Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead

C. Coho salmon

February 2003

Co-manager review draft

This section deals specifically with coho salmon. It is part of a larger report, the remaining sections of which can be accessed from the same website used to access this section (http://www.nwfsc.noaa.gov/). The main body of the report (Background and Introduction) contains background information and a description of the methods used in the risk analyses.

C. COHO

C.1 BACKGROUND AND HISTORY OF LISTINGS

Coho salmon (*Oncorhynchus kisutch*) is a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from Monterey Bay in California north to Point Hope, AK, through the Aleutians, and from Anadyr River south to Korea and northern Hokkaido, Japan (Laufle et al. 1986). From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water (Gilbert 1912, Pritchard 1940, Sandercock 1991). The primary exceptions to this pattern are "jacks," sexually mature males that return to freshwater to spawn after only 5-7 months in the ocean. However, in southeast and central Alaska, the majority of coho salmon adults are 4-year-olds, having spent an additional year in fresh water before going to sea (Godfrey et al. 1975, Crone and Bond 1976). The transition zone between predominantly 3-year-old and 4-year-old adults occurs somewhere between central British Columbia and southeast Alaska.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. West Coast coho smolts typically leave freshwater in the spring (April to June) and re-enter freshwater when sexually mature from September to November and spawn from November to December and occasionally into January (Sandercock 1991). Stocks from British Columbia, Washington, and the Columbia River often have very early (entering rivers in July or August) or late (spawning into March) runs in addition to "normally" timed runs.

Status reviews

The status of coho salmon for purposes of ESA listings has been reviewed many times, beginning in 1990. The first two reviews occurred in response to petitions to list coho salmon in the Lower Columbia River and Scott and Waddell creeks (central California) under the ESA. The conclusions of these reviews were that NMFS could not identify any populations that warranted protection under the ESA in the LCR (Johnson et al. 1991, *FR* 56(124):29553), and that Scott and Waddell creeks' populations were part of a larger, undescribed ESU (Bryant 1994, *FR* 59(80):21744).

A review of West Coast (Washington, Oregon, and California) coho salmon populations began in 1993 in response to several petitions to list numerous coho salmon populations and NMFS' own initiative to conduct a coastwide status review of the species. This coastwide review identified six coho salmon ESUs, of which the three southern most were proposed for listing, two were candidates for listing, and one was deemed "not warranted" for listing (Weitkamp et al. 1995, *FR* 60(142): 38011). In October 1996, the BRT updated the status review for the Central California (CC) ESU, and concluded that it was at risk of extinction (NMFS 1996a). In October 1996, NMFS listed this ESU as threatened (*FR* 61(212): 56138).

In December 1996, the BRT updated the status review update for both proposed and candidate coho salmon ESUs (NMFS 1996b). However, because of the scale of the review, comanagers' requests for additional time to comment on the preliminary conclusions, and NMFS' legal obligations, the status review was finalized for proposed coho salmon ESUs in 1997 (NMFS 1997), but not for candidate ESUs. In May 1997, NMFS listed the Southern Oregon/Northern California coasts (SONCC) ESU as threatened, while it announced that listing of the Oregon Coast (OC) ESU was not warranted due to measures in the OCSRI plan (*FR* 62(87): 24588). This finding for OC coho salmon was overturned in August 1998, and the ESU listed as threatened (*FR* 63(153): 42587).

The process of updating the coho salmon status review was begun again in October 1998 for coho salmon in Washington and the lower Columbia River. However, this effort was terminated before the BRT could meet, due to competing activities with higher priorities.

In response to a petition by (Oregon Trout et al. 2000), the status of Lower Columbia River (LCR) coho salmon was revisited in 2000, with BRT meetings held in March and May 2001 (NMFS 2001a). The BRT concluded that splitting the LCR/Southwest Washington coast ESU to form separate LCR and Southwest Washington coast coho salmon ESUs was most consistent with available information and the LCR ESU was at risk of extinction. Like the 1996 status review update, these results were never finalized.

The coho salmon BRT[1] met in January 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs. This report summarizes new information and the preliminary BRT conclusions on the following ESUs: Lower Columbia River, Oregon Coast, Southern Oregon/Northern California coasts, and Central California coast.

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[1] The biological review team (BRT) for the updated status review for West Coast coho salmon included: Dr. Robert Iwamoto, Dr. Orlay Johnson, Dr. Pete Lawson, Gene Matthews, Dr. Paul McElhany, Dr. Thomas Wainwright, Dr. Robin Waples, Laurie Weitkamp, and Dr. John Williams, from NMFS Northwest Fisheries Science Center (NWFSC); Dr. Peter Adams, Dr. Eric Bjorkstedt, and Dr. Brian Spence from NMFS Southwest Fisheries Science Center (SWFSC); and Dr. Reginald Reisenbichler from the Northwest Biological Science Center, USGS Biological Resources Division, Seattle.

C.2.1 OREGON COASTAL NATURAL COHO

C.2.1.1 Previous BRT Conclusions

Status at a glance:

Listing status	threatened
Historic Peak abundance	~1,500,000
Historic populations	14?
Extant populations	14?
5-year geometric mean	51,114 spawners
overall (32 year) lambda	1.007 (spawners), 0.940 (recruits)
recent (12 year) lambda	1.089 (spawners), 0.990 (recruits)

Summary of major risk factors and status indicators

The Oregon Coastal Coho ESU has been assessed in two previous status reviews; one in 1995 (Schiewe 1996b) and again in 1997 (Schiewe 1997). In the 1995 status review (Weitkamp et al. 1995), the BRT considered evidence from many sources to identify ESU boundaries in coho populations from Washington to California. For the most part, evidence from physical environment, ocean conditions/upwelling patterns, marine and coded wire tag recovery patterns, coho salmon river entry and spawn timing as well as estuarine and freshwater fish and terrestrial vegetation distributions were the most informative to the ESU delineation process. Genetic information was utilized for an indication of reproductive isolation between populations and groups of populations. Based on this assessment, six ESUs were identified, including the Oregon Coast coho ESU which includes naturally spawning populations in Oregon coastal streams north of Cape Blanco, to south of the Columbia River

Evaluation of ESU under conditions in 1997

In 1997, there were extensive survey data available for coho salmon in this region. Overall, spawning escapements had declined substantially during the century, and may have been at less than 5% of their abundance in the early 1900s. Average spawner abundance had been relatively constant since the late 1970s, but pre-harvest abundance had declined. Average recruits-per-spawner may also have declined. Coho salmon populations in most major rivers appeared to have had heavy hatchery influence, but some tributaries may have been sustaining native stocks.

For this ESU, information on trends and abundance were better than for the more southerly ESUs. Main uncertainties in the assessment included the extent of straying of hatchery fish, the influence of such straying on natural population trends and sustainability, the condition of freshwater habitat, and the influence of ocean conditions on population sustainability. Total average (5-year geometric mean) spawner abundance for this ESU in 1996 was estimated at about 52,000. Corresponding ocean run size for the same year was estimated to be about 72,000; this corresponds to less than one-tenth of ocean run sizes estimated in the late 1800s and early

1900s, and only about one-third of those in the 1950s (ODFW 1995a). Total freshwater habitat production capacity for this ESU was estimated to correspond to ocean run sizes between 141,000 under poor ocean conditions and 924,000 under good ocean conditions (OCSRI Science Team 1996). Abundance was unevenly distributed within the ESU at this time, with the largest total escapement in the relatively small Mid/South Coast Gene Conservation Group (GCG), and lower numbers in the North/Mid Coast and Umpqua GCGs.

Trend estimates using data through 1996 showed that for all three measures (escapement, run size, and recruits-per-spawner), long-term trend estimates were negative. More recent escapement trend estimates were positive for the Umpqua and Mid/South Coast Monitoring Areas, but negative in the North/Mid Coast. Recent trend estimates for recruitment and recruits-per-spawner were negative in all three areas, and exceed 12% annual decline in the two northern areas. Six years of stratified random survey (SRS) population estimates showed an increase in escapement and decrease in recruitment.

To put these data in a longer term perspective, ESU-wide averages in 1996 that were based on peak index and area under the curve (AUC) escapement indices, showed an increase in spawners up to levels of the mid-to-late 1980s, but much more moderate increases in recruitment. Recruitment remained only a small fraction of average levels in the 1970s. An examination of return ratios showed that spawner-to-spawner ratios had remained above replacement since the 1990 brood year as a result of higher productivity of the 1990 brood year and sharp reductions in harvest for the subsequent broods. As of 1996, recruit-to-spawner ratios for the 1991-1994 broods were the lowest on record, except for 1988 and, possibly, 1984.

The 1997 BRT considered risk of extinction for this ESU under two scenarios: first, if present conditions and existing management continued into the foreseeable future and, second, if certain aspects of the Oregon Coastal Salmon Restoration Initiative (OCSRI) Draft Conservation Plan (Oregon Plan 1997) relating to harvest and hatchery production were implemented. The OCSRI is now (2003) called The Oregon Plan for Salmon and Watersheds.

Population abundance

Between the 1995 and 1997 status reviews, escapement increased for the ESU as a whole, but recruitment and recruits per spawner remained a small fraction of historical abundance. Spawning was distributed over a relatively large number of basins, both large and small. Natural escapement from 1990-1996 was estimated to be on the order of 50,000 fish per year in this ESU, reaching nearly 80,000 fish in 1996 coincident with drastic reductions in harvest. Pre-fishery recruitment was higher in 1996 than in either 1994 or 1995, but exhibited a fairly flat trend since 1990. The 1996 estimate of ESU-wide escapement indicated an approximately four-fold increase from 1990. When looked at on a finer geographic scale, the northern Oregon coast as of 1996, still had very poor escapement, the north/central coast showed mixed escapement with strong increases in some streams but continued very poor escapement in others, and the south/central coast continued to have increasing escapement.

Both recruitment and recruits-per-spawner had declined rapidly (12% to 20% annual declines from 1986 to 1996) in two of the three ODFW GCGs in this ESU. These declines were steeper and more widespread in this ESU than in any other for which data are available, and recruits-per-spawner continued to decline since this ESU was reviewed in 1994. Spawner-to-spawner ratios have remained above replacement since the 1990 brood year, as a result of higher productivity of the 1990 brood year and sharp reductions in harvest for the subsequent broods. Recruit-to-spawner ratios for the 1994-1996 broods were the lowest on record, except for 1988. The new data from 1994 to 1996 do not change the overall pattern of decline coupled with a periodic fluctuation in recruits-per-spawner. There has been a long-term pattern of peaks in recruits-per-spawner every 4-5 years, with the height of the peaks declining through time.

Risks that this decline in recruits-per-spawner posed to sustainability of natural populations, in combination with strong sensitivity to unpredictable ocean conditions, was the most serious concern identified in 1997 by the BRT for this ESU. Some aspects of this concern were addressed by examining results of the viability models, although none of them incorporated declining recruits per spawner except as a consequence of changing ocean conditions. Preliminary results of viability models provided a wide range of results, with one model suggesting that most Oregon coastal stocks could not sustain themselves at ocean survivals that have been observed in the last 5 years, even in the absence of harvest, and another suggesting that stocks are highly resilient and would be at significant risk of extinction only if habitat degradation continues into the future. Consequently, a major question in evaluating extinction risk for this ESU was whether recent ocean and freshwater conditions would continue.

Population trends and production

For this ESU, fishery recruitment forecasts for 1997 were slightly below the actual 1996 recruitment (PFMC 1997), and actual returns were drastically lower; about 25% of 1996 recruitment and the second lowest on record after 1977. Stream production studies conducted by ODFW (Solazzi and Johnson 1996) indicated that 1996 smolt production in four central coast study streams was lower than recent averages, with overwinter survival the lowest or second lowest on record for the two streams for which estimates were made, and that age-0 fish production was also low. They concluded that the "most significant impact was on juvenile coho salmon eggs that were in the gravel at the time of the [1995-96] flood." While these results were based on a small sample of streams and may not reflect average effects of the flood, they suggested that the floods would reduce 1997 and 1998 adult returns to some coastal basins. Longer-term effects of the floods can also be expected to vary among basins, but most reports available to us suggest that long-term effects should generally be neutral or slightly beneficial (*e.g.* from sediment removal and increased off-channel habitat) to coho salmon.

Hatchery production and genetic risks

Widespread spawning by hatchery fish as indicated by scale data was also a major concern to the BRT. Scale analysis to determine hatchery-wild ratios of naturally spawning fish indicate moderate to high levels of hatchery fish spawning naturally in many basins on the Oregon coast, and at least a few hatchery fish were identified in almost every basin examined. Although it is possible that these data do not provide a representative picture of the extent of this problem, they represented the best information available at the time. In addition to concerns for genetic and ecological interactions with wild fish, these data also suggest natural spawner abundance may have been overestimated by ODFW and that the declines in recruits-per-spawner in many areas may have been even more alarming than current estimates indicate. However, by 1997 Oregon had made some significant changes in its hatchery practices, such as substantially reducing coho production levels in some basins, switching to on-station smolt releases, and minimizing fry releases. Uncertainty regarding the true extent of hatchery influence on natural populations, however, was a strong concern.

Another concern discussed by the BRT in 1997 was the asymmetry in the distribution of natural spawning in this ESU, with a large fraction of the fish occurring in the southern portion and relatively few in northern drainages. Northern populations were also relatively worse off by almost every other measure: steeper declines in abundance and recruits-per-spawner, higher proportion of naturally spawning hatchery fish, and more extensive habitat degradation.

Habitat conditions

With respect to habitat, the BRT had two primary concerns: first, that the habitat capacity for coho salmon within this ESU has significantly decreased from historical levels; and second, that the Nickelson and Lawson (1998) model predicted that, during poor ocean survival, only high quality habitat is capable of sustaining coho populations, and subpopulations dependent on medium and low quality habitats would be likely to go extinct. Both of these concerns caused the BRT to consider risks from habitat loss and degradation to be relatively high for this ESU.

Influence of OCSRI

The 1997 BRT considered only two sets of measures from the OCSRI: harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures would be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. In order to carry out these evaluations, the BRT made the following assumptions:

1) The ocean harvest management regime would be continued as proposed into the foreseeable future, not revised in the year 2000 as stated in the plan. Without this assumption, effects of the plan beyond 2000 could not be evaluated.

2) Hatchery releases would continue at or below 1997 release levels (including approximately 1 million annual fry releases) into the foreseeable future.

3) The goals of maintaining naturally-spawning hatchery fish at less than 10% or 50% of natural escapement (depending on genetic similarity with natural fish) would be achieved and demonstrated by effective monitoring.

Some members had a strong concern that we do not know enough about the causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures.

Harvest measures

Some members of the BRT felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it was re-evaluated in the year 2000, concern that combining the Umpqua and south/central coast GCGs into a larger aggregate (as would occur in the proposed harvest plan) might not adequately protect genetic diversity, and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

Hatchery measures

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins, substantially higher releases of smolts in the Yaquina River Basin (which by ODFW's own assessment has more high quality habitat than any other coastal basin), and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts which may have less impact on wild fish. Another concern was the plan's lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Previous BRT Conclusions

In 1997, the BRT concluded that, assuming that 1997 conditions continued into the future (and that proposed harvest and hatchery reforms were not implemented), this ESU was not at significant short-term risk of extinction, but that it was likely to become endangered in the foreseeable future. A minority felt that the ESU was not likely to become endangered. Of those members who concluded that this ESU was likely to become endangered, several expressed the opinion that it was near the border between this and a "not at risk" category. The BRT generally agreed that implementation of the harvest and hatchery proposals of the OCSRI would have a positive effect on the status of the ESU, but the BRT was about evenly split as to whether the effects would be substantial enough to move the ESU out of the "likely to become endangered" category. Some members felt that, in addition to the extinction buffer provided by the estimated 80,000 naturally produced spawners in 1996, the proposed reforms would promote higher escapements and alleviate genetic concerns so that the ESU would not be at significant risk of extinction or endangerment. Other members saw little reason to expect that the hatchery and harvest reforms by themselves would be effective in reducing what they viewed as the most serious threat to this ESU—declining recruits-per-spawner. If the severe declines in recruits-per-

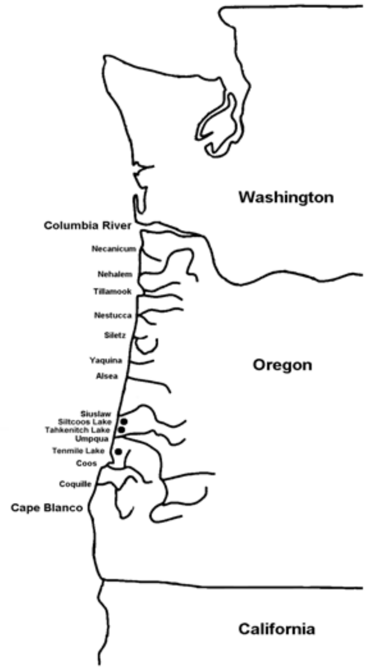

Figure C.2.1.1. Map of Oregon and Washington coasts showing the 11 major river systems plus three coastal lakes that comprise the Oregon Coast Coho Salmon ESU

spawner of natural populations in this ESU were partly a reflection of continuing habitat degradation, then risks to this ESU might remain high even with full implementation of the hatchery and harvest reforms. While harvest and hatchery reforms may substantially reduce short-term risk of extinction, habitat protection and restoration were viewed as key to ensuring long-term survival of the ESU, especially under variable and unpredictable future climate conditions. The BRT therefore concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

Listing status

The Oregon Coast ESU of coho salmon was listed as a Threatened Species on August 10, 1998. The ESU includes all naturally spawned populations of coho salmon in Oregon Coastal Streams south of the Columbia River and north of Cape Blanco (Figure C.2.1.1).

C.2.1.2 New Data

Population abundance

For the Oregon Coast ESU, the BRT has received updated estimates of total natural spawner abundance based on stratified random survey (SRS) techniques, broken down by ODFW's Monitoring Areas (MAs), for 11 major river basins, and for the coastal lakes system (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34 Corvallis, Oregon

97333, pers.commun. Nov. 14, 2002) (ODFW's Monitoring Areas are similar, but not identical, to the GCGs that were the population units in the 1997 update). These data are for the return years 1990-2001 and are presented in Table C.2.1.1. Spawner escapement estimates for 2002 were not available at the time of this writing. Preliminary examination of survey results through late December indicates that 2002 escapements will be equal to or higher than 2001 escapements in most basins with the most notable exceptions being small ocean tributaries. Total recent average (5-year geometric mean) spawner abundance for this ESU is estimated at about 55,000, up from 52,000 in the 1997 update and also slightly higher than the estimate at the time of the status review. Corresponding ocean run size is estimated to be about 178,000; this corresponds to one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995a). Present abundance is more evenly distributed within the ESU than it was in 1997. The largest total escapement remains in the relatively small Mid/South Coast MA and has almost doubled since 1996, but the North and Mid-North Coast MAs have increased 10-fold by 2001. The Umpqua MA is up by a factor of 4. (Table C.2.1.1).

We have updated ocean exploitation estimates based on: Oregon Productivity Index (OPI) estimated catch and escapement based on SRS methods ("OPI-SRS") for 1970-1993, post-season results of the Coho Fishery Regulation Assessment Model ("FRAM") for 1994-2000, and the pre-season FRAM estimate for 2001 (OPI-SRS and FRAM from PFMC 2001). The ODFW Standard Index spawner escapement estimates were discontinued in 1999 and data from 1970-1989 were standardized to the SRS data. All analyses were done using this updated time series. Exploitation rates are based on ocean catch and incidental mortality plus escapement. Recruits are calculated as spawners divided by 1 minus the ocean exploitation rate. A major assumption is that progeny of natural spawners are affected by fishing gear the same as hatchery fish, so that ocean mortalities are in the same proportion as escapement. Freshwater harvest is not directly assessed, but is conventionally considered to be 10% of ocean escapement for retention fisheries and 1% for catch and release fisheries. The BRT also did not attempt to adjust trends for the contribution of stray hatchery fish; sufficient data for such an adjustment are not available for these populations.

We determined that the coded-wire-tag-based index (CWT) has become less useful since the implementation of coho non-retention fisheries in 1994. The CWT index depends on ocean recoveries of coded-wire tags and there are no tag recoveries in non-retention fisheries. Non-catch mortalities (hook-and-release, drop-off, illegal retention) are either estimated in the coho FRAM or estimated externally and input directly in the model.

We used escapement estimates provided by ODFW (Table C.2.1.1) (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34 Corvallis, Oregon 97333, pers.comm. Nov. 14, 2002). The SRS escapement data indicate that, on an ESU-wide basis, spawning escapement reached a 30-year high in 2001 (Figures C.2.1.2 and C.2.1.3). This high escapement is due to a combination of improved marine survival and sharply curtailed ocean fisheries. When looked at on a finer geographic scale, the far north coast has responded well, the north-central coast is mixed with strong increases in some streams but continued very poor escapement in others, and the mid-south coast rebounded after a 4-year drop (Table C.2.1.1).

Table C.2.1.1. Numbers of wild spawners in the Oregon Coast Coho ESU estimated from ODFW Stratified Random Surveys, 1990—2001 return years. Results are sub-totaled by ODFW Monitoring Area, rivers, lakes, and coast-wide.

Monitoring Area / Location	Return Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
North Coast												
Necanicum and Elk Creek	191	1,135	185	941	408	211	768	253	946	728	468	5,252
Nehalem	1,552	3,975	1,268	2,265	2,007	1,463	1,057	1,173	1,190	3,713	14,518	22,334
Tillamook Bay	265	3,000	261	860	652	289	661	388	271	2,175	1,956	1,885
Nestucca	189	728	684	401	313	1,811	519	271	169	2,201	1,155	3,944
Sand Lake and Neskowin Cr		240	24	41	77	108	275	61	0	47	0	71
Miscellaneous	0	204	0	0	0	0	0	0	0	0	0	0
North Coast Total	2,197	9,281	2,423	4,509	3,457	3,881	3,280	2,147	2,576	8,864	18,097	33,486
Mid-North												
Salmon	385	39	28	364	107	212	271	237	8	175	236	0
Siletz	441	984	2,447	400	1,200	607	763	336	394	1,177	2,800	1,437
Yaquina	381	380	633	549	2,448	5,668	5,127	384	365	2,588	628	3,039
Beaver Creek	23	0	756	500	1,259	0	1,340	425	1,041	3,366	716	5,274
Alsea	1,189	1,561	7,029	1,071	1,279	681	1,637	680	213	2,050	2,414	3,339
Yachats	280	28	337	287	67	117	176	99	102	150	76	52
Siuslaw	2,685	3,740	3,440	4,428	3,205	6,089	7,625	668	1,089	2,724	6,571	11,024
Miscellaneous	207	23	700	180	251	231	1,188	13	71	0	11	764
Mid-North Total	5,592	6,755	15,371	7,779	9,815	13,605	18,127	2,843	3,283	12,230	13,452	24,929

Table C.2.1.1 (continued).

Monitoring Area / Location	Return Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Umpqua:												
Lower Umpqua and Smith	589	1,316	1,759	4,804	1,689	6,803	4,904	935	5,118	2,323	3706	11,545
Umpqua	455	0	192	1,431	1,240	352	339	397	444	1,289	2,693	7,358
Elk Creek and Calapooya Cr.	185		0	0	708	2,315	1,709	196	379	434	1,906	2,409
South Umpqua	2,508	2,284	0	2,415	579	755	1,685	512	678	1,219	489	6,050
Cow Creek			201	661	269	1,124	1,112	193	1,807	1,234	1,617	6,217
Umpqua Total	3,737	3,600	2,152	9,311	4,485	11,348	9,749	2,233	8,426	6,499	10,411	33,579
Mid-South:												
Coos Bay and Big Creek	2,273	3,813	16,545	15,284	14,685	10,351	12,128	1,127	3,167	4,945	5,326	42,705
Coquille	2,712	5,651	2,115	7,384	5,035	2,116	16,169	5,720	2,466	3,001	6,063	13,136
Miscellaneous	0	0	0	0	0	0	0	0	0	0	0	0
Mid-SouthTotal	4,985	9,464	18,660	22,668	19,720	12,467	28,297	6,847	5,633	7,946	11,389	55,841
Coast-wide Rivers	16,512	29,100	38,605	44,267	37,477	41,301	59,453	14,069	19,918	35,539	53,349	147,835
Lakes	4394	7,251	1,986	10,145	5,842	11,216	13,494	8,603	11,108	12,711	12,747	15,062
Coast-wide Total	20,906	36351	40,591	54,412	43,319	52,517	72,947	22,672	31,026	48,250	66,096	162,897

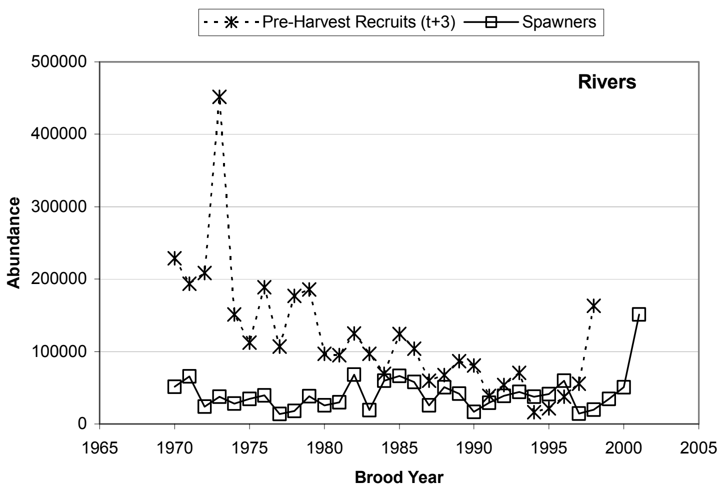

Figure C.2.1.2. Time series of spawners and pre-harvest recruits, by brood year, for rivers in the Oregon Coast Coho Salmon ESU.

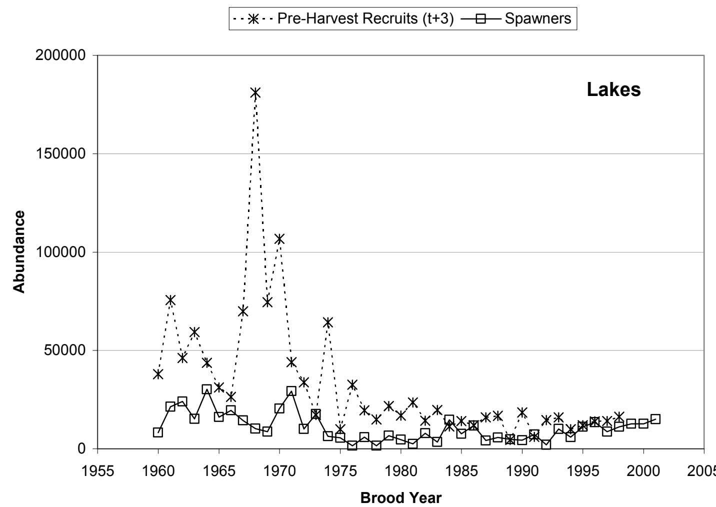

Figure C.2.1.3. Time series of spawners and pre-harvest recruits, by brood year, for lakes in the Oregon Coast Coho Salmon ESU.

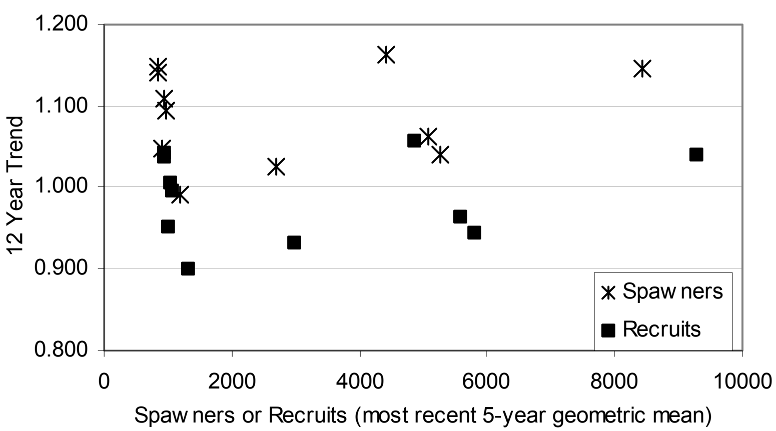

Figure C.2.1.4. Short-term (12-year, 1990-2001) trends in spawners and recruits vs. the recent 5-year geometric mean abundance plotted for 11 major river populations.

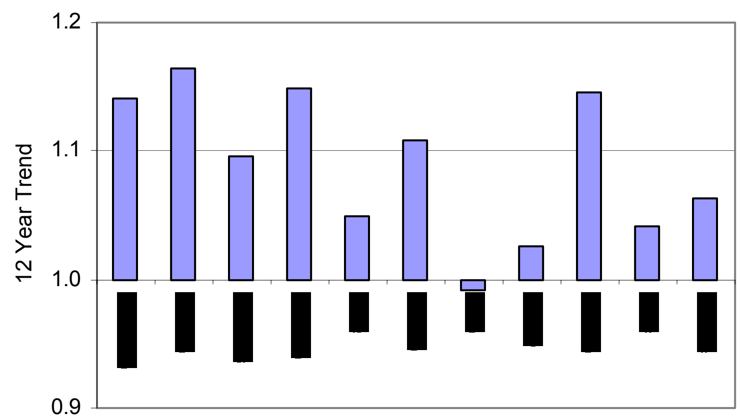

Figure C.2.1.5. Short-term (12-year, 1990-2001) trends in spawner abundance for 11 major river basins in the Oregon Coast Coho Salmon ESU. Basins are ordered from north to south

In the return years 1997-1999 (brood years 1994-1996), and for the first time on record (since 1950), recruits failed to replace the parental spawners: a recruitment failure occurred in all three brood cycles, even before accounting for harvest-related mortalities (Figure C.2.1.2). Since 1999, improving marine survival and higher rainfall has resulted in an upswing in wild recruitment. Fishery recruitment for 2001 was up about three-fold from 2000 with about 178,000 recruits, but well below the 30-year high of 450,000 observed in 1973. Given current habitat conditions OCN coho are thought to require an overall marine survival rate of 0.03 to achieve a spawner:recruit ratio of 1:1 (Nickelson and Lawson 1998). Since 1990, marine survival after exploitation has exceeded 0.03 in only the year 2001. Increases in recruits and spawners (Figures C.2.1.2 and C.2.1.3) reflect this improved marine survival. It is far from certain that these favorable marine conditions will continue and, given the current freshwater habitat conditions, the ability of OCN coho to survive another prolonged period of poor marine survival is in doubt.

Growth rates/productivity

Trend analyses were performed on short-term and long-term time series of spawner abundance and pre-harvest recruit abundance calculated as described above. Short-term trends were based on stratified-random-sampling (SRS) estimates of abundance in 11 major river basins considered to be the principal populations in this ESU. Short-term trends used data from 1990-2001 return years. Long-term trends were estimated separately for the aggregated coastal rivers (including several small systems outside the 11 major river basins) and for the coastal lakes. The river trends were based on data calibrated to the SRS time series from 1970-2001. The lake trends were based on the historical time series of lakes abundance from 1970-2001.

Twelve-year trends of spawner abundance for 11 major river systems are illustrated in Figures C.2.1.4 and C.2.1.5. Spawner trends have been positive in 10 of the 11 basins, with the biggest increases (> 10% per year) on the north coast (Necanicum, Nehalem, Nestucca), mid-coast (Yaquina) and the Umpqua, and with smaller increases on the central (Siletz, Siuslaw) and south (Coos, Coquille) coast. The Alsea was the only system to show a decrease in spawners (Figure C.2.1.5).

Twelve-year trends in pre-harvest recruits (Figures C.2.1.4 and C.2.1.6) show a less favorable picture. Necanicum, Nehalem, Nestucca and Umpqua all showed positive trends of about 5% per year. The Yaquina had a slightly positive trend of about 1% per year. The remaining six basins showed declines ranging up to 10% per year in the Alsea. The most recent 5-year geometric mean abundance showed little relationship to trend (Figure C.2.1.4). Twelve-year trends for the ESU as a whole showed an increase in spawners of 8% per year and a decline in recruits of 1% per year.

Long-term (32-year) trends in spawner abundance for both the lakes and rivers have been relatively flat (Figure C.2.1.7), with lakes declining about 2% per year and rivers increasing about 1% per year. Lakes and rivers trends in recruits have been negative, with both lakes declining about 6% per year.

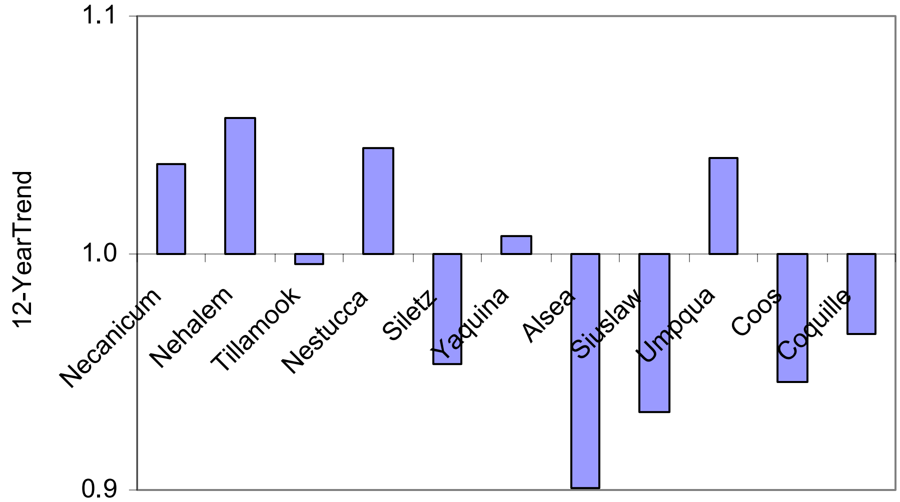

Figure C.2.1.6. Short-term (12-year, 1990-2001) trends in recruit abundance for 11 major river basins in the Oregon Coast Coho Salmon ESU. Basins are ordered from north to south

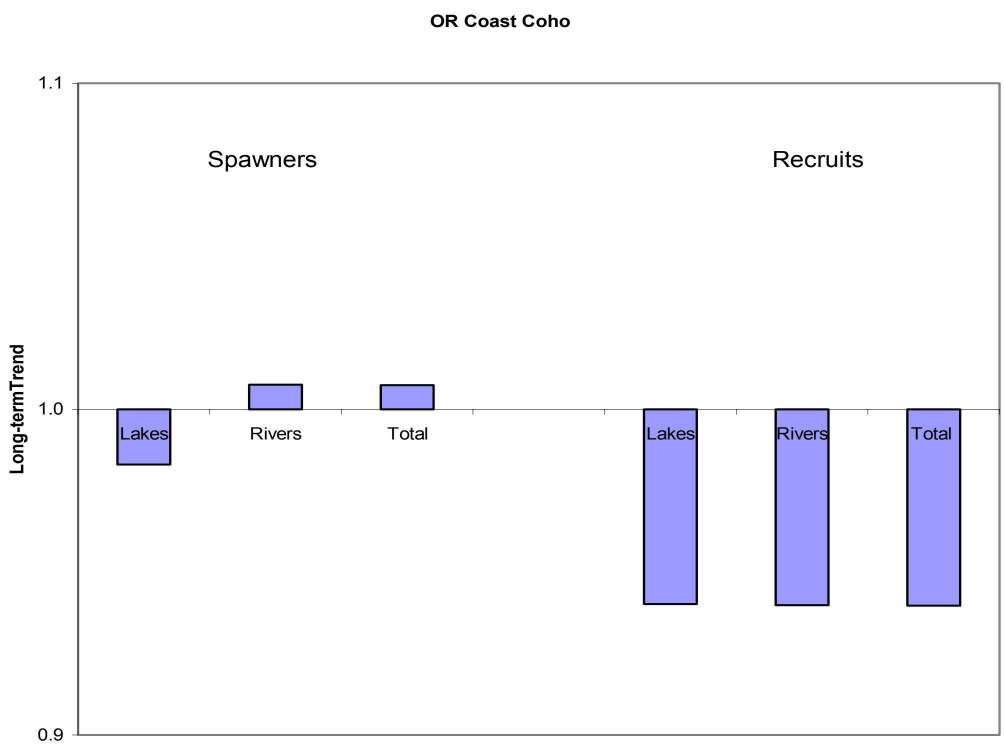

Figure C.2.1.7. Long-term trends (32 years, 1970 – 2001) for spawners and recruits in coastal lakes (Lakes), river basins (Rivers), and total OCN (Total) in the Oregon Coast Coho Salmon ESU.

For the ESU as a whole, spawners have increased at less than 1% per year over the past 32 years while recruits have declined at a 6% rate.

Population spatial structure

We have very limited direct information about the spatial structure of these populations. Recent analyses (Nickelson and Lawson 1998, Nickelson 2001) have assumed that spawners from major river basins are largely isolated and that each basin comprises at least one population. The Umpqua River is large and diverse enough to hold several populations, but for the purposes of this analysis was considered as one. The three coastal lakes, Siltcoos, Tahkenitch, and Tenmile, are considered to be a single population, but may actually be separate. Genetic analyses are currently being conducted to resolve these questions, but results were not available at the time of this review. This is a change from the Status Review Update in 1997 (Schiewe 1997) when the coast was considered to consist of four populations, called “Gene Conservation Groups.” Three of these groups (North/Mid Coast, Mid/South Coast, and Umpqua) were in the Oregon Coast ESU and the fourth (South Coast) was in the S. Oregon/N. California ESU.

Population diversity

New information on population diversity is anecdotal. With extremely low escapements in recent years many small systems have shown local extirpations. For example, Cummins Creek, on the central coast, had zero spawners in 1998 (Steve Johnson, ODFW, 2040 Marine Science Drive, Newport, Oregon, pers. comm. January 15, 2003), indicating the loss of a brood cycle. These systems are apt to be repopulated by stray spawners if abundances increase. Whether these events represent loss of genetic diversity is not known.

Harvest impacts

Historical harvest rates on OPI area coho salmon were in the range of 60% to 90% from the 1960s into the 1980s. Modest harvest reductions were achieved in the late 1980s, but rates remained high until a crisis was perceived and most directed coho salmon harvest was prohibited in 1994. Subsequent fisheries have been severely restricted and most reported mortalities are estimates of indirect (non-catch) mortality in chinook fisheries and selective fisheries for marked (hatchery) coho. Estimates of these indirect mortalities are somewhat speculative and there is a risk of substantial underestimation.

Amendment 13—The Pacific Fishery Management Council adopted Amendment 13 (PFMC 1998) to their Salmon Fishery Management Plan in 1998. This amendment was developed as part of the Oregon Plan for Salmon and Watersheds (formerly OCSRI). It specified an exploitation rate harvest management regime with rates for OCN dependent on marine survival (as indexed by hatchery jack/smolt ratios) and parental and grand-parental spawning escapements. Exploitation rates ranged from 13% to a maximum of 35%. In 2000, Amendment 13 was reviewed, and the harvest rate matrix modified to include a 0-8% category under conditions of extremely poor marine survival as had been observed in the late 1990. At the same time, the maximum exploitation rate was increased to 45%. Exploitation rates were calculated to allow a doubling of spawners under conditions of moderate to good ocean survival.

Risk assessment was conducted for Amendment 13 (PFMC 1998) and the 2000 Amendment 13 Review (PFMC 2000) using the Nickelson/Lawson coho salmon habitat-based life-cycle model (Nickelson and Lawson 1998). The model was augmented to include a simulation of the fishery management process, including errors in spawner assessment, prediction, and harvest management. In general, the exploitation-rate management with a 35% cap showed a lower risk of pseudo-extinction than managing for an escapement goal of 200,000 spawners, but higher risk than a zero-harvest scenario. Starting from the very low escapements of 1994, basins on the North Coast had higher extinction risks than those on the North-central and South-central coasts.

Mark-selective fisheries—Beginning in 1998 most adult hatchery-origin coho salmon in the OPI area were marked with an adipose fin clip. This allowed the implementation of mark-selective fisheries, with legal retention only of marked fish. Unmarked fish are to be released unharmed. Recreational mark-selective fisheries have been conducted on the Oregon coast in each year since 1998, with quotas ranging from 13,000 to 24,000 marked fish. Commercial troll fisheries targeting chinook salmon were also operating.

Both fisheries catch and release coho salmon, resulting in incidental mortalities. In addition, some coho encounter the gear but escape or are eaten by predators – so called "drop-offs." Estimates of non-catch mortalities from hook and release and drop off are difficult because they are, by their nature, unobserved. Field studies in the 1990s (NRC 1996) and a literature review and meta-analysis resulted in the adoption, by the PFMC, of hooking mortality rates of 13% for recreational fisheries and 24% for commercial fisheries. In addition, drop-off mortalities were assumed to equal 5% of the number of fish brought to the boat. Based on these mortality rates the PFMC uses a coho Fisheries Regulation Assessment Model (FRAM) to estimate non-catch mortalities in Council-managed fisheries. Post-season estimates of OCN exploitation rates based on FRAM modeling have ranged from 0.07 to 0.12 since the cessation on directed coho salmon fishing in 1994 (Table C.2.1.2). There is concern that these rates may be underestimates, and that actual mortalities may be greater. It is difficult to assess the risk to these stocks resulting from harvest at these levels.

Despite these uncertainties there is no doubt that harvest-related mortalities have been reduced substantially over the past decade. This reduction is reflected in positive short-term trends in spawner escapements (Figure C.2.1.5) despite continued downward trends in pre-harvest recruits for six of 11 major river basins (Figure C.2.1.6). Harvest management has succeeded in maintaining spawner abundance in the face of a continuing downward trend in productivity of these stocks. Further harvest reductions can have little effect on spawning escapements. Future remedies must be found outside of harvest management until the decline of productivity is reversed.

Table C.2.1.2. OPI area hatchery marine survival, Oregon coastal hatchery adult returns per smolt, and OI area exploitation rate on unmarked coho salmon. All values are lagged to adult return year.

Year	OPI Hatchery Adults per Smolt	Coastal Hatchery Adults per Smolt	OPI Area Unmarked Exploitation Rate	OPI Marine Survival after Exploitation
1990	0.020	.003	0.72	.006
1991	0.050	.007	0.57	.022
1992	0.026	.004	0.56	.011
1993	0.011	.003	0.45	.006
1994	0.018	.005	0.03	.017
1995	0.024	.005	0.23	.018
1996	0.021	.006	0.15	.018
1997	0.006	.005	0.13	.005
1998	0.008	.005	0.07	.007
1999	0.011	.008	0.08	.010
2000	0.023	.014	0.09	.021
2001	0.050	.044	0.07	.046

Habitat condition

Freshwater—The Oregon Plan for Salmon and Watersheds (Oregon Plan 1997) is the most ambitious and far-reaching program to improve watersheds and recover salmon runs in the Pacific Northwest. It is a voluntary program focused on building community involvement, habitat restoration, and monitoring. All State agencies with activities affecting watersheds are required to evaluate their operations with respect to salmon impacts and report on actions taken to reduce these impacts to the Governor on a regular basis. The original Coastal Salmon Restoration Initiative was written in 1997, so the Plan has been in operation for about 5 years. This is a major positive step in recovering salmon runs throughout the State. However, measurable benefits from this program will take years or decades to materialize.

Marine—The regime shift in 1976 was the beginning of an extended period of poor marine survival for coho salmon in Oregon. Conditions worsened in the 1990s, and OPI hatchery survival reached a low of 0.006 adults per smolt in 1997 (1996 ocean entry, Table C.2.1.3). Coastal hatcheries appear to have fared even worse, although adult counts at these facilities are often incomplete, biasing these estimates low. Following an apparent shift to a more productive climate regime in 1998 marine survival has started to improve, reaching 0.05 for adults returning in 2001 (Table C.2.1.3). The Pacific Decadal Oscillation (PDO) had been in a cold, productive phase for about 4 years and in August reversed indicating a warm, unproductive period. This reversal may be short-lived; the PDO historically has show a 20-60 year cycle. However, "the rising influence of global warming should throw up a big caution sign to us when trying to use past decadal patterns as predictive models for the future" (Nathan J. Mantua, School of Marine Affairs/Joint Institute for the Study of Atmospheric and Oceanic Climate Impacts Group, University of Washington, Seattle, pers. comm. January 7, 2003).

Table C.2.1.3. Millions of smolts released, adult returns, and number of operating hatcheries on the Oregon Coast from 1990 to 2001. Excludes three small hatcheries: Elk River, Cedar Creek, and Eel Lake. An additional 5.4 million smolts were released from private facilities in 1990.

Year	Smolts Released (millions)	Adult Returns to Hatchery	Number of Hatcheries[1]
1990[2]	5.70	15,489	6
1991	5.30	39,555	6
1992	6.20	23,307	6
1993	4.33	20,209	6
1994	5.02	23,435	6
1995	3.71	25,173	6
1996	3.28	23,422	7
1997	2.92	17,776	7
1998	1.66	15,287	7
1999	1.06	13,347	6
2000	0.86	14,984	5
2001	0.93	38,149	5

A long-term understanding of the prospects for OCN coho can be constructed from a simple conceptual model incorporating a trend in habitat quality and cyclical ocean survival (Figure C.2.1.8, Lawson 1993). Short-term increases in abundance driven by marine survival cycles can mask longer-term downward trends resulting from freshwater habitat degradation (as in Figure C.2.1.8) or longer-term trends in marine survival that may be a consequence of global climate change. Decreases in harvest rates (C in Figure C.2.1.8) can increase escapements and delay ultimate extinction (D in Figure C.2.1.8). Harvest rates have been reduced to the point where no further meaningful reductions are possible. The current upswing in marine survival is a good thing for OCN coho, but will only provide a temporary respite unless other downward trends are reversed.

C.2.1.3 New Comments

Petition for listing

On April 25, 2002 Regional Administrator D. Robert Lohn received a petition to define and list the wild stocks of coho along the Oregon Coast as a threatened species, pursuant to the Endangered Species Act, 16, U.S.C. Sec. 1531 et. seq. (2001) ("ESA"). The petitioners presented recent scientific reports relating to the "behavioral, physiological, ecological, reproductive and evolutionary differences between the hatchery and wild stocks" of Oregon coast coho salmon. The petition was in response to the findings of Alsea Valley Alliance v. Evans. The petitioners consisted of Trout Unlimited, Oregon Council of Trout Unlimited, Washington Council of Trout Unlimited, Oregon Trout, Washington Trout, Native Fish Society, Oregon Council of Fly Fishers, Pacific Coast Federation of Fisherman's Associations and the Institute for Fisheries Resources, Oregon Natural Resources Council, Save our Wild Salmon, Orange Ribbon Foundation, American Rivers, Audubon Society of Portland, National Wildlife Federation, and the Siskiyou Regional Education Project. The petitioners stated that:

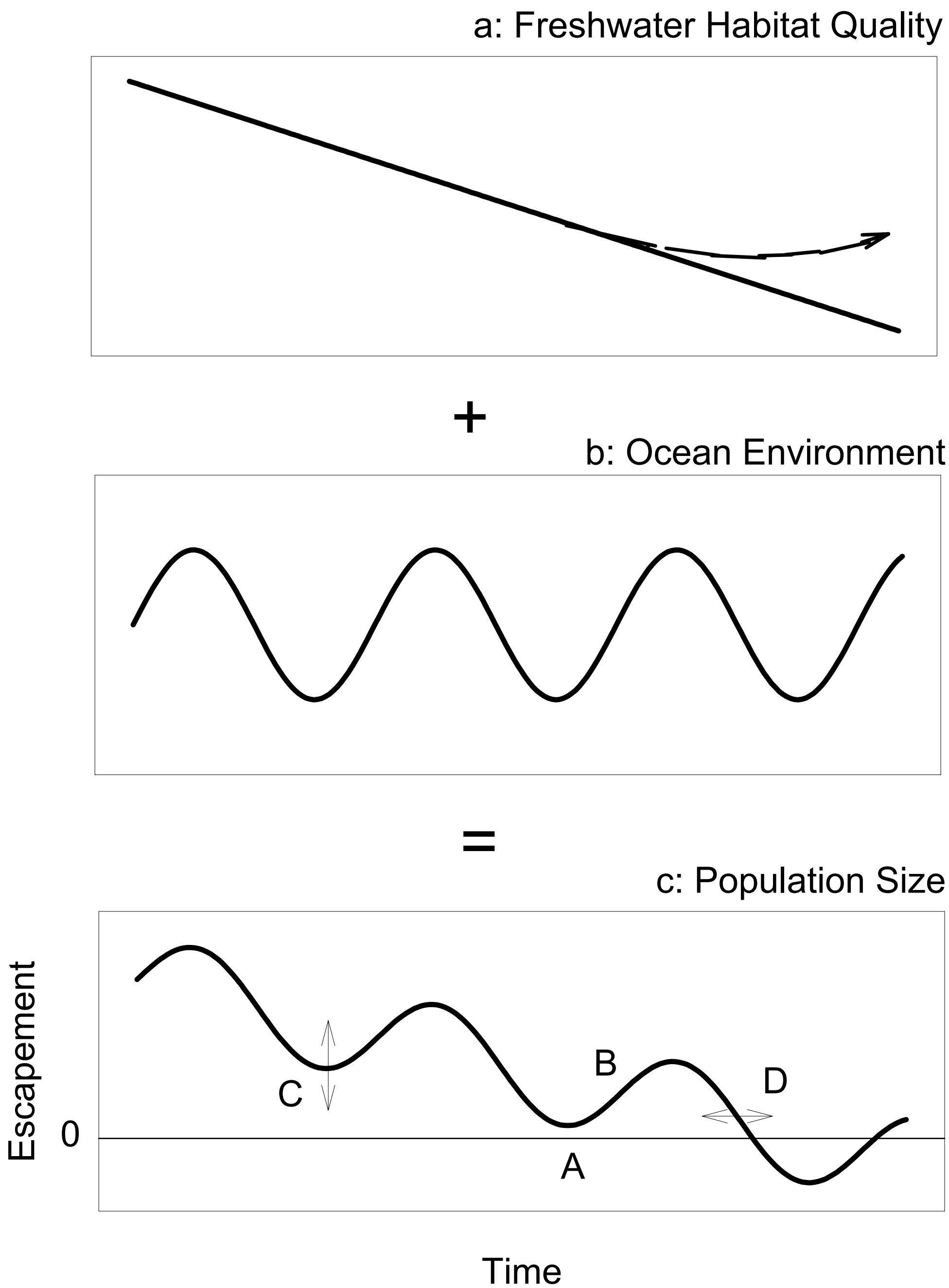

Figure C.2.1.8. Conceptual model of effects of declining habitat quality and cyclic changes in ocean productivity on the abundance of Oregon's coastal natural coho salmon. a: trajectory over time of habitat quality. Dotted line represents possible effects of habitat restoration projects. b: generalized time series of ocean productivity. c: sum of top two panels. Labeled points on c: A = situation in the mid 1990s, B = current situation, C = change in escapement from increasing or decreasing harvest, and D = change in time of extinction from increasing or decreasing harvest.

> "NMFS has previously made findings of the detrimental impact that the artificial production of Oregon coast coho have on wild stocks, including genetic impacts, disease transmission, predation, take for broodstock purposes, and competition (62 Fed. Reg. 24588, 24600 (NMFS 1997); Flagg et al. 2000). Furthermore, recent reports indicate that these impacts are not localized, but rather widespread in every basin in the Oregon coast where wild coho are present, based on the presence of hatchery coho in every stream system (ODFW 1995b; Jacobs et al 2001). Additionally, the fluctuations in the ocean conditions, and the changes in the ocean carrying capacity, may exacerbate the impacts in certain years (NWPPC 1999). Additional reports suggest that the impact of these hatchery programs is resulting in at least phenotypic differences (genetic and environmental) between coho, and is not limited to hatchery management practices alone, but due to other direct biological and environmental effects (IMST 2001; Flagg et al. 2000; Chilcote 2002)."

The petitioners cited substantial updated information on current abundance, historical abundance and carrying capacity, trends in abundance, natural and human-influenced factors that cause variability in survival and abundance, possible threats to genetic integrity, and recent events such as the current el Nino, significant flood events in 1995-1996 and 1998, and recently improved ocean conditions (Trout Unlimited 2002).

Independent multidisciplinary science team

Since the 1997 status review, the Oregon Plan for Salmon and Watersheds (formerly Oregon Coastal Salmon Restoration Initiative Conservation Plan) has developed into an extensive effort to recover threatened or endangered salmonid populations through a combination of grass-roots actions through watershed councils, refocusing effort and resources of fisheries and other state agencies, and convening a group of scientists to "advise the state on matters of science related to the Oregon Plan for Salmon and Watersheds" (IMST 2002b). This group of scientists consists of a seven-member team with "recognized expertise in fisheries artificial propagation, stream ecology, forestry, range, watershed and agricultural management" and is known as the Independent Multidisciplinary Science Team (IMST). The IMST has been responsible for a series of review documents on the science relating to recovery of Oregon coastal coho stocks. The first of these was a workshop of agency and university fisheries professionals convened to help in the discussion of "Defining and Evaluating Recovery of OCN Coho Salmon Stocks: Implications for Rebuilding Stocks under the Oregon Plan" (IMST 1999). Alternative recovery definitions are proposed and criteria for evaluating recovery are discussed.

Additional reports issued by this team germane to the deliberations of the Oregon coastal coho BRT include: "Conservation Hatcheries and Supplementation Strategies for Recovery of Wild Stocks of Salmonids: Report of a Workshop" (IMST 2000), and "The scientific basis for artificial propagation in the recovery of wild anadromous salmonids in Oregon" (IMST 2001), which analyzes the hatchery programs of ODFW, presents three substantial conclusions and puts forth a series of ten recommendations based on these conclusions. In addition, a comprehensive look at the "Recovery of Wild Salmonids in Western Oregon Lowlands" (IMST 2002a) provides an extensive analysis of a series of five science questions relating to the importance of lowlands to the recovery of salmonids, with twenty-one recommendations relating to recommended actions by state agencies to contribute to the recovery of salmonids in lowland areas. They do not, however, present substantially new information that can shed light on the evaluation of risk to the Oregon coastal coho ESU.

Douglas County Board of Commissioners—The board submitted a report, "Viability of coho salmon populations on the Oregon and northern California coasts," submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Little of the data presented in the report is new, but independent analyses focus on unique aspects of the data. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast. While the report reached no conclusions regarding overall status of the ESU, the Board cites the report in concluding that coho salmon populations in this ESU are "strongly viable."

C.2.1.4. New Hatchery/ESU Information

Interactions between hatchery and wild fish are generally considered to have negative outcomes for the wild fish. A growing body of literature documents reduced spawning success, fresh water survival and production of wild fish when hatchery fish are present (IMST 2001, Einum and Fleming 2001, Flagg et al. 2000, ISG 1996, NRC 1996, Flagg and Nash 1999, Chilcote 2002). Additional negative interactions are associated with mark-selective fisheries directed at hatchery coho salmon in the ocean. In the past 12 years there have been closures of some Oregon coastal hatchery facilities, reduction in numbers of smolts released from the remaining facilities, and efforts to include more native broodstock. In principle, these changes should somewhat reduce risks to naturally spawning coho on the Oregon coast.

Starting in 1999 most adult coho salmon of hatchery origin were marked with an adipose fin clip. This has enabled the introduction of mark-selective fisheries for hatchery (fin-clipped) coho salmon. An additional benefit is better accounting of hatchery fish spawning in the wild.

Hatchery smolts released are reported in Table C.2.1.3. Numbers have dropped from a high of 6.2 million in 1992 to 0.93 million in 2001. Over that time period several small hatcheries have closed or stopped releasing coho. For three years (1995 – 1997) coho smolts were released from the acclimation facility on Yaquina Bay. In 1999 Fall Creek Hatchery on the Alsea River stopped releasing coho salmon smolts. The percentage of hatchery-origin spawners on natural spawning grounds has also decreased (Table C.2.1.4). From 1990 to 1998 hatchery spawners ranged from 7% to 22% coast wide. In the most recent three years the range has been 2% to 7%. The decrease is most notable in North Coast systems that had up to 70% hatchery spawners in the early 1990s and have been below 5% since 1999. The system most heavily affected is the Salmon River, where, in 2001, all 1,285 natural spawners were hatchery origin. Tillamook continues to show more than 10% hatchery-origin spawners in most years, and the Alsea River had 15% hatchery spawners in 2001 despite the closure of the Fall Creek Hatchery in that system.

Overall, the reduction in hatchery activity is expected to benefit wild runs. However, it may take several years before these benefits become apparent, depending on the mix of demographic and genetic effects on natural production. In the meantime, the future of the hatchery program is uncertain. On one hand, public opinion and a perceived short-term benefit may create pressure to increase hatchery activity despite the likely negative effects on wild runs. On the other hand, Oregon State budget problems may force additional hatchery closures. The Trask and Salmon River hatcheries were scheduled to be closed in 2001 but were given a last-minute reprieve by the Oregon Legislature.

Preliminary ESU categorizations of hatchery populations of Oregon Coast coho are presented in Appendix C.5.1. See "Artificial Propagation" in the General Introduction for explanation of the categories.

Table C.2.1.4 Proportion of natural spawning fish of hatchery origin. Data from 1990-1998 are based on scale analysis. Data from 1999-present are based on fin clips.

Management Area: Location	Return Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
North Coast:												
Necanicum and Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Nehalem	0.65	0.22	0.43	0.81	0.43	0.49	0.74	0.45	0.23	0.00	0.00	0.02
Tillamook Bay	0.00	0.00	0.00	0.53	0.29	0.62	0.14	0.08	0.00	0.06	0.11	0.13
Nestucca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03
Sand Lake and Neskowin Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00
North Coast Avg.	0.57	0.11	0.28	0.70	0.34	0.33	0.49	0.32	0.12	0.01	0.02	0.03
Mid-North:												
Salmon	0.11	0.00	0.80	0.00	0.93	0.84	0.90	0.43	0.99	0.17	0.54	1.00
Siletz	0.00	0.71	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30
Yaquina	0.38	0.00	0.00	0.00	0.00	0.00	0.16	0.27	0.38	0.00	0.00	0.05
Beaver Creek	0.00		0.00	0.00	0.00		0.00	0.00	0.21	0.00	0.00	0.07
Alsea	0.01	0.00	0.17	0.00	0.00	0.00	0.00	0.27	0.87	0.00	0.00	0.15
Yachats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siuslaw	0.00	0.00	0.00	0.04	0.38	0.00	0.26	0.00	0.11	0.07	0.00	0.00
Miscellaneous	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00
Mid-North Avg.	0.05	0.26	0.14	0.02	0.26	0.08	0.25	0.17	0.45	0.02	0.02	0.11

Table C.2.1.4 (continued).

Management Area / Location	Return Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Umpqua:												
Lower Umpqua and Smith	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.03	0.01
Umpqua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.06	0.08	0.34
Elk Creek and Calapooya Cr.	0.00				0.00	0.00	0.00	0.00	0.10	0.15	0.03	0.02
South Umpqua	0.00	0.00		0.00	0.00	0.08	0.77	0.21	0.36	0.04	0.00	0.08
Cow Creek			0.00	0.00	0.71	0.08	0.58	0.00	0.68	0.00	0.09	0.09
Umpqua Avg.	0.06	0.00	0.00	0.00	0.13	0.01	0.43	0.08	0.09	0.03	0.05	0.13
Mid-South												
Coos Bay and Big Creek	0.00	0.00	0.03	0.05	0.03	0.01	0.00	0.00	0.02	0.00	0.00	0.02
Coquille	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Mid-South Avg.*	0.00	0.00	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Coast-wide Rivers	0.17	0.11	0.09	0.21	0.15	0.07	0.22	0.11	0.16	0.02	0.02	0.07

C.2.2 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO

C.2.2.1 Previous BRT Conclusions

The Southern Oregon/Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU) extends from Cape Blanco in southern Oregon to Punta Gorda in northern California (Weitkamp et al. 1995). The status of coho salmon throughout their West Coast Range, including the SONCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates have been published by NMFS, one addressing all West Coast coho salmon ESUs (Schiewe 1996b) and a second specifically addressing the Oregon Coast and Southern Oregon-Northern California ESUs (Schiewe 1997). Information from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

Status indicators and major risk factors

California populations—Data on population abundance and trends were limited for the California portion of the SONCC ESU. The BRT found no regular estimates of natural spawner escapement for coho salmon in the SONCC, and most information used by the BRT came from reviews by CDFG (1994) and Brown et al. (1994). Historical point estimates of coho salmon abundance for the early 1960s and mid 1980s cited in these reviews were taken from CDFG (1965), Wahle and Pearson (1987), and Sheehan (1991)[2]. These estimates suggest that statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish (E. Gerstung, CDFG pers. commun. cited in Brown et al. 1994). By the early-to-mid 1960s, statewide escapement was estimated to have declined to just under 100,000 fish (CDFG 1965), with approximately 43,000 fish (44%) originating from rivers within the SONCC ESU (Table C.2.2.1). Wahle and Pearson (1987) estimated that statewide coho salmon escapement had declined to approximately 30,000 fish by the mid-1980s, with about 12,400 (41%) originating within the SONCC ESU. For the late 1980s, Brown et al. (1994) estimated wild and naturalized coho salmon populations at 13,240 for the state, and 7,080 (53%) for the California portion of the SONCC ESU. To derive their estimate, they employed a "20-fish rule" in which all streams known to historically support coho salmon, except those for which recent surveys indicated coho salmon no longer persist (19% of the total), were assumed to still support 20 spawners. For streams where a recent estimate of spawner abundance existed, they used either that estimate or 20 fish, whichever was larger. They suggested that application of the "20-fish rule" likely overestimated total abundance. As Brown et al. (1994) point out, all of these historic estimates are "guesses" of fishery managers and biologists generated using a combination of limited catch statistics, hatchery records, and personal observations.

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[2]For mid-1980s estimates, Brown et al. (1994) cite Wahle and Pearson (1987) who estimate 30,480 total spawners in California whereas CDFG (1994) cites Sheehan's (1991) estimate of 33,500 spawners. It is unclear how Sheehan's estimates were derived and no basin-specific estimates are presented; thus, we have included the estimates of Wahle and Pearson (1987) in Table C.2.2.1 rather than the Sheehan (1991) estimates cited by the BRT (Weitkamp 1995).

Table C.2.2.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Southern Oregon/Northern California Evolutionarily Significant Unit.

	Estimated Escapement				
River/Region	**CDFG (1965)[a]** **1965**		**Wahle & Pearson (1987)[b]** **1984-1985**		**Brown et al. (1994)[c]** **1987-1991**
CA rivers trib. to Oregon Coast streams		1,000			
Smith River		5,000		2,000	820[d]
Other Del Norte County		400			180[d]
Klamath River		15,400		3,400	1,860
Mainstem Klamath River & tributaries	8,00		1,000		
Shasta River	800		300		
Scott River	800		300		
Salmon River	800		300		
Trinity River	5,00		1500		
Redwood Creek		2,000		500	280
Mad River		2,000		500	460
Eel River		14,000		4,400	2,040[d]
Mainstem Eel River	500		200		
Van Duzen River	500		200		
South Fork Eel River	13,0		4,000		
North Fork Eel River	0		0		
Middle Fork Eel River	0		0		
Mattole River		2,000		500	760[d]
Other Humboldt County		1,500		1,130	680[d]
ESU Total		**43,300**		**12,430**	**7,080**
California Statewide Total		**99,400**		**30,480**	**13,240**

a. Excludes ocean catch.
b. Estimates are for wild or naturalized fish; hatchery returns excluded
c. Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
d. Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.

Additional information regarding the status of coho salmon in the SONCC ESU was obtained from an analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support coho populations (Brown et al. 1994). Of 115 historical streams in the SONCC ESU for which recent data were available, 73 (63%) were determined to still support coho salmon, whereas it was believed they had been lost from 42 (37%). Schiewe (1996b) presented more recent data (1995-1996) on presence of coho salmon within the SONCC ESU, which suggested that the percentage of streams still supporting coho salmon was lower than estimated by Brown et al. (1994). Of 176 streams recently surveyed in the SONCC ESU, 92 (52%) were found to still support coho salmon (P. Adams, NMFS Southwest Fisheries Science Center, pers. comm. cited in Schiewe 1996b). The percentage of streams still supporting coho salmon was lower (46%) in Del Norte County than in Humboldt County (55%). It was unclear whether the apparent reduction in percentage of streams occupied by coho salmon was a function of trends in local extinctions or an artifact of sampling error.

Two recent reviews assessing the status of coho salmon stocks in California were also reviewed by the BRT. Nehlsen et al. (1991) identified coastal populations of coho salmon north of San Francisco Bay (includes portions of the SONCC and CCC ESUs) as being at moderate risk of extinction and Klamath River coho salmon as a stock of special concern. The Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992), utilizing more detailed information on individual river basins, considered three stocks of coho salmon in the SONCC ESU as at high risk of extinction (Scott River [Klamath], Mad River, and Mattole River), and eight more stocks as of special concern (Wilson Creek, Lower Klamath River, Trinity River, Redwood Creek, Little River, Humboldt Bay tributaries, Eel River, and Bear River)[3].

Oregon populations—For the 1997 status update (Schiewe 1997), the BRT was asked to evaluate the status of the ESU under two conditions: first, under existing conditions; second, assuming that hatchery and harvest reforms of the Oregon Coastal Salmon Restoration Initiative (OCSRI) were implemented.

Evaluation under existing conditions—In the Rogue River Basin, natural spawner abundance in 1996 was slightly above levels in 1994 and 1995. Abundances in the most recent 3 years were all substantially higher than abundances in 1989-1993, and were comparable to counts at Gold Ray Dam (upper Rogue) in the 1940s. Estimated return ratios for 1996 were the highest on record, but this may have been influenced by an underestimate of parental spawners. The Rogue River run included an estimated 60% hatchery fish in 1996, comparable to previous years. The majority of these hatchery fish returned to Cole Rivers Hatchery, but there was no estimate of the number that strayed into natural habitat.

Evaluation with hatchery and harvest reforms—The BRT considered only two sets of measures from the OCSRI—harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures will be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. The BRT had several concerns regarding both the harvest and hatchery components of the OCSRI plan. Some members had a strong concern that we do not know enough about the

[3] Weitkamp et al. (1995), citing Higgins et al. (1992), indicate that the numbers of stocks at “moderate risk of extinction” and “of special concern” in the SONCC are 6 and 10, respectively. These numbers appear to be in error.

causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures. Some felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it is re-evaluated in the year 2000 and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts, which may have less impact on wild fish. Another concern was the plan's lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Specific risk factors identified by the BRT included low current abundance, severe decline from historical run size, the apparent frequency of local extinctions, long-term trends that are clearly downward, degraded freshwater habitat and associated reduction in carrying capacity, and widespread hatchery production using exotic stocks. Of particular concern to the BRT was evidence that several of the largest river basins in the SONCC—including the Rogue, Klamath, and Trinity rivers—were heavily influenced by hatchery releases of coho salmon. Historical transfer of stocks back and forth between SONCC and CCC streams was common, and SONCC streams have also received plants from stocks from hatcheries in the lower Columbia River/Southwest Washington, Puget Sound/Strait of Georgia, and Oregon Coast ESUs. However, the BRT considered the frequency of out-of-basin plants to be relatively low compared with other coho salmon ESUs. Recent (late 1980s and early 1990s) droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance.

Previous BRT conclusions

In the 1995 status review, the BRT was unanimous in concluding that coho salmon in the SONCC ESU were not in danger of extinction but were likely to become so in the foreseeable future if present trends continued (Weitkamp 1995). In the 1997 status update, estimates of natural population abundance in this ESU were based on very limited information. Favorable indicators included recent increases in abundance in the Rogue River and the presence of natural populations in both large and small basins, factors that may provide some buffer against extinction of the ESU. However, large hatchery programs in the two major basins (Rogue and Klamath/Trinity) raised serious concerns about effects on, and sustainability of, natural populations. New data on presence/absence in northern California streams that historically supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contained coho salmon compared to the percentage presence in an earlier study. However, it was unclear whether these new data represented actual trends in local extinctions, or were biased by sampling effort. This new information did not change the BRT's conclusion regarding the status of the SONCC ESU. Although the OCSRI proposals were directed specifically at the Oregon portion of this ESU, the harvest proposal would affect ocean harvest of fish in the California portion as well. The proposed hatchery reforms can be expected to have a positive effect on the status of populations in the Rogue River Basin. However, the BRT concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

Listing status

Coho salmon in the SONCC ESU were listed as threatened in May of 1997 (62FR24588). On July 18, 1997, NMFS published an interim rule (62FR38479) that identified several exceptions to the Endangered Species Act's Section 9 take prohibitions.

C.2.2.2 New Data and Analyses

California populations

Since the status review for West Coast coho salmon (Weitkamp 1995) and subsequent updates (Schiewe 1996b, and Schiewe 1997) were completed, new data and analyses related to the status of coho salmon in the California portion of the SONCC ESU have become available. Most data are of two types: 1) compilations of presence-absence information for coho streams from the period 1987 to the present, and 2) new data on densities of juvenile coho salmon in index reaches surveyed by private timber companies. We found no time series of adult counts (excepting those substantially influenced by hatchery production), and only five time series of adult spawner indices (maximum live/dead counts) for tributaries of the Eel River (Sprowl Creek), the Mad River (Canon Creek), and the Smith River (West Branch of Mill Creek [two datasets] and East Branch of Mill Creek) that span a period of 8 years or more. Limitations of these datasets are discussed in detail below.

Two independent analyses of presence-absence and limited time series data for the SONCC have been published recently. CDFG (2002) analyzed coho salmon presence-absence for SONCC streams spanning brood years 1986-2000. Using an independent dataset, NMFS (2001) published an updated status review for coho salmon in the California portion of the SONCC. Since then, scientists at the Southwest Fisheries Science Center have continued compiling data on coho salmon distribution and abundance and re-analyzed the updated data, inclusive of data used in the CDFG (2002) analysis. Thus, results presented in this report supercede those presented in NMFS (2001).

CDFG presence-absence analysis

Methods—Staff at the North Coast Region of the California Department of Fish and Game attempted to gather all published and unpublished data collected for 392 streams identified by

Brown and Moyle (1991) as historical coho salmon streams[4]. Sources of data included field notes, planting records, and fish surveys from federal, state and tribal agencies, private landowners, and academic institutions, as well as summaries contained in several recently published status reviews (Ellis 1997, Brownell et al. 1999, and NMFS 2001). For each stream and year in which surveys were conducted, observations of coho salmon presence or absence were assigned to the appropriate brood year. If more than one life stage was observed during a survey, then presence was assigned to more than one brood year. Streams that were not surveyed during a particular year were assigned a "presence" value if fish were documented in an upstream tributary during that year. Overall, the CDFG dataset encompasses records from brood year 1986 to 2000, or five complete brood cycles. Additionally, CDFG (2002) presented results of an extensive field study conducted in the summer of 2001 in which 287 of the 392 Brown and Moyle (1991) streams were surveyed for juvenile coho salmon presence-absence[5].

For their brood-year analysis, CDFG (2002) compared the percentage of streams for which coho salmon were detected at any time during two time periods: brood years 1986-1991 and 1996-2000. The first period was designed to coincide with the period encompassed by the Brown and Moyle (1991) study. Statistics were generated based on data from all streams within the SONCC on the original Brown and Moyle list as well as the subset of these streams that were sampled at least once during each of the two time periods. CDFG (2002) also calculated the percentage of streams for which coho salmon were detected in the 2001 field survey.

Results—Including only streams on the Brown and Moyle list, CDFG (2002) found that coho salmon were observed in 143 of 235 (61%) streams surveyed during the period covering brood years 1986-1991 (Table C.2.2.2). This number is similar to the value of 63% found by Brown and Moyle (1991) based on information on about half as many streams (115). For brood years 1995-2000, surveys were conducted on 355 of the 392 historical coho salmon streams. Of these, coho salmon were detected in 179 (50%), suggesting a decline in occupancy. However, when the analysis was restricted to only the 223 streams for which data were available from both time periods, the percent of streams in which coho were detected went from 62% in 1986-1991 to 57% in 1995-2000, a change that was not statistically significant (Pearson Chi square test, p =0.228; Yates corrected chi square test, p =0 .334).

For the 2001 field survey, presence was confirmed in only 121 (42%) of the 287 streams surveyed within the SONCC ESU. CDFG (2002) makes two cautions in interpreting their year 2001 results. First, CDFG considered sampling intensity to be sufficient to have a high likelihood of detecting fish for only 110 of the 166 streams where coho salmon were not found. Second, they note that absence of fish in a single year class does not mean that fish have been extirpated from the system.

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[4]Brown and Moyle (1991) identified 396 streams in California as historical coho streams; however, four of those streams were dropped by CDFG either because barriers make historically occupancy highly unlikely, because the record of occurrence likely reflects a hatchery outplanting, or because streams were duplicated in the Brown and Moyle list.

[5]CDFG repeated their survey of Brown and Moyle (1991) streams in the summer of 2002; however, those data were unavailable at the time of their analysis.

Table C.2.2.2. Historical presence of coho salmon in the SONCC ESU, as determined by Brown and Moyle (1991) and the California Department of Fish and Game's presence-by-brood-year investigation (as of February 2002). County classifications are based on the location of the mouth of the river system. Table modified from CDFG (2002).

County/River Basin	Brown and Moyle (1991) Calendar years 1987-1990				CDFG (2002) Brood years 1986-1991				CDFG (2002) Brood years 1995-2000			
	no. of streams	**no. of streams w/info.**	**coho present**	**%**	**no. of streams**	**no. of streams w/info.**	**coho present**	**(%)**	**no. of streams**	**no. of streams w/info.**	**coho present**	**%**
Del Norte County												
Coastal	9	1	1		8	5	3		8	8	6	
Smith River	41	2	2		41	21	7		41	39	14	
Klamath River	113	41	21		112	82	48		112	89	55	
Subtotal	163	44	24	54%	161	108	58	53%	161	136	75	55%
Humboldt County												
Coastal	34	7	7		33	16	14		33	32	18	
Redwood Creek	14	3	3		14	12	12		14	14	11	
Mad River	23	2	2		23	10	8		23	22	14	
Eel River	124	56	34		123	80	48		123	116	45	
Mattole River	38	3	3		38	9	3		38	35	16	
Subtotal	233	71	49	69%	231	127	85	67%	231	219	104	47%
ESU Total	**396**	**115**	**73**	**63%**	**392**	**235**	**143**	**61%**	**392**	**355**	**179**	**50%**

NMFS presence-absence analysis

Methods—Scientists at the NMFS Southwest Fisheries Science Center compiled a presence-absence database for the SONCC comparable to that developed by CDFG. This dataset is a composite of information contained in the NMFS (2001) status review update, additional information gathered by NMFS since the 2001 status review was published, and data used in the CDFG (2002) analysis. There are four significant differences between the data and analytical approach used by NMFS as compared with CDFG. First, the NMFS database includes alls stream with some historical record of coho salmon presence, including many not found on the Brown and Moyle (1991) list. Second, the NMFS database spans a slightly different time period: brood years 1987 to 2001 (rather than 1986 to 2000). At the time these data were compiled, data from summer 2002 field surveys were only partially reported; thus, results from brood year 2001 are preliminary. Third, unlike CDFG (2002), we did not infer presence in streams on the basis of occurrence in upstream tributaries. Although there is an intuitive logic to assigning presence to streams en route to a particular location, including these "inferred presence" values in the analysis tends to positively bias the overall estimate of percent occupancy because the same logic cannot be applied in the case of a recorded "absence." And finally, in our analysis, we present summary information both by brood year and by brood cycle (3-year aggregation). In contrast, in their brood year analysis, CDFG (2002) calculated percent occupancy for 6-year time spans (two complete brood cycles); any observation of presence during that 6-year window resulted in a value of presence for the entire period.

Results for the NMFS presence-absence analyses are presented by major watersheds or aggregations of adjacent watersheds (Table C.2.2.3). In general, results from larger watersheds are presented independently, whereas data from smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams.

Results—On an annual basis, the estimated percentage of streams in the SONCC for which coho salmon presence was detected has generally fluctuated between 38% and 58% between brood years 1986 and 2000 (Figure C.2.2.1). The data suggest an apparent decline in percent of streams containing coho between 1995 and 2000; however, that decline may be due to an increase in the number of streams sampled covering brood years 1999 and 2000. Data that have been reported for the 2002 summer sampling season suggest a strong year class; however, the number of streams for which data have been reported is small compared to previous years. The pattern is similar whether all historical coho streams or just those identified in Brown and Moyle (1991) are considered (Figure C.2.2.1).

Table C.2.2.3. Percent of surveyed streams within the SONCC ESU for which coho salmon were detected for four time intervals: brood years 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists (based on NMFS and CDFG data combined).

		1987-1989			1990-1992			1993-1995			1996-1998			1999-2001		
County and River Basins	**Number of Streams with Historical Presence**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**
Del Norte (includes OR tributaries)																
Illinois River	9	0	0%	100%	2	100%	0%	2	50%	50%	7	100%	0%	4	75%	25%
Smith River-Winchuck River	57	16	19%	81%	18	44%	56%	45	56%	44%	29	34%	66%	44	43%	57%
Klamath River -Trinity River	199	124	65%	35%	118	70%	30%	136	68%	32%	135	63%	37%	129	55%	45%
Humboldt																
Redwood Creek	32	15	80%	20%	18	94%	6%	20	80%	20%	14	86%	14%	21	76%	24%
Stone/Big Lagoons	5	0	0%	100%	1	100%	0%	0	0%	100%	2	50%	50%	5	20%	80%
Litte River - Strawberry Creek	9	8	100%	0%	9	100%	0%	6	100%	0%	5	100%	0%	6	83%	17%
Mad River	25	7	100%	0%	6	83%	17%	7	86%	14%	7	71%	29%	24	67%	33%
Humboldt Bay tributaries	41	17	94%	6%	13	100%	0%	29	100%	0%	16	88%	13%	23	70%	30%
Eel River	224	105	48%	52%	124	58%	42%	130	58%	42%	58	29%	71%	150	30%	70%
Bear River-Guthrie Creek	5	0	0%	100%	0	0%	100%	3	0%	100%	2	0%	100%	4	0%	100%
Mattole River-McNutt Gulch	57	5	60%	40%	11	36%	64%	21	71%	29%	41	80%	20%	41	37%	63%
ESU Total	**663**	**297**	**60%**	**40%**	**320**	**67%**	**33%**	**399**	**66%**	**34%**	**316**	**60%**	**40%**	**451**	**46%**	**54%**

[1] Total number of steams surveyed at least once within the three-year interval

[2] Percentage of surveyed streams where coho were present in one or more years during the inerval

[3] Percentage of surveyed streams where coho were absent in all years of survey during the interval

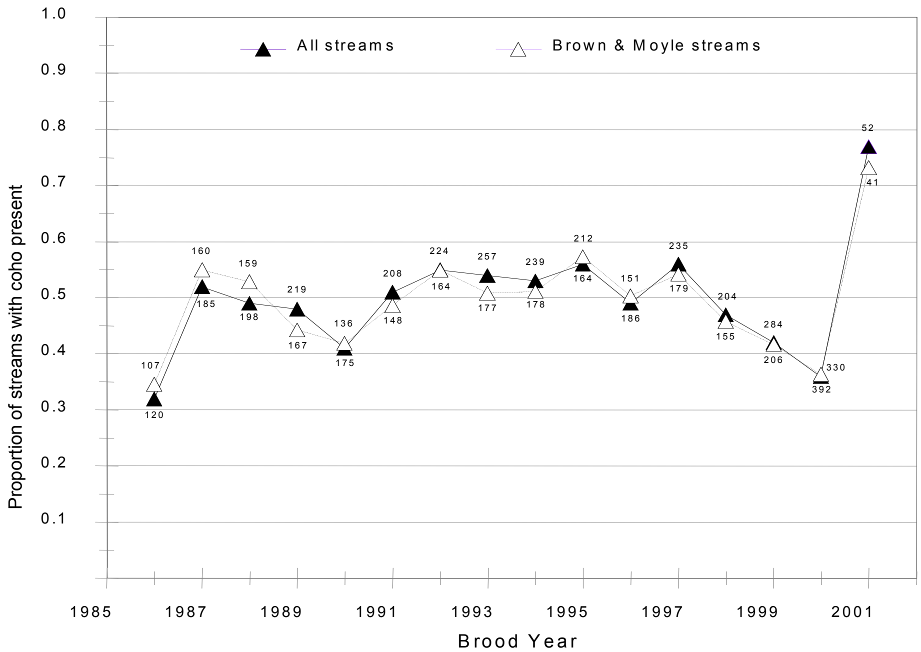

Figure C.2.2.1. Percent of streams surveyed for which coho salmon presence was detected, by brood year, for all historic coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the SONCC ESU. Sample sizes (i.e. number of streams surveyed) are shown above next to data points. Data are from combined NMFS and CDFG datasets.

When data were aggregated over complete brood cycles (3-year periods), the percentage of streams for which coho salmon presence was detected remained relatively constant (between 60% and 67%) between the 1987-1989 and 1996-1998 brood cycles (Table C.2.2.3). Percent occupancy for the 1999-2001 brood cycle was lower at 46%; however, interpretation of this apparent decline is complicated by two factors. First, the number of streams surveyed was higher than in any other period due to CDFG's intensive survey of the Brown and Moyle streams in the summer of 2001, a drought year. Second, reporting from the 2002 summer season (brood year 2001) remains incomplete, and as noted above, preliminary data indicate that the 2001 brood year was strong. Thus, it is likely that the percent occupancy for this period will increase after all data from CDFG's 2002 survey and other sources are analyzed. When analysis was restricted to streams on the Brown and Moyle (1991) list, the ESU-wide pattern was almost identical, with percent occupancy values being within 1%-2% for all time periods (data not shown). Overall, it appears that there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to the present.

In general, the number of streams sampled within any individual watershed (or grouping of watersheds) was sufficiently small or variable among time periods to make interpretation of local patterns difficult. However, there are a few noteworthy results for watersheds where sampling frequency is higher. Most notable was coho salmon occurrence within the Eel River basin, which appears to have declined from between 48% and 58% in the period between 1987 and 1995 to about 30% in the past two brood cycles. Similarly, the percentage of streams with coho salmon presence in the Klamath-Trinity system appears to have declined over the five brood cycles examined, though the magnitude of the decrease is smaller. In both these cases, anecdotal reports suggest that inclusion of more data from the 2002 sampling year may increase the observed percentages because of the relatively strong adult returns in the winter of 2001-2002. Still, the relatively low percentage of streams that still support coho salmon in the Eel River and the possible downward trend in the Klamath River basin, despite continued heavy hatchery influence, are cause for concern given that these are the largest river basins in the California portion of the SONCC.

The results of NMFS analysis are generally consistent with those of CDFG (2002), but depart from those of NMFS (2001), which suggested a significant decline in percent occupancy in the SONCC from 1989 to 2000. This discrepancy resulted from bias in data used in that analysis towards values of "presence," particularly in the late 1980s to mid 1990s. A more exhaustive examination of stream surveys from the SONCC region compiled by CDFG has substantially increased the total number of observations in the dataset (especially in the earliest years) and those additional observations have been strongly weighted toward "absences."

Adult time series

Spawner surveys have been conducted annually by the California Department of Fish and Game on 4.5 miles of Sprowl Creek, tributary to the Eel River, since 1974 (except in 1976-1977) and on 2 miles of Cannon Creek, tributary to the Mad River, since 1981 (PFMC 2002b). Inconsistent sampling frequency from years—anywhere from one to seven surveys on Sprowl Creek and one to10 surveys on Cannon Creek per year—precludes use of these data for meaningful time series analysis. However, peak live/dead counts for both creeks have generally been low (often 0) during the period of record (Figures C.2.2.2a and C.2.2.2b). Spawner surveys have been conducted by Jim Waldvogel (UC Cooperative Extension) on the West Branch Mill Creek, a tributary to the Smith River, from 1980 to 2001. Peak live/dead counts have fluctuated between two and 28 fish during this period (Figure C.2.2.2c). Surveys have also been conducted on the west branch of Mill Creek, as well as the east branch, by Stimson Timber Company since 1993. Maximum live/dead counts recorded by Stimson on the west branch have been higher than those reported by Waldvogel, but have shown a substantial drop during the 8 years of record (Figure C.2.2.2d). A similar decline has been observed on the east branch of Mill Creek (Figure C.2.2.2e).

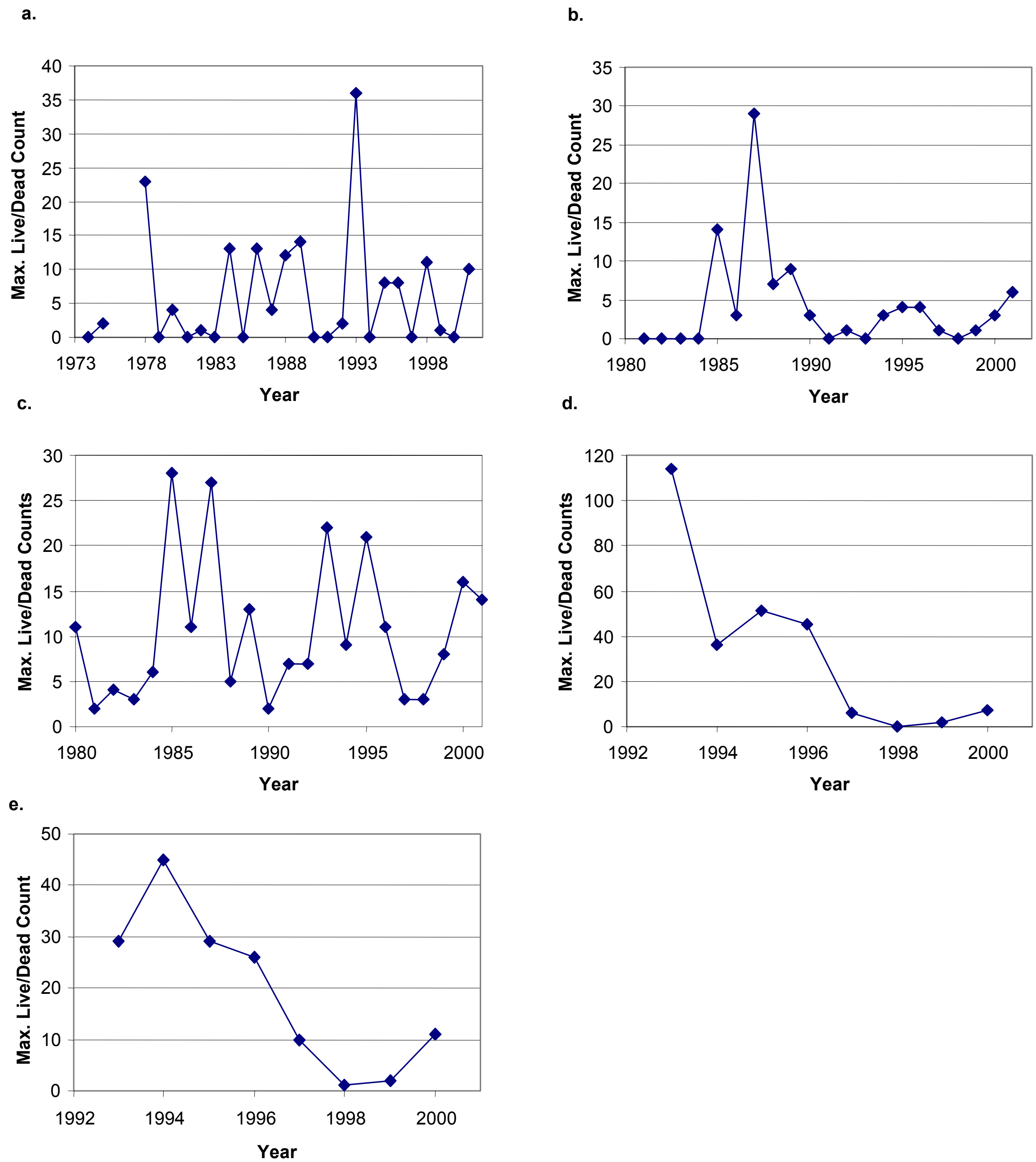

Figure C.2.2.2. Indices of spawner abundance (maximum live/dead counts) for coho salmon in SONCC river systems. a) Sprowl Creek (Eel River) surveys conducted by CDFG (PFMC 2002b); b) Cannon Creek (Mad River) surveys conducted by CDFG (PFMC 2002b); c) West Branch Mill Creek surveys conducted by J. Waldvogel, UC Cooperative Extension (unpubl. Data); d) West Branch Mill Creek surveys conducted by Stimson Timber Company; and e) East Branch Mill Creek surveys conducted by Stimson Timber Company.

Juvenile time series

Methods—Juvenile density during summer have been made at seven index sites within the Eel River basin over the past 8 to 18 years. We performed an exploratory analysis of juvenile density to determine whether such patterns observed in juveniles are consistent with those observed in the analysis of presence-absence information.

To estimate a trend, data were ln-transformed and then normalized so that each data point was expressed as a deviation from the mean of that specific time series. The normalization was intended to prevent spurious trends that could arise from different methods of data collection and reporting units. Following transformation, time series were aggregated, based on watershed structure, into groups thought to plausibly represent independent populations. Linear regression was used to estimate trends (i.e., slopes) for each aggregate dataset. Analysis was restricted to 1) sites where a minimum of 8 years of data were available, and 2) putative populations where more than 65% of the observations were non-zero values.

Results—Aggregate trends were estimated for two putative populations in the SONCC ESU: the South Fork Eel River (based on five sites) and Middle Fork Eel River (two sites). In both cases, trends were positive, but not significantly different from 0 (South Fork: slope 0.053, 95% CI from -.074 to 0.180; Middle Fork: slope 0.016, 95% CI from -0.051 to 0.180).

Oregon populations

One effect of the Oregon Plan has been increased monitoring of salmon and habitats throughout the Oregon coastal region. Besides continuation of the abundance data series analyzed in the 1997 status update, Oregon has expanded its random survey monitoring to include areas south of Cape Blanco, including monitoring of spawner abundance, juvenile densities, and habitat condition.

Spawner abundance—In the Oregon portion of the ESU, spawner abundance is monitored only in the Rogue River Basin. Other small coastal basins have limited coho salmon habitat, and are not thought to have sustainable local coho salmon populations (Jacobs et al. 2002). Within the Rogue Basin, two methods are used to monitor adult abundance: beach-seine surveys conducted at Huntley Park in the upper estuary, and stratified-random spawning ground surveys (Jacobs et al. 2002). The Huntley Park seine estimates provide the best overall assessment of both naturally produced and hatchery coho salmon spawner abundance in the basin (Figure C.2.2.3). Spawner survey-based abundance estimates are also available for the basin since 1998, when the surveys were expanded south of Cape Blanco. These estimates are consistently lower than the seine-based estimates, which may be due in part to losses during upstream migration (Jacobs et al. 2002); however, ODFW considers the seine-based estimates to be more accurate as an overall assessment of spawner abundance (S. Jacobs, ODFW, pers. comm. October 2002). The spawning-ground surveys allow examination of the distribution of spawners among subbasins: in 2001, the majority of spawners were in main tributaries (Illinois and Applegate Rivers and Evans and Little Butte Creeks).

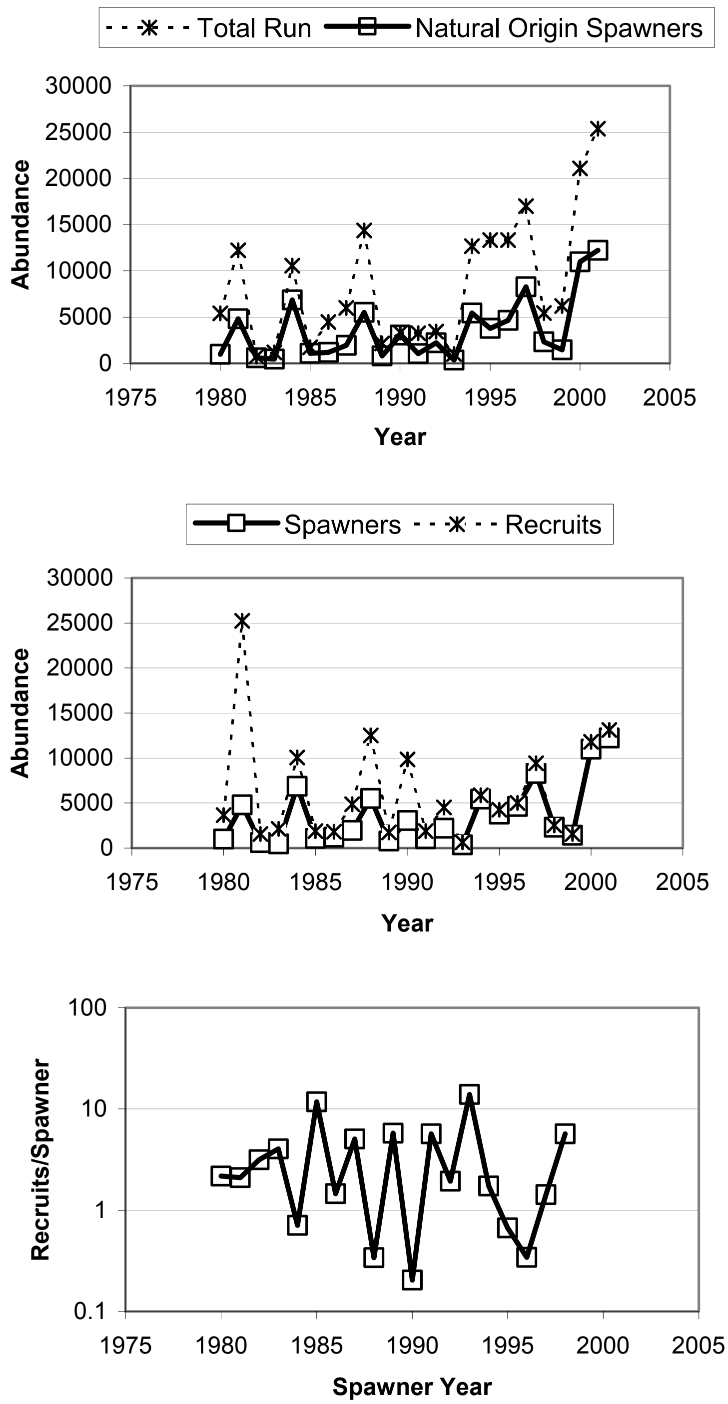

Figure C.2.2.3. Trends in Rogue River coho salmon populations, based on ODFW surveys at Huntley Park (Jacobs et al. 2002). Upper panel—total and natural-origin spawner abundance; middle panel—pre-harvest recruits and spawner abundance; bottom panel—recruits (lagged 3 years) per spawner (note logarithmic scale).

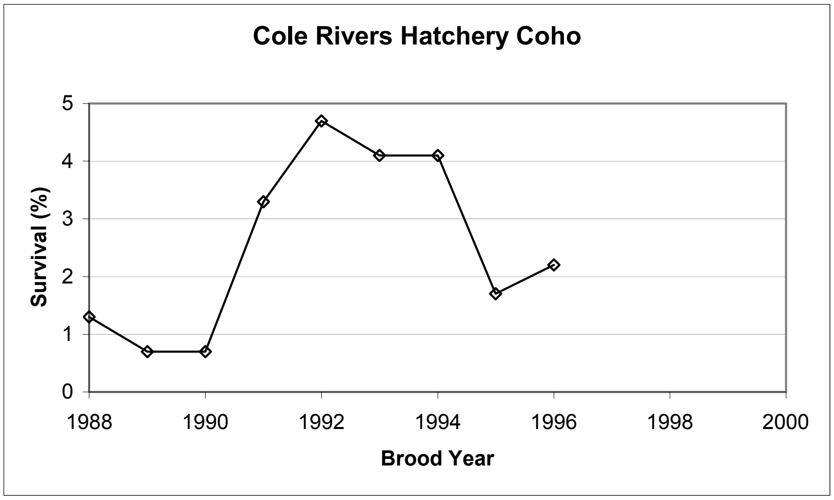

Figure C.2.2.4. Percent survival of CWT-marked coho salmon from Cole Rivers Hatchery, calculated from data in Lewis (2002).

The occurrence of hatchery fish in natural spawning areas is also a consideration for the productivity of the natural population. In Figure C.2.2.3, it can be seen that roughly half of the total spawning run in the Rogue River Basin is hatchery fish. However, many of these fish return to Cole Rivers Hatchery, rather than spawning in natural habitat. Based on fin-mark observations during spawning-ground surveys, the average percent of natural spawners that are of hatchery origin has ranged from less than 2% (2000) to nearly 20% (1998) in recent years. These hatchery spawners are largely concentrated in the mainstem tributaries, with very few hatchery fish observed in major tributaries (Jacobs et al. 2002).

Results—Mean spawner abundance and trends for Rogue River coho salmon are given in Table C.2.2.4. Both short- and long-term trends in naturally produced spawners are upward; however, this increasing trend in spawners results from reduced harvest, as trends in pre-harvest recruits are flat (Figure C.2.2.3). Recruits per spawner fluctuate widely, but has little apparent trend (Figure C.2.2.3). Fluctuations in naturally produced spawner abundance are generally in phase with survival of hatchery fish (Figure C.2.2.4), suggesting that ocean conditions play a large role in population dynamics. Note that hatchery-fish survival for the Rogue River stock is generally higher and follows a different pattern than the general OPI survival index (see Oregon Coast ESU discussion).

Juvenile density—Regular monitoring of juvenile coho salmon in the Oregon portion of the SONCC ESU began in 1998, and 4 years of data are currently available, as reported in Rodgers (2002). Several statistics are reported, including percent occupancy and mean density. Methods differ from the California surveys reported above, so direct comparison of results is problematic. The most comparable statistic to the California presence/absence data is "percentage of sites with at least one pool containing coho," which has been steadily increasing from about 30% in 1998 to 58% in 2001; this compares with a range of 52% to 80% for other parts of the Oregon coast. Percentage of pools per site containing coho salmon has also increased, reaching 41% (s.e. 4.9%) in 2001. Mean juvenile density has also increased over the 3 years. In 2001, overall mean density of juveniles in surveyed pools was 0.38 fish per square meter (fish·m^{-2}); this compares with a range of 0.27 to 0.50 fish·m^{-2} for other areas of the Oregon coast.

Table C.2.2.4 Abundance and trend estimates for Rogue River Basin coho salmon naturally-produced spawners, estimated from Huntley Park seine data (Jacobs et al. 2002) from 1980 to 2001. Shown are the most recent geometric mean (along with minimum and maximum values for the data series) and two trend estimates (see Methods section), both long- and short-term, along with the probability that the true trend is decreasing.

Parameter	Value	95% C.I.	P(decrease)
5-year geometric mean abundance			
Last 5 years	5170		
Minimum	1143		
Maximum	5170		
TREND (Regression estimate)			
Short-term (1990-2001)	1.17	(0.99, 1.38)	0.03
Long-term (1980-2001)	1.08	(1.01, 1.15)	0.01
TREND (Lamda estimate)			
Short-term (1990-2001)	1.19	(1.02, 1.39)	0.02
Long-term (1980-2001)	1.08	(0.93, 1.26)	0.12

Habitat condition—The Oregon Plan Habitat Survey (OPHS) began in 1998, as part of the ODFW Aquatic Inventories Project begun in 1990. Information here is derived from the Survey's year 2000 report (Flitcroft et al. 2001). The survey selects 500-m to 1,000-m sites along streams according to a spatially balanced random selection pattern. The survey includes both summer and winter habitat sampling. In addition to characterization of the site's streamside and upland processes, specific attributes sampled are: large wood, pools, riparian structure, and substrate. The program has established benchmark thresholds as indicators of habitat quality:

- Pool area greater than 35% of total habitat area;
- Fine sediments in riffle units less than 12% of all sediments;
- Volume of large woody debris greater than 20 m^3 per 100 m stream length;
- Shade greater than 70%;
- Large riparian conifers more than 150 trees per 305 m stream length.

For the combined 1998-2000 surveys in the Oregon portion of the SONCC ESU, 6% of sites surveyed met none of the benchmarks, 29% met one, 38% met two, 20% met three, 5% met four, and 2% met all five benchmarks. No trends in habitat condition can yet be assessed from this data, but it will provide a basis for future assessment of changes in habitat quality.

C.2.2.3 New Comments

The Siskiyou County Farm Bureau submitted comments arguing that SONCC coho salmon should not be protected under ESA, particularly because the relationship of Iron Gate Hatchery fish in the Klamath River to the SONCC ESU remains uncertain. Their principal arguments is that widespread historical outplanting of juvenile coho salmon and incorporation of non-native fish into hatchery broodstock make application of the ESU concept inappropriate; they argue that all West Coast coho salmon should be considered a single ESU.

The Siskiyou Project submitted comments supporting continued listing of coho salmon in the SONCC under ESA. They argue that 1) the status of native, naturally reproducing coho salmon in the SONCC remains unchanged since they were listed in 1997; 2) increases in adult coho salmon observed in 2001 and 2002 are mostly due to improved ocean conditions and reduced harvest, and are not indicative of long-term trends; 3) severe drought in the winter 2001-2002 and summer 2001 are likely to result in lower smolt production in spring 2002 and adult returns in 2003; 4) habitat already in poor condition is likely to deteriorate with increasing human demands for natural resources and inadequate regulations; and 5) continued large releases of hatchery coho salmon pose a threat to naturally produced fish through competition, mixed-stock fishing, and reduced fitness associated with interbreeding of hatchery and wild fish. The Siskiyou Project also includes a report authored by Cindy Deacon Williams, private consultant, titled *Review of the status of Southern Oregon/Northern California coho with thoughts on recovery planning targets*. Ms. Williams' report presents basin-by-basin assessments of the status of coho salmon (using primarily previously published analyses), habitat conditions, and ongoing activities that pose risks to coho salmon. She also recommends numeric recovery criteria for SONCC coho salmon and argues that habitat targets are needed to ensure recovery.

The Douglas County Board of Commissioners submitted a report, *Viability of coho salmon populations on the Oregon and northern California coasts*, submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Little of the information presented in the report is specific to the SONCC ESU. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast, some information for the Rogue River basin, but no new information for California populations.

Daniel O'Hanlon, attorney at law, submitted comments on two occasions (April 12, 2002 and July 24, 2002) on behalf of Save Our Shasta and Scott Valley Towns (S.O.S.S), an organization of citizens concerned about the effects of ESA regulations. The latter submission includes comments submitted to the California Fish and Game Commission regarding the petition to list coho salmon in Northern California under the state Endangered Species Act, which include, by reference, a critique of CDFG's (2002) status review prepared by Dr. Charles Hanson. Though the critique is of the state's analysis of coho status, some the arguments are germane to the federal status review since the underlying data are comparable. The essential arguments from this collection of documents are 1) the limited data presented in the initial status reviews was insufficient to assess, in a scientifically rigorous way, the degree of extinction risk facing coho salmon in the SONCC; 2) there is no evidence of an immediate or near-term risk of extinction based on analysis of either presence-absence data or abundance trend data; presence-absence data have a number of weaknesses, and historical trend data (abundance and harvest) are unreliable; and 3) existing regulatory structures are adequate to protect coho salmon; new regulations would hinder, rather than help coho recovery.

The Yurok Tribal Fisheries Program submitted recent data from various sampling efforts in the lower Klamath River and its tributaries. Included were data from downstream migrant traps, adult snorkel surveys, tribal harvest, and harvest catch-per-unit effort. Data on relative contribution of wild and hatchery fish at the lower Klamath and lower Trinity downstream migrant trapping sites are discussed in the section on New Hatchery/ESU Information below. Other data were incorporated into NMFS presence-absence analysis discussed above. None of the time series available met the minimum criterion of 8 years, which was decided upon by the BRT as the minimum needed for trend analysis.

C.2.2.4 New Hatchery/ESU Information

Weitkamp et al. (1995) identified four hatcheries that were producing and releasing coho salmon within the SONCC ESU during the mid 1990s: Mad River Hatchery, Trinity River Hatchery, Iron Gate Hatchery, and Cole Rivers Hatchery. Prairie Creek hatchery produced coho salmon for many years, but closed in 1992 (CDFG 2002). Rowdy Creek hatchery is a privately owned hatchery that has produced coho salmon in the past; however, the facility did not produce coho salmon in 1999 and 2000 due to lack of adult spawners (CDFG 2002), and no further production of coho salmon at this facility is planned (Andrew VanScoyk, Rowdy Creek Hatchery, pers. comm.).

Iron Gate Hatchery—Iron Gate Hatchery (IGH), located on the Klamath River near Hornbrook, California, approximately 306 km from the ocean, was founded in 1965 and is operated by the California Department of Fish and Game (CDFG). The IGH stock was developed initially from Trinity River coho salmon released in 1966, though releases of Cascade (Columbia River) stock were made in 4 of the first 5 years of hatchery operation. An unknown stock was also released in 1970. Since 1977, only Klamath Basin fish have been released from IGH, including 2 years when Trinity River fish were planted (1977 and 1994).

Annual releases of coho salmon from IGH have decreased from an average of approximately 147,000 fish from 1987-1991 to about 72,000 fish from 1997-1999 (Table C.2.2.5), which is near CDFG's goal of 75,000 yearlings released per year. Adult returns averaged 1,120 fish between 1991 and 2000, and an average of 161 females have been spawned annually during this period.

Table C.2.2.5. Average annual releases of coho salmon juveniles (fry and smolts) from selected hatcheries in the SONCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002.

Hatchery	**SSHAG Category**	**Average Annual Releases 1987-1991**	**1992-1996**	**1997-2002**
Cochran Ponds (HFAC)		35,391[a]	na[b]	0[b]
Mad River	4	372,863	91,632	82,129[c]
Prairie Creek		89,009[d]	0[e]	0[e]
Trinity River	2	496,813	385,369	527,715
Iron Gate (Klamath)	2	147,272	92,150	71,932[f]
Rowdy Creek		0	12,534[g]	10,615[h]
Cole Rivers (Rogue)	1	271,492	240,000[i]	315,000[j]
Total		**1,413,380**	**821,685**	**1,007,391**

[a] Average from 2 years (1987-1988).
[b] Coho salmon were produced by the Humboldt Fish Action Council (HFAC) through the 1994 brood year; release data for 1992 to 1996 are currently unavailable; no fish were released after 1996 (S. Holz, HFAC, pers. commun.)
[c] CDFG ceased spawning coho salmon at Mad River Hatchery in 1999; yearling were last released in 2001
[d] Average from 4 years (1987-1988, 1990-1991)
[e] Prairie Creek hatchery ceased producing coho salmon in 1992.
[f] Does not include releases from year 2002 (data not available)
[g] Average from 2 years (1995-1996); data not available for 1992-1995.
[h] Rowdy Creek hatchery ceased releasing coho in year 2001.
[i] Average from 1991-1995.
[j] Average from 1996-2002; includes juvenile coho salmon released to lakes.

The California Department of Fish and Game and National Marine Fisheries Service Joint Hatchery Review Committee (2001) noted that no accurate estimates of the relative contribution of wild vs. hatchery fish are available for the Klamath River basin. Beginning in 1995, coho salmon released from IGH have been marked with left maxillary clips; however, return information has been published for only a single year, 2000. These data indicate that 80% of 1,353 fish returning to IGH were marked hatchery fish, with 98% being Iron Gate releases. A few fish from the Trinity and Cole Rivers (Rogue River, Oregon) hatcheries were also taken. The significance of this high percentage of hatchery fish with respect to total production in the Klamath Basin is uncertain since IGH lies near the upper end of the accessible habitat.

Additional information about the composition of Klamath Basin stocks is available from downstream migrant trap data collected by Yurok Tribal Fisheries (2002) in 1997 and 1998. The lower Klamath River trap is located below the confluence of the Klamath and Trinity rivers and thus captures fish from both the Iron Gate and Trinity hatcheries. During 2 years of sampling, Trinity hatchery fish dominated the total catch accounting for 73% and 83% of all fish caught in 1997 and 1998, respectively. Iron Gate Hatchery fish accounted for around 5% of the catch in both years. Naturally produced coho salmon made up 22% of the total catch in 1997 and 12% of the catch in 1998. In 1998, a trap was also operated on the lower Trinity River. Only 9% of the smolts captured at this trap were naturally produced. Assuming that this proportion accurately reflected the relative contributions of naturally produced and hatchery Trinity River fish to catch at the Lower Klamath trap, then the percentages of naturally produced and hatchery fish exiting the Klamath River proper (above the Trinity confluence) were approximately 42% and 58%, respectively.

The BRT was uncertain about whether the use of non-native stocks to start the Iron Gate population was of sufficient importance to have lasting effects on the present population. Thus, they reached no conclusion about whether the hatchery stock should be included in the ESU (Schiewe 1997). Subsequently, Iron Gate was determined to be a Category 2 hatchery (SSHAG 2003). For other SSHAG hatchery stock categorizations, see Appendix C.5.1.

Trinity River Hatchery—Trinity River Hatchery (TRH), located below Lewiston Dam approximately 248 km from the ocean, first began releasing coho salmon in 1960. The TRH facility originally used Trinity River fish for broodstock, though coho salmon from Eel River (1965), Cascade River (1966, 1967, and 1969), Alsea River (1970), and Noyo River (1970) have also been reared and released at the hatchery as well as elsewhere in the Trinity Basin.

Trinity River Hatchery produces the largest number of coho salmon of any production facility in California. CDFG's annual production target is 500,000 yearlings. Actual production averaged 496,813 from 1987-1991, decreased to 385,369 from 1992-1996, and then increased again to 527,715 fish from 1997-2002 (Table C.2.2.5). During the period 1991-2001, an average of 3,814 adult coho were trapped and 562 females were spawned at the TRH.

It is commonly assumed that there is little production of wild coho salmon in the Trinity River system, and available data support this assumption. Outmigrant trapping on the lower Trinity River indicates that marked TRH fish made up 91%, 97%, and 65% of the catch in years 1998, 1999, and 2000, respectively. Additionally, significant fractions of the naturally produced fish are likely the progeny of hatchery strays. Between 1997 and 2001, an estimated 85% to 95% of in-river spawners upstream of the South Fork Trinity River were TRH strays (Wade Sinnen, pers. comm. cited in CDFG 2002).

The BRT concluded that coho salmon from the Trinity River Hatchery should be considered part of the SONCC ESU since out-of-basin and out-of-ESU transfers ceased by 1970 and production since that time has been exclusively from fish within the basin. The lack of natural production within the Trinity Basin, however, remains a significant concern. The Trinity Hatchery is a Category 2 hatchery (SSHAG 2003).

Mad River Hatchery—Mad River Hatchery (MRH), located approximately 20 km upriver near the town of Blue Lake, first began producing coho salmon in 1970. The original broodstock (1970) was from the Noyo River, which lies outside of the SONCC ESU, and Noyo fish were released from the hatchery during 12 additional years between 1971 and 1996. Other stocks released from the hatchery include out-of-ESU transfers from the Trask River (1972), Alsea River (1973), Klaskanie River (1973), Green River (1979), and Sandy River (1980), as well as out-of-basin, within-ESU transfers from the Trinity River (1971), Klamath River (1981, 1983, 1986-1989), and Prairie Creek (1988, 1990).

Releases of Mad River fish declined substantially during the past decade, from an average of 372,8643 fish in 1987-1991 to just over 82,000 in the period from 1997-2001 (Table C.2.2.5).

Production of coho salmon at MRH ceased after brood year 1999, thus, the year 2001 releases represent the final year of hatchery production. Adult returns were low during the 1990s, with an average of 38 adults trapped and 16 females spawned during the period between 1991 and 1999. No information was available regarding the relative contribution of naturally produced and artificially propagated fish within the Mad River basin. However, concern about both out-of-ESU and out-of-basin stock transfers, as late as 1996, was sufficiently great that the Mad River Hatchery was excluded from the SONCC ESU by NMFS (Schiewe 1997). This conclusion has been rendered moot by the decision to cease producing coho salmon at the Mad River facility.

Rowdy Creek Hatchery—Rowdy Creek Hatchery is a privately owned hatchery in the Smith River Basin constructed in 1977. Production emphasis has been on chinook and steelhead, but small numbers of coho salmon were trapped and bred during the period 1990 to 1998. Only local coho salmon broodstock have been used at the Rowdy Creek facility (Schiewe 1997).

Annual releases of coho salmon yearlings averaged 12,534 between 1995 and 1996, and 15,923 from 1997 to 2000, when releases were terminated (Table C.2.2.5). Adult returns to the hatchery averaged just 26 fish in the 11 years that coho salmon were trapped (A. Van Scoyk, Rowdy Creek Hatchery, unpublished data). No information was available on the relative contribution of Rowdy Creek Hatchery coho salmon to the Smith River population as a whole, but it was undoubtedly a minor component during the period of operation.

In its status review update, the BRT (Schiewe 1997) concluded that the Rowdy Creek Hatchery population should be considered part of the ESU, but that it was not essential for ESU recovery. This conclusion has been rendered moot by the decision to cease producing coho salmon at the facility.

Cole Rivers Hatchery—The Cole Rivers Hatchery has raised Rogue River (Oregon stock #52) coho salmon since 1973 to mitigate for lost production due to construction of Lost Creek Dam. This stock was developed from local salmon trapped in the river, and has no history of out-of-basin fish being incorporated. Recent releases (1996-2002) have averaged 315,000 per year, compared to a 1991-1995 average of 240,000 per year (Table C.2.2.5); the increase is due to inclusion in the data of large-sized coho salmon released to lakes in the basin in recent years (Bill Waknitz, NMFS, pers. comm.). Spawning of hatchery fish in nature is essentially limited to mainstem tributaries and (to a lesser extent) the Applegate River, and interbreeding with natural fish is limited by separation in spawning time (Jacobs et al. 2002). The hatchery is rated as a Category 1 hatchery (SSHAG 2003).

Summary

Artificial propagation of coho salmon within the SONCC has been substantially reduced in the past 8 to 10 years, with the exception of Cole Rivers Hatchery on the Rogue River and the Trinity River hatchery. Annual releases from the Cole Rivers and Trinity hatcheries have recently averaged 315,000 and 500,000 fish, respectively. Production has ceased at one major facility (Mad River), as well as well as several minor facilities (Rowdy Creek, Eel River, and Mattole River). Production at Iron Gate Hatchery on the Klamath River has been reduced by approximately 50%. Genetic risks associated with out-of-basin and out-of-ESU stock transfers have largely been eliminated. However, two significant genetic concerns remain: 1) the potential for domestication selection in hatchery populations such as Trinity River, where there is little or no infusion of wild genes, and 2) out-of-basin straying by large numbers of hatchery coho.

Harvest impacts

Retention of coho salmon by commercial troll fishers south of Cape Falcon, OR, has been prohibited since 1993 (PFMC 2002b). From Cape Falcon, OR, south to Horse Mountain, CA, retention of coho salmon in recreational ocean fisheries has been prohibited since 1994, and in 1995, this prohibition was extended to include all California ocean recreational fisheries (CDFG 2002). The conservation objective set by the Pacific Fishery Management Council for the past five seasons has been an overall ocean exploitation of $\leq$13% for SONCC coho salmon as indicated by exploitation of Rogue/Klamath hatchery stocks (PFMC 2002b). Post-season estimates of Rogue/Klamath exploitation rate are unavailable; however, projected exploitation rates ranged from 3.0% to 11.7% during the period 1998 to 2002 (PFMC 1998-2002a). Inside harvest estimates of coho salmon are not available for rivers in the California portion of the SONCC (PFMC 2002b).

C.2.2.5 Comparison with Previous Data

New data for the SONCC coho salmon ESU includes expansion of presence-absence analyses, a limited analysis of juvenile abundance in the Eel River basin, a few indices of spawner abundance in the Smith, Mad, and Eel river basins, and substantially expanded monitoring of adults, juveniles, and habitat in southern Oregon. None of these data contradict conclusions reached previously by the BRT. Nor do any of recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONCC ESU. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. Although the 2001 brood year appears to be the one of the strongest perhaps of the last decade, it follows a number of relatively weak years. The Rogue River stock is an exception; there has been an average increase in spawners over the last several years, despite 2 low years (1998, 1999).

No new information has been provided that suggests risks beyond those identified in previous status reviews. Termination of hatchery production of coho salmon at the Mad River and Rowdy Creek facilities has eliminated potential adverse risk associated with hatchery releases from these facilities. Likewise, restrictions on recreational and commercial harvest of coho salmon since 1994 have likely had a positive impact on coho salmon adult returns to SONCC streams.

C.2.3 CENTRAL CALIFORNIA COHO

C.2.3.1 Previous BRT Conclusions

The Central California Coast (CCC) coho salmon Evolutionarily Significant Unit extends from Punta Gorda in Northern California south to and including the San Lorenzo River in Central California (Weitkamp et al. 1995). The status of coho salmon throughout their West Coast range, including the CCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates with information pertaining to the CCC ESU were published by NMFS in 1996 (Schiewe 1996a, b). Analyses from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

Status indicators and major risk factors

Data on abundance and population trends of coho salmon within the CCC ESU were limited. Historical time series of spawner abundance for individual river systems were unavailable. Brown et al. (1994) presented several historical point estimates of coho salmon spawner abundance (excluding ocean catch) for the entire state of California for 1940 and for various rivers and regions in the early 1960s and mid 1980s (Table C.2.3.1). Coho salmon were estimated to number between 200,000 and 500,000 statewide in the 1940s (E. Gerstung, CDFG, pers. comm., cited in Brown et al. 1994). Coho salmon spawning escapement was estimated to have declined to about 99,400 fish by the mid-1960s, with approximately 56,100 (56%) originating from streams within the CCC ESU (Table C.2.3.1). In the mid-1980s, spawning escapement was estimated to have dropped to approximately 30,480 in California and 18,050 (59%) within the CCC ESU. Employing the "20-fish rule" (see status review update for Southern OR-Northern CA Coast coho salmon for details), Brown et al. (1994) estimated wild and naturalized coho salmon populations at 6,160 (47% of the statewide total) for the CCC ESU during the late 1980s (Table C.2.3.1). All of these estimates are considered to be "best guesses" based on a combination of limited catch statistics, hatchery records, and personal observations of local biologists (Brown et al. 1994).

Further information regarding status was obtained from Brown et al.'s (1994) analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support populations. Of 133 historical coho salmon streams in the CCC ESU for which recent data were available, 62 (47%) were determined to still support coho runs while 71 (53%) apparently no longer support coho salmon (Table C.2.3.2). A subsequent analysis of surveys from 1995-1996 found a somewhat higher (57%) percentage of occupied streams (Schiewe 1996b, based on pers. comm. with P. Adams, NMFS Southwest Fisheries Science Center).

Nehlsen et al. (1991) provided no specific information on individual coho salmon populations in their 1991 status review, but concluded that salmon stocks in small coastal streams north of San Francisco were at moderate risk of extinction and those in coastal streams south of San Francisco Bay were at high risk of extinction. A subsequent status review by the Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992) found four populations (Pudding Creek, Garcia River, Gualala River, and Russian River) as high risk of extinction and five (Ten Mile, Noyo, Big, Navarro, and Albion rivers) as stocks of concern.

Table C.2.3.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Central California Coast Evolutionarily Significant Unit.

	Estimated Escapement		
	CDFG (1965)[a]	Wahle & Pearson (1987)[b]	Brown et al. (1994)[c]
River/Region	**1963**	**1984-1985**	**1987-1991**
Ten Mile River	6,000	2,000	160[d]
Noyo River	6,000	2,000	3,740
Big River	6,000	2,000	280
Navarro River	7,000	2,000	300
Garcia River	2,000	500	
Other Mendocino County	10,000	7,000[e]	470[f]
Gualala River	4,000	1,000	200
Russian River	5,000	1,000	255
Other Sonoma County	1,000		180
Marin County	5,000		435
San Mateo & Santa Cruz Counties	4,100	550	140
San Mateo County	1,000		
Santa Cruz County (excl. San	1,500	50	
San Lorenzo River	1,600	500	
ESU Total	**56,100**	**18,050**	**6,160**
Statewide Total	**99,400**	**30,480**	**13,240**

[a]Values excludes ocean catch.
[b]Estimates are for wild or naturalized fish; hatchery returns excluded.
[c]Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
[d]Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.
[e]Value may include Marin and Sonoma County fish.
[f.]Appears to include Garcia River fish.

Risk factors identified by the BRT included extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the BRT concluded that the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and that there were relatively few native coho salmon left in the ESU (Weitkamp et al. 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (Schiewe 1996a), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (=Kingfisher Flat) and Noyo River brood stocks have regularly incorporated wild broodstock and, thus, were unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions were identified as natural factors contributing to reduced run size.

Table C.2.3.2. Historical presence of coho salmon in the CCC ESU, as determined by Brown and Moyle (1991) and the California Department of Fish and Game's analysis of recent presence (1995-2001). County classifications are based on the location of the mouth of the river system. Data from CDFG (2002).

	Brown et al. (1994) Calendar years 1987-1990				**CDFG (2002) Years 1995-2001**				
County/River Basin	**no. of streams**	**no. of streams w/info.**	**coho present**	**%**	**no. of streams surveyed in 2001**	**no. of streams w/coho present**	**no. of streams w/coho assumed present**	**no. of streams w/coho not detected in 2001**	**Percent present (1995-2001)**
Mendocino									
Coastal	44	35	13	37%	30	11	10	19	52%
Ten Mile River	11	10	7	79%	11	9	0	2	82%
Noyo River	13	12	11	92%	8	7	5	1	92%
Big River	16	13	11	85%	8	3	6	5	64%
Navarro River	19	8	4	50%	14	6	1	8	47%
Subtotal	103	78	46	59%	71	36	22	35	62%
Sonoma County									
Coastal	10	2	1	50%	4	0	0	4	0%
Gualala River	11	2	1	50%	10	0	0	10	0%
Russian River	32	24	2	8%	29	1	1	28	0%
Subtotal	53	28	4	14%	43	1	1	42	4%
Marin County									
Coastal	10	7	7	100%	15	6	0	9	40%
Subtotal	10	7	7	100%	15	6	0	9	40%
Tribs. to S.F. Bay									
Coastal	7	7	0	0%	6	0	0	6	0%
Subtotal	7	7	0	0%	6	0	0	6	0%
South of S.F. Bay									
Coastal	13	13	5	38%					
Subtotal	13	13	5	38%					
ESU Total	**186**	**133**	**62**	**47%**	**135**	**43**	**23**	**92**	**42%**

Previous BRT conclusions

Based on the data presented above, the BRT concluded that all coho salmon stocks in the CCC ESU were depressed relative to historical abundance and that most extant populations have been heavily influenced by hatchery operations. They unanimously concluded that natural populations of coho salmon in this ESU were in danger of extinction (Weitkamp et al. 1995). After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction, while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (Schiewe 1996b).

Listing status

Coho salmon in the CCC ESU were listed as threatened in October 1996.

C.2.3.2 New Data and Analyses

Significant new information on recent abundance and distribution of coho salmon within CCC ESU has become available, much of which has been summarized in two recent status reviews (NMFS 2001; CDFG 2002). Most of these data are of two types: 1) compilations of presence-absence information for coho salmon throughout the CCC during the period 1987 to the present, and 2) new data on densities of juvenile coho salmon collected at a number of index reaches surveyed by private timber companies, CDFG, and other researchers. Excepting adult counts made at the Noyo Egg Collecting Station, which are both incomplete counts and strongly influenced by hatchery returns, there are no current time series of adult abundance within this ESU that span 8 or more years. Outmigrating smolts have been trapped at two trapping facilities in Caspar Creek and Little River since the mid-1980s; however, these are partial counts and only recently have mark-recapture studies been performed that allow correction for capture efficiency at these two sites. Thus, these smolt counts can only be considered indices of abundance.

Two analyses of presence-absence data have recently been published. CDFG (2002) performed an analysis that focused on recent (1995-2001) presence of coho salmon in streams identified as historical producers of coho salmon by Brown and Moyle (1991). NMFS (2001) published an updated status review that analyzed coho salmon presence in streams throughout the CCC during the period 1989 to 2000. Scientists at NMFS' Southwest Fisheries Science Center have continued to compile information of coho salmon presence-absence and have incorporated data into a database that is now summarized by brood year (rather than year of sampling) and covers brood years 1986-2001. Data from CDFG's 2001 field survey of the Brown and Moyle (1991) streams has been incorporated into this database. Analyses presented in the present status review update supercede those presented in NMFS (2001b).

CDFG presence-absence analysis

Methods—Methods used by CDFG (2002) for analyzing presence-absence information in the CCC differed from those used for the SONCC analysis. Analysis focused on results from CDFG's 2001 summer juvenile sampling effort in which 135 of 173 streams identified by Brown and Moyle (1991) as historical coho salmon streams within the CCC ESU were sampled. Additionally, CDFG assumed presence of coho salmon in any stream for which presence had been detected during any 3 consecutive years during the period 1995-2001. An estimate of percent coho salmon presence was calculated by totaling the number of streams for which presence was either observed or assumed, and dividing by the total number of streams surveyed, inclusive of those where presence was assumed. No formal statistical analysis of trends was performed because of the lack of comparable data from previous time periods.

Results—For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42% of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62%), followed by Marin County (40%), Sonoma County (4%), and San Francisco Bay tributaries (0%) (Table C.2.3.2). Although the numbers are not directly comparable with those derived by Brown et al. (1994), because the specific streams and methods used differ between the two studies, the general regional and overall ESU patterns are similar (Table C.2.3.2). The apparent decrease in percent presence in Marin County is likely a function of the increase in number of streams surveyed by CDFG rather than actual extirpations of populations.

NMFS presence-absence analysis

Methods—Scientists at NMFS' Southwest Fisheries Science Center compiled survey information from streams with historical or recent evidence of coho salmon presence within the CCC ESU. Data were provided primarily by the California Department of Fish and Game, private landowners, consultants, academic researchers, and others who have conducted sampling within the CCC during the years 1988 to 2002. The majority of data come from summer juvenile surveys, though information from downstream migrant trapping and adult spawner surveys were also included. Observations of presence or absence for a particular stream were assigned to the appropriate brood year based on the life stages observed (or expected in the case of absences). The resulting dataset spans brood years 1987 to 2001, though data from the 2002 summer field season (brood year 2001) were not fully reported at the time the analysis was performed.

Results for NMFS' presence-absence analysis are presented by major watersheds or aggregations of adjacent watersheds. Results from larger watersheds are typically presented independently, whereas data from smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams.

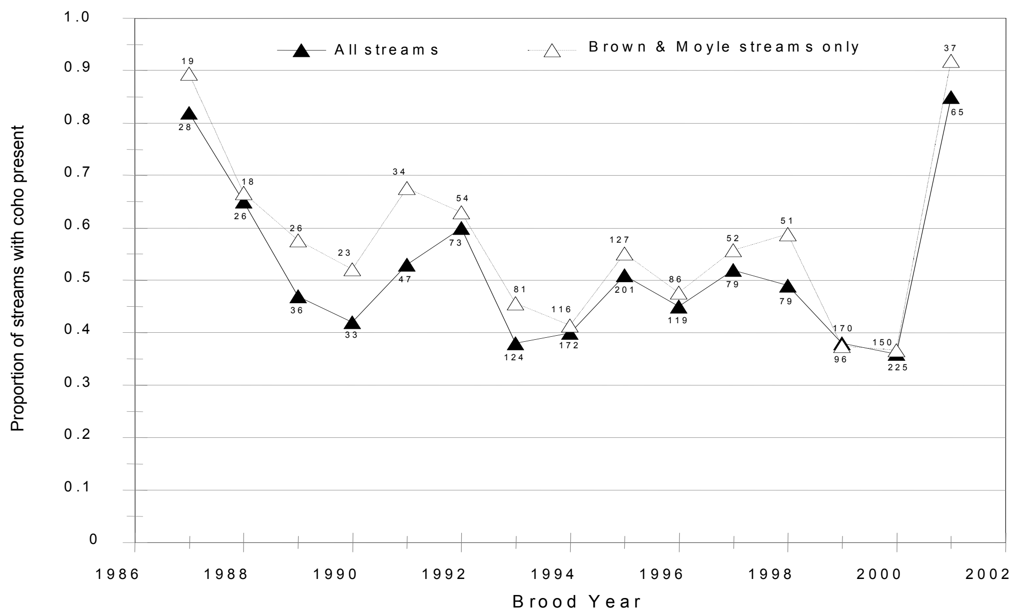

Figure C.2.3.1. Percent of streams surveyed for which coho salmon presence was detected, by brood year, for all historic coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the CCC ESU. Sample sizes (i.e. number of streams surveyed) are shown above next to data points. Data are from combined NMFS and CDFG datasets.

Results—The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001 (Figure C.2.3.1). Several caveats, however, warrant discussion. First, the number of streams surveyed per year also shows a general increase from 1987 to 2000; thus, there may be a confounding influence of sampling size if sites surveyed in the first half of the time period are skewed disproportionately toward observations in streams where presence was more likely. Second, sample size from brood year 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for brood year 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high percentage of streams where presence was detected shown in Figure C.2.3.1 is likely inflated.

Two other patterns were noteworthy. First, compared with percent presence values for the SONCC ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general, percent occupancy was relatively low in brood years 1990, 1993, 1996, and 1999, suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in brood years 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2%-15%) for the Brown and Moyle streams compared with the ESU as a whole, indicating that the Brown and Moyle streams do not constitute a random subset of CCC streams.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 73% in 1987-1989, to 63% in 1990-1992, to less than 50% in the last three brood cycles (Table C.2.3.3). Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 brood year. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late 1980s to the mid-1990s and remains below 50% for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos creeks, have lost one or more brood lineages (Smith 2001).

Results from our presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC the proportion of streams occupied is highest in Mendocino County, but that populations in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. NMFS analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any trends.

Adult time series

No time series of adult abundance free of hatchery influence and spanning 8 or more years are available for the CCC ESU. Adult counts from the Noyo Egg Collecting Station (ECS) dating back to 1962 represent a mixture of naturally produced and hatchery fish, and counts are incomplete most years since trap operation typically ceased after brood stock needs were met. Thus, at best they represent an index of abundance. Assuming that these counts reflect general population trends, there appears to have been a significant decline in abundance of coho salmon in the South Fork Noyo River beginning in 1977 (Figure C.2.3.2). No formal analysis of trends was conducted because of the uncertainty of the relationship between catch statistics and population size, as well as the relative contribution of hatchery fish to total numbers during the entire period of record.

Smolt time series

California Department of Fish and Game personnel have trapped outmigrating smolts at Caspar Creek and Little River since 1986. These counts are partial counts, uncorrected for capture efficiency. As such, they provide only indices of abundance. However, they likely capture gross changes in smolt abundance over the years (Figure C.2.3.3). The most recent 5-year means were 1,168 and 379 for Caspar Creek and Little River, respectively. For both locations, the estimated long-term trend is negative (but not significantly different from 0), while the short-term trend is positive (also not significantly different from 0) (Table C.2.3.4). For Little River, smolt counts were higher in each year from 1986 to 1989 than in any year since. For both sites, lambda values are greater than 1, though 95% confidence limits indicate the values are not significantly different from one.

Table C.2.3.3. Percent of surveyed streams within the CCC ESU for which coho salmon were detected for four time intervals: brood years 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists (based on combined NMFS and CDFG data).

		1987-1989			1990-1992			1993-1995			1996-1998			1999-2001		
County and River Basins	**Number of Streams with Historical Presence**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**
Mendocino																
Coastal (Punta Gorda to Abolabodiah Cr.)	24	4	75%	25%	6	50%	50%	16	50%	50%	11	18%	82%	19	32%	68%
Ten Mile River	25	6	50%	50%	15	53%	47%	17	65%	35%	14	57%	43%	16	94%	6%
Pudding Cr. to Noyo River	43	4	75%	25%	8	88%	13%	35	66%	34%	15	80%	20%	38	68%	32%
Coastal (Hare Cr. to Russian Gulch)	14	8	100%	0%	4	100%	0%	9	67%	33%	9	67%	33%	4	75%	25%
Big and Little Rivers	28	5	20%	80%	7	57%	43%	20	75%	25%	16	81%	19%	16	38%	63%
Albion River	16	3	100%	0%	3	100%	0%	15	80%	20%	1	100%	0%	14	86%	14%
Little Salmon & Big Salmon Cr.	6	0	0%	100%	3	100%	0%	4	75%	25%	4	75%	25%	4	100%	0%
Navarro River	30	1	100%	0%	1	0%	100%	24	58%	42%	6	67%	33%	23	52%	48%
Coastal (Greenwood Cr. to Brush Cr.)	8	3	0%	100%	2	50%	50%	8	13%	88%	0	0%	100%	8	0%	100%
Garcia River to Digger Cr.	8	3	100%	0%	2	0%	100%	8	13%	88%	5	20%	80%	7	0%	100%
Sonoma																
Gualala River	15	1	100%	0%	1	0%	100%	11	0%	100%	1	0%	100%	11	9%	91%
Fort Ross to Russian River	53	4	50%	50%	14	50%	50%	37	51%	49%	29	24%	76%	36	8%	92%
Marin																
Tomales Bay Rivers	25	3	100%	0%	4	100%	0%	14	36%	64%	10	90%	10%	21	57%	43%
Coastal (Redwood Cr. to Bolinas Lagoon)	6	0	0%	100%	1	100%	0%	2	50%	50%	4	75%	25%	5	100%	0%
San Francisco Bay																
SF Bay Rivers	6	0	0%	100%	4	0%	100%	6	0%	100%	4	0%	100%	0	0%	100%
San Mateo/Santa Cruz																
Coastal (SF Bay to Aptos Creek)	17	7	100%	0%	7	100%	0%	13	69%	31%	14	57%	43%	12	67%	33%
Monterey																
Coastal (Carmel R. to Big Sur R.)	2	0	0%	100%	0	0%	100%	2	0%	100%	0	0%	100%	2	0%	100%
ESU Total	**326**	**52**	**73%**	**27%**	**82**	**63%**	**37%**	**241**	**53%**	**47%**	**143**	**54%**	**46%**	**236**	**48%**	**52%**

[1] Total number of steams surveyed at least once within the three-year interval

[2] Percentage of surveyed streams where coho were present in one or more years during the interval

[3] Percentage of surveyed streams where coho were absent in all years of survey during the interval

Table C.2.3.4. Population trend analysis for Caspar Creek and Little River smolt outmigrant data. Trends are based on smolt counts uncorrected for trap efficiency (see text). Data source: Scott Harris, CDFG, unpublished data.

Stream	5-year mean	5-year min.	5-year max.	Lambda	Long-term trend [a]	Short-term trend [a]
Caspar Cr.	1,168	830	1,383	1.002 (0.851, 1.178)	-0.017 (-0.081, 0.048)	0.040 (-0.069, 0.149)
Little R.	379	82	1,203	0.919 (0.669, 1.347)	-0.063 (-0.358, 0.232)	0.273 (-0.256, 0.803)

[a]Values in parentheses are lower and upper bounds for 95% confidence limits.

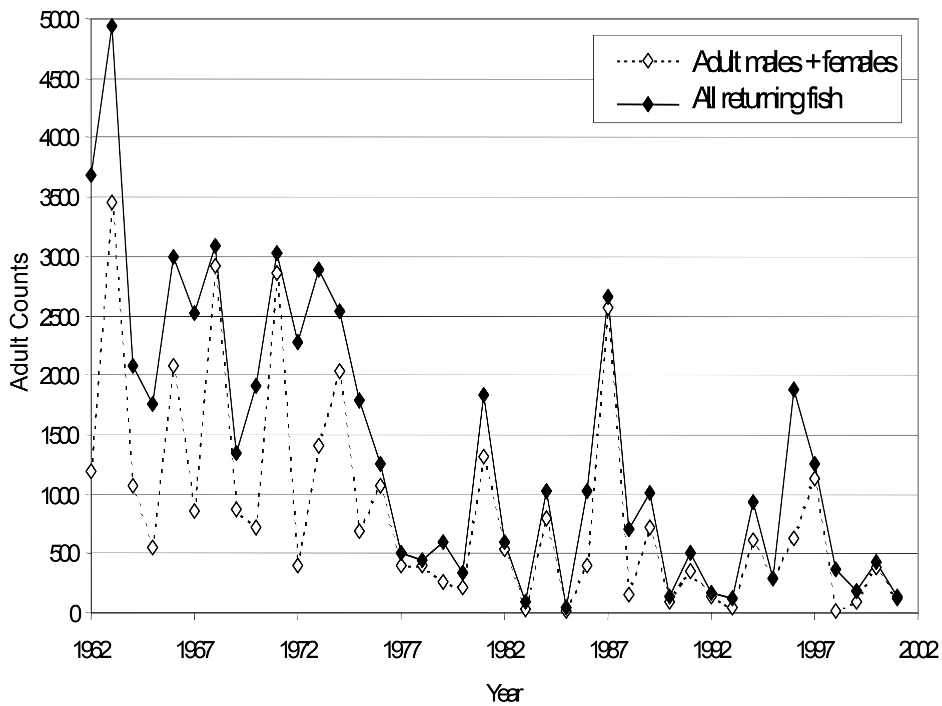

Figure C.2.3.2. Counts of adult coho salmon at Noyo Egg Collecting Station from 1962 to 2002. Solid line with closed symbol indicates total fish captured (including grilse); dashed line with open symbols indicates adult males and females only. Counts are partial counts and thus are only a crude index of adult abundance. Data source: Grass 2002.

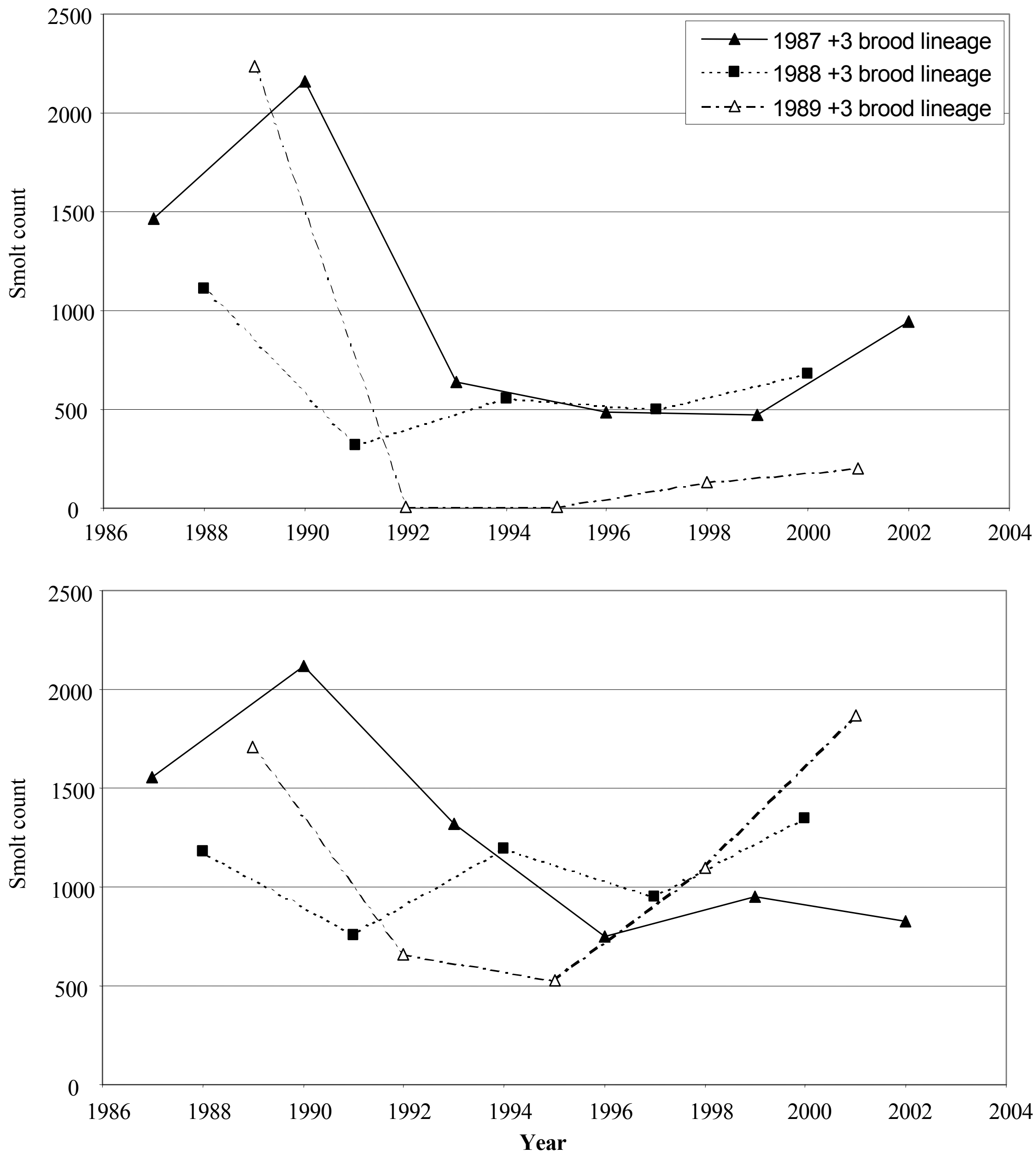

Figure C.2.3.3. Coho salmon smolt counts at a) Caspar Creek and b) Little River, Mendocino County. Lines track brood lineages. Data are counts of smolts uncorrected for trap efficiency and thus should be viewed as coarse indices of abundance.

Table C.2.3.5. Trend slopes and confidence intervals for nine putative coho populations in the CCC ESU.

Watershed	No. Sites	Aggregate **Slope**	95% confidence interval	
			Lower bound	**Upper bound**
Pudding Creek	1	-0.019	-0.103	0.065
Noyo River	8	-0.091	-0.195	0.013
Caspar Creek	2	-0.039	-0.109	0.030
Little River	2	-0.044	-0.118	0.029
Big River	2	0.146	-0.001	0.293
Big Salmon Creek	5	-0.005	-0.110	0.100
Lagunitas Creek	3	0.095	-0.123	0.312
Redwood Creek	1	0.091	-0.345	0.527
Waddell/Scott/Gazos creeks	3	-0.111	-0.239	0.018

Juvenile time series

Methods—While recent estimates of adult and smolt abundance are scarce for the CCC ESU, estimates (or indices) of juvenile density during summer have been made at more than 50 index sites within the CCC in the past 8 to 18 years. Methods for analyzing these data are described in detail in the SONCC coho salmon status review update. Briefly, data from individual sampling sites were ln-transformed and normalized to prevent spurious trends arising from different data collection methods or reporting units. Data were then grouped into units thought to represent plausible independent populations, based on watershed structure. Trends were then estimated for putative populations by estimating the slope (and associated 95% confidence intervals) for the aggregated data. Analysis was restricted to 1) sites where a minimum of 6 years of data were available, and 2) putative populations where more than 65% of all observations were non-zero values.

Nine geographic areas (putative populations) were represented in the aggregated data including Pudding Creek, Noyo River, Caspar Creek, Big River, Little River, Big Salmon Creek, Lagunitas Creek, Redwood Creek, and coastal streams south of San Francisco Bay, including Waddell, Scott, and Gazos creeks. Spatially, these sites cover much of the CCC ESU; however, several key watersheds are not represented, including the Ten Mile, Navarro, Garcia, Gualala, and Russian Rivers. Although considerable sampling has been done in the Ten Mile River basin, the high proportion of zero values precluded analysis of these data.

Results—Overall, analysis of juvenile data provided little evidence of either positive or negative trends for the putative populations examined. Estimated slopes were negative for six populations and positive for three; however, none of the estimated slopes differed significantly from zero (Table C.2.3.5).

C.2.3.3 New Comments

Homer T. McCrary, vice president of Big Creek Lumber, submitted 375 pages comprised primarily of excerpts from historical documents related to operation of hatcheries in Santa Cruz County from the early 1900s to 1990. The expressed intent of this compilation was "to assist the efforts of resource professionals, scientists, regulators, fisheries restoration advocates and all interested parties in establishing a more complete historical perspective on salmonid populations." Quantitative information regarding hatchery and stocking histories is discussed in the Harvest Impact section.

C.2.3.4 New Hatchery/ESU Information

The BRT (Weitkamp et al. 1995) identified four production facilities that had recently produced coho salmon for release in the CCC ESU: the Noyo Egg Collecting Station (reared at Mad River Hatchery) and Don Clausen (Warm Springs) hatchery, both operated by CDFG; Big Creek Hatchery (Kingisher Flat Hatchery), operated by the Monterey Bay Salmon and Trout Program; and the Silver-King ocean ranching operation. The latter facility closed in the late 1980s.

Noyo Egg Collecting Station—The Noyo Egg Collecting Station, located on the South Fork Noyo River approximately 17 km inland of Fort Bragg, began operating in 1961 and has collected coho salmon in all but a few years since that time. Fish have historically been reared at the Mad River Hatchery, Don Clausen (Warm Springs) Hatchery, and the Silverado Fish Transfer Station. There are no records of broodstock from other locations being propagated with Noyo fish for release back into the Noyo system, but a few out-of-ESU transfers directly into the Noyo system have been recorded, including Alsea and Klaskanine, OR stocks (SSHAG 2003).

Average annual release of coho salmon yearlings was 108,000 from 1987-1991 (Weitkamp et al. 1995), declined to about 52,000 between 1992 and 1996, and then increased again to about 72,000 fish between 1997 and 2002, inclusive of 2 years where no yearlings were released (Table C.2.3.6). Releases have been made exclusively to the ECS or elsewhere in the South Fork Noyo drainage in the past decade. Between 1991 and 2001, adult returns averaged 572 individuals, though these represent incomplete counts in most years, as counting typically ceased after broodstock needs were met (Grass 2002). On average, 91 females were spawned annually during this 11-year period (Grass 1992-2002).

There are no basin-wide estimates of natural and artificial production for the Noyo Basin as a whole; however, marking of coho salmon juveniles released from the Noyo ECS on the South Fork began in 1997, and returns have been monitored since the 1998-1999 spawning season. In the 1998, 1999, and 2000 brood years, marked hatchery fish constituted 85%, 70%, and 80%, respectively, of returning adults captured at the ECS.

The BRT (Schiewe 1996a) concluded that, although exotic stocks have occasionally been introduced into the Noyo system, the regular incorporation of local natural fish into the hatchery population made the likelihood that this population differs substantially from naturally spawning fish in the ESU is low and, therefore, included them in the ESU. Since CCC coho salmon were listed, no significant changes in hatchery practices have occurred. The Noyo ECS operation has been classified as a Category 1 hatchery (SSHAG 2003).

Don Clausen (Warm Springs) Hatchery—The Don Clausen Hatchery (a.k.a. Warm Springs stock), located on Dry Creek in the Russian River system 72 km upstream of the mouth, began operating in 1980. Initial broodstock used were from the Noyo River system, and Noyo fish were planted heavily from 1981 to 1996.

Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 57,000 in the years between 1992 and 1996, and Noyo River broodstock continued to constitute about 30% of the releases during the latter period. Production of coho salmon at the facility ceased entirely after 1996 (Table C.2.3.6). Adult returns averaged 245 fish between 1991 and 1996, but following the cessation of releases, no more than four coho salmon have been trapped at the hatchery in any subsequent year.

Because the Warm Spring population was originally derived from Noyo River stock and continued to receive transfers from the Noyo system throughout its operation, the BRT concluded that the hatchery population was not a part of the ESU.

Beginning in 2001, however, a captive broodstock program was initiated at the Don Clausen facility. A total of 337 juveniles were electro-fished from Green Valley and Mark West Springs creeks, two Russian River tributaries that still appear to support coho salmon, as well as Olema Creek, a tributary to Lagunitas Creek. Specific mating protocols for these fish have not yet been determined. The captive broodstock program proposes to eventually release 50,000 fingerlings and 50,000 yearlings into five Russian River tributaries. Under the captive broodstock program, the Don Clausen Hatchery has been classified as a Category 1 hatchery (SSHAG 2003).

Kingfisher Flat (Big Creek) Hatchery—The Monterey Bay Salmon and Trout Program (MBSTP) has operated Kingfisher Flat Hatchery, located on Big Creek, a tributary to Scott Creek, since 1976. The facility is near the site of the former Big Creek Hatchery, which was operated from 1927 to 1942, when a flood destroyed the facility. An additional facility in Santa Cruz County, the Brookdale Hatchery on the San Lorenzo River, operated from 1905 to 1953. Both the Big Creek and Brookdale hatcheries were supplied with eggs taken at an egg-collection facility located on Scott Creek; additional eggs were provided from other hatcheries around the state. Production of coho salmon at both hatcheries was sporadic. Releases of Sisson (Mt. Shasta) coho salmon were made in Scott Creek and other Santa Cruz County streams in 1913, 1915, and 1917. In subsequent years, releases from both facilities back into Scott Creek in included both Scott Creek fish (1929, 1930, 1934, and 1936-1939), as well as fish from Ft. Seward, Mendocino County (1932), and Prairie Creek, Humboldt County (1933, 1935, and 1939). Throughout these years, only fry were released (generally during July through September), and numbers of fish were relatively small. In the 10 years between 1929 and 1939, during which coho salmon were planted in Scott Creek, the total fry release averaged about 34,000 fish. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Table C.2.3.6. Average annual releases of coho salmon juveniles (fry and smolts) from hatcheries in the CCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002. Data sources: Weitkamp et al. 1995; Grass 1992-2002; Williams 1993; Cartwright 1994; Quinones 1995-1999; CDFG Hatchery Staff 2000; Wilson 2001-2002.

Hatchery	SSHAG Cat.	Annual Average Releases		
		1987-1991	1992-1996	1997-2002
Monterey Bay Salmon and Trout	1	25.764	na[a]	na[a]
Silver-King		95,074[b]	0[c]	0[c]
Noyo Egg Collecting Station	1	107,918	52,012[d]	72,363[e]
Don Clausen (Warm Springs) Hatchery	1	123,157	56,891[f]	0[g]
Total		351.913	108.903	72.363

[a] Data not available; however, operations have been sporadic over last 10 year due to low adult returns.
[b] Average from 4 years of data (1984-1988).
[c] Ceased operating in the 1980s.
[d] No yearling coho were released in 1995.
[e] No yearling coho were released in 2000 or 2001.
[f] Releases included both Warm Springs Hatchery and Noyo River ECS fish.
[g] Don Clausen Hatchery ceased releasing coho salmon in 1996.

Since 1976, when MBSTP began operating the Kingfisher Flat Hatchery, only local brood stock have been used at the hatchery. Mating protocols follow a priority scheme in which wild x wild broodstock are used in years of relatively high abundance, wild x hatchery crosses are done when wild fish are less available, and hatchery x hatchery crosses are made when wild fish are unavailable (D. Streig, MBSTP, pers. commun.). Under the current management plan, up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs observed must be allowed to spawn undisturbed in their natural habitat, and then only one in four females may be taken to spawn. In recent years, few or no fish have been taken, due to low abundance; however, in 2001, 123 coho were observed and 26 “wild” females were taken for spawning. Of the 123 coho observed, 40% were marked hatchery fish. There are no other data available to assess the relative contribution of hatchery versus naturally produced coho salmon.

In its 1996 coho status review update, the BRT concluded that the Kingfisher Flat (Scott Creek) hatchery population should be considered part of the ESU and was essential for ESU recovery (Schiewe 1996a). This was based on the fact that there was regular incorporation of local broodstock into the hatchery population in the years that coho were produced between 1905 and 1943, and there have been no out-of-basin or out-of-ESU transfers since the hatchery was restarted in 1976. The MBSTP operation has been classified as a Category 1 hatchery (SSHAG 2003). For other SSHAG categorizations of hatchery stocks, see Appendix C.5.1.

A captive broodstock program for Scott Creek will be initiated at the NMFS Santa Cruz Laboratory in 2003.

Summary

Artificial propagation of coho salmon within the CCC ESU has been reduced since this ESU was listed in 1996 (Table C.2.3.6). The Don Clausen Hatchery has ceased production of coho salmon, and releases from the Noyo ECS operation declined over the past 6 years, in part because coho were not produced during 2 of those 6 years. The Monterey Bay Salmon and Trout Program has produced few coho salmon for release in the last 6 years due to low adult returns to

Scott Creek. Genetic risks associated with out-of-basin transfers appear minimal. However, potential genetic modification in hatchery stocks resulting from domestication selection or low effective population size remains a concern.

Harvest impacts

Retention of coho salmon by commercial troll fishers south of Cape Falcon, Oregon, has been prohibited since 1993 (PFMC 2002). From Cape Falcon, OR, south to Horse Mountain, CA, retention of coho salmon in recreational ocean fisheries has been prohibited since 1994, and in 1995 this prohibition was extended to include all California ocean recreational fisheries (CDFG 2002b). The conservation objective set by the Pacific Fishery Management Council for the past five seasons has been an overall ocean exploitation of $\leq$13% for CCC coho salmon as indicated by Rogue/Klamath hatchery stocks (PFMC 2002b). Post-season estimates of Rogue/Klamath exploitation rate are unavailable; however, projected exploitation rates ranged from 3.0% to 11.7% during the period 1998 to 2002 (PFMC 1998-2002a). Inside harvest estimates of coho salmon are not available for rivers in the CCC ESU (PFMC 2002b).

C.2.3.5 Comparison with Previous Data

New data for the CCC coho salmon ESU includes expansion of presence-absence analyses, an analysis of juvenile abundance in 13 river basins, smolt counts from two streams in the central portion of the ESU, and one adult time series for a population with mixed wild and hatchery fish. The presence-absence analysis suggests possible continued decline of coho salmon between the late 1980s and the late 1990s, a pattern that is mirrored in the limited smolt and adult counts. Juvenile time series suggest no obvious recent change in status, but most observations underlying that analysis were made in the period from 1993 to 2002. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. A number of coho populations in the southern portion of the range appear either extinct or nearly so, including those in the Gualala, Garcia, and Russian Rivers, as well as smaller coastal streams in San Francisco Bay and South of San Francisco Bay. Although the 2001 brood year appears to relatively strong, data were not yet available from many of the most at-risk populations within the CCC.

No new information has been provided that suggests additional risks beyond those identified in previous status reviews. Termination of hatchery production at the Don Clausen (Warm Springs) Hatchery and reductions in production at the Noyo and Kingfisher Flat (Big Creek) facilities suggest a decrease in potential risks associated with hatcheries; however, the lack of substantive information regarding the relative contribution of hatchery and naturally produced fish at these facilities adds uncertainty as to the potential risks these operations may pose to the genetic integrity of the Noyo River and Scott Creek stocks. Restrictions on recreational and commercial harvest of coho salmon since 1994 have reduced exploitation rate on CCC coho salmon.

C.2.4 LOWER COLUMBIA RIVER COHO

C.2.4.1 Previous BRT Conclusions

- The BRT was very concerned that the vast majority (over 90%) of the historic populations in the LCR coho salmon ESU appear to be either extirpated or nearly so.
- The two populations with any significant production (Sandy and Clackamas) are at appreciable risk because of low abundance, declining trends and failure to respond after a dramatic reduction in harvest.
- The majority of the previous BRT votes were for "at risk of extinction" with a substantial minority in "likely to become endangered."

Current Listing Status—threatened

C.2.4.2 New Data and Analyses

New data include:

- Spawner abundance through 2001 (previous review had data through 1999)
- new estimates of the fraction of hatchery spawners

New analyses include:

- Tentative designation of relatively demographically independent populations (not reviewed by WLC-TRT)
- Recalculation of previous BRT metrics with additional years data
- Estimates of median annual growth rate (λ) under different assumptions about the reproductive success of hatchery fish
- Estimates of current and historically available kilometers of stream
- New PVA risk evaluation metric for estimating relative extinction risks of populations

Historical population structure—As part of its effort to develop viability criteria for LCR salmon and steelhead, the Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has identified historically demographically independent populations of chinook and steelhead (Myers et al. 2002). Population boundaries are based on an application of Viable Salmonid Populations definition (McElhany et al. 2000). Based on the framework for chinook and steelhead, we tentatively designated populations of LCR coho (Figure C.2.4.1). We hypothesized that the LCR coho ESU historically consisted of 23 populations. The populations shown in Figure C.2.4.1 are used as the units for the new analyses in this report.

For other species, the WLC-TRT partitioned LCR populations into a number of "strata" based on major life-history characteristics and ecological zones (McElhany et al. 2002). The WLC-TRT analysis suggests that a viable ESU would need a number of viable populations in each of these strata. Coho do not have the major life history variation seen in LCR steelhead or chinook and would be divided into strata based only on ecological zones. The strata and associated populations for coho are identified in Table C.2.4.1.

Table C.2.4.1. The ecological zones are based on ecological community and hydrodynamic patterns. The recent abundance is the geometric mean of natural origin spawners of the last 5 years of available data and the min-max are the lowest and highest 5-year geometric means in the time series. The data years are the data years used for the abundance min-max estimates, the extinction risk estimate and the trends (Table C.2.4.3). The fraction hatchery is the average percent of spawners of hatchery origin over the last 4 years. The harvest rate is the percent of adults harvested averaged over 1995-1997.

Ecological Zone	Population	Recent Abundance	Data Years	Hatchery Fraction (%)	Harvest Rate (%) (1995-1997)
Coastal	Youngs Bay				
	Grays River				
	Big Creek				
	Elochoman				
	Clatskanie				
	Mill, Germany,Abernathy				
	Scappoose				
Cascade	Cispus	Extirpated			
	Tilton	Extirpated			
	Upper Cowlitz	Extirpated			
	Lower Cowltiz				
	North Fork Toutle				
	South Fork Toutle				
	Coweeman				
	Kalama				
	North Fork Lewis				
	East Fork Lewis				
	Clackamas	1126 (725-2816)	1957-2001	6	28
	Salmon Creek				
	Sandy	332 (227-1553)	1977-2001	1	29
	Washougal				
Gorge	Lower Gorge Tributaries				
	Upper Gorge Tributaries				
	White Salmon	Extirpated			
	Hood River				
Summary	**Total**	**1,468**			
	Average			**4**	**29**

Table C.2.4.2. Trend and growth rate for subset of Lower Columbia chinook populations (95% C.I. are in parentheses). The long-term analysis used the entire data set (see Table C.2.4.2 for years). The criteria for the short-term data set are defined in the methods section. In "Hatchery = 0" columns, hatchery fish are assumed to have zero reproductive success. In the "Hatchery = Wild" columns, hatchery fish are assumed to have the same relative reproductive success as natural origin fish.

Population	Long-Term Analysis			Short-Term Analysis		
	Trend	Median Growth Rate (λ)		Trend	Median Growth Rate (λ)	
		Hatchery = 0	Hatchery =Wild		Hatchery = 0	Hatchery = Wild
Clackamas	1.010 (0.994-1.025)	1.024 (0.924-1.135)	1.024 (0.915-1.123)	0.941 (0.809-1.095)	0.964 (0.870-1.068)	0.963 (0.869-1.067)
Sandy	1.001 (0.940-1.065)	1.012 (0.877-1.168)	1.012 (0.867-1.152)	0.965 (0.820-1.136)	0.973 (0.843-1.124)	0.973 (0.843-1.123)

Abundance and trends

References for abundance time series and related data are in Appendix _. Recent abundance of natural origin spawners, recent fraction of hatchery origin spawners, and recent harvest rates for LCR steelhead populations are summarized in Table C.2.4.1. Natural origin fish had parents that spawned in the wild as opposed to hatchery origin fish whose parents were spawned in a hatchery. Some populations are above impassible barriers and are completely extirpated. Most of the other populations, except for the Clackamas and Sandy are believed to have very little, if any, natural production.

Clackamas—The Clackamas calculation had a recent mean abundance of 1,126 and a relatively low recent fraction of hatchery origin spawners at 6% (Table C.2.4.1). Time series for the Clackamas population are shown in Figures C.2.4.2-C.2.4.6. Figure C.2.4.2 shows the total adult count and natural origin adults passing the North Fork dam. The majority of natural coho spawning occurs above the North Fork dam. Since almost all LCR coho females and most males spawn at 3 years of age, a strong cohort structure is produced. Figure C.2.4.3 show the three adult cohorts on the Clackamas. The Clackamas basin has had a history of hatchery coho introductions from out-of-basin stocks. These out-of-basin stocks are believed to have an earlier run timing than the native Clackamas coho. One hypothesis holds that this run timing distinction persists and the Clackamas coho actually consist of two populations; an early and a late population (Figure C.2.4.4). However, records of run timing from the recent past suggest that the Clackamas coho may currently consist of a single population that has a very recent artificial bimodal distribution because of harvest patterns (see previous status review updates for more complete discussion and references). In previous analyses, both ODFW and the BRT have treated the Clackamas as a single population and in this status review update; we treat the Clackamas as a single population.

The long-term trends and growth rate (λ) estimates over the entire time series (1957-2001) have been slightly positive and the short-term trends and λ have been slightly negative (Table C.2.4.2). However, both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Table C.2.4.3).

Table C.2.4.3. Probability the trend or growth rate is less than one. In the "Hatchery = 0" columns, the hatchery fish are assumed to have zero reproductive success. In the "Hatchery = Wild" columns, hatchery fish are assumed to have the same relative reproductive success as natural origin fish.

	Long-Term Analysis			Short-Term Analysis		
		Lambda			Lambda	
Population	**Trend**	**Hatchery = 0**	**Hatchery = Wild**	**Trend**	**Hatchery = 0**	**Hatchery = Wild**
Clackamas	0.507	0.380	0.481	0.817	0.619	0.623
Sandy	0.680	0.457	0.520	0.722	0.582	0.582

Since the late 1980s, the number of preharvest recruits has declined relative to the number of spawners (Figure C.2.4.5). Despite upturns in the last 2 years, the population has had more years below replacement since 1990 than above. Thus, even with the dramatic reductions in harvest rate (Figure C.2.4.6), the population failed to respond because of this recruitment failure. Although the recent increases in recruitment are encouraging, the population has not regained earlier levels and is unknown if they will persist. The recent increases in recruitment are attributed to increased marine survival, which we cannot predict with any certainty.

Sandy—The Sandy population had a recent mean abundance of 342 spawners and a very low fraction of hatchery origin spawners (Table C.2.4.1). Trends in the Sandy are similar to the Clackamas, though the long-term time series is shorter (Figures C.2.4.7-C.2.4.8). The long-term trends and growth rate (λ) estimates over the entire time series (1977-2001) have been slightly positive and the short-term trends and λ have been slightly negative (Table C.2.4.2). However, both the long-term and short-term trends and λ have relatively high probabilities of being less than one (Table C.2.4.3).

The late 1980s recruitment failure observed in the Clackamas is also present in the Sandy population (Figure C.2.4.9). If anything, it may be more pronounced and the overall abundance is lower. Again, despite reductions in harvest (Figure C.2.4.10), the population has failed to recover to earlier recruitment levels, despite the encouraging last 2 years.

Other Oregon populations

The lower Columbia coho ESU is dominated by hatchery production. There is very little (and in some years practically no) natural production in Oregon outside the Clackamas and Sandy. ODFW has conducted coho spawner surveys in lower Colombia tributaries since the late 1940s. We have combined these surveys to obtain spawners-per-mile information at the scale of our population units (Figures C.2.4.11- C.2.4.14). In many years over the last 2 decades, these surveys have observed no natural origin coho spawners.

Table C.2.4.4. Total coho hatchery releases into the Columbia basin (Data from DART website http://www.cqs.washington.edu/dart/hatch.html made available by the Fish Passage Center).

Year	Hatchery Releases
2000	29,902,509
2001	25,730,650
2002	9,558,355

Washington populations

The Washington side of this ESU is also dominated by hatchery production and there are no populations with appreciable natural production. A study by NRC (1996) indicated that 97% of 425 fish surveyed on the spawning grounds were first-generation hatchery fish. Based on smolt trap data, some natural production of coho does occur in the Cedar River, a tributary of the East Fork Lewis (D. Rawding, pers comm.). However, there is no indication that this sub-population is self-sustaining.

C.2.4.3 New Hatchery/ESU Information

Hatchery production

The Lower Columbia coho ESU is dominated by hatchery production. Recent coho releases in the Columbia basin (including releases upstream of the ESU boundary) are shown in Table C.2.4.4. The total expected return of hatchery coho salmon to the Columbia basin in 2002 was over a million adults (ODFW News Release, 13 September, 2002; we have not yet obtained the final 2002 return data.).

Loss of habitat from barriers

An analysis was conducted by Steel and Sheer (2002) to assess the number of stream km historically and currently available to salmon populations in the LCR (Table C.2.4.5). Stream km usable by salmon are determined based on simple gradient cut offs and on the presence of impassable barriers. This approach will over estimate the number of usable stream km, as it does not take into consideration habitat quality (other than gradient). However, the analysis does indicate that for some populations the number of stream habitat km currently accessible is greatly reduced from the historical condition.

ESU summary

Based on the updated information provided in this report, the information contained in previous LCR status reviews, and preliminary analyses by the WLC-TRT, we have tentatively identified the number of historical and currently viable populations (Table C.2.4.5). Only two populations have appreciable levels of natural production (Clackamas and Sandy). Thus, 21 of the 23 historical populations (91%) are currently extirpated, or nearly so. Of the two populations with natural production, both have experienced recruitment failure over the last decade. Recent abundances of the two populations are relatively low (especially the Sandy), placing them in a range where environmental, demographic and genetic stochastity can be significant risk factors.

Table C.2.4.5. Loss of habitat from barriers. The potential current habitat is the kilometers of stream below all currently impassible barriers between a gradient of 0.5% and 4%. The potential historical habitat is the kilometers of stream below historically impassible barriers between a gradient of 0.5% and 4%. The current-to-historical habitat ratio is the percent of the historical habitat that is currently available. This table does not consider habitat quality.

Population	Potential Current Habitat(%)	Potential Historical Habitat (km)	Current to Historical Habitat Ratio
Youngs Bay	178	195	91
Grays River	133	133	100
Big Creek	92	129	71
Elochoman	85	116	74
Clatskanie	159	159	100
Mill, Germany,Abernathy	117	123	96
Scappoose	122	157	78
Cispus	0	76	0
Tilton	0	93	0
Upper Cowlitz	4	276	1
Lower Cowltiz	418	919	45
North Fork Toutle	209	330	63
South Fork Toutle	82	92	89
Coweeman	61	71	86
Kalama	78	83	94
North Fork Lewis	115	525	22
East Fork Lewis	239	315	76
Clackamas	568	613	93
Salmon Creek	222	252	88
Sandy	227	286	79
Washougal	84	164	51
Lower Gorge Tributaries	34	35	99
Upper Gorge Tributaries	23	27	84
White Salmon	0	71	0
Hood River	35	35	100
Total	3,286	5,272	62

Table C.2.4.6. Number of populations in the ESU. Populations with "some current natural production" may have some natural origin recruits present but are not necessarily considered self-sustaining ("viable").

	Total
Historical	23
Some current natural production	3-20
Currently "viable"	0-2

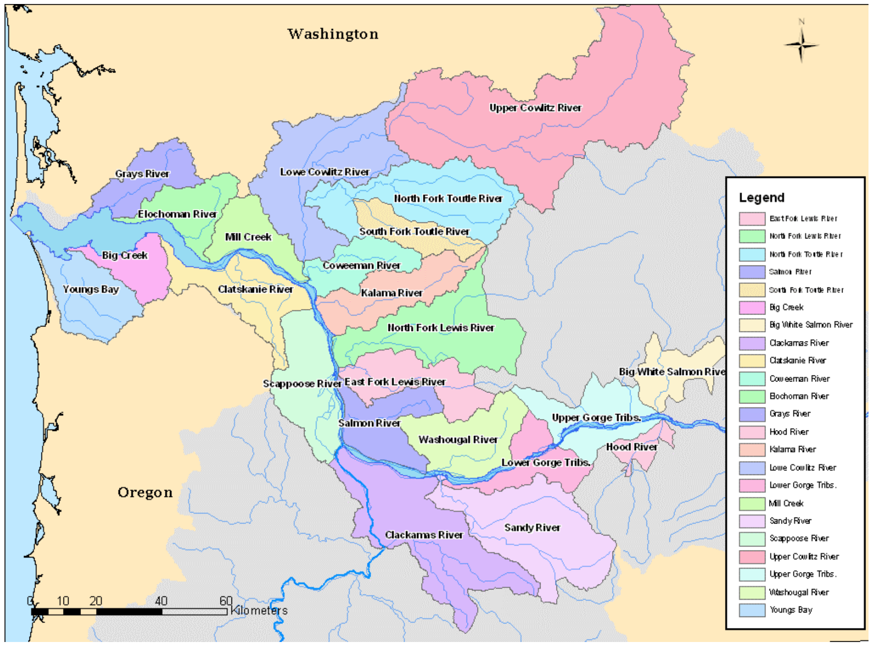

Figure C.2.4.1. Tentative populations of LCR coho. Based on work by WLC-TRT for chinook and steelhead (Myers et al. 2002).

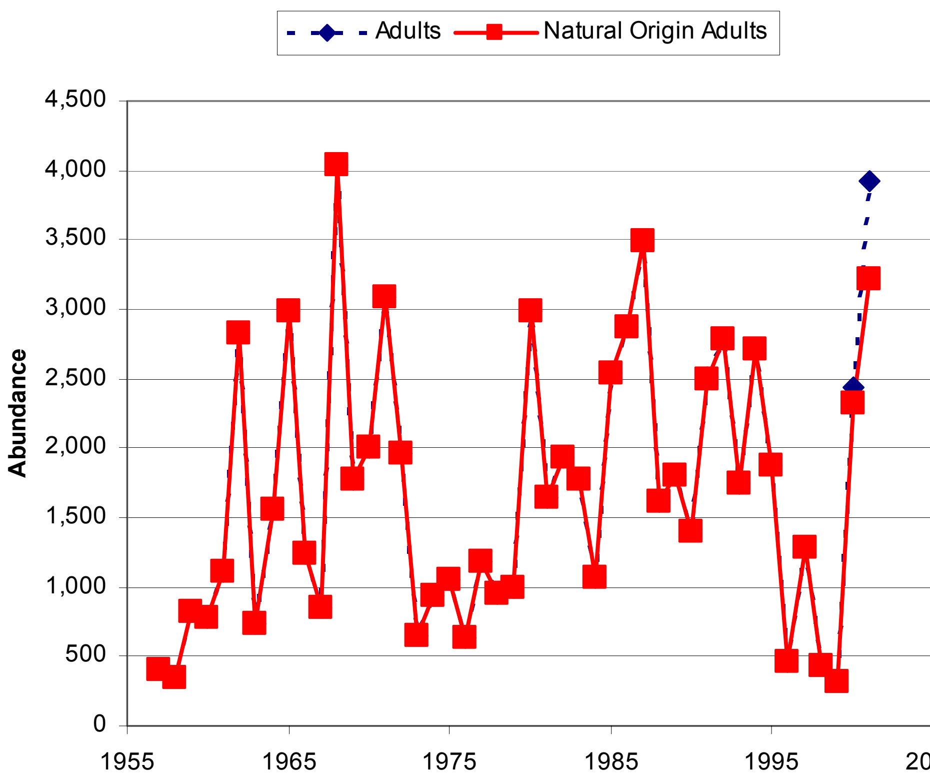

Figure C.2.4.2. Clackamas North Fork Dam counts of coho salmon.

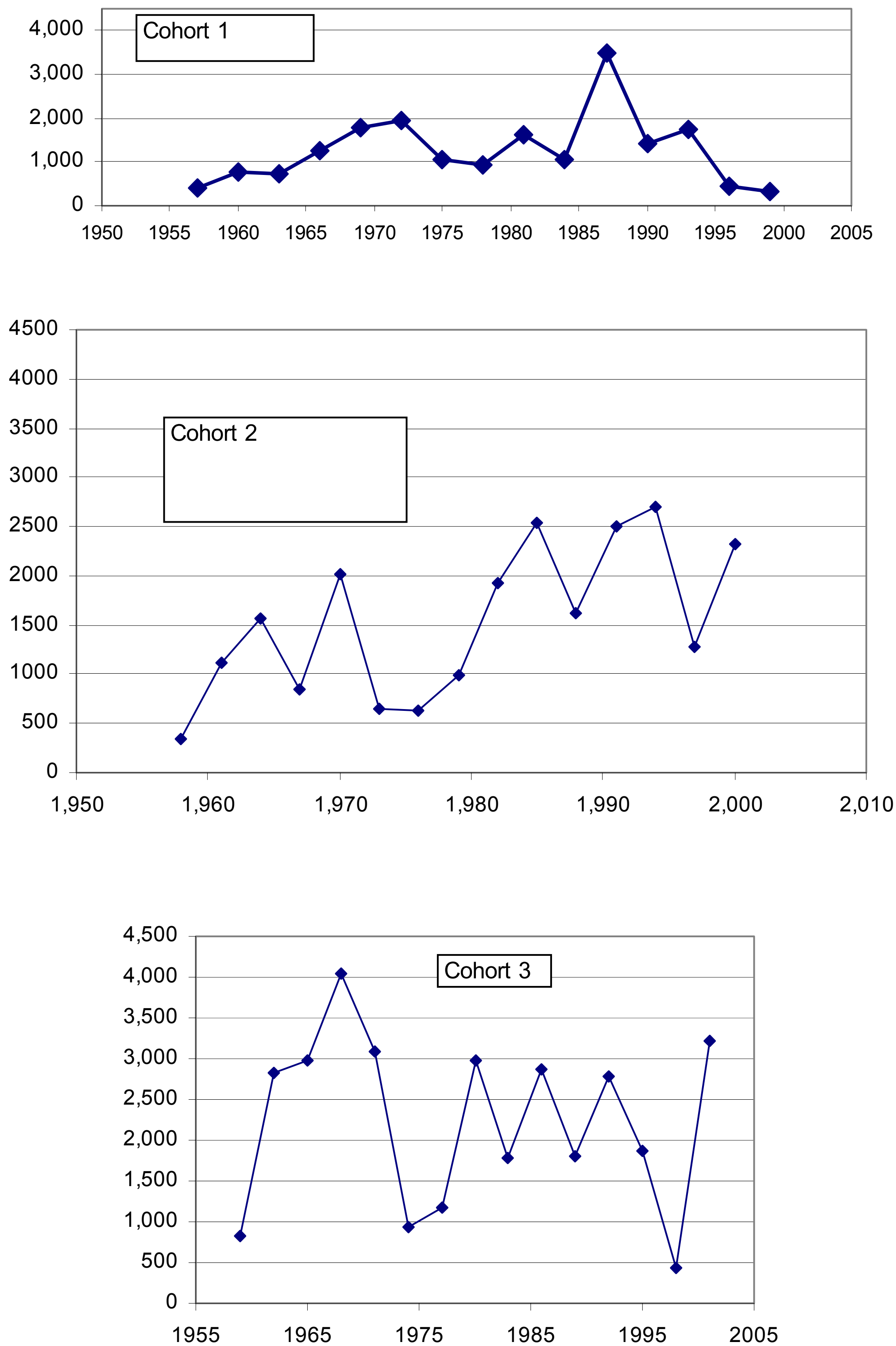

Figure C.2.4.3. Adult Clackamas River coho (North Fork dam count) by cohort.

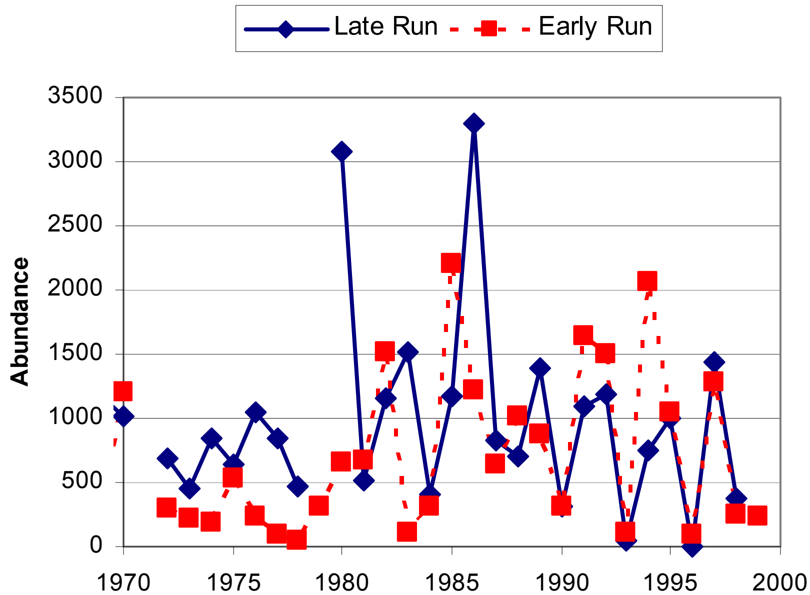

Figure C.2.4.4. Clackamas River early-run and late-run coho. Coho that arrive before November 1st are considered early run and those that arrive after November 1st are considered late run.

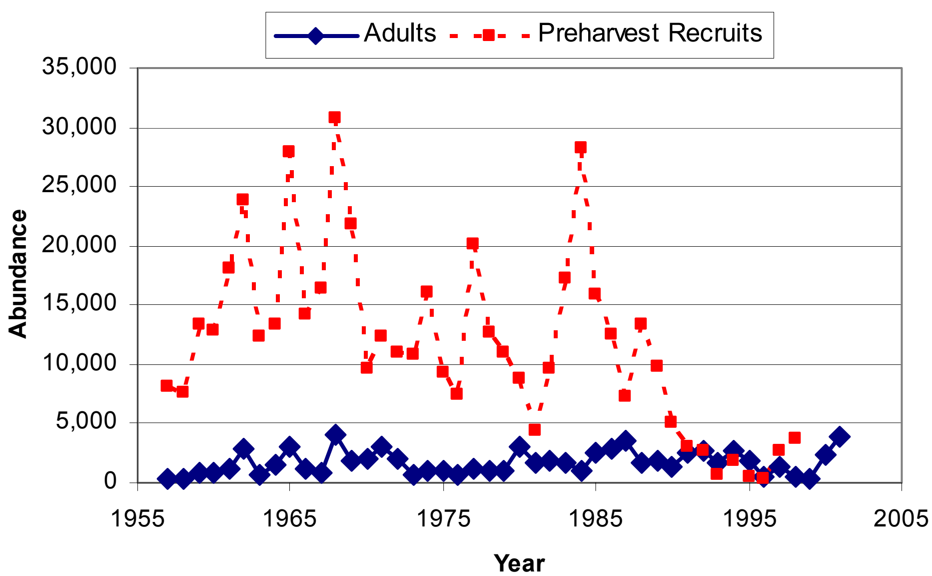

Figure C.2.4.5. Estimate of preharvest coho recruits and spawners in the Clackamas River. Based on adult counts at North Fork dam.

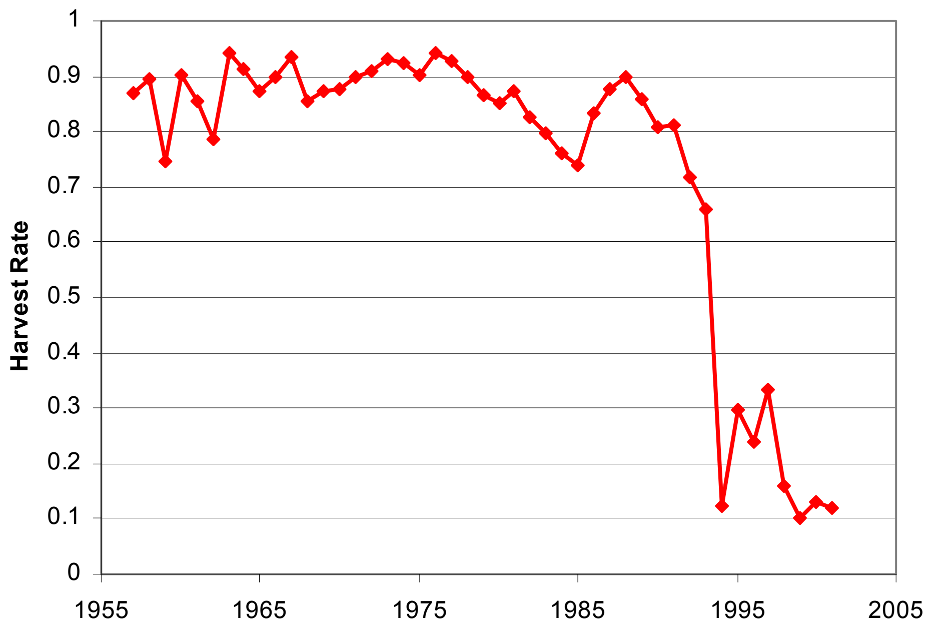

Figure C.2.4.6. Clackamas River natural origin coho harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by a switch to retention-only marked hatchery fish and timing the fishery to protect natural runs.

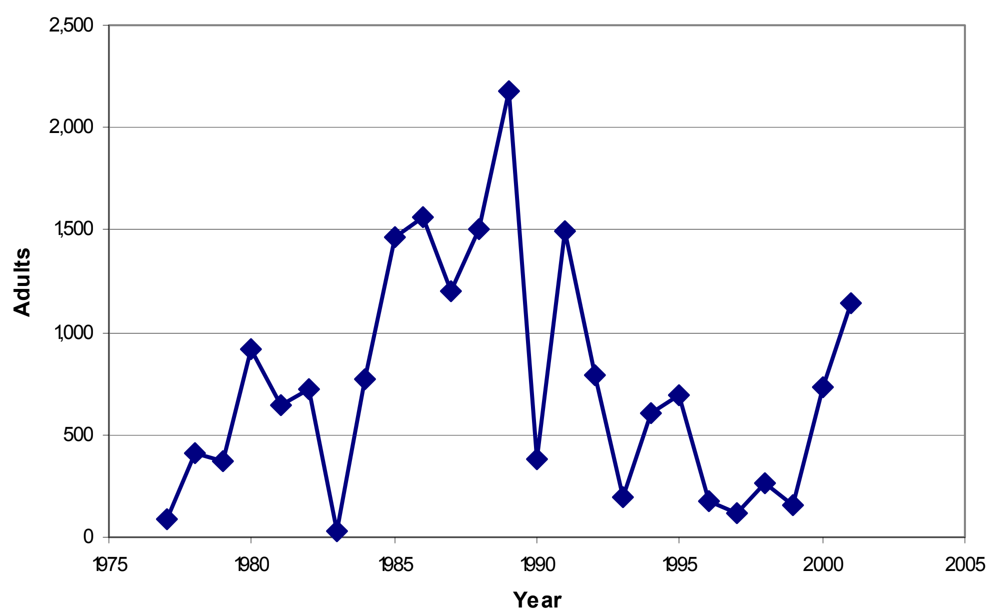

Figure C.2.4.7. Count of adult (≥3 years old) coho at the Marmot dam on the Sandy River.

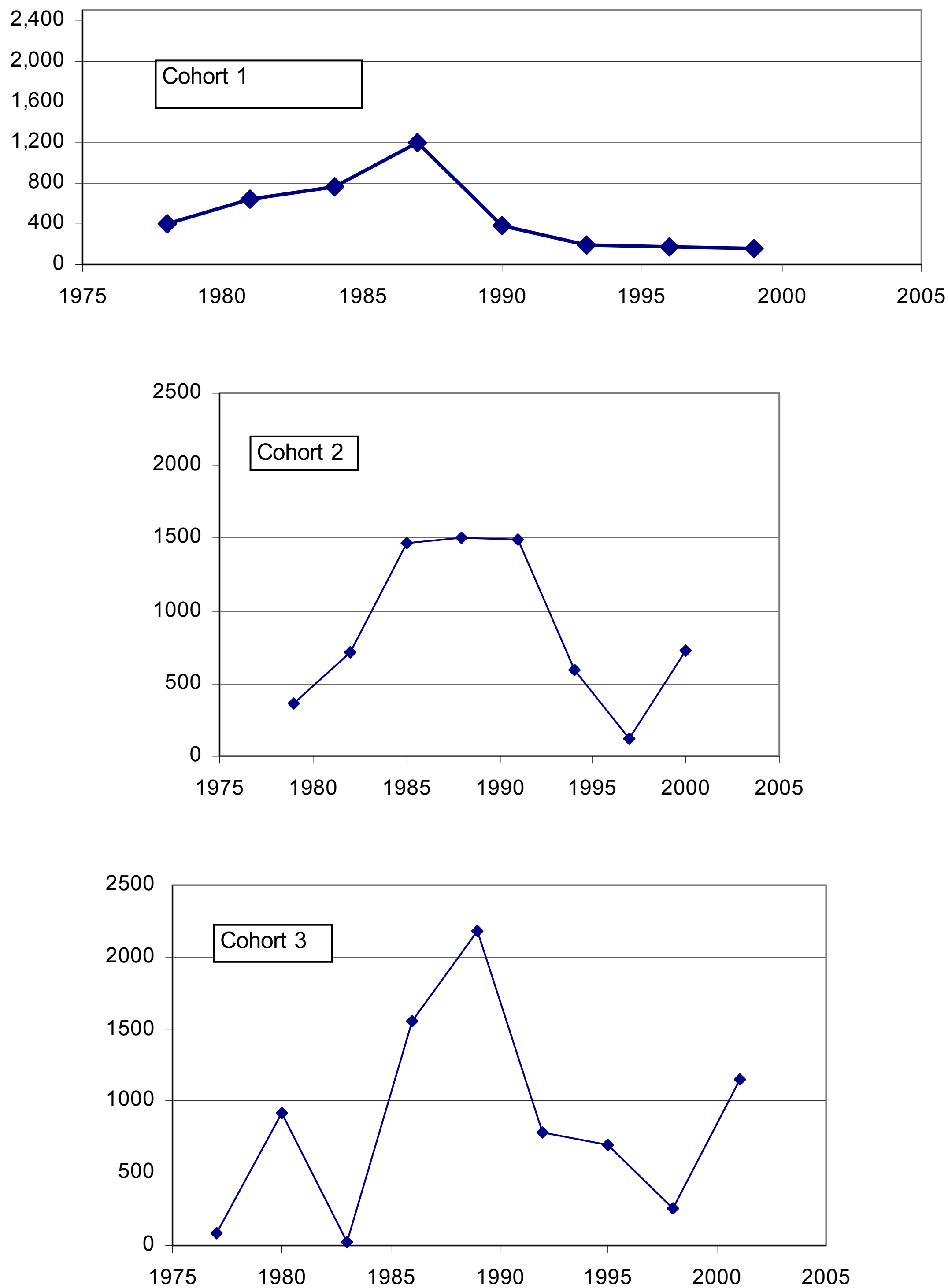

Figure C.2.4.8. Adult Sandy River coho (Marmot dam count) by cohort.

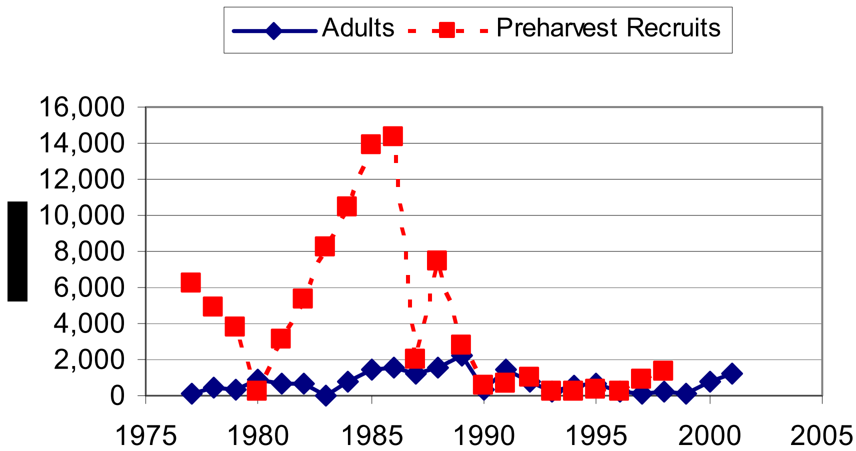

Figure C.2.4.9. Estimate of preharvert coho recruits and spawners in the Sandy River. Based on adult counts at Marmot dam.

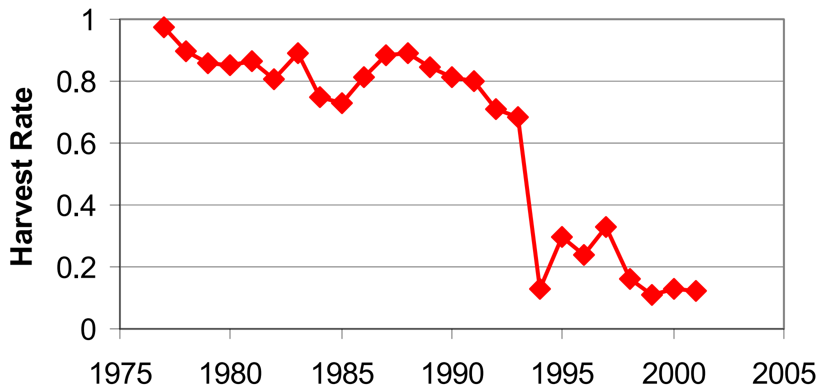

Figure C.2.4.10. Sandy River natural origin coho harvest rate (M. Chilcote, pers. comm.). The reduction in harvest rate was achieved by switch to retention only marked hatchery fish and timing the fishery to protect natural runs.

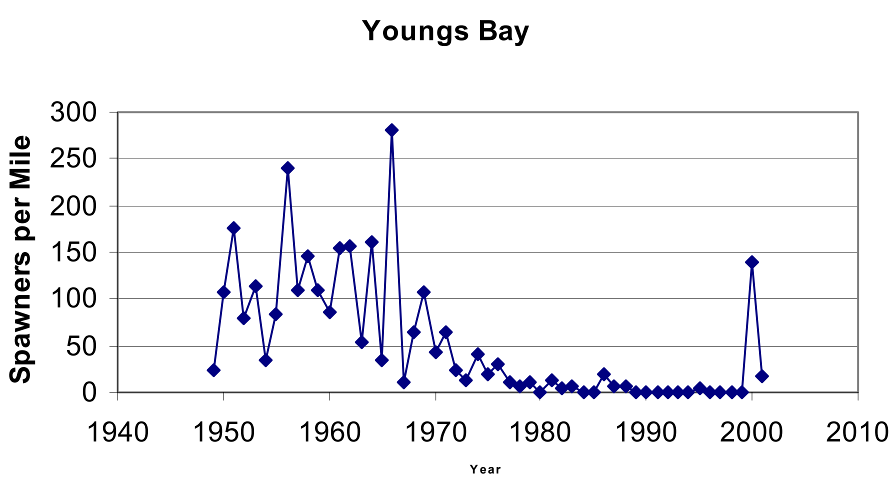

Figure C.2.4.11. Youngs Bay coho spawners per mile.

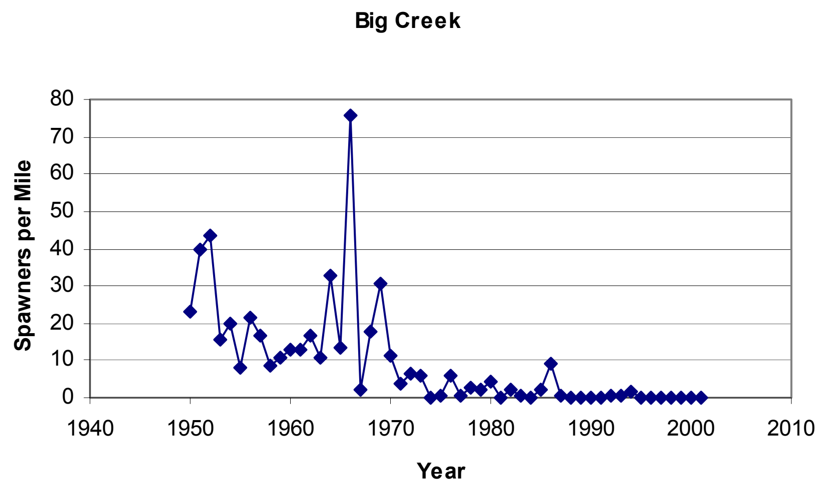

Figure C.2.4.12. Big Creek Spawners per mile.

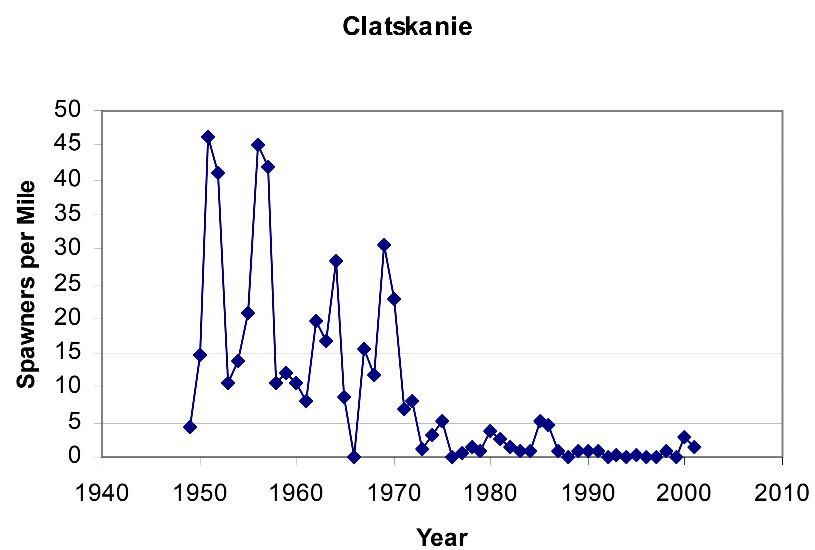

Figure C.2.4.13. Clatskanie Spawners per mile.

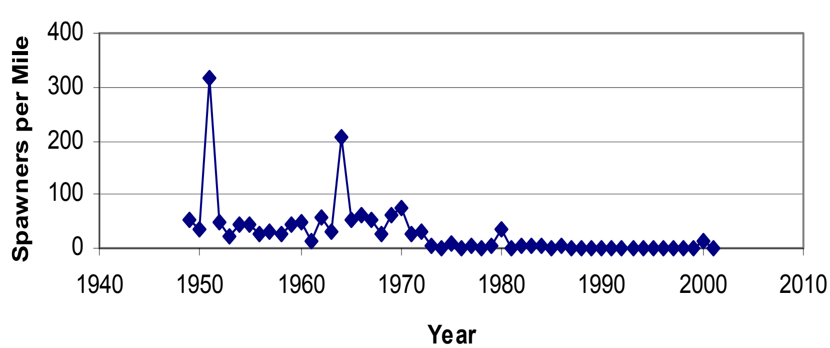

Figure C.2.4.14. Scappoose Spawners per mile.

C.3 PRELIMINARY COHO BRT CONCLUSIONS

Oregon Coast coho

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 exceeded the number observed for any year in the past several decades, and preliminary indications are that 2002 numbers may be higher still, at least in some areas. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by 3 years of low spawner escapements—the result of 3 consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These 3 years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for Oregon coast coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are mixed or slightly positive, the long-term trends in productivity in this ESU are still negative.

The BRT votes (the majority of which were cast in the “likely to become endangered” category) reflected ongoing concerns for the long-term health of this ESU. Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance. As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU (mean score 3.8; Table C.3.1). With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions.

A minority of the BRT felt that the large number of spawners in the last few years (together with preliminary projections of another “good” year in 2003) demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

Southern Oregon/Northern California Coasts coho

A majority of BRT votes fell into the "likely to become endangered" category, with minority votes falling in the "endangered," and "not warranted" categories. The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure (mean score = 3.1) and diversity (mean score = 2.8) were considered moderate by the BRT (Table C.3.1).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue; however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho streams (between 32% and 56% from brood year 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 brood year, likely due to favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain; however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems a well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in brood year 2001 suggests that much habitat remains accessible to coho salmon. The BRT's concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

Central California Coast coho

A majority of the BRT votes fell into the "endangered" category, with the remainder falling into the "likely to become endangered" category. The BRT found CCC coho salmon to be at very high risk in three of four risk categories, with mean scores of 4.8, 4.5, and 4.7 for abundance, growth rate/productivity, and spatial structure, respectively (Table C.3.1). Scores for diversity (mean 3.6) indicated BRT members considered CCC coho salmon to be at moderate or increasing risk with respect to this risk category. Principal concerns of the BRT continue to be low abundance and long-term downward trends in abundance of coho salmon throughout the ESU, as well as extirpation or near extirpation of populations across most of the southern two-thirds of the historical range of the ESU, including several major river basins. Potential loss of genetic diversity associated with range reductions or loss of one or more brood lineages, coupled with historical influence of hatchery fish, were primary risks to diversity identified by the BRT. Improved oceanic conditions coupled with favorable stream flows apparently contributed to a strong year class in broodyear 2001, as evidenced by an increase in detected occupancy of historical streams. However, data were lacking for many river basins in the southern two-thirds of the ESU where populations are considered at greatest risk. Although viewed as a positive sign, the strong year follows more than a decade of relatively poor returns. The lack of current estimates of naturally produced spawners for any populations within the ESU—and hence the need to use primarily presence-absence information to assess risk—continues to concern the BRT.

Lower Columbia River coho

The status of this ESU was reviewed by the BRT only a year ago, so relatively little new information was available. A majority of the likelihood votes for Lower Columbia River coho fell in the “danger of extinction” category, with the remainder falling in the “likely to become endangered” category. As indicated by the risk matrix totals (Table C.3.1), the BRT had major concerns for this ESU in all risk categories (mean scores ranged from 4.3 for growth rate/productivity to 4.8 for spatial structure/connectivity). The most serious overall concern was the nearly total absence of naturally produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short- and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas.

The paucity of naturally produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

Table C.3.1. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section “Factors Considered in Status Assessments” for a description of the risk categories) for the four coho ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/ Productivity	Spatial Structure and Connectivity	Diversity
Oregon Coast	2.5 (2-5)	3.8 (3-5)	2.5 (2-4)	25 (2-4)
S. Oregon / N. California Coast	3.8 (2-5)	3.5 (2-5)	3.1 (2-4)	2.8 (2-4)
Central California	4.8 (4-5)	4.5 (4-5)	4.7 (4-5)	3.6 (2-5)
Lower Columbia	4.8 (4-5)	4.3 (4-5)	4.8 (4-5)	4.5 (4-5)

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C.5 APPENDICES

Appendix C.5.1. Preliminary SSHAG (2003) categorizations of hatchery populations of the four coho ESUs reviewed. See "Artificial Propagation" in General Introduction for explanation of the categories.

	Stock	Run	Basin	SSHAG Category
Oregon Coast	NF Nehalem	(# 32)	Nehalem	3
	Fishhawk Lake	(# 99)	Nehalem	3
	Trask River	(# 34)	Trask	3
	Siletz	(# 33)	Siletz	3
	Umpqua	(# 55)	Umpqua	3
	Cow Creek	(# 18)	Umpqua	3
	Woahink		Stilcoos	1
	Coos	(# 37)	Coos	1
	Coquille	(# 44)	Coquille	1
S. Oregon/N. California	Rogue River	(# 52)	Rogue River	1
	Iron Gate		Klamath	2
	Trinity River		Trinity	2
	Mad River		Mad River	4
Central California	Noyo River		Noyo River	1
	Don Clausen		Russian	1
	Monterey Bay		Scott Creek	1
Lower Columbia River	Big Creek		Big Creek	2 or 3
	Klaskanine		Klaskanine	4
	Tanner Creek		Lower Gorge	3
	Sandy River	late	Sandy	2 or 3
	Eagle Creek		Clackamas	3
	Little White Salmon		Upper Gorge	3
	Toutle	Type S	Cowlitz	2
	Type S Complex	Type S	various	3
	Cowlitz	Type N	Cowlitz	2
	Type N Complex	Type N	various	3

Appendix C.5.2. Lower Columbia Coho Time Series References

Population	Clatskanie River Coho
Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish/Mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, Eric. 2002.
Abundance Notes	data from Streamnet
Population	Scappoose Coho
Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish/Mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, Eric. 2002
Abundance Notes	data from Streamnet
Population	Big Creek Coho
Years of Data, Length of Series	1950 - 2001, 52 years
Abundance Type	Fish/Mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, Eric. 2002.
Abundance Notes	data from Streamnet
Population	Clackamas River Coho
Years of Data, Length of Series	1950 - 2001, 52 years
Abundance Type	Fish/Mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, Eric. 2002
Abundance Notes	data from Streamnet
Population	Youngs Bay Coho
Years of Data, Length of Series	1949 - 2001, 53 years
Abundance Type	Fish/Mile
Abundance References	Fulop, J.; Whisler, J.; Morgan, B.. 1998; Morgan, B., Whisler, J. and Fulop, J.. 1998; White, E., Morgan, B. and Fulop, J.. 1999; Ollerenshaw, Eric. 2002
Abundance Notes	data from Streamnet

Population	Sandy River Coho (Marmot Dam)
Years of Data, Length of Series	1977 - 2001, 25 years
Abundance Type	Dam count
Abundance References	Cramer 2002
Population	Clackamas River Coho (North Fork Dam)
Years of Data, Length of Series	1957 - 2001, 45 years
Abundance Type	Dam count
Abundance References	Cramer 2002