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COMMENTS AND RECOMMENDATIONS TO THE STATE WATER RESOURCES CONTROL BOARD REGARDING

REVIEW OF STANDARDS FOR THE SAN FRANCISCO BAY/ SACRAMENTO-SAN JOAQUIN DELTA ESTUARY

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The Natural Heritage Institute ("NHI") submits this statement in response to the Notice of the Fourth Public Workshop to Review Standards for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. These comments respond to the first key issue posited by the Notice: What fish and wildlife standards should the SWRCB evaluate as alternatives in this review? This submittal includes a letter from Professor Peter Moyle concurring in the analysis and recommendations presented. NHI will present a separate statement on the economic and social effects of standards functionally equivalent to the "Club Fed" proposals.

I. INTRODUCTION

The spring run chinook salmon is eligible for protection under federal and state endangered species laws. Once the most abundant race of salmon in California producing about one million fish annually, less than 1,000 native spring run return annually, primarily to Mill and Deer Creeks in Tehama County.[1] The spring chinook has been a major cultural, biological and economic asset in this state. Among salmonids it is unique in returning from the ocean during the spring months to high Sierra streams which are cold enough to allow holding over the hot summers.

Spring chinook were decimated by dams closing access to most of their historic spawning habitat during the middle of the century, but these reduced populations stabilized by the 1950s, then continued to decline steeply since the 1960s, and particularly over the last decade. (See Figure 1.) There is little question that the major factor in these recent declines has been the increasing level of water exports out of the San Francisco-San Joaquin delta estuary ("delta").

Several of California's preeminent fishery biologists have concluded that spring run chinook should be listed as "endangered".[2] The California Department of Fish and Game ("CDFG") has informed this Board that spring run populations have reached record lows, and that this fish should be considered for listing.[3] Most recently, the Delta Native Fishes Recovery Team[4] has given spring run a "recovery potential rating" of 3C, similar to the delta smelt at 2C. This rating indicates that the degree of threat is quite high, "1" is the highest level of

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[1] Moyle, P. June 26, 1992. Causes of Decline in Estuarine Fish Species, WRINT-NHI-9, p. 6 (hereinafter "WRINT-NHI-9").

[2] See, e.g., Moyle, P.B., J.E. Williams, E.D. Wikramanayake, Fish Species of Special Concern of California. Final Report prepared for California Department of Fish and Game, Inland Fisheries Division. p. 6. (1989)

[3] WRINT-DFG Exhibit No. 14, Water Quality and Water Quantity Needs for Chinook Salmon Production in the Upper Sacramento River, pp 2-3 (hereinafter "WRINT-DFG-14").

[4] The Delta Native Fishes Recovery Team was appointed by the U.S. Fish and Wildlife Service on March 31, 1993 as part of the recovery effort for the delta smelt. The Team was given a much broader mandate than the recovery of that species, however, and is charged to "address the Delta ecosystem as a whole, considering the population declines of other native fishes, in addition to delta smelt, that require active management to restore sustainable populations." The Team includes representatives from U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Geological Service, U.S. Bureau of Reclamation, California Department of Fish and Game, California Department of Water Resources, U.C. Davis, San Jose State University and private consultants. The final report is scheduled for release this summer.

threat. By comparison, the Sacramento splittail, already listed as a candidate species, was given a rating of 7C. (P. Moyle, pers. comm.)

The Board's triennial review of compliance with federal water quality requirements provides it with a timely opportunity to anticipate and prevent the imminent threat of extinction of this species before the federal government is forced to do so under the Endangered Species Act ("ESA"). As the Governor's 1992 Water Policy stated: "[O]nly by managing whole aquatic ecosystems can we save species from being reduced to critically low populations."[5] In expressing concern over the Delta smelt listing, Governor Wilson decisively reaffirmed his belief that:

> "[T]he long-term solution to the problems of the Bay-Delta lies in anticipatory, multi-species habitat conservation, rather than the one-time single species process that characterizes the approach that has brought us to this perilous point." (Letter to President Clinton from Governor Wilson, March 8, 1993)(emphasis added).

Consistent with this apprehension over crisis management is the Governor's position that the State, and not the federal government, should take the lead on issues relating to California water management. "It's high time for California to reclaim control of its destiny....I am advancing the radical notion that Californians ...should be making decisions about how we use our water." (1992 Water Policy at 6.)

For these reasons, the Natural Heritage Institute today recommends that the Board adopt measures necessary to protect spring run chinook smolt outmigration through the delta. The last genetically pure runs of spring chinook spawn in Mill and Deer Creeks, tributaries of the Upper Sacramento River. These fish migrate through the delta as yearlings in the October-January period, when very limited smolt protections are in place,[6] and no additional protections are proposed. Moreover, it is likely that there will be increased adverse impacts on these smolts if the water projects shift more of their pumping to this period as a result of protections for the spring months proposed by EPA and other "Club Fed" members. Ecosystem

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[5] Governor's Water Policy Statement, p. 4 (April 6, 1992)(hereinafter "1992 Water Policy").

[6] The only relevant measure in place during this period is the winter run chinook Biological Opinion requirement that the state and federal water projects maintain flows in the western delta (QWEST) greater than negative 2000 cfs November 1 through January 31 based on a 14-day running average. National Marine Fisheries Service, Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project, (Feb. 12, 1993)(hereinafter "NMFS Bio. Opin.").

management demands that we avoid causing further harm to one species in order to restore another.

Our proposal is relatively modest. A great deal of information has been developed regarding the survival of Sacramento River smolts as they pass through the delta, based primarily on fall chinook data. Fishery biologists in and outside of government with whom we have consulted agree that the measures which have been developed and debated over the last several years for fall run are likely to benefit spring run as well. As discussed in detail herein, we urge the Board to extend certain measures which were recommended by the U.S. Fish and Wildlife Service during the WRINT proceedings to enhance fall run smolt survival (WRINT-FWS-7) to periods necessary to protect spring run yearling smolts as well, primarily November through January. Specifically, we propose: (1) closure of the delta cross channel gate; (2) maximum total CVP and SWP export limits varying with year classification; and (3) minimum flows at Jersey Point of 1000 cfs in all water years. (See Section V below.)

Adoption of the proposal detailed herein would be a major step toward the protection of the spring run chinook salmon, and would enable the State to retain control of its water management system, as well as restore a vital economic and biological resource. Alternatively, failure of the State to act effectively at this key juncture will inevitably result in the invocation of the federal ESA, and further erosion of state dominion over its resources.

II. SPRING RUN CHINOOK ABUNDANCE

Historic Background

Spring chinook were once the most abundant race of salmon in California's Central Valley, and one of the largest runs on the Pacific Coast.[7] Large spring run populations occupied 26 streams in the Sacramento-San Joaquin drainage, principally in the middle reaches of the San Joaquin, Feather, Upper Sacramento, McCloud and Pit Rivers and their tributaries. (Recovery Team Draft at 1-2.) By 1992, however, "wild spring run populations [were] less than 0.5% of the historic runs" which numbered up to a million fish. (WRINT-NHI-9 at 6; P.Moyle, pers. comm.)

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[7] California Department of Fish and Game, Water Projects Branch. June 1966. Sacramento Valley East Side Investigation, Department of Water Resources Bulletin No. 137. p. 3 (hereinafter "CDFG Bul. 137"); California Department of Fish and Game. Nov. 1993. Restoring Central Valley Streams: A Plan for Action. p. IV-3 (hereinafter "CDFG Plan"); Delta Native Fishes Recovery Team Report; Sacramento Spring Run Chinook Salmon, March 28, 1994 Draft, p. 4 (hereinafter "Recovery Team Draft").

Almost 30 years ago, the California Department of Fish and Game warned of the threat that Central Valley water development posed to spring run chinook:

> "In a little over 100 years, civilization has almost succeeded in destroying this splendid race of salmon [spring run] in California's Central Valley. Only remnants of the once abundant populations remain. With the accelerated expansion of water developments in the Sacramento System and the Sacramento-San Joaquin Delta, spring run salmon in the Central Valley are threatened with extirpation." (CDFG Bul. 137 at 3.)

Indeed, overall population trends for spring run chinook have been documented as declining for many decades.[8] More than 20 "historically large populations" of spring run chinook have been extirpated or reduced nearly to zero since 1940. The remnant wild spring runs on Mill, Deer, Butte and Big Chico Creeks have "exhibited statistically significant declines" over the same period. (Campbell and Moyle 1990.)

The primary spring run populations were all eliminated with the construction of dams that blocked access to holding areas in the 1940s and 1950s, and even earlier. (Recovery Team Draft at 2.) The last large run in the San Joaquin River occurred in 1945, when 56,000 adults returned. (Id. at 4.) Spring run were completely eradicated in the San Joaquin River following the construction of Friant Dam in 1948. This event has been graphically described by CDFG biologist George Warner:

> "In 1948, disaster struck. Friant Dam ... had been completed and the Bureau of Reclamation assumed control of the river ... Bureau officials diverted water desperately needed by salmon down the Friant-Kern Canal to produce surplus potatoes and cotton in the lower San Joaquin Valley."[9]

CDFG crews attempted to trap spring chinook and truck them to the base of Friant to spawn. However, when the juvenile salmon attempted to migrate out to the ocean, they were stranded on a dry stretch of river bed. "The tragic conclusion to the history of the 1948 spring run was that the only beneficiaries of our

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[8] Campbell, E.A. and P.B. Moyle. 1990. Historical and recent population sizes of Spring-Run Chinook Salmon in California. In the proceedings of the 1990 Northeast Pacific Chinook and Coho Salmon Workshop, American Fisheries Society, Humboldt State University, Arcata, California. pp. 155-216 (hereinafter "Campbell and Moyle 1990").

[9] George Warner, "Remember the San Joaquin" in California Salmon and Steelhead: The Struggle to Restore and Imperiled Resource, A. Lufkin ed., Univ. of Cal. Press, Berkeley, CA (1991)(hereinafter "Warner 1991").

efforts to salvage a valuable resource were the raccoons, herons and egrets." (Warner 1991) Efforts to rescue spring run failed as well in 1949 and 1950, and the San Joaquin spring run chinook became extinct. (Recovery Team Draft at 4. See also, CDFG Bul. 137 at 3 ("Spring run salmon have been totally eliminated from the San Joaquin river system by large dams on the Mokelumne, Tuolumne, Merced, Stanislaus, and San Joaquin Rivers.")[10]

With the demise of the San Joaquin spring runs, the Sacramento River stocks constituted the only remaining natural runs in the Central Valley. The Sacramento River drainage as a whole is estimated to have supported spring chinook runs exceeding 100,000 fish in many years between the late 1880s and 1940s, and this estimate may be low by a factor of three or four. (Recovery Team Draft at 4; Campbell and Moyle 1991.)

However, as in the San Joaquin drainage, the Sacramento River populations were dramatically reduced following the construction of barrier dams in the 1940s. Most critically, the closure of Shasta Dam in 1945 cut off access to major spring run spawning grounds in the McCloud, Pit and Upper Sacramento Rivers. (Recovery Team Draft at 5.) This limited spring chinook to the mainstem Sacramento, as well as the Feather, Yuba and American Rivers and several tributary creeks downstream of the Red Bluff Diversion Dam including Butte, Big Chico, Antelope, Mill and Deer. (CDFG Bul. 137 at 4.) As discussed below, wild spring run remain today only in a few creeks in the Sacramento River drainage.

Current Geographic Range of Spring Run Chinook

It is widely accepted that pure spring run chinook no longer spawn and have been rendered extinct in the mainstem Sacramento River and certain east valley rivers. Fishery biologists are in general agreement that true spring run stocks are now limited to spawning in Mill and Deer Creeks, and possibly to Big Chico, Butte and several other east valley creeks.[11]

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[10] See also Brown, Randall L. and Sheila Greene. (1994) An Evaluation of the Feather River Hatchery As Mitigation for the Construction of the California State Water Project's Oroville Dam, Environment Services Office, California Department of Water Resources. p. 6 (hereinafter "Brown and Greene 1994") ("The spring Chinook run to the San Joaquin River was eliminated when Friant Dam was built and, and there are presently no spring Chinook in San Joaquin tributaries.")

[11] See, e.g., Vogel, Daniel and Keith Marine. July 1991. U.S. Bureau of Reclamation Central Valley Project; Guide to Upper Sacramento River Chinook Salmon Life History, CH2M Hill. p. 4.

In its 1991 Guide to Upper Sacramento River Chinook Salmon Life History, the Bureau of Reclamation determined that spring run chinook no longer exist in the mainstem Sacramento River.

> "There is a general consensus among fishery scientists that a 'genetically pure' mainstem spawning population of Sacramento River spring run salmon no longer exists .... The fall run and spring run have likely crossbred to become one protected late-summer through fall spawning run in the mainstem. **The only remaining genetically-pure spring run stocks in the upper Sacramento River basin are believed to be those utilizing the tributary spawning habitats (e.g., Mill Creek and Deer Creek).**" (Vogel 1991)(emphasis added.)

Significantly, the Department of Fish and Game supports the Bureau's view. CDFG has concluded that "the only remaining spring run populations in the Central Valley probably exist in Mill and Deer Creeks, and possibly Butte and Big Chico Creeks."[12] Moreover, CDFG has previously informed this Board that Mill and Deer Creeks are the key remaining areas where significant numbers of "genetically pure" strains of spring run chinook continue to exist. WRINT-DFG-14 at 3.

The multi-agency Delta Native Fishes Recovery Team has reached this conclusion as well, determining that spring run no longer exist in the mainstem Sacramento River, and that wild spring chinook remaining in the Sacramento drainage are limited to Deer and Mill Creeks, with a few fish present in Antelope, Battle, Butte and Big Chico Creeks in some years. (Recovery Team Draft at 2.) This Board has also received testimony from Professor Moyle that less than 1000 true spring chinook remain, "primarily in Deer and Mill Creeks." (WRINT-NHI-9 at 6.)

The confinement of spring run to these east valley creeks was accurately predicted by CDFG almost thirty years ago as the inevitable result of this species' unusual "critical habitat requirements" which call for, inter alia, cold deep pools to enable holding over the summer months followed by spawning in the early fall. (CDFG Bul. 137 at 4.) The closure of Shasta Dam forced spring chinook to spawn in lowland rivers and tributaries historically colonized by fall chinook, which led to the complete hybridization and eradication of spring run in these areas. By contrast, in Mill and Deer Creeks spring chinook are able to isolate themselves from fall run during the spawning season by migrating up to higher elevations, thus avoiding the danger of hybridization. (Id.) "Thus," CDFG recognized in 1966, "the role

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[12] Fisher, Frank. June 1992. Chinook Salmon, Growth and Occurrence in the Sacramento-San Joaquin River System, Inland Fisheries Division, Cal. Dept. of Fish and Game, Redding, CA. p.38 (hereinafter "Fisher 1992").

of the Sacramento Valley East Side tributaries in preserving spring run salmon is a very important one." (Id.)

The susceptibility of spring run to extinction through hybridization with fall run long has been a major concern of resources agencies and fishery biologists. During the pre-dam period, spring and fall chinook runs were spatially separated at different spawning sites, which enabled them to maintain their genetic integrity. (Recovery Team Draft at 5.) When the major dams blocked spring run access to their historic spawning grounds, and dam operations altered downstream river temperatures, spring chinook were forced to occupy what had been exclusive fall chinook spawning habitat in the mainstem Sacramento River. As a consequence, spring run chinook interbred with fall run fish in the mainstem Sacramento, and other rivers and tributaries which were occupied by fall run. (Recovery Team Draft at 5.)

As early as 1957, the U.S. Fish and Wildlife Service noted that the closure of Shasta Dam had resulted in the hybridization of spring run stocks in the mainstem Sacramento River. The Service reported that: "A true spring run has not been observed in any numbers either in Battle Creek or below Keswick Dam [on the mainstem Sacramento River] since the season of 1945."[13] The mixing of stocks was facilitated by the fact that spring and fall run spawning periods substantially overlap. Thus, in 1963 the Service observed that when fall and spring chinook were forced to compete for spawning areas in what had been previously limited to fall run habitat, spring chinook were eliminated.[14]

By 1966, CDFG determined that spring chinook runs on the Yuba and American Rivers were "extinct" as a result of hybridization. (CDFG Bul 137.) Nearly 30 years later, the Department of Water Resources ("DWR") confirmed that true spring run no longer exist in the Feather River as a result of

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[13] Cope, Oliver B. and Daniel Slater. 1957. Role of Coleman Hatchery in Maintaining A King Salmon Run, Research Report 47, Fish and Wildlife Service, U.S. Department of the Interior. p. 18 (hereinafter "Cope 1957").

[14] "This competition, plus the indicated hybridizing of the spring and fall races, appears to have held down the spring run, perhaps even to have eliminated it as a distinct race in the mainstem Sacramento River....The status of the spring run in the mainstem is thus speculative." Slater, Daniel. Nov. 1963. Winter-Run Chinook Salmon in the Sacramento River, California, Special Scientific Report -- Fisheries No. 461, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C. (hereinafter "Slater 1963").

hybridization occurring at the hatchery.[15] Efforts to replace wild spring run populations through hatchery production elsewhere have failed, as well, and indeed provide further evidence of the vulnerability of this fish to hybridization when forced to cohabitate with fall run.

> "For Shasta, Friant and Trinity dams, it was assumed that hatchery production would replace lost natural production of salmon. This assumption has proven to be false; hatcheries have succeeded mainly in slowing the decline of California's salmon populations and in substituting fall-run (or hybrid) hatchery fish for wild spring chinook." (Recovery Team Draft at 7.)

In sum, water resources and fisheries agencies agree that pure spring chinook remain extant only on a few tributary streams which were never colonized by fall run, primarily Mill and Deer Creeks. Spring run which spawned in the mainstem Sacramento River, and certain tributaries with hatcheries, were completely hybridized by fall run, rendering spring run extinct in those areas.

Wild Spring Run Chinook Abundance

Based on the foregoing discussion, the relevant data regarding the abundance of spring run stocks in the Sacramento system are the historic population counts on Mill and Deer Creeks, and other tributaries with genetically pure spring run populations. According to prior CDFG testimony, **spring run populations in Mill and Deer Creeks declined by over 80% between the late 1960s and the late 1980s.** (WRINT-DFG-14 at 3.)[16]

The Recovery Team has documented this assertion in its recent study:

> "In Mill and Deer Creeks, the estimates of spawning fish averaged 2,300 and 1,200 fish, respectively (Marcotte,

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[15] In its 1994 evaluation of the Feather River Hatchery ("FRH"), DWR stated that "it is important to determine if Feather River Chinook called 'springs' by hatchery staff truly belong to this race." (Brown and Greene 1994 at 7.) The resulting data demonstrated that they do not. About 20% of the tagged juvenile salmon from "fall" females were subsequently identified as "spring" run when they returned as adults. Similarly, about 30% of tagged juveniles from "spring" females returned as fall run adults. DWR concluded that the fish labeled "spring run" by the hatchery is not true spring run at all, but rather "a combination of fall and spring races." (Brown and Greene 1994 at 7.)

[16] As NHI has demonstrated in prior submittals, this Board is required to establish water quality standards that maintain both the uses and water quality conditions that existed in 1968, California's marker date for purposes of the federal Clean Water Act anti-degradation provisions. (SWRCB Res. No. 68-16.) This time frame has particular salience for standard setting.

1984). Since 1985, the combined yearly totals for both creeks have been less than 900 fish ... Spawning populations in other tributary streams are considerably less, with an estimated 40-100 fish in Antelope Creek (Airola, 1983 [incomplete survey]). The spring chinook numbers in Antelope Creek have dropped during the last few years to <10 individuals per year (Campbell and Moyle 1991; E. Gerstung, CDFG pers. comm.) Up to 100 fish have held in Big Chico Creek (Marcotte 1984), but that stream currently supports a much smaller run of probably less than 20 adults (E. Gerstung, pers. comm.). In Butte Creek, the numbers have fluctuated considerably from year to year and in the past have been augmented by fish from the Feather River Hatchery." (Recovery Team Draft at 5.)

Adult spring run population data on Mill and Deer Creeks have been collected with some regularity since 1940. Spring run data are available on Butte Creek for 1956-1987. These counts are set forth on Table 1. Although the data have gaps, Table 1 clearly establishes a major decline in spring run abundance in these creeks since the 1950s and 1960s. During the past decade, annual spring run populations in Deer Creek have averaged about 550 fish, and 390 fish on average in Mill Creek. (CDFG Plan at VII-56, VII-65). This trend is vividly illustrated by Figure 1, which depicts the population data from Table 1 in bar graphs. In all three graphs, the drop off in spring run abundance during the 1980s is striking.

In the other relevant tributaries, the spring run declines have been dramatic as well, with remaining populations even smaller than in Mill and Deer Creeks. Antelope Creek historically supported an average annual population of about 500 spring chinook, but in the last decade, this number dwindled to a few individuals. (CDFG Plan at VII-25.) In the 1950s and 1960s Big Chico Creek supported an average annual spring run population of about 500 fish, and there is now only "a remnant spring chinook population." (CDFG Plan at VII-38.)[17]

Population counts of adult "spring run" have been taken at Red Bluff Diversion Dam annually since 1967, but these counts reflect the hybrid fall-spring race that now spawns in the mainstem Sacramento River. CDFG has previously informed this Board that the fish labeled as "spring run" in the Red Bluff Diversion Dam counts are not wild spring run, but only the hybrid

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[17] The Recovery Team's stated objective for spring chinook is to "restore the rates of outmigrating smolts to levels that existed before the construction of the pumps of the CVP and SWP in the South Delta." That objective translates into a range of 5,000 to 10,000 returning spawners in the tributaries, with a fifteen year average of no less than 8,000 fish. (Recovery Team Draft at 9.)

race. (WRINT-DFG-14 at 3). The Recovery Team also has accepted the conclusion that the Red Bluff "spring run" counts reflect a hybrid species, and therefore do not represent spring run chinook populations. (See Recovery Team Draft at 5.)[18]

Nevertheless, CDFG believes the Red Bluff data do reflect gross trends for spring run, and tends to support the population data gathered in the tributaries. (Fisher 1992 at 38.) The Red Bluff "spring run" counts are set forth on Table 2. These counts demonstrate that between 1969 and 1980, returning "spring run" spawners averaged 17,000 fish per year, reflecting a range of 3,600 to 25,000. (Recovery Team Draft at 5.) From 1981 to 1993, the average number of returning "spring run" dropped to 8,902, reflecting a range of 23,400 fish in the early 1980s to a low of 388 fish in 1993.

In sum, Mill and Deer Creek spring run populations have declined by 80% since the late 1960s, and now number about 1000 fish total. The population counts at Red Bluff, while not meaningful in terms of total abundance, support the existence of a steep decline in spring chinook populations.

III. REASONS FOR DECLINE IN SPRING RUN POPULATIONS

Historically, the major decreases in spring chinook abundance are attributable to the loss of upstream habitat due to upstream water development, the final blow occuring in the 1940s with the closure of Shasta, Friant and other Central Valley dams. (Recovery Team Draft at 5-6.) However, as established above, spring run populations have continued to decline in recent decades, long after of those permanent losses. It is this recent decline which threatens Sacramento system spring run with extinction, and which this proposal is intended to address.

During the spring of 1994, NHI convened several meetings of state and federal fishery agencies and independent fishery biologists to discuss the status of wild spring run chinook, and the factors affecting its survival.[19] When asked to rank order

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[18] The Red Bluff counts are taken upstream of the tributaries on which spring run return to spawn, and therefore are unrelated to spring run population counts on Mill and Deer Creeks. Some confusion over spring chinook abundance has resulted from the labeling of mainstem Sacramento and Feather River hybrids as "spring run" in the Red Bluff counts. As demonstrated above, there is widespread scientific consensus that spring run have been extirpated in the mainstem Sacramento River. Moreover, aerial spawning surveys conducted by CDFG confirm that spring run no longer exist in the mainstem Sacramento, and that the fish commonly referred to as "spring run" is actually the hybrid race. (Fisher 1992)

[19] Meeting participants included representatives from CDFG, FWS, NMFS, UC Davis, EPA and the State Board.

the major impediments to spring chinook recovery today, these experts unanimously agreed that adverse hydrodynamic conditions in the delta are the single greatest threat facing spring chinook, with the ocean harvest and tributary habitat conditions rating as lesser (but still important) issues. This proposal for spring run protections in the delta has been developed in close consultation with those agency personnel and other spring chinook experts, and following their counsel, targets the impairment of habitat in the delta for regulatory attention.

This section briefly reviews the work currently underway to minimize or eliminate barriers to spring run recovery upstream and in the ocean, as well as the scientific basis for concern regarding the impact of delta operations on spring chinook.

Out of Delta Factors: Ocean Harvest

Commercial salmon harvesting has operated under severe restrictions for the last three seasons. In 1992, fishermen lost 60% of their traditional twenty week season north of Point San Pedro (near Half Moon Bay), which did not open until August 1. In 1993, salmon fishing was prohibited for seven weeks between Point San Pedro and Point Arena. This cutback represented 35% out of the heart of the harvest season (June and July), a period during which the greatest number of fish are usually caught.

This year fishing was prohibited above Point San Pedro until June 11, and from June 15 until the end of June salmon fishing was forbidden along the entire coast with the exception of the relatively small area between Point San Pedro and Point San Reyes.[20] Even prior to the imposition of the current prohibitions, the Pacific Fishery Management Council has imposed various restrictions on the commercial salmon harvest for over a decade. While these restrictions were not imposed primarily to benefit Sacramento spring run chinook, their timing is highly likely to have benefitted this race given that spring run migrate upstream from April through June.

Out of Delta Factors: Tributary Conditions

Unlike many Central Valley tributaries, Mill and Deer Creeks are favored with "relatively pristine" habitat, and CDFG has determined that these two streams have significant potential for increasing natural populations of spring chinook. (CDFG Plan at VII-56, VII-66.) Nevertheless, a variety of problems in the tributaries have impeded spring run abundance in recent years, primarily agricultural diversions and resultant up- and down-

[20] Pacific Fishery Management Council, Review of Fisheries (1992-1993); Pacific Coast Federation of Fishermen's Assns., pers. comm.)

stream migration problems, as well as other factors. In addition, the U.S. Forest Service has proposed timber harvesting in the upper watershed which threatens loss of additional holding and spawning areas. (CDFG Plan at VII-57, VII-65-66.)

Within the last two years, a coalition has been formed to tackle wild spring run chinook habitat and transport issues in the tributary streams. The "Spring Run Work Group" is an unusual confederation of local landowners, state and federal agencies, commercial and sport fishermen, and conservation organizations. Given the complexity of the issues and traditional antagonism of the parties, the Work Group has made substantial progress.

Specifically, the Work Group members have been successful in obtaining screens for various diversion facilities, fish countering equipment for use on the tributaries and the removal of several barriers to fish migration in Mill and Deer Creeks. Landowners on these creeks are entering into Memoranda of Agreement with the Department of Water Resources for water exchanges designed to benefit fish passage in these streams. Landowners are now working with CDFG in allowing the agency access across private property to assess habitat and conduct fish counts. Some cattle ranchers have voluntarily agreed to fence off the upper part of Deer Creek to protect riparian habitat and water quality. Watershed committees have been formed to address issues specific to Deer, Mill, Butte, Antelope, Clear and Big Chico Creeks.

In addition, the Work Group has had some preliminary success in obtaining public funding for various programs including financing from the Four Pumps Agreement for a warden program to address poaching problems. Public funds are being sought as well for spring chinook recovery activities, development of encroachment maps, and a water gauge for the tributaries.

The Work Group specifically limited its mission to the tributaries in order to target its limited resources to the areas in which its members have the greatest expertise. Nevertheless, there has been clear recognition that delta problems play the major role in the life history of spring chinook.

Role of the Delta

As indicated above, it is the consensus of fishery experts that delta operations and resultant changes in delta hydrodynamics is the central problem facing spring run chinook today. This consensus reflects the work of the Delta Native Fishes Recovery Team, which has recently concluded that:

> "Smolt mortality is probably a major factor affecting spring run chinook abundance as it is for all runs of salmon in the Sacramento-San Joaquin drainage...When pumping rates are

high at the SWP and CVP pumping plants, and outflows are relatively low, spring chinook smolts are probably entrained in large numbers, are consumed by predators in Clifton Court Forebay and other off-channel areas, or are otherwise diverted from their downstream migration." (Recovery Team Draft at 7.)

The Board has been apprised of the critical role played by through-delta smolt survival on the abundance chinook salmon. "Club Fed"[21] has based certain of its proposed water quality standards and implementation recommendations on evidence previously presented to the Board by FWS which strongly indicates that smolt survival is the key to the maintenance of salmon populations. FWS extensively studied the factors relating to chinook survival in the Sacramento River system for the Board's WRINT proceedings, and determined that smolt mortality in the delta appears to be linked directly to the diversion of fishes off of their migratory route and into the interior delta. [WRINT-FWS-7.]

FWS identified four problems specific to smolts migrating down the Sacramento River; (1) diversion off of the mainstem into the central delta via the delta cross channel and Georgiana Slough; (2) reverse flows (and related problems) caused by federal and state water project pumping which further propels fish off-course toward the south delta and the pumps rather than out to sea; (3) high water temperatures in the delta; and (4) low flows through the delta which may impede smolt migration rates, and thus expose these fishes to a variety of delta hazards for longer periods. [WRINT-FWS-7 at 10-29] With the exception of water temperature,[22] each of these factors applies to all outmigrating chinook on the Sacramento system. (FWS, pers. comm.)

In addition to data provided by FWS, Professor Peter Moyle presented the Board with substantial evidence during the WRINT proceedings demonstrating that the operation of the federal and state water projects "is the single biggest factor causing the declines" in upper estuary biota including salmon. (WRINT-NHI-9 at 16.) Professor Moyle developed a matrix rating the factors causing the declines of key species in the Upper Sacramento-San Joaquin estuary, including specifically spring run chinook. (See

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[21] The four federal agencies that have submitted a coordinated package of Bay-delta proposals are the U.S. Environmental Protection Agency ("EPA"), the National Marine Fisheries Service ("NMFS"), the Bureau of Reclamation and FWS. They are referred to collectively herein as "Club Fed."

[22] Temperature is a major factor for fall run because this species outmigrates during hot spring months. Mill and Deer Creek spring chinook smolts, in contrast, journey through the delta in colder fall and winter months. (See below.)

WRINT-NHI-10) A copy of this matrix is attached hereto for your reference.

WRINT-NHI-10 establishes that state and federal water project operations are a "major cause of decline" for spring run chinook. Note that the only other "major" cause of spring chinook declines is "out of delta factors," meaning primarily declines which took place prior to 1970 as the result of dams and diversions. (WRINT-NHI-9 at 8.) Professor Moyle concluded that an indispensable component of spring run recovery must be measures to curtail diversions of fishes into the interior delta during smolt outmigration to reduce their vulnerability to entrainment and to delta predators. (WRINT-NHI-9 at 6.)

In sum, efforts to protect and enhance spring run by restricting the ocean harvest and curtailing water use in the tributaries are clearly important and worthwhile. Nevertheless, these efforts will be of limited utility unless simultaneous protections are afforded to spring chinook during the outmigration of these fish through the delta.

IV. APPLICABILITY OF CLUB FED PROPOSALS TO SPRING RUN

Scope of Proposed Club Fed Implementation Measures

Prior to developing a proposal for spring chinook protections, we analyzed the delta standards proposed by Club Fed to ascertain the extent to which these would benefit spring run. This package of standard and measures -- when fully implemented -- will afford virtually no protection to Mill and Deer spring chinook. The relevant Club Fed proposals would be in effect only during the months of April through June. Moreover, existing measures required by the winter run Biological Opinion, which might benefit spring chinook, apply primarily in February through April. However, Deer and Mill Creek spring chinook outmigrate through the delta between November through January, a time when there are only very limited protections in place to protect smolts, and when none are proposed in the Club Fed package.

Of the various Club Fed proposals, the EPA water quality standards for Fish Migration and Cold Water Habitat Criteria would offer the protections most relevant to spring run.[23] EPA's smolt survival criteria are intended to provide protection at the 1956-1970 historic level for Sacramento River fall run smolts. EPA's recommendations for implementing this level of protection are roughly equivalent to "Alternative D" developed by FWS and set forth in WRINT-FWS-7. These measures include: (1) closure of the cross delta channel gates and the Georgiana

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[23] Proposed EPA Water Quality Standards, 59 Fed. Reg. 822-826 (Jan. 6, 1994).

Slough; (2) establishing minimum flows at Rio Vista and Jersey Point; and (3) establishing export limits for various year types. (59 Fed. Reg. 824; WRINT-FWS-7 at 57.) These measures, if finally adopted however, would apply only in the spring months April through June. (59 Fed. Reg. 824.)

Similar measures have been imposed by the Biological Opinion for the endangered winter chinook, but these are in effect primarily from February 1 through April 30.[24] In any event, these measures are intended to benefit winter run chinook, and benefits to spring run and other outmigrating chinook in the delta during this period would be incidental. In addition, the Opinion is subject to frequent amendment and thus cannot serve as the type of durable protections required.

Spring Run Life History

There is agreement among the state and federal agency personnel and fishery biologists with whom NHI has consulted that with the exception of water temperature, the factors affecting fall run migration through the delta are likely to be the same for spring run smolts as well. (See, e.g., 59 Fed. Reg. 826.) Thus, if spring smolts overlap with fall run in the delta, EPA's proposed implementation measures would afford a similar level of protection to both races. However, the critical Deer and Mill spring run out-migration through the delta occurs in November through January, and possibly as early as October. As established above, this timing is well outside of the period during which the Club Fed water quality protections would (theoretically) be in place.

Adult spring run begin entering the tributaries in early March continuing through April and peaking in early May. Unlike winter run and other chinook species, adult spring run hold over in the tributaries during the hot summer months. (Recovery Team Draft at 3.) Spring chinook spawning occurs in Mill and Deer Creeks in late August and continues through October. (Recovery Team at 3.) This is consistent with historic records of spring run spawning times in the Upper Sacramento drainage, as well as with recent spawning stock surveys. (F.Fisher, pers. comm.) It has been observed that spring run populations spawning in higher elevation creeks, such as Mill and Deer, do so several weeks earlier than spring run in creeks at lower elevations, such as Butte and Big Chico. (F. Fisher, pers. comm.)

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[24] The only protection in place that could benefit spring run smolts outmigrating during the November through January period is a requirement in the winter run Biological Opinion for a negative 2000 cfs QWEST criteria which is in effect at this time. (NMFS Bio. Opin.) However, this measure is not considered to be adequate protection for outmigrating spring run during this period. (CDFG, pers. comm.)

Because of their higher elevation, Mill and Deer Creeks more closely resemble historic spring run spawning habitat. Spring chinook in these creeks thus follow the true incubation and migration pattern for spring run. Juveniles begin to emerge from the gravel over six months from first spawning, and rear in the tributaries until they are yearlings. They outmigrate beginning in mid-October. (Recovery Team Draft at 3.)

By contrast, in Butte and Big Chico Creeks which are located at lower elevations than Mill and Deer, juvenile spring chinook first emerge from the gravel in early December, just 90 days or so after spawning. Many of these Butte and Big Chico juveniles do not rear in the tributaries until they are yearlings, but outmigrate soon after hatching, from early December until June. [F. Fisher, pers.comm.)

These two migration patterns for spring run have led agency personnel to conclude that spring chinook almost certainly outmigrate through the delta from November through March, but most critically in the November through January period when Mill and Deer spring run are moving through the delta. (CDFG, pers. comm.; FWS pers. comm.)

The critical nature of the early winter period for spring run is confirmed by data gathered by FWS regarding outmigration patterns of smolt size fish. (See Figure 3.[25]) Not surprisingly, the FWS data indicate that most smolts are in the delta in April and May, with still substantial numbers of smolts occurring in March and late February. However, the chart also reveals that smaller populations of smolts are in the delta late November through early January. These numbers probably reflect late fall and some winter run as well as spring run outmigrants.

The Board should bear in mind, however, that we are here concerned with a spring run population that is down to less than a thousand fish. It is therefore not surprising that spring run outmigrants in the November through January period are not reflected in large numbers in the data.

In sum, the relevant Club Fed recommendations, even if fully enacted as proposed, would offer no protection to the remaining pure spring chinook smolts outmigrating from Mill and Deer Creeks during the critical November through January period. Given the highly stressed state of this race, protective measures for spring run are required immediately that apply to this period.

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[25] FWS developed Figure 3 with a series of graphs depicting the log of abundance of salmon smolts in the delta by size from October through June. "Smolt size" was considered to be between 70mm and 300mm. FWS obtained this data from several sources as indicated on Figure 3.

V. PROPOSAL TO PROTECT SPRING RUN SMOLTS IN THE DELTA

Our consultations with agency personnel and other biologists have revealed a high level of agreement that measures which have been proposed for implementation in order to benefit fall chinook, are very likely to benefit spring chinook if in place during their critical outmigration period. The three recommendations below are prioritized in terms of the measures which are most likely to obtain the highest benefits for spring run, and other smolts outmigrating in the late fall and winter period, with the least water costs.

(1) Closure of the cross delta channel during the relevant time period.

The cross delta channel diverts approximately 40% of the Sacramento River when the gates are open. (WRINT-FWS-7 at 10.) FWS has established that salmon smolts moving down the Sacramento River are diverted into the central delta in large numbers when these gates are open, and that smolts diverted in this manner have a far lower chance of survival than smolts migrating to the western delta via the mainstem Sacramento River. (WRINT-FWS-7 at 10-13) Specifically, tagged experiments in 1983, 1987 and 1988 established that smolts released below the closed cross delta channel and Georgiana Slough had a 1.3 to 2.4 times better survival index than fish released into the channel at the same time. (WRINT-FWS-7 at 11.)[26]

The significance of avoiding diversion of smolts into the interior delta also was acknowledged by NMFS in the development of winter run protections. (NMFS Bio. Opin. at 40-42.) NMFS determined that closure of the channel gates during the smolt outmigration period "will improve the overall survival of the winter-run chinook salmon emigrant population by reducing the number of fish exposed to adverse conditions in the central delta." (NMFS Bio. Opin. at 55.)

For these reasons, we recommend that the FWS fall chinook Alternative D recommendation for closure of the delta cross channel gates be extended to include the period from November 1 through January 31. (See WRINT-FWS-7, Table 14, Alternative D.)

Our proposal today recommends closure of only the delta cross channel gates, in order to avoid adverse species impacts

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[26] FWS has also recommended closure of Georgiana Slough which diverts about 30% of the Sacramento River into the interior delta with deleterious consequences for outmigrating smolts. (WRINT-FWS-7 at 10.) However, the potential benefits to juvenile chinook salmon from closure of Georgiana Slough may be outweighed by harm to adult chinook salmon migrating upstream as well as other species which use the channel for rearing and migration. Investigations have just begun to try and address this issue. (D. McKee, pers. comm.)

associated with closure of Georgiana Slough. However, this means that a substantial portion of outmigrating smolts will be diverted into the interior delta via Georgiana. Thus, additional measures such as those described below will be crucial in protecting the large number of spring smolts which are likely to be diverted off of the mainstem Sacramento River even if this first measure is adopted.

(2) Limits on maximum total state and federal water project exports during the relevant time period.

As discussed above, FWS data demonstrate that SWP and CVP pumping adversely affect fish diverted into the central delta, and to a lesser degree, fish migrating down the mainstem Sacramento River. CWT smolts released into the Sacramento River have been salvaged at the CVP and SWP facilities, "indicating that they are being directly impacted by the export pumping plants." (WRINT-FWS-7 at 13-22.) This is consistent with data developed by CDFG establishing an extremely high correlation between total export volumes during the December through March period, and resultant year class population for salmon smolts. Figure 2 demonstrates that as export volumes during the smolt outmigration months have increased, the populations of returning adults from that smolt class decreased precipitously. The correlation is .882, a highly significant relationship. Figure 2 covers the 1967-1992 period. (F. Fisher, pers. comm.) We have relied on late fall run data because this is the race of chinook salmon which most closely shares the outmigration period of spring chinook from Mill and Deer Creeks.

Of course, this type of statistical correlation does not take into account other causal factors, and therefore is not, by itself, conclusive proof of a causal relationship between high exports and declines in adult chinook populations. Nevertheless, the very high correlation between these events is compelling evidence of a high probability of causality.

The FWS fall chinook Alternative D includes a recommendation for a cap on maximum total CVP and SWP exports as follows:

W	6000 cfs
AN	5000 cfs
B	4000 cfs
D	3000 cfs
C	2000 cfs

(See WRINT-FWS-7, Table 14, Alternative D.) For the reasons discussed above, we recommend that export caps in this range be imposed from November 1 through January 31. NHI and its consultants will continue to work with the State Board, the Service and others toward developing specific export cap recommendations appropriate to this time period.

(3) Minimum Flows At Jersey Point.

FWS has indicated that calculated reverse net flows in the southern delta are a likely cause of mortality for outmigrating Sacramento River chinook smolts which have been diverted into the interior delta. (WRINT-FWS-7 at 13-22 Figures 4 and 5; FWS, pers. comm.) The Service evaluated the impact of Jersey Point flow on Sacramento River smolt survival indices, and found that survival increased when Jersey Point flows were greater. (WRINT-FWS-7, Table 5.) FWS has concluded that "these relationships would support the fact that positive flows at Jersey Point may increase the survival of fish migrating down the Sacramento [River from] Ryde ...as well as for fish diverted into the central delta and moving to the San Joaquin via the Mokelumne River." (WRINT-FWS-7 at 22.)

NMFS also has recognized the impact of calculated reverse net flows in the south delta on Sacramento River outmigrating smolts which have been diverted into the interior delta via the delta cross channel or Georgiana Slough. "[U]pon reaching the mouth of the Mokelumne River on the lower San Joaquin River [after being diverted through the cross channel], juvenile winter run chinook salmon will often be exposed to upstream (reverse) flows under proposed operation of the Delta water export facilities." (NMFS Bio. Opin. at 41.) On this basis NMFS determined that the export facilities should be operated so as to avoid any reverse flows during winter run outmigration, stating that "elimination of reverse flow conditions in the western delta [during smolt out-migration] is likely to reduce loss of winter run chinook salmon juveniles in the delta." (NMFS Bio. Opin. at 57.)

The FWS fall chinook Alternative D includes a recommendation for a minimum QWEST of of 1000 cfs in all water year types. (See WRINT-FWS-7, Table 14, Alternative D.) For this reason, we recommend extension of this measure for the period from November 1 through January 31.[27]

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[27] The analyses reported by FWS, and the minimum flow standard recommended here, are based on QWEST, the calculated net freshwater flow at Jersey Point. This flow has never been measured, but is calculated from flows, exports and assumed consumption in the delta. Thus, the uncertainty in QWEST is high. Since QWEST is much smaller than tidal flows in the region, hydrodynamicists do not believe that it is a useful variable in terms of the net movement of salt or particles. However, it has been used extensively as an index of net flow balance in the delta for analyses of salmon and other fish. We believe that until better indices are available, that QWEST should be used to indicate the conditions for fish in the southern delta.

Relevant Smolt Survival Index Data

The proposal above is based on the premise that the factors demonstrated by FWS to affect Sacramento fall run smolt survival are similar to the factors affecting Sacramento spring run smolts, with the exception of temperature. This thesis has been corroborated by recent Code Wire Tagged ("CWT") experiments conducted by the Service with outmigrating smolts during the late fall and early winter period at issue.

In December 1993, FWS released pairs of CWT late fall hatchery smolts into Georgiana Slough and the Sacramento River at Ryde. This experiment was conducted: (1) to verify that even larger fish than had previously been released would be adversely affected by diversion into the interior delta; and (2) to ascertain whether smolts released in cooler water would have higher survival rates than previously measured. (FWS, pers. comm.) Water temperature at release was 51 degrees, and the size of the two groups at release was 119mm and 129mm respectively.

The experiment outcome paralleled FWS' previous fall run smolt survival results; the survival index for smolts released into Georgiana Slough was significantly lower than for those released into the Sacramento River at Ryde, just downstream of Georgiana. The smolt survival index was .21 for the Georgiana release, and 1.62 for the Ryde release. This data translates into a ratio of mainstem Sacramento River survival to central delta survival of 7.71. (FWS, pers. comm.) This means that smolts outmigrating in December are **almost eight times more likely to survive** if measures are taken to keep them on the mainstem migratory route instead of being diverted into the central delta, during a period when temperature was not a contributing factor to mortality. CWT experiments for fall run demonstrated that mainstem Sacramento survival was higher by at least a factor of three up to a factor of eight. (FWS, pers. comm.)[28]

These results are significant in several respects. First, they indicate that even larger smolts, which outmigrate when they are yearlings, are highly susceptible to the adverse impacts of diversion into the delta and high exports. This is directly applicable to spring run smolts which outmigrate as yearlings. Second, at 51 degrees, temperature was almost certainly eliminated as a cause of smolt mortality, thus strongly suggesting that water project pumping was primarily responsible

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[28] In making these observations we do not suggest that the delta is inherently inhospitable to salmon. To the contrary, the data establish that the altered hydrodynamics in the delta are harmful, underscoring the need to institute measures to restore the delta for all species and to halt further habitat decline.

for the high relative mortality level of the Georgiana releases. Exports during the experiment were extremely high, in excess of 10,000 cfs between release date and peak recovery at Chipps Island for both groups. (FWS, pers. comm.)

Although the December 1993 experiment was conducted with late fall run smolts instead of Mill and Deer spring chinook, the data clearly support the position that, aside from temperature, factors affecting fall run affect spring run as well, and that similar protective measures should be established during their critical outmigration period in November-January.

CONCLUSION

Without question, in the absence of immediate and dramatic action by the State, the Sacramento spring run chinook is heading for an Endangered Species Act listing. California is still reeling from recent battles over how to best protect other delta species teetering on the brink of extinction. Thus, we are today joining with other concerned agencies and citizens, in calling on the Board to take action to salvage this race.

This proposal is consistent with and complimentary to other actions already underway to eliminate barriers to spring run recovery in the ocean and tributary streams. It offers the Board a means of seizing the initiative, and targeting action where it will generate the greatest return. In this way, the Board may be able to accomplish three critical goals: (1) retention of State control over environmental water management; (2) protection of an important native resource; (3) preventing the loss of recovery benefits won through considerable sacrifice in the ocean harvest and the Upper Sacramento tributaries; and (4) salvage of the commercial fishing industry.

Ultimately, the story of spring chinook in California is a heartbreaker. The state has idly watched this once abundant race dwindle to a few hundred fish in a handful of creeks, knowing all the while that this was the inevitable result of its water development choices. It is precisely for this type of situation that the safety net of the endangered species laws is designed; when government has failed to invoke less intensive measures to prevent steep population declines. The uncompromising remedies of the ESA are triggered only once a species has been compromised by other priorities for so long, and in so many places, that it is hanging by a last vital thread.

If the Board does not step in to do so, the citizens of this state will soon have achieved, against all biological odds, the complete extinction of this "splendid race" of salmon, depriving not only ourselves, and what is left of our commercial fishing industry, of this native species, but future Californians as well. This Board is in a unique position to prevent this from

occurring. We urge you to take action in the course of this proceeding to do so.

DEPARTMENT OF WILDLIFE, FISH AND CONSERVATION BIOLOGY
UNIVERSITY OF CALIFORNIA, DAVIS
DAVIS, CA 95616

9 July 1994

Cynthia Koehler
Natural Heritage Institute
114 Sansome St., Suite 1200
San Francisco CA 94104

Dear Cynthia:

Thanks for giving me the opportunity to review the proposal/testimony on Sacramento spring run chinook salmon you have prepared for the State Water Resources Control Board. You have done a superb job of summarizing the information on this endangered run, as well as problems associated with its decline and recovery. I strongly agree with your conclusions that action must be taken soon to make the Delta a more hospitable place for juvenile salmon; if action is not taken there will be little choice but to file a petition to the National Marine Fisheries Service to have spring run chinook listed as an endangered species. My own research indicates that endangered status can be justified at the present time but I have not been supporting listing spring run chinook because of I want to give voluntary recovery actions a chance to work. I am particularly appreciative of the efforts taking place in upstream areas to protect the salmon; it would be great if there was a similar cooperative effort in the Delta so listing can be avoided.

I appreciate the fact that NHI is continuing to attempt to work with SWRCB in their workshops. I must admit I find it very hard to get excited about the SWRCB workshops, since I do not see much new information coming out of them, except updated documentation of the declines of fishes such as spring run chinook salmon. Most of what I have to say on Delta fish declines was included in Herbold, Jassby, & Moyle (1992, Status and Trends Report on Aquatic Resources in the San Francisco Estuary) and in the D-1630 testimony I helped NHI put together. The most important points are that (1) the ever-increasing amount of water diversion is the biggest cause of declines of the estuarine biota, including spring run chinook salmon, and (2) other factors interact with diversions to contribute to the declines but their effects will be largely undetectable until we reverse the trends in diversions. The other factors may make recovery more difficult, however. Unfortunately, some of the biotic changes may be irreversible (e.g., invasions of non-native organisms made easier by reduced outflows). To try to separate out the other factors from diversions strikes me as either naive or an effort to confuse the issue by implying that we do not really know that diversions are the major cause of the biotic declines. In the case of spring run

chinook salmon, the major declines earlier this century were caused by elimination of upstream spawning habitats by dams and diversions. However, the single biggest cause of the continuing decline of the remnant Sacramento drainage populations seems to be unfavorable conditions in the Delta, mainly the SWP/CVP diverions.

The following points are updates or expansions on Herbold et al. (1992) on how factors other than the big diversions affect fish in the estuary.

Natural variability in precipitation. The continuing pattern of extreme natural conditions emphasizes the point that most water development in California took place during a time of exceptionally stable weather conditions. My guess is that the last ten years are a better predictor of future conditions than the previous 50 before that. To state a non-original generality: we would be much better off if our water system, especially for agriculture, was supply driven rather than demand driven.

Pollution. The clean up of the estuary mandated by the Clean Water Act actually improved conditions for many organisms (including people) but there is some concern that we have done such a great job of removing nutrients from the Bay that levels are now lower than they were before all the natural sources were reduced. Jassby thinks that export of organic matter in water diversions may be one of the factors contributing to biotic declines.

The rice industry managed to greatly reduce the impact of their herbicides on fish in recent years by changing their cultural practices; in the 1980s these herbicides were demonstrably hurting striped bass larvae. A new worry is episodes of infusions of pesticides such as carbofuran that are applied simultaneously to certain crops by most farmers and that wash into the system simultaneously, flushing through the Delta in a short enough period of time to be hard to detect. As they flush through the system, such pesticides can be lethal to crustaceans and other organisms low on the food chain that serve as food for juvenile salmon and other fishes. Again, with more diversion, there is less dilution of pollutants.

Note that there is also a status and trends report on pollutants, although it is on the wishy-washy side.

Habitat alteration. This is covered well in Herbold et al. One of the general factors affecting fish is the lost of shallow water habitat for rearing of juvenile salmon. Perhaps the flooding of Delta islands could be used strategically to re-create more of this lost habitat.

Note that restoration of the San Joaquin River as spawning habitat for anadromous fishes would have a salutory effect on chinook salmon, splittail, striped bass, and other species.

Introduced species. The remarkable thing about all the invasions that have taken place in the estuary, to the point where

its biota is now dominated by exotic species, is how few species have actually gone extinct as a result. I like to argue that thicktail chub and Sacramento perch disappeared as the result of predation/competition from non-native fishes, but the evidence is circumstantial. Temperate freshwater and estuarine organisms are very good at interacting with other species and establishing 'new' communities, an artifact of evolution and survival during the unstable Pleistocene period. This is not to say we should ignore the invasion problem; we should not. The effects of new invaders is often unpredictable (the next one may indeed cause widespread extinction) and the constant arrival of new invaders in the estuary makes fisheries, etc. much harder to manage (sound management is based on predictability). Also the next invader may cause enormous economic damage. For example, I am surprised at how little concern there seems to be in California over the zebra mussel. There is a reasonable probability this wonderfully adept fouling organism will become established here if present trends continue, with the potential of quickly clogging up power plants and water intakes and diversions.

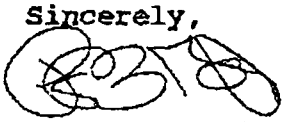
I suspect that water diversions increase the invasibility of the estuary by depleting the established species so that "biotic resistance" to invasion is reduced.

Exploitation. This doesn't seem to be the problem it once was for fishes, although poaching is being touted by CDFG as a major problem. A good case is being made for striped bass that the disappearance in recent years (possibly from fishing) of the largest females (which produce the most eggs by far) has helped to create the downward spiral in recruitment. However, what effects striped bass may have little relevance to most other organisms (e.g., delta smelt).

Overharvest of wild fish clearly is a problem for salmon and the salmon fisheries of California are in the process of being shut down as a consequence. However, one of the main reasons overharvest became a problem is that there have been fewer fish available to harvest, thanks to diversions.

Hope this helps.

Sincerely,



Peter B. Moyle
Professor of Fisheries

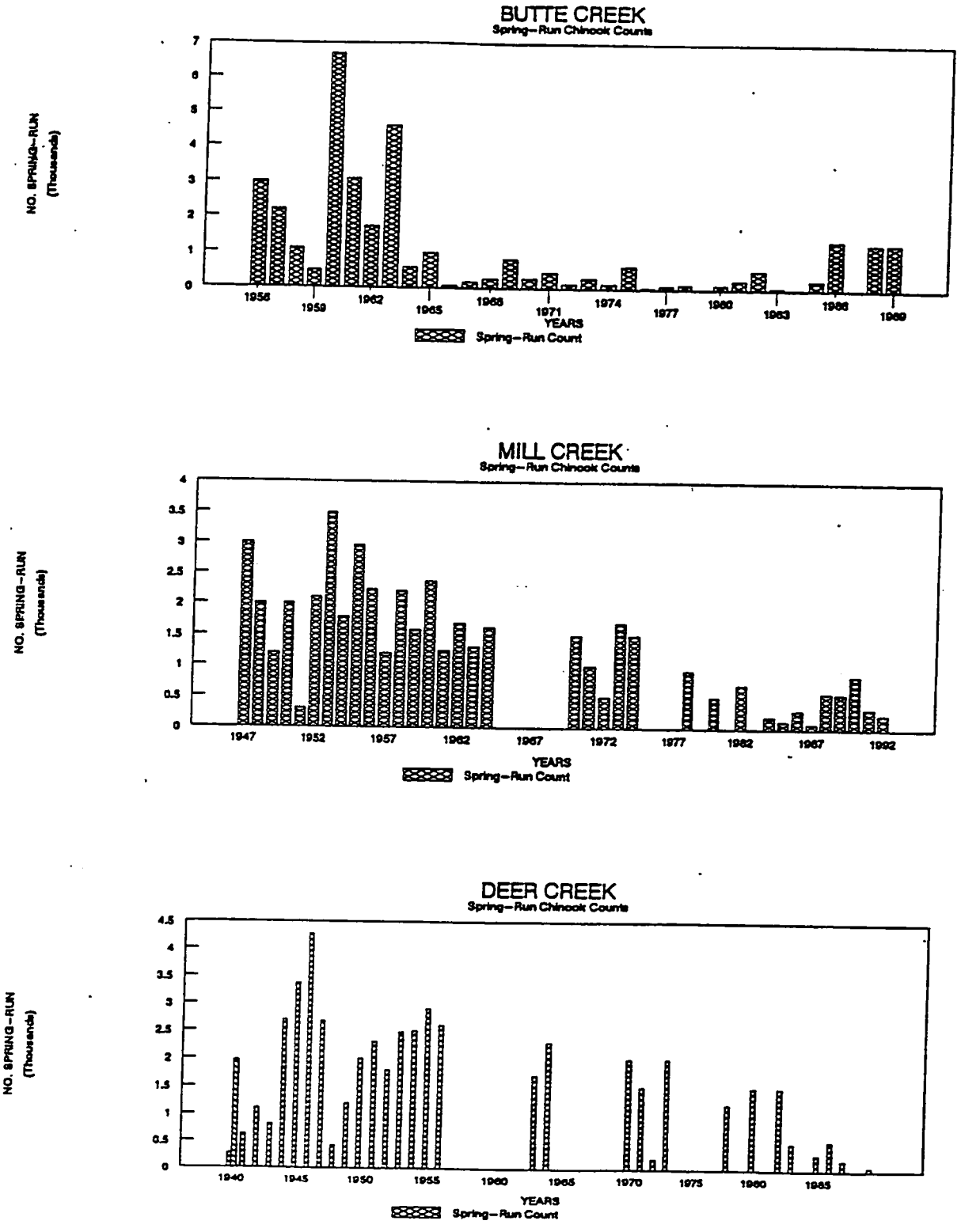
Exhibit WRINT-NIII-10

Table of Ratings of factors causing the declines of key species in the upper Sacramento-San Joaquin Estuary since 1970

	Delta Dependency	Out of Delta Factors	Natural Factors	Increased Water Clarity	Decreased Sewage	Toxic Compounds	Decreased Reproduction	Exploitation	Predation	Introduced Species	Power Plants	In-Delta Diversions	SWP/CVP Pumping
Keratella	LOW	-	3	4	2	4	-	-	-	4	-	3	2
Daphnia	LOW	-	2	3	3	4	-	-	-	4	-	3	1
Eurytemora	HI	-	2	3	-	4	-	-	-	1	-	3	2
Neomysis	HI	-	2	3	-	4	-	-	-	2	3	3	1
Crangon	MED	3	2	-	-	4	-	-	-	2	-	4	2
salmon													
winter run	MED	1	2	4	-	2	3	2	2	3	3	3	1
spring run	MED	1	2	4	-	4	3	2	2	3	3	3	1
fall run	MED	1	2	4	-	4	3	2	2	3	3	3	1
striped bass	HI	4	2	-	4	2	3	3	-	3	3	3	1
sturgeon (both)	LO	1	1	-	-	4	-	2	-	-	2	-	3
American shad	MED	2	2	4	-	4	-	3	4	3	-	3	1
delta smelt	HI	-	2	-	-	-	-	-	-	4	3	3	1
longfin smelt	HI	-	2	-	-	-	-	-	-	3	3	4	1
threadfin smelt	LOW	-	2	-	4	4	-	-	4	3	4	2	1
starry flounder	LOW	2	1	-	-	2	-	-	-	-	-	-	2
splittail	HI	2	2	-	-	4	-	-	4	3	4	2	2

1 = major cause of decline
2 = secondary contributing cause
3 = minor contributing cause
4 = possible minor cause (but unlikely)
- = not a cause

FIGURE 1

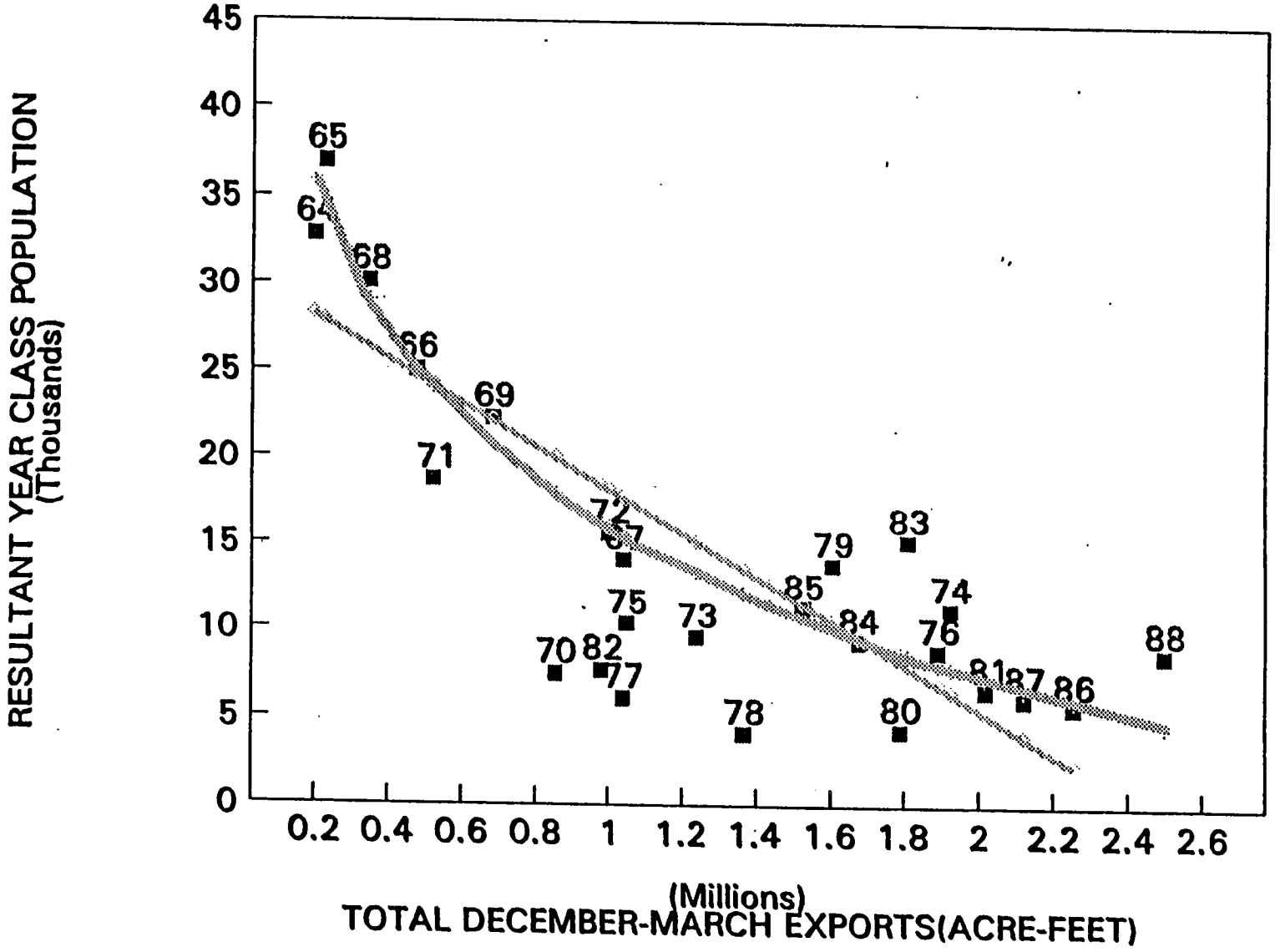


(Source: CDFG, Inland Fisheries Division (1994))

FIGURE 2

LATE FALL RUN

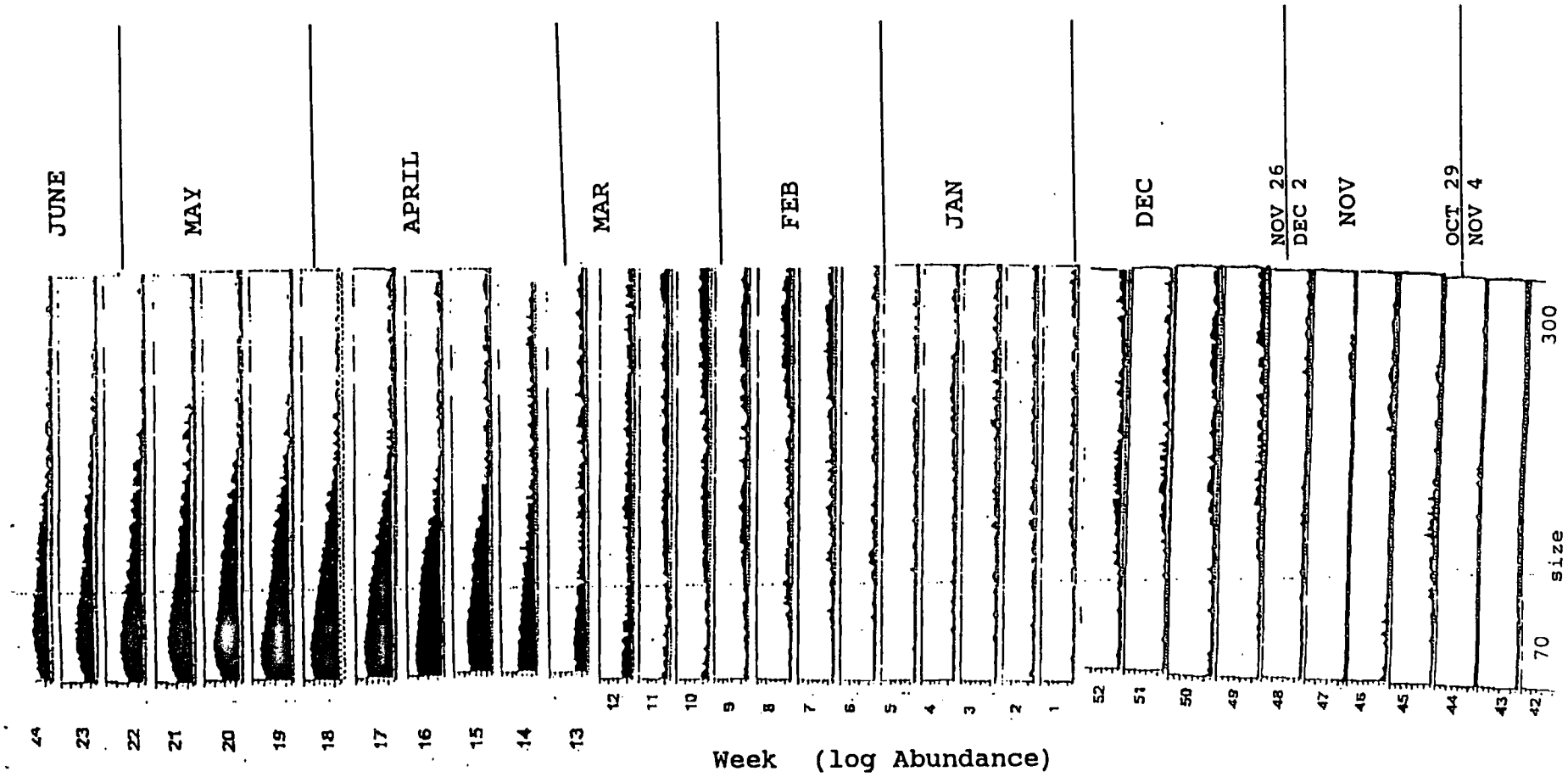
r=.882;r=.762



(Source: CDFG, Inland Fisheries Division)

FIGURE 3

A series of graphs one for each week, between the end of October through June, depicting the log of abundance of juvenile salmon in the Delta (y axis) versus size (between 70mm to 300mm). Data was obtained from several sources, Sacramento trawl, Chipps Island trawl and Beach seine (1991-1993), Montezuma Slough and fyke nets at Sacramento (1992-1993), rotary screw trap in the cross channel and push net (throughout Delta, 1993), fish facility recoveries from the CVP and SWP between 1980 and March of 1994. Tagged fish were excluded with the exception of fish facility recoveries between 1980 and 1991.



(Source: U.S. Fish and Wildlife Service (1994))

TABLE 1

Mill Creek and Deer Creek
Spring-Run Population Estimates

	Mill Creek	Deer Creek	Butte Creek[8]	footnotes for Mill and Deer Creeks
Year	Spring Chinook	Spring Chinook	Spring Chinook	
1940		268		1
1941		635		1,7
1942		1108		1,7
1943		812		1
1944		2692		1
1945		3363		1
1946		4272		1
1947	3000	2669		1
1948	2000	419		1,7
1949	1200	1200		2

1. Cramer, F.K., et. al., 1952
2. Azevedo, R.L., et. al., 1958
3. DFG. 1967, DWR Bull. No. 137, 1967
4. DFG Counts, 4/5-7/6
5. Spring-run snorkel counts - actual number counted; no correction factor.
6. DFG counts, preliminary estimates.
7. Partial count - Deer Creek
8. Brown, C.J. CDFG (1992)

(Source: CDFG, Inland Fisheries Division (1994))

	Mill Creek	Deer Creek	Butte Creek[8]	footnotes for Mill and Deer Creeks
1950	2000	2000		2
1951	300	2300		2
1952	2100	1800		2
1953	3485	2475		2,3
1954	1789	2500		2,3
1955	2967	2900		2,3
1956	2233	2600	3000	2,3
1957	1203		2192	3
1958	2212		1100	3
1959	1580		500	3
1960	2368		6700	3
1961	1245		3100	3
1962	1692		1750	3
1963	1315	1702	4600	3

1. Cramer, F.K., et. al., 1952
2. Azevedo, R.L., et. al., 1958
3. DFG. 1967, DWR Bull. No. 137, 1967
4. DFG Counts, 4/5-7/6
5. Spring-run snorkel counts - actual number counted; no correction factor.
6. DFG counts, preliminary estimates.
7. Partial count - Deer Creek
8. Brown, C.J. CDFG (1992)

(Source: CDFG, Inland Fisheries Division (1994))

	Mill Creek	Deer Creek	Butte Creek[8]	footnotes for Mill and Deer Creeks
1964	1628	2290	600	3
1965			1000	
1966			80	
1967			180	
1968			280	
1969			830	
1970	1500	2000	285	
1971	1000	1500	470	
1972	500	200	150	
1973	1700	2000	300	
1974			150	
1975			650	
1976			46	
1977			100	

1. Cramer, F.K., et. al., 1952
2. Azevedo, R.L., et. al., 1958
3. DFG. 1967, DWR Bull. No. 137, 1967
4. DFG Counts, 4/5-7/6
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8. Brown, C.J. CDFG (1992)

(Source: CDFG, Inland Fisheries Division (1994))

	Mill Creek	Deer Creek	Butte Creek[8]	footnotes for Mill and Deer Creeks
1978			128	
1979			10	
1980			119	
1981			250	
1982			534	
1983			50	
1984	191		23	4
1985	291		254	
1986		543	1371	
1987	90	200	14	
1988	572			6
1989	563	77		6
1990	844			6
1991	319	449		6

1. Cramer, F.K., et. al., 1952
2. Azevedo, R.L., et. al., 1958
3. DFG. 1967, DWR Bull. No. 137, 1967
4. DFG Counts, 4/5-7/6
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7. Partial count - Deer Creek
8. Brown, C.J. CDFG (1992)

(Source: CDFG, Inland Fisheries Division (1994))

	Mill Creek	Deer Creek	Butte Creek[8]	footnotes for Mill and Deer Creeks
1992	237	209		5,6
1993	73	259		6
1994	723	591		
Yrs of Record	32	30	32	

1. Cramer, F.K., et. al., 1952
2. Azevedo, R.L., et. al., 1958
3. DFG. 1967, DWR Bull. No. 137, 1967
4. DFG Counts, 4/5-7/6
5. Spring-run snorkel counts - actual number counted; no correction factor.
6. DFG counts, preliminary estimates.
7. Partial count - Deer Creek
8. Brown, C.J. CDFG (1992)

(Source: CDFG, Inland Fisheries Division (1994))

TABLE 2

Red Bluff Diversion Dam
Spring-Run Population Estimates

Year	Spring Chinook
1967	23514
1968	14864
1969	26505
1970	3652
1971	5830
1972	7346
1973	7762
1974	3933
1975	10703
1976	25983
1977	13730
1978	5903
1979	2900
1980	9696
1981	21025
1982	23438
1983	3931
1984	8147
1985	10747
1986	16691
1987	11204
1988	9781

(Source: CDFG, Inland Fisheries Division (1994)) - Page 1

1989	5255
1990	3922
1991	773
1992	431
1993	388

(Source: CDFG, Inland Fisheries Division (1994)) - Page 2