J.C. Boyle Reservoir**	**J.C. Boyle Bypassed Reach**	**J.C. Boyle Peaking Reach**	**Copco Reservoir**	**Copco Bypassed Reach**	**Fall Creek**	**Iron Gate Reservoir**	**Iron Gate Dam to Shasta River**
Musculium lacustre	lake fingernail clam	x		x			x				
Pisidium spp.	unidentified peaclam		x		x	x					
Pisidium casertanum	ubiquitous peaclam				x	x		x	x		x
Pisidium insigne	tiny peaclam								x		
Pisidium ultramontanum	montane peaclam					x					x
Pisidium variabile	triangular peaclam		x	x		x	x				x
Sphaerium securis	pond fingernail clam		x								
Sphaerium simile	grooved fingernail clam	x		x		x				x	
Anodonta oregonensis	Oregon floater[a]	--	x		--	--	--	--	--	--	x
Anodonta californiensis	California floater			x							
Gonidia angulata	western ridgemussel[a]	--	x	--	--	x	--	--	--	--	x

[a] The unionid mussels *Anodonta oregonensis* and *Gonidia angulata* in the Keno, J.C. Boyle peaking, and Iron Gate to Shasta River reaches were identified during a summer, 2003, bivalve field survey that focused only on these three reaches.