Status Review Update for Deferred ESUs[a] of
West Coast Chinook Salmon
(Oncorhynchus tshawytscha)
from Washington, Oregon, California, and Idaho

[a](Central Valley Spring Run, Central Valley Fall- and Late-Fall Run, Southern Oregon and Northern California Coastal, California Coastal, Deschutes River Summer/Fall Run, and Snake River Fall-Run ESUs)

16 July 1999

Prepared by the
West Coast Chinook Salmon Biological Review Team[1]

---

[1]The Biological Review Team (BRT) for chinook salmon included, from NMFS Northwest Fisheries Science Center: Peggy Busby, Dr. Stewart Grant, Dr. Robert Iwamoto, Dr. Robert Kope, Dr. Conrad Mahnken, Gene Matthews, Dr. James Myers, Dr. Mary Ruckleshaus, Dr. Michael Schiewe, David Teel, Dr. Thomas Wainwright, F. William Waknitz, Dr. Robin Waples, and Dr. John Williams; NMFS Southwest Region: Gregory Bryant and Craig Wingert; NMFS Southwest Fisheries Science Center: Dr. Steve Lindley, and Dr. Peter Adams; NMFS Alaska Fisheries Science Center (Auke Bay Laboratory): Alex Wertheimer; and from the USGS National Biological Service: Dr. Reginald Reisenbichler.

SUMMARY

The Biological Review Team (BRT) for the updated west coast chinook salmon status review met in Seattle, 22-24 June 1999 to discuss new information recieved regarding the status of four evolutionarily significant units (ESUs) under the Endangered Species Act (ESA) and re-evaluate the ESU designations and risk determinations.

All four of the ESUs considered were proposed for listings under the ESA by NMFS (1998a) in early 1998. Two of the ESUs were proposed for threatened listings (Central Valley Fall- and Late-Fall Run and Southern Oregon and California Coastal Chinook Salmon ESUs), one was the modification of an ESU already listed as threatened (Snake River Fall-Run Chinook Salmon ESU), and one was proposed as endangered (Central Valley Spring-Run Chinook Salmon ESU). The final conclusions of the BRT are summarized below.

ESU Configurations

Central Valley Spring-Run Chinook Salmon ESU

This ESU occupies the Sacramento River Basin, and includes chinook salmon entering the Sacramento River from March to July and spawning from late August through early October, with a peak in September.

The BRT reiterated its previous decisions that the spring run populations in the Central Valley constituted a distinct ESU, and that the extirpated spring-run populations in the southern portion of this ESU may have constituted their own ESU (based on ecological and biogeographical data).

Central Valley Fall- and Late-Fall-Run Chinook Salmon ESU

This ESU occupies the Sacramento and San Joaquin River Basins and includes fall and late-fall run chinook salmon. The BRT also reaffirmed its previous conclusion that Central Valley fall- and late-fall runs are different life history forms, but belong in the same ESU. Additionally, the BRT concluded that further information was required to establish whether chinook salmon spawning in tribuatries to San Francisco Bay were part of the Central Valley Fall- and Late-Fall-Run or the California Coastal Chinook Salmon ESU.

"Proposed" Southern Oregon and California Coastal Chinook Salmon ESU:
Southern Oregon and Northern California Coastal Chinook Salmon ESU
California Coastal Chinook Salmon ESU.

The majority of the BRT concluded that the proposed Southern Oregon and California Coastal Chinook Salmon ESU be split into two ESUs; Southern Oregon and Northern California Coastal Chinook Salmon ESU, extending from Euchre Creek through the Lower Klamath River (inclusive), and California Coastal Chinook Salmon ESU, extending from Redwood Creek south through the Russian River (inclusive). This new ESU boundary is similar to that designated between Klamath Mountain Province and Northern California Steelhead ESUs. The BRT concluded that the Russian River Basin presently contained the most southern persistent population of chinook salmon on the California coast.

"Proposed" Snake River Fall-Run Chinook Salmon ESU:
Deschutes River Summer/Fall-Run Chinook Salmon ESU
Snake River Fall-Run Chinook Salmon ESU

The majority of the BRT felt that the proposed ESU configuration, combining ocean-type fish in the Snake and Deschutes River Basins into one ESU, was not supported by the information available. A slight majority concluded that the Deschutes River summer/fall-run should be considered its own ESU, rather than be grouped with either the Snake River Fall-Run or Upper Columbia River Summer- and Fall-Run Chinook Salmon ESUs. There was considerable uncertainty on the historical configuration of this new ESU, specifically whether it included fall-run populations in the John Day, Umatilla, and Walla Walla Rivers.

ESU Risk Determination

Central Valley Spring-Run Chinook Salmon ESU

A majority of the BRT concluded that the Central Valley Spring-Run Chinook Salmon ESU is likely to become endangered in the foreseeable future, and a minority felt that it is presently in danger of extinction. There was moderately high certainty in this risk evaluation. The FEMAT voting method (FEMAT 1993) produced similar results–the majority of the likelihood points were assigned to the "likely to become endangered" risk category.

Central Valley Fall- and Late-Fall-Run Chinook Salmon ESU

A majority of the BRT concluded that the Central Valley Fall- and Late-Fall-Run Chinook Salmon ESU is not presently in danger of extinction, nor is it likely to become so in the foreseeable future. A minority felt that this ESU is likely to become endangered in the foreseeable future. There was moderate uncertainty associated with this risk evaluation The risk assessment using the FEMAT voting method produced similar results–a majority of the likelihood points were distributed in the "not likely to become endangered" risk category.

Southern Oregon and Northern California Coastal Chinook Salmon ESU

The BRT was unanimous in concluding that the chinook salmon in the Southern Oregon-Northern California Coastal Chinook Salmon ESU are not presently in danger of extinction, nor are they likely to become so in the foreseeable future. The certainty in the risk evaluation was moderately high. The risk scores using the FEMAT method indicated similar levels of risk to the ESU–a majority of the likelihood points were assigned to the "not likely to become endangered" risk category.

California Coastal Chinook Salmon ESU

A majority of the BRT concluded that the chinook salmon in the California coastal ESU are likely to become endangered in the foreseeable future, and a minority felt that they are presently in danger of extinction. The certainty in this risk evaluation was moderate. The risk assessment conducted using the FEMAT voting method produced similar results–a majority of the likelihood points were assigned to the "likely to become endangered" risk category, and a sizeable minority were distributed in the "presently in danger of extinction" category.

Deschutes River Summer/Fall-Run Chinook Salmon ESU

Evaluation of the status of the ESU that includes the Deschutes River was difficult because the historic and current extent of the ESU is not well characterized. For this reason, the BRT did not attempt a formal extinction risk analysis for this ESU. However, the BRT did discuss abundance, trend, and other information for the Deschutes River population(s). A majority of the BRT concluded that ocean-type chinook salmon in the Deschutes River are not presently in danger of extinction, nor are they likely to become so in the foreseeable future. A large minority concluded that this population is likely to become endangered. The BRT was highly uncertain in its risk determinations-most of the certainty scores were 2 or 3, and the highest score was a 4.

Snake River Fall-Run Chinook Salmon ESU

The BRT conclusions did not substantially change the Snake River Fall-Run Chinook Salmon ESU, and the status of this ESU was not revisited.

INTRODUCTION

On 9 March 1998, the National Marine Fisheries Service (NMFS) published a federal register notice describing 11 new evolutionary significant units (ESUs) and 1 modification of an existing ESU for chinook salmon from the states of Washington, Oregon, California, and Idaho (NMFS 1998a). The notice included a proposed rule to list as threatened or endangered seven chinook salmon ESUs under the U.S. Endangered Species Act (ESA). This proposal was largely based upon the status review conducted by the west coast chinook salmon biological review team (BRT) convened by NMFS (Myers et al. 1998).

On 24 March 1999, NMFS announced its intention to delay by 6 months the final rule for the Central Valley Spring Run, Central Valley Fall/Late-Fall Run, and Southern Oregon and California Coastal Chinook Salmon ESUs, and the modification of the Snake River Fall Run Chinook Salmon ESU because of substantial scientific disagreements (Schiewe 1999). In May and June 1999, the NMFS held several co-manager meetings with federal, state, and tribal agencies to discuss and present new technical information and recent analysis of chinook salmon data since the proposed rule. The BRT met in June 1999 to discuss comments and new data received in response to the proposed rule and extension to determine if the new information warranted any modification of the conclusions of the original BRT. This report summarizes the final BRT conclusion on the follow ESUs: Central Valley Spring Run, Central Valley Fall and Late-Fall Run, Southern Oregon and California Coastal, and Snake River Fall Run Chinook Salmon ESUs.

BACKGROUND INFORMATION

On 14 March 1994, the National Marine Fisheries Service (NMFS) was petitioned by the Professional Resources Organization-Salmon (PRO-Salmon) to list spring-run populations of chinook salmon (*Oncorhynchus tshawytscha*) in the North Fork and South Fork Nooksack River, the Dungeness River[2], and the White River as threatened or endangered species under the Endangered Species Act (ESA), either singly or in some combination (PRO-Salmon 1994). At about the same time, NMFS also received petitions to list additional populations of other Pacific salmon species in the Puget Sound area. In response to these petitions and the more general concerns for the status of Pacific salmon throughout the region, NMFS announced on 12 September 1994, that it would initiate ESA status reviews for all species of anadromous salmonids in Washington, Oregon, California, and Idaho (NMFS 1994). Subsequent to this announcement, NMFS was petitioned on 1 February 1995, by the Oregon Natural Resources

---

[2] The use of the term "spring-run" to describe the chinook salmon returning to the Dungeness River has been discontinued by state, tribal, and federal agencies. It has been replaced with the term "native," but in this report the term "spring-run" has been retained for the purpose of maintaining consistency with older references to the stock.

Council (ONRC) and Richard K. Nawa to list 197 stocks of chinook salmon either separately or in some combination. The results of the status review are published in Myers et al. (1998).

In determining whether a listing under the ESA is warranted, two key questions must be addressed:

1) Is the entity in question a "species" as defined by the ESA?
2) If so, is the "species" threatened or endangered?

The ESA allows listing of "distinct population segments" of vertebrates as well as named species and subspecies. However, the ESA provides no specific guidance for determining what constitutes a distinct population, and the resulting ambiguity has led to the use of a variety of criteria in listing decisions over the past decade. To clarify the issue for Pacific salmon, NMFS published a policy document describing how the agency will apply the definition of "species" in the ESA to anadromous salmonid species, including sea-run cutthroat trout and steelhead (NMFS 1991). The NMFS policy stipulates that a salmon population (or group of populations) will be considered "distinct" for purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the biological species. An ESU is defined as a population that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species.

If it is determined that a listing(s) is warranted, then NMFS is required by law (1973 ESA Sec. 4(a)(1)) to identify one or more of the following factors responsible for the species' threatened or endangered status: 1) destruction or modification of habitat, 2) overutilization by humans, 3) disease or predation, 4) inadequacy of existing regulatory mechanisms, or 5) other natural or human factors. This status review does not formally address factors for decline; except insofar as they provide information about the degree of risk faced by the species in the future if current conditions continue. A separate document identifies factors for decline of chinook salmon from Washington, Oregon, California, and Idaho (NMFS 1998b).

Previous Conclusions of the BRT

Central Valley Spring-Run Chinook Salmon ESU

There were lengthy discussions by the BRT concerning the disposition of spring runs in the Sacramento River and a number of different scenarios were considered. The majority of the BRT felt that the spring-run chinook salmon in the Sacramento River represented a separate ESU. A minority felt that the spring-run fish are part of a larger ESU that also includes the fall and late-fall runs. Based largely on environmental factors, the BRT also considered the possibility that spring-run fish from the San Joaquin River were historically part of a separate ESU, but little life history and genetic information was available to evaluate this hypothesis. The

BRT felt that it was important to develop additional genetic information to elucidate the status of the remnant spring-run populations in Butte, Deer, and Mill Creeks and their relationship to spring-run fish from the mainstem Sacramento and Feather Rivers.

This ESU occupies the Sacramento River Basin, and includes chinook salmon entering the Sacramento River from March to July and spawning from September through early October, with a peak in September. Spring-run fish in the Sacramento River exhibit an ocean-type life history, emigrating as fry, subyearlings, and yearlings. Marine coded-wire-tag (CWT) recoveries are primarily from fisheries off the California and Oregon coast. Differences in adult size, fecundity, and smolt size were also observed between spring- and fall-run chinook salmon in the Sacramento River. DNA analyses indicated moderate differences between the spring, fall, and late-fall runs in the Sacramento River.

Spring-run chinook salmon were once the predominant run in the Central Valley. Dam construction and habitat degradation has eliminated spring-run populations from the entire San Joaquin River Basin and from many tributaries to the Sacramento River Basin. Abundance has declined dramatically from historical levels, and much of the present day production is from artificial propagation. There are only a few naturally-spawning populations remaining and these all have relatively low abundances (<1000). Furthermore, there is concern that the Feather River Hatchery propagated spring-run fish have been inadvertently hybridized with fall-run fish. Hatchery release practices result in high levels of straying and an increased potential for hatchery strays spawning with native fish. The majority of the BRT previously concluded that this ESU was at risk of extinction in the foreseeable future.

Central Valley Fall and Late-Fall-Run Chinook Salmon ESU

A majority of the BRT felt that fall and late-fall chinook salmon in the Central Valley represented a single ESU. Contrasting minority viewpoints were that 1) spring-run fish are part of the same ESU that includes the fall and late-fall runs; 2) fall and late-fall runs constituted separate ESUs; and 3) fall-run fish in the San Joaquin River Basin constituted their own ESU.

This ESU occupies the Sacramento and San Joaquin River Basins and includes fall and late-fall run chinook salmon. These populations enter the Sacramento and San Joaquin Rivers from July through March and spawn from October through March. Fish in this ESU are ocean-type chinook salmon, emigrating predominantly as fry and subyearlings and remaining off the California coast during their ocean migration. Fall-run chinook salmon in the Sacramento and San Joaquin River Basins are physically and genetically distinguishable from coastal forms .

Total abundance in this ESU is relatively high, perhaps near historical levels. However, the status of populations in the San Joaquin River Basin are extremely depressed. Spawning and rearing habitat quality through the ESU are severely impacted by agricultural and municipal water use activities. Returns to the hatcheries account for 20% of the spawning escapement, and hatchery strays spawning in the wild may account for an additional 30% of the spawning escapement. The exchange of stocks among Central Valley hatcheries may have resulted in considerable loss of among population genetic diversity. Furthermore, naturally-spawning populations that are least influenced by hatchery strays are experiencing generally negative trends in abundance. Finally, relatively high ocean and freshwater harvest rates may threaten the sustainability of naturally spawning populations. The majority of the BRT felt that this ESU is likely to become at risk of extinction in the foreseeable future (Myers et al. 1998).

Southern Oregon and California Coastal Chinook Salmon ESU

This ESU, previously proposed by the BRT, includes native spring and fall runs of chinook salmon south of Cape Blanco, Oregon. Historically, the range may have extended to the Ventura River, California, but currently does not extend south of San Francisco Bay, California. Also included in this ESU are populations in the Klamath River Basin from the mouth upriver to the confluence of the Trinity and Klamath Rivers. Chinook salmon in this ESU exhibit an ocean-type life history, with marine distribution predominantly off the California and Oregon coasts. In contrast, populations north of Cape Blanco (Oregon Coast Chinook Salmon ESU) migrate in a northerly direction, travelling as far north as British Columbia and Alaska. The Cape Blanco region is a major biogeographic boundary for numerous species. Fall-run populations predominate in this ESU, with the exception of the Rogue River Basin where there is a substantial spring run. The status of naturally-spawning chinook salmon in San Francisco Bay was not determined by the BRT due to a lack of information. Furthermore, the BRT was unable to document the existence of extant naturally-spawning chinook salmon populations south of San Francisco Bay. Ecologically, the majority of the river systems in this ESU are relatively small and heavily influenced by a maritime climate.

A minority of the BRT felt that coastal chinook salmon from south of the Klamath River should be considered a separate ESU. Allozyme data, which show some level of genetic divergence between coastal chinook salmon populations north and south of the Klamath River, support this argument, as do the establishment of ESU boundaries for steelhead south of the Klamath River and for coho salmon south of Punta Gorda. A nearly total lack of biological information for chinook salmon south of the Eel River makes this issue difficult to resolve.

Populations in this ESU have generally experienced declines in abundance from historical levels, with the exception of populations in the Rogue River. Spring-run populations outside of the Rogue River have undergone severe declines. There is an almost complete lack of abundance data for coastal rivers south of the Klamath River, and many rivers which historically sustained large populations of fall-run chinook salmon contain severely reduced populations or their populations have been nearly extirpated. The BRT unanimously concluded that this ESU was likely to become at risk of extinction in the foreseeable future.

Snake River Fall-Run Chinook Salmon ESU

After considerable discussion, a plurality of the BRT concluded that the Deschutes River population should be considered part of the Snake River Fall-Run Chinook Salmon ESU. Separate minorities favored two other scenarios: 1) The Deschutes River population is part of a separate ESU that, historically, also included ocean-type fish in the Umatilla, John Day, and Walla Walla Rivers. Populations in the latter three rivers are considered to be extinct (Kostow 1995). 2) All ocean-type chinook salmon upstream of the historical site of Celilo Falls (approximately the location of the Dalles Dam) belonged to one ESU. A further minority was undecided on the ESU status of these populations. All of the BRT members were concerned about the lack of definitive information for the Deschutes River population(s).

This ESU occupies tributaries to the Columbia River from the Dalles Dam to the confluence of the Snake and Columbia Rivers, and inclusive of the Snake River Basin. It includes all native populations of fall-run chinook salmon in the mainstem Snake River and the following subbasins: Deschutes, John Day, Tucannon, Grand Ronde, Imnaha, Salmon, and Clearwater Rivers. Previously, this ESU had only included fall-run chinook salmon from the Snake River Basin, but based on new information presented in this review the ESU was expanded to include the Columbia River populations listed above. Fish from this ESU exhibit an ocean-type life history. Genetic and ocean migration differences contrast fish from this ESU with those from the Upper Columbia Summer- and Fall-Run Chinook Salmon ESU. The BRT also noted ecological differences between the Snake River Basin and the upper Columbia River (above the confluence of the Snake River).

Historically the Snake River component of this ESU was the predominant source of production. The 5-year average (1990-1996) for Snake River fall-run chinook salmon was about 500 adults (compared with 72,000 in the 1930s and 1940s). The abundance of naturally-spawning fish in the Deschutes River has averaged about 6,000 fish (1990-96). There was some uncertainty as to the origins of fish spawning in the lower Deschutes River, and their relationship to fish in the upper Deschutes River (above Sherars Falls). Extirpated populations in the John Day, Umatilla, and Walla Walla Rivers are believed to have belonged to this ESU. Hydrosystem development blocks access to most of the historical spawning habitat in the Snake River portion of this ESU. Additionally, migration corridors are affected by hydrosystem development. Snake River fall-run chinook salmon are currently listed as a threatened species under the federal ESA. The BRT concluded that the newly defined ESU (which includes the Deschutes River population) is likely to become in danger of extinction in the foreseeable future.

NEW INFORMATION

Comments on the Proposed Listing of Chinook Salmon ESUs

Comments with significant scientific content received as of June 22, 1999:

Alaska, State of (AK), 21 August 1998,
Snake River Fall Run
Association of California Water Agencies (ACWA), 29 June 1998,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run
Southern Oregon and California Coastal
Beyerlin, Steve, 7 May 1998,
Southern Oregon and California Coastal,
Boucher, David and Allison, 7 July 1998,
Central Valley Fall Run and Late-Fall Run,
Brookings Harbor Chamber of Commerce (BHCC), 7 July 1998,
Southern Oregon and California Coastal,
California Department of Fish and Game (CDFG), 14 Aug 1998 ,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run
Southern Oregon and California Coastal
Upper Klamath and Trinity River
California Sportfishing Protection Alliance (CSPA), 12 May 1998,
Central Valley Spring Run
Central Valley Fall Run and Late-Fall Run
Southern Oregon and California Coastal
Cannon, Tom, 26 May 1999,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run
Central Valley Project Water Association (CVPWA), 26 June 1998,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run
City and County of San Francisco (CCSF), 30 June 1998,
Central Valley Fall Run and Late-Fall Run
Southern Oregon and California Coastal
Columbia River Inter-Tribal Fish Commission (CRITFC), 30 June 1998,
Snake River Fall Run
Confederated Tribes of The Warm Springs Reservation (CTWSRO), 29 June 1998,
Snake River Fall Run
Confederated Tribes of the Warm Springs Reservation (CTWSRO). 22 June 1999,

Snake River Fall Run
Del Norte Board of Supervisors (DNBS), 24 June 1998,
Southern Oregon and California Coastal,
Department of Water Resources (DWR), 29 June 1998,
Central Valley Spring Run
Central Valley Fall-Run and Late-Fall Run,
East Bay Municipal Utility District (EBMUD), 18 June 1998,
Central Valley Spring Run
Central Valley Fall Run and Late-Fall Run
Idaho Department of Fish and Game (IDFG), 17 May 1999,
Snake River Fall Run
Lower Rogue Watershed Council (LRWC), undated 1998,
Southern Oregon and California Coastal
Northwest Forest Resource Council (NFRC), 8 June 1998,
Southern Oregon and California Coastal
Snake River Fall Run
Olympic Resources Management (ORM), undated, 1998,
Southern Oregon and California Coastal
Olson, Doug, August 4, 1998
Snake River Fall Run
Oregon Department of Fish and Wildlife (ODFW), 30 June 1998,
Central Valley Fall and Late-Fall Run
Southern Oregon and California Coastal
Snake River Fall Run
Oregon Department of Fish and Wildlife (ODFW), 9 September 1998,
Southern Oregon and California Coastal
Snake River Fall Run
Oregon Department of Fish and Wildlife (ODFW), 10 May 1999,
Southern Oregon and California Coastal
Oregon Department of Fish and Wildlife (ODFW). 16 June 1999,
Southern Oregon and California Coastal
Snake River Fall Run
Pacific Coast Federation of Fishermen's Association (PCFFA), 30 June 1998,
Central Valley Spring Run
Central Valley Fall and Late-Fall
Southern Oregon and California Coastal
Upper Klamath and Trinity River
Pacific Gas and Electric Company (PGE), 8 June 1998,
Central Valley Spring Run
Central Valley Fall Run, and Late-Fall Run
Patt, Olney (CTWSRO), 22 June 1999,

Snake River Fall Run
Southern Oregon and California Coastal

San Joaquin Tributaries Association and the Merced, Modesto, Oakdale, South San Joaquin and Turlock Irrigation Districts (SJTA), 30 June 1998,
Central Valley Fall and Late-Fall Run

Siskiyou Project (SP), 30 January 1998,
Southern Oregon and California Coastal
Upper Klamath and Trinity Rivers

Smith River Advisory Council (SRAC), 12 June 1998,
Southern Oregon and California Coastal

South Coast Coordinating Watershed Council (SCCWC), 6 May 1998,
Southern Oregon and California Coastal

State Water Contractors (SWC), 30 June 1998,
Central Valley Spring Run
Central Valley Fall Run and Late-Fall Run

State of Alaska (AK), 21 August 1998,
Snake River Fall Run

Tehama-Colusa Canal Authority (TCCA), 25 June 1998,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run

Tuolumne River Preservation Trust (TRPT), 30 June 1998,
Central Valley Fall and Late-Fall Run, ,

Turlock Irrigation District and Modesto Irrigation District (TIDMID), 29 June 1998,
Central Valley Fall and Late-Fall-Run,

United States Department of the Interior (USDI), 23 July 1998,
Central Valley Spring Run
Central Valley Fall and Late-Fall Run
Snake River Fall Run,

Utter, Fred, 22 June 1998,
Central Valley Spring Run
Central Valley Fall Run and Late-Fall Run

Washington Department of Fish and Wildlife (WDFW), 13 July 1998,
All ESUs

Washington Department of Fish and Wildlife (WDFW), 11 May 1999,
Snake River Fall Run

Yurok Tribe (YT), 18 June 1999,
Southern Oregon and California Coastal

General Comments:

CRITFC (1998) presented a number of general comments on the West Coast Status Review.

1) CRITFC (1998) argued that the use of ESUs is not specifically provided for in the ESA, and that ESUs do not correspond to Distinct Population Segments (DPS).
   a). Electrophoretic data cannot be used to imply evolutionary significance
   b). Electrophoretic differences do not imply local adaptation
   c). NMFS assumes that the dominant force affecting the divergence of gene frequencies is natural selection.

2) NMFS did not use the best scientific and commercial information in its analysis of artificial propagation programs.

3) NMFS makes arbitrary decisions on risk determinations, and does not make use of the best scientific methods for determinations of extinction risk.

WDFW (1998) identified what they considered to be several "inconsistencies" in the determination of ESU boundaries.

1)That the genetic distance between Columbia River ocean-type ESUs was greater than the distances between coastal ESUs. Figures presented in the West Coast Status Review (Myers et al. 1998) did not provide a useful comparison of these distances.

2) WDFW (1998) believed that the use of the terms ocean and stream-type might be misleading to the reader. Grouping ESUs and their component populations into one of two groups might downplay the diversity that exists within and between ESUs.

3) WDFW (1998) was concerned that critical habitat and ESU boundaries in the proposed rule did not extend beyond impassable dams. They noted that several currently "impassable" dams are expected to be removed or made passable, and the status of fish recolonizing these areas needs to be addressed.

NFRC (1998) disagreed with proposed listings for six ESUs: Southern Oregon and California Coastal, Puget Sound, Lower Columbia River, Upper Willamette River, Upper Columbia River Spring Run, and Snake River Fall Run. They did not provide comments on any additional ESUs.

1) They argued that there was insufficient scientific information presented to justify the establishment of the six chinook salmon ESUs discussed. Information was lacking concerning a number of "key" criteria for defining ESU. NFRC (1998) contended that NMFS did not find any life history, habitat, or phenotypic characteristics that were

unique to any of the ESUs discussed. Furthermore, they disagreed with evolutionary significance of allozyme differences. Disagreement within the BRT was also given as a reason for challenging the proposed listing decision.

2) They argued that recent declines in abundance in the six ESUs were related to natural factors: avian predation, marine mammal predation, and especially changes in ocean productivity. Until ocean conditions improved, the potential for recovery was extremely limited. Furthermore, they contend that NMFS did not show how the present declines were significantly different from natural variability in abundance, nor that abundances were below the current carrying capacity of the marine environment and freshwater habitat.

3) In an examination of causal factors for decline and existing risks NFRC (1998) lists a number of anthropogenic factors not sufficiently addressed in the West Coast Status Review (Myers et al. 1998) or Federal Register Notice (NMFS 1998a). They highlight the fact that much of the remaining freshwater habitat classified as "good to fair" is located in forested lands, while there has been a considerable loss of estuarine and lower river (floodplain) habitat. This environmental modification would most strongly impact coastal ocean-type fish. Competition and predation resulting from the introduction of exotic species may also be reducing salmonid survival and the potential for recovery. Lastly, the modification of the hydraulic characteristics of many rivers in combination with the interruption of fish migration by dams has severely limited the production potential of natural populations.

ESU Specific Comments:

Central Valley Spring-Run Chinook Salmon ESU--CDFG (1998a) indicated that spring-run chinook salmon in the Sacramento River Basin do not begin spawning until late September, rather than August, as stated in the Status Review. Furthermore, CDFG (1998a) was concerned that the BRT was inconsistent in separating spring and fall runs in the Central Valley, but not in the upper Klamath River Basin.

ACWA (1998) felt that Central Valley Spring-Run populations have remained stable, although at low levels of abundance. Current fluctuations are consistent with natural terrestrial and ocean productivity cycles. ACWA (1998) suggested that information on cohort replacement rates, the level of interaction between fall and spring runs, and the impact of various factors relating to the survival of emigrating juveniles and returning adults need to be further investigated before a listing determination can be made. Furthermore, conservation actions to restore habitat under various programs, such as CALFED, are sufficient to prevent this ESU from becoming extinct.

PGE (1998) comments listed several programs that are underway to provide improved fish passage through PGE operated facilities. Programs on Battle and Cow Creek, and the Yuba River involved modified flow regimes, improved passage facilities, and improved monitoring. Furthermore, they believed that because of the limited number of hatchery fish released into Butte Creek the genetic integrity of this spring-run population was intact.

CSPA (1998) comments agreed with the proposed listing for this ESU. They cited low abundance, loss of habitat, and degradation of remaining habitat. Additionally, they asserted that FERC had failed to adequately provide protect for chinook salmon in the Central Valley.

Cannon (1999) concurred with the proposed listing for spring-run chinook salmon in the Central Valley. He further listed several factors for decline that impact the spring run: predation by non-native species, dam and reservoir operations, catastrophic stranding, incorporation of naturally produced salmon into hatchery broodstocks, and competition and predation by hatchery chinook salmon and steelhead on naturally produced chinook salmon. He suggested that the recent increases in Butte Creek spring run chinook salmon were due to high flows through the Sutter Bypass during the recent wet years. Spring-run adults returning to the upper Sacramento River would be attracted to the Bypass and routed up into Butte Creek. Therefore, spring-run fish currently spawning in Butte Creek represent an amalgamation of fish from the upper Sacramento River and its tributaries.

SWC (1998) comments describe in some detail efforts being made to improve freshwater habitat and migration corridors for chinook salmon via the Bay-Delta Accord and CALFED. Similarly, changes in harvest management to reduce the commercial and recreational harvest have resulted in a decreased risk facing Central Valley chinook salmon stocks. Current abundances are low, but the trends are generally positive (especially in Butte Creek). SWC (1998) also states that regulatory mechanisms exist to protect chinook salmon, without resorting to the ESA.

DWR (1998) did not support an endangered listing for this ESU, but felt a threatened listing was more in order. They based this decision on the relatively stable population sizes for most spring-run fish over the last twenty years, and the increasing abundance found in Butte Creek. Genetic studies indicate that spring-runs in Butte, Deer, and Mill Creeks are more similar to each other than to Sacramento River fall run and late-fall run chinook salmon, and that NMFS incorrectly suggested that the Butte Creek populations were the product of hatchery releases. DWR (1998) also noted that the DNA work by D. Hedgecock (U.C. Davis) was not designed to distinguish runs in the Central Valley, but rather identify winter-run fish from the other runs. Furthermore, habitat restoration programs planned, or in progress, under the CALFED and other agreements greatly reduced the current and future risks facing these fish. DWR (1998) stated that the majority of habitat degradation for this ESU occurred decades ago, and the quality of the remaining spring run habitat has probably improved in recent years. According to DWR (1998), NMFS also needed to consider the impact of the State of California's ESA listing for spring run, actions by NMFS and the PFMC to protect winter-run chinook salmon which benefit spring run population, and the DWR's 4-pumps program.

Utter (1998) (peer reviewer) stated that the genetic information presented was not sufficient to justify the creation of a separate Spring-Run Chinook Salmon ESU and Fall- and Late-Fall Run Chinook Salmon ESU.

USDI (1998) expressed the hope that conservation programs, such as the Central Valley Project Improvement Act (CVPIA) and CALFED, could be used to address many of the risk issues rather than resorting to an ESA listing.

TCCA (1998) comments highlighted the conservation programs that are currently underway in the Central Valley. It was also pointed out that trends were computed for a 10 year period (since 1984) which included 6 drought years. TCCA (1998) also pointed out that there were no commercial or recreation harvest estimates for the spring run.

PCFFA (1998) agreed with NMFS that current abundances are low, but stable. They felt that habitat restoration programs may further reduce risk facing the spring run populations; however, water diversion allowed under the Bay-Delta Accord may actually negatively impact emigrating spring-run juveniles. The possibility of a California Endangered Species Act listing may provide sufficient protection to eliminate the need for a federal ESA listing. PCFFA (1998) recommended that NMFS not list this ESU, but if a listing decision was made that it should be "threatened" and not "endangered".

CVPWA (1998) disagreed with NMFS's proposed listing, asserting that conservation programs that are currently in place, in addition to those proposed, are sufficient to reduce the risk of extinction facing this ESU.

Central Valley Fall and Late-Fall Run Chinook Salmon ESU--CDFG (1998a) disagreed with the conclusions of the BRT in regards to the risk analysis of this ESU. They highlighted habitat restoration programs that are underway throughout the Central Valley.

ACWA (1998) presented a number of arguments concerning the proposed listing for this ESU. Firstly, they recommended that fall and late-fall runs be established as separate ESUs. Differences in spawn timing, rearing, and emigration periods were given as the rationale for this action. They disagreed with the BRT in concluding that a large proportion of the ESU has been lost or is in danger of extinction. San Joaquin River tributaries, they assert, have improved substantially in recent years. They also asserted that the overall abundance in the ESU is very, "near historical levels" as stated in Myers et al. (1998). Based on their interpretation of the Myers et al. (1998), they submit that high harvest rates and hatchery programs were largely responsible for conditions that the BRT felt put the ESU at risk. ACWA (1998) suggested that

NMFS had other regulatory means at its disposal to correct these factors, rather than employing the ESA. The ACWA (1998) comments also focused on the issue of hatchery produced fish. They argued that NMFS needs to identify which hatchery populations are in the ESU and which are not before making any conclusions on the status of this ESU. Additionally, since there was considerable uncertainty in distinguishing natural and hatchery chinook salmon voiced by the BRT, ACWA (1998) believed that making any listing decision was not possible. If the two types of chinook are indistinguishable then hatchery fish should be included in abundance estimates for risk determination. ACWA (1998) also pointed out that the only two stocks in this ESU identified by Nehlsen et al. (1991) were the San Joaquin and Cosumnes Rivers, which were of "special concern", and this category did not require a regulatory protection. Finally, ACWA (1998) listed several conservation programs that were presently underway in the Central Valley and for which funds had been committed for the foreseeable future.

TRPT (1998) agreed with the decision to list Central Valley Fall Run Chinook Salmon. Habitat degradation and loss have severally depressed Central Valley fall-run populations, especially in the San Joaquin River Basin. Hatchery programs and fishery impacts need greater scrutiny to assure the sustainability of the Central Valley chinook salmon in the long-term. The TRPT (1998) also acknowledged the conservation programs that are currently underway or being proposed, but concluded that they were insufficient to reduce the risks facing this ESU. The TRPT (1998) comments also included data which indicated a rising proportion of CWT fish being recovered in tributaries to the San Joaquin, furthermore, these CWT estimates did not take into account the contribution of unmarked hatchery-reared fish.

SJTA (1998) comments included a listing of existing and planned conservation efforts (e.g. modified flow and flow ramping rates, temperature monitoring and control, and gravel restoration) in rivers throughout the San Joaquin River Basin. Additionally, there were a number of juvenile and adult monitoring studies, both planned and underway. It was the opinion of the SJTA (1998) that these efforts reduced the risk of extinction faced by chinook salmon in this ESU, and that a listing was not warranted.

PGE (1998) comments listed several programs that are underway to provide improved fish passage through PGE operated facilities. Programs on Battle and Cow Creek and the Yuba River involved modified flow regimes, improved passage facilities, and improved monitoring.

David and Allison Boucher's comments addressed what they felt was the inability of CDFG to provide adequate protection to native chinook salmon in the San Joaquin Basin (Boucher and Boucher 1998). The release of unmarked hatchery fish was cited as an unexcusable practice that complicates the restoration of native fish. Furthermore, they felt that the sport fishery that was allowed on the Merced River was an unacceptable risk. Finally, habitat restoration efforts on the Stanislaus and Tuolumne Rivers by CDFG were very limited and inadequate for the recovery of this ESU.

CSPA (1998) agreed with the proposed listing for this ESU. They felt that although total abundance is high, the majority of these fish are hatchery produced. Furthermore, they encouraged NMFS to determine the number of wild fish remaining in the Central Valley. In determining the risks facing this ESU, CSPA (1998) suggested that NMFS use the San Joaquin Basin as a benchmark.

Cannon (1999) concurred with the proposed listing for fall-run chinook salmon in the Central Valley. He further listed several factors for decline that impact the fall run: predation by non-native species, dam and reservoir operations, catastrophic stranding, incorporation of naturally produced salmon into hatchery broodstocks, and competition and predation by hatchery chinook salmon and steelhead on naturally produced chinook salmon.

EBMUD (1998) provided extensive comments regarding the proposed listing for Central Valley Fall Run chinook salmon. EBMUD (1998) asserted that recent run sizes for the San Joaquin Basin have been increasing, in part due to improvements in habitat (gravel, temperature) and flow. EBMUD (1998) also described in detail improvement in habitat that would result from the CALFED program, and that these results were predictable given the definitive nature of the program and the guaranteed nature of the funding. They believed that the BRT was incorrect in not including hatchery produced fish in abundance estimates (due to the high degree of interbreeding between naturally produced and hatchery produced fish). Furthermore, the BRT did not conclusively show that hatchery produced fish were a risk to naturally-produced fish. EBMUD (1998) also outlined changes in the hatchery program at the Mokelumne River Hatchery to reduce the proportion of imported eggs used in production. Alternatively, if hatchery impacts were great, NMFS should conclude that the Central Valley Fall Run and Late-Fall Run Chinook Salmon ESU was similar to the Lower Columbia River Coho Salmon ESU and exclude the Central Valley Chinook Salmon ESU from consideration for listing. EBMUD (1998) also suggested that NMFS reexamine the inclusion of both fall run and late-fall run fish into one ESU.

CCSF (1998) comments concerned status of hatchery fish in the Central Valley and the importance of considering hatchery fish in the risk determination. NMFS needed to define hatchery fish, provide a method for distinguishing hatchery and natural production, and justify the exclusion of hatchery fish from the risk determination (given that the majority of the broodstock originated from within the ESU). CCSF (1998) also asserted that the small river systems that flow into San Francisco Bay did not historically support chinook salmon.

SWC (1998) asserted in their comments that there is no justification in the ESA to separate hatchery and naturally produced fish from abundance estimates. The SWC (1998) also suggests that critical habitat be extended into ocean fishery areas. SWC (1998) comments describe in some detail efforts being made to improve freshwater habitat for chinook salmon via the Bay-Delta Accord and CALFED. Additionally, SWC (1998) believe that changes in hatchery practices in the Central Valley have reduced the risk presented by hatchery produced fish. Similarly, changes in harvest management to reduce the commercial and recreational harvest have resulted in a decreased risk facing Central Valley chinook salmon stocks. SWC (1998) also asserted that Central Valley chinook salmon populations have historically undergone extreme fluctuations in abundance due to environmental fluctuations, and NMFS did not adequately take these fluctuations, and the ability of the natural populations to recover, into account when assessing the risk of extinction. SWC (1998) also states that regulatory mechanisms exist to protect chinook salmon, without resorting to the ESA.

TIDMID (1998) stated that escapement in the Tuolumne River has undergone considerable fluctuations since monitoring began in the 1940s. Currently, the abundances are increasing following several years of drought during the early 1990s. Estimates of CWT recoveries indicate that approximately 20% of the natural escapement is from tagged groups (there is no expansion of unmarked groups). The majority of these CWT fish are from releases of Merced River Hatchery Fish into the Tuolumne River. TIDMID (1998) agreed with NMFS that ocean harvests have been high (0.65 in 1996-97), and the impact on rivers with natural production (like the Tuolumne River) may be excessive. TIDMID (1998) also cited several factors that significantly influence the survival of chinook salmon from the Tuolumne River: 1) the Delta Pumps which killed 35-44 percent of subyearling juveniles and 55-67 percent of yearling juveniles (1973-1988), 2) predation by introduced bass species. TIDMID (1998) also outlined a number of restoration projects that are underway in the Tuolumne River Basin which should benefit chinook salmon. Additionally, efforts are underway to reduce the number of Merced River fish released in the Tuolumne River. TIDMID (1998) indicated that the use of more recent data for the Tuolumne River would produce a positive trend rather than the negative trend presented in Myers et al. (1998). TIDMID (1998) also highlighted the wide range of risk scores submitted by the BRT (as an indicator of inconsistency), and was criticial of the use of averages to produce a final determination.

DWR (1998) did not support a threatened listing for this ESU. They argued that habitat restoration programs planned, or in progress, under the CALFED and other agreements greatly reduced the current and future risks facing these fish. DWR (1998) stated that because naturally-produced and hatchery-produced fish are genetically indistinguishable, they should not be excluded from abundance-based risk estimates. Alternatively, the situation in the Central Valley fall-run and late-fall run ESU is similar to that found in the Lower Columbia River with coho salmon. In the case of coho salmon, NMFS determined that no listing was warranted because the ESU had ceased to exist. DWR (1998) did not agree with the NMFS determination that the San Joaquin River Basin constituted a significant portion of the ESU, and the depressed nature of San Joaquin fall run stocks was not an adequate basis for a listing. They contended that NMFS also needs to consider the impact of the State of California's ESA listing for spring run, actions by NMFS and the PFMC to protect winter-run chinook salmon which benefit spring run population, and the DWR's 4-pumps program.

USDI (1998) expressed the hope that conservation programs, such as the Central Valley Project Improvement Act (CVPIA) and CALFED, could be use to address many of the risk issues rather than resorting to an ESA listing.

TCCA (1998) comments highlighted the conservation programs that are currently underway in the Central Valley. It was also pointed out that trends were computed for a 10 year period (since 1984) which included 6 drought years. They also highlight the high overall escapement level for this ESU, and in light of NMFS' inability to distinguish between hatchery and naturally-produced fish TCCA (1998) felt that there was not sufficient evidence to justify a listing.

The PCFFA (1998) did not believe that a listing is warranted for this ESU. Although numerous habitat problems were cited, there have been a number of improvements in the Central Valley. Overall abundance is quite high, and further research is needed to better understand the influence of hatchery-produced fish. The PCFFA (1998) also called for more genetic sampling to determine if the San Joaquin River Basin should be established as a separate ESU, although they stated that the much of the San Joaquin fall-run return were merely strays from the Sacramento River.

CVPWA (1998) disagreed with NMFS's proposed listing asserting that conservation programs that are currently in place, in addition to those proposed, are sufficient to reduce the risk of extinction facing this ESU.

Southern Oregon and California Coastal Chinook Salmon ESU--Although CDFG (1998a) argued for a splitting of fall- and spring-run stocks in the Upper Klamath and Trinity River Chinook Salmon ESU to provide better protection for the spring-run chinook salmon, they did not do so for this ESU because "both stocks [runs] are in big trouble...". CDFG (1998a) wondered whether data were available for populations in the Smith River and Blue Creek.

The ACWA (1998) disputed the southern border of the ESU. They asserted that there is no definitive proof that chinook salmon populations existed in any of the San Francisco Bay tributaries. Furthermore, they stated that with the extinction of native chinook salmon in the Russian River that there are no chinook salmon population in Marin County. ACWA (1998) proposed that ESU boundaries should extend no farther south than to the limit of extant chinook salmon populations.

PGE (1998) comments listed several programs that are underway to provide improved fish passage through PGE operated facilities. PGE has improved fish passage facilities at the Cape Horn Dam, and is currently developing minimum flow levels with FERC for the Eel River. PGE (1998) also discussed the risks to chinook salmon in the Eel River Basin by the introduction of the Sacramento squawfish (*Ptycholcheilus grandis*) in the late 1970s. Increases in the number of squawfish in the Eel River Basin corresponded with declines in chinook salmon during the 1980s and 1990s. Additionally, PGE (1998) believed that the chinook salmon population in the Russian River was never historically abundant.

SRAC (1998) suggested that this ESU be divided into two ESUs: 1) the Transboundary ESU from the Rogue River south to the Klamath River, 2) the California Coast ESU from Redwood Creek to San Francisco Bay. This division would be based primarily on existing genetic evidence, although DNA studies that are currently underway may shed further light on this situation. Furthermore, SRAC (1998) stated that population trends in the California portion of the Transboundary ESU are positive and that the Transboundary ESU would not require a protection under the ESA.

PCFFA (1998) did not believe that a listing was warranted for this ESU. They were concerned about diversions of water from the Eel River, but indicated that existing regulatory mechanism existed to address these issues, but only if they were properly enforced. It was also indicated that the coho salmon listing should provide adequate protection for chinook salmon in this ESU.

ORM (1998) provided information on the status of Lobster Creek, a tributary to the Rogue River. This information outlined the historical causes of habitat degradation in the Rogue River Basin and current conservation and monitoring programs that are underway or planned for the Lobster Creek Basin. Many of these activities were coordinated among a number of agencies as part of the Oregon Coastal Salmon Restoration Initiative and Forest.

Steve Beyerlin, President of the Curry Guide Association, did not agree with the NMFS proposal to list this ESU (Beyerlin 1998). It was suggested that the ESU be divided into two ESUs: 1) from the Rogue to the Smith River (inclusive), and 2) from below the Smith River to the mouth of the Sacramento. Respondents base this decision on the large geographic size of the existing ESU, lower rates of straying in chinook salmon relative to steelhead–yet, steelhead have more finely divided ESUs, and the physical distinctiveness of Rogue River chinook salmon relative to fish in the Klamath and Sacramento Rivers. Beyerlin (1998) also suggests that NMFS has underestimated the impact of predators (such as cormorants) on chinook salmon population.

The LRWC (1998) argued that existing ESU be split into two ESUs, those populations north or south of the Eel River (with the Eel River in the southern ESU). They stated that geophysical and genetics differences were sufficient to justify this split.

BHCC (1998) disagreed with the NMFS proposed boundaries for this ESU. They suggested that geological, hydrological, and topographical differences found within the existing ESU are of sufficient magnitude to justify splitting the ESU (although the number and actual boundaries of the new ESU(s) were not given). Furthermore, they also highlighted the differences between this ESU and the ESUs for coho salmon and steelhead in the same geographic area.

DNBS (1998) disagreed with the proposed boundaries and status of this ESU. Their interpretation of biological and genetic information in the SR indicates that the proposed ESU should be divided into two ESUs, 1) a "Transboundary" ESU that extends southward to the Klamath River (inclusive), and 2) a California Coast ESU. Furthermore, DNBS (1998) believe that the "Transboundary" ESU status to be not at risk of extinction.

SCCWC (1998) disagreed with the proposed boundary and status of this ESU, citing geological differences between areas in this ESU (i.e. the Klamath Mountains and California Coast Range Geological Provinces are very distinct). Additionally, SCCWC (1998) asserts that the ESU does not correspond with the fishing areas (that are, in part, determined by NMFS), such as the Klamath Management Zone, were are supposed to be biologically based. Existing ESUs for coho salmon and steelhead would indicate that a finer scale of division is called for. Furthermore, if an ESU including Southern Oregon and Northern California Coastal is established, it should not be recommended for listing as threatened or endangered.

SP (1998) recommended that spring-run chinook salmon be identified as a distinct ESU. They indicated that spring-run fish are at a higher risk of extinction in most ESUs because of 1) their run timing and extended freshwater holding period, which makes them more vulnerable to fishing and predation; and 2) their use of headwater regions that have suffered more extensive degradation relative to mainstem "fall-run" areas. Additionally, the SP (1998) identified the Illinois River chinook salmon as being at considerable risk. Finally, they expressed little confidence that the Northwest Forest Plan is adequately enforced, and can offer little protection for chinook salmon.

ODFW (1998b, 1999c) disagreed with the boundaries for this ESU. Their interpretation of the genetic information suggested that two ESUs existed within the Southern Oregon and California Coastal Chinook Salmon ESU: 1) a Southern Oregon/Northern California "ESU" and 2) a California Coastal "ESU." Furthermore, ecological and geological differences between their suggested ESUs were substantial and would have a considerable influence on the life history and local adaptation differences between chinook salmon populations in these regions. They highlighted the fact that there were no yearling outmigrants in the southern portion of this ESU, but that yearling migrants in the northern portion are indicative of life history and underlying ecological differences between their two suggested ESUs. ESU boundaries established for steelhead and coho salmon further suggest that a biological transition zone exists to the south of the Klamath River Basin.

ODFW (1999a) provided updated abundance data for several chinook salmon populations in the northern part of the proposed ESU, which supports an improving trend in abundance for many basins. ODFW (1999a) also provided revised abundance estimates for Rogue River spring-run spawning escapement. ODFW highlighted the fact that a number of hatchery/STEP programs had been discontinued or reduced since the BRT last reviewed this ESU. In conclusion, ODFW believes that the "Southern Oregon and Northern California ESU" does not warrant protection under the ESA.

YT (1999) highlighted genetic and life history differences from a number of sources that supported the split in the Southern Oregon and California Coastal Chinook Salmon ESU at the lower Klamath River. They also raised a number of issues regarding the boundary between the coastal ESU(s) and the Upper Klamath and Trinity Rivers Chinook Salmon ESU. Although they concurred with NMFS in placing the Blue Creek fall-run chinook salmon with other coastal populations (specifically the northern portion of the proposed Southern Oregon and California Coastal Chinook Salmon ESU), they suggested that further study was necessary prior to deciding the status of other chinook salmon populations in the lower Klamath River.

Snake River Fall-Run Chinook Salmon ESU--CRITFC (1998) argued that in spite of the lack of significant genetic differences among fall chinook salmon populations above Bonneville Dam, NMFS amputated the Deschutes and Lyons Ferry samples from the "cloud" of points describing Upper Columbia River populations. Furthermore, since summer-run chinook salmon were the predominant run timing in the Columbia River Basin, the fall- and spring-run populations are remnants of the tails of a normal distribution of run timing. Therefore, separate fall and spring ESUs may interfere with the recovery of summer chinook.

CTWSRO (1998) responded with two main criticisms of the Status Review Process. 1) That the ESU designation is incorrect. Firstly, because the ESA makes no provision for ESUs, only species, subspecies, and DPSs. Secondly, because there are a number of important life history traits that were not adequately considered in comparing Snake River and Deschutes River fall-run chinook salmon. CTWSRO (1998) specifically discussed differences in age at maturation, run timing, spawning timing, and emergence timing. Additionally, the genetic data does not adequately show that Deschutes and Snake River populations have a strong affinity for each other. Furthermore, they discuss differences in the Snake and Deschutes River Basins' hydrologies, water quality, and temperatures. 2) NMFS did not consider 1997 escapement data and trends in determining risk analysis.

In subsequent comments the CTWSRO (1999) and Patt (1999) presented life history, genetic, and ecological information that further supported the separation of the Snake River fall-run from Deschutes River summer/fall-run fish. CTWSRO (1999) and Patt (1999) argued that there is very little genetic differentiation between all fall-run chinook salmon above the Dalles Dam. Also, examination of age structure data indicated a stronger similarity between fall-run fish from the Hanford Reach and the Deschutes River, than between fall-run fish from the Snake and Deschutes Rivers. They further suggested that similarities in ocean distribution between Snake

River and Deschutes River fall-run fish is based on a limited number of ocean recoveries and should not be given much consideration. They further argue that ecological conditions in the Deschutes River Basin are unique to the upper Columbia and Snake River Basins. Finally, they suggested the summer-run that may have existed in the Deschutes River exhibited an ocean-type life history and that this would have evolutionarily more closely resembled the situation in the upper Columbia River, rather than the Snake River Basin.

Doug Olson (Olson 1998) supported the minority BRT opinion that the Deschutes River fall-run chinook salmon should be part of an ESU that includes the John Day, Umatilla, and Walla Walla River Basins; however, further information was required to resolve the ultimate placement of the Deschutes River and Marion Drain populationsin an ESU.

ODFW (1998b, 1999c) did not agree with the NMFS proposed incorporation of the Deschutes River fall-run chinook salmon into the Snake River Fall-Run Chinook Salmon ESU. They questioned the origin and integrity of the existing Snake River fall run. The magnitude of the genetic differences observed between Snake River fish and those in the Deschutes River and the mid/upper mainstem Columbia River was not consistent with differences used to define other ESUs. The clustering of populations, they suggested, was subject to the interpretation of the geneticist. Ecological differences were also presented. The historical spawning habitat for the Snake River fall run was located well above the Hells Canyon, which is ecologically quite distinct from that found in the lower Snake River (where the fish currently spawn) and the Deschutes River Basin. They further suggested that fish displaced from the mid-Columbia River by the construction of John Day Dam were displaced into the Snake River at a time when Snake River populations were severely depressed. An alternative ESU configuration would include the existing population(s) in the Deschutes River Basin and the populations that historically existed in the John Day, Umatilla, and perhaps the Walla Walla and Klickitat Rivers. Given the relatively healthy status of the existing population, they recommended that this population not be listed. ODFW (1999c) suggested an alternative configuration that would group the Deschutes River fall-run chinook salmon population with the Upper Columbia River Summer- and Fall-Run Chinook Salmon ESU.

AK (1998) agreed with NMFS in the inclusion of the Deschutes River population into the Snake River Fall-Run Chinook Salmon ESU ("Available scientific and commercial data clearly support the conclusion that they are from the same evolutionary lineage and therefore should be considered together as one ESU".) Additionally, NMFS should include the Lyons Ferry Hatchery population into the ESU for purposes of risk determination. AK (1998) also asserted that jacks should be included in the ESU abundance for the risk determination. Finally, AK (1998) presented information that indicates that the 1978 abundance was lower than the 1990 abundance. This was based on the inclusion of non-Snake River strays in to 1978 abundance estimate, and the exclusion of Lyons Ferry fish and strays from outside of the ESU in the 1990 estimates. Given the abundance of naturally-spawning fish in the Deschutes River and fish returning to the Lyons Ferry Hatchery, it was the opinion of AK (1998) that this ESU is not in danger of extinction, now or in the foreseeable future.

IDFG (1999) disagreed with the inclusion of the Deschutes River into the Snake River Fall-Run Chinook Salmon ESU, but concurred with a minority opinion that grouped the Deschutes River with "extinct" populations in the John Day, Umatilla, and Walla Walla Rivers. They stated that a host of uncertainties relative to the genetic characteristics, CWT data, and recent history of the Deschutes River population(s), make separating the Deschutes River fall-run chinook salmon from the Snake River Fall-Run Chinook Salmon ESU a reasonable step. Furthermore, the creation of distinct Snake River and Deschutes River ESUs would be a more effective management structure.

USDI (1998) agreed with NMFS in including the Deschutes River fall-run chinook salmon in the Snake River Fall-Run Chinook Salmon ESU.

WDFW (1999) did not comment directly on the inclusion of the Deschutes River into the Snake River Fall-Run ESU, but argued for the continued exclusion of Marion Drain fall-run chinook salmon from either the Snake River Fall-Run Chinook Salmon ESU or a Deschutes River Fall-Run complex.

Scientific Disagreements on Proposed Rule

The following is a summary of issues presented in a memorandum (Schiewe 1998) related to four evolutionarily significant units (ESUs) of chinook salmon that have been proposed for listing under the Endangered Species Act (ESA) and for which there remain substantial scientific disagreements about biological data and its interpretation. These ESUs are: Central Valley Spring Run, Central Valley Fall and Late Fall Runs, Southern Oregon and California Coastal, and Snake River Fall Run. The configuration of an additional ESU, Upper Klamath and Trinity River, which was not proposed for listing, but for which there is substantial scientific disagreement may require further review.

Sources for the information discussed below include public and peer-review comments received on the proposed listing.

I. Issues Relating to ESU Definitions

I.1. Inclusion of spring and fall-run chinook salmon in the same ESU.--A number of co-managers and several of the peer-reviewers felt that in a number of cases where spring- and fall-run chinook salmon were included in the same ESU, distinct ESUs should have been established. These recommendations were substantiated with information on ecological differences in spring and fall-run spawning and juvenile rearing habitat. Furthermore, it was argued that separation in spawning time and location provided a significant amount of reproductive isolation, even in those systems where dams had restricted access to historical spring-run spawning habitat. Several of the commenters highlighted these ecological and life history differences in those ESUs where genetic data were limited or lacking. Furthermore, the commenters stated that the lumping of different runs was inconsistent given the creation of distinct fall- and spring-run ESUs in the Central Valley of California. Alternatively, Utter (1998) (peer reviewer) indicated that the genetic differences observed between the Central Valley Fall- and Late-Fall Chinook Salmon ESU and Central Valley Spring-Run Chinook Salmon ESU were not compelling enough to justify their separation into two ESUs.

ESUs affected: Southern Oregon and California Coastal, Central Valley Fall and Late-Fall, and Central Valley Spring Run.

Comments: The relationship between different chinook salmon temporal runs within the same geographic area varies depending on the region. For example, in Puget Sound and in the Columbia River, considerable information is available on the relationship between spring- and fall-run populations. The two runs are well differentiated by both genetic and life history traits in the upper Columbia and Snake Rivers, whereas the same characters show only modest differences between runs in Puget Sound. These patterns are well established and would not be likely to change if additional information were gathered.

Relationships in some other areas, especially those south of Cape Blanco, Oregon, are much less clear. At the time of the Coastwide Status Review (Myers et al. 1988) the BRT had limited genetic information on the relationship between spring and fall runs in the Central Valley and Klamath River Basin. The only allozyme information available for spring-run chinook salmon in both of these regions is from hatchery broodstocks. Furthermore, available information suggests that these "spring-run" broodstocks have undergone significant hybridization with fall-run chinook salmon returning to the Feather River Hatchery in the Central Valley. In the Upper Klamath and Trinity River Chinook Salmon ESU, there was no genetic information available for naturally-spawning populations. The majority of the BRT concluded that the case for separating the spring and fall runs in this ESU on a habitat and life-history basis alone was not as compelling as was the case in the Central Valley. New genetics information pertinent to this issue is presented and discussed in this memo.

I. 2. Southern Oregon and California Coastal Chinook Salmon ESU Configuration--Oregon Department of Fish and Wildlife (ODFW 1998b), CDFG (1998a), and a number of other commenters disputed the geographic boundaries of this ESU. Comments focused on two main issues: 1) splitting the ESU just south of the Klamath River, and 2) revising the southern boundary to the Russian River or north of the Russian River. Regarding the first issue, genetic data presented in the Status Review indicated that this ESU contained two somewhat distinct subgroups. Populations separated into two geographically distinct regions, with the break between the Klamath River and Redwood Creek. Reviewers argued that the genetic distance that this separation occurred at was comparable to that used to define ESUs in the upper Columbia River Basin. Furthermore, it was argued that there were considerable ecological differences between the northern "Transboundary ESU" and the southern "California Coastal ESU". These geological and environmental differences had been used, in part, by the steelhead BRT to define the boundary between the Klamath Mountain Province and Northern California Steelhead ESUs. ODFW (1998b) further contended that the depressed status of chinook salmon in the southern portion of this ESU was dramatically different from that found in the northern part, and that the causal factor(s) for this difference may be related to environmental differences between the regions of this ESU.

Regarding the second issue of the ESU's southern border, several citations were given to substantiate their claim that self-sustaining chinook salmon populations do not presently, and never did historically, exist in river basins south of the Russian River or in San Francisco Bay. Additionally, they contend that chinook salmon native to the Russian River are extinct, and that the historical abundance of the population was never very large and may have been intermittent.

Comments: In the BRT discussions prior to the proposed listing, a minority of the BRT had concluded that this ESU should be split into two ESUs. Part of the rationale for the majority of the BRT deciding not to divide the ESU was the absence of biological information on populations in the southern portion of the ESU. Although genetic information was available for some southern stocks, a majority of the BRT felt that, in the absence of other supporting information, the genetic differences observed were not large enough to support splitting the ESUs.

At the time of the proposed listing, information on the historical distribution of chinook salmon south of the Mattole River was very limited. Historical records from the turn of the century indicate that the southernmost population was in the Ventura River. The extant coastal populations south of the Mattole River include: fall-run population(s) in the Ten-Mile (Mendocino County), Noyo, Garcia, and Russian Rivers. CDFG (1998a) and other reviewers concluded that the native run in the Russian River was extirpated early in this century, and genetic information and hatchery transfer records indicate that the current population is composed of a myriad of introduced stocks. Chinook salmon have also been observed spawning in the Guadalupe River (south San Francisco Bay), but the BRT was unable to resolve the origin of this population.

New information received since the proposed listing and the BRT conclusions related to these issues are discussed at length later in this memo.

I.3 Snake River Fall-Run Chinook Salmon ESU Configuration--ODFW (1998b), Confederation Tribes of the Warm Springs Reservation (CTWSRO 1998), CRITFC (1998), and other reviewers disagreed with the inclusion of the Deschutes River fall-run chinook salmon into this ESU. They argued that the Deschutes River and Snake River Basins are ecologically distinct. Furthermore, the geographic distance between these basins would preclude any significant genetic exchange, especially if one considers the historical spawning distribution of the Snake River chinook salmon. There were a number of scenarios given to explain the genetic similarity between the Deschutes River and Snake River fall-run populations. One scenario presented by ODFW suggested that due to the loss of the majority of their historical spawning habitat, the existing Snake River Fall-Run Chinook Salmon ESU no longer represented the historic population. An alternative view was that the genetic differences between all ocean-type chinook salmon above the Dalles Dam were relatively small, and the clustering of populations was subject to possible bias depending on the analytical procedures used. It was also stressed that the existing allozyme information was acquired after the Columbia River Basin had undergone considerable alterations (mainstem dam construction) and many of the native populations had been extirpated. It was also suggested that the marine coded-wire tag (CWT) recovery information for the Deschutes River fall-run, was potentially biased due to the limited number of tags recovered and the limited number of broodyears that were tagged. CTWSRO (1999) and Patt (1999) asserts that an ocean-type summer-run existed (and may still exist) in the Deschutes River, and this would evolutionarily link the Deschutes River ocean-type fish more with ocean-type fish in the Upper Columbia Summer- and Fall-Run Chinook Salmon ESU. Some reviewers suggested that all ocean-type chinook salmon above the historical location of Celilo Falls should be considered one ESU. The most commonly suggested alternative ESU configuration included the Deschutes River, and the now extinct populations that were in the John Day, Umatilla, and Walla Walla Rivers, as a separate ESU.

Comments: The BRT had considerable uncertainty regarding the ESU configuration for these populations, and none of the alternatives considered (including the configuration in the proposed rule) was favored by a majority of the members. New information has been presented to the BRT by the CTWSRO (1999), Patt (1999), and ODFW (1999b). This information and the discussion by BRT are presented later in this memo.

II. Issues Related to Risk Analysis

II.1. Consideration of existing conservation programs--A number of comments were received from state and municipal water authorities, irrigation districts, and power companies indicating that the NMFS did not adequately consider existing conservation programs. Examples of programs ranged from the Central Valley-wide CALFED program, to more localized efforts to improve fish passage, water release temperature control, and improvements in flow release ramping rates in a single watershed. It was also highlighted that many of these efforts are occurring in basins with important naturally-spawning populations (Battle Creek, Cow Creek, Butte Creek, Tuolumne River, Mokelumne River).

ESUs affected: Central Valley Fall and Late-Fall Run, Central Valley Spring Run, and Southern Oregon and California Coastal

II.2 Distinguishing naturally-produced and hatchery-produced chinook salmon-- ACWA (1998) and other resources agencies disagreed with the NMFS conclusion that a considerable portion of the naturally-spawning population in the Central Valley were hatchery strays. They argued that in the absence of definitive information regarding the proportion of strays spawning naturally that the BRT could not adequately define risks. Additionally, they argued that if hatchery and natural populations were indistinguishable then hatchery abundance should be included in the risk determination process.

ESUs affected: Central Valley Fall and Late-Fall Run

The (California) DWR (1998) and CDFG (1998a) presented genetic information which indicates that the spring-run chinook salmon population in Butte Creek is not the result of strays from the Feather River Hatchery as was speculated by the BRT. The 1998 abundance estimate for the Butte Creek spring run is approximately 19,000 spawners. If these fish are included in the total abundance estimate for the Central Valley Spring-Run Chinook Salmon ESU there is a several fold increase in abundance.

ESUs affected: Central Valley Spring Run

The State of Alaska (AK 1998), CDFG (1998a), and several other commenters challenged the NMFS exclusion of hatchery fish abundances from the risk assessment. They argued that in many instances hatchery and naturally-spawning fish have co-mingled for generations. These fish are genetically indistinguishable and effectively represent one population. In many cases the persistence of naturally-spawning fish has been dependant on the continued operation of the hatchery program. Under these conditions, they contend, hatchery abundances should be included in the assessment of the risk of extinction for an ESU.

ESUs affected: Puget Sound, Lower Columbia River, Upper Willamette River, Snake River Fall Run, Central Valley Fall and Late-Fall Run

ESU CONFIGURATIONS

New Information on ESU Configurations

Genetic Information

NMFS recently analyzed new genetic data for California chinook salmon. In 1998 and 1999 NMFS, CDFG, USFWS, and USFS collected samples of spawned adult chinook salmon from 13 rivers and hatcheries in the Central Valley and Klamath River Basin (Table 1). The new samples were analyzed along with allozyme data for California and southern Oregon chinook salmon that were previously used in the NMFS coastwide status review (Myers et al. 1998). Genetic relationships among populations were examined with cluster analyses of Cavalli-Sforza and Edwards (1967) chord distances using 34 polymorphic loci that were available from the combined data sets.

The population structure revealed by the new analysis of allozyme data was consistent with the delineations of major genetic groups described in previous genetic studies of California and southern Oregon chinook salmon (Utter et al. 1989, Bartley et al. 1992, Myers et al. 1998). The most genetically divergent group of samples were from the Central Valley (Figs. 1 and 2). The remaining samples formed two large genetic groups composed of samples from the Klamath River Basin and those from coastal rivers. The single sample from the lower Klamath River, Blue Creek, was included in the cluster of coastal samples. The samples from coastal rivers were further differentiated into two subclusters of samples from rivers south of the Klamath River and those to the north (including the Blue Creek sample).

Within the Central Valley, the most genetically divergent sample was from the Coleman NFH winter-run population (Fig. 3). Spring-run chinook salmon sampled from Deer and Butte Creeks were distinct from the winter-run fish sample and also from samples of fall- and late-fall chinook salmon from the Central Valley. The Deer Creek and Butte Creek samples were genetically distinct from each other. The sample of spring-run chinook salmon from the Feather River Hatchery was genetically intermediate between spring- and fall-run samples and most similar to the sample of Feather River Hatchery fall-run chinook salmon. Samples of fall-run and late-fall run populations formed a diverse subcluster that included samples from both Sacramento and San Joaquin populations.

Several subclusters appeared within the samples of chinook salmon from the Klamath River Basin (Fig. 4). The sample from Blue Creek was the most genetically distinct of all the samples from the Klamath River Basin. Samples from the Trinity and Salmon rivers (both fall- and spring-run populations) clustered separately from samples from rivers in the upper Klamath River Basin. The sample of fall-run chinook salmon from the South Fork Trinity River did not cluster closely with any other sample.

Table 1. Allozyme analysis of chinook salmon from California and southern Oregon. Samples in **bold** have been added to the data base since the 1998 West Coast Status Review (Myers et al. 1998). Sample numbers (No.) correspond to data points on Figs. 1-4. NMFS - Northwest Fisheries Science Center, National Marine Fisheries Service; UCD - University of California, Davis (Bartley et al. 1992).

No.	Source	Run	N	Date	Adult / Juvenile	Laboratory
	Sacramento River Basin					
1	**MercedRiver**	**fall**	**40**	**1998**	**A**	**NMFS**
2	Merced Hatchery	fall	180	1988, **1998**	J, **A**	NMFS,UCD
3	**Tuolmne River**	**fall**	**35**	**1998**	**A**	**NMFS**
4	**Stanislas River**	**fall**	**25**	**1998**	**A**	**NMFS**
5	Nimbus Hatchery	fall	250	1981, 1984, 1988	J. J, J	NMFS,UCD
6	Feather Hatchery	fall	300	1981, 1984, 1988	J, J, J	NMFS,UCD
7	Feather Hatchery	spring	244	1981, 1984, 1988	J, J, A	NMFS
8	Coleman Hatchery	fall	279	1981, 1987, **1998**	J, J, **A**	NMFS,UCD
9	**Coleman Hatchery**	**late fall**	**80**	**1999**	**A**	**NMFS**
10	**Upper Sacramento River**	**late fall**	**80**	**1999**	**A**	**NMFS**
11	**Coleman Hatchery**	**winter**	**51**	**1998**	**A**	**NMFS**
12	**Butte Creek**	**spring**	**50**	**1998**	**A**	**NMFS**
13	**Deer Creek**	**spring**	**32**	**1998**	**A**	**NMFS**
	California Coast					
14	Mattole River	fall	150	1984, 1987	J, J	NMFS,UCD
15	Van Duzen River	fall	100	1987	J	UCD
16	Salmon Creek	fall	96	1987	J	UCD
17	Redwood Creek (Eel River)	fall	93	1987	J	UCD
18	Benbow Creek	fall	99	1987	J	UCD
19	Hollow Tree Creek	fall	100	1987	J	UCD
20	Mid Fork Eel River	fall	95	1987	J	UCD
21	Mad River Hatchery	fall	149	1984, 1987	J, J	NMFS,UCD
22	North Fork Mad River	fall	61	1987	J	UCD
23	Redwood Creek.	fall	195	1987	J	UCD
	Klamath and Trinity River Basin					
24	Blue Creek	fall	100	1987	J	UCD
25	Iron Gate Hatchery	fall	247	1981, 1984, 1987	J, J, J	NMFS,UCD

Table 1. (cont)

26 Trinity Hatchery	fall	270	1981, 1984, 1987, **1998**	J, J, J, **A**	NMFS,UCD
27 Trinity Hatchery	spring	250	1982, 1984, **1998**	J, J, **A**	NMFS
28 Salmon River	fall	98	1987	J	UCD
29 Salmon River	**spring**	**29**	**1998**	**A**	**NMFS**
30 Shasta River	fall	131	1984, 1987	J, J	NMFS,UCD
31 Bogus Creek	fall	128	1987	J	UCD
32 South Fork Trinity River	fall	100	1987	J	UCD
Southern Oregon and northern California Coasts					
33 Rowdy Creek Hatchery	fall	112	1984, 1987	J, J	NMFS,UCD
34 Mid fork Smith River	fall	99	1987	J	UCD
35 Winchuck River	fall	170	1984, 1995	A, J	NMFS
36 Chetco River	fall	343	1981, 1984, 1988, 1996	J, J, J, J	NMFS,UCD
37 Pistol River	fall	200	1984, 1995	J, J	NMFS
38 Hunter Creek	fall	100	1995	J	NMFS
39 Cole Rivers Hatchery	spring	263	1981, 1985, 1995	J, J, J	NMFS
40 Applegate River	fall	181	1984, 1988	J, J	NMFS,UCD
41 Rogue River at Gold Hill	fall	100	1988	J	UCD

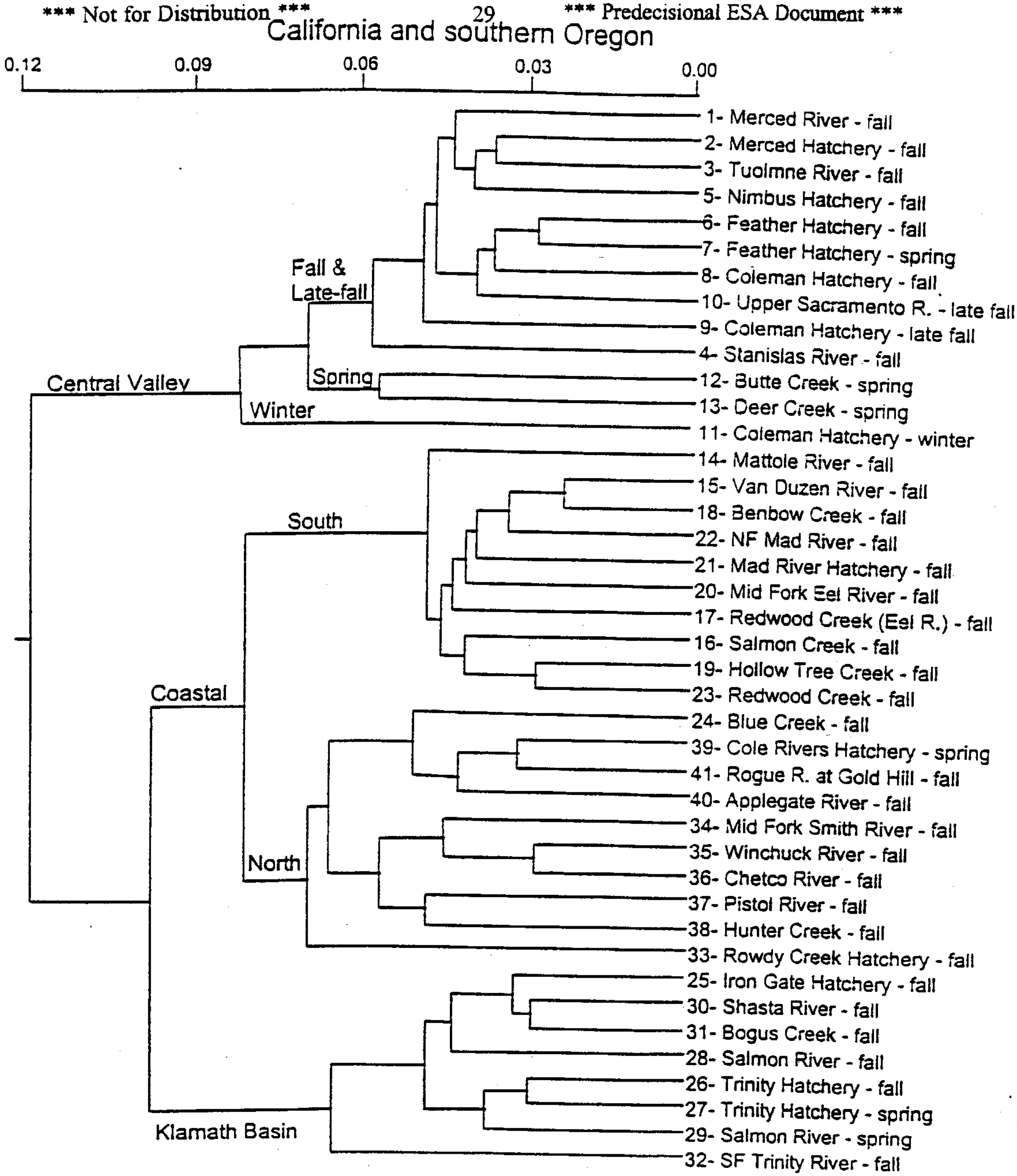

Figure 1. Unweighted pair group method with arithmetic averages (UPGMA) dendrogram of Cavalli-Sforza and Edwards (1967) chord distances based on 34 allozyme loci between 41 composite samples of chinook salmon from California and southern Oregon. Sample numbers correspond to those ~~in~~ Table 1. Data are from Utter et al. 1989, Bartley et al. 1992, and NMFS unpublished.

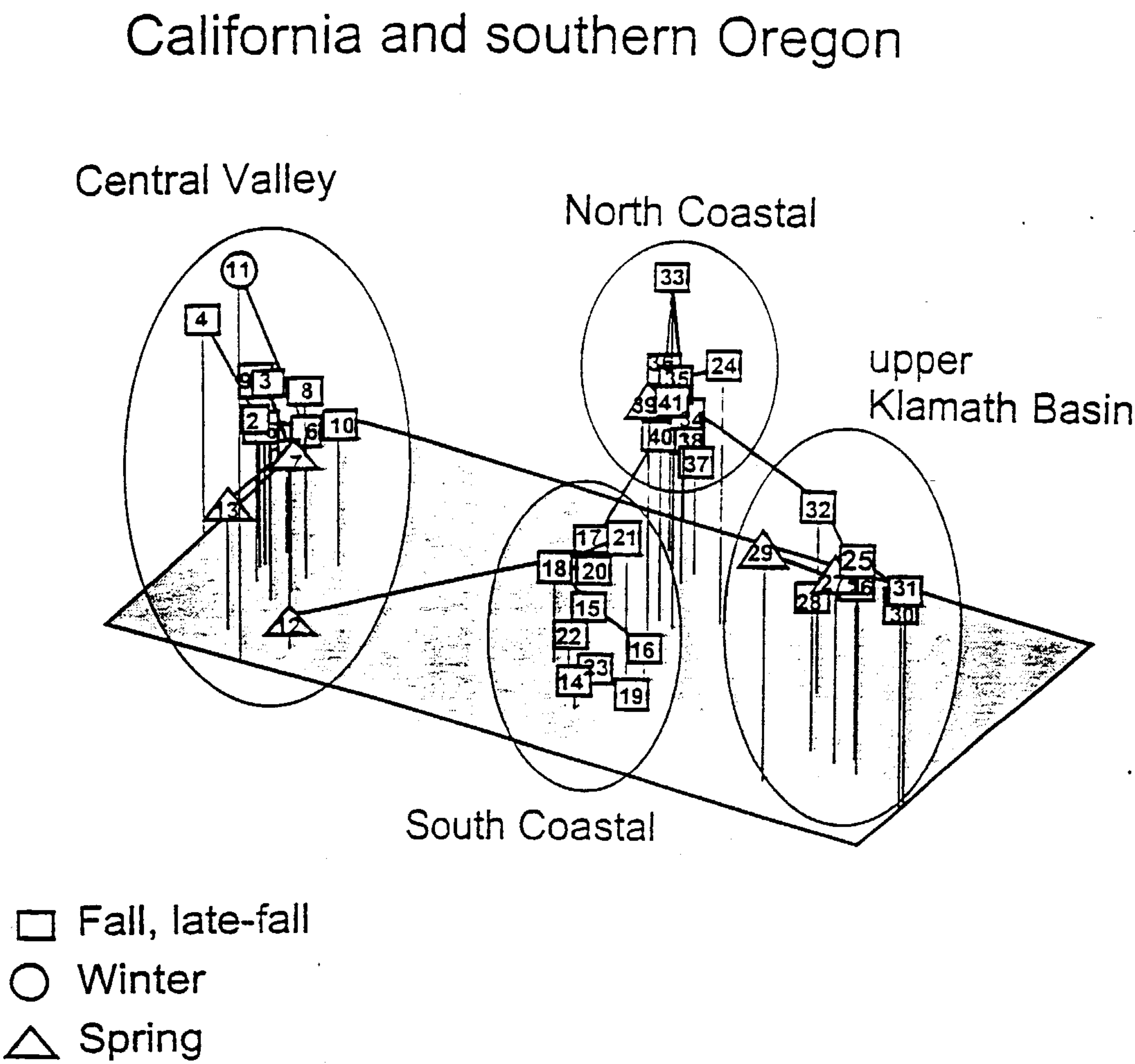

Figure 2. Multidimensional scaling (MDS) of Cavalli-Sforza and Edwards (1967) chord distances based on 34 allozyme loci between 41 composite samples of chinook salmon from California and southern Oregon. Sample numbers correspond to those in Table 1 and to the dendrogram in Figure 1. Data are from Utter et al. 1989, Bartley et al. 1992, and NMFS unpublished.

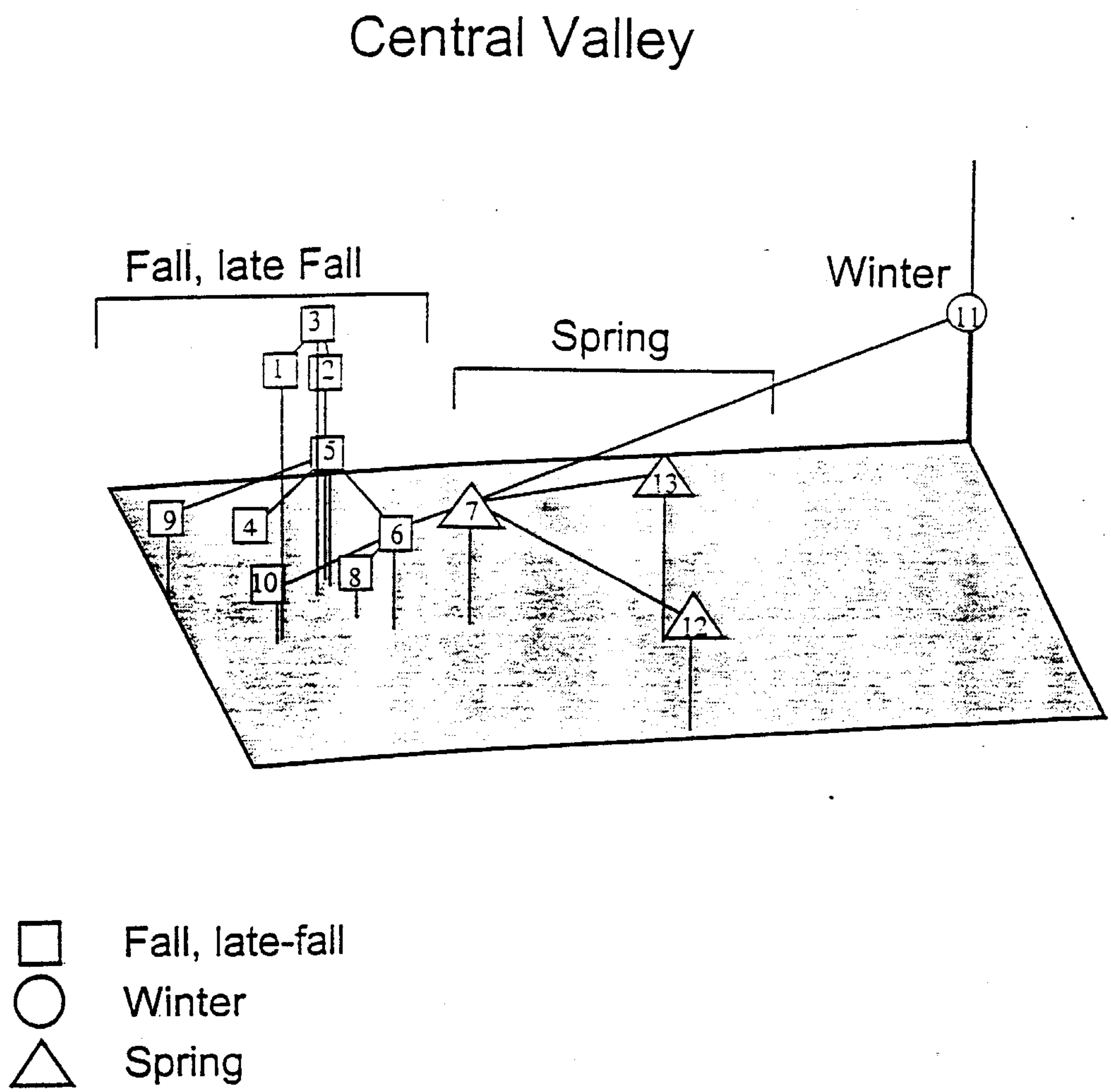

Figure 3. Multidimensional scaling (MDS) of Cavalli-Sforza and Edwards (1967) chord distances based on 34 allozyme loci between 13 composite samples of chinook salmon from California's Central Valley. Sample numbers correspond to those in Table 1. Data are from Utter et al. 1989, Bartley et al. 1992, and NMFS unpublished.

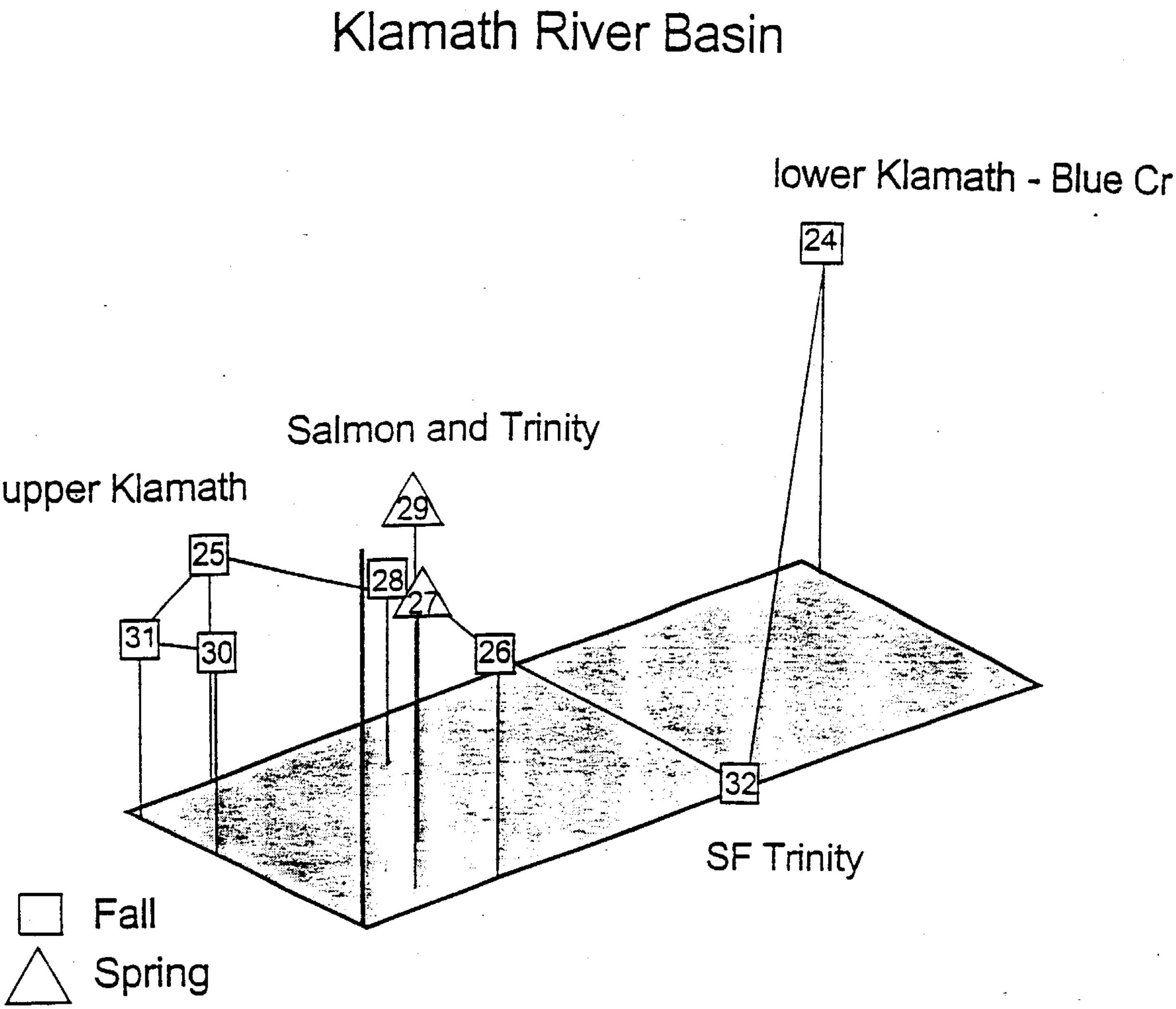

Figure 4. Multidimensional scaling (MDS) plot of Cavalli-Sforza and Edwards (1967) chord distances based on 34 allozyme loci between 9 composite samples of chinook salmon from the Klamath River Basin. Sample numbers correspond to those in Table 1. Data are from Utter et al. 1989, Bartley et al. 1992, and NMFS unpublished.

Microsatellite DNA variation has also been used in recent studies to examine genetic relationships among populations of chinook salmon in California. Nielsen et al. (1994) surveyed 10 microsatellite loci in samples taken in 19 Central Valley rivers and hatcheries to study genetic diversity within and among winter-, spring-, fall-, and late-fall runs of chinook salmon. Samples were collected in more than a single year from 16 locations. Analysis of molecular variance showed that 10.7% of microsatellite allelic variation could be attributed to year-to-year variations within populations. Only 6.6% was attributable to differences among temporal spawning runs, suggesting relatively recent within-basin divergence of spawning timing. The Sacramento River winter-run population was the most genetically divergent population examined in their study and was most closely related to spring-run chinook salmon from Butte Creek. Paired comparisons of microsatellite allelic frequencies among spring-run chinook salmon demonstrated significant differences in fish collected from Deer, Mill, and Butte Creeks. Spring-run populations as a whole were differentiated from other spawning runs (winter, fall, and late-fall runs)

Nielsen also found significant heterogeneity among fall-run hatchery stocks and also among natural spawning fall-run populations but there was no significant geographic structure at the basin level for wild fall-run chinook salmon. However, comparisons of wild fall-run carcasses and hatchery stocks suggest that naturally-spawning fall-run fish in several basins retain some degree of genetic distinctiveness not found in hatcheries. Allele-frequencies for carcass collections made on the American, Tuolumne, Merced, and Feather Rivers were significantly different from samples of hatchery populations found within the same drainage. Merced and Mokelumne Rivers were found to be most similar to hatchery populations on their respective rivers. The heterogeniety comparisons for some wild fall-run carcass collections may have been biased by small sample sizes (<20). Fall-run hatchery populations were differentiated from populations of other run-times but samples of wild fall-run populations were not compared to populations of winter-, spring- or late-fall runs.

Naturally spawning late-fall run fish were differentiated in allozyme analysis from all other populations including Coleman NFH late-fall run salmon. The natural spawning late-fall run population was most genetically similar to either winter-run fish or the Coleman NFH late-fall population, depending on the genetic distance measure used. Nei's genetic distance indicated that late-fall run populations were most similar to hatchery fall-run populations.

Banks et al. (1999) studied 5 to 11 microsatellite loci in 41 samples to assess genetic diversity among winter-, spring-, fall, and late-fall run chinook salmon in California's Central Valley. Samples were collected from 1991 through 1997 at 19 localities. Prior to analysis, samples were corrected for run admixture (by removing individuals which were identified as belonging to other temporal runs) and then pooled into homogeneous samples within each run. Six samples had significant linkage disequilibria, which can be an indication of genetic admixture. Removal of small numbers of fish brought three of these samples into equilibrium. Significant linkage disequilibrium remained in two fall-run samples from Coleman NFH and a wild fall-run sample from the Sacramento River despite the removal of substantial numbers of fish. These samples were dropped from subsequent analyses that assessed genetic differentiation among run-times. The largest set of homogeneous samples within each run was then determined by stepwise removal of individual samples until F_{ST} for the remaining population pool was nonsignificant ($p = 0.05$). Five homogeneous sub-populations were found: 1) wild and hatchery broodstock winter-run (1996 sample excluded), 2) wild spring-run from Deer and Mill Creeks, 3) wild spring-run from Butte Creek (1994 sample excluded), 4) wild and hatchery fall-run (American River wild 1995, Stanislaus River wild 1995, Merced River wild 1995, Coleman NFH 1994 excluded), and 5) wild and hatchery late-fall run. Winter-run samples were the most genetically divergent. Butte Creek spring-run chinook salmon were the next most divergent, followed by spring-run samples from Deer and Mill Creeks. Fall and late-fall runs were separated by a very small genetic distance. It is noteworthy that the sample of Butte Creek spring-run fish did not show evidence of introgression from Feather River hatchery fall-run stock. However, fewer alleles and lower heterozygosities in both winter-run and Butte Creek spring-run samples indicate that these populations may have experienced past reductions in population size.

Banks et al. (1999) used 5 microsatellite loci to investigate genetic relationships among 11 fall- and spring-run chinook salmon populations in the Klamath River and to compare these populations to chinook salmon from the Central Valley. Despite extensive experimentation, no homogeneous population pools were found. Thus, population samples were kept separate and a unweighted pair group method with arithmetic averages (UPGMA) dendrogram was constructed using Nei's (1978) genetic distance. The dendrogram revealed two large clusters of populations. Klamath River Basin populations were differentiated from Central Valley populations. Winter-run chinook salmon were genetically distinct and did not cluster with other populations. Within the Klamath River Basin, Blue Creek from the lower Klamath River was the most genetically divergent population. The most upstream populations from the Klamath River (Scott River, Shasta River, and Iron Gate Hatchery) were differentiated from subclusters of fall- and spring-run populations in the Trinity and Salmon Rivers.

Nielsen et al. (1994) and Nielsen (1995) examined mitochondrial DNA variation in 14 samples of chinook salmon from Central Valley rivers and hatcheries and 1 sample from Guadalupe River, a southern tributary of San Francisco Bay. Fisher's exact comparisons between spring-run samples from Deer Creek (n=15) and Butte Creek (n=27) were not significant, and a comparison between wild (n=22) and hatchery (n=8) late-fall was also not significant. Both spring-run and late-fall run were different in mtDNA haplotype frequency from winter- and fall-runs. Nielsen et al. (1999) concluded that their data support their earlier conclusions (Nielsen et al. 1994) that fall-, late-fall, spring-, and winter-runs of Central Valley chinook salmon show consistently significant differences for the mtDNA locus, indicating infrequent straying and limited gene flow among the temporal spawning runs.

Pairwise comparisons of mtDNA samples among rivers showed no significant differences among samples of fall-run chinook salmon collected from carcasses in the Stanislaus (n=11), Merced (n=12), and Tuolumne (n=8) Rivers. Allele frequencies for the samples of fall-run carcasses were compared to those in samples of fall-run fish from Merced (n=60), Feather (n=98), Nimbus (n=52), and Mokelumne (n=14) hatchery populations. The Stanislaus River wild chinook salmon sample was significantly different from all of the hatchery populations except Nimbus Hatchery (American River). The Merced River carcass sample was only different from Feather River Hatchery. Fish from the Tuolumne River were not significantly different from any of the fall-run hatchery populations. Nielsen et al. (1999) concluded that additional sampling is needed to test for significant genetic differences among natural spawning and hatchery populations of fall-run chinook salmon.

A sample of chinook salmon from Guadalupe River (n=29) showed significant haplotype frequency differences from samples of the four spawning runs in the Central Valley, primarily due to a haplotype (CH9) found in 2 fish in the Guadalupe River sampled at the Alameda Expressway. This haplotype has not been observed in fish from the Central Valley but has been found in samples of Russian River chinook salmon. The remaining 27 samples from the Guadalupe River could not be differentiated from chinook salmon from the Merced and Feather River hatcheries using mtDNA.

Kim et al. (1999) et al. examined genetic variation in a major histocompatibility complex exon in winter-, spring-, fall- and late fall-run adult chinook salmon taken from the upper Sacramento River between 1991 and 1995. There were a total of four alleles in the samples. An analysis of population structure indicated that winter-run chinook salmon were the most genetically distinct. Fall- and late fall-run samples were closely related to each other. Spring-run samples were genetically intermediate between the winter and fall-/late fall-runs. A sample of Butte Creek spring-run chinook salmon was genetically similar to mainstem spring-run samples.

On 22 June 1999, the Confederated tribes of the Warm Springs Reservation provided the BRT with a preliminary report of genetic studies of fall-run chinook salmon in the Deschutes River (CTWSRO 1999). Both allozyme and mtDNA loci were used to address the question "Is the Deschutes fall chinook population more genetically and demographically related to the Snake River fall chinook populations than to any other population in the Columbia Basin?" Adult fish were sampled from the Deschutes River and from Priest Rapids and Lyons Ferry hatcheries for mtDNA analysis. Nucleotide diversity and divergence among populations was considered very low. Allozyme analysis was based on samples of juvenile chinook salmon collected from populations in the Deschutes, Clearwater, Grande Ronde, and Columbia (Hanford Reach) rivers and Lyons Ferry and Priest Rapids hatcheries. In the Deschutes River, juvenile fish were collected from above and below Sherar's Falls. Genetic markers were used to separate fall- and spring-run chinook salmon in the juvenile samples. Large proportions of spring-run individuals were found in the samples from the Clearwater (28 of 77) and Grande Ronde (16 of 40) Rivers.

The new samples were analyzed along with allozyme data from previous studies. The authors concluded from the mtDNA and allozyme data that there is little or no geographic organization of

the fall-run genetic data and no compelling evidence to support adding the Deschutes River to the Snake River Fall-Run Chinook Salmon ESU.

Ecological and Life History Information

Central Valley Spring Run Chinook Salmon ESU--The apparent rebound of spring-run chinook salmon in the Butte Creek Basin warrants a review of available historical and current information concerning this population. Yoshiyama et al. (1996) reported that spring, fall, and probably late-fall runs of chinook salmon historically utilized Butte Creek. Gold mining, logging activities, and irrigation withdrawals have all had a considerable impact on habitat quality (Clark 1929, Hanson et al. 1940). In 1917, two diversion dams were constructed by PG & E. The Centerville Diversion Dam eliminated access to the upper watershed (Mills and Ward 1996). Clark (1929) reported that the fall run had declined dramatically, and summer flows in the lower river had been reduced by irrigation withdrawals. There was no mention of the status of a spring run. A survey by Hanson et al. (1940) reported that much of the upper watershed had been logged off, and mining operations continued to impact the river flow. It was reported that " none of the flow of Butte Creek except perhaps a little seepage reaches the Sacramento River during this summer (Hanson et al. 1940)."

Yoshiyama et al. (1996) reported that Butte Creek spring-run chinook salmon enter the creek in February through April (compared to May or June for Feather River spring-run chinook salmon). USFS monitoring (which began in 1930) indicated that flows in Butte Creek peak during the February to June period (peaks vary from 1000 to over 10,000 cfs, 25,000 cfs in 1997), but are below 100 cfs during much of the remainder of the year (USGS 1999). Although Butte Creek originates in the Sierra Nevada Mountains (2000 m), spring run adults spawn at a relatively low altitude (300 m), in part because of the absence of passage at the Centerville Dam. Yoshiyama et al. (1996) were uncertain if spring-run chinook salmon historically migrated above a 7.6 m waterfall located near the Centerville Dam. Spring-run chinook salmon spawn in September. Juveniles emigrate primarily as fry (December - March) and may rear in the Sacramento River Delta for extended periods (Baracco 1996). Fall-run chinook salmon are reported to spawn further downstream, below the Parrot-Phelam Dam (Yoshiyama et al. 1996).

Central Valley Fall and Late-Fall Run Chinook Salmon ESU--Much of the new information concerned the ESU status of the San Joaquin River Basin relative to the Sacramento River Basin. The San Joaquin River Basin includes the Mokelumne, Consumnes, Calaveras, Stanislaus, Tuolumne, and Merced Rivers. Historically, salmon also utilized the Kings River during years of high precipitation (Yoshiyama et al. 1996). Ecologically, the Consumnes and Calaveras are distinct from the other San Joaquin River Basin tributaries in that their flows are influenced by rainfall rather than snow melt. Historically, fall-run chinook salmon were present in all of the basins, and there is some evidence that a late-fall run may have existed in the Mokelumne River (Yoshiyama et al. 1993). Furthermore, Reynolds et al. (1993) described a "winter-run" population that spawned in the Calaveras River from 1972-1984; however, this population appears to have been extirpated and its relationship with other temporal runs in the Central Valley was never established. Impassible dams and water withdrawals have severely reduced the quantity and quality of salmon habitat in the San Joaquin River Basin. Presently, only 45 percent of the total historical chinook salmon habitat is accessible (not including habitat in the Kings River Basin). Much of the habitat lost would have been utilized by spring run chinook salmon; moreover, water conditions in the remaining habitat are degraded. Ecologically, rivers in the San Joaquin (including the Mokelumne River) and American River Basins experience peak flows in May, fed primarily by snow melt from the Sierra Nevada Range. Geologically, the Sierra Nevada Range is very different from the volcanic structure of the Cascades that constitute the headwaters for most rivers in the northern portion of the Central Valley.

There is little historical information concerning the life history characteristics of fall-run chinook salmon in the San Joaquin River Basin. Fall-run chinook salmon in the San Joaquin River Basin enter freshwater in late September or October (depending on water conditions), and spawn in November and December, with some spawning continuing into January. The mean date of entry (for the years 1974-95) into the trap at the Merced River Fish Facility is 21 October. In 1939, Hatton (1940) reported that the date of river entry for the fall run varied from early and mid-October for the Tuolumne and Merced Rivers, early November for the Mokelumne River, and early December for the Consumnes River. The majority of juveniles emigrate during their first winter (January to March). The run and spawn timing currently exhibited by fall-run fish in the San Joaquin River Basin may not reflect historical timing due, in part, to changes in river flow and temperature conditions over the last century. However, it is clear that the environmental conditions in the San Joaquin River represent the extreme of chinook salmon temperature tolerance. In the 1870s, salmon were observed migrating through the San Joaquin River in July and August when water temperatures were in excess of 26° C (USFC 1876). Despite an apparent tolerance to high water temperatures conditions San Joaquin River Basin chinook salmon populations continued to decline until only the late portion of the fall run remained to ascend the tributaries (Clark 1929).

The age at maturation for fall-run chinook salmon varies considerably from year to year, due to differential survival of emigrating juveniles and returning adults related to water conditions. Most notably, a number of female San Joaquin River fall-run chinook salmon mature after only two years (Myers et al. 1998).

Southern Oregon and California Coastal Chinook Salmon ESU--Little new information on the life history traits is available for this ESU. The timing of adult chinook salmon passage over dams in the Mad River (Sweasey Dam) and South Fork Eel River (Benbow

Dam) in 1948-49 (Murphy and Shapovalov 1950) does not indicate a shift in run-timing when compared with recent information presented in Myers et al. (1998), indicating that introductions of out-of-basin stocks have had little observable impact.

Review of ocean distribution information collected in 1986-1989 (Gall et al. 1989) suggests that there may be geographic and timing differences in the ocean distribution of chinook salmon from the Smith River and Southern Oregon relative to the more southenly Eel River and other coastal stocks.

There was little information available on the southern limit of self-sustaining chinook populations in this ESU. Cobb (1930) discussed the existence of fall-run populations in the Noyo and Mattole Rivers; furthermore, the Noyo River fall-run population was large enough to sustain a small fishery early in this century. Clark (1940) estimated that the salmon catch in the Eel River during 1916 was nearly 450,000 kgs, and 32,000 kgs. in the Mad River during 1918. Snyder (1908) described the presence of chinook salmon in the Russian River; however, Shapavalov (1944) made no mention of the presence of chinook salmon in the Russian River. In October of 1972, a number of salmon (no identification of the species was possible) were observed spawning in the Russian River below Dry Creek (Holman 1972). Nielsen et al. (1994) reported that mtDNA haplotypes from some of the fall-run chinook salmon smolts captured in 1993 and 1994 from the Russian River did not match haplotypes from the Russian River hatchery (Warm Springs Hatchery) population; in fact, there was a rare haplotype that was only found in chinook salmon from the Russian and Guadalupe (San Francisco Bay) Rivers . In 1999, several naturally-produced chinook salmon juveniles (~130) were collected in the Russian River Basin by the Sonoma County Water Agency and a subset of these have been genetically analyzed by the Bodega Bay Marine Lab.

Within San Francisco Bay there are a number of streams where chinook salmon have been observed (Jones 1999). Spawning chinook salmon or redds have been observed in the Guadalupe River, Napa River, Petaluma River, Walnut Creek, and Green Valley Creek (Jones 1999). There is very little information on the origin or sustainability of chinook salmon "populations" in these systems, except for fish sampled in Guadalupe River, which show genetic affinities to Central Valley and Russian River fall-run fish (Nielsen 1994).

South of San Francisco Bay, chinook salmon have historically been documented in the San Lorenzo and Pajaro Rivers (Snyder 1913), and the Ventura River (Jordan and Gilbert 1881). Recently, adult chinook salmon have also been observed in Scott Creek, but in low numbers and only on an intermittent basis (D. Streig, Monterey Bay Salmon & Trout Project, pers. comm.). Currently, there are no known persistent populations of chinook salmon on the coast south of San Francisco Bay.

Snake River Fall-Run Chinook Salmon ESU--The similarity in life history traits between the Deschutes and Snake River fall-run populations was an important factor in the proposed ESU designation incorporating these two geographically separated basins into one ESU. The CTWSRO (1999) has provided both new information on life history traits and a reanalysis of information previously reviewed by the BRT (Myers et al. 1998). Similarities in ocean distribution, as reflected by CWT recoveries, were observed for wild Deschutes River fall-run and Snake River fall-run chinook salmon. Analysis by CTWSRO (1999) indicates that there was a strong correlation (0.95) in the ocean distributions of Deschutes River and Snake River fish; however, there were equally strong similarities between Deschutes River fish and fall-run fish from a number of Lower Columbia River Basins. The correlation between the distribution of ocean recoveries for the Deschutes River fall run and upriver "bright" fall-run chinook salmon (i.e. Hanford Reach, Priest Rapids) was much weaker (0.61). Because only 35,000 Deschutes River fall-run fish were tagged during each of three broodyears (1977-1979), and of these only 79 tags were recovered in the ocean fishery, the CTWSRO (Patt 1999) cautioned the use of this information to establish the ESU configuration.

Age structure information was also used in the initial BRT decision to group fall-run chinook salmon in the same ESU. In the Coastwide Status Review (Myers et al. 1998), similarities were observed between the Deschutes River and Snake River fall-run populations, relative to Hanford Reach and other upper Columbia River fall-run populations. Age structure for the Deschutes River, Snake River (using Lyons Ferry return data), and Hanford Reach fall run fish was determined using scale data from several broodyears in the late 1970s and 1980s. The CTWSRO (Patt 1999) presented run reconstruction data provided by Howard Schuller (ODFW). For the Deschutes and Hanford Reach data series this information was based on scales recovered from returning adults, age-length indices, and CWT recoveries and represents a more complete description of the populations concerned than was presented in Myers et al. (1998). However, the Snake River age structure data were not based on the direct measurement of Snake River fish, but rather used an index of upriver bright stocks. It was advised that considerable caution be used in employing the Snake River age structure data in any comparisons (H. Schuller, ODFW, pers. comm. June 29, 1999).

Spawn timing differences presented by CTWSRO (1999) indicated that Deschutes River fish spawn primarily in October (in contrast to the November peak spawning cited in Myers et al. 1998), rather than in early and mid November as for fall-run chinook salmon in the Snake River and Hanford Reach of the Columbia River (Myers et al. 1998). This earlier timing may be related to water conditions in the Deschutes River, or may be a indicator of the integration of a historical summer run into the fall run. Historic information indicated that fall-run chinook in the Snake River near Salmon Falls (Rkm 922) used to arrive on the spawning grounds in late August and September, and ripe fish were caught in the fishery in early October (Evermann 1896). Spawning was nearly complete by the end of October. At present, Snake River fall-run chinook salmon spawn in late October and early November (Garcia et al. 1999). Differences in the spawning time of present day and historical Snake River fall-run chinook salmon populations may be a response to different temperature and flow regimes in the lower river (the current accessible habitat), or may indicate the extirpation of the earlier, upriver, spawning populations from the ESU.

Fecundity estimates provided an additional life history trait for comparison. Myers et al. (1998) cited average fecundity values for Deschutes River fall-run chinook salmon of 4,439, and for Lyons Ferry Hatchery fish (Snake River) 3,102 eggs/female (adjusted to 4,011 eggs/female @ a standard length of 740 mm POH) . Other fecundity estimates (Howell et al. 1985) for wild Snake River fall-run chinook salmon (trapped at Oxbow Dam) of 4,276 (1961-1969) and 4,185 eggs/female (1977-1983) do not include spawner sizes and are difficult to compare. Meristic data was also reviewed to assess the similarities between the fall-run stocks under consideration. Of the traits analyzed by Schreck et al. (1986), only lateral line scale counts were potentially useful in discriminating between the Deschutes, Snake, and mainstem Columbia River (Hanford Reach) populations. Deschutes River fall-run chinook salmon exhibited a lower mean lateral scale count (136.6) compared to fall-run fish from Hanford Reach (140.6) and the Snake River (Lyons Ferry Hatchery) (143.3). The Deschutes River lateral line scale counts most closely resembled those from several fall-run populations in the Lower Columbia River (below the location of Celilo Falls); however, these differences may not be statistically significant.

Little documentation is available on the existence of a summer run in the Deschutes River Basin. This issue is relevant to the discussion on ESU configuration due to the ocean-type life history expressed by summer run fish in the Upper Columbia River and the stream-type life history expressed by summer run fish in the Snake River Basin. If, as has been asserted by Patt (1999), a summer run in the Deschutes River Basin exhibited an ocean-type life history then it would provide an evolutionary link with the upper Columbia River ocean-type stocks. Information presented by the CTWSRO (1999) suggests that there was a significant temporal separation in the arrival of spring-run and so-called summer/fall-run adults at the Pelton Dam Trap (Rkm 161). Jonasson and Lindsay (1988), Beaty (1996), and Lichatowich (1998) also have suggested that a summer-run existed in the Deschutes River.

Whether these summer-run fish historically spawned above the present site of Pelton Dam, or above Sherar's Falls, which reportedly was impassable during low summer flows early in this century, is not known although both scenarios would have provided for the geographic separation of summer and fall runs. In the 1960s, three returning adults that were tagged passing Bonneville Dam during July were later recovered in the Metolious River, tributary to the Deschutes River at Rkm 178 (above Pelton Dam) (Galbreath 1966). However, Nehlsen (1995) cited several personal communications which indicate that fall spawning fish were not observed in the Basin above the site of Pelton Dam. Analysis of downstream juvenile migrants (1959-1962) through the Pelton project did not detect any subyearling migrants (which would be consistent with the presence of ocean-type fish).

Analysis of mtDNA variability from fish sampled at Sherar's Falls and the Pelton Dam Trap suggests that genetic differences exist between adults collected at the two sampling locations (CTWSRO, 1999). It has been suggested that the genetic differences are indicative of a vestigial run of summer-run fish that have retained the propensity to migrate farther upstream than do fall-run fish. However, Jonasson and Lindsey (1988) state that there in no correlation between the date of ascending Sherar's Falls and the date or location of subsequent spawning. Furthermore, analysis of scales from adults sampled at Sherar's Falls in 1978 indicated that stream-type fish constituted 31.2%, 25%, 4.4%, and 2.2% of run passing the Falls in July, August, September, and October, respectively (Aho et al. 1979). During 1979, the percentage of stream-type fish during this same period dropped to 14%, 5.5% for July and August, respectively. The possibility exists that many of the fish sampled in the mtDNA study (especially at the Pelton Trap) were stream-type fish; further analysis of allozyme variation may resolve this issue.

Ecological differences between the Deschutes River Basin, the upper Columbia River Basin, and the Snake River Basin (especially historical fall-run spawning areas in the upper mainstem Snake River) were reviewed previously (Waples et al. 1991; Myers et al. 1998). Although the mainstem Columbia River and the lower reaches of its tributaries (including the Snake River) are all in the Columbia River Basin Ecoregion (Omernick and Gallant 1986), the upper Snake River (above the Hells Canyon Dam complex) flows through three different ecoregions. Irving and Bjornn (1981) indicated that prior to 1958 the major spawning area for Snake River fall-run chinook salmon was in a 30 mile section between Swan Falls Dam and Marsing, Idaho, and historically, fall-run chinook salmon spawning extended as far upstream as Shoshone Falls (Howell et al. 1985). Historically, most of the fall-run chinook spawning would have taken place in the Snake River Basin/High Desert Ecoregion.

Fall-run chinook salmon population(s) in the John Day, Umatilla, and Walla Walla Rivers were thought to have been extirpated (Kostow 1995). However, there have been recent reports of chinook salmon spawning in the lower mainstem John Day River, but there is no information to establish the source of these fish, or whether they were reproductively successful.

Discussions and Conclusions by the BRT on ESU Configurations

Central Valley Spring-Run Chinook Salmon ESU

The BRT reiterated its previous decisions that the spring run populations in the Central Valley constitute a distinct ESU, and that the extirpated spring-run populations in the southern portion of this ESU may have constituted their own ESU (based on ecological and biogeographical data).

The BRT discussed several issues related to the configuration of the Central Valley Spring-Run Chinook Salmon ESU. It was agreed that the genetic data (allozyme, microsatellite and MHC DNA, and mtDNA) indicated that spring-run fish spawning in Butte Creek were not the progeny of Feather River Hatchery spring-run releases, but represented a naturally spawning population distinct from both Feather River fish and spring-run chinook salmon in Deer and Mill Creek. Further sampling and analysis of mainstem Sacramento River spring-run fish (the population not presently genetically described) was identified by the BRT as potentially important to further understanding the relationship among Central Valley spring-run chinook salmon populations. Furthermore, the BRT generally agreed that hatchery operations at the Feather River Hatchery had resulted in the hybridization of spring- and fall-run fish. However, the BRT concluded that the Feather River spring run may retain "spring run" life history characteristics and was still part of this ESU.

Central Valley Fall- and Late-Fall Run Chinook Salmon ESU

The majority of the BRT concurred with proposed configuration of the Central Valley Fall- and Late-Fall Run Chinook Salmon ESU. It was agreed that the new genetic information on spring-run and winter-run populations in the Central Valley further reinforced the previous decision by the BRT to establish ESUs for the winter- and spring-run distinct from the fall and late-fall run (Myers et al. 1998). The BRT also reaffirmed its previous conclusion that Central Valley fall- and late-fall runs are in the same ESU.

There was considerable discussion about the possible existence of a distinct fall- and late-fall run ESU in the southern portion of the exiting ESU. A majority of the BRT members felt it was likely that, historically, ecological differences in the northern and southern Central Valley were large enough to have historically supported two ESUs of fall- and late-fall chinook salmon, with fish from the American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin River Basins being in the southern ESU and fish from areas north of the American River being in a northern ESU. Allozyme analysis indicated that samples of hatchery and naturally-spawning fall-run chinook salmon from the American River and San Joaquin River Basin formed a cluster within the general grouping of Central Valley chinook salmon populations. Some BRT members felt that the genetic distinctiveness of some samples of natural spawners in San Joaquin River Basin was indicative of vestigial native populations. Another view expressed by members of the BRT was that the between-population diversity among fall-run populations in the Central Valley has been artificially constricted due to large scale transfers of hatchery fall-run chinook salmon, and that the apparent genetic outliers may reflect within-ESU diversity that existed prior to anthropogenic impacts. Most of the BRT felt that, even if two ESUs of fall- and late-fall chinook salmon historically occurred in the Central Valley, only a single ESU is identifiable now. A minority of the BRT felt that life history, ecological, and biogeographic information indicates that two ESUs still exist.

The status of chinook salmon spawning in tributaries to San Francisco Bay was also discussed. The presence of chinook salmon adults (including observed spawning activities) has been recorded in a number of rivers and creeks draining into San Francisco Bay; however, the BRT was unable to establish if any of these populations were self-sustaining. Although the historical relationship between chinook salmon spawning in San Francisco Bay tributaries and the coastal and Central Valley ESUs is not known, present day adults may have originated from the numerous off-site releases of Central Valley hatchery fall-run chinook salmon into the delta or San Francisco Bay. Additional information on genetic and life history traits for San Francisco Bay chinook salmon and their relationships with Central Valley and coastal chinook salmon populations are necessary to resolve this issue.

"Proposed" Southern Oregon and California Coastal Chinook Salmon ESU: Southern Oregon and Northern California Coastal Chinook Salmon ESU California Coastal Chinook Salmon ESU.

The majority of the BRT concluded that the proposed Southern Oregon and California Coastal Chinook Salmon ESU be split into two ESUs; Southern Oregon and Northern California Coastal Chinook Salmon ESU, extending from Euchre Creek through the Lower Klamath River (inclusive), and California Coastal Chinook Salmon ESU, extending from Redwood Creek south through the Russian River (inclusive). This new ESU boundary is similar to that designated between Klamath Mountain Province and Northern California Steelhead ESUs. The BRT concluded that the Russian River Basin presently contained the most southern persistent population of chinook salmon on the California coast. Historically, chinook salmon were observed as far south as the Ventura River (Myers et al. 1998); however, it is unclear if coastal populations south of the Russian River were historically persistent or if they were merely colonized by more northerly populations on an intermittent basis during favorable climatic periods.

The BRT reconsidered the reconfiguration of this proposed ESU based on a number of issues. The acquisition of new samples for allozyme analysis from the Central Valley and Upper Klamath and Trinity River made possible a new analysis indicating distinct clusters of coastal populations north and south of the Klamath River, with genetic distances between these clusters corresponding roughly to the differences observed between Central Valley Spring and Fall and Late-Fall Chinook Salmon ESUs, and the Washington and Oregon Coast Chinook Salmon ESUs.

Ecological differences between the northern and southern portions of the Southern Oregon and California Coastal Chinook Salmon ESUs were also discussed. Rivers to the north (especially the Rogue River) tended to be somewhat larger than those to the south . River flows in the northern portion tend to peak in January, while those to the south peak in February (Myers et al. 1998). Annual precipitation is considerably higher in the northern portion than the south. These geographic and ecological differences may be responsible for the presence of a limited proportion of yearling outmigrants (<10%) in the northern portion of the ESU compared with the apparent absence of yearling outmigrants in the southern portion. Furthermore, soils in the southern portion are highly erosive, causing high silt loads that result in berms which close off the mouths of many of the rivers during summer low flows. River conditions in most of these coastal basins have very limited temporal windows for adult access and juvenile emigration, especially in the south. Given these conditions, it is unlikely that substantial differences in the life history traits normally measured (run timing, spawning timing, juvenile emigration) could evolve among most rivers in the northern and southern portions of this ESU. However, the BRT did consider the presence of spring-run chinook salmon in the northern portion of the ESU, Rogue and Smith Rivers, as a further indicator of geographic and life history differences (although there may have historically been a spring run in the Eel River). Finally, there was some ocean harvest information presented that indicated differences in the migration pattern of populations from the northern (Rogue and Smith Rivers) and southern (Eel River) portions of the proposed ESU (Gall et al. 1989).

"Proposed" Snake River Fall-Run Chinook Salmon ESU:
Deschutes River Summer/Fall-Run Chinook Salmon ESU
Snake River Fall-Run Chinook Salmon ESU

The majority of the BRT felt that the proposed ESU configuration, combining ocean-type fish in the Snake and Deschutes River Basins into one ESU, was not supported by the information available. A slight majority concluded that the Deschutes River summer/fall-run should be considered its own ESU, rather than be grouped with either the Snake River Fall-Run or Upper Columbia River Summer- and Fall-Run Chinook Salmon ESUs. There was considerable uncertainty on the historical configuration of this new ESU--specifically whether it included fall-run populations in the John Day, Umatilla, and Walla Walla Rivers.

In reaching this conclusion the BRT discussed at length several scenarios for the configuration of the Snake River Fall-Run Chinook Salmon ESU and the potential reconfiguration of the Upper Columbia River Summer- and Fall-Run Chinook Salmon ESU. The BRT identified four configurations for discussion: 1) the grouping of all ocean-type chinook salmon above the historic site of Celilo Falls into one ESU, 2) the proposed configuration, with Deschutes River summer/fall-run chinook salmon being grouped with the existing Snake River Fall-Run Chinook Salmon ESU and a separate Upper Columbia River Summer- and Fall-Run Chinook Salmon ESU, 3) the grouping of Deschutes River summer/fall-run chinook salmon with other ocean-type mainstem and tributary spawners in the Upper Columbia River Summer- and Fall-Run Chinook Salmon ESU and a separate Snake River Fall-Run Chinook Salmon ESU, and 4) the creation of a new Deschutes River Chinook Salmon ESU, which may or may not have included the extirpated populations that existed in the John Day, Umatilla, and Walla Walla Rivers, along with the separate existing Snake River Fall-Run and Upper Columbia River Summer- and Fall-Run Chinook Salmon ESUs.

There was considerable debate on the importance of ecological and geographic factors in providing the basis for reproductive isolation and local adaptation. Some members of the BRT argued that because the mainstem Columbia River (above Celilo Falls) and the lower reaches of its tributaries are all in the Columbia Basin Ecoregion, there was an ecological link for the majority of the existing spawning populations of ocean-type fish. Historically, mainstem and tributary spawners may have formed a continuum of populations throughout the upper Columbia River and, to a lesser extent the Snake River. Furthermore, genetic and life history differences are modest (or the interpretations of the existing data ambiguous) between ocean-type chinook salmon populations above Celilo Falls, suggesting that perhaps all of the populations are part of a single ESU.

Alternatively, some members of BRT argued that the three lines of evidence (genetics, ecology, life history) used in 1990-91 status review (Waples et al. 1991) to determine that Snake and Upper Columbia fall chinook are in separate ESUs are still valid. In addition, the historic spawning distribution of most of Snake River fall-run populations was well separated from Columbia River fall-run chinook salmon (Irving and Bjornn 1981). After considering all of these factors, none of the BRT felt that the new information provided gave sufficient cause to group all upriver bright fall-run chinook salmon into one ESU.

The BRT reviewed the evidence for including Deschutes River fall-run chinook salmon in the Snake River Fall-Run Chinook Salmon ESU. There was some discussion related to the different interpretations of genetic data and ocean recoveries of CWTs provided by co-managing agencies. Many BRT members were uncertain of the assertion made by CTWSRO (1999) that genetic samples from the Grande Ronde and Clearwater Rivers were representative of historical Snake River populations. Spawning surveys indicated that prior to 1990, redd counts in the Grande Ronde River were at or near zero, with counts in the Clearwater River numbering in the low tens of redds (Irving and Bjornn 1981, Howell et al. 1985, and Garcia et al. 1999). Recent increases in redd counts in the Snake River Basin, above Lower Granite Dam, have coincided with a large influx of non-Snake River fish (PAC 1998), such that CTWSROs genetic sampling may not be representative of native Snake River fish. Nevertheless, the BRT concluded that the weight of genetic evidence, from a number of different sources, indicate a closer relationship of Deschutes River fish with Snake River fish, than with Columbia River fish. Data from CWT studies also show Deschutes River fall-run chinook salmon have an ocean distribution and age at capture more similar to Snake River (both Lyons Ferry Hatchery fish and wild Snake River fish) than to Columbia River upriver bright fall-run populations. Additionally, if (as has been suggested by ODFW 1999c) the Deschutes River fall-run population was part of a larger historic ESU that included the John Day, Umatilla and Walla Walla River, these intermediate populations could have provided a link between the Deschutes and Snake River Basins. However, the ecological distinctiveness of the historical Snake River, Umatilla, and Walla Walla, and Deschutes River spawning habitats argues against them being included in the same ESU; for example, Deschutes is a spring-fed stream with relatively stable water temperature, very different from mainstem Snake River. The BRT was divided on the conclusiveness of the genetic and of ocean distribution data for placing Deschutes River fall-run chinook salmon in the Snake River Fall-Run Chinook Salmon ESU.

Discussions on the grouping of Deschutes River and Upper Columbia River summer- and fall-run populations focused on the historic distribution of mainstem spawners in Columbia River, which extended more or less continuously from Celilo Falls to Kettle Falls, thus providing a link between different tributary populations, including the Deschutes River. In contrast, the center of fall run spawning activity in the Snake River Basin was far removed from the confluence of the Snake and Columbia Rivers. Environmental features of the Columbia River are more similar over this entire area than either is to upper Snake River Basin. Tributary spawners in Yakima, Wenatchee, Okanogan are already in the Upper Columbia River Summer- and Fall-Run Chinook Salmon ESU, so some members of the BRT asserted that it was reasonable to include Deschutes River ocean-type chinook salmon with the other upper river tributaries as well. It was discussed that the Deschutes River summer-run exhibited an ocean-type life history. If that were the case, then the relationship between summer- and fall runs in the Deschutes River would resemble the Upper Columbia River summer- and fall-runs, rather than the situation in the Snake River where the summer and fall-runs are in different evolutionary lineages.

The BRT reaffirmed the conclusion of previous status reviews that had found that Snake River and Upper Columbia River ocean-type fish are in different ESUs. There was much less certainty about the ESU affinities of the Deschutes River population. The scenario with the Deschutes River population in a separate ESU from the Snake River Fall-Run and Upper Columbia River Summer- and Fall-Run Chinook Salmon ESUs, received a slight majority of the votes, with the remainder being about equally divided between options for including the Deschutes River in the Upper Columbia or Snake River Chinook Salmon ESUs. One of the factors that influenced some BRT members to vote for three separate ESUs was the lack of conclusive evidence for including the Deschutes River in either of the existing ESUs. Furthermore, much of the written information was presented to the BRT by the co-managers with little time (< 24 hours) to properly evaluate its accuracy and relevance.

Under the assumption that the Deschutes River population is in a separate ESU from Upper Columbia or Snake River fish, the BRT was not able to resolve the historical extent of that ESU. The major uncertainty centers on the ESU status of historical populations from the John Day, Umatilla, and Walla Walla Rivers, which have been extirpated. The lack of biological information for these historic populations makes a determination of their ESU status difficult. Some of the BRT members felt that the Deschutes River is distinctive enough ecologically to have supported its own ESU, while others felt that the historic ESU probably also included ocean-type populations in tributaries at least as far upstream as the confluence with the Snake River. The BRT did agree that all mainstem Columbia River spawners above Celilo Falls historically were probably part of what is now termed the Upper Columbia River Summer- and Fall-Run

Chinook Salmon ESU. The BRT also agreed that all ocean-type chinook salmon in the Deschutes River (in particular, any vestigial summer-run fish that may exist) are part of the same ESU as the Deschutes River fall-run population.

ESU RISK DETERMINATION

Overall Evaluation of Risk and Uncertainty

To tie the various risk considerations into an overall assessment of extinction risk for each ESU, the BRT members scored risks in a number of categories using a matrix form, then drew conclusions regarding overall risk to the ESU after considering the results. The general risk categories evaluated were: abundance, trends in abundance/productivity/variability, geneticintegrity, and "other risks". More detailed explanation of these categories and of the nature and use of this matrix approach is provided in Myers et al. (1998, Appendix E). The summary of overall risk to an ESU uses categories that correspond to definitions in the Endangered Species Act: in danger of extinction, likely to become endangered in the foreseeable future, or neither. (Note, however, that these votes on overall risk do not correspond to recommendations for a particular listing action. They are based only on past and present biological condition of the populations and do not contain a complete evaluation of conservation measures as required under the ESA for a listing determination.) The risk summary votes do not reflect a simple average of the risk factors for individual categories, but rather a judgement of overall risk based on likely interactions among, and cumulative effects of, the different factors. A single factor with a "high risk" score may be sufficient for an overall conclusion of "in danger of extinction," but such an overall determination also could result from a combination of several factors with low or moderate risk scores.

The BRT used two methods to characterize the uncertainty underlying their risk evaluations. One way the BRT captured the levels of uncertainty associated with the overall risk assessments was for each member to attach a certainty score (1=low, 5=high) to their overall risk evaluation for each ESU. For example, a BRT member who felt strongly that an ESU was likely to become endangered in the foreseeable future (or not currently at significant risk) would vote for that category of risk and assign a certainty score of 4 or 5; if that member were less sure about the level of risk, a lower certainty score would be given to the risk vote.

The second method for characterizing uncertainty was fashioned after an approach used by the Forest Ecosystem Management Assessment Team (FEMAT 1993). Each BRT member was given 10 total "likelihood" points to distribute in any way among the three risk categories. For example, complete confidence that an ESU should be in one risk category would be represented by most or all of the 10 points allocated to that category. Alternatively, a BRT member who was undecided about whether the ESU was endangered but who felt the ESU was at some risk could allocate the same (or nearly the same) number of points into each of the "endangered" and "not presently endangered but likely to become so" categories. This assessment process follows well-documented peer-reviewed methods for making probabilistic judgements (references in FEMAT 1993, p. IV, 40-45). The BRT interpretation of these scores was similar to FEMAT's, which said "the likelihoods are not probabilities in the classical notion of frequencies. They represented degrees of belief [in risk evaluations], expressed in a probability-like scale that could be mathematically aggregated and compared across [ESUs]" (FEMAT 1993 p. IV-44).

General Risk Conclusions

The two methods used by the BRT to characterize uncertainty in risk assessments generally were consistent in their outcomes. In the first method, the certainty scores for most ESUs were moderate to high (in the range of 3 to 5), reflecting a fair amount of certainty regarding the conservation status of chinook salmon in the ESUs evaluated. Results from the FEMAT method were generally concordant with and support information provided by the first method.

That is, when the majority of BRT votes fell in a particular risk category, the majority of likelihood points also fell in the same category. For some of the ESUs, a small fraction of likelihood votes occurred in the "in danger of extinction" category. This result reflects the limited information available for conducting risk evaluations for chinook salmon. Although in many cases available information did not provide conclusive evidence of high risk, it also did not

clearly demonstrate that the ESUs were not at risk. As a result, at least some BRT members felt that they could not completely exclude the possibility that a particular ESU is presently in danger of extinction.

Previous and Updated Risk Information for Chinook Salmon ESUs

The following section first summarizes risk information available to and conclusions of the BRT at the time of the discussion of these ESUs for the Status Review (Myers et al. 1998). NMFS has received updated and new information pertaining to risk–those data spanning more than a few years for adult abundance are summarized in Appendix A. The final subsection within each ESU subheading below briefly discusses new and updated risk information obtained since the Status Review.

Central Valley Spring-Run Chinook Salmon ESU

Historically, spring-run chinook salmon were abundant in the Sacramento River system and constituted the dominant run in the San Joaquin River Basin (Reynolds et al. 1993). Clark (1929) estimated that there were historically 6,000 stream miles of salmonid habitat in the Sacramento-San Joaquin River Basin, but only 510 miles remained by 1928. Subsequently, elimination of access to spawning and rearing habitat resulting from construction of impassable dams has extirpated spring-run chinook salmon from the San Joaquin River Basin and the American River. Construction of impassible dams has also curtailed access to habitat in the upper Sacramento and Feather Rivers.

In 1939, an estimated 5,786 spring-run chinook salmon passed the Anderson-Cottonwood Irrigation Dam (Redding) on the upper Sacramento River (Hanson et al. 1940). Calkins et al. (1940) estimated a spawning escapement of 38,792 fish for the Sacramento River based on fishery landings. In the mid-1960s, CDFG (1965) estimated total spawning escapement of spring-run chinook salmon to be 28,500, with the majority (15,000) spawning in the mainstem Sacramento River and the remainder scattered among Battle, Cottonwood, Antelope, Mill, Deer, Big Chico, and Butte Creeks and the Feather River. CDFG (1965) reported spring-run chinook salmon to be extinct in the Yuba, American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin Rivers. Today, spawner survey data are available for the mainstem Sacramento River, Feather River, Butte Creek, Deer Creek and Mill Creek (Big Eagle & Assoc. and LGL Ltd 1995). Small populations are also reported in Antelope, Battle, Cottonwood, and Big Chico Creeks (Campbell and Moyle 1990, Reynolds et al. 1993, Yoshiyama et al. 1996).

Spawning escapement has been estimated by a combination of methods, including snorkel surveys, aerial surveys, boat surveys, foot surveys, and fishway counts at Red Bluff Diversion Dam (Reavis 1985). The California Department of Fish and Game has estimated spawning escapement since the late 1940s or 1950s for the remaining populations except those in the mainstem Sacramento River, which have been counted at Red Bluff Diversion Dam since 1967. The sum of the 5-year geometric mean escapements for this ESU at the time of the Status Review was 6,700 spawners, of which 4,300 (64%) had returned to the Feather River (Myers et al. 1998; Fig. 29, Appendix E). The Feather River Hatchery releases several million spring-run chinook salmon annually, with the bulk of their production released off-site into the Sacramento River Delta. Therefore, the origin of the fish returning to the Feather River is uncertain, and fish from these releases may stray to other parts of the valley. Of the remaining 2,400 spawners, 435 were in the mainstem Sacramento River where their spawning overlaps in both time and space with the more abundant fall run. Sacramento River mainstem spawners have declined sharply since the mid-1980s, from 5,000-15,000 to a few hundred fish. The Feather River spring-run population is believed to be hybridized with the fall run in the Sacramento River (Reynolds et al. 1993), and probably includes many hatchery strays from the Feather River Hatchery program. The remaining three natural populations (Butte, Deer, and Mill Creeks) are small and, at the time of the Status Review, all had long-term declining trends in abundance (Myers et al. 1998; Fig. 30, Appendix E).

Efforts to enhance runs of Sacramento River spring-run chinook salmon through artificial propagation date back over a century, although programs were not continuously in operation during that period. We found no recent records of introduction of spring-run fish from outside the Sacramento-San Joaquin River Basin. In the 1940s, trapping of adult chinook salmon that originated from areas above Keswick and Shasta Dams may have resulted in stock mixing, and further mixing with fall-run fish apparently occurred with fish transferred to Coleman Hatchery. Deer Creek, one of the locations generally believed most likely to retain essentially native spring-run fish, was a target of adult outplants from the 1940s trapping operation, but the success of those transplants is uncertain. Since 1967, artificial production has focused on the program at the Feather River Hatchery (discussed above). Cramer (1996) reported that half of the hatchery-reared spring-run fish returning to the Feather River did not return to the hatchery, but spawned naturally in the river. Given the large number of juveniles released off station, the potential contribution of straying adults to rivers throughout the Central Valley is considerable. The termination of CWT marking programs for hatchery-derived spring-run fish and the absence of spring-run carcass surveys for most river systems prevented the accurate estimation of the contribution of naturally spawning hatchery strays. Cramer (1996) reported that up to 20% of the Feather River spring-run chinook salmon are recovered in the American River sport fishery. Furthermore, the use of a fixed date to distinguish returning spring- and fall-run fish at the Feather River Hatchery may have resulted in considerable hybridization between the two runs (Campbell and Moyle 1990).

Harvest rates appear to be moderate. Ocean fishery management focuses on the abundant fall run, and no defined management objectives for spring-run fish were in place at the time of the Status Review. In spite of the similarity in ocean distribution with fall-run fish, because of the smaller average size, spring-run harvest rates are probably lower than those for the fall run.

Reynolds et al. (1993) reported that spring-run fish were likely to have interbred with fall-run fish in the mainstem Sacramento and Feather Rivers, but the extent of hybridization was unknown. They also reported that pure strain spring-run fish may still exist in Deer and Mill Creeks.

The only previous assessment of risk to stocks in this ESU is that of Nehlsen et al. (1991), who identified several stocks as being at risk or of special concern (Myers et al. 1998; Appendix E). Four stocks were identified as extinct (spring/summer-run chinook salmon in the American, McCloud, Pit, and San Joaquin [including tributaries] Rivers) and two stocks (spring-run chinook salmon in the Sacramento and Yuba Rivers) were identified as being at a moderate risk of extinction. Due to lack of information on chinook salmon stocks that are presumed to be extinct, the relationship of these stocks to existing ESUs is uncertain. They are listed in the Status Review (Myers et al. 1998) based on geography and to give a complete presentation of the stocks identified by Nehlsen et al. (1991).

Previous Conclusions of the BRT--The majority of the BRT concluded that chinook salmon in this ESU were in danger of extinction; a minority felt that this ESU was not presently in danger of extinction, but was likely to become so in the foreseeable future. The BRT identified several concerns regarding the status of this ESU. Native spring-run chinook salmon have been extirpated from all tributaries in the San Joaquin River Basin, which represents a large portion of the historic range and abundance. The only streams considered to have wild spring-run chinook salmon were Mill and Deer Creeks, and possibly Butte Creek (tributaries to the Sacramento

River), and these were relatively small populations with sharply declining trends. Demographic and genetic risks due to small population sizes were thus considered to be high.

Habitat problems were considered by the BRT to be the most important source of ongoing risk to this ESU. Spring-run fish cannot access most of their historical spawning and rearing habitat in the Sacramento and San Joaquin River Basins (which is now above impassable dams), and current spawning is restricted to the mainstem and a few river tributaries in the Sacramento River. The remaining spawning habitat accessible to fish is severely degraded. Collectively, these habitat problems greatly reduce the resiliency of this ESU to respond to additional stresses in the future. The general degradation of conditions in the Sacramento River Basin (including elevated water temperatures, agricultural and municipal diversions and returns, restricted and regulated flows, entrainment of migrating fish into unscreened or poorly screened diversions, and the poor quality and quantity of remaining habitat) has severely impacted important juvenile rearing habitat and migration corridors.

The BRT also expressed concern for threats to genetic integrity posed by hatchery programs in the Central Valley. Most of the spring-run chinook salmon production in the Central Valley is of hatchery origin, and naturally spawning populations may be interbreeding with both fall- and spring-run hatchery fish. This problem is exacerbated by the increasing production of spring-run chinook salmon from the Feather River Hatchery, especially in light of reports suggesting a high degree of mixing between spring- and fall-run broodstock in the hatcheries. In addition, hatchery strays have been considered to be an increasing problem due to the management practice of releasing a larger proportion of fish off-station (primarily into the Sacramento River delta and San Francisco Bay).

Updated risk information–Abundance of spring-run chinook salmon has increased in several streams since 1996, the most recent year considered in the previous risk evaluation by the BRT (Appendix A). The Feather River population abundance has been fairly constant at 3,000-7,000 fish per year spawning naturally. The 5-year geometric mean abundance of spring-run chinook salmon in the Feather River increased from 4,260 fish through 1996 to 5,013 through 1998. CDFG and other fisheries biologists familiar with Central Valley runs believe that the so-called spring-run fish in the Feather River are not likely to be representative of historically wild spring-run fish because of the introgression between wild spring-run populations and hatchery spring- and fall-run chinook (CDFG 1998a). Nevertheless, two streams that are considered to contain good "wild" populations of spring-run chinook salmon in this ESU, Deer and Mill Creeks, also have shown increases in mean abundance. The 5-year geometric mean abundance in Deer Creek increased from 564 through 1997 to 805 through 1998, and in Mill Creek, the mean abundance increased from 252 through 1996 to 346 through 1998. The short-term trend in abundance in Mill Creek is still negative: a -7.1 percent decline in abundance per year; but the same trend is highly positive in Deer Creek: a +19 % increase per year.

The most impressive change in status since the previous BRT risk evaluation for this ESU has occurred in Butte Creek–in 1998, 20,259 spring-run chinook salmon returned to the creek, resulting in a 5-year geometric mean abundance of 2,302 fish and a 27.8 percent increase in abundance per year. Escapements in this system fell as low as 14 fish in 1987, and have been below 100 fish several times over the last 40 years. As stated earlier, the origin of the Butte Creek fish is not clear. The increased numbers are not easily attributable to hatchery sources from the Feather River because of the dissimilarity in genetic composition (Kim et al. 1999, Banks et al. submitted) and lack of concordance of trends in abundance (CDFG 1998b) of Butte Creek and Feather River fish. The 1998 escapement is impressively large (the largest on record), and is 2.6 times bigger than the 1995 parental cohort (7500). The recent escapements of the other two cohorts; however, were both less than 1,000 fish, and 1999 escapement is expected to be low due to the extreme 1997 New Years Day flood.

The mainstem spawning population of spring-run chinook salmon above Red Bluff Diversion Dam has continued to decline in abundance since the previous risk evaluation. The 5-year geometric mean abundance through 1998 is estimated to be around 300 fish, down from a mean of 435 through 1996.

CDFG discussed sporadic reports of spring-run chinook salmon in Antelope, Cottonwood and Big Chico Creeks, but the infrequent occurrence of these fish indicates that they may not represent self-sustaining populations (CDFG 1998a).

The primary risk factors for this ESU identified by CDFG include competition and hybridization with fall-run chinook and hatchery spring-run chinook, disease, predation, interactions with non-indigenous fish species, and harvest (CDFG 1998a).

Central Valley Fall- and Late-Fall Run Chinook Salmon ESU

The historical abundance of Central Valley fall- and late-fall run chinook salmon is poorly documented. For the San Joaquin River, Reynolds et al. (1993) reported abundance in the early 1990s to be only a remnant of the historical abundance. They estimated that production (ocean-run size) of San Joaquin River fall- and late-fall-run chinook salmon historically approached 300,000 adults and probably averaged approximately 150,000 adults. In the mid-1960s, escapement to the San Joaquin River Basin totaled only about 2,400 fish, spawning in the Stanislaus, Tuolumne, and Merced Rivers.

Calkins et al. (1940) estimated abundance at 55,595 fish in the Sacramento River Basin during the period 1931-39. In the early 1960s, adult escapement was estimated to be 327,000, predominantly in the mainstem Sacramento River (187,000), but with substantial populations in the Feather (50,000), American (36,000), and Yuba (22,000) Rivers and in Battle Creek (21,000); remaining escapement was scattered among numerous tributaries (CDFG 1965). At that time, total Central Valley fall-run chinook salmon escapement (including the Sacramento, Mokelumne, and San Joaquin River Basins) was estimated at 331,700 adults (CDFG 1965).

Much of the historical fall-run spawning area in the Sacramento River was below major dam sites, and therefore the fall run was not as severely affected by early water projects as were spring and winter runs (Reynolds et al. 1993). Extreme stream temperatures are a major limiting factor in juvenile production; gravel depletion, fluctuating flows, flow reversals in the delta, point and non-point source pollution, rearing habitat limitations, and losses at diversions also limit natural production (Dettman et al. 1987, CACSST 1988).

Spawning escapement has been estimated using a variety of survey methods. The larger spawning populations are estimated using modified Schaeffer or Jolly-Seber multiple mark-recapture methods with tagged carcasses (Reavis 1984). The fall and late-fall runs in the mainstem Sacramento River have been monitored since 1967 by counts in the fishways at Red Bluff Diversion Dam. Since 1992, the dam reservoir has been increasingly drawn down from about September to May to allow the winter run to pass unimpeded. This has precluded counting the late-fall run since 1992 and limited counts of late-fall run fish in the last several years.

The bulk of the spawning escapement at the time of the Status Review had been to the Feather and American Rivers and to Battle Creek (Myers et al. 1998; Fig. 29, Appendix E). The long-term trends in escapement were relatively stable, while the recent trends were mixed (Myers et al. 1998; Fig. 30, Appendix E). These are all streams with major salmon hatcheries. State hatcheries on the American and Feather Rivers transport their smolts to saltwater for release to avoid mortality in the delta due to flow reversals, unscreened diversion dams, and predators. Transportation of smolts increases the straying rate of adults when they return and makes it more difficult to account for hatchery strays in the spawning escapement (Cramer 1989). In the San Joaquin River Basin, homing fidelity may be more dependent on the presence of sufficient instream flows (CDFG 1997).

Estimates of the relative contribution of hatchery and natural fish to spawning escapements are difficult to obtain. According to Dettman et al. (1987), for 1978-84 an average of 20% of the ocean catch of Central Valley salmon originated at Feather River Hatchery and 24% at Nimbus Hatchery. For the same period, total Sacramento River spawning escapement was comprised of 22% Feather River Hatchery origin and 26% Nimbus Hatchery origin; 78% of the total Feather River run and 87% of the American River run were hatchery fish. For this period, natural production averaged only 12,000 fish in the Feather River and 8,000 fish in the American River. An alternative analysis (Cramer 1989) concluded that total hatchery contribution to the Sacramento River run for 1978-87 was only about one-third, and hatchery proportions in escapement were only 26% in the Feather River and 29% in the American River. Methods used in both studies have biases; Dettman and Kelley's estimates were biased toward hatchery fish and Cramer's estimates toward natural fish. Cramer suggested that the true proportions are probably somewhere between the two groups of estimates.

Fall- and late-fall-run chinook salmon in the Central Valley have been propagated for more than a century. In general, a relatively small number of hatcheries have accounted for the tens of millions of fall-run fish planted annually. The overwhelming majority of fish used have come from stocks within this ESU (Myers et al. 1998; Table 6, Appendix D). However, the practice of releasing fish off-station, especially into the Sacramento River Delta region, has resulted in widespread straying by hatchery-reared fish (Bartley and Gall 1990, Fisher 1995). Hatchery strays represent a considerable proportion of fish spawning naturally in many rivers, even those rivers without hatcheries. Straying, in conjunction with frequent exchanges of surplus eggs between hatcheries, may be responsible for the low levels of genetic differentiation among fall-run chinook salmon stocks in the Central Valley (Bartley and Gall 1990). The high contribution of hatchery fish to naturally spawning escapement may be due in part to the high survival of hatchery fish that are transported to the Sacramento River Delta (Dettman et al. 1987).

In contrast to the situation with the fall run, the culture of late-fall-run fish has been relatively limited. The majority of production has come from one hatchery (Coleman NFH) and such production has occurred only within the last 20 years. Late-fall-run fish releases constituted less than 2% of the combined fall- and late-fall-run releases for this ESU at the time of the Status Review (Myers et al. 1998).

Ocean harvest rate indices from 1990-94 (Central Valley Index=catch / [catch + escapement]) were in the range of 71-79% (PFMC 1996b). Freshwater recreational harvest at the time of the Status Review was believed to be increasing and approaching 25% (PFMC 1997). Late fall fish are larger in size and experience higher harvest rates. The Central Valley Index is not a true harvest rate because: 1) it does not distinguish between races or cohorts, 2) it does not include freshwater catch or ocean catch landed north of Point Arena, California, and 3) does not include shaker mortality (hook and release mortality of undersized fish).

Angler harvest in the Sacramento River Basin was estimated by creel census in 1991, 1992, and 1993 (Wixom see footnote 10, Wixom et al. 1995). The creel census data provided a harvest estimate of approximately 20% in freshwater for those years.

The only previous assessment of risk to stocks in this ESU is that of Nehlsen et al. (1991), who identified two stocks (San Joaquin and Cosumnes Rivers) as of special concern (Myers et al. 1998, Appendix E). The Cosumnes River has had no documented spawning escapement of fall-run chinook salmon since 1989, and surveys in 1991 through 1994 have failed to find spawning salmon (Big Eagle & Assoc. and LGL Ltd. 1995).

Previous Conclusions of the BRT--A majority of the BRT concluded that chinook salmon in this ESU were not in danger of extinction but were likely to become so in the foreseeable future. A minority of the BRT felt that chinook salmon in this ESU were not presently at significant risk or were undecided on its status. Although total population abundance in this ESU was relatively high, perhaps near historical levels, the BRT previously identified several concerns regarding its status. The abundance of natural fall-run chinook salmon in the San Joaquin River Basin was low, leading a number of BRT members to conclude that a large proportion of the historic range of this ESU has been lost or is in danger of extinction. Most of the historical spawning habitat for this ESU is downstream from impassable dams, so habitat blockage is not as severe as for winter- and spring-run chinook salmon in this region. However, there has been a severe degradation of the remaining habitat, especially due to agricultural and municipal water use activities in the Central Valley (which result in point and non-point pollution, elevated water temperatures, diminished flows, and smolt and adult entrainment into poorly screened or unscreened diversions).

Natural runs throughout the ESU were very depressed at the time of the Status Review. Returns to hatcheries accounted for only about 20% of fall-run chinook salmon spawners in the Central Valley; however, due to high rates of straying by hatchery fish released off-station, production from hatcheries may have been responsible for a much larger proportion of natural spawning escapement. A mitigating factor for the overall risk to the ESU was that a few of the Sacramento and San Joaquin River Basin tributaries were showing recent, short-term increases in abundance. However, those streams supporting natural runs considered to be the least influenced by hatchery fish had the lowest abundance and the most consistently negative trends of all populations in the ESU. In general, high hatchery production combined with infrequent monitoring of natural production made assessing the sustainability of natural production problematic, resulting in substantial uncertainty in assessing the status of this ESU.

Other concerns identified by the BRT previously were the high ocean and freshwater harvest rates in the 1990s, which may have been higher than was sustainable by natural populations, given the productivity of the ESU under habitat conditions during that time.

Updated risk information–The trends in abundance of fall and late-fall run chinook salmon in this ESU continue to be mixed (Appendix A). Natural spawning abundance is quite high (5-year geometric mean = 190,000 natural spawners for the Sacramento River Basin). The number of mainstem fall-run spawners continues to decline in the upper Sacramento River, as indicated by estimates for spawners above Red Bluff Diversion Dam (5-year geometric mean abundance through 1996 = 78,996 fall run, and mean abundance through 1998 = 24,515 fall-run fish). These estimates represent the total number of fall-run chinook salmon returning to that portion of the river, including hatchery fish. Available evidence suggests that at least 20-40% of these natural spawners are of hatchery origin (Heberer 1999). The other Sacramento River Basin streams showing continued declines in abundance of fall-run chinook salmon are Deer and Mill

Creeks (short-term trend in abundance through 1998 = -10 %/year for Mill Creek, long-term trend in abundance through 1998 = -2.8 for Deer Creek). All other streams for which there are abundance data show increases in abundance over the past 10 years. As discussed in the BRT report (Myers et al. 1998), many of the streams with high abundance of fall-run chinook salmon in this ESU are influenced by hatchery programs (especially the Feather and American Rivers and Battle Creek), so the contribution of those populations to overall persistence of the wild component of the ESU is not clear.

The late-fall component of the Sacramento River run continues to have low, but perhaps stable abundances. Recent estimates up to 1992, when Red Bluff Diversion Dam counts were still accurate, ranged from 6,700-9700. Estimates from 1993-1997, were essentially incomplete due to the inability to monitor fish at the Red Bluff Diversion Dam. Beginning in 1998, carcass surveys again allowed a reasonable estimate to be made, and the 1998 abundance estimate (9,717) seems comparable to the early 1990s. Nevertheless, there is considerable uncertainty in estimating the recent trend in abundance due to changes in estimation methods.

Populations of fall-run chinook salmon in the San Joaquin River Basin have exhibited synchronous population booms and busts, and currently they appear to be on an upward trend in abundance. Aside from a negative short-term trend in abundance in the Stanislaus River (short-term trend in abundance through 1998 = -6.2 %/year), the other tributaries to the San Joaquin River are exhibiting increases in abundance over the most recent 10 years (Appendix A). Lindley (unpubl. data) developed a series of models relating recruitment of fall chinook in the Tuolomne and Stanislaus rivers to various factors to see if there was a simple explanation for the high variability in recruitment. Explanatory variables examined included spring river flow, ocean harvest, hatchery releases, sea surface temperature, and spawning stock. The model providing the best fit to empirical data was a logistic growth (stock-recruit) model with the carrying capacity parameter, a linear function of river flow during the downstream juvenile migration period (S. Lindley, unpubl. ms.). The apparent dependency of stock-recruitment relationships on flow does not rule out the potential influences of other factors (e.g., hatchery production) on variability in recruitment (S. Lindley, unpubl. ms.).

The influence of hatchery fish on natural production in the San Joaquin River Basin is not clear. As in the rest of the Central Valley, the nature of coded wire tag applications and insufficient sampling of natural spawners makes quantitative estimation of hatchery influence difficult.

Southern Oregon and California Coastal Chinook Salmon ESU

The peak historic cannery pack of chinook salmon in the range of this ESU was 31,000 cases in 1917, indicating a run-size of about 225,000 at that time. CDFG (1965) estimated escapement for the California portion of the ESU at about 88,000 fish, predominantly in the Eel River (55,500) with smaller populations in the Smith River (15,000), Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several smaller streams in Del Norte and Humboldt counties. Based on the 1968 angler catch records for the Oregon portion of the ESU (which estimated escapements of about 90,000 fish), the average escapement for the entire ESU in the 1960s was estimated to be 178,000 fish.

Within this ESU, more recent abundance data vary regionally. Dam counts of upstream migrants are available on the South Fork Eel River at Benbow Dam from 1938 to 1975, and at Gold Ray Dam on the Rogue River from 1944 to the present. Counts at Cape Horn Dam on the upper Eel River are available from the 1940s to the present, but they represent a small, highly variable portion of the run.

In the Oregon portion of this ESU, coastal rivers are monitored by surveys of index reaches. Surveys were begun in 1948 with the intent of monitoring trends in escapement rather than estimating total escapement (Cooney and Jacobs 1994). Because the original selection criteria for index reaches included ease of access and availability of spawners, spawner densities in these index reaches are not representative of spawner densities in other areas. Consequently, though the spawner counts in index reaches may be relatively precise, they are not accurate for assessing abundance.

In 1953 Oregon began using catch report cards, called "punch cards," to report angler catch in rivers and estuaries (Nicholas and Hankin 1988). This reporting system provides precise estimates of catch on a river-by-river basis, which can be expanded by the harvest rate for each river to provide estimates of terminal run-size. Unfortunately, freshwater and estuarine harvest rates are poorly known for most rivers, and vary considerably. Harvest rates depend on fishing effort and angler success rates. Fishing effort varies with run-size, weather, river conditions, and angler success rate. Angler success rates, in turn, depend on weather and river conditions, as well as run-size. Nicholas and Hankin (1988) used estimates of average angler harvest rates to convert angler catch to run-size. These estimates, although imprecise, are probably more accurate for estimating average run-size than expansions based on peak index counts.

In assessing abundance and trends in the Status Review (Myers et al. 1998), we used expansions of angler catch from ODFW's punch card database (ODFW 1993) and Nicholas and Hankin's (1988) average harvest rates to calculate geometric means of terminal run-size and spawning escapement for the 5-year period 1990-94. Trends were calculated from either the peak index counts or from dam counts where they were available.

Expanded angler catch data produced a 5-year geometric mean spawning escapement of 132,000 (run-size of 148,000) for the Oregon portion of this ESU at the time of the Status Review (Myers et al. 1998). The majority of this escapement (126,000) was the spring and fall runs in the Rogue River (Myers et al. 1998; Fig. 31, Appendix E). No total escapement estimates were available for the California portion of this ESU, although partial counts indicated that escapement in the Eel River exceeded 4,000. Data available to assess trends in abundance were limited. Trends at the time of the Status Review were mixed, with predominantly strong negative trends in the Rogue and Eel River basins, and mostly upward trends elsewhere. Longer term trends, where data were available, were flatter (e.g. Rogue River) (Myers et al. 1998; Fig. 32, Appendix E).

Habitat loss and/or degradation is widespread throughout the range of the ESU. The California Advisory Committee on Salmon and Steelhead Trout (CACSST 1988) reported habitat blockages and fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the most predominant problems for anadromous salmonids in California's coastal basins. They identified associated habitat problems for each major river system in California. CDFG (1965, Vol. III, Part B) reported that the most critical habitat factor for coastal California streams was "degradation due to improper logging followed by massive siltation, log jams, etc." They cited road building as another cause of siltation in some areas. They identified a variety of specific critical habitat problems in individual basins, including extremes of natural flows (Redwood Creek and Eel River), logging practices (Mad, Eel, Mattole, Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers), and dams with no passage facilities (Mad, Eel, and Russian Rivers), and water diversions (Eel and Russian Rivers). The BRT expected that such problems also occur in Oregon streams within the ESU. The Rogue River Basin in particular has been affected by mining activities and unscreened irrigation diversions (Rivers 1963) in addition to problems resulting from logging and dam construction. Kostow (1995) estimated that one-third of spring-run chinook salmon spawning habitat in the Rogue River was inaccessible following the construction of Lost Creek Dam (RKm 253) in 1977. Major flood events in February 1996 and January 1997 probably affected habitat quality and survival of juveniles within this ESU, although the some members of the BRT believe that the long-term effects of these floods may be beneficial to chinook salmon.

Artificial propagation programs have been less extensive in the Southern Oregon and Coastal California Chinook Salmon ESU than in neighboring regions. The Rogue, Chetco and Eel River Basins and Redwood Creek have received numerous releases, derived primarily from local sources. In contrast, releases into the Russian River have been predominately from a variety of sources from outside the ESU (Myers et al. 1998; Table 6, Appendix D). In the absence of genetic information, it is not possible to evaluate the long-term impact of these transfers into the Russian River. San Francisco Bay has also received considerable numbers of introduced fish, the majority of which are off-station releases of Central Valley fall-run chinook salmon. Information on the impact of hatchery-derived fish on naturally spawning populations is limited. For the entire ESU, the hatchery contribution to total spawning escapement is probably low. However, the hatchery-to-wild ratio of Rogue River spring-run chinook salmon, as measured at Gold Ray Dam (RKm 201), has exceeded 60% in some years (Kostow 1995). The majority of the hatchery fish counted at Gold Ray Dam probably return to Cole Rivers Hatchery (located above the dam), but rates of straying into natural spawning habitat are unknown.

Ocean harvest rates for this ESU have not been estimated, but should be comparable to ocean harvest rates on Klamath fall-run chinook salmon (21% in 1991 [PFMC 1996a]). Freshwater and estuarine harvest rates at the time of the Status Review are on the order of 25-30% (calculated from data in PFMC 1996b - Table B4).

Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern (Myers et al. 1998, Appendix E). Nehlsen et al. (1991) identified seven stocks as at high extinction risk and seven stocks as at moderate extinction risk. Higgins et al. (1992) provided a more detailed analysis of some of these stocks, and identified nine chinook salmon stocks as at risk or of concern. Four of these stocks agreed with the Nehlsen et al. (1991) designations, while five fall-run chinook salmon stocks were either reassessed from a moderate risk of extinction to stocks of concern (Redwood Creek, Mad River, and Eel River) or were additions to the Nehlsen et al. (1991) list as stocks of special concern (Little and Bear Rivers). In addition, two fall-run stocks (Smith and Russian Rivers) that Nehlsen et al. (1991) listed as at moderate extinction risk were deleted from the list of stocks at risk by Higgins et al. (1992), although the USFWS (1997a) reported that the deletion for the Russian River was due to a finding that the stock was extinct. Nickelson et al. (1992) considered 11 chinook salmon stocks within the ESU, of which 4 (Applegate River fall run, Middle and Upper Rogue River fall runs, and Upper Rogue River spring run) were identified as healthy, 6 as depressed, and 1 (Chetco River fall run) as of special concern due to hatchery strays. Huntington et al. (1996) identified three healthy Level II fall-run stocks in their survey (Applegate and Middle and Upper Rogue Rivers).

Previous Conclusions of the BRT--The BRT was unanimous in its conclusion that chinook salmon in this ESU were likely to become at risk of extinction in the foreseeable future. Overall abundance of spawners was highly variable among populations, with populations in California and spring-run chinook salmon throughout the ESU being of particular concern. There was a general pattern of downward trends in abundance in most populations for which data were available, with declines being especially pronounced in spring-run populations. The BRT felt that the extremely depressed status of almost all coastal populations south of the Klamath River was an important source of risk to the ESU. There was a general concern expressed by the BRT that no current information was available for many river systems in the southern portion of this ESU, which historically maintained numerous large populations. These populations form a genetically distinct subgroup within the ESU. Although (as discussed above) at the time of the Status Review, the majority of the BRT concluded that these California coastal populations did not form a separate ESU, the BRT acknowledged that they represent a considerable portion of genetic and ecological diversity within this ESU.

Current hatchery contribution to overall abundance was considered relatively low except for the Rogue River spring run, which also contains almost all of the documented spring-run abundance in this ESU. Fall-run chinook salmon in the Rogue River represented the only relatively healthy population the BRT could identify in this ESU. The BRT questioned whether there were sustainable populations outside the Rogue River Basin. All river basins have degraded habitats resulting from agricultural and forestry practices, water diversions, urbanization, mining, and severe recent flooding. The BRT was very concerned about the risks to spring-run chinook in this ESU; their stocks were in low abundance and they had continued to decline dramatically in the years preceding the Status Review. In addition, the lack of population monitoring, particularly in the California portion of the range, led to a high degree of uncertainty regarding the status of these populations.

Southern Oregon-Northern California Coastal Chinook Salmon ESU

As stated in the ESU Determinations section, the BRT concluded that the previously proposed Southern Oregon and California Coastal Chinook Salmon ESU be split into two ESUs at the Klamath River. The southern boundary of the newly defined Southern Oregon and Northern California Chinook Salmon ESU goes up to and includes the Klamath River mouth and lower tributaries. The following section briefly discusses updated risk information considered by the BRT for the redefined Southern Oregon and Northern California Coastal Chinook Salmon ESU.

Updated risk information–New abundance information was provided by the ODFW for a number of smaller Oregon streams in this ESU (Appendix A; ODFW 1999b). Recent total estimated escapement of fall- and spring-run chinook salmon in Oregon streams is close to 100,000 fish (ODFW 1999b). The largest run of fall chinook salmon in the ESU occurs in the Rogue River, and ODFW recently has revised its estimates of abundance to average over 51,000 fish in the run during the most recent 5 years (ODFW 1999b). In addition, ODFW estimated that the escapement of fall chinook to the Chetco River in 1995 and 1996 was 8,500 and 3,500 fish, respectively. In spite of the high estimated abundances in the Chetco River, between 31-58% of those naturally spawning fish were estimated to be of hatchery origin (ODFW 1999b).

Although trends in abundance are mixed over the long term, most short-term trends in abundance of fall chinook salmon are positive in the smaller coastal streams in the ESU. Spawning ground surveys from a number of smaller coastal and tributary streams from Euchre Creek to the Smith River show declines in abundance from the late 1970s through the early 1990s, but recently, the peak counts are predominantly showing increases. In addition to adult counts, downstream migrant trapping generally shows increases in production in fall chinook juveniles over the last four years in the Pistol and Winchuck Rivers and in Lobster Creek, a tributary to the lower Rogue River. Short- and long-term trends in abundance for the Rogue

River fall chinook are declining, but as mentioned above, the overall run size is still large.

Coastal California streams support small, sporadically monitored populations of fall- run chinook salmon (Appendix A). Trends in fall chinook salmon abundance in those California streams that are monitored are mixed; in general, the trends tend to be more negative in streams that are farther south along the coast (i.e., populations in the Eel, Mattole and Russian rivers). Estimates of absolute population abundance are not available for most populations in the California portion of the region encompassing this ESU.

The numbers of hatchery fall chinook salmon released into some southern Oregon coastal streams recently have been reduced or discontinued. Releases of fall chinook salmon into the lower Rogue River were reduced to 75,000 smolts and 75,000 unfed fry, and the Chetco River program recently was reduced to 150,000 smolts (ODFW 1999b). ODFW also has provided the BRT with new estimates of the percentage of hatchery fall chinook salmon spawning naturally in the Chetco River (ODFW 1999b). In 1995 and 1996, the percentage of naturally spawning hatchery fish was 31 % and 58 %, respectively. During those same years, the estimated numbers of naturally spawning adults returning to the Chetco River were 8,530 and 3,561 fall chinook salmon, respectively (ODFW 1999).

Most spring-run chinook salmon in this ESU continue to be distributed in a few, small populations that are declining in abundance (Appendix A). The run size of spring-run chinook salmon in the Rogue River above Gold Ray Dam has averaged 7,709 over the last 5 years, and the estimated percentage of hatchery fish in the run has ranged from 25-30 % over that time period (ODFW 1999b). The Smith River contains the only known populations of spring-run chinook salmon on the California coast, and those runs continue to decline in the Middle Fork, and are increasing in the South Fork. ODFW believes that spring-run chinook populations in the Smith River probably have always been small, based on in-river fishery landings, historical cannery records and the judgement of local biologists (ODFW 1999b).

California Coastal Chinook Salmon ESU

Historical abundance information and conclusions of the previous BRT report (Myers et al. 1998) relating to the California Coastal ESU are discussed above under the Southern Oregon and California Coastal Chinook Salmon ESU, since at the time of the Status Review, this ESU was proposed to be part of that larger ESU (Myers et al. 1998).

Updated risk information–Fall chinook salmon in the California Coastal Chinook Salmon ESU occur in relatively low numbers in northern streams, and their abundance is sporadic in streams in the southern portion of the geographic region encompassing this ESU. Estimates of absolute population abundance are not available for most populations in this ESU. The 5-year geometric mean abundance of fall chinook passing Cape Horn Dam on the upper Eel River is 36 fish, but those counts are considered to be a small and variable fraction of the run in the Eel River.

Trends in fall chinook salmon abundance in those California streams that are monitored are mixed; in general, the trends tend to be more negative in streams that are farther south along the coast (i.e., populations in the Eel, Mattole and Russian rivers). Trends in abundance in several tributaries in the Redwood Creek drainage have been monitored since 1995; these numbers will be useful in assessing the status of chinook salmon in those streams in the future. Trends in abundance in the Mad River Basin have been declining over the long-term, but they are showing signs of increase in recent years (Appendix A.) Peak index counts and carcass surveys have been conducted since the mid-1960s in Sprowl and Tomki Creeks, both tributaries to the Eel River. The long-term trend in abundance in Sprowl Creek is -4.4%/year, but recent years are showing increases. In contrast, both the long- and short-term trends in abundance in Tomki Creek are severely declining (Appendix A). Shorter-term monitoring has been occurring in other Eel River tributaries since the late 1980s; abundance in Hollow Tree and Redwood creeks has been declining precipitously. Recent monitoring of index areas in the Mattole and Russian River Basins indicates declining trends in abundance, with the exception of increasing abundance at the Coyote Valley Fish Facility on the Russian River from 1992-98.

Hatchery chinook salmon occur in the Russian and North Fork Mad rivers, but the contribution of hatchery fish to natural spawning escapements is not known.

Snake River Fall-Run Chinook Salmon ESU

The Snake River portion of this ESU has been extensively reviewed by NMFS (Waples et al. 1991b, NMFS 1995b), and that information is not repeated here. In the first part of this section, we discuss populations not included in the earlier status review, and provide abundance information for the Snake River population available to the BRT at the time of the Status Review. In later subsections, we discuss updated risk information considered by the BRT for this risk evaluation.

Snake River fall-run chinook salmon adult abundance is monitored at Lower Granite Dam and by redd counts in the mainstem Snake River between Lower Granite and Hells Canyon Dams. Because redd counts are incomplete, the BRT has relied primarily on the dam count data. Deschutes River summer- and fall-run adults are also monitored by dam counts (at Pelton Ladder, RKm 160) and by redd counts in the lower river (Kostow 1995). The introduced Umatilla River stock is also monitored, but we did not include this information in our assessments. In the years 1992-96, returns of naturally spawning fish to the Deschutes River (about 6,000 adults per year) were higher than in the Snake River (5-year mean about 1,000 total and 500 natural adults per year) (Myers et al. 1998, Fig. 43, Appendix E). However, historically the Snake River populations dominated production in this ESU, with total abundance estimated to be about 72,000 in the 1930s and 1940s and probably substantially higher before that. Trends in escapement were mapped in Figure 44 (Myers et al. 1998) and listed in Appendix E (Myers et al. 1998), and they indicated recent increases in both populations.

Almost all historical spawning habitat in the Snake River was blocked by the Hells Canyon Dam complex. Remaining habitat has been reduced by inundation from lower Snake River reservoirs. Spawning and rearing habitats in the mid-Columbia River region are affected largely by agriculture including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia and Snake River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat.

The two components of the original Snake River Chinook Salmon ESU, the Snake and Deschutes Rivers, have very different histories of artificial propagation effort. The hatchery contribution to Snake River escapement was estimated at greater than 47% at the time of the Status Review, although nearly all of the releases into the Snake River have been derived stocks within the ESU. The Lyons Ferry Hatchery has been the primary artificial propagation facility for fall-run fish in the Snake River since 1984. Considerable numbers of hatchery strays from outside of the ESU—upriver bright fall-run chinook salmon from the Umatilla River restoration program and mainstem Columbia River releases—have been observed returning to the Snake River (Lyons Ferry Hatchery and Lower Granite Dam) (Waples et al. 1991b, LaVoy and Mendel 1996). The proportionally high level of hatchery input, small population size, and introgression from non-native hatchery strays pose a significant risk to the genetic integrity and diversity of the Snake River population.

In contrast, there is no hatchery on the Deschutes River and the historical number of releases into the river relative to the naturally spawning component is minimal (Myers et al. 1998; Appendix D). A small number of stray hatchery fish are recovered annually in the Deschutes River (Olsen et al. 1992), but the impact of these is probably small based on the number of strays relative to naturally spawning native fish.

Harvest rates on these populations were high in 1982-89, with Snake River (Lyons Ferry Hatchery) fall-run chinook salmon averaging 34.9% ocean exploitation, 26% inriver exploitation, and 53% total exploitation (PSC 1994). As a result of the ESA listing, ocean harvest rates for the Snake River fall-run chinook salmon decreased to 11.5% in 1995 and 23.0% in 1996 (PFMC 1997). Harvest rates for Hanford Reach fall-run chinook salmon have averaged 39% ocean exploitation and 64% total exploitation (PSC 1994).

Previous assessments of stocks within this ESU have identified several as being at risk or of concern (Appendix E). Nehlsen et al. (1991) identified three stocks as extinct (Umatilla River, Walla Walla River, and Snake River above Hells Canyon Dam) and one as a high risk of extinction (Snake River). Due to lack of information on chinook salmon stocks that are presumed to be extinct, the relationship of these stocks to existing ESUs is uncertain. They are listed here based on geography and to give a complete presentation of the stocks identified by Nehlsen et al.

(1991). WDF et al. (1993) considered one stock within the Snake River Chinook Salmon ESU, which was considered to be of native origin and predominantly natural production. The status of this stock was considered to be depressed.

Previous Conclusions of the BRT--Snake River fall-run chinook salmon currently are listed as a threatened species under the ESA. As discussed above, the BRT previously did not reach a majority decision about the ESU status of Deschutes River fall-run chinook salmon, but a plurality concluded that the Snake River Fall-Run Chinook Salmon ESU also included fall-run chinook salmon in the Deschutes River and, historically, populations from the John Day, Umatilla, and Walla Walla Rivers that had been extirpated in the 20th century.

Assessing extinction risk to the newly configured ESU was difficult because of the geographic discontinuity and the disparity in the status of the two remaining populations. Historically, the Snake River populations dominated production in this ESU; total abundance is estimated to have been about 72,000 in the 1930s and 1940s, and it was probably substantially higher before that. Production from the Deschutes River was presumably only a small fraction of historic production in the ESU. In contrast, 1990-96 returns of naturally spawning fish to the Deschutes River (about 6,000 adults per year) were much higher than in the Snake River (5-year mean at the time of the Status Review was about 500 adults per year; Myers et al. 1998). Long term trends in abundance at the time of the Status Review were mixed—slightly upward in the Deschutes River and downward in the Snake River. On a more positive note, short-term trends in both remaining populations were upward.

In spite of the relative health of the Deschutes River population, a majority of the BRT concluded that the ESU was likely to be in danger of extinction in the foreseeable future in a significant portion of its range, with the remainder being undecided on its status. The BRT was concerned that almost all historical spawning habitat in the Snake River Basin was blocked by the Hells Canyon Dam complex, and other habitat blockages have occurred in Columbia River tributaries. Hydroelectric development on the mainstem Columbia and Snake Rivers continued to affect juvenile and adult migration. Remaining habitat was reduced by inundation in the mainstem Snake and Columbia Rivers, and the ESU's range also was affected by agricultural water withdrawals, grazing, and vegetation management.

An additional source of risk to the Snake River chinook salmon was the continued straying by non-native hatchery fish into natural production areas. The BRT also noted that considerable uncertainty existed regarding the origins of fall-run chinook salmon in the lower Deschutes River and their relationship to fish in the upper Deschutes River.

Updated risk information As discussed above in the ESU Determinations section, the BRT concluded that the Snake River Fall-Run Chinook Salmon ESU should remain its own ESU.

The BRT was not able to conclude with certainty what is the ESU affinity of the Deschutes River population. The following sections review briefly new risk information received by the BRT for chinook salmon in the Deschutes and Snake River Chinook Salmon ESUs. Since the Snake River Chinook Salmon ESU is already listed and the ESU status of the Deschutes River is uncertain, the BRT did not conduct a formal risk analysis for either of the following river basins. We report new and updated risk information here for completeness.

Deschutes River Summer/Fall Run Chinook Salmon ESU.--Updated information on the abundance of fall-run chinook salmon in the Deschutes River indicates that the run continues to increase in number–the most recent estimated 5-year geometric mean abundance is over 16,000 fish, and the short-term trend in abundance has been increasing by 18 %/year (Appendix A, PSFMC 1999). However, there is considerable uncertainty associated with the run size estimates of chinook salmon in the Deschutes River (Beaty 1996). The population estimate is based on aerial redd surveys above and below Sherars Falls and a mark-recapture survey for fish passing above Sherars Falls. The expansion estimate is based on an estimate of the number of adults per redd for the whole river, calculated using the mark-recapture data for fish above the Falls. Since the late 1970s, the distribution of spawners has shifted from the bulk of the spawning occurring above Sherars Falls to a greater proportion of all spawners occurring below the falls. The total number of redds below the falls has not significantly declined since 1972, but the redd counts above the falls have declined dramatically over that time period (Beaty 1996). The shift in relative abundance of spawning adults above and below Sherars Falls has resulted in an expansion estimate based on mark-recapture studies on an increasingly small proportion of the total population in the river. The errors in run size estimation for the Deschutes River have become so high that the overall estimate of run size is not reliable. Because of the problems associated with the run size estimates, the BRT considered the trends in redd counts to be a relatively more reliable indicator of the status of the Deschutes River chinook salmon. Nevertheless, there is reportedly high inter-annual variation in the quality of redd counts due to visibility problems during aerial surveys (Beaty 1996), so even the redd count data are not completely reliable.

Counts of chinook salmon at Pelton trap on the Deschutes River have declined since the late 1950s. The 5-year geometric mean abundance of fish at the trap is 81, and the short term trend in abundance is declining by over 6 %/yr (Appendix A). These fish may be representative of a remnant summer run of chinook salmon (CTWSRO 1999).

The percentage of hatchery chinook salmon in the Deschutes River continues to be very low, as reported in more detail in the historical information obtained at the time of the Status Review (see above).

Snake River Summer/Fall-Run Chinook Salmon ESU.--The estimated abundance of fall-run chinook salmon in the Snake River (above Lower Granite Dam) has been increasing over the most recent 10 years (5-year geometric mean abundance = 565 naturally produced fish, increasing by 13.7 %/year.) Redd counts from streams in the Snake River Basin starting in the mid 1980s-90s show mostly increasing trends in abundance, although the estimated population sizes continue to be very small (Appendix A.)

Discussion and Conclusions of ESU Risk Analyses

Central Valley Spring-Run Chinook Salmon ESU

A majority of the BRT concluded that the Central Valley Spring-Run Chinook Salmon ESU is likely to become endangered in the foreseeable future, and a minority felt that it is presently in danger of extinction. There was moderately high certainty in this risk evaluation–most of the certainty scores were 4s, and they ranged from 2-5. The FEMAT voting method produced similar results–the majority of the likelihood points were assigned to the "likely to become endangered" risk category.

The BRT was especially concerned about the low abundances in this ESU (Table 2). Spring-run populations are in the 100s of fish in most streams, except for a single cohort in Butte Creek, which had 20,000 spawners in 1998, and the hatchery-supported Feather River population. The BRT was encouraged by the increase in abundance in Butte Creek, but cautioned that the projected return for next year is not expected to be as large. In addition, the other bright spots of naturally-produced abundance in the ESU are in Deer and Mill creeks, and their population sizes remain small. The largest population of spring-run chinook salmon in the ESU is in the Feather River, and the BRT noted with concern the high influence of both fall- and spring-run hatchery fish in that run. Because of extensive introgression with fall-run fish, the prospects for using the Feather River stock for conservation purposes in this ESU are unclear. The complete extirpation of the spring run from the San Joaquin River and loss of historical spawning habitat above dams in the Sacramento River Basin has resulted in a greatly reduced distribution of spring-run fish in the Central Valley. The primary reasons for the change in the risk evaluation from "presently in danger of extinction" previously proposed by the BRT were the increase in abundance of Butte Creek fish in recent years, and genetic evidence that the chinook salmon in Butte Creek are not just hatchery strays, as discussed in the ESU determinations section.

The BRT noted a number of recent events that may affect the abundance of the Central Valley Spring-Run Chinook Salmon ESU. Reduced ocean and river harvest levels, the Federal listing of winter-run chinook salmon and Central Valley steelhead, the state listing of spring-run chinook salmon, and the habitat improvements occurring under the CalFed program should have improved conditions for fish in this ESU. In contrast, the 1997 New Years Day flood is expected to sharply reduce spring-run returns in 1999, although some BRT members noted that the effects of the flood could be beneficial over the long term.

Central Valley Fall and Late-Fall Run Chinook Salmon ESU

A majority of the BRT concluded that the Central Valley Fall- and Late-Fall-Run Chinook Salmon ESU is not presently in danger of extinction, nor is it likely to become so in the foreseeable future. A minority felt that this ESU is likely to become endangered in the foreseeable future. There was moderate uncertainty associated with this risk evaluation–most of the certainty scores were 3-4, but the scores ranged from 1-5. The risk assessment using the FEMAT voting method produced similar results–a majority of the likelihood points were distributed in the "not likely to become endangered" risk category.

The change in the risk evaluation from "likely to become endangered" previously proposed by the BRT primarily was due to the increases in abundance in Central Valley streams. Most of the concerns expressed by the BRT for this ESU were in the trends/productivity and genetic integrity risk categories (Table 2). Declines in abundance in the upper Sacramento River fall run and the late-fall run remain worrisome. The continued high abundance of fall-run hatchery fish in natural spawning escapements in this ESU was also a source of concern to the BRT. It appears that there are several large, hatchery-influenced populations of fall-run chinook salmon in this ESU, and reliable estimation of the natural productivity of these spawning populations is not possible. The fact that the most abundant fall-run spawning populations in the ESU are influenced by hatchery fish adds to the uncertainty of the status of the native, naturally-produced populations. In addition, although most of the hatchery fish in the Central Valley are from Central Valley broodstock, a number of streams contain fall-run chinook salmon not native to that particular stream. The recent upward trends in fall-run chinook salmon populations in the San Joaquin tributaries was a promising note, but the BRT noted with concern the high variation in abundance and its strong correspondence with human- and naturally-impacted flow regimes. The late-fall chinook salmon escapement appears to be fairly stable, but the BRT was concerned about the uncertainty in the escapement estimates.

The major sources of continued threats to the chinook salmon in this ESU are habitat degradation (primarily water withdrawals and shifts in stream hydrographs), water quality, loss of riparian and estuarine habitat, and the influence of hatchery fish. The BRT felt that several recent actions are likely to mitigate the threats facing chinook salmon in the Central Valley Fall- and Late-Fall Chinook Salmon ESU, including harvest reductions, the listing of winter-run chinook salmon and steelhead under the Federal Endangered Species Act, the listing of spring-run chinook salmon under the California Endangered Species Act, improvements in water flow and habitat conditions due to the CalFed program (e.g., the Vernalis Adaptive Management Plan (VAMP) and Category II Restoration Projects, among others), and the recently initiated comprehensive review of hatchery programs in the Central Valley by the CDFG and the U. S. Fish and Wildlife Service.

California Coastal Chinook Salmon ESU

A majority of the BRT concluded that the chinook salmon in the California Coastal Chinook Salmon ESU are likely to become endangered in the foreseeable future, and a minority felt that they are presently in danger of extinction. The certainty in this risk evaluation was moderate–most of the certainty scores were 4s, but they ranged from 1-4, and there were several 1s and 2s. The risk assessment conducted using the FEMAT voting method produced similar results–a majority of the likelihood points were assigned to the "likely to become endangered" risk category, and a sizeable minority were distributed in the "presently in danger of extinction" category.

Most of the concerns the BRT had about the status of this ESU were related to the abundance and trends/productivity risk categories (Table 2). The BRT felt that widespread declines in abundance of chinook salmon relative to historical levels and the present distribution of small populations with sometimes sporadic occurrences contribute to the risks faced by this ESU. Overall, the BRT was concerned about the paucity of information on the presence or abundance of chinook salmon in the geographic area encompassing this ESU. The abundance data series are short-term for most of the streams in this ESU, and there are no current data for the long time series at Benbow Dam for the population that may have been the largest historically (South Fork Eel River).

The BRT felt that habitat degradation and water withdrawals in the river drainages in coastal California have contributed to the continued reduction in abundance and distribution of chinook salmon in this ESU. Smaller coastal drainages such as the Noyo, Navarro, Garcia and Gualala rivers likely supported chinook salmon runs historically, but they contain few or no fish today. The Russian River probably contains some natural production, but the origin of those fish is not clear because of a number of introductions of hatchery fish over the last century. The BRT was concerned about the extinction of the spring run in the upper Eel River, which represents an important loss of life history diversity in this ESU.

The BRT noted several factors that are likely to have improved the conditions for chinook salmon in the California Coastal Chinook Salmon ESU, including reductions in the KMZ and Central Valley index, the listing of coho salmon and steelhead under the federal Endangered Species Act, changes in harvest regulations by the states of Oregon and California to protect coho salmon and steelhead, improvements in stream water quality due to enhanced enforcement of Clean Water Act standards, and changes in timber and land-use practices resulting from the Headwaters HCP.

Southern Oregon and Northern California Coastal Chinook Salmon ESU

The BRT was unanimous in concluding that the chinook salmon in the Southern Oregon-Northern California Coastal Chinook Salmon ESU are not presently in danger of extinction, nor are they likely to become so in the foreseeable future. The certainty in the risk evaluation was moderately high–a majority of the certainty scores were 4, and they ranged from 3-5. The risk scores using the FEMAT method indicated similar levels of risk to the ESU–a majority of the likelihood points were assigned to the "not likely to become endangered" risk category.

The BRT was encouraged by the overall numbers of chinook salmon in this ESU and by the recent increases in abundance in many of the smaller coastal streams (Table 2). In addition to the large runs returning to the Rogue River, chinook salmon appear to be well distributed in a number of coastal streams throughout the geographic region encompassing this ESU. Although many of the new data sets received for review by the BRT are of short duration, the BRT was encouraged by recent efforts by the co-managers to improve monitoring of chinook salmon in this region. Risks associated with the presence of hatchery fish in this ESU are relatively low; nevertheless, the BRT was concerned about the high percentages of naturally-spawning hatchery fish in the Chetco River and in the spring-run chinook salmon population in the Rogue River. In addition, the restricted distribution of spring-run chinook salmon to the Rogue and Smith River basins and their significant decline in the Rogue River could represent an important threat to the total diversity of fish in this ESU.

The BRT noted several factors that are likely to have improved the conditions for chinook salmon in the Southern Oregon-Northern California Coastal Chinook Salmon ESU, including reductions in the KMZ troll fishery, the listing of coho salmon under the federal Endangered Species Act, changes in harvest regulations by the states of Oregon and California to protect naturally produced coho salmon and steelhead, and changes in timber and land-use practices on federal public lands resulting from the Northwest Forest Plan.

Deschutes River Summer/Fall-Run Chinook Salmon ESU

The BRT conclusions did not substantially change the Snake and Upper Columbia River Chinook Salmon ESUs, and the status of these ESUs was not revisited.

Evaluation of the status of the ESU that includes the Deschutes River is difficult because the historic and current extent of the ESU is not well characterized. For this reason, the BRT did not attempt a formal extinction risk analysis for this ESU. However, the BRT did discuss abundance, trend, and other information for the Deschutes River population. A majority of the BRT concluded that ocean-type chinook salmon in the Deschutes River are not presently in danger of extinction, nor are they likely to become so in the foreseeable future. A large minority concluded that this population is likely to become endangered. The BRT was highly uncertain in its risk determinations--most of the certainty scores were 2 or 3, and the highest score was a 4. The risk evaluation using the FEMAT voting method also indicated high uncertainty among BRT members. Only slightly more of the total likelihood points were distributed in the "not likely to become endangered" than in the "likely to become endangered" category.

The BRT was concerned about the uncertainty in the abundance estimates for fall- and summer-run chinook salmon in the Deschutes River. Uncertainty about the true population status centered primarily around different indicators of status emerging from analysis of redd counts (declining sharply in the upper basin; stable in the lower basin) and run-size estimates based on expansion of mark-recapture studies (which indicate a relatively large and increasing population). The only conclusion the BRT felt it could make from the data was that the numbers of chinook salmon above Sherars Falls have been severely declining since the mid-1970s, and the population below the falls may be stable. The shift in the proportion of the total Deschutes River fall-run chinook salmon run spawning above and below Sherars Falls has resulted in unreliable expansion estimates for escapement above and below the falls. In addition, the change in the estimated ratio of the number of adults/redd over time represents a significant problem for interpreting the expansion procedure used to generate the abundance estimates. The BRT was hopeful that recent efforts by the CTWSRO and ODFW to conduct more extensive mark/recapture studies in the lower river will improve escapement estimates.

The BRT also was concerned about the severe decline and possible extinction of the summer-run chinook salmon in the Deschutes River. The significant reduction in this life history form represents an important loss to the historical diversity in this ESU. The uncertainty associated with the geographic boundaries containing the historical ESU added to the overall uncertainty in the risk evaluation. The historical run sizes of fall-run chinook salmon in the Umatilla, John Day, Walla Walla Rivers are not well known, and the numbers of fall-run chinook salmon in them today are very low and do not represent naturally self-sustaining runs. If fall-run chinook salmon that historically occurred in those streams were considered to be part of the Deschutes River Chinook Salmon ESU, a higher extinction risk may have been appropriate for the current ESU because extinction of the ESU would have occurred over a significant portion of its range.

Table 2. Summary of BRT conclusions for extinction risk categories for the chinook salmon ESUs. Numbers in each cell denote the number of BRT members voting for a particular risk level for each risk category. The five-point scale is described in Myers et al. (1998, Appendix E). 1 indicates a low risk score and 5 indicates the highest risk. A formal risk evaluation was not conducted for the Deschutes River chinook salmon (see text).

Central Valley Spring-Run Chinook Salmon ESU

	Risk Score					
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution	0	0	2	12	3	4.1
Trends/Productivity	0	3	11	2	2	3.2
Genetic Integrity	0	2	5	10	1	3.6

Central Valley Fall and Late-Fall Run Chinook Salmon ESU

	Risk Score					
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution	4	10	3	1	0	2.1
Trends/Productivity	0	7	10	1	0	2.7
Genetic Integrity	0	9	5	4	0	2.7

California Coastal Chinook Salmon ESU

	Risk Score					
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution	0	0	2	13	3	4.1
Trends/Productivity	0	0	4	12	2	3.9
Genetic Integrity	0	10	6	2	0	2.6

Table 2, cont'd.

Southern Oregon and Northern California Coastal Chinook Salmon ESU

	Risk Score					
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution	3	12	3	0	0	2.0
Trends/Productivity	1	12	5	0	0	2.2
Genetic Integrity	2	14	2	0	0	2.0

HATCHERY POPULATIONS

Introduction

For those ESUs that are identified as threatened or endangered in the final listing determination (Central Valley Spring Run and California Coastal), it will be necessary for NMFS to determine the ESA status of hatchery populations that are associated with the listed ESU(s). According to NMFS policy (NMFS 1993, see also Hard et al. 1992), two key questions must be addressed for each hatchery stock associated with a listed species: 1) Is it part of the ESU? And, if so, 2) Should the hatchery population be listed? The focus of these evaluations should be on "existing hatchery fish," which are defined in the policy to include prespawning adults, eggs, or juveniles held in a facility, as well as fish that were released prior to the listing but have not completed their life cycle.

The first question--the ESU status of existing hatchery populations--is a biological one, and the guiding principle should be whether the hatchery population contains genetic resources similar to those of natural populations in the ESU. The second question is an administrative one. According to NMFS policy, existing fish would generally not be listed even if they are part of the ESU unless they are considered "essential" for recovery (see discussion below).

To address the ESU question, the BRT considered information on stock histories and broodstock collection methods for existing hatchery populations associated with the four ESUs. Additionally, where available, the BRT considered genetic information on hatchery populations and their relationship with naturally spawning populations within and outside of the ESU. In evaluating importance for recovery, the BRT considered the relationship between the natural and hatchery populations and the degree of risk faced by the natural population(s), whether the hatchery stock might be used to assist in recovery. Hatchery programs that have not recently produced chinook salmon were not considered.

It is important to note two considerations with respect to the evaluations of hatchery populations. First, the BRT conclusion apply to individual hatchery stocks and not to facilities. Second, a determination that a stock is not "essential" for recovery does not preclude it from playing a role in recovery. Any hatchery population that is part of the ESU is available for use in recovery if conditions warrant. In this context, an "essential" hatchery population is one that is vital to fully incorporate into recovery efforts at the outset (for example, if the associated natural population(s) were already extinct or at high risk of extinction). Under these circumstances, NMFS would consider taking the administrative action of listing the existing hatchery population at the time of the final listing determination. Fish that are progeny of listed fish taken into a hatchery for broodstock will be listed, so any hatchery population involved in formal recovery under the ESA will eventually be comprised of listed fish.

Information on Hatchery Stocks

Central Valley Spring-Run Chinook Salmon ESU

Feather River Spring-Run Stock--The Feather River Hatchery was constructed to mitigate the loss of spawning and rearing habitat due to the construction of Oroville Dam. Prior to the completion of the Oroville Dam spring-run chinook salmon were transported above the dam construction site to spawn naturally. In 1965 and 1966, 1,185 and 744 spring-run chinook salmon were trapped and hauled 10.4 km above the dam site. Operations at the hatchery began in 1967 when 29 females out of a total of 129 adults trapped were spawned to establish the broodstock program. Early attempts to hold spring-run chinook salmon prior to maturation resulted in very high mortalities. In subsequent years, the hatchery gate was not opened until late in August or early September, which may have resulted in some of the broodstock spawning naturally. Excluded from their natural spawning habitat, spring-run chinook salmon hold and spawn below the Thermalito Diversion Dam. In the absence of spatial separation from the fall-run chinook salmon there is considerable potential for hybridization between the spring and fall runs both naturally and in the hatchery (Yoshiyama et al. 1996). Furthermore, the overlap in spawning timing between runs has potentially resulted in a dilution of the genetic integrity of the less numerous spring run. Genetically, spring-run chinook salmon from the Feather River Hatchery most closely resemble fall-run from chinook salmon the Feather River Hatchery. Whether this similarity is due to hybridization between the two runs, the result of their monophyletic evolution (which is the norm for most populations south of the Columbia River Basin), or, in part, both, is not known. Furthermore, Feather River spring run is the nearest (genetic) population to the two naturally spawning populations for which we have samples for (Butte Creek and Deer Creek; see New Genetic Information).

Watershed: Feather River
Recent 5 year abundance: 5,013
Recent hatchery collection: 4850 (5 year average)

California Coastal Chinook Salmon ESU

Freshwater Creek Stock--The Humboldt Fish Action Council operates a trapping and rearing station on Freshwater Creek, which drains into Humboldt Bay. During the 1996/97 return year, 20 fall-run chinook salmon were trapped and 5 females spawned (Radford 1998). Juveniles have been released in Freshwater Creek and Clooney Creek (a nearby system). Stocking records do not document large releases of non-native fish into this basin, although during 1970-72 there were some 584,000 fish planted of unknown origin.

Watershed: Humboldt Bay
Recent 5 year abundance: not known
Recent hatchery collection: 20

Redwood Creek Stock--The Pacific Coast Federation of Fishermen's Associations (Eel River Project) operates a trap and rearing facility in the Redwood Creek Basin. The program was establish in 1984 and is currently in operation. During the 1996/97 collection season , 23 females were spawned. The progeny of spawned adults are returned to the Redwood Creek watershed (Radford 1998). Genetically, Redwood Creek fall-run chinook salmon cluster with other samples from the Eel River Basin.

Watershed: Eel River Basin
Recent 5 year abundance: not known
Recent hatchery collection: 73

Hollow Tree Creek Stock--The Hollow Tree Creek stock was founded by trapping returning adults from Hollow Tree Creek, a tributary to the South Fork Eel River, in 1979. The egg taking station was a cooperative venture funded by CDFG, timber companies, and sport and commercial fishers. Water hardened eggs are transferred to the Ten-Mile River Hatchery for incubation and rearing, prior to being returned to Hollow Tree Creek. The facility is currently being operated by the Salmon Restoration Association of California. During the first year of trapping 300 chinook salmon (142 females) were intercepted at the trap. During 1995, 114 chinook salmon were trapped, 111 subsequently released, and 3 females were spawned. Most recently (1996/97) 313 chinook salmon adults were trapped, and 49 females spawned (Radford 1996, 1998). Genetically, Hollow Tree Creek fall-run chinook salmon cluster with other samples from the Eel River Basin.

Watershed: Eel River
Recent 5 year abundance: (100s-1000s)
Recent hatchery collection: 313

Van Arsdale Egg Collection Station Broodstock--The Van Arsdale Station (Snow Mountain Station) has been in operation since 1907. Prior to the 1970s returning adult chinook salmon were trapped at Capehorn Dam, and passed above the Dam. In the mid-1970s, a program was begun to rear eggs collected from returning fall-run chinook salmon. In some years, eggs from Iron Gate Hatchery (upper Klamath and Trinity Rivers Chinook Salmon ESU) were imported and released into the Eel River (1972-77, 625,000 eggs). Broodstock are collected at the trap at Capehorn Dam and at a nearby tributary to the Eel River, Outlet Creek. Both naturally-produced and returning hatchery-produced fish are used as broodstocks.

Watershed: Eel River
Recent 5 year abundance: (100s-1000s)
Recent hatchery collection: 200, of which 59 were hatchery marked (returned to trap)

Mad River Hatchery Stock--The Mad River Fish Hatchery began operations in 1971. During the first year, no adult chinook salmon broodstock were trapped locally, but 650,000 juvenile fall chinook salmon from the Minter Creek Hatchery (Puget Sound Chinook Salmon ESU) were released. The next year, 323 adult fall-run chinook salmon were trapped from the Mad River. In 1973, 45 female chinook salmon from Freshwater Creek were brought to the Mad River Hatchery; their offspring constituted about half of the juveniles released in the Mad River. In subsequent years returning adults have provided the eggs for the hatchery production. Recent (1980s) allozyme studies indicated that the original Minter Creek Hatchery release probably contributed very little the present broodstock.

Watershed: Mad River
Recent 5 year abundance: 100s-1000s
Recent hatchery collection: low

Yager Creek Stock:--Since 1976, the Pacific Lumber Company has operated a trapping and rearing complex in the Van Duzen River Basin. During the 1996/97 adult collection, 73 returning fall-run chinook salmon adults were trapped (16 were subsequently released). There were 23 females spawned, which produced approximately 24,000 subyearling fish for release into Yager Creek and other tributaries of the Van Duzen.

Watershed: Van Duzen
Recent 5 year abundance: (very low)
Recent hatchery collection: 60

Mattole River Stock--The Mattole Watershed Salmon Support Group traps adults returning to the mainstem Mattole River. Juveniles are subsequently reared at, and released from, a number of smaller rearing facilities through the river basin. No adults were trapped in 1995 because of permitting difficulties with CDFG (Radford 1996). In 1996/97, 24 females were trapped, 6 females spawned, and 23,000 subyearling juveniles released (Radford 1998). There have been no introductions of fish from outside of the basin into the Mattole River.

Watershed: Mattole River
Recent 5 year abundance: not known (100+)
Recent hatchery collection: 20

Warm Spring Hatchery Fall-Run Chinook Salmon Stock--Comments received from CDFG assert that chinook salmon native to the Russian River Basin were extirpated early in the 1900s. The founding stock of chinook salmon for the Warm Springs Hatchery in the Russian River Basin was acquired from the Rowdy Creek Hatchery (Smith River) in 1980. In subsequent years fish were imported from Wisconsin (Great Lakes (ex-Washington and Oregon Coast)), Hollow Tree Creek (Eel River Basin), SilverKing Ocean Farms, Noyo River, and Mad River Hatchery. No adult chinook salmon were trapped prior to the return of the first released juveniles. Returning broodstock were collected at the hatchery (Dry Creek). Additional adult broodstock were collected at the Outlet Creek Trap (Eel River Basin). Returns were only able to meet production needs during the 1989 return year. During the 1998/99 collection season, no adults returned to the hatchery trap (CDFG 1999). The current broodstock does not apparently represent one genetic lineage, but an amalgamation of stocks from within and outside of the ESU.

Watershed: Russian River
Recent 5 year abundance: not known (100s)
Recent hatchery collection: 11

Petaluma River Stock--During 1995 the United Anglers Program at the Casa Grande High School trapped 34 fall-run chinook salmon from the Petaluma River (1996); however only 12 adults (3 females) were collected during 1996/97 (Radford 1998).. Progeny from adults were reared at the High School prior to being transferred to the Tyee Club for release into San Francisco Bay. There is no life history or genetic information on this stock; however, hundreds of thousands of juvenile Central Valley chinook salmon are released into San Francisco Bay and stray into local tributaries during their adult return migration.

Watershed: Petaluma River
Recent 5 year abundance: not known (very low)
Recent hatchery collection: 12

Feather River Hatchery Fall-Run Chinook Salmon Stock--Eggs and juveniles produced from adults returning to the Feather River Hatchery (Central Valley Late-Fall and Fall Chinook Salmon ESU) were used at a number non-profit facilities along the coast. The Central Coast Salmon Enhancement Inc. (Port San Luis), Fishery Foundation of California (San Pablo Bay), Monterey Bay Salmon and Trout Project (Monterey Bay), and the Tyee Club of San

Francisco (San Francisco Bay) all release Feather River fish, although some only hold the fish for acclimation prior to release. There is are no facilities to recover returning adults.

Watershed: Various
Recent 5 year abundance: not known (very small)
Recent hatchery collection: NA (imported)

Nimbus Hatchery Fall-Run Chinook Salmon Stock:--Eggs and juveniles produced from adults returning to the Nimbus Hatchery (Central Valley Late-Fall and Fall Chinook Salmon ESU) were used at a number non-profit facilities along the coast. The Fishery Foundation of California (San Pablo Bay) releases fish from floating net-pens after they have been held for only a few hours. There is are no facilities to recover returning adults.

Watershed: Various
Recent 5 year abundance: not known (very small)
Recent hatchery collection: NA (imported)

Determining the ESU status of Hatchery Broodstocks

For practical purposes, a hatchery population will be considered to be part of a biological ESU if the population or populations from which it was derived were also part of the ESU. More specifically, a hatchery population will be considered part of the biological ESU so long as the proportion of non-ESU fish incorporated into the hatchery population over its history has not been substantially higher than the proportion of stray non-ESU fish in natural populations within the ESU.

Categories of hatchery populations (all within the ESU)

Category 1: The hatchery population is closely associated with and very similar to a particular wild population. For example:

-The hatchery population was recently founded (e.g. within one or two generations) from a large (either in absolute terms or as a proportion of the donor population), representative sample of a single wild population.

-The hatchery population was founded some time in the past (e.g. more than two generations ago) as a large representative sample from a single wild population, and has received regular, substantial and representative infusions of wild fish from the original founding population into the broodstock since that time.

Category 2: The hatchery population is associated with but potentially diverged from a particular wild population. For example:

-The hatchery population was founded from a single wild population some time in the past, but the sample was not representative or was small or the broodstock has received few or no reintroductions of wild fish since the time of founding.

Category 3: The hatchery population is known or suspected to be substantially diverged from all wild populations currently or formally in the ESU. For example:

-The hatchery population has been deliberately artificially selected.

-The hatchery population was founded with a very small number of fish or has received few or no infusions of wild fish into the broodstock since the time of founding.

-The hatchery population was founded from a mixture of several wild or hatchery populations from within the ESU.

Discussions and Conclusions of the BRT on Hatchery Broodstock Status

Central Valley Spring Run Chinook Salmon ESU

The consensus of the BRT was that the Feather River Hatchery stock of spring-run chinook salmon is part of the ESU. Although there was considerable information indicating that hybridization between spring- and fall-run fish had occurred in the hatchery, the BRT concluded that the spring-run stock still exhibited life history characteristics consistent with spring-run fish in the Central Valley. While genetic analysis revealed a strong similarity between spring- and fall-run fish in the Feather River (and other Central Valley fall-run stocks) relative to other spring-run stocks in the Central Valley, many members of the BRT were uncertain how the present analysis reflected the historical relationship between the two runs in the Feather River Basin. However, the BRT was unanimous in concluding that the spring run had undergone some genetic change during artificial propagation. The majority of the BRT considered this a category 3 stock, and not essential for recovery.

California Coastal Chinook Salmon ESU

The BRT unanimously agreed that the Redwood Creek, Hollow Tree Creek, Freshwater Creek, Mad River Hatchery, Van Arsdale Station, Yager Creek, and Mattole River stocks of fall-run chinook salmon were all part of the ESU. The majority of the stocks were maintained via small supplementation programs, in many cases a high proportion of the broodstock collected were of natural origin. Furthermore, most of the programs have been in operation for a limited number years, reducing the risk of domestication. In some cases information on the programs was very limited, with almost no genetic or life history information. The majority of the votes were split between a Type 1 and 2 classification for the Redwood Creek, Hollow Tree Creek, Freshwater Creek, and Mattole River stocks (reflecting the short duration of these programs and inclusion of naturally produced as broodstock) . For the Mad River Hatchery, Van Arsdale Station, and Yager Creek stocks, the general consensus of the BRT was that these were Type 2 stocks. The BRT unanimously agreed that none of the stocks reviewed was considered essential for recovery, with the exception of the Mattole River and Van Arsdale Station stocks which were considered essential for recovery by a minority of the BRT.

The BRT unanimously agreed that the Warm Springs Hatchery stock of fall-run chinook salmon was not part of this ESU, primarily due to the large numbers of out-of ESU fish transferred to the hatchery, and the genetic analysis which indicates that these transfers have influenced the genetic character of the stock. Furthermore, fall-run fish of Feather River or Nimbus Hatchery origin that are released in this ESU are also not part of the ESU, due to their out-of-ESU origin. Because of the uncertainty related to the ESU status of San Francisco Bay and the impact of Central Valley fall-run strays, it was unclear which ESU this stock should be evaluated relative to.

Types of conservation strategies that would be reasonable to consider for different categories of hatchery population

This list consists of conservation strategies that are reasonable to consider for the different categories of hatchery populations. As is discussed in the NMFS's *Interim Policy on Artificial Propagation of Pacific Salmon Under the Endangered Species Act* (FR 58:17573-6), artificial propagation should not be considered a substitute for addressing the underlying causes of an ESU's decline. Furthermore, even under ideal circumstances artificial propagation may entail genetic and ecological risks to natural populations. The determination of whether to actually pursue one of the strategies listed below should be based on an objective analysis of potential benefits and hazards on a case by case basis, as well as how the proposed action fits into the overall recovery strategy of the ESU.

Artificial reserves: Artificial reserves provide a conservation benefit by maintaining a population in a protected, often productive, artificial environment. Populations held captive for part or all of their life-cycle help to ensure that even if many or all of the wild populations in an ESU become extinct, at least part of the ESU may survive in captivity and be available for reintroduction or supplementation efforts. As they are defined here, fish in artificial reserve populations are generally not intended to spawn in the wild in significant numbers unless or until the population is needed for supplementation or reintroduction purposes. Category 1 populations, because they are closely associated with and similar to a particular wild population, are likely to provide the greatest benefits and least risks as reserve populations, but category 2 and even category 3 hatchery populations may provide conservation benefits as artificial reserves in specific cases.

Supplementation: For purposes of this paper, supplementation is defined as the use of artificial propagation to increase the number of natural spawners in a population. A supplemented population essentially exists concurrently in both a natural and artificial environment. Supplementation by definition involves close integration with a natural population, and therefore has a greater potential to lead to genetic change in a natural population than does an artificial reserve project that is successfully isolated from natural populations. In most cases only category 1 hatchery populations should be considered as candidates for use in supplementation projects, and then only for supplementation of the natural population from which the hatchery population was derived. Category 2 hatchery populations should be considered as candidates for use in supplementation only if a risk/benefit analysis clearly indicates that supplementation with such a population is likely to provide a net benefit to the species and a more appropriate category 1 hatchery population is not available or cannot be created in a timely manner. Because they are by definition genetically diverged from any natural population in the ESU, category 3 hatchery populations should not be used for supplementation except in extreme circumstances.

Reintroduction: For purposes of this paper, reintroduction is defined as the establishment of a natural population in an area formally inhabited by a now extinct conspecific natural population. In many cases, the ideal source of fish for reintroduction purposes may be a category 1 or category 2 hatchery population derived from the extinct natural population. If such a hatchery population is not available, any population (hatchery or natural) or even combination of populations within the ESU could potentially be a candidate source of fish for reintroduction. The choice of which population(s) should be based on objective assessment of the likelihood of success, risks the reintroduction may impose to other populations or species (including the donor population), and how the reintroduction fits into the overall recovery strategy for the ESU. If possible, reintroducing fish from the same donor population into many areas of a large or diverse ESU should be avoided in order to promote and maintain diversity among populations.

REFERENCES

Alaska, State of (AK). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by 21 August 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Anderson, D.G. 1998. Redwood Creek basin 1996-1997 spawning and carcass survey annual progress report. Redwood National and State Parks, Orick, CA. 8 pp.

Anderson, D.G. 1999. Redwood Creek basin 1997-1998 spawning and carcass survey annual progress report. Redwood National and State Parks, Orick, CA. 8 pp.

Association of California Water Agencies (ACWA). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by D. Smith, 29 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Aho, R., G. Concannon, J. Ziller, and S. Pribyl. 1979. An ecological and fish cultural study of Deschutes River salmonids. Annual progress report of the Oregon Department of Fish and Wildlife.

Banks, M. and M. Bartron. 1999. Microsatellite DNA variation among Klamath River chinook salmon sampled from fall and spring runs, Completion Report March 1999. Submitted to the Yurok Tribe Fisheries Program.

Banks, M.A., V.K. Rashbrook, M.J. Calavetta, C.A. Dean, and D. Hedgecock. Microsatellite DNA Variation in Chinook Salmon of California's Central Valley. 1999. Canadian Journal of Fisheries and Aquatic Sciences 00: 000-000 (in press).

Bartley, D. M., and G. A. E. Gall. 1990. Genetic structure and gene flow in chinook salmon populations of California. Trans. Am. Fish. Soc. 119:55-71.

Bartley, D., B. Bentley, J. Brodziak, R. Gomulkiewicz, M. Mangel, and G. A. E. Gall. 1992. Geographic variation in population genetic structure of chinook salmon from California and Oregon. U.S. National Marine Fisheries Service Fishery Bulletin 90:77-100 (authorship amended per errata, Fishery Bulletin 90[3]:iii).

Beaty, R.E. 1996. Evaluation of Deschutes River fall chinook salmon. Technical Report 96-6. Columbia River Inter-Tribal Fish Commission, Portland , Or. July 1996.

Beyerlin, S. 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon 7 May 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Big Eagle & Aassociates and LGL Limited. 1995. Chinook salmon catch, escapement and historical abundance data. June 9, 1995.

Boucher, D. And A. Boucher (1998). Documents submitted to the ESA Administrative Record for west coast chinook salmon 7 July 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Brown, M.W. 1938. The salmon migration in the Shasta River (1930-1934). California Fish and Game.

Brookings Harbor Camber of Commerce (BHCC). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by L. Cohen. 7 July 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

California Advisory Committee on Salmon and Steelhead Trout (CACSST). 1988. Restoring the balance. Calif. Dep. Fish Game, 84 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth St., Sacramento, CA 95814.)

California Department of Fish and Game (CDFG). 1965. California fish and wildlife plan. Three volumes. Sacramento, CA. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth St., Sacramento, CA 95814.)

California Department of Fish and Game (CDFG). 1997. San Joaquin River chinook salmon enhancement project: Annual report fiscal year 1995-96. CDFG Report dated April 1997. 104 p. (Available from California Department of Fish and Game, Region 4, 1234 East Shaw Avenue, Fresno, CA 93710)

California Department of Fish and Game (CDFG). 1998a. Documents submitted to the ESA Administrative Record for west coast chinook salmon by J. Schaefer. 14 August 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

California Department of Fish and Game (CDFG). 1998b. A status review of the spring-run chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River drainage. CDFG report to the Fish and Game

California Department of Fish and Game (CDFG). 1999a. California Department of Fish and Game Grand Table for Central Valley Salmon Populations. Provided by Robert Kano, May 20, 1999.

California Department of Fish and Game (CDFG). 1999b. Annual chinook and steelhead counts, Van Ardsdale Fisheries Station. Submitted by Alan Grass, February 19, 1999 to Greg Bryant. Risk Group files.

California Department of Fish and Game (CDFG). 1999c. Data provided at Co-managers Meeting 5/11/99, Eureka, CA, including: 1) History of fish trapped at Warm Springs Hatchery (Royce Gunther, CDFG Hatchery Manager, 707-433-6325);2) Coyote Valley Fish Facility; 3) Dry Creek Chinook; 4).Van Arsdale Fisheries Station (Alan Grass, CDFG Hatchery Manager); and 5) Summary of chinook salmon spawner surveys conducted in Mendocino County - Eel River Basin.

California Sportfishing Protection Alliance (CSPA). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by B. Baiocchi. 12 May 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Calkins, R. D., W. F. Durand, and W. H. Rich. 1940. Report of the board of consultants on the fish problem of the upper Sacramento River. Stanford Univ., 34 p. (Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Campbell, E. A., and P. B. Moyle. 1990. Historical and recent populations sizes of spring-run chinook salmon in California. *In*: T. J. Hassler (editor), Northeast Pacific chinook and coho salmon workshops and proceeding, Humbolt State University, Arcata, CA, p. 155-216.

Cannon, T. 1999. Documents submitted to the ESA Administrative Record for west coast chinook salmon. 26 May 1999. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Cavalli-Sforza, L. L., and A. W. F. Edwards. 1967. Phylogenetic analysis: Models and estimation procedures. Evolution 21:550-570.

Central Valley Project Water Association (CVPWA) 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by S. Birk. 26 June 1998. (Available from Protected Resources Division, NMFS. 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

City and County of San Francisco (CCSF) 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by D.W. Furman. 30 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Clark, G. H. 1929. Sacramento-San Joaquin salmon (*Onchynchus tschawytscha*) fishery of California. Calif. Fish Game Bull. 17:73.

Clark, G.H. 1940. California salmon catch records. California Fish and Game. 26:49-66.

Columbia River Inter-Tribal Fish Commission (CRITFC). 1998. Letter from T. Strong (Columbia River Inter-Tribal Fish Commission) to G. Griffin (Protected Resources Division, NMFS Northwest Region) dated 30 June 1998.

Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). 1999. Documents submitted to the ESA Administrative Record for update on west coast chinook salmon by Colleen Fagan, June 1999.

Cooney, C. X., and S. E. Jacobs. 1994. Oregon coastal salmon spawning surverys, 1992. Oreg. Dep. Fish Wildl, Fish Div. Info. Rep., No. 94-2, 103 p.

Cramer, S. P. [1989]. Contribution of Sacramento Basin hatcheries to ocean catch and river escapement of fall chinook salmon. S.P. Cramer & Associates, 113 p. (Available from S. P. Cramer and Associations, Inc., 300 S.E. Arrow Creek Land, Gresham, OR, 97080.)

Cramer, S. P. 1996. The status of late-fall and spring chinook salmon in the Sacramento River Basin in regards to the Endangered Species Act. S.P. Cramer & Associates, 39 p. (Available from S.P. Cramer & Associates, Inc., 300 S.E. Arrow Creek Lane, Gresham, OR 97080.)

Data Access in Real Time Adult Passage (DARTAP). 1999. Columbia River Basin Research, University of Washington, Seattle, WA. (Available through Online Internet database at HTTP://www.cqs.washington.edu/dart/adult.html).

Delarm, M. R., and R. Z. Smith. 1990. Assessment of present anadromous fish production facilities in the Columbia River Basin Volume 4: Washington Department of Fish Hatcheries. Bonneville Power Administration. 89-045, 130 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife-PJ, P.O. Box 3621, Portland, OR 97208.)

Del Norte Board of Supervisors (DNBS). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by F. Galea. 26 May 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Department of Water Resources (DWR). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by C. Crothers, 29 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Dettman, D. H., D. W. Kelley, and W. T. Mitchell. 1987. The influence of flow on Central Valley salmon. Prepared for the California Dept. of Water Resources. Revised July 1987. , 66 p. (Available from D.W. Kelley and Associates, 8955 Langs Hill Rd., P.O. Box 634, Newcastle, CA 95658.)

East Bay Municipal Utility District (EBMUD). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by R.C. Nuzum. 18 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Evermann, B .W. 1896. A preliminary report on salmon investigations in Idaho in 1894. Bull. U.S. Fish Comm. 15: 253-284.

Fagan. 1998. Fall Chinook Salmon Monitoring Program, 1997. Submitted by C. Calica 7/98.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic, and social assessment. U.S. Forest Service, National Marine Fisheries Service, Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, U..S. Environmental Protection Agency. Portland, Oregon, and Washington D.C. 843 p + appendices.

Gale, D. 1999. Submitted salmonid adult counts for the Yurok Tribal Fisheries Program. April 21, 1999.

Fuss, H.J., and C. Ashbrook. 1995. Hatchery operation plans and performance summaries. Volume I (2). Puget Sound. Annual Report. Washington Department of Fish Wild., Assessment and Develop. Div., Olympia. (Available from Washington Dept. of Fish and Wildlife, 600 Capital Way N., Olympia, Washington, 98501-1091.)

Galbreath, J.L. 1966. Timing of tributary races of chinook salmon through the lower Columbia River based on analysis of tag recoveries. Fish Comm. Oreg., Res. Briefs 12: 58-80.

Gall, G.A.E., B. Bentley, C. Panattoni, E. Childs, Q. Chun-fang, S. Fox, M. Mangel, J. Brodziak, and R. Gomulkiewicz. Chinook mixed fishery project. University of California, Davis. 192 pp + Appendices.

Garcia, A.P., R.D. Waitt, C.A. Larsen, S.M. Bradbury, B.D. Arnsberg, M. Key, and P.A. Groves. 1999. Spawning distribution of fall chinook salmon in the Sanke River. Annual Report 1998. Chapter Two: Fall chinook salmon spawning ground surveys in the Snake River Basin upriver of Lower Granite Dam, 1998. Prepared by USFWS for U.S. Dept. of Energy. Project No. 9801003, Contract No. 98 AI 37776. March 1999.. 23 p. (Available from BPA, Division of Fish and Wildlife, P.O. Box 3621, Portland, OR 97208-3621.)

Hanson, H. A., O. R. Smith, and P. R. Needham. 1940. An investigation of fish-salvage problems in relation to Shasta Dam. U.S. Dep. Interior, Bureau of Fish., Special Scientific Report. 10, 200 p.

Hard, J. J., R. P. Jones, Jr., M. R. Delarm, and R. S. Waples. 1992. Pacific salmon and artificial propagation under the Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo., NMFS-NWFSC-2, 56 p.

Harris, Scott. 1998. Chinook Tomki River numbers. Email from Harris (CDFG) to Greg Bryant, October 5, 1998.

Hatton, S.R. 1940. Progress report on the Central Valley fisheries investigations, 1939. California Fish and Game. 26: 334-373.

Heberer, C. 1999. Memo to Craig Wingert, NMFS, SWR. Synopsis of inriver harvest information for chinook salmon in the Central Valley. 10 pp. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Humboldt Chapter of the American Fisheries Society Arcata, CA, 24 p.

Holman, G. 1972. King salmon spawning - Russian River, Sonoma County. Memorandum of the California Department of Fish and Game dated November 20, 1972. 2 p.

Holden, B. 1999. Smith River chinook data submitted to the ESA Administrative Record for Update on Southern Oregon/Northern California Chinook Salmon ESU. Baker Holden, Sixes River National Forest. June 3, 1999.

Hoopa Valley Tribal Council (HVTC). 1995. Letter from George Kautsky to Mr. Big Eagle regarding summaries of catch, escapement and juvenile production data. Hoopa Valley Tribal Council, Natural Resource Division, Fisheries Department. 4 p.

Horner, N., and T.C. Bjornn. 1979. Status of Upper Columbia River Fall Chinook Salmon (Excluding Snake River Populations.) 45 p.

Howard, C.F. 1998. Fall salmonid spawning escapement estimates for Rock Creek and Mill Creek. Fourth Interim Report (1993/94-1997/98). Stimson Lumber Company, Crescent City, CA.

Howard, C.F. 1999. Chinook and coho salmon spawning escapement estimates for Rock Creek and Mill Creek. Fifth Interim Report (1993/94-1998/99). Stimson Lumber Company, Crescent City, CA. March 5, 1999.

Howard, C. and P. Albro. 1997. Juvenile outmigrant monitoring program, 1997 progress report for the West Branch and East Fork of Mill Creek. Rellim Redwood Co., Crescent City, Ca. September 30, 1997.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Orrmann. 1985. Stock assessment of Columbia River anadromous salmonids. Vol: I. U.S. Dep. Energy, Bonneville Power Administration. Project No. 83-335, 558 p.

Hubbs, C.L. 1946. Wandering pink salmon and other salmonid fishes into southern California. California Fish and Game. 81-86.

Huntington, C., W. Nehlsen, and J. Bowers. 1996. A survey of healthy native stocks of anadromous salmonids in the Pacific Northwest and California. Fisheries 21(3):6-14.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992a. Stock summary reports for Columbia River anadromous salmonids. Volume III: Washington subbasins below McNary Dam. Bonneville Power Administration. Project No. 88-108, 1077 p.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, and K. Hatch. 1992b. Stock summary reports for Columbia River anadromous salmonids. Vol. IV: Washington subbasins above McNary Dam. Bonneville Power Administration. Project No. 88-108, 375 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife, Public Information Officer - PJ, P.O. Box 3621, Portland, OR, 97208.)

Idaho Department of Fish and Game (IDFG). 1999. Letter from E. B. Bowles (IDFG) to R. Waples (Northwest Fisheries Science Center, NMFS) dated 17 May 1999. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Irving, J.S. and T.C. Bjornn. 1981. Status of Snake River Fall chinook salmon in relation to the Endangered Species Act. U.S. Fish and Wild. Service Report. 55 p.

Jewett, P.F. 1979. Mokelumne River fish installation annual report for 1976-77 season. Anadromous Fisheries Branch Administrative Report No. 79-4. 13 p.

Jonasson, B.C., and R.B. Lindsay. 1988. Fall chinook salmon in the Descutes River. Oregon Department of Fish and Wildlife Research and Development Section, Information Report 88-6, p.

Jones, W. 1999. Documents submitted to the ESA Administrative Record for west coast chinook salmon. May 1999. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.

Jordan, D.S. 1894. Notes on the freshwater fishes of San Luis Obispo County, California. Bull. U.S. Fish Comm., XIV: 141-142.

Jordan, D.S., and C.H. Gilbert. 1881. Notes on the fishes of the Pacific Coast of the United States. Proc. U.S. Nat. Mus., IV: 29-70.

Kim, T.J., K.M. Parker, and P.W. Hedrick. 1999. Major histocompatibility complex differentiation in Sacramento River Chinook Salmon. Genetics 151: 1115-1122.

Klatte, B. and T. Roelofs. 1997. Salmon redd composition, escapement and migration studies in Prairie Creek, Humboldt County, California, 1996-1997: 1997 Final Report - DRAFT. Humboldt State University, Arcata, California. 32 pp.

Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oreg. Dep. Fish Wildl. Rep., 217 p. + appendices. (Available from Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR, 97207.)

LaVoy, L., and G. Mendel. 1996. Stock composition of fall chinook at Lower Granite Dam in 1995. Washington Department of Fish and Wildlife, Columbia River Progress Report No. 96-13.

Lichatowich, J. 1998. A conceptual foundation for the management of native salmonids in the Deschutes River. Final Draft, November 1998. Report to Portland General Electric Company.

Lower Rogue Watershed Council (LRWC). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon. Undated 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.

Marshall, A. R., C. Smith, R. Brix, W. Dammers, J. Hymer, and L. LaVoy. 1995. Genetic diversity units and major ancestral lineages for chinook salmon in Washington. *In* C. Busack and J. B. Shaklee (editors), Genetic diversity units and major ancestral lineages of salmonid fishes in Washington. p 111-173. Wash. Dep. Fish Wildl. Tech. Rep. RAD 95-02. (Available from Washington Department of Fish and Wildlife, 600 Capital Way N., Olympia WA 98501-1091.)

Mills, T., and P. Ward. 1996. Status of actions to restore Central Valley spring-run chinook salmon: a special report to the Fish and Came Commission. Calif. Dept. Fish and Game. Inland Fisheries Division 56 pp.

Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. U.S. Fish. Wildl. Serv. Monograph I: 1-489.

Murphy, G.I. and L. Shapovalov. 1950. A preliminary analysis of northern California salmon and steelhead runs. California Fish and Game. 487-507.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

National Marine Fisheries Service (NMFS). 1993. Interim policy on artificial propagation of Pacific salmon under the Endangered Species Act. Federal Register [Docket No. 921186-2286, 5 April 1993] 58(63):17573-17576.

National Marine Fisheries Service (NMFS). 1994. Listing endangered and threatened species and designating critical habitat: Initiation of status reviews for pink salmon, chum salmon,chinook salmon, and sea-run chtthroat trout populations in Washington, Oregon, Idaho, and California. Federal Register [I.D. 081694D, 12 September 1994] 59(175):46808-46810.

National Marine Fisheries Service (NMFS). 1995. Proposed recovery plan for Snake River Salmon. 364 p. + appendixes.

Natural Resources Consultants (NRC). 1996. Artificial propagation of anadromous Pacific salmonids, 1950 to present. Chinook salmon. Contract report to U.S. Dept Comm., NOAA, NMFS, February 1996. Includes electronic database. (Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Portland, OR 97232.)

National Marine Fisheries Service (NMFS). 1998a. Endangered and threatened species: proposed endangered status for two chinook salmon ESUs and proposed threatened status for five chinook salmon ESUs; proposed redefinition, threatened status, and revision of critical habitat for one chinook salmon ESU; proposed designation of chinook salmon critical habitat in California, Oregon, Washington, Idaho. Federal Register [Docket No. 980225050-8050-01; I.D. 022398C] 63(45): 11482-11520.

National Marine Fisheries Service (NMFS). 1998b. Factors contributing to the decline of chinook salmon: an addendum to the 1996 West Coast steelhead factors for decline report. 74 p. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St. , Suite 500, Portland, Oregon 97232).

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

Nehlsen, W. 1995. Historical salmon and steelhead runs of the upper Deschutes River and their environments. 65 p. (Available from Portland General Electric Company, Hydro Licensing Department, Atten Mary May, 3WTCR04, 121 SW Salmon St, Portland OR 97204.)

Nei, M. 1978. Estimation of average heterozygosity and genetic distance from a small number of individuals. Genetics 89:583-590.

Nicholas, J. W., and D. G. Hankin. 1988. Chinook salmon populations in Oregon coastal river basins: Description of life histories and assessment of recent trends in run strengths. Oreg. Dep. Fish Wildl., Fish. Div. Info. Rep., No. 88-1, 359 p.

Nickelson, T. E., J. W. Nicholas, A. M. McGie, R. B. Lindsay, D. L. Bottom, R. J. Kaiser, and S. E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Oreg. Dep. Fish Wildl., Research and Development Section and Ocean Salmon Management. Unpubl. manuscr., 83 p. (Available from Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR 97207.)

Nielsen, J.L. 1995. Mitochondrial DNA Frequency Distributions in Chinook Salmon form the Sacramento-San Joaquin Basin and Guadalupe River 1992-1994. Report to California Department of Fish and Game.

Nielsen, J.L., M.C. Fountain, D.R. Sundermeyer, E.L. Heine, C.L. Malone, and O.L. Avelino. 1999. Microsatellites Variation in Chinook Salmon Spawning Runs from the Central Valley, California, 1992-1997. Report to California Department of Fish and Game.

Nielsen, J.L., D. Tupper, and W.K. Thomas. 1994. Mitochondrial DNA polymorphisms in unique runs of chinook salmon (Oncorhynchus tshawytscha) from the Sacramento-San Joaquin River basin. Conservation Biology 8(3):882-884.

Northwest Forest Resource Council (NFRC). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by J.F. Palmisano. 7 July 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Olsen, E., P. Pierce, M. McLean, and K. Hatch. 1992. Stock Summary Reports for Columbia River Anadromous Salmonids Volume I: Oregon. U.S. Dep. Energy., Bonneville Power Administration. Project No. 88-108. (Available from Bonneville Power Administration, Division of Fish and Wildlife, Public Information Officer - PJ, P.O. Box 3621, Portland, OR 97208.)

Olson, D. 1998. Letter from D. Olson (peer reviewer) to G. Griffin (Protected Resources Division, NMFS Northwest Region) dated 22 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Olympic Resources Management (ORM). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by R. Burns. Undated 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.

Omernik, J.M., and A.L. Gallant. 1986. Ecoregions of the Pacific Northwest. U.S. Environ. Protec. Agen. Rep. EA/600/3-86/033, 39 p.

Oregon Department of Fish and Wildlife (ODFW). 1993. Oregon salmon and steelhead catch data, 1980-92. Oreg. Dep. Fish Wildl., Fish Div., 22 p.

Oregon Department of Fish and Wildlife (ODFW). 1997. Electronic datda and documents submitted to ESA administrative record for west coast chinook salmon status review by S. Jacots. September 1997.

Oregon Department of Fish and Wildlife (ODFW). 1998a. Documents submitted to the ESA Administrative Record for west coast chinook salmon by J.W. Greer, 13 October 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Oregon Department of Fish and Wildlife (ODFW). 1998b. Letter from J.W. Greer (ODFW) to Robin Waples (Conservation Biology, NWFSC, NMFS) dated 9 September 1998. 3 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Oregon Department of Fish and Wildlife (ODFW). 1999a. Letter from J.Martin (ODFW) to Robin Waples (Conservation Biology, NWFSC, NMFS) dated 10 May 1999. 2p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

ODFW. 1999b. Deschutes River fall chinook salmon update. Data submitted for ESA Administrative Record for update on Snake River Fall-Run Chinook Salmon ESU at co-managers meeting, June 11, 1999.

Oregon Department of Fish and Wildlife (ODFW). 1999c. Letter from J.W. Greer (ODFW) to Robin Waples (Conservation Biology, NWFSC, NMFS) dated 16 June 1999. 5 p. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Pacific Coast Federation of Fisherman's Associations (PCFFA). 1998. Letter from G.H. Spain (PCFFA) to Garth Griffin (Protected Resources Division) dated 30 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Pacific Fishery Management Council (PFMC). 1996. Review of the 1995 ocean salmon fisheries. Pacific Fishery Management Council, 115 p. + appendixes. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 234, Portland, OR 97201.)

Pacific Fishery Management Council (PFMC). 1997. Review of 1996 ocean salmon fisheries. Pacific Fishery Management Council. 275 p.

Pacific Fishery Management Council (PFMC). 1998. Review of 1997 Ocean Salmon Fisheries. Pacific Fishery Management Council.

Pacific Fishery Management Council (PFMC). 1999. Review of 1998 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 1999.

Pacific Gas and Electric Company (PGE). 1998. Letter from T. Morford (PGE) to Protected Species Division, NMFS, dated 8 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Pacific States Marine Fisheries Commission (PSMFC). 1997. Streamnet Microsoft Access computerized database submitted to the ESA Administrative Record for west coast chinook salmon status review by D. Anderson. May 1997.

Pacific States Marine Fisheries Commission (PSMFC). 1999. Streamnet Microsoft Access computerized. June 1999.

Pacific Fishery Management Council (PFMC). 1999. Review of 1998 ocean salmon fisheries. Pacific Fishery Management Council. 109 p. + appendices. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201).

Pacific Salmon Commission (PSC). 1994. Pacific Salmon Commission Joint Chinook Technical Committee 1993 annual report. Pacific Salmon Commission. Report Chinook (94)-1, 121 p. + appendixes.

Patt, Olney. 1999. Letter from O. Patt (CTWSRO) to J. Myers (Northwest Fisheries Science Center, NMFS) dated 22 June 1999. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Peterson, G.D. 1999. Final report, spawning ground surveys, 1998-1999 season, Mattole River watershed. BLM Cooperative Agreement 1422-B300-A7-1010, Task Order 002. Mattole Salmon Group, Petrolia, CA. April 1999.

Preston, L. 1999. Mad River and Freshwater Creek data submitted to the ESA Administrative Record for Update on Southern Oregon and Northern California Chinook Salmon ESU (May 24, 1999) by Larry Preston, CDFG.

Production Advisory Committee (PAC). 1998. Analysis of Klickitat Hatchery fall chinook straying past Lower Granite Dam developed by a subgroup of the U.S. v. Oregon Production Advisory Committee January 26, 1998. 17 pp. (Available from

Professional Resource Organization-Salmon (PRO-Salmon). 1994. Petition for a rule to list nine Puget Sound salmon populations as threatened or endangered under the Endangered Species Act and to disignate critical habitat. Unpublished manuscr., 86 p. (Available from PRO-Salmon, Washington Public Employees Association, 124 10th Ave. S.W., Olympia, WA 98501

Radford, L. 1996. Cooperative artificial propagation programs for salmon and steelhead, 1994-1995. California Department of Fish and Game Inland Fisheries Administrative Report No. 96-2. 18 p.

Radford, L. 1998. Cooperative artificial propagation programs for salmon and steelhead, 1996-1997. California Department of Fish and Game Inland Fisheries Administrative Report No. 98-5. 20 p.

Reavis, R. 1985. Annual report: Chinook salmon spawning stocks in California's central valley, 1984. Draft. Calif. Dep. Fish Game, Anadromous Fisheries Branch Administrative Report, 51 p.

Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring central valley streams: A plan for action. Calif. Dep. Fish Game, Sacramento, CA, 184 p.

Rivers, C. M. 1963. Rogue River fisheres, volume 1: History and development of the Rogue River Basin as related to its fishery prior to 1941. Oreg. State Game Comm. Portland, OR. Unpubl. manuscr., 264 p.

Roelofs, T. and B. Klatte. 1996. Anadromous salmonid escapement and downstream migraitons studies in Prairie Creek, California, 1995-1996: 1996 Progress Report. Humboldt State University, Arcata, CA. 18 pp.

Roelofs, T.D. and M.D. Sparkman. 1999. Effects of sediment from the Redwood National Park bypass project (CALTRANS) on anadromous salmonids in Prairie Creek State Park 1995-1998. Fisheries Department and Humboldt State University Foundation, Humboldt State University, Arcata, CA. 28 pp.

San Joaquin Tributaries Association and the Merced, Modesto, Oakdale, South San Joaquin and Turlock Irrigation Districts (SJTA). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by S.T. Steffen. 30 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Shapovalov, L. 1944. Preliminary report on the fisheries of the Russian River System, California. California Division of Fish and Game Report 44-13. 8 p.

Schiewe, M.H. 1998. Memorandum from M.H. Schiewe (NWFSC, NMFS) to W. Stelle (Northwest Region, NMFS) and W. Hogarth (Southwest Region, NMFS) dated 30 October 1998. 8 p. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Schreck, C. B., H. W. Li, C. S. Sharpe, K. P. Currens, P. L. Hulett, S. L. Stone, and S. B. Yamada. 1986. Stock identification of Columbia River chinook salmon and steelhead trout. U.S. Dep. Energy, Bonneville Power Administration. Project No. 83-45, 184 p. (Available from Bonneville Power Administration, Division of Fish and Wildlife, Public Information Officer-PJ, P.O. Box 3621, Portland, OR 97208.)

Snyder, J.O. 1908. The fauna of Russian River, California, and it relation to that of the Sacramento. Science, N.S., XXVII: 269-271.

Snyder, J.O. 1913. The fishes of the streams tributary to Monterey Bay, California. Bull. U.S. Bur. Fish., 32: 49-72.

Siskiyou Project (SP). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by R.K. Nawa. 30 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Smith River Advisory Council (SRAC). 1998. Letter from J. Waldvogel (SRAC) to C. Wingert (Protected Resources Division, NMFS) dated 12 June 1998. 2 p. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Snider, B., B. Reavis and S. Hill. 1999. Upper Sacramento River Fall-run Chinook Salmon Escapement Survey, September - December 1998. California Department of Fish and Game, Habitat Conservation Division, Water and Aquatic Habitat Conservation Branch, Stream Evaluation Program. May 1999.22 p. + figures.

South Coast Coordinating Watershed Council (SCCWC). 1998. Letter from L. La Bonte (SWCCWC) to W. Stelle (Northwest Region, NMFS) dated 6 May 1998. 1 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

State Water Contractors (SWC). 1998. Documents submitted to the ESA Administrative Record for west coast chinook salmon by E. Garner. 30 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Steiner Environmental Consulting (SEC). 1997. Docments submitted to ESA Admin. Record for west coast chinook salmon by D. Ebert, August 1997.

Stauff 1999. Data submitted to ESA Admin. Record for Update on Southern Oregon/Northern California Chinook Salmon ESU (May 19, 1999) by Russ Stauff, ODFW, Gold Beach, OR.

Tehama-Colusa Canal Authority (TCCA). 1988. Documents submitted to the ESA Administrative Record for west coast chinook salmon by A.R. Bullock. 25 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Tuolumne River Preservation Trust (TRPT). 1998. Letter from T. Ramirez (TRPT) to G. Griffin and C. Wingert (Protected Resources Division, NMFS) dated 30 June 1998. 5 p + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Turlock Irrigation District and Modesto Irrigation District (TIDMID). 1998. Letter from D. Olson (peer reviewer) to G. Griffin (Protected Resources Division, NMFS Northwest Region) dated 29 June 1998. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

United States Commission of Fish and Fisheries (USFC). 1876. Correspondence relating to the San Joaquin River and its fishes. Report of the Commissioner for 1873-4 and 1874-5. Part XXIII, pp. 481-483.

United States Department of the Interior (USDI). 1998. Letter from W.Taylor (Office of Environmental Policy and Compliance, U.S. Department of the Interior) to G. Griffin (Protected Resources Division, NMFS Northwest Region) dated 23 June 1998. 4 p. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

U.S. Fish and Wildlife Service (USFWS). 1997. Documents submitted to the ESA Administrative Record for west coast chinook salmon by D. Finberg, 26 February 1997. 4 p. (Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Suite 500, Portland, OR 97232).

U.S. Forest Service (USFS). 1997. Documents submitted to the ESA administrative record for west coast chinook slamon by M. McCain, 16 September 1997. 19 p.

Utter, F., G. Milner, G. Ståhl, and D. Teel. 1989. Genetic population structure of chinook salmon, *Oncorhynchus tshawytscha*, in the Pacific Northwest. U.S. National Marine Fisheries Service Fishery Bulletin 87:239-264.

Utter, F. 1998. Letter from F. Utter (peer reviewer) to G. Griffin (Protected Resources Division, NMFS Northwest Region) dated 22 June 1998. 1 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Van Cleve, R. 1945. A preliminary report on the fishery resources of California in relation to the Central Valley Project. California Fish and Game. 31:33-52.

Waldvogel,D. 1997. Documents submitted to ESA Admin. Record for west coast chinook 9/16/97.

Waldvogel, D. 1999. Documents submitted to ESA Admin. Record for update on west coast chinook 6/7/99.

Waples, R. S., J. Robert, P. Jones, B. R. Beckman, and G. A. Swan. 1991. Status review for Snake River fall chinook salmon. U.S. Dep. of Commerce. NOAA Tech. Memo. NMFS F/NWC-201, 73 p. (Available from National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Washington Department of Fish and Wildlife (WDFW). 1997. Documents submitted to the ESA administrative record for west coast chinook salmon by R. Brix, 18 September 1997.

Washington Department of Fish and Wildlife (WDFW). 1998. Letter from C. Smith (WDFW) to R. Waples (Northwest Fisheries Science Center, NMFS) dated 13 July 1998. 11 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Washington Department of Fish and Wildlife (WDFW). 1999. Letter from B. Crawford (WDFW) to R. Waples (Northwest Fisheries Science Center, NMFS) dated 11 May 1999. 2 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl. Olympia 212 p. and 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091.)

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, P.B. Moyle. 1996. Historical and present distribution of chinook salmon in the Central Valley Drainage of California. Sierra Nevada Ecosystem Project: Final report to Congress, vol. III. p 309-361.

Yurok Tribal Fisheries Program (YTFP). 1997. Documents submitted to the ESA administrative record for west coast chinook salmon by Yurok Tribal Fisheries Program, 31 January, 1997. 27 p.

Yurok Tribe (YT). 1999. Letter from T. Fletcher to R. Waples (Northwest Fisheries Science Center, NMFS) dated 18 June 1999. 3 p. + attachments. (Available from Protected Resources Division, NMFS, 525 N.E. Oregon St., Suite 500, Portland, OR 97232.)

APPENDIX A.

Appendix A: Summary of chinook salmon abundance data considered, by ESU and River/Stock.

ESU River Basin	Sub-basin	Run[1]	Production[2]	Status summaries[3] A	B	C	D	E	P?[4]	Data Years	Recent abundance Data type[5]	5-Year Geometric mean[6]	Trends Long-term[7]	Short-Term[8]	Data References
Central Valley Spring-Run															
Sacramento R		Sp	Natural	B					P	1967-98	DC	291	-11.8	-32.0	CDFG 1999a
			Natural							1951-98	DC,SC,RC	305	-3.8	-32.0	CDFG 1998, CDFG 1999a
	Battle Cr	Sp	Mixed							1946-97	SC,RC,WC	259	-6.0		CDFG 1998, CDFG 1999a
	Antelope Cr	Sp	Natural						P	1953-98	SE,SC,SN	5	-7.2		CDFG 1998, CDFG 1999a
	Mill Cr	Sp	Natural						P	1947-98	SC,RC,DC	346	-4.8	-7.1	CDFG 1998, CDFG 1999a
	Deer Cr	Sp	Natural						P	1940-98	WC,SC,RC SN,DC	805	-2.6	19.0	CDFG 1998, CDFG 1999a
	Big Chico Cr	Sp							P	1956-98	SC,SN,TC	14	-7.7	17.0	CDFG 1998, CDFG 1999a
	Butte Cr	Sp	Natural						P	1955-98	SN,CS,RC, SC,DC	2,302	-1.7	27.8	CDFG 1998, CDFG 1999a
	Feather R	Sp	Mixed						P	1954-98	TE	5,013	3.7	3.7	CDFG 1998, CDFG 1999a
	Yuba R	Sp		B					P						
	American R	Sp/Su		X											
	McCloud R	Sp/Su		X											
	Pit R	Sp/Su		X											
San Joaquin R (& tribs)		Sp/Su		X											
Central Valley Fall-Run															
Sacramento R		Early Fa							P						
	Above RBDD	Fa	Mixed							1967-98	DC, CS	24,515	-4.1	-8.3	CDFG 1999a, Snider et al. 1999
	In-river only	Late Fa	Mixed						P	1971-98	DC, CS	8,501	-2.8		CDFG 1999a
	In-river + CNFH transfers	Late Fa	Mixed							1967-98	DC, CS	8,757	-4.8		BE and LGL 1995, CDFG 1999a
	Cow Cr	Fa	Natural							1953-84	CS,SC,RC	1,317	-4.2		CDFG 1999a
	Bear Cr	Fa	Natural							1953-76	RC,CS,SC	203	3.5		CDFG 1999a
	Clear Cr	Fa	Natural							1953-98	SC,RC	5,492	1.9	14.7	CDFG 1999a
	Cottonwood Cr	Fa	Natural							1953-92	RC,CS	825	-0.3		CDFG 1999a
	Battle Cr	Fa	Mixed							1946-98	CS,WC	45,584	3.1	15.6	CDFG 1999a
	Antelope Cr	Fa	Natural							1953-92	SE,SC,SN	232	-5.3		CDFG 1999a
	Mill Cr	Fa	Natural							1952-98	CS,RC	925	-3.1	-10.1	CDFG 1999a

ESU	River Basin	Sub-basin	Run[1]	Production[2]	Status summaries[3] A	B	C	D	E	P?[4]	Recent abundance Data Years	Data type[5]	5-Year Geometric mean[6]	Trends Long-term[7]	Short-Term[8]	Data References
		Deer Cr	Fa	Natural							1952-98	CS,RC	303	-2.8		CDFG 1999a
		Feather R	Fa	Natural						P	1953-98	CS	48,923	0.7	4.0	CDFG 1999a
		Yuba R	Fa	Natural						P	1953-98	CS	19,231	1.9	14.1	CDFG 1999a
		American R	Fa	Natural						P	1952-98	CS	51,909	1.6	20.1	CDFG 1999a
	San Joaquin R		Fa	Natural	C						1952-98	DC,CS	10,834	-2.7	18.5	CDFG 1999a
		Cosumnes R	Fa	Natural	C					P	1953-88	CS	245	-6.4		CDFG 1999a
		Mokelumne R	Fa	Natural						P	1951-98	DC,CS	3,390	0.6	41.0	CDFG 1999a
		Stanislaus R	Fa	Natural						P	1951-98	CS	824	-4.8	-6.2	CDFG 1999a
		Tuolumne R	Fa	Natural						P	1951-98	CS	2,210	-4.5	24.4	CDFG 1999a
		Merced R	Fa	Natural						P	1954-98	CS	3,146	6.4	31.9	CDFG 1999a
California Coastal																
	Redwood Cr		Fa	Natural	B	C				P						
		Little R	Fa	Natural		C				P						
		Prairie Cr	Fa	Natural							1995-98	WC		72.6		Roelofs & Klatte 1996, Klate & Roelofs 1997, Roeloffs & Saprkkman 1999
			Fa	Natural							1995-98	RC		33.4		Roelofs & Klatte 1996, Klate & Roelofs 1997, Roeloffs & Saprkkman 1999
			Fa	Natural							1995-98	CS		-0.1		Roelofs & Klatte 1996, Klate & Roelofs 1997, Roeloffs & Sparkman 1999
		Lost Man Cr	Fa	Natural							1996-97	WC		72.7		Anderson 1998, Anderson 1999
			Fa	Natural							1996-97	CS		-80.0		Anderson 1998, Anderson 1999
	Mad R		Fa		B	C				P	1938-64	DC	143	-10.7		BE and LGL 1995
		North Fork	Fa	Mixed							1985-98	SC		-8.0	10.0	BE and LGL 1995, PSMFC 1997, Preston 1999
		Canon Cr	Fa	Natural							1964-98	PI		-4.9	19.7	PFMC 1997, Preston 1999
	Humboldt Bay	Tributaries	Fa		A	A				P						
		Freshwater Cr	Fa	Natural							1985-90	WC		-39.5		Preston 1999
	Eel R		Fa			C				P	1947-98	DC	36	+0.1	-9.4	PSMFC 1997, SEC 1997, CDFG 1999b
											1980-96	CS	15	0.8	-34.2	SEC 1998
											1946-98	HE	90	0.7	21.6	CDFG 1999c
		Lower	Fa		B											
		Sprowl Cr	Fa	Natural							1966-98	PI		-4.4	+0.2	PFMC 1998, PFMC 1999

ESU	River Basin	Sub-basin	Run[1]	Production[2]	Status summaries[3] A	B	C	D	E	P?[4]	Data Years	Recent abundance Data type[5]	5-Year Geometric mean[6]	Trends Long-term[7]	Short-Term[8]	Data References
		Tomki Cr	Fa	Natural							1964-98	CS	63	-15.3	-44.2	BE and LGL 1995, PFMC 1997, PSMFC 1997, Harris 1998, CDFG 1999c
		Hollow Tree Cr	Fa	Natural							1987-98	TE	29	-25.4	-19.9	CDFG 1999c
		Redwood	Fa	Natural							1987-93	TE		-90.0		CDFG 1999c
		South Fork	Fa	Natural							1938-75	WC	4,022	-0.2		BE and LGL 1995
	Outlet Cr	Baechtel Cr	Fa	Natural							1986-98	PI		-0.3		CDFG 1999c
		Long Valley Cr	Fa	Natural							1987-98	PI		-20.9		CDFG 1999c
		Ryan Cr	Fa	Natural							1987-98	PI		-13.9		CDFG 1999c
		Willits Cr	Fa	Natural							1986-98	PI		-7.4		CDFG 1999c
	Bear R		Fa			C				P						
	Mattole R		Fa	Natural	A	A				P	1994-98	SC		-5.2		Peterson 1999
			Fa	Natural							1994-98	CS		-10.0		Peterson 1999
			Fa	Natural							1994-98	RC		-0.1		Peterson 1999
	Russian R		Fa	Hatchery – Warm Springs	A					P	1980-98	TC	28	5.6	-18.1	CDFG 1999c
				Hatchery – Coyote Valley Fish Facility							1992-98	TC		21.5		CDFG 1999c
Southern Oregon/Northern California Coastal																
	Euchre Cr	Upper	Fa	Natural	A		D			P	1986-98	PI[9]		-3.1	-8.7	BE and LGL 1995, ODFW 1997, PSMFC 1997, Stauff 1999
		Upper Cedar Fork	Fa	Natural							1988-98	PI[10]		-12.8	-12.8	Stauff 1999
		Sharp Bend	Fa	Natural							1989-98	PI[10]		40.3	40.3	Stauff 1999
	Rogue R		Sp	Natural						P	1968-92	AC	30,426			Nicholas and Hankin 1988, ODFW 1993
				Mixed							1942-98	DC	7,709	-1.9	-9.2	BE and LGL 1995, PFMC 1999, ODFW 1999a
			Fa	Natural							1977-98	CS	51,813	-1.0	-10.8	ODFW 1999a
				Mixed							1977-98	DC	57,188	1.5	-4.4	ODFW 1999a
			Fa	Mixed							1977-98	SE	26,756	-4.1	1.3	ODFW 1999a
			Fa	Mixed							1977-96	AC	50,180	7.3	3.0	ODFW 1999a
		Jim Hunt	Fa	Natural							1965-98	PI[9]		-7.2	-13.1	Stauff 1999
		Upper Lobster	Fa	Natural							1972-98	PI[9]		-4.3	10.4	Stauff 1999
		Youth Camp on Lobster/Rogue	Fa	Natural							1995-98	PI[10]		17.9		Stauff 1999

ESU					Status summaries[3]						Recent abundance			Trends		
River Basin		Sub-basin	Run[1]	Production[2]	A	B	C	D	E	P?[4]	Data Years	Data type[5]	5-Year Geometric mean[6]	Long-term[7]	Short-Term[8]	Data References
		South Fork Lobster/ Rogue	Fa	Natural							1995-98	PI[10]		20.8		Stauff 1999
		Upper East Fork Lobster/Rogue	Fa	Natural							1995-98	PI[10]		-18.8		Stauff 1999
		Quosatana	Fa	Natural							1963-98	PI[10]		-8.0	-8.2	Stauff 1999
		Shasta Costa	Fa	Natural							1986-98	PI[10]		-14.4	-7.6	Stauff 1999
		Saunders	Fa	Natural							1989-98	PI[10]		51.3	51.3	Stauff 1999
		Lower	Fa		A		D			P						Stauff 1999
		Middle	Fa				H		H-H							Stauff 1999
		Upper	Sp				H									Stauff 1999
			Fa				H		H-H							Stauff 1999
		Illinois R	Fa				D			P						Stauff 1999
		Applegate R	Fa				H		H-H							Stauff 1999
	Hunter Creek		Fa		A		D			P						Stauff 1999
		Upper	Fa	Natural							1987-98	PI[9]		29.9	29.9	Stauff 1999
		Little SF	Fa	Natural							1989-98	PI[10]		60.1	60.1	Stauff 1999
		Leith's	Fa	Natural							1995-98	PI[10]		-15.9		Stauff 1999
	Pistol R	Deep Cr	Fa	Natural	B		D			P	1960-98	PI[9]		3.2	23.9	Stauff 1999
		Upper Deep Cr	Fa	Natural							1989-98	PI[10]		38.1	38.1	Stauff 1999
		South Fork	Fa	Natural							1994-97	PI[10]		6.4		Stauff 1999
		Upper South Fork	Fa	Natural							1995-98	PI[10]		-28.6		Stauff 1999
		Kuntz-Davis	Fa	Natural							1994-97	PI[10]		-0.0		Stauff 1999
	Chetco R	Big Emily Cr	Fa	Natural			S-2			P	1971-98	PI[9]		-4.0	0.2	Stauff 1999
		Upper Jack Cr	Fa	Natural							1989-98	PI[10]		13.1		Stauff 1999
		Mill Cr	Fa	Natural							1986-98	PI[10]		13.5	7.2	Stauff 1999
		Wilson Cr	Fa	Natural							1989-98	PI[10]		11.4	11.4	Stauff 1999
		Panther Cr	Fa	Natural							1986-98	PI[10]		4.9	3.8	Stauff 1999
		NF Chetco R	Fa	Natural							1989-98	PI[10]		-4.0	-4.0	Stauff 1999
	Winchuck R	Bear Cr	Fa	Natural	B		D			P	1964-98	PI[9]		-1.9	14.2	Stauff 1999
		Upper Bear Cr	Fa	Natural							1989-98	PI[10]		9.0	9.0	Stauff 1999
		Wheeler Cr	Fa	Natural							1989-96	PI[10]		13.5		Stauff 1999
		Upper Wheeler Cr	Fa	Natural							1995-98	PI[10]		73.2		Stauff 1999
		East Fork Winchuck	Fa	Natural							1986-95	PI[10]		-7.6	-11.4	Stauff 1999
		4th of July Cr	Fa	Natural							1986-98	PI[10]		2.2	-0.6	Stauff 1999
		Upper 4th of July Cr	Fa	Natural							1995-98	PI[10]		23.7		Stauff 1999

ESU				Status summaries[3]						Recent abundance			Trends		
River Basin	Sub-basin	Run[1]	Production[2]	A	B	C	D	E	P?[4]	Data Years	Data type[5]	5-Year Geometric mean[6]	Long-term[7]	Short-Term[8]	Data References
Smith R		Sp		A	A										
		Fa		B					P						
	South Fork	Sp							P	1991-98	SC		14.1	14.1	USFS 1997, Holden 1999
	Middle Fork	Sp							P	1991-98	SC		-6.7	-6.7	USFS 1997, Holden 1999
	North Fork	Sp							P	1992-98	SC		26.2		USFS 1997, Holden 1999
	Mill Cr	Fa	Mixed							1980-98	SC		+0.0	6.3	BE and LGL 1995, PSMFC 1997, Waldvogel 1997, 1999
		Fa	Natural							1994-97	WC		20.3		Howard & Albro 1997
	West Branch Mill Cr	Fa	Natural							1993-98	SN, SC	210	8.4		Howard 1998, Howard 1999
										1994-98	RC		-6.2		Howard 1999
	East Fork Mill Cr	Fa	Natural							1993-98	SN, SC	132	37.1		Howard 1998, Howard 1999
										1994-98	RC		-7.5		Howard 1999
	Rock Cr	Fa	Natural							1993-98	SN, SC	20	-4.4		Howard 1998, Howard 1999
Klamath R	Lower tributaries	Fa	Natural	B	B				P						
	Blue Cr	Fa	Natural							1988-98	SN		14.7	14.7	YTFP 1997, Gale 1999
	Pine Cr	Fa	Natural							1982-94	CS,RC,SC	12	5.0		HVTC 1995
Deschutes River Fall-run															
Deschutes R		Su	Unresolved							1957-90	TC	48	-1.6		BE and LGL 1995, PSMFC 1997
		Fa	Natural: Pelton trap						P	1957-97	TC	81	-1.9	-6.3	Beaty 1996, PSFMC 1999
		Fa	Natural							1977-98	TE	16,377	4.3	18.0	PSFMC 1999, CTWSRO 1999
			Natural: above Sherars Falls							1977-98	TE	2,959	-4.6	8.7	ODFW 1999b
		Fa	Natural: total redds							1972-98	RC		-5.5	5.4	PSFMC 1999, Beaty 1996
			Natural: Redds above Sherars Fall							1972-98	RC		-10.8	-1.6	Beaty 1996, CTWSRO 1999
			Natural: Redds below Sherars Falls							1972-98	RC		1.0	9.5	Beaty 1996. CTWSRO 1999
			Natural: Sherars Falls Trap							1977-98	TC		-5.6	1.3	CTWSRO 1999
Snake River Fall-run															
John Day R		Fa							P						

ESU	River Basin	Sub-basin	Run[1]	Production[2]	Status summaries[3]: A	B	C	D	E	P?[4]	Recent abundance: Data Years	Data type[5]	5-Year Geometric mean[6]	Trends: Long-term[7]	Short-Term[8]	Data References
	Walla Walla R		Fa		X											
	Snake R		Fa	Natural	A			NW D			1975-98	TE	565	-0.7	13.7	BE and LGL 1995, WDFW 1997, PFMC 1999
				Mixed							1975-98	DC	1,244	3.8	12.5	BE and LGL 1995, PSMFC 1997, DART 1999
											1940-80	DC	1,728	-5.2		Irving & Bjornn 1981
		Head of Lower Granite Dam to Hells Canyon Dam		Natural							1986-98	RC		9.6	4.8	Garcia et al. 1999
		Upstream of Lower Granite Dam		Natural							1991-98	RC		17	17	Garcia et al. 1999
		Snake R above Hells Canyon Dam	Fa		X											
		Clearwater	Fa	Natural							1988-98	RC		25.9	25.9	Garcia et al. 1999
			Fa	Natural							1952-72	DC		27.6		BE and LGL 1995
		NF Clearwawter	Fa	Natural							1992-98	RC		11.5		Garcia et al. 1999
		SF Clearwater	Fa	Natural							1992-98	RC		0		Garcia et al. 1999
		Lohsa R, Crooked Fork	Sp	Natural							1969-96	RC		-5.8	-19.4	BE and LGL 1995, PSMFC 1997
		Grande Ronde R	Fa	Natural							1986-98	RC		33.2	47.8	Garcia et al. 1999
		Imnaha R	Fa	Natural							1987-98	RC		17.1	17.1	Garcia et al. 1999
		Salmon R	Fa	Natural							1992-98	RC		4.0	4.0	Garcia et al. 1999
Additional populations that are not in Snake River Fall-run ESU but whose trends provide information about environmental conditions:																
?	Umatilla R		Fa	Natural	X					P	1983-97	DC	512	41.5	14.3	BE and LGL 1995, PSMFC 1997, Fagan 1998
?	Snake R	Clearwater R	Su		X											
?			Fa	Natural	X						1952-72	DC	41	27.6		BE and LGL 1995
?				Natural							1988-94	RC		21.6	21.6	BE and LGL 1995
?		Lower Clearwater	Sp							P						
?		Dworshak Hatchery	Sp							P						
?		SF Clearwater	Sp							P						
?		Kooksia Hatchery	Sp							P						
?		Lochsa R	Sp	Mixed						P	1967-91	RC		-0.4	-23.8	BE and LGL 1995
?		Selway R	Sp	Natural						P	1969-96	RC		-8.9	-12.3	PSMFC 1997

NOTES

? Not an ESA issue (chinook salmon were not historically present in the watershed or current stocks are not representative of historical stocks).

[1] Run timing designations: Fa -- fall; Sp -- spring; Su -- summer; Wi -- winter (as reported by data reference).

[2] Production: (as reported by data reference).

[3] Status summaries from the following sources;

A--Nehlsen et al. (1991):

E, endangered (US); X, extinct; A+, possibly extinct; A, high extinction risk; B, moderate extinction risk; C, special concern.

B--Higgins et al. (1992):

A, high risk of extinction; B, moderate risk of extinction; C, stock of concern.

C--Nickelson et al. (1992):

H, healthy; D, depressed; S, special concern; U, unknown.

1, May not be a viable population; 2, Hatchery strays; 3, Small, variable run.

D--WDF et al. (1993): Three characters represent stock origin, production type, and status, in that order.

Origin: N, native; M, mixed; X, non-native; U, unknown; -, unresolved by state and tribes.

Production: W, wild; C, composite; A, cultured; U, unknown; -, unresolved.

Status: H, healthy; D, depressed; C, critical; U, unknown.

E--Huntington et al. (1996):

H-I, healthy Level I (abundance at least two-thirds as great as would be found in the absense of human impacts).

H-II, healthy Level II (abundance between one-third and two thirds as great as expected without human impacts).

[4] Petition status [P?]: Indicates (by 'P') stocks included in the ONRC and Nawa petition dated 31 January 1995. Parentheses indicate stock is included as part of a larger unit in the petition.

[5] Data Type Codes: AC, angler catch expanded (1988-92); CS, carcass; DC, dam count; FM, fish per mile; HE, total estimated hatchery escapement; IT, index total; PC, peak or index live fish, surveys combined; PI, peak or index live fish; PR, peak redd count; RC, redd count; RH, resting hole counts; RM, redds per mile; RMC, redds per mile (surveys combined); SC, spawner counts; SE, seine catches; SN, snorkle counts; TC, trap count; TE, total estimated escapement (includes hatchery escapement only for mixed production type); TL, total live fish count; WC, wier count. SE, seine counts.

[6] Most recent 5 years of data used to calculate spawning escapement geometric mean. (Expanded angler catch = 1988-92).

[7] Trend (Long-term): Calculated for all data collected after 1950.

[8] Short-term Trend: Calculated for most recent 7-11 years during the period 1988-98, except as noted.

[9] Oregon Department of Fish and Wildlife Standard Spawner Surveys.

[10] Oregon Department of Fish and Wildlife Supplemental Spawner Surveys.