State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

CENTRAL VALLEY ANADROMOUS SPORT FISH ANNUAL RUN-SIZE, HARVEST, AND POPULATION ESTIMATES, 1967 THROUGH 1991

Compiled by:

Terry J. Mills
Senior Biologist, Fisheries

and

Frank Fisher
Associate Fishery Biologist

THIRD DRAFT

Inland Fisheries Technical Report
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CENTRAL VALLEY ANADROMOUS SPORT FISH ANNUAL RUN-SIZE, HARVEST, AND POPULATION ESTIMATES, 1967 THROUGH 1991 [1/]

INTRODUCTION

Central Valley anadromous sport fish estimated population sizes and abundance trend data for the baseline period of 1967-1991 are provided in this report. This report has been prepared as supportive documentation required for implementation of Public Law 102-575, the Central Valley Project Improvement Act (CVPIA) passed by Congress and signed into law by the President on October 30, 1992. The CVPIA requires the Secretary of the Interior to implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the 25-year period of 1967-1991.

Anadromous sport fish species using the rivers and streams of California's Central Valley include: chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*O. mykiss*), sturgeon (*Acipenser ssp.*), striped bass (*Roccus saxatillis*), and American shad (*Alosa sapidissima*).

Virtually all anadromous fishes populations in the Central Valley of California have exhibited significant declines from 1967 through 1991. The major losses in the populations have been primarily from the naturally reproducing components. These declines are recognized as partially the result of water management activities, as well as habitat degradation, poor water quality, and catastrophic natural events.

GENERAL DESCRIPTION OF CENTRAL VALLEY ANADROMOUS FISH RESOURCES

Anadromous fish migrate from freshwater to estuarine and marine environments early in their life, mature in the ocean, and return inland to spawn in freshwater streams and rivers. Chinook salmon and striped bass are the predominant anadromous species using the waterways of the Central Valley. The four distinct runs of chinook salmon which spawn in the Sacramento River system are named for the season during which they first return to freshwater as adults. Fall-run chinook usually spawn within a few weeks of their arrival in the fall. Late-fall-run chinook spawn in the winter. Spring-run chinook spend the summer in deep, cool pools and spawn in the fall. Winter-run chinook enter the river in the winter and spawn early the following summer.

Both spring- and fall-run chinook salmon were abundant in the upper Sacramento River prior to Federal-State water development, although significant declines were noted by 1929.

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Causes of the declines were thought to include overharvest, blockage by irrigation dams, and habitat degradation. There is limited information on the magnitude of the salmon runs prior to the construction of the Central Valley Project (CVP) and the early decline of the populations. However, in 1905 the combined chinook salmon egg collection at three upper Sacramento River egg stations located off the main river represented the spawn of at least 30,000 adult salmon, which would indicate that the total from all other tributaries and main stem could easily exceed that number by more that tenfold. Based on total catch data for the Sacramento-San Joaquin rivers, it has been estimated that the peak chinook salmon runs in the Sacramento River system may have been as large as 800,000 to 1 million fish, with an average run size of about 600,000 prior to 1915.

The large runs of salmon in the San Joaquin River near Fresno during the 1940s were predominantly spring-run chinook. This significant run of salmon was extirpated as a result of the closure of Friant Dam in 1949. Chinook salmon production in the San Joaquin River drainage (ocean harvest plus spawning escapement) historically approached 300,000 adults but probably averaged nearer 150,000 prior to the construction of recent water storage projects.

The San Joaquin River system now supports only a remnant run of fall chinook salmon, and the population numbers can vary widely from year to year depending upon the timing and magnitude of flows available for migration, spawning, rearing, and emigration. San Joaquin River salmon populations are particularly affected by water export operations in the Sacramento-San Joaquin Delta which often can capture all of the San Joaquin River flow.

Sturgeon were common in the Delta in the mid-1800s, but commercial exploitation severely reduced the population by 1900.

American shad, introduced in the Sacramento River in 1871, are found in the Sacramento and San Joaquin river systems. In the Sacramento River and its major tributaries, their upstream migrations extend to Nimbus Dam on the American River, the Oroville Project Fish Barrier Dam on the Feather River, and to Englebright Dam on the Yuba River. Few adults pass Red Bluff Diversion Dam on the Sacramento River. Shad enter the lower portions of the Tuolumne and Stanislaus rivers, which are tributary to the San Joaquin River.

Striped bass were introduced into the lower Sacramento-San Joaquin Delta in two small plants from the East Coast. The first release of 132 small fish was made near Martinez in 1879 and in 1882 an additional 300 were released in lower Suisun Bay. Within 10 years a commercial fishery had developed and did well until it was closed in 1935 in an effort to build up the sport fishery.

Fall-run Chinook Salmon

Fall-run chinook are the most abundant run of salmon in the Central Valley. Adult fall run migrate into the river system from July through December and spawn from early October

through late December. Peak spawning occurs in October and November, although the timing of runs varies from stream to stream. Egg incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June. Although the majority of young fall chinook migrate to the ocean during the first few months following emergence, a small number may remain in fresh water and migrate as yearlings. Chinook salmon mature at 3-4 years of age although sexually mature 2-year-old males ("jacks") are common. The traditional fall-run chinook spawning areas are downstream from the major dam sites; therefore, this run has not been as severely affected by dam construction as the spring and winter runs which historically spawned at higher elevations. The fall runs of the Sacramento and San Joaquin systems may be genetically distinct and the San Joaquin fall-run chinook is managed by the California Department of Fish and Game (CDFG) as a separate stock.

The most abundant spawning populations are in the main stem Sacramento, Feather, Yuba, and American rivers (Figure 1). Important Eastside Delta streams include the Cosumnes and Mokelumne rivers (Figure 2). Chinook salmon spawning areas in the San Joaquin drainage are located in the Stanislaus, Tuolumne, and Merced rivers (Figure 3).

Late-fall-run Chinook Salmon

Late-fall chinook migrate into the Sacramento River from mid-October through mid-April, which overlaps the mid-October through December fall-run spawning migration. The late-fall-run spawn from January through mid-April. Incubation occurs from January through June, and rearing and emigration of fry and smolts occurs from April through mid-October. Although the presence of late-fall chinook was recognized prior to 1970, they were not included in earlier Central Valley spawning stock inventories. Annual counts of late-fall-run chinook salmon became possible following the construction and operation of the Red Bluff Diversion Dam (RBDD) and its fish ladders in the late 1960s.

Late-fall-run chinook salmon estimated population sizes presented in this report are for the main stem Sacramento River (Figure 1).

Winter-run Chinook Salmon

Most winter-run chinook migrate into the Sacramento River system at age 3, with 100% spawning in the main stem of the river (Figure 1). A few winter-run salmon were observed in the Calaveras River during the late 1980s. Winter-run salmon enter the Sacramento River from mid-December through early August and spawn in the upper main stem Sacramento River from mid-April to mid-July. The winter run usually appear in the Sacramento River near Red Bluff in December and often spend a relatively long time in-river before spawning. Incubation occurs from mid-April through mid-August, with emigration of fry and smolts beginning in late July and ending the following June.

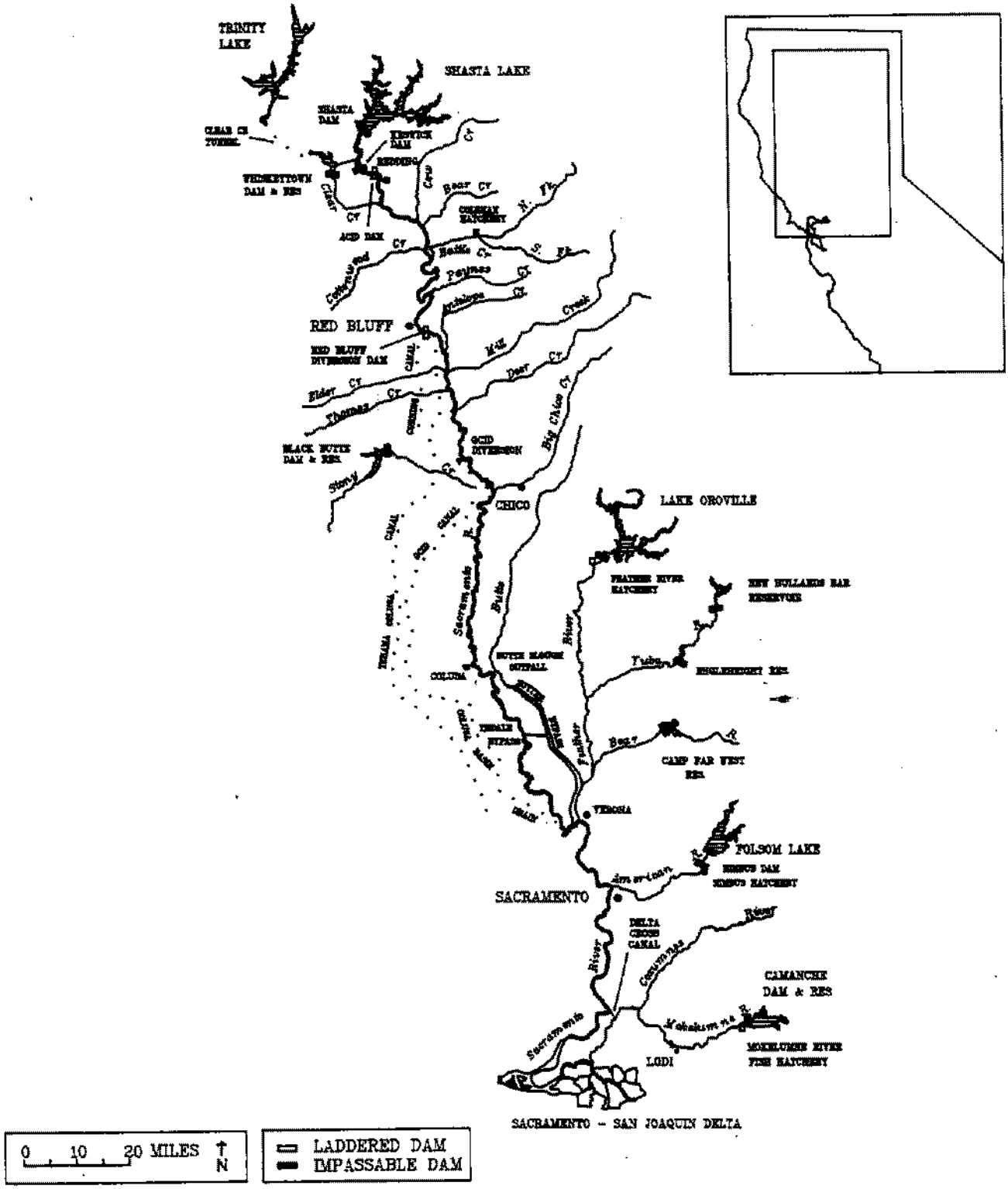

FIGURE 1. Location Map of the Sacramento Valley Depicting the Major and Minor Tributaries Used by Anadromous Fish.

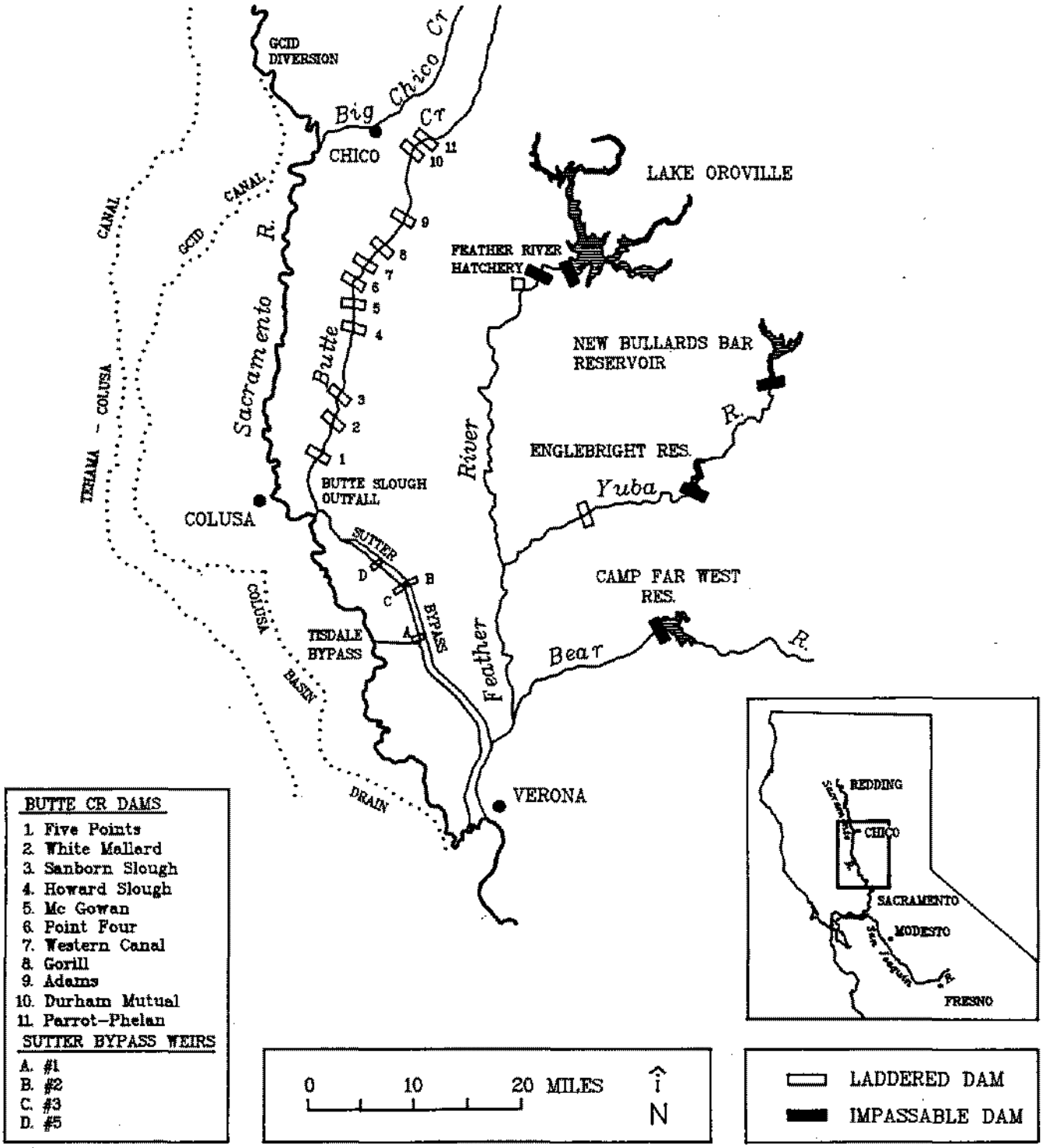

FIGURE 2. Location Map of the Sacramento River from Chico to Verona.

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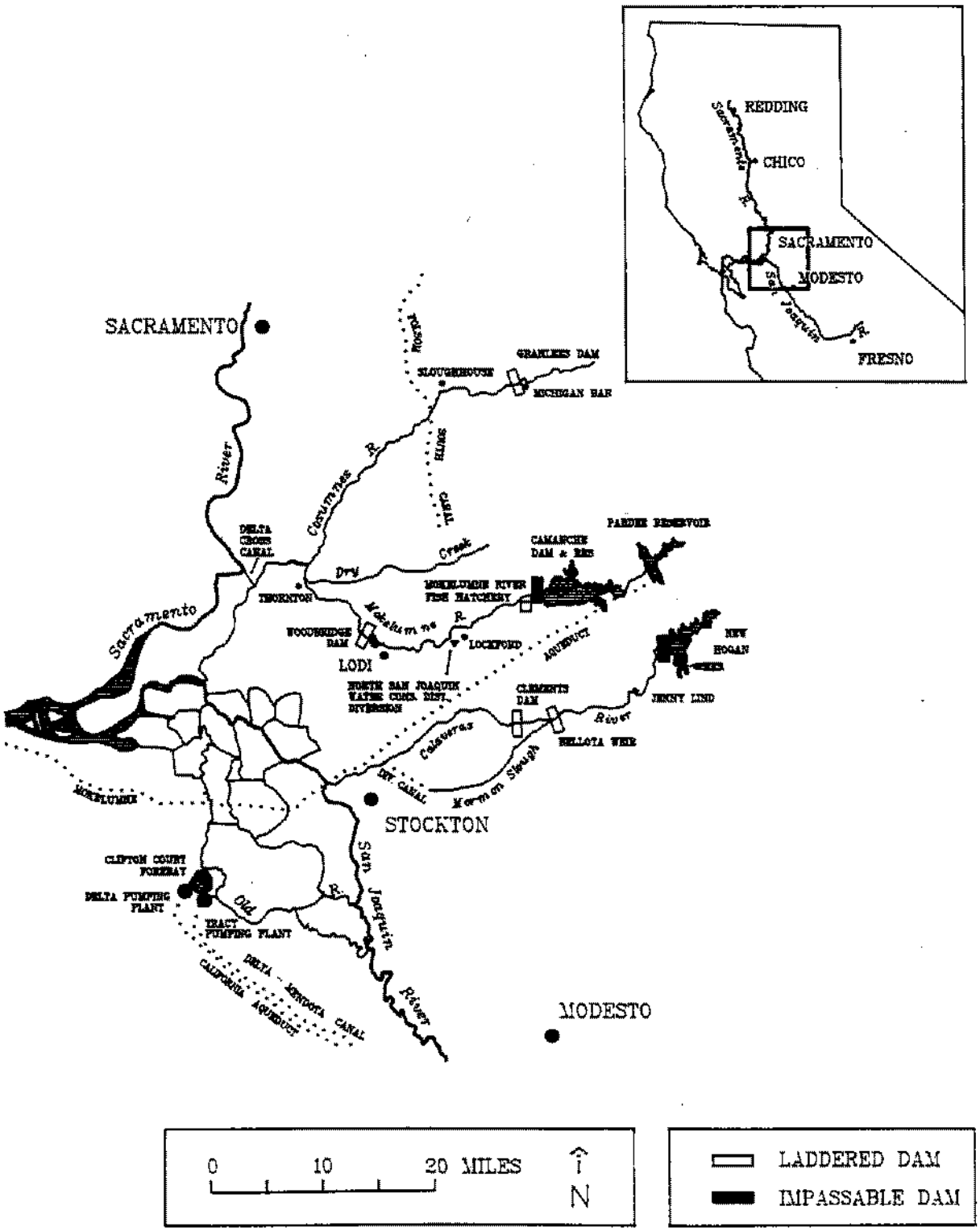

FIGURE 3. Location Map of the Eastside Delta Tributary Streams.

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Historically, winter-run chinook salmon spawned during April to July in the McCloud River. The completion of Shasta and Keswick dams in the early 1940s blocked their access to the stream. Winter-run salmon, however, were able to spawn successfully below Keswick Dam, taking advantage of cooler summer water temperatures provided by water storage project releases. With water conditions similar to those denied them by the dam, they recovered dramatically during the 1940s and 1950s, eventually surpassing the main stem spring-run chinook in significance. Beginning in 1970, fish counts at RBDD revealed a dramatic decline in winter-run stocks. The population has declined from a high of nearly 118,000 spawners in 1969, to less than 200 spawners in recent years.

Spring-run Chinook Salmon

Spring-run chinook were, perhaps, historically the most abundant stock in the Central Valley. The race migrated to headwater areas upstream from the present location of major dams. Construction of dams causing barriers to migration, higher water temperatures, and streamflow alteration have resulted in the extirpation of spring-run chinook in the San Joaquin River system and in most other Central Valley tributaries. Now only the Sacramento River and its tributaries support remnant runs.

Spring-run chinook enter the Sacramento River from late March through September. Many early arriving adults hold in cool-water habitats through summer, then spawn in the fall. Spawning occurs from mid-August through early October with the peak in September. Spring- and fall-run salmon spawning overlaps during early October in the main stem Sacramento River and other places where their habitats have been reduced by dams. Incubation occurs from mid-August through mid-March with rearing and emigration of fry and smolts beginning in late November and continuing through April. A significant migration of yearlings from upper tributary watersheds also occurs in September through December. Because this race is a fall spawner like fall-run chinook, populations of spring- and fall-run chinook have interbred in the main stem Sacramento and Feather rivers. A genetically uncontaminated stock may still exist in eastside Sacramento River tributaries above the mouth of the Feather River such as Deer, Mill, Antelope, Battle, Big Chico, and Butte creeks (Figures 4 and 5)

Steelhead Trout

Steelhead trout is an anadromous strain of rainbow trout that migrates to sea and later returns to inland rivers as adults to spawn. In contrast to chinook salmon, not all steelhead die after spawning. With natural spawning greatly reduced in the Sacramento-San Joaquin river system, steelhead populations are highly dependent on hatcheries to maintain fishable populations. Nevertheless, steelhead are highly prized by inland sport anglers.

Steelhead are generally distributed from southern California to the Aleutian Islands. Within California's Central Valley, a viable population of naturally produced steelhead is

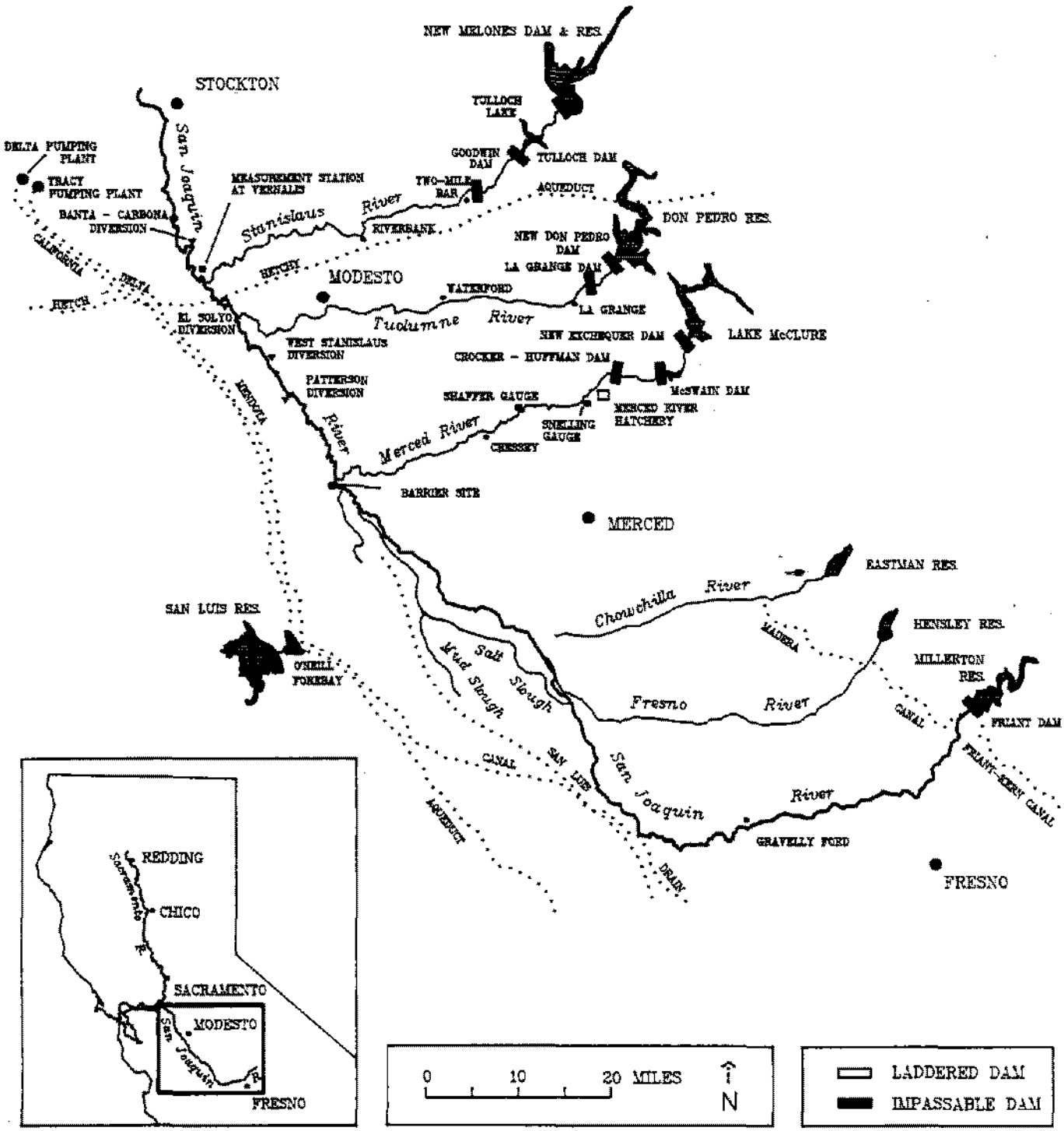

FIGURE 4. Location Map of the San Joaquin Drainage.

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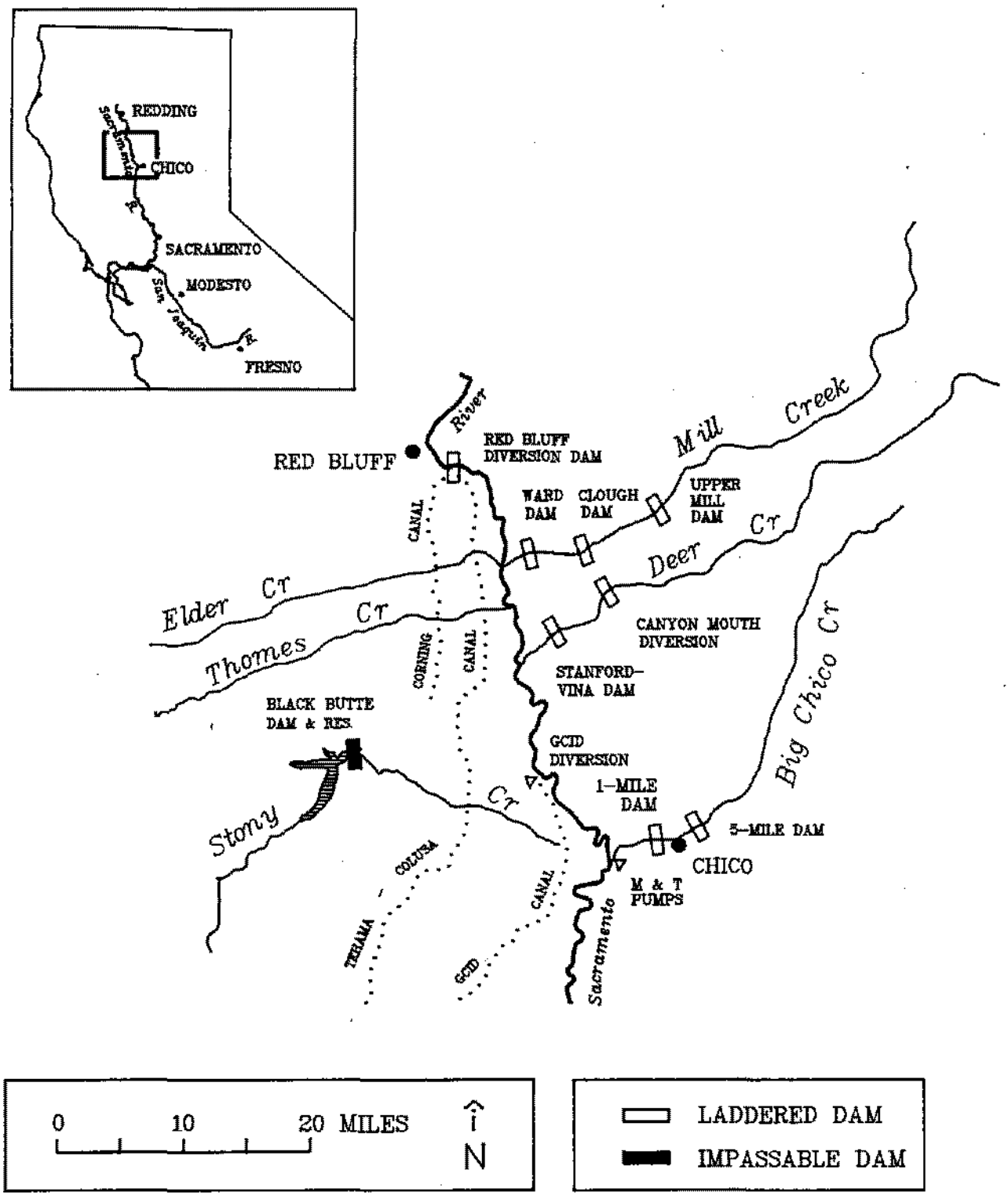

FIGURE 5. Location Map of the Sacramento River from Red Bluff to Chico.

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only found in the Sacramento River and its tributaries. No significant steelhead populations now occur in the San Joaquin River system.

In the Sacramento River, upstream migration occurs from early August through November with the peak occurring in mid-September. Some upper Sacramento River steelhead runs peak in mid-winter. Sacramento River system steelhead spawners are typically 2- or 3-years old and weigh 2-12 lbs. The Eel River strain of steelhead introduced into the American River at Nimbus Fish Hatchery has mixed with the remnants of the American River, and other Sacramento River strains; this seems to have resulted in steelhead larger than those found in the upper Sacramento River. Mad River steelhead were also introduced in the American River, but the results have been inconsequential. Spawning in the Sacramento River and its tributaries usually occurs from January through March, and individuals which survive the spawning run return to the sea between April and June. Females in the American River contain an average of 3,500 eggs, with a range of 1,500-4,500.

Striped Bass

Striped bass are native to the Atlantic Coast from the Gulf of St. Lawrence to the eastern part of the Gulf of Mexico. Since being introduced into the San Francisco Bay complex in the latter part of the last century they have become one of the most popular and abundant sport fish within the Central Valley. The bulk of the striped bass population is in the Sacramento-San Joaquin River system including the San Francisco Bay complex, the nearby ocean, the Delta, and the larger tributary streams downstream from the impassable dams. Striped bass support one of the most important sport fisheries in the San Francisco Bay region, the Delta, and the lower part of the Sacramento River.

Striped bass begin spawning in the spring when the water temperature reaches 58°F. Most spawning occurs from April to mid-June. They spawn in fresh water where there is moderate to swift current. One important spawning area is the main stem Sacramento River from Courtland to Colusa.

Female striped bass usually spawn for the first time in their fourth or fifth year when they are about 18 to 22 inches long. Most males mature at age 3. A 5-lb female may release as many and 250,000 eggs in one season, and a 12-lb fish may release over a million eggs. The eggs are quite small but after being released and fertilized they absorb water, triple their diameter, and become transparent and very hard to see. The eggs are only slightly heavier than water. With moderate current they are held suspended in the water column but sink to the bottom and die in the absence of sufficient flow. The larval bass are hatched in about two days, the length of time depending upon the temperature.

Sturgeon

Sturgeons include the largest fishes found in fresh water and some are among the largest of all fishes. Sturgeon are slow growing and very long-lived. There are two species of

sturgeon in California: the white sturgeon (*A. transmontanus*) and the green sturgeon (*A. medirostris*).

The commercial sturgeon fishery was short-lived and in 1901 the Legislature temporarily abolished the fishery. At the time white sturgeon were claimed to be on the verge of extinction. The fishery remained closed until 1910, was re-opened for two years, and then closed until 1916. In 1917 the fishery was again abolished by the Legislature, and the taking or possession of sturgeon was completely prohibited until 1954, at which time the fishery was reopened for sport fishing only. At present, angling for sturgeon is most intense in San Pablo Bay, but some sturgeon are taken well up the larger rivers.

White sturgeon are most abundant in the Sacramento-San Joaquin River system. Studies by the CDFG indicate that the adult sturgeon spawning migration occurs in late winter and spring when fish move through the Delta, using both the Sacramento and San Joaquin channels. Some migrate well up the Sacramento River past the mouth of the Feather River. By summer, following spawning, most have returned to the lower estuary and bay.

Actual spawning of either white or green sturgeon has not been well described. Other species of sturgeon are known to migrate upstream and spawn in areas of fast water and coarse gravel bottom. The eggs settle into the crack between rocks and are adhesive. Hatching time for some other species of sturgeon ranges from two to five days depending partly on water temperature.

American Shad

American shad are members of the herring family. American shad were first introduced into the Sacramento River in 1871, with several supplemental introduction later. Shad did remarkably well and were being harvested in marketable quantities by 1879.

American shad are very strongly anadromous. Shad spawning runs occur from late April to early July. In many of the spawning streams some shad go as far upstream as they are able, but unlike salmon, shad do very poorly at ascending fishways and are stopped even by relatively low dams. Formerly, shad ascended the Sacramento River to Redding in some years. Since the construction of the RBDD, most of the run stops at that point.

Spawning takes place where there is good current in tidal fresh water or farther upstream. Most spawning occurs over gravel or sand bottoms and a female may release from 120,000 to 650,000 eggs. Many shad die after completion of spawning. The fertilized eggs are not adhesive and are slightly heavier than water and drift with the current near the bottom. Hatching is usually completed in 4 to 6 days depending on water temperature.

Some young shad move downstream into brackish water soon after hatching but large numbers remain in fresh water into November when they are 5 to 6 months old. By December most have left fresh water.

RESOURCE ASSESSMENT AND POPULATION ESTIMATION PROCEDURES AND METHODS

Population Estimation Procedures

Common methods used to estimate inland population sizes of anadromous fish species include (i) direct counts, (ii) mark-recapture methodology, and (iii) indexing of spawning areas.

The direct count method generally involves observing and counting salmon and steelhead as they ascend a fishway or ladder. This method is used in the Central Valley at the RBDD in the Sacramento River and at hatchery facilities that propagate salmon and steelhead. A variant of the direct count method is use of electronic fish counting devices calibrated to register the passage of an adult-sized fish through a confined tube. Direct counts usually involve procedures to account for fish passage when an observer is not present, or to calibrate errors in electronic counting devices. Often, direct counts are impaired by high turbidity or flows which eliminate opportunities to observe fish. Counts for days of no observation are generally accounted for by interpolation of data surrounding the periods of no observation.

Snorkel surveys are conducted to observe and count adult spring-run chinook during the summer as they reside in deep, cool pools in the upper reaches of some tributary streams. This method of direct count requires intensive and exhaustive efforts by skilled observers to locate and identify spring-run. Generally, snorkel counts are used as a relative measure of fish abundance and not as an absolute count.

Mark-recapture techniques include the use of various methods such as the Petersen, Schaefer, Schumacher and Eschmeyer, and Jolly-Seber methods. The most common method is the Adjusted Petersen Method. This method is a "single census" method in which fish are marked once and during subsequent recapture efforts the numbers of marked and unmarked fish are recorded. The other methods are of the "multiple census" type in which fish are marked and added to the population over a considerable period during which samples are taken and examined for recaptures.

The various mark-recapture methods all have similar assumptions about survival of marked fish, loss of tags, marked fish becoming randomly mixed with the unmarked population, all marks are recognized and reported, and only negligible recruitment to the population during the recovery period. In many instances it is possible to provide corrections to negate known violation of the assumptions, such as corrections for tag loss or adjustments for known mortality.

Indexing is a more speculative approach to population estimation and relies heavily on the experience and knowledge of the observer. This method is most often used on small tributary streams having chinook salmon spawning populations that are too small to allow

mark-recapture methods or would require intensive efforts to conduct direct counts. In this method, the observer may conduct one or two surveys of the creek or a portion of the creek during the spawning season and, based on observations, estimate population abundance in increments of 100 fish. Usually this method is for streams that support several hundred or fewer fish.

Aerial redd counting is a method used in the Sacramento Valley, particularly in the Sacramento River between Princeton and Keswick. The redd counts below RBDD are compared to redd counts above RDBB and a ratio is calculated. The number of salmon spawning above RBDD is determined by direct count and the number of salmon spawning below is determined by multiplying the redd ratio and the number of spawners above RBDD.

Salmon. Historically, salmon populations were indirectly monitored by commercial catch records but beginning in the early 1940s spawning ground surveys were initiated. These early surveys developed the groundwork methodology for making population estimates that became refined by the 1960s. Spawning stock surveys are routinely conducted by the CDGF to determine compliance with the management goals for Central Valley salmon stocks. The estimates involve a combination of spawning ground surveys using mark and recapture methodology, fish ladder counts, and aerial redd surveys. The methods used throughout the 1967-1991 time period have been consistent and are relatively reliable. In some years, due to budgetary constraints, minor tributaries were not surveyed, therefore, no estimates are available for these streams. These spawning ground surveys are applicable only to fall-run salmon populations and yield the most complete and thorough estimates of all Central Valley stocks.

With the completion of RBDD in 1967, and its associated fish counting facilities, resource assessment in the upper Sacramento River began a new phase. Runs of spring, late-fall, and winter chinook salmon along with steelhead trout could be systematically counted. Although these runs and species were previously known to be abundant, no consistent method for enumeration was possible because of annual variations in flow, visibility, and lack of reliable counting facilities. Conventional spawning ground surveys using mark and recapture methods could not be employed because spawning and migration times typically occur during seasonal high water. Counts of steelhead entering many tributaries are lacking for the same reasons previously mentioned. Additionally, some unknown number of salmon and steelhead remain below RBDD and spawn in the lower river and tributaries. Therefore, for spring, late-fall and winter chinook along with steelhead, the total estimates are incomplete and represent only that proportion passing upstream of the counting facilities.

Annual salmon population levels are compiled from published and draft annual spawning stock reports and hatchery production reports. Each annual report details methods used for population determinations. These records are organized and arranged at various levels from individual river or tributary to the entire Central Valley. Since spawning stock estimates are reported as total number of spawners, both adults and grilse combined, determination of annual age structure was necessary. Currently the proportion of grilse is reported from each

annual survey. Prior to 1980, the annual fraction of grilse was unreported. Fortunately, field survey records are available to determine the annual age composition within individual rivers. It was assumed that the fraction of grilse observed at RBDD was applicable to all tributaries in the upper Sacramento River.

Steelhead Trout. Steelhead estimates are derived from direct counts at fishways and at hatcheries. Some estimates are the result of mark-recapture experiments, and some are a variant calculated by dividing hatchery returns by the estimated harvest rates.

Sturgeon. Tagging studies are the method by which mark-recapture estimates of abundance of white sturgeon ≥40 inches total length (the minimum legal size until 1990). Sturgeon of both species were captured for tagging in trammel nets in the fall in San Pablo Bay, and occasionally in Suisun Bay. Sturgeon were tagged with disc-dangler tags attached below the anterior end of the dorsal fin, measured, and immediately released near the site where they were captured.

In years when a recapture sample was available from tagging in a later year(s), white sturgeon abundance was estimated using the Petersen Method. When adequate recapture samples from later years were not available, the multiple census method of Schumacher and Eschmeyer was used and was based on recaptures during the same tagging season.

Some assumptions inherent in sturgeon mark-recapture experiments are probably violated. These include:

1. Assumptions of random distribution of tagged sturgeon in the untagged population and equal vulnerability of tagged and untagged fish to the fishing gear are likely violated by the multiple census technique.

2. Both methods deal with a population that is probably not closed and the proportion of the entire population represented by the estimate is unknown and may vary between estimates.

Few green sturgeon were tagged each year and none were recaptured during tagging, so no independent estimate of their abundance was possible. Instead, green sturgeon abundance was estimated by dividing white sturgeon abundance estimates by the ratio of white:green sturgeon observed during tagging.

For the purpose of calculating 1967-1990 mean abundance, population estimates in years when no tagging occurred were computed by linear interpolation.

Striped Bass. The abundance of adult striped bass (fish ≥38 cm FL before 1982 and fish ≥42 cm FL since 1982) was estimated using mark-recapture experiments since 1969. A modified Petersen estimator $N=M(C+1)/(R+1)$ is used, where N = bass abundance, M =

number of tagged fish released, C = number of fish subsequently examined for tags, and R = number of tagged fish in the recapture sample.

Gill nets and fyke traps are used to capture bass during their spring spawning migration to the Delta and Sacramento River. The fish are tagged with individually numbered disc-dangler tags and released. The population is sampled during a year-round census of angler catches and during subsequent spring tagging.

From 3,100 to 18,400 tags have been applied annually. Creel census clerks, sampling at 4-6 fishing ports from Wednesday to Sunday each week, have observed 1,500 to 38,700 bass and 16 to 891 tags annually. Since 1969, the tagged:untagged ratio has varied from 1:37 (1973) to 1:108 (1985).

The abundance estimation procedures are complicated by sex- and age-sampling biases. Males spend more time on the spawning grounds than females, so two to three times as many males are tagged. In contrast, censused females slightly outnumber censused males. Three- and 4-year-old striped bass are underrepresented in the tagging sample because many of those fish are not mature and they have not taken up adult migratory patterns. Also, the gill nets tend to select for smaller fish. Hence, all tagging and recapture samples are stratified by sex and age.

Sex is determined for each fish tagged. If milt is extruded, the fish is classified as male and if not, it is classified as female. About 75-90% of the censused fish are sexed by dissection. The remainder of censused fish are assumed to have the same sex ratio as this sample.

To stratify by age, scales are sampled and lengths are measured on nearly all tagged bass. Scales are obtained from 75-905 individual censused bass. For both tagged and censused fish, a computer program uses an age-length key developed from the aged fish to apportion unaged fish into the appropriate age classes.

These procedures allow the estimation of abundance of individual year classes and to increase sample sizes for estimates of each year class with each successive sampling period.

Two additional problems must be solved in estimating 3-year-old striped bass abundance.

1. Only about one-half of age 3 fish are legal size during the tagging period and recruitment is not complete until about 6 months later. Therefore, the tagged:untagged ratio observed during the first creel census after tagging would underestimate total age 3 abundance, but overestimate abundance of legal-sized age 3 fish. (The solution is to estimate abundance starting with the tagging sample taken the following spring.)

2. Few 3-year-old females are tagged so their abundance is estimated indirectly by assuming that it is equal to the abundance of 3-year-old males.

Due to the sampling biases, the most accurate annual estimates for both sexes, except that the age 3 estimates, are first divided by two to eliminate fish recruited after the tagging period.

American Shad. Except for 1976 and 1977, no annual population estimated of adult American shad are available for Central Valley rivers and streams. Populations of adult American shad in the Sacramento River system were estimated at 3.04 and 2.79 million in 1976 and 1977, respectively. These estimates were derived from mark-recapture data. Adult fish were captured in gill nets in the Sacramento-San Joaquin River Estuary (Delta) near Pittsburg during their upstream migration in March, April, and May. This location is downstream from sport fishing areas. The Petersen estimator was derived from creel census of areas upstream from the tagging and release site. Angler captured fish were examined for tags and an estimator was calculated based on the number of marked fish observed in the sample.

Central Valley Creel Census and Angler Survey Data. Creel census is often used to monitor the harvest of anadromous fish within rivers and streams of the Central Valley. Typically, creel census methodology uses a stratified random sampling procedure in which census areas are predefined and then sampled on a random, but structured, basis throughout the survey period. Sampling is stratified by location and time. Catch and effort data collected during the structured sampling are expanded to account for days, times, and location where no sampling occurred.

Occasionally, angler surveys are conducted in conjunction with mark-recapture studies to gather tag recovery data to estimate population size (Appendix 1).

Limited harvest information is available for determinations of inland sport catches of salmon and steelhead resources. While no comprehensive measure of in-river sport catches have been made on a consistent basis, fragmented census surveys have been made for some rivers during various times. River sport catches of chinook salmon has received little emphasis because of low annual mortality associated from this source. One simple approach to estimate annual harvest made by Meyer (1985) and assumed a constant fraction of the total escapement run was harvested annually. He applied 10% of the ocean sport catch as a reasonable estimate, combining the various runs. Rowell (Unpublished report, Red Bluff) conducted a salmon and steelhead creel census during 1967 through 1975. These estimates combined with Red Bluff Diversion Dam (RBDD) counts provide estimates for both the river reach above RBDD and the total in-river harvest.

Chinook Salmon

A significant relationship between harvest rates above RBDD and the total river allows annual estimates of individual salmon races to be made (Figure 6, Appendix 1).

A similar analysis was applied to steelhead catch and population statistics; a relationship between total population levels and catch. Hallock (1961), Rowell (1980) and Wixom (pers comm.) reported steelhead catches for a several differing time periods. The annual proportion caught varied between 20 to 66%, but averaged around 35%. Staley (1976) found during two years studied a similar harvest rate for the American River; 33%.

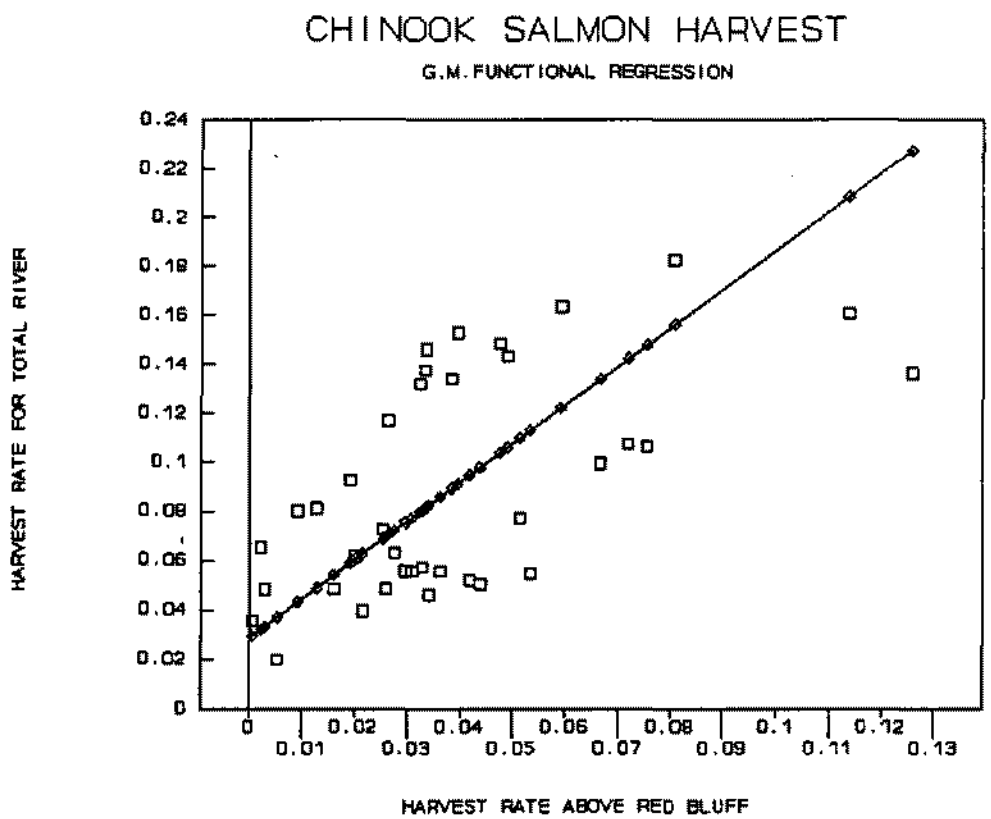

FIGURE 6. Relationship of Chinook Salmon Harvest Rate above Red Bluff Diversion Dam to Total In-river Harvest Rate.

Unfortunately, annual steelhead populations are not measured for most Central Valley rivers. Estimates of harvest can only be obtained for the Sacramento River, using RBDD counts as

an index of total population. A significant relationship between population size and catch was developed for Sacramento River steelhead harvest and applied to RBDD counts (Figure 7).

The annual harvest rate determined by this relationship is equivalent to 38% of the available population. These steelhead catches should be considered as minimum estimates.

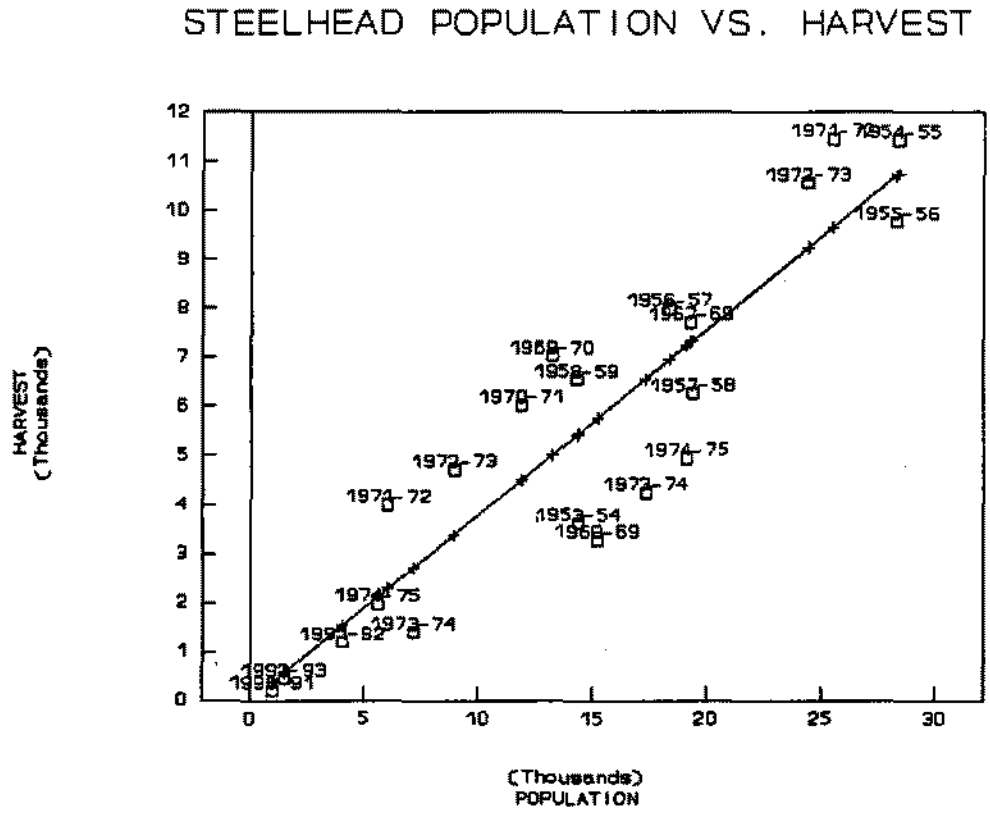

FIGURE 7. Relationship Between Annual Steelhead Population and Harvest.

Ocean Harvest Monitoring

The ocean salmon fisheries are intensively monitored to provide estimates of total pounds and numbers of salmon landed at ports along the California coast. Port sampling is conducted using a random subsampling of landed fish which allows landing data to be expanded to account for periods when no sampling occurs.

Third draft, subject to revision
Not approved by the Department of Fish and Game

Anglers participating in the coastal charter boat and sport skiff fisheries for salmon are censused upon return to port. Not every boat is sampled but the methodology allows for expansion of data to provide an estimate for total sport harvest.

Overview

California ocean salmon harvest statistics are extrapolated from data obtained by fishery sampling programs, in combination with data from records that DFG requires commercial salmon buyers and commercial charterboat operators to maintain. California's ocean fishery sampling programs are designed to sample at least 20% of the salmon (chinook and coho) landed in the ocean commercial and recreational (charterboat and skiff) fisheries. Commercial salmon buyers are required to complete California Fish and Game market receipts for all deliveries of salmon that they buy. Charterboat operators are required to maintain California Fish and Game logbook records for all fishing trips.

Area and Time Stratifications

The five major ports sampled for the ocean troll fishery are Crescent City, Eureka, Fort Bragg, San Francisco, and Monterey. In some cases, the major ports may consist of several small adjacent sub-ports. Sampling is carried out during the entire season at all ports.

The same basic five ports design is used to sample the recreational skiff and charterboat fisheries. However, major ports may contain several smaller sub-port strata. Sub-ports are areas within major ports where anglers may come ashore, but which are small enough to allow the sampler to interview all private skiff fishermen that land within that area on a sample day. The charterboat sample area includes all docks in a port area where landings occur. Sampling is also carried out the entire season at all five ports for the charterboat and skiff fisheries.

Semi-monthly time periods are the basic time strata used to sample all fisheries. The periods are from the 1st to the 15th and the 16th to the end of the month. In addition, recreational sampling is stratified by weekend day, or holiday, and weekday.

Fishery Sampling Programs

Ocean Commercial (Troll) Fishery. Field samplers are assigned to the five major port areas and instructed to sample commercial salmon buying stations on a random basis, bearing in mind that they must sample boats returning from multi-day trips and those that have fished only one day. The sample unit is a landing of salmon by a commercial troller and from each boat the sampler must obtain a complete sample of all fish for the sample to be valid.

Ocean Recreational (Charterboat and Skiff) Fishery. Field samplers are assigned to pre-selected sub-ports chosen on a random basis and stratified by weekend, or holiday, and

weekday. They are instructed to interview all recreational skiff anglers who landed within their assigned sample area, and to tally number of boats missed and not sampled.

Estimation Procedure

Commercial Fishery. Numbers of salmon landed by the commercial fishery within time and port stratum and by species are estimated by dividing the pounds of salmon sold to the commercial salmon buyers and reported on pink tickets, by species average weights obtained from sample data. The estimation equation is:

$$\text{Total number of salmon} = \frac{\text{Weight of salmon landed}}{\left(\dfrac{\text{Weight of salmon sampled}}{\text{Number of salmon sampled}}\right)}$$

Recreational Fishery. Numbers of salmon landed by the recreational skiff fishery within time and port stratum and by species are estimated from field sampling.

The estimation equation is:

$$\text{Total number salmon} = \left(\frac{\text{Number of sampled fish}}{1}\right)\left(\frac{\text{Number of possible fishing days}}{\text{Number of days sampled}}\right)\left(\frac{\text{Number of ports}}{\text{Number of subport samples}}\right)$$

Artificial Production Facilities

Salmon and Steelhead Hatcheries

Salmon and steelhead are propagated at four State-operated hatcheries and one federally operated hatchery in the Central Valley. The State hatcheries include Feather River Hatchery, Nimbus Hatchery on the American River, Mokelumne River Hatchery, and Merced River Hatchery. The U.S. Fish and Wildlife Service operates Coleman National Fish Hatchery on Battle Creek, tributary to the upper Sacramento River.

All the hatcheries propagate fall-run chinook and steelhead. Feather River Hatchery also propagates spring-run chinook, and Coleman National Fish Hatchery propagates winter-run and late-fall-run chinook.

Hatchery counts generally represent the number of fish counted during spawning and sorting procedures associated with propagating the various races and species.

DATA SUMMARY AND POPULATION ESTIMATES

Chinook Salmon

Estimates of the number of naturally spawning chinook salmon (all races combined) during 1967-1991 ranged from 106,603 in 1990 to 490,723 in 1969, with a 25-year average of 246,994 (Table 1).

During the base period, Sacramento fall-run chinook salmon were the predominate race spawning in the Central Valley. Estimated numbers of naturally spawning fall-run chinook in the Sacramento system ranged from 92,442 in 1990 to 256,817 in 1969 with a 25-year average of 176,092 (Table 1, Appendix 2). Estimates of naturally spawning San Joaquin fall-run chinook salmon, including the Mokelumne, Cosumnes, and Calaveras rivers, ranged from 854 in 1991 to 76,184 in 1985 with a 25-year average of 20,644 (Table 1, Appendices 2 and 3).

Late-fall-run chinook salmon are found predominantly in the Sacramento River. Observers have recorded late-fall-run fish in many other tributaries of the Sacramento River but, because of typically high flows and turbidity during their spawning period, no estimates of abundance are available other than those based on the RBDD counts. In the Sacramento River, the numbers of late-fall-run chinook salmon have ranged from 1,141 in 1982 to 37,208 in 1967 with a 25-year average of 14,159 (Table 1, Appendix 4).

Spring-run chinook salmon estimated spawning populations have ranged from 1,641 in 1991 to 27,335 in 1969 with a 25-year average of 12,990 (Table 1).

Winter-run chinook salmon have been observed in the Calaveras River during the late 1970's and early 1980's, however, they are presently found only in the Sacramento River. Estimated numbers of winter-run spawners in the Sacramento River have ranged from 191 in 1991 to 117,808 in 1969 with a 25-year average of 23,109 (Table 1).

During the same period, ocean sport and commercial fishers harvested an average of 706,595 chinook salmon (grilse and adults combined) along the coast from Crescent City to Monterey. Catch estimated ranged from 357,805 in 1983 to 1,488,568 in 1988 (Table 2, Appendices 5 and 6).

During the base period, an average of 28,435 salmon (all races combined) returned to hatcheries in the Central Valley (Table 3, Appendices 7, 8, and 9). Hatchery returns were primarily fall-run chinook with relatively few spring-run and late-fall-run fish (Table 3).

TABLE 1.Estimated number of chinook salmon returning to spawn naturally in rivers and streams of the Central Valley during 1967 through 1991 (Sheet 1 of 2).

Year	Sacramento Fall-run chinook [1]			San Joaquin Fall-run chinook [2]			Sacramento Late-fall-run chinook [3]		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	38,410	104,790	143,200	1,176	21,359	22,535	5,730	31,478	37,208
1968	18,181	155,859	174,040	11,211	6,577	17,788	1,910	32,823	34,733
1969	48,528	208,289	256,817	1,935	49,662	51,597	1,747	35,431	37,178
1970	30,121	147,279	177,400	8,539	28,550	37,089	1,823	17,367	19,190
1971	35,775	140,691	176,466	2,986	38,580	41,566	2,277	12,046	14,323
1972	43,795	80,622	124,417	2,454	12,321	14,775	2,398	29,155	31,553
1973	40,640	197,193	237,833	674	6,438	7,112	711	21,493	22,204
1974	25,364	185,953	211,317	762	3,625	4,387	329	6,116	6,445
1975	29,691	141,884	171,575	968	6,258	7,226	816	15,847	16,663
1976	21,926	155,767	177,693	505	3,894	4,399	581	14,699	15,280
1977	22,831	139,971	162,802	60	990	1,050	873	8,217	9,090
1978	23,635	115,363	138,998	254	2,473	2,727	959	7,921	8,880
1979	46,397	152,982	199,379	456	3,897	4,353	44	8,696	8,740
1980	25,472	110,833	136,305	702	5,600	6,302	566	7,181	7,747
1981	42,575	145,503	188,078	8,022	20,295	28,317	168	1,429	1,597
1982	43,396	129,388	172,784	2,681	14,214	16,895	186	955	1,141
1983	41,714	88,676	130,390	32,312	10,970	43,282	1,221	12,053	13,274
1984	41,030	115,509	156,539	18,335	37,641	55,976	2,357	3,550	5,907
1985	41,563	211,695	253,258	4,311	71,873	76,184	1,670	5,990	7,660
1986	27,356	212,739	240,095	3,117	18,588	21,705	490	6,220	6,710
1987	66,364	150,965	217,329	18,269	6,689	24,958	780	13,663	14,443
1988	26,517	197,841	224,358	1,138	20,798	21,937	2,094	8,589	10,683
1989	24,060	116,726	140,786	282	3,489	3,771	286	9,589	9,875
1990	9,443	83,499	92,942	312	663	975	1,536	5,385	6,921
1991	11,546	87,070	98,616	207	647	854	888	5,643	6,531
Average	33,053	143,083	176,137	4,867	15,844	20,710	1,298	12,861	14,159

TABLE 1.Estimated number of chinook salmon returning to spawn naturally in rivers and streams of the Central Valley during 1967 through 1991 (Sheet 2 of 2).

Year	Sacramento Spring-run chinook [4]			Sacramento Winter-run chinook [5]			Central Valley Total chinook salmon		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	11,397	12,297	23,694	24,985	32,321	57,306	81,698	202,245	283,943
1968	3,317	11,827	15,144	10,299	74,115	84,414	44,917	281,202	326,119
1969	2,843	24,492	27,335	8,953	108,855	117,808	64,006	426,729	490,735
1970	1,420	6,017	7,437	8,324	32,085	40,409	50,228	231,297	281,525
1971	2,464	6,336	8,800	20,864	32,225	53,089	64,366	229,878	294,244
1972	1,343	7,053	8,396	8,541	28,592	37,133	58,531	157,743	216,274
1973	2,082	9,680	11,762	4,623	19,456	24,079	48,729	254,261	302,990
1974	2,538	5,545	8,083	3,788	18,109	21,897	32,782	219,347	252,129
1975	7,683	15,670	23,353	7,498	15,932	23,430	46,656	195,591	242,247
1976	4,067	22,006	26,073	8,634	26,462	35,096	35,712	222,829	258,541
1977	5,421	8,409	13,830	2,186	15,028	17,214	31,372	172,614	203,986
1978	1,093	7,063	8,156	1,193	23,669	24,862	27,134	156,489	183,623
1979	707	2,203	2,910	113	2,251	2,364	47,717	170,029	217,746
1980	3,734	8,081	11,815	1,072	84	1,156	31,545	131,780	163,325
1981	8,249	13,066	21,315	1,744	18,297	20,041	60,757	198,591	259,348
1982	4,528	21,644	26,172	270	972	1,242	51,061	167,947	218,234
1983	672	3,809	4,481	392	1,439	1,831	76,311	116,947	193,258
1984	4,373	3,988	8,361	1,869	794	2,663	67,965	161,481	229,446
1985	3,792	7,631	11,423	329	3,633	3,962	51,665	300,822	352,487
1986	1,606	17,290	18,896	451	2,013	2,464	33,020	256,850	289,870
1987	4,177	7,330	11,507	236	1,761	1,997	89,826	180,408	270,234
1988	2,132	9,521	11,653	708	1,386	2,094	32,589	238,136	270,725
1989	884	6,304	7,188	53	480	533	25,566	136,587	162,153
1990	948	4,376	5,324	16	425	441	12,256	94,347	106,603
1991	433	1,208	1,641	38	153	191	13,112	94,721	107,833
Average	3,276	9,714	12,990	4,687	18,421	23,109	47,181	199,924	247,105

1. Escapement data for the Sacramento River and its tributaries north of and including the American River.
2. Escapement data for the Mokelumne, Cosumnes, Calaveras, Stanislaus, Tuolumne, and Merced rivers.
3. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.
4. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.
5. Escapement data for the main stem Sacramento River above Red Bluff Diversion Dam.

TABLE 2.Chinook salmon harvest estimates for the ocean commercial (troll) and sport (charterboat and skiff) fisheries during 1967 through 1991.

YEAR	Ocean Commercial Chinook Harvest	Ocean Sport Chinook Harvest	Total Ocean Harvest of Chinook
1967	337,884	72,566	410,450
1968	472,009	154,244	626,253
1969	551,423	155,768	707,191
1970	516,648	147,800	664,448
1971	433,927	188,271	622,198
1972	492,203	200,522	692,725
1973	816,968	197,953	1,014,921
1974	491,562	157,465	649,027
1975	578,709	103,734	682,443
1976	539,930	80,993	620,923
1977	600,185	103,585	703,770
1978	637,658	72,722	710,380
1979	726,760	119,628	846,388
1980	588,650	85,185	673,835
1981	588,059	84,027	672,086
1982	765,160	138,724	903,884
1983	293,983	63,822	357,805
1984	299,759	87,803	387,562
1985	366,298	171,109	537,407
1986	825,588	141,616	967,204
1987	876,334	192,543	1,068,877
1988	1,317,207	171,361	1,488,568
1989	530,938	186,627	717,565
1990	423,447	139,829	563,276
1991	294,865	80,833	375,698
Average	574,646	131,949	706,595

TABLE 3. Returns of chinook salmon (all races combined) to hatchery facilities operated in the Central Valley during 1967 through 1991.

Year	Fall-run Chinook Salmon Hatchery Return			Spring-run Chinook Salmon Hatchery Returns			Late-fall-run Chinook Salmon Hatchery Returns			Total Returns of Salmon to Hatcheries		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	3,310	11,383	14,693	3	143	146	0	0	0	3,313	11,526	14,839
1968	4,331	14,155	18,486	0	216	216	0	0	0	4,331	14,371	18,702
1969	2,841	9,435	12,276	1	111	112	37	750	787	2,879	10,296	13,175
1970	2,874	16,474	19,348	0	235	235	291	2,769	3,060	3,165	19,478	22,643
1971	3,485	15,241	18,726	0	484	484	192	1,017	1,209	3,677	16,742	20,419
1972	4,859	9,512	14,371	0	256	256	42	507	549	4,901	10,275	15,176
1973	4,409	21,926	26,335	0	205	205	13	390	403	4,422	22,521	26,943
1974	2,719	16,383	19,102	0	198	198	36	669	705	2,755	17,250	20,005
1975	2,996	14,092	17,088	0	691	691	73	1,425	1,498	3,069	16,208	19,277
1976	2,149	11,484	13,633	14	699	713	23	586	609	2,186	12,769	14,955
1977	2,098	19,190	21,288	0	121	121	73	683	756	2,171	19,995	22,165
1978	3,516	11,871	15,387	0	202	202	200	1,653	1,853	3,716	13,726	17,442
1979	6,905	16,999	23,904	0	50	50	4	825	829	6,909	17,874	24,783
1980	4,730	24,802	29,532	0	122	122	63	804	867	4,793	25,728	30,521
1981	9,578	34,830	44,408	113	356	469	274	2,331	2,605	9,965	37,517	47,482
1982	10,303	30,784	41,087	210	1,700	1,910	307	1,579	1,886	10,821	34,062	44,883
1983	11,731	19,992	31,723	72	1,640	1,712	88	870	958	11,891	22,502	34,393
1984	11,568	34,461	46,029	251	1,311	1,562	251	377	628	12,070	36,149	48,219
1985	6,767	36,587	43,354	39	1,593	1,632	85	303	388	6,891	38,483	45,374
1986	6,495	30,008	36,503	191	1,242	1,433	58	730	788	6,743	31,981	38,724
1987	13,375	21,139	34,514	287	926	1,213	43	760	803	13,706	22,824	36,530
1988	3,168	28,074	31,242	280	6,553	6,833	90	367	457	3,538	34,994	38,532
1989	4,133	25,566	29,699	693	4,385	5,078	26	856	882	4,851	30,808	35,659
1990	4,330	21,404	25,734	0	1,306	1,306	43	149	192	4,372	22,860	27,232
1991	3,130	25,080	28,210	155	4,148	4,303	38	241	279	3,323	29,469	32,792
Average	5,432	20,835	26,267	92	1,156	1,248	94	826	920	5,618	22,816	28,435

Steelhead Trout

Estimates of the numbers of naturally spawning steelhead are very conservative, and do not include estimates for locations where steelhead likely spawn. Counts conducted earlier than the specified base time period had enumerated populations in excess of 1,000 steelhead in both Mill and Deer creeks. The primary source of data regarding naturally spawning steelhead is from annual counts at RBDD. These counts are corrected by subtracting the number of steelhead returning to Coleman National Fish Hatchery and the difference is assumed to represent the naturally spawning component. During the base period and average of 6,574 steelhead spawned naturally in the Sacramento River system above RBDD and ranged from 470 in 1989 to 19,615 in 1968 (Table 4).

Sturgeon

Estimates of the abundance of white sturgeon range from 20,700 in 1974 to 114,700 in 1967 with a 25-year mean of 63,501 (Table 5). Green sturgeon abundance has ranged from 200 in 1974 to 1,850 in 1967 with a 25-year mean of 867 (Table 5).

Striped Bass

Estimates of the abundance of legal-sized striped bass have ranged from 574,364 in 1990 to 1,948,000 in 1967 with a 25-year mean of 1,252,259 (Table 6).

American Shad

Only two estimates of the abundance of American shad are available from studies conducted in the Sacramento River system. Results of that study estimate that 3,04 and 2.79 million adult American shad were present in 1976 and 1977, respectively.

Inland Harvest of Chinook Salmon and Steelhead

The estimated catch of all races of chinook salmon in the Sacramento River exclusive of the tributary streams ranged from 5,133 in 1983 to 19,750 in 1969 (Table 7, Appendix 10). Fall chinook were most abundant with an average inland harvest of 7,615. Steelhead harvest ranged from 470 in 1989 to 19,615 in 1968 (Table 8, Appendix 11).

SUMMARY AND CONCLUSIONS

The Act requires restoration goals to be established for Central Valley anadromous fish populations at not less than twice the average levels attained during the period of 1967-1991. Lack of quantitative data for some of the fisheries during the 1967-1991 base period precludes determination of some elements that need to be encompassed in setting goals. For example, it is not known how many Central Valley chinook salmon were harvested in the ocean fisheries nor is it known how many were harvested inland. Likewise, except for two

TABLE 4. Estimates of steelhead trout returning to the Upper Sacramento River and to hatcheries operated throughout the Central Valley, 1967 through 1991.

Year	Natural Spawning	Steelhead Returns to Hatcheries					Grand Total
	Upper Sacramento	Coleman	Feather River	Nimbus	Mokelumne	Subtotal	
1967	15,312	1,532	563	642	17	2,754	18,066
1968	19,615	3,229	1,005	1,183	103	5,520	25,135
1969	15,222	4,939	361	3,056	24	8,380	23,602
1970	13,240	4,046	1,945	1,734	134	7,859	21,099
1971	11,887	3,742	78	3,033	115	6,968	18,855
1972	6,041	1,486	288	2,256	14	4,044	10,085
1973	8,921	2,645	1,000	2,506	11	6,162	15,083
1974	7,150	1,834	715	3,157	18	5,724	12,874
1975	5,579	1,099	458	2,164	2	3,723	9,302
1976	8,902	2,162	573	3,181	0	5,916	14,818
1977	6,099	2,069	163	1,307	0	3,539	9,638
1978	2,527	697	131	619	0	1,447	3,974
1979	3,499	865	189	680	0	1,734	5,233
1980	11,887	4,264	314	1,310	0	5,888	17,775
1981	3,363	1,118	547	821	0	2,486	5,849
1982	2,757	1,275	891	3,190	0	5,356	8,113
1983	3,486	938	1,238	1,003	0	3,179	6,665
1984	2,036	529	783	5,155	0	6,467	8,503
1985	4,489	2,084	1,721	910	0	4,715	9,204
1986	3,769	2,299	1,554	1,193	0	5,046	8,815
1987	2,963	1,176	1,018	1,431	48	3,673	6,636
1988	1,872	915	2,587	705	0	4,207	6,079
1989	470	492	1,106	289	7	1,894	2,364
1990	2,272	1,319	1,193	594	11	3,117	5,389
1991	991	991	1,024	223	20	2,258	3,249
Average	6,574	1,910	858	1,694	40	4,482	11,056

TABLE 5. Estimates of the abundance of white sturgeon and green sturgeon in the Central Valley, 1967 through 1991.

Year	White Sturgeon Abundance	Years Abundance Estimated	Ratio White: Green	Green Sturgeon Abundance
1967	114,700	**	62.0:1	1,850
1968	40,000	**	38.6:1	1,040
1969	36,783			900
1970	33,567			760
1971	30,350			620
1972	27,133			480
1973	23,917			340
1974	20,700	**	101.9:1	200
1975	31,460			444
1976	42,220			688
1977	52,980			932
1978	63,740			1,176
1979	74,500	**	52.6:1	1,420
1980	83,120			1,378
1981	91,740			1,336
1982	100,360			1,294
1983	108,980			1,252
1984	117,600	**	106.3:1	1,210
1985	107,700	**	127.3:1	760
1986	96,850			635
1987	86,000	**	163.7:1	510
1988	66,267			520
1989	46,553			530
1990	26,800	**	49.7:1	540
1991	--			--
Average	63,501			867

TABLE 6. Estimated abundance of adult striped bass in the Central Valley, 1967 through 1991.

Year	Adult Striped Bass Abundance						Total Adults
	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	
1967	--	--	--	--	--	--	1,948,000
1968	--	--	--	--	--	--	1,944,000
1969	1,083,448	412,448	269,245	170,505	69,147	182,957	1,646,026
1970	1,309,098	484,360	201,040	128,928	89,809	168,708	1,727,394
1971	858,574	602,350	224,357	118,366	77,139	148,216	1,599,715
1972	1,249,964	521,549	407,093	124,223	61,635	143,425	1,882,907
1973	742,520	480,825	234,728	176,698	173,945	199,703	1,637,159
1974	941,360	338,683	272,919	136,202	108,783	149,946	1,477,213
1975	933,690	619,066	265,656	160,725	76,422	261,056	1,849,770
1976	1,037,674	480,548	190,596	130,718	123,493	136,884	1,581,076
1977	534,040	176,888	223,172	92,257	25,101	139,863	924,301
1978	1,213,574	254,939	136,032	33,091	42,797	77,996	1,151,642
1979	929,368	398,345	179,211	48,490	26,797	38,174	1,155,701
1980	379,696	560,208	211,661	85,511	29,323	39,448	1,115,999
1981	531,916	342,590	186,690	54,036	27,787	34,249	911,300
1982	821,584	217,768	97,861	41,291	35,796	21,618	825,126
1983	564,464	394,577	232,066	39,333	25,684	35,856	1,009,748
1984	867,977	359,026	187,021	27,919	10,341	24,373	1,042,668
1985	418,749	538,559	190,319	64,699	5,267	15,970	1,024,188
1986	526,171	329,553	282,682	105,575	22,710	34,522	1,037,127
1987	629,384	274,892	172,848	132,469	56,632	46,816	998,349
1988	350,695	386,400	133,161	112,265	43,050	42,189	892,413
1989	271,064	322,833	145,643	43,819	46,890	19,863	724,580
1990	325,543	151,540	149,504	59,245	27,361	23,944	574,364
1991	207,588	210,395	151,888	54,586	39,158	65,881	625,702
Average	669,126	354,334	189,816	85,638	49,803	82,066	1,252,259

TABLE 7. Estimated harvest of chinook salmon in the Sacramento River, 1967 through 1991.

Year	Late-Fall Run	Winter Run	Spring Run	Fall Run	Total
1967	2,504	3,602	1,885	4,267	12,258
1968	2,047	11,308	802	4,471	18,628
1969	1,433	9,095	1,659	7,563	19,750
1970	748	4,440	762	7,889	13,839
1971	1,165	6,735	400	9,477	17,778
1972	2,658	2,944	1,149	5,987	12,303
1973	2,599	2,944	1,149	6,465	13,157
1974	567	2,014	1,047	10,632	14,883
1975	1,190	2,014	1,047	10,632	14,883
1976	921	4,268	2,145	11,047	18,381
1977	1,058	1,667	830	4,889	8,443
1978	528	910	538	4,839	6,816
1979	477	107	151	7,438	8,173
1980	460	55	803	4,839	6,172
1981	335	961	1,185	3,699	6,179
1982	162	50	1,115	4,578	5,905
1983	593	59	234	4,247	5,133
1984	241	78	745	6,087	7,150
1985	430	548	1,171	16,533	18,682
1986	2,340	138	1,846	15,340	19,665
1987	943	89	688	9,630	11,350
1988	680	0	600	11,488	12,768
1989	685	0	322	6,850	7,856
1990	330	0	215	5,290	5,835
1991	531	0	57	10,075	10,663
AVERAGE	1,025	2,143	855	7,615	11,637

TABLE 8. Estimated harvest of steelhead above Red Bluff Diversion Dam, 1967-1991.

Year	Upper Sacramento Population Estimate	Estimated Angler Harvest above Red Bluff Diversion Dam
1967	15,312	5,795
1968	19,615	5,761
1969	15,222	5,761
1970	13,240	5,011
1971	11,887	4,499
1972	6,041	2,286
1973	8,921	3,376
1974	7,150	2,706
1975	5,579	2,111
1976	8,902	3,369
1977	6,099	2,308
1978	2,527	956
1979	3,499	1,324
1980	11,887	4,499
1981	3,363	1,273
1982	2,757	1,043
1983	3,486	1,319
1984	2,036	771
1985	4,489	1,699
1986	3,769	1,426
1987	2,272	860
1988	1,872	708
1989	470	178
1990	2,272	860
1991	991	375
Average	6,574	2,488

years of population data, no contemporaneous data exists for American shad. In compliance with the Act, the average population levels for chinook salmon, steelhead trout, sturgeon, striped bass, and American shad are determined to be as follows.

TABLE 9. Estimated average numbers of anadromous fish in the ocean sport and commercial fisheries, inland sport fisheries, spawning escapements, and population estimates for the 1967-1991 baseline period.

Species or Stock		1967-1991 Average Harvest Estimate	1967-1991 Average Population Estimate
Chinook Salmon	Sacramento Fall Run	7,615 [1]	176,092
	San Joaquin Fall Run	No estimate	20,644
	Spring Run	855 [1]	12,990
	Late-fall Run	1,025 [1]	14,159
	Winter Run	2,143 [1]	23,109
	Ocean Sport Harvest (Statewide)	131,949	Not applicable
	Ocean Commercial Harvest (Statewide)	574,646	Not applicable
Steelhead	Sacramento Valley	2,488 [1]	6,574
	San Joaquin Valley	No estimate	No estimate
Sturgeon	White	Contained in population estimate	63,501
	Green	Contained in population estimate	867
Striped Bass	Central Valley	Contained in population estimate	1,252,259
American Shad	Sacramento Valley	No estimate	No estimate
	San Joaquin Valley	No estimate	No estimate

[1]. Harvest estimate for main stem Sacramento River and does not include estimated harvest of salmon or steelhead in tributary streams or rivers.

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APPENDIX 1.Angler Harvest Estimates for the Sacramento River Basin, 1967-1991.

BACKGROUND

Limited harvest information is available for determinations of inland sport catches of salmon and steelhead in the Central Valley. Although no comprehensive measure of in-river sport harvest has been made on a consistent basis, fragmented census surveys have been made for some rivers during various times. Inland sport catch of chinook salmon has received little emphasis because of low annual mortality associated from this source. One simple approach to estimate annual in-river harvest of chinook salmon was made by Meyer (1985) who assumed the in-river harvest was a constant fraction of the total ocean sport harvest. He applied 10% as a reasonable estimate, combining the various runs. Rowell (unpublished report, Department of Fish and Game, Red Bluff) conducted a salmon and steelhead creel census in the Sacramento River above Red Bluff Diversion Dam during 1967 through 1975. These estimates combined with RBDD counts provide estimates for both the river reach above RBDD and the total harvest of chinook salmon in the Sacramento exclusive of the tributaries, and for the harvest of steelhead trout above RBDD.

Methods and Results

Chinook Salmon

A significant relationship between harvest rates above RBDD and the total river allows annual estimates of individual salmon races to be made (Figure 1).

Annual spawning stock survey reports from 1967-1991 provide estimates of salmon harvest rates in the reach above RBDD. Ladder counts combined with estimated catches made at resorts and boat ramps permit crude estimates of annual harvest upon individual salmon runs (Table 1). The spawner estimates and estimated catches presented in the tables are not segregated to account for those fish destined to spawn naturally and those returning to hatcheries.

These catches reflect only that portion of the run caught above Red Bluff. Considerable numbers are harvested in the river below Red Bluff with stocks caught further downstream to the Carquinez Straits. Converting the numbers caught to proportions (Table 2) allows application of the relationship between harvest above RBDD to total river catches.

Thus applying an estimated annual harvest rate for the total river to yearly spawning escapements yields a harvest index for each run (Table 3).

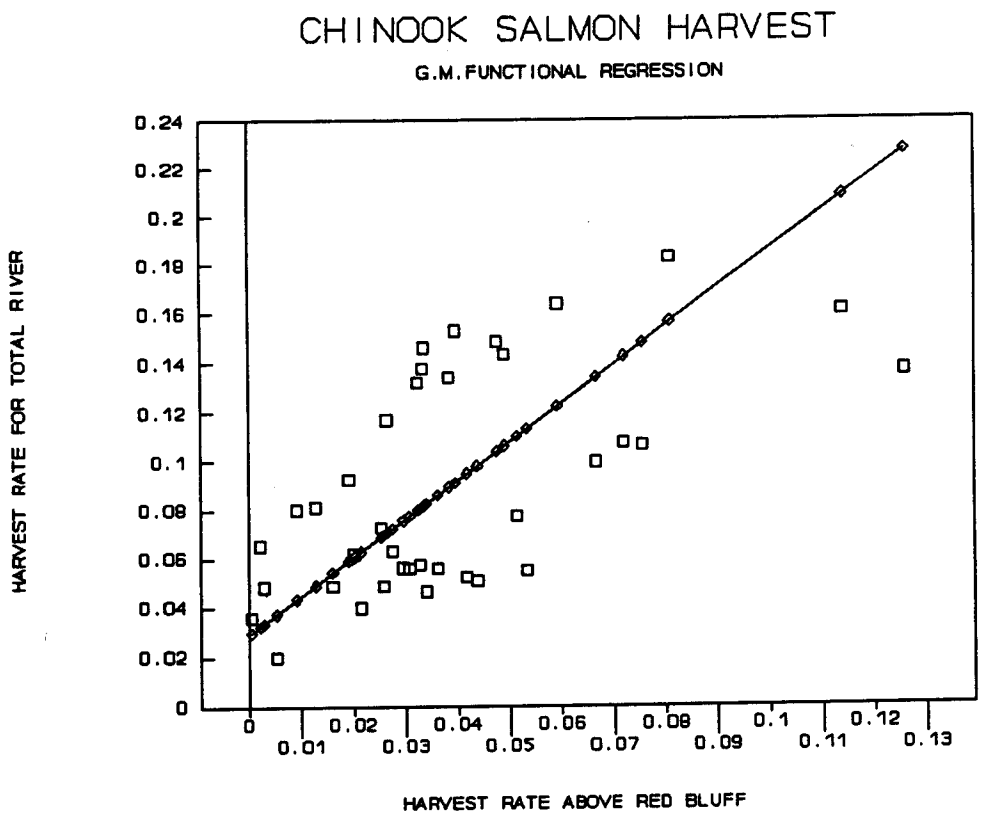

FIGURE 1. Relationship of Chinook Salmon Harvest Rate above Red Bluff Diversion Dam to Total In-river Harvest Rate.

Third draft, subject to revision
Not approved by the Department of Fish and Game

TABLE 1.Salmon Counts and Estimated Catches Upstream of Red Bluff Diversion Dam.

Year	Late-fall run chinook		Winter-run chinook		Spring-run chinook		Fall-run chinook	
	Spawner Estimate	Estimated Catch	Spawner Estimate	Estimated Catch	Spawner Estimate	Estimated Catch	Spawner Estimate	Estimated Catch
1967	37,208	No est.	57,306	No est.	23,514	No est.	89,220	821
1968	34,733	668	84,414	5,631	14,864	239	12,2095	354
1969	38,752	207	117,808	3,628	26,505	571	13,3815	1,714
1970	25,310	26	40,409	2,080	3,652	416	80,935	3,110
1971	16,741	435	43,089	3,484	5,830	148	63,918	3,139
1972	32,651	1,092	37,133	1,204	7,346	308	42,503	2,022
1973	23,010	1,229	24,079	1,428	7,762	587	53,891	2,136
1974	7,855	217	21,897	580	3,933	133	54,952	1,804
1975	19,659	398	23,430	851	10,703	469	63,091	3,132
1976	16,198	290	35,096	2,067	25,983	888	60,719	3,307
1977	10,602	478	17,214	744	13,730	277	40,444	825
1978	12,586	107	24,862	127	5,903	234	39,826	674
1979	10,398	114	2,364	25	2,900	43	62,108	1,128
1980	9,481	120	1,156	14	9,696	333	37,610	1,031
1981	6,807	89	20,041	246	21,025	370	53,744	299
1982	4,913	14	1,242	9	23,438	282	48,431	1,069
1983	15,190	101	1,831	4	3,931	77	42,096	737
1984	7,163	23	2,663	1	8,147	324	73,254	1,556
1985	8,436	120	3,962	275	10,747	547	97,707	5,079
1986	8,286	1,331	2,464	43	16,691	867	104,873	5,681
1987	16,049	307	1,997	20	11,204	233	103,063	2,856
1988	11,597	221	2,094	21	9,781	203	139,966	3,878
1989	11,639	223	533	5	5,255	109	84,057	2,329
1990	7,039	77	441	4	3,922	65	55,710	1,598
1991	7,039	209	191	0	773	22	44,937	5,655
Average	15,984	337	22,709	937	11,089	323	71,719	2,237

TABLE 2. Calculated Harvest Rates of Individual Salmon Races Upstream of RBDD and Estimated Total River Based on Regression.

Year	Harvest Rate Above Red Bluff Diversion Dam				Total River Harvest Rate			
	Late-Fall Run	Winter Run	Spring Run	Fall Run	Late-Fall Run	Winter Run	Spring Run	Fall Run
1967	ne	ne	ne	0.9%	6.7%	6.3%	8.0%	4.3%
1968	1.9%	6.7%	1.6%	0.3%	5.9%	13.4%	5.4%	3.3%
1969	0.5%	3.1%	2.2%	1.3%	3.7%	7.7%	6.3%	4.9%
1970	0.1%	5.1%	11.4%	3.8%	3.0%	11.0%	20.9%	8.9%
1971	2.6%	8.1%	2.5%	4.9%	7.0%	15.6%	6.9%	10.6%
1972	3.3%	3.2%	4.2%	4.8%	8.1%	8.0%	9.5%	10.4%
1973	5.3%	5.9%	7.6%	4.0%	11.3%	12.2%	14.8%	9.1%
1974	2.8%	2.6%	3.4%	3.3%	7.2%	7.0%	8.2%	8.0%
1975	2.0%	3.6%	4.4%	5.0%	6.1%	8.6%	9.8%	10.7%
1976	1.8%	5.9%	3.4%	5.4%	5.7%	12.2%	8.3%	11.5%
1977	4.5%	4.3%	2.0%	2.0%	10.0%	9.7%	6.0%	6.1%
1978	0.9%	0.5%	4.0%	1.7%	4.2%	3.7%	9.1%	5.5%
1979	1.1%	1.1%	1.5%	1.8%	4.6%	4.5%	5.2%	5.7%
1980	1.3%	1.2%	3.4%	2.7%	4.9%	4.8%	8.3%	7.2%
1981	1.3%	1.2%	1.8%	0.6%	4.9%	4.8%	5.6%	3.7%
1982	0.3%	0.7%	1.2%	2.2%	3.3%	4.0%	4.8%	6.3%
1983	0.7%	0.2%	2.0%	1.8%	3.9%	3.2%	5.9%	5.6%
1984	0.3%	0.0%	4.0%	2.1%	3.4%	2.9%	9.1%	6.2%
1985	1.4%	6.9%	5.1%	5.2%	5.1%	13.8%	10.9%	11.1%
1986	16.1%	1.7%	5.2%	5.4%	28.2%	5.6%	11.1%	11.4%
1987	1.9%	1.0%	2.1%	2.8%	5.9%	4.4%	6.1%	7.2%
1988	1.9%	1.0%	2.1%	2.8%	5.9%	0.0%	6.1%	7.2%
1989	1.9%	0.9%	2.1%	2.8%	5.9%	4.4%	6.1%	7.2%
1990	1.1%	0.9%	1.7%	2.9%	4.5%	0.0%	5.5%	7.4%
1991	3.0%	0.0%	2.8%	12.6%	7.5%	0.0%	7.4%	22.7%
Average	2.4%	2.8%	3.4%	3.3%	6.7%	6.5%	8.2%	8.1%

TABLE 3. Annual Chinook Salmon Harvest Estimate for the Sacramento River, 1967-1991.

Year	Late-Fall Run	Winter Run	Spring Run	Fall Run	Total
1967	2,504	3,602	1,885	4,267	12,258
1968	2,047	11,308	802	4,471	18,628
1969	1,433	9,095	1,659	7,563	19,750
1970	748	4,440	762	7,889	13,839
1971	1,165	6,735	400	9,477	17,778
1972	2,658	2,944	1,149	5,987	12,303
1973	2,599	2,944	1,149	6,465	13,157
1974	567	2,014	1,047	10,632	14,883
1975	1,190	2,014	1,047	10,632	14,883
1976	921	4,268	2,145	11,047	18,381
1977	1,058	1,667	830	4,889	8,443
1978	528	910	538	4,839	6,816
1979	477	107	151	7,438	8,173
1980	460	55	803	4,839	6,172
1981	335	961	1,185	3,699	6,179
1982	162	50	1,115	4,578	5,905
1983	593	59	234	4,247	5,133
1984	241	78	745	6,087	7,150
1985	430	548	1,171	16,533	18,682
1986	2,340	138	1,846	15,340	19,665
1987	943	89	688	9,630	11,350
1988	680	0	600	11,488	12,768
1989	685	0	322	6,850	7,856
1990	330	0	215	5,290	5,835
1991	531	0	57	10,075	10,663
AVERAGE	1,025	2,143	855	7,615	11,637

Steelhead Trout

A similar analysis was applied to steelhead catch and population statistics; a relationship between total population levels and catch. Hallock (1961), Rowell (1980) and Wixom (pers comm.) reported steelhead catches for a several differing time periods. The annual proportion caught varied between 20 to 66%, but averaged around 35%. Staley (1976) found during two years studied a similar harvest rate for the American River; 33%. Unfortunately, annual steelhead populations are not measured for most Central Valley Rivers. Estimates of harvest can only be obtained for the Sacramento River, using RBDD counts as an index of total population. A significant relationship between population size and catch was developed for Sacramento River steelhead harvest and applied to RBDD counts (Figure 2.)

The annual harvest rate determined by this relationship is equivalent to 38% of the available population and yields the catch estimates of Table 4. These steelhead catches should be considered as minimum estimates.

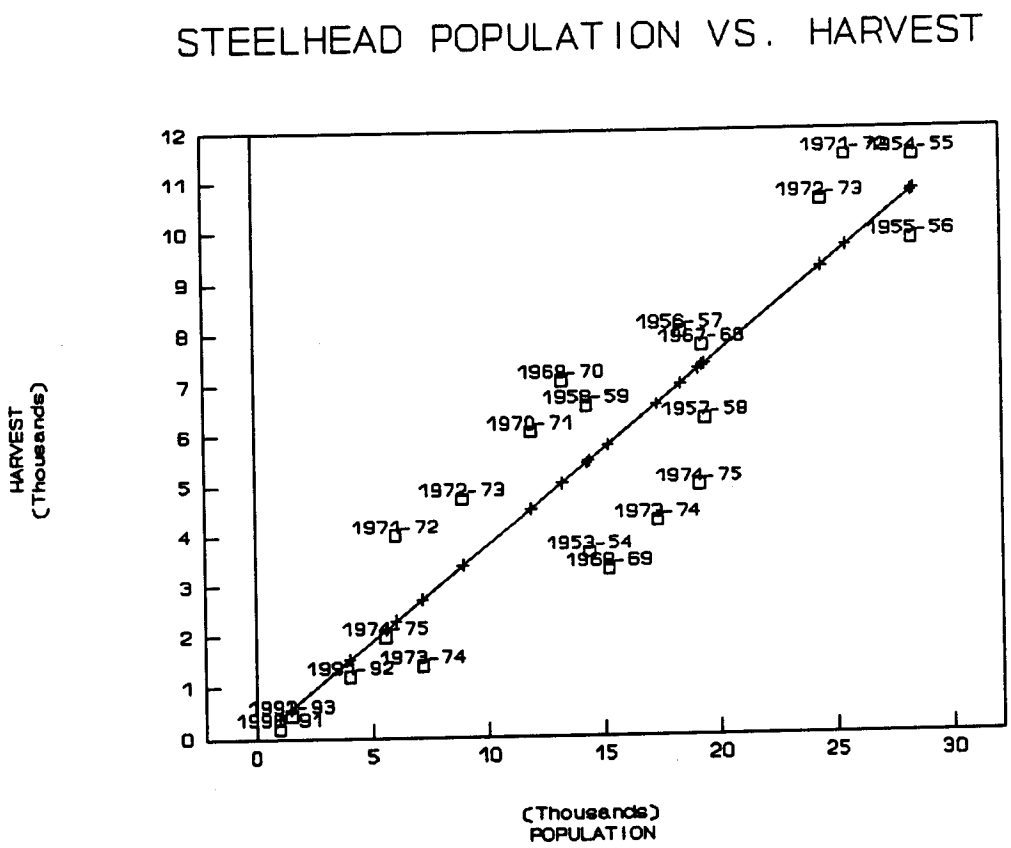

FIGURE 2. Relationship Between Annual Steelhead Population and Harvest.

Third draft, subject to revision
Not approved by the Department of Fish and Game

TABLE 4. Annual Steelhead Harvest Above Red Bluff Diversion Dam.

Year	Upper Sacramento Population Estimate	Estimated Angler Harvest above Red Bluff Diversion Dam
1967	15,312	5,795
1968	19,615	5,761
1969	15,222	5,761
1970	13,240	5,011
1971	11,887	4,499
1972	6,041	2,286
1973	8,921	3,376
1974	7,150	2,706
1975	5,579	2,111
1976	8,902	3,369
1977	6,099	2,308
1978	2,527	956
1979	3,499	1,324
1980	11,887	4,499
1981	3,363	1,273
1982	2,757	1,043
1983	3,486	1,319
1984	2,036	771
1985	4,489	1,699
1986	3,769	1,426
1987	2,272	860
1988	1,872	708
1989	470	178
1990	2,272	860
1991	991	375
Average	6,574	2,488

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APPENDIX 2. Estimates of abundance for naturally spawning stocks of fall-run chinook salmon in the Sacramento River basin, 1967-1991 (N.E. = No Estimate). (Sheet 1 of 5).

Year	Sacramento River			Clear Creek			Cow Creek			Cottonwood Creek		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	15,714	71,586	87,300	67	303	370	94	426	520	108	492	600
1968	9,881	97,519	107,400	74	726	800	694	6,846	7,540	786	7,754	8,540
1969	15,864	116,336	132,200	149	1,091	1,240	668	4,902	5,570	596	4,371	4,967
1970	11,418	60,392	71,810	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1971	18,928	61,275	80,203	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1972	17,944	32,746	50,690	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1973	17,335	43,065	60,400	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1974	14,780	61,014	75,794	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1975	22,242	68,173	90,415	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1976	12,288	70,736	83,024	150	863	1,013	107	619	726	359	2,068	2,427
1977	12,676	51,997	64,673	267	1,095	1,362	N.E.	N.E.	N.E.	296	1,216	1,512
1978	17,035	65,258	82,293	12	48	60	N.E.	N.E.	N.E.	232	888	1,120
1979	38,246	76,953	115,199	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1980	11,059	41,355	52,414	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1981	27,180	41,805	68,985	1,447	2,225	3,672	N.E.	N.E.	N.E.	1,322	2,034	3,356
1982	11,970	29,594	41,564	226	559	785	N.E.	N.E.	N.E.	202	498	700
1983	23,997	34,247	58,244	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	412	588	1,000
1984	21,753	34,311	56,064	1,552	2,448	4,000	97	153	250	194	306	500
1985	19,604	83,575	103,179	133	567	700	57	243	300	76	324	400
1986	11,666	90,664	102,330	144	1,116	1,260	34	266	300	68	532	600
1987	39,214	69,413	108,627	235	415	650	181	320	500	217	383	600
1988	11,931	74,523	86,454	615	3,838	4,453	28	172	200	17	103	120
1989	12,092	47,476	59,568	437	1,717	2,154	51	199	250	142	558	700
1990	5,371	44,361	49,732	86	713	799	8	67	75	19	156	175
1991	3,591	25,372	28,963	251	1,776	2,027	31	219	250	85	602	687
Average	16,951	59,750	76,701	365	1,219	1,584	171	1,203	1,373	302	1,345	1,647

APPENDIX 2 (continued). Estimates of abundance for naturally spawning stocks of fall-run chinook salmon in the Sacramento River basin, 1967-1991 (N.E. = No Estimate). (Sheet 2 of 5)

Year	Battle Creek			Paynes Creek			Antelope Creek			Mill Creek		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	389	1,771	2,160	N.E.	N.E.	N.E.	11	49	60	90	410	500
1968	271	2,679	2,950	N.E.	N.E.	N.E.	7	73	80	69	681	750
1969	384	2,816	3,200	36	264	300	22	158	180	204	1,496	1,700
1970	528	2,792	3,320	N.E.	N.E.	N.E.	64	336	400	110	580	690
1971	775	2,510	3,285	N.E.	N.E.	N.E.	48	157	205	231	749	980
1972	719	1,311	2,030	N.E.	N.E.	N.E.	97	178	275	223	408	631
1973	1,234	3,066	4,300	N.E.	N.E.	N.E.	57	143	200	121	299	420
1974	447	1,847	2,294	N.E.	N.E.	N.E.	86	354	440	184	760	944
1975	597	1,829	2,426	N.E.	N.E.	N.E.	22	68	90	297	911	1,208
1976	466	2,681	3,147	N.E.	N.E.	N.E.	9	51	60	36	209	245
1977	1,098	4,506	5,604	N.E.	N.E.	N.E.	129	531	660	89	367	456
1978	366	1,404	1,770	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	62	238	300
1979	1,471	2,959	4,430	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	269	541	810
1980	1,042	3,898	4,940	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	68	252	320
1981	2,732	4,201	6,933	N.E.	N.E.	N.E.	160	247	407	402	618	1,020
1982	2,094	5,176	7,270	9	21	30	47	115	162	372	918	1,290
1983	2,154	3,073	5,227	41	59	100	25	35	60	82	118	200
1984	3,225	5,087	8,312	35	55	90	101	159	260	2,250	3,550	5,800
1985	4,553	19,408	23,961	11	49	60	3	12	15	794	3,386	4,180
1986	2,138	16,615	18,753	17	133	150	2	18	20	65	509	574
1987	2,856	5,056	7,912	7	13	20	N.E.	N.E.	N.E.	102	180	282
1988	7,294	45,558	52,852	1	9	10	1	9	10	205	1,282	1,487
1989	3,872	15,204	19,076	10	40	50	12	48	60	317	1,247	1,564
1990	697	5,756	6,453	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1991	820	5,793	6,613	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	19	131	150
Average	1,689	6,680	8,369	19	71	90	48	144	192	278	827	1,104

APPENDIX 2 (continued). Estimates of abundance for naturally spawning stocks of fall-run chinook salmon in the Sacramento River basin, 1967-1991 (N.E. = No Estimate). (Sheet 3 of 5)

Year	Deer Creek			Miscellaneous Streams [1]			Butte Creek			Big Chico Creek		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	11	49	60	5	25	30	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1968	25	245	270	29	281	310	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1969	90	660	750	194	1,426	1,620	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1970	80	421	500	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1971	59	189	248	24	76	100	145	470	615	N.E.	N.E.	N.E.
1972	108	196	304	42	78	120	159	291	450	N.E.	N.E.	N.E.
1973	194	482	676	108	268	376	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1974	125	515	640	59	242	300	39	161	200	N.E.	N.E.	N.E.
1975	81	247	328	148	452	600	246	754	1,000	N.E.	N.E.	N.E.
1976	47	268	315	53	303	356	95	545	640	N.E.	N.E.	N.E.
1977	43	177	220	63	257	320	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1978	19	71	90	N.E.	N.E.	N.E.	4	16	20	N.E.	N.E.	N.E.
1979	259	521	780	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1980	44	166	210	32	119	151	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1981	323	497	820	260	400	660	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1982	138	342	480	52	128	180	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1983	152	218	370	87	123	210	412	588	1,000	206	294	500
1984	264	416	680	116	184	300	N.E.	N.E.	N.E.	78	122	200
1985	171	729	900	11	49	60	19	81	100	5	20	25
1986	29	227	256	26	204	230	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1987	23	41	64	16	29	45	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1988	2	14	16	1	9	10	21	129	150	N.E.	N.E.	N.E.
1989	73	285	358	20	80	100	1	4	5	N.E.	N.E.	N.E.
1990	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
1991	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.
Average	103	303	406	67	237	304	114	304	418	96	146	242

APPENDIX 2 (continued). Estimates of abundance for naturally spawning stocks of fall-run chinook salmon in the Sacramento River basin, 1967-1991 (N.E. = No Estimate). (Sheet 4 of 5)

Year	Feather River			Yuba River			American River			Total Natural Spawners		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	3,515	6,585	10,100	15,275	8,225	23,500	3,132	14,868	18,000	38,410	104,790	143,200
1968	2,428	9,772	12,200	1,141	5,859	7,000	2,777	23,423	26,200	18,181	155,859	174,040
1969	19,895	36,305	56,200	2,218	3,012	5,230	8,208	35,452	43,660	48,528	208,289	256,817
1970	13,495	44,675	58,170	1,673	12,157	13,830	2,753	25,927	28,680	30,121	147,279	177,400
1971	10,005	33,495	43,500	350	5,300	5,650	5,210	36,470	41,680	35,775	140,691	176,466
1972	16,243	26,957	43,200	4,907	4,351	9,258	3,352	14,107	17,459	43,795	80,622	124,417
1973	13,671	51,429	65,100	3,232	20,887	24,119	4,688	77,554	82,242	40,640	197,193	237,833
1974	6,523	52,777	59,300	1,353	16,456	17,809	1,769	51,827	53,596	25,364	185,953	211,317
1975	2,604	35,131	37,735	756	4,885	5,641	2,699	29,433	32,132	29,691	141,884	171,575
1976	6,645	52,157	58,802	491	3,288	3,779	1,181	21,978	23,159	21,926	155,767	177,693
1977	1,959	35,709	37,668	1,509	7,213	8,722	4,701	36,904	41,605	22,831	139,971	162,802
1978	4,257	28,743	33,000	1,053	6,363	7,416	595	12,334	12,929	23,635	115,363	138,998
1979	3,268	25,147	28,415	1,989	10,441	12,430	896	36,419	37,315	46,397	152,982	199,379
1980	2,276	29,329	31,605	2,146	10,260	12,406	8,805	25,454	34,259	25,472	110,833	136,305
1981	4,250	40,488	44,738	1,978	12,047	14,025	2,521	40,941	43,462	42,575	145,503	188,078
1982	8,296	39,660	47,956	15,668	23,699	39,367	4,323	28,677	33,000	43,396	129,388	172,784
1983	4,382	18,441	22,823	2,452	11,804	14,256	7,313	19,087	26,400	41,714	88,676	130,390
1984	6,358	35,196	41,554	2,641	7,324	9,965	2,196	25,251	27,447	40,859	114,563	155,422
1985	1,807	48,385	50,192	2,927	10,139	13,066	11,392	44,728	56,120	41,563	211,695	253,258
1986	6,277	40,567	46,844	2,445	16,961	19,406	4,443	44,929	49,372	27,356	212,739	240,095
1987	14,390	44,584	58,974	6,164	12,346	18,510	2,960	18,185	21,145	66,364	150,965	217,329
1988	2,711	51,505	54,216	1,785	6,716	8,501	1,905	13,974	15,879	26,517	197,841	224,358
1989	2,999	26,987	29,986	1,574	8,263	9,837	2,459	14,619	17,078	24,060	116,726	140,786
1990	875	24,125	25,000	1,220	2,780	4,000	1,167	5,541	6,708	9,443	83,499	92,942
1991	2,502	25,300	27,802	2,740	11,239	13,979	1,506	16,639	18,145	11,546	87,070	98,616
Average	6,465	34,538	41,003	3,187	9,681	12,868	3,718	28,589	32,307	33,046	143,046	176,092

APPENDIX 2 (continued). Estimates of abundance for naturally spawning stocks of fall-run chinook salmon in the Sacramento River basin, 1967-1991. (Sheet 5 of 5)

Footnotes:

1. Miscellaneous streams include Spring Gulch, China Gulch, Olney, Ash, Stillwater, and Inks creeks.

APPENDIX 3. Estimates of naturally spawning fall-run chinook salmon in the San Joaquin River drainage, 1967-1991 (N.E. = No Estimate).

Year	Stanislaus River			Tuolumne River			Merced River			San Joaquin Totals		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	345	11,540	11,885	333	6,467	6,800	141	459	600	819	18,466	19,285
1968	3,620	2,765	6,385	6,510	2,090	8,600	310	240	550	10,440	5,095	15,535
1969	308	12,019	12,327	580	31,620	32,200	25	575	600	913	44,214	45,127
1970	2,585	6,712	9,297	3,146	15,254	18,400	1,584	3,116	4,700	7,315	25,082	32,397
1971	913	12,708	13,621	1,444	20,441	21,885	142	1,448	1,590	2,499	34,597	37,096
1972	443	3,855	4,298	857	4,243	5,100	399	2,129	2,528	1,699	10,227	11,926
1973	49	1,185	1,234	93	1,896	1,989	169	628	797	312	3,708	4,020
1974	246	504	750	99	1,051	1,150	71	929	1,000	416	2,484	2,900
1975	172	1,028	1,200	136	1,464	1,600	207	1,493	1,700	515	3,985	4,500
1976	134	466	600	165	1,535	1,700	79	1,121	1,200	378	3,122	3,500
1977	0	0	0	0	450	450	29	321	350	29	771	800
1978	17	33	50	94	1,206	1,300	89	436	525	199	1,676	1,875
1979	6	94	100	123	1,060	1,183	253	1,667	1,920	382	2,821	3,203
1980	17	83	100	53	506	559	80	2,771	2,851	150	3,360	3,510
1981	24	976	1,000	4,504	9,749	14,253	2,733	6,758	9,491	7,261	17,483	24,744
1982	N.E.	N.E.	N.E.	378	6,748	7,126	68	3,006	3,074	445	9,755	10,200
1983	250	250	500	12,195	2,641	14,836	12,603	3,850	16,453	25,048	6,741	31,789
1984	4,438	7,001	11,439	7,246	6,556	13,802	6,165	18,495	24,660	17,849	32,052	49,901
1985	1,252	12,070	13,322	1,452	38,870	40,322	1,083	13,758	14,841	3,787	64,698	68,485
1986	1,001	4,887	5,888	503	6,785	7,288	381	5,142	5,523	1,885	16,814	18,699
1987	2,265	4,027	6,292	13,748	1,003	14,751	1,390	1,505	2,895	17,403	6,535	23,938
1988	494	11,850	12,344	311	6,038	6,349	190	2,570	2,760	995	20,458	21,453
1989	57	1,911	1,968	45	1,229	1,274	25	104	129	127	3,244	3,371
1990	191	301	492	21	75	96	6	18	24	218	394	612
1991	106	166	272	8	45	53	30	89	119	144	300	444
Average	789	4,018	4,807	2,162	6,761	8,923	1,130	2,905	4,035	4,049	13,523	17,572

APPENDIX 4. **Estimates of naturally spawning fall-run chinook salmon in the Cosumnes, Mokelumne, and Calaveras rivers, 1967 through 1991 (N.E. = No Estimate).**

Year	Cosumnes River			Mokelumne River			Total Eastside		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	55	445	500	303	2,448	2,750	358	2,893	3,250
1968	513	987	1,500	258	495	753	771	1,482	2,253
1969	695	3,705	4,400	327	1,743	2,070	1,022	5,448	6,470
1970	157	443	600	1,068	3,024	4,092	1,225	3,467	4,692
1971	55	446	500	433	3,537	3,970	487	3,983	4,470
1972	424	1,176	1,600	198	551	749	622	1,727	2,349
1973	105	795	900	256	1,936	2,192	362	2,730	3,092
1974	66	219	285	280	922	1,202	346	1,141	1,487
1975	120	605	725	249	1,252	1,501	370	1,856	2,226
1976	N.E.	N.E.	N.E.	56	343	399	56	343	399
1977	N.E.	N.E.	N.E.	31	219	250	31	219	250
1978	6	94	100	39	563	602	45	657	702
1979	10	140	150	64	936	1,000	74	1,076	1,150
1980	40	160	200	513	2,079	2,592	553	2,239	2,792
1981	1	4	5	760	2,808	3,568	761	2,812	3,573
1982	N.E.	N.E.	N.E.	2,236	4,459	6,695	2,236	4,459	6,695
1983	126	74	200	7,137	4,156	11,293	7,264	4,229	11,493
1984	80	920	1,000	406	4,669	5,075	486	5,589	6,075
1985	15	205	220	509	6,970	7,479	524	7,175	7,699
1986	N.E.	N.E.	N.E.	1,232	1,774	3,006	1,232	1,774	3,006
1987	N.E.	N.E.	N.E.	866	154	1,020	866	154	1,020
1988	30	70	100	113	271	384	143	341	484
1989	N.E.	N.E.	N.E.	155	245	400	155	245	400
1990	N.E.	N.E.	N.E.	94	269	363	94	269	363
1991	N.E.	N.E.	N.E.	64	346	410	64	346	410
Average	147	617	764	706	1,847	2,553	806	2,226	3,072

APPENDIX 5. **Estimates of naturally spawning spring-run chinook salmon in tributaries of the Sacramento River, excluding the Feather River, 1967 through 1991 (N.E. = No Estimate).**

Year	Sacramento River			Mill Creek			Deer Creek			Butte Creek			Spring-run Totals		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	11,31	12,20	23,514	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	87	93	180	11,39	12,29	23,694
1968	3,255	11,60	14,864	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	61	219	280	3,317	11,82	15,144
1969	2,757	23,74	26,505	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	86	744	830	2,843	24,49	27,335
1970	698	2,954	3,652	287	1,214	1,500	382	1,618	2,000	54	231	285	1,420	6,017	7,437
1971	1,632	4,198	5,830	280	720	1,000	420	1,080	1,500	132	338	470	2,464	6,336	8,800
1972	1,175	6,171	7,346	80	420	500	64	336	400	24	126	150	1,343	7,053	8,396
1973	1,374	6,388	7,762	301	1,399	1,700	354	1,646	2,000	53	247	300	2,082	9,680	11,762
1974	1,235	2,698	3,933	471	1,029	1,500	785	1,715	2,500	47	103	150	2,538	5,545	8,083
1975	3,521	7,182	10,703	1,15	2,349	3,500	2,797	5,704	8,500	214	436	650	7,683	15,67	23,353
1976	4,053	21,93	25,983	N.E.	N.E.	N.E.	7	37	44	7	39	46	4,067	22,00	26,073
1977	5,382	8,348	13,730	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	39	61	100	5,421	8,409	13,830
1978	791	5,112	5,903	124	801	925	161	1,039	1,200	17	111	128	1,093	7,063	8,156
1979	705	2,195	2,900	N.E.	N.E.	N.E.	N.E.	N.E.	N.E.	2	8	10	707	2,203	2,910
1980	3,064	6,632	9,696	158	342	500	474	1,026	1,500	38	81	119	3,734	8,081	11,815
1981	8,137	12,88	21,025	6	9	15	10	15	25	97	153	250	8,249	13,06	21,315
1982	4,055	19,38	23,438	121	579	700	260	1,241	1,500	92	442	534	4,528	21,64	26,172
1983	590	3,341	3,931	N.E.	N.E.	N.E.	75	425	500	8	43	50	672	3,809	4,481
1984	4,261	3,886	8,147	100	91	191	N.E.	N.E.	N.E.	12	11	23	4,373	3,988	8,361
1985	3,568	7,179	10,747	40	81	121	100	201	301	84	170	254	3,792	7,631	11,423
1986	1,419	15,27	16,691	25	266	291	46	497	543	117	1254	1371	1,606	17,29	18,896
1987	4,067	7,137	11,204	32	57	89	73	127	200	5	9	14	4,177	7,330	11,507
1988	1,790	7,991	9,781	105	467	572	N.E.	N.E.	N.E.	238	1062	1300	2,132	9,521	11,653
1989	646	4,609	5,255	68	488	556	9	68	77	160	1140	1300	884	6,304	7,188
1990	698	3,224	3,922	150	694	844	82	376	458	18	82	100	948	4,376	5,324
1991	204	569	773	84	235	319	119	330	449	26	74	100	433	1,208	1,641
Average	2,815	8,274	11,089	199	624	824	345	971	1,317	69	291	360	3,276	9,714	12,990

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 1 of 6).

CHINOOK SALMON LANDINGS (STATEWIDE)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	4,333	13,464	6,259	5,912	5,835	10,616	10,879	8,315	5,552	1,401	72,566
1968	7,523	12,139	7,233	7,661	12,018	24,396	39,508	25,850	10,001	7,914	154,244
1969	10,097	20,326	10,654	8,439	16,296	30,664	27,745	13,896	12,229	5,414	155,768
1970	6,251	8,823	7,907	10,725	20,132	32,731	36,533	16,423	7,113	1,161	147,800
1971	11,622	39,387	14,473	10,314	14,396	32,217	40,963	11,070	9,153	4,676	188,271
1972	33,183	30,925	15,870	9,099	21,525	31,315	26,550	21,485	9,443	1,127	200,522
1973	6,837	16,300	20,595	13,709	21,308	51,563	30,186	18,338	12,826	6,291	197,953
1974	15,734	40,670	18,904	9,004	18,080	23,425	15,678	7,607	6,802	1,561	157,465
1975	18,791	4,661	13,451	10,804	11,142	15,532	13,574	6,405	5,758	3,616	103,734
1976	2,686	1,221	6,634	13,031	14,125	11,813	12,619	5,654	10,616	2,594	80,993
1977	4,096	5,510	15,525	5,038	9,450	35,221	14,783	8,406	4,063	1,492	103,585
1978	9,790	8,594	3,149	2,899	9,066	15,050	9,001	4,925	7,642	2,606	72,722
1979	7,876	15,161	11,597	5,219	16,617	28,382	14,353	13,456	6,967	0	119,628
1980	4,703	12,033	6,671	5,807	18,229	19,379	8,911	5,404	4,048	0	85,185
1981	3,393	3,141	8,471	3,372	10,649	23,703	16,074	8,912	4,993	1,319	84,027
1982	11,187	11,379	5,052	7,406	15,911	24,307	31,220	15,112	13,952	3,198	138,724
1983	2,627	3,080	4,790	11,389	12,427	15,104	8,189	4,550	1,610	56	63,822
1984	392	758	5,932	7,434	17,264	26,585	18,901	7,461	2,317	759	87,803
1985	12,134	17,970	11,950	17,575	28,587	45,422	23,552	7,302	4,898	1,719	171,109
1986	1,183	16,091	23,458	9,528	24,729	37,415	21,386	5,280	1,962	584	141,616
1987	5,520	14,084	19,211	12,368	23,113	51,041	44,051	14,946	7,126	1,083	192,543
1988	6,808	15,934	24,943	20,482	38,219	43,329	12,190	4,032	4,610	814	171,361
1989	7,950	12,734	42,566	8,554	27,839	48,712	19,748	12,370	3,744	2,410	186,627
1990	6,690	17,599	21,645	6,088	28,109	34,015	15,185	5,039	3,756	1,703	139,829
1991	0	8,001	13,029	4,825	19,906	25,123	5,742	1,952	2,232	23	80,833
Average	8,056	13,999	13,599	9,067	18,199	29,482	20,701	10,168	6,537	2,141	131,949

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 2 of 6).

CHINOOK SALMON LANDINGS (CRESCENT CITY)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	0	0	0	1	25	379	258	7	0	0	670
1968	0	0	0	0	9	188	183	24	0	0	404
1969	0	0	0	0	68	2,490	354	4	0	0	2,916
1970	0	0	0	0	52	165	630	0	0	0	847
1971	0	1	0	0	357	689	435	38	0	0	1,520
1972	0	0	0	0	191	373	601	9	0	0	1,174
1973	0	0	0	0	1,158	2,134	839	36	0	0	4,167
1974	0	0	0	4	98	1,088	1,237	81	0	0	2,508
1975	0	0	0	0	327	922	146	0	0	0	1,395
1976	0	0	0	0	0	1,154	1,579	264	0	0	2,991
1977	0	0	0	0	307	4,966	2,127	0	0	0	7,400
1978	0	0	0	7	417	701	861	0	0	0	1,986
1979	0	0	0	3	563	1,124	1,189	0	0	0	2,879
1980	0	0	0	1	1,061	834	682	140	0	0	2,718
1981	0	0	0	7	589	1,178	2,233	0	0	0	4,007
1982	0	0	0	4	614	2,258	3,181	139	0	0	6,196
1983	0	0	0	0	1,338	1,400	633	74	0	0	3,445
1984	0	0	0	11	33	1,841	1,617	21	0	0	3,523
1985	0	0	0	2,462	4,619	8,857	1,961	90	0	0	17,989
1986	0	0	0	270	1,555	2,624	1,296	15	0	0	5,760
1987	0	0	0	259	3,745	4,294	2,286	1,476	0	0	12,060
1988	0	0	0	1,006	7,418	7,560	1,241	11	0	0	17,236
1989	0	0	0	417	3,589	17,990	3,227	52	0	0	25,275
1990	0	0	0	118	6,451	5,975	151	22	0	0	12,717
1991	0	0	0	7	1,321	1,943	35	61	0	0	3,367
Average	0	0	0	183	1,436	2,925	1,159	103	0	0	5,806

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 3 of 6).

CHINOOK SALMON LANDINGS (EUREKA)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	0	0	0	29	276	1,661	1,182	17	0	0	3,165
1968	0	0	0	34	249	1,415	592	25	0	0	2,315
1969	0	0	5	46	1,448	9,135	9,716	274	14	0	20,638
1970	0	0	64	166	5,369	12,102	13,248	1,523	52	0	32,524
1971	0	0	20	80	4,960	9,205	3,620	160	6	0	18,051
1972	0	2	2	119	1,269	3,703	1,579	205	3	0	6,882
1973	0	0	0	122	1,776	3,692	1,678	315	1	0	7,584
1974	0	0	3	167	2,068	4,342	1,765	741	13	0	9,099
1975	0	0	0	205	2,697	4,233	679	7	0	0	7,821
1976	0	0	0	15	3,698	2,460	819	119	0	0	7,111
1977	0	0	0	768	309	10,141	1,991	52	0	0	13,261
1978	0	0	0	0	713	1,117	478	0	0	0	2,308
1979	0	0	1	8	721	1,955	891	50	21	0	3,647
1980	0	0	0	2	795	2,607	584	58	0	0	4,046
1981	0	0	0	5	268	2,474	1,653	6	0	0	4,406
1982	0	0	0	0	3,802	2,780	483	19	0	0	7,084
1983	0	0	0	3	2,059	2,770	510	108	34	0	5,484
1984	0	0	0	8	95	3,840	588	75	5	0	4,611
1985	0	0	5	6,404	4,905	12,772	2,142	156	0	0	26,384
1986	0	0	0	477	2,590	3,278	4,090	24	0	0	10,459
1987	0	0	0	1,139	3,706	6,490	6,500	601	0	0	18,436
1988	0	0	0	572	5,689	7,018	904	162	0	0	14,345
1989	0	0	0	1,645	7,503	12,195	3,200	99	0	0	24,642
1990	0	0	0	931	5,140	4,631	374	33	0	0	11,109
1991	0	0	0	57	6,382	2,788	13	267	1	0	9,508
Average	0	0	4	520	2,739	5,152	2,371	204	6	0	10,997

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 4 of 6).

CHINOOK SALMON LANDINGS (FORT BRAGG)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	0	0	0	0	3	659	1,501	415	0	0	2,578
1968	0	2	2	19	207	1,280	939	163	11	0	2,623
1969	0	0	6	0	586	2,004	1,013	344	6	1	3,960
1970	0	0	0	246	412	1,243	1,146	242	2	0	3,291
1971	0	0	2	14	272	914	1,087	84	0	0	2,373
1972	0	4	26	260	1,034	3,195	337	18	0	0	4,874
1973	0	8	6	110	1,455	3,407	308	4	1	0	5,299
1974	0	0	4	12	292	1,941	1,981	38	0	0	4,268
1975	0	0	0	57	351	922	390	104	0	0	1,824
1976	0	0	0	18	287	1,469	543	6	1	0	2,324
1977	0	0	0	11	41	2,168	3,698	405	0	0	6,323
1978	0	0	1	15	616	1,386	516	0	0	0	2,534
1979	0	0	0	0	564	2,877	1,110	75	0	0	4,626
1980	0	0	1	51	328	721	194	13	0	0	1,308
1981	0	0	5	37	434	1,006	290	10	5	0	1,787
1982	0	0	0	62	843	1,319	709	15	0	0	2,948
1983	0	0	0	12	747	931	232	11	0	0	1,933
1984	0	0	1	3	251	594	143	7	0	0	999
1985	0	0	1	33	806	3,913	221	10	1	0	4,985
1986	0	0	8	170	3,227	6,399	780	0	0	0	10,584
1987	0	4	45	253	2,359	5,208	1,115	217	0	0	9,201
1988	0	0	311	1,110	3,431	3,799	707	48	0	0	9,406
1989	0	0	58	182	2,527	2,409	579	36	12	0	5,803
1990	0	0	1	84	1,588	1,472	191	52	0	0	3,388
1991	0	0	6	156	1,629	3,580	467	16	0	0	5,854
Average	0	1	19	117	972	2,193	808	93	2	0	4,204

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 5 of 6).

CHINOOK SALMON LANDINGS (SAN FRANCISCO)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	4,211	12,821	5,983	3,678	4,045	6,011	7,126	7,763	5,496	1,369	58,503
1968	6,643	8,922	3,437	4,690	9,022	18,572	34,853	22,828	8,360	6,479	123,807
1969	9,455	17,108	8,152	6,942	12,453	14,861	14,879	12,758	11,831	5,070	113,517
1970	6,017	8,038	6,775	9,064	11,583	16,599	18,695	13,671	5,909	949	97,300
1971	8,973	36,964	12,124	8,280	7,716	20,086	34,171	9,882	4,907	2,776	145,879
1972	31,737	29,611	14,323	7,613	17,734	22,191	23,029	20,199	9,039	1,027	176,503
1973	6,225	14,914	18,861	12,610	16,056	37,731	26,154	17,450	11,678	5,338	167,017
1974	15,025	38,079	18,516	7,667	9,998	15,276	10,632	6,725	6,779	1,545	130,242
1975	17,858	3,561	11,880	9,908	6,982	7,452	11,895	6,262	5,655	3,524	84,977
1976	2,257	929	6,023	12,021	9,155	5,594	9,497	5,232	10,505	2,547	63,760
1977	3,737	4,389	14,178	3,541	8,649	17,802	6,899	7,866	4,045	1,488	72,595
1978	9,622	8,336	2,850	2,638	6,760	11,626	7,106	4,916	7,628	2,603	64,085
1979	6,829	13,752	8,538	5,095	14,735	22,273	11,080	13,300	6,945	0	102,547
1980	4,243	11,530	5,525	5,521	15,110	14,685	7,367	5,146	3,966	0	73,093
1981	2,971	2,507	6,806	3,239	9,327	18,593	11,713	8,882	4,937	1,109	70,084
1982	10,527	10,123	2,999	7,056	10,251	17,480	26,460	14,871	13,945	3,198	116,910
1983	2,332	3,000	3,812	10,325	7,928	9,571	6,785	4,347	1,561	56	49,717
1984	377	683	3,222	6,766	16,209	19,227	16,345	7,352	2,297	755	73,233
1985	10,486	12,784	10,688	8,519	18,017	19,475	18,857	7,033	4,897	1,719	112,475
1986	1,048	12,251	11,395	7,296	13,397	19,747	14,022	4,874	1,650	575	86,255
1987	3,801	7,390	16,763	9,307	9,849	22,360	29,666	12,261	7,052	1,077	119,526
1988	5,324	13,696	20,767	15,896	18,773	21,659	9,110	3,806	4,610	814	114,455
1989	7,321	8,234	20,365	4,803	12,260	11,424	10,974	12,158	3,716	2,404	93,659
1990	5,058	13,309	15,075	4,273	6,580	10,646	13,625	4,883	3,513	600	77,562
1991	0	3,220	6,079	3,733	6,838	9,962	4,869	1,523	1,027	23	37,274
Average	7,283	11,846	10,205	7,219	11,177	16,436	15,432	9,440	6,078	1,882	96,999

APPENDIX 6. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Recreational Fishery by Area and Month, 1967–1991 (Sheet 6 of 6).

CHINOOK SALMON LANDINGS (MONTEREY)

YEAR	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1967	122	643	276	2,204	1,486	1,906	812	113	56	32	7,650
1968	880	3,215	3,794	2,918	2,531	2,941	2,941	2,810	1,630	1,435	25,095
1969	642	3,218	2,491	1,451	1,741	2,174	1,783	516	378	343	14,737
1970	234	785	1,068	1,249	2,716	2,622	2,814	987	1,150	212	13,838
1971	2,649	2,422	2,327	1,940	1,091	1,323	1,650	906	4,240	1,900	20,448
1972	1,446	1,308	1,519	1,107	1,297	1,853	1,004	1,054	401	100	11,089
1973	612	1,378	1,728	867	863	4,599	1,207	533	1,146	953	13,886
1974	709	2,591	381	1,154	5,624	778	63	22	10	16	11,348
1975	933	1,100	1,571	634	785	2,003	464	32	103	92	7,717
1976	429	292	611	977	985	1,136	187	33	110	47	4,807
1977	359	1,121	1,347	718	144	144	68	83	18	4	4,006
1978	168	258	298	239	560	220	40	9	14	3	1,809
1979	1,047	1,409	3,058	113	34	153	83	31	1	0	5,929
1980	460	503	1,145	232	935	532	84	47	82	0	4,020
1981	422	634	1,660	84	31	452	185	14	51	210	3,743
1982	660	1,256	2,053	284	401	470	387	68	7	0	5,586
1983	295	80	978	1,049	355	432	29	10	15	0	3,243
1984	15	75	2,709	646	676	1,083	208	6	15	4	5,437
1985	1,648	5,186	1,256	157	240	405	371	13	0	0	9,276
1986	135	3,840	12,055	1,315	3,960	5,367	1,198	367	312	9	28,558
1987	1,719	6,690	2,403	1,410	3,454	12,689	4,484	391	74	6	33,320
1988	1,484	2,238	3,865	1,898	2,908	3,293	228	5	0	0	15,919
1989	629	4,500	22,143	1,507	1,960	4,694	1,768	25	16	6	37,248
1990	1,632	4,290	6,569	682	8,350	11,291	844	49	243	1,103	35,053
1991	0	4,781	6,944	872	3,736	6,850	358	85	1,204	0	24,830
Average	773	2,153	3,370	1,028	1,875	2,776	930	328	451	259	13,944

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 1 of 6).

CHINOOK SALMON LANDINGS (STATEWIDE)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	49,077	118,813	72,262	49,922	37,740	10,070	0	337,884
1968	34,520	114,743	126,382	112,612	66,192	17,560	0	472,009
1969	69,094	154,314	105,714	141,550	54,858	25,893	0	551,423
1970	28,434	128,466	144,528	98,587	83,006	33,627	0	516,648
1971	327	88,515	149,567	127,705	55,138	12,675	0	433,927
1972	321	172,198	139,402	101,736	62,277	16,269	0	492,203
1973	60,072	224,396	212,478	192,245	79,673	48,104	0	816,968
1974	88,784	117,553	120,538	93,285	51,134	20,268	0	491,562
1975	44,452	138,455	148,075	160,738	56,117	30,872	0	578,709
1976	56,694	144,286	132,359	149,387	36,794	20,410	0	539,930
1977	82,641	169,527	101,533	140,548	78,189	27,747	0	600,185
1978	31,522	231,946	218,193	101,789	33,940	20,268	0	637,658
1979	38	220,130	94,688	217,652	135,674	58,578	0	726,760
1980	0	234,283	0	257,386	54,963	42,018	0	588,650
1981	0	202,939	59,062	175,247	111,191	39,620	0	588,059
1982	59,844	201,249	84,193	247,387	139,373	33,114	0	765,160
1983	2,187	93,452	84,076	83,615	26,841	3,812	0	293,983
1984	0	32,854	57,516	113,257	74,088	22,044	0	299,759
1985	0	92,449	88,766	106,144	59,166	19,773	0	366,298
1986	0	223,621	293,200	215,133	84,533	9,101	0	825,588
1987	0	264,923	301,634	205,405	84,142	20,230	0	876,334
1988	0	390,784	382,786	370,942	111,881	60,814	0	1,317,207
1989	0	176,152	137,583	112,466	80,514	23,317	906	530,938
1990	0	145,197	173,971	71,743	25,384	7,099	53	423,447
1991	0	80,061	87,080	49,660	65,551	12,134	379	294,865
Average	24,320	166,452	140,623	147,846	69,934	25,417	54	574,646

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 2 of 6).

CHINOOK SALMON LANDINGS (CRESCENT CITY)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	4,261	19,012	9,670	8,190	1,749	208	0	43,090
1968	140	9,599	8,366	8,742	2,578	46	0	29,471
1969	565	6,066	8,414	4,859	2,430	399	0	22,733
1970	684	2,171	31,969	4,519	6,219	618	0	46,180
1971	0	6,268	39,336	7,218	1,455	143	0	54,420
1972	0	18,777	14,994	3,775	1,266	259	0	39,071
1973	244	10,369	5,912	8,699	492	192	0	25,908
1974	573	7,621	10,135	4,158	1,675	148	0	24,310
1975	63	3,032	3,677	25,374	1,007	1,511	0	34,664
1976	55	4,129	9,894	2,977	3,382	534	0	20,971
1977	556	12,608	5,836	8,950	7,098	1,237	0	36,285
1978	1,053	25,472	28,342	2,438	1,649	682	0	59,636
1979	0	11,464	11,043	32,189	15,321	1,766	0	71,783
1980	0	16,919	0	4,849	5,277	5,577	0	32,622
1981	0	27,868	2,676	6,623	31,230	13,424	0	81,821
1982	0	9,725	8,084	18,780	33,044	3,684	0	73,317
1983	0	2,619	15,909	4,094	2,064	0	0	24,686
1984	0	2,872	768	5,869	4,860	0	0	14,369
1985	0	0	0	0	0	0	0	0
1986	0	208	4,598	2,823	5,584	763	0	13,976
1987	0	781	29,165	3,211	0	378	0	33,535
1988	0	727	13,770	0	0	1,122	0	15,619
1989	0	392	4,447	0	631	0	0	5,470
1990	0	0	0	0	1,386	0	0	1,386
1991	0	0	0	0	0	0	0	0
Average	328	7,948	10,680	6,733	5,216	1,308	0	32,213

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 3 of 6).

CHINOOK SALMON LANDINGS (EUREKA)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	29,507	64,429	32,552	7,906	2,642	791	0	137,827
1968	7,212	61,163	32,417	8,386	6,433	69	0	115,680
1969	12,189	52,479	18,631	26,064	17,663	1,074	0	128,100
1970	10,876	56,786	28,249	28,607	24,757	5,221	0	154,496
1971	1	32,275	58,169	41,710	7,166	1,128	0	140,449
1972	20	54,398	36,135	15,407	2,123	281	0	108,364
1973	7,353	100,118	55,048	30,014	1,103	475	0	194,111
1974	7,077	45,988	20,177	8,416	2,322	462	0	84,442
1975	3,483	51,023	61,716	64,958	1,371	780	0	183,331
1976	2,608	53,950	40,957	65,896	1,040	968	0	165,419
1977	22,112	56,224	32,448	40,810	9,029	552	0	161,175
1978	7,734	88,448	46,945	10,305	1,279	457	0	155,168
1979	0	101,380	22,598	35,614	42,898	15,873	0	218,363
1980	0	89,492	0	20,264	10,846	10,681	0	131,283
1981	0	49,196	4,149	10,845	28,315	7,204	0	99,709
1982	0	39,618	9,364	24,348	15,952	6,372	0	95,654
1983	0	9,292	16,381	5,841	3,663	0	0	35,177
1984	0	6,203	296	4,703	2,777	0	0	13,979
1985	0	0	0	0	0	0	0	0
1986	0	0	15,813	4,316	13,803	2,806	0	36,738
1987	0	0	50,279	0	0	4,458	0	54,737
1988	0	0	28,795	0	0	17,619	0	46,414
1989	0	0	9,831	0	2,028	4,702	906	17,467
1990	0	0	0	0	4,349	1,887	53	6,289
1991	0	0	0	0	0	4,319	379	4,698
Average	4,407	40,498	24,838	18,176	8,062	3,527	54	99,563

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 4 of 6).

CHINOOK SALMON LANDINGS (FORT BRAGG)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	3,122	12,755	3,872	19,273	27,558	3,305	0	69,885
1968	1,172	4,322	27,357	37,706	23,461	6,632	0	100,650
1969	6,013	18,031	15,312	49,471	16,710	14,691	0	120,228
1970	2,020	11,922	28,059	21,348	21,642	4,152	0	89,143
1971	0	18,134	25,185	32,145	12,160	735	0	88,359
1972	0	30,145	28,839	43,572	10,808	1,608	0	114,972
1973	2,323	18,182	74,387	73,700	3,854	1,808	0	174,254
1974	4,047	9,590	29,329	38,795	17,066	1,303	0	100,130
1975	2,927	11,904	51,606	42,961	11,229	5,726	0	126,353
1976	1,844	13,928	31,835	53,992	9,906	4,178	0	115,683
1977	2,943	28,357	19,284	33,689	40,283	14,330	0	138,886
1978	1,916	30,980	45,602	34,587	12,330	6,439	0	131,854
1979	2	30,367	7,789	80,180	57,586	26,543	0	202,467
1980	0	20,268	0	82,602	14,102	13,471	0	130,443
1981	0	22,485	31,675	36,661	19,081	6,722	0	116,624
1982	7,701	25,005	19,140	100,081	17,822	8,001	0	177,750
1983	0	8,238	21,764	18,124	7,620	140	0	55,886
1984	0	4,438	3,579	24,292	4,118	13,324	0	49,751
1985	0	17,269	29,524	65,724	35,816	5,647	0	153,980
1986	0	57,019	96,525	90,197	28,104	574	0	272,418
1987	0	71,544	89,448	127,588	49,204	3,432	0	341,216
1988	0	91,548	110,116	157,350	52,196	13,453	0	424,663
1989	0	7,445	20,453	64,369	46,334	5,628	0	144,229
1990	0	6,782	45,549	19,802	5,030	2,390	0	79,553
1991	0	0	0	0	34,271	1,267	0	35,538
Average	1,441	22,826	34,249	53,928	23,132	6,620	0	142,197

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 5 of 6).

CHINOOK SALMON LANDINGS (SAN FRANCISCO)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	11,228	17,546	20,756	13,229	3,386	3,388	0	69,533
1968	12,870	31,925	47,886	47,268	24,272	3,732	0	167,953
1969	22,459	42,069	47,164	47,752	8,931	8,374	0	176,749
1970	10,102	39,768	44,930	30,079	19,663	18,555	0	163,097
1971	74	22,453	20,215	40,093	33,744	9,176	0	125,755
1972	20	49,156	46,994	36,026	46,236	11,126	0	189,558
1973	31,878	60,368	32,281	35,071	44,994	37,820	0	242,412
1974	62,093	40,603	44,583	35,590	23,977	15,939	0	222,785
1975	27,151	46,642	18,269	19,103	32,109	17,160	0	160,434
1976	28,918	42,226	31,434	17,022	8,195	10,436	0	138,231
1977	41,645	47,678	28,007	45,951	13,501	8,382	0	185,164
1978	10,219	50,900	46,294	31,019	11,493	8,233	0	158,158
1979	36	52,402	42,723	57,344	15,096	12,486	0	180,087
1980	0	75,287	0	115,499	12,343	8,649	0	211,778
1981	0	49,499	15,908	96,108	26,918	11,477	0	199,910
1982	22,944	86,013	27,919	74,276	58,215	12,394	0	281,761
1983	763	30,087	5,394	25,274	10,025	3,476	0	75,019
1984	0	2,642	26,439	71,452	58,590	8,545	0	167,668
1985	0	54,983	50,384	35,644	22,455	12,215	0	175,681
1986	0	72,877	119,597	79,771	26,983	3,074	0	302,302
1987	0	157,648	110,099	49,824	28,544	9,500	0	355,615
1988	0	220,664	173,728	175,382	47,103	25,816	0	642,693
1989	0	121,304	77,751	25,550	20,889	10,323	0	255,817
1990	0	84,317	78,515	25,545	9,233	1,537	0	199,147
1991	0	58,309	52,152	30,522	28,311	5,537	0	174,831
Average	11,296	62,295	48,377	50,416	25,408	11,094	0	208,886

APPENDIX 7. Chinook Salmon Landings (Numbers of Fish) in the California Ocean Commercial Fishery by Area and Month, 1967–1991 (Sheet 6 of 6).

CHINOOK SALMON LANDINGS (MONTEREY)

YEAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
1967	959	5,071	5,412	1,324	2,405	2,378	0	17,549
1968	13,126	7,734	10,356	10,510	9,448	7,081	0	58,255
1969	27,868	35,669	16,193	13,404	9,124	1,355	0	103,613
1970	4,752	17,819	11,321	14,034	10,725	5,081	0	63,732
1971	252	9,385	6,662	6,539	613	1,493	0	24,944
1972	281	19,722	12,440	2,956	1,844	2,995	0	40,238
1973	18,274	35,359	44,850	44,761	29,230	7,809	0	180,283
1974	14,994	13,751	16,314	6,326	6,094	2,416	0	59,895
1975	10,828	25,854	12,807	8,342	10,401	5,695	0	73,927
1976	23,269	30,053	18,239	9,500	14,271	4,294	0	99,626
1977	15,385	24,660	15,958	11,148	8,278	3,246	0	78,675
1978	10,600	36,146	51,010	23,440	7,189	4,457	0	132,842
1979	0	24,517	10,535	12,325	4,773	1,910	0	54,060
1980	0	32,317	0	34,172	12,395	3,640	0	82,524
1981	0	53,891	4,654	25,010	5,647	793	0	89,995
1982	29,199	40,888	19,686	29,902	14,340	2,663	0	136,678
1983	1,424	43,216	24,628	30,282	3,469	196	0	103,215
1984	0	16,699	26,434	6,941	3,743	175	0	53,992
1985	0	20,197	8,858	4,776	895	1,911	0	36,637
1986	0	93,517	56,667	38,026	10,060	1,884	0	200,154
1987	0	34,950	22,643	24,782	6,394	2,462	0	91,231
1988	0	77,845	56,377	38,210	12,582	2,804	0	187,818
1989	0	47,011	25,101	22,547	10,632	2,664	0	107,955
1990	0	54,098	49,907	26,396	5,386	1,285	0	137,072
1991	0	21,752	34,928	19,138	2,969	1,011	0	79,798
Average	6,848	32,885	22,479	18,592	8,116	2,868	0	91,788

APPENDIX 8. **Returns of fall-run chinook salmon to hatchery facilities operated in the Sacramento Valley during 1967 through 1991.**

Year	Coleman National Fish Hatchery			Feather River Hatchery			Nimbus Hatchery			Sacramento Valley Totals		
	grilse	adults	total	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	1,339	6,101	7,440	1,186	670	1,856	731	4,416	5,147	3,256	11,187	14,443
1968	585	5,770	6,355	1,938	4,006	5,944	1,177	4,056	5,233	3,700	13,832	17,532
1969	441	3,237	3,678	1,668	2,710	4,378	613	2,992	3,605	2,722	8,939	11,661
1970	1,011	5,345	6,356	882	2,473	3,355	768	7,861	8,629	2,661	15,679	18,340
1971	860	2,785	3,645	1,030	2,511	3,541	1,405	8,705	10,110	3,296	14,000	17,296
1972	1,140	2,081	3,221	2,021	1,614	3,635	1,641	5,401	7,042	4,802	9,096	13,898
1973	1,303	3,237	4,540	1,289	7,188	8,477	1,680	10,855	12,535	4,271	21,281	25,552
1974	592	2,444	3,036	1,249	5,397	6,646	672	7,528	8,200	2,514	15,368	17,882
1975	815	2,497	3,312	1,000	4,265	5,265	845	6,567	7,412	2,660	13,329	15,989
1976	658	3,788	4,446	496	2,702	3,198	892	4,323	5,215	2,045	10,814	12,859
1977	1,105	4,531	5,636	492	8,292	8,784	501	6,367	6,868	2,098	19,190	21,288
1978	390	1,492	1,882	880	3,879	4,759	2,049	6,113	8,162	3,319	11,484	14,803
1979	2,898	5,831	8,729	609	3,481	4,090	3,105	7,246	10,351	6,613	16,557	23,170
1980	2,005	7,498	9,503	465	3,225	3,690	2,036	13,507	15,543	4,506	24,230	28,736
1981	5,210	8,013	13,223	977	7,305	8,282	2,801	17,792	20,593	8,988	33,110	42,098
1982	5,691	14,069	19,760	1,142	6,421	7,563	2,572	8,326	10,898	9,405	28,816	38,221
1983	3,607	5,149	8,756	1,394	6,305	7,699	2,465	6,435	8,900	7,466	17,889	25,355
1984	8,399	13,249	21,648	594	8,694	9,288	1,948	10,301	12,249	10,941	32,244	43,185
1985	3,101	13,219	16,320	198	5,613	5,811	1,309	7,784	9,093	4,608	26,616	31,244
1986	1,423	11,058	12,481	2,491	6,010	8,501	911	4,784	5,695	4,825	21,852	26,677
1987	5,892	10,429	16,321	3,467	6,641	10,108	3,021	3,476	6,497	12,380	20,546	32,926
1988	1,874	11,705	13,579	292	6,188	6,480	664	7,961	8,625	2,830	25,854	28,684
1989	2,433	9,553	11,986	1,099	6,479	7,578	506	9,234	9,740	4,038	25,266	29,304
1990	1,581	13,054	14,635	1,868	4,257	6,125	826	4,031	4,857	4,274	21,343	25,617
1991	1,325	9,358	10,683	1,440	8,918	10,358	356	6,772	7,128	3,121	25,048	28,169
Average	2,354	7,020	9,247	1,207	5,010	6,216	1,420	7,313	8,733	4,981	19,343	24,196

APPENDIX 9. **Returns of fall -run chinook salmon to hatchery facilities on rivers tributary to the Eastside Delta and San Joaquin Basin, 1967 through 1991.**

Year	Mokelumne Hatchery			Merced Hatchery			Eastside and San Joaquin Totals		
	grilse	adults	total	grilse	adults	total	grilse	adults	total
1967	54	196	250	Merced River Hatchery was first operated in the fall of 1970			54	196	250
1968	632	322	954				632	322	954
1969	119	496	615				119	496	615
1970	180	728	908	34	66	100	213	795	1,008
1971	171	1,059	1,230	18	182	200	189	1,241	1,430
1972	38	315	353	19	101	120	57	416	473
1973	58	350	408	80	296	375	137	646	783
1974	134	86	220	71	929	1,000	205	1,015	1,220
1975	250	149	399	85	615	700	336	763	1,099
1976	57	17	74	46	654	700	103	671	774
1977	0	0	0	0	0	0	0	0	0
1978	180	304	484	17	83	100	197	387	584
1979	262	245	507	30	197	227	292	442	734
1980	219	420	639	4	153	157	224	572	796
1981	324	1,062	1,386	266	658	924	590	1,720	2,310
1982	894	1,783	2,677	4	185	189	898	1,968	2,866
1983	2,890	1,683	4,573	1,375	420	1,795	4,265	2,103	6,368
1984	155	804	959	471	1,414	1,885	627	2,217	2,844
1985	39	184	223	88	1,123	1,211	127	1,307	1,434
1986	798	1,115	1,913	45	605	650	843	1,720	2,563
1987	535	95	630	460	498	958	995	593	1,588
1988	35	93	128	32	425	457	66	519	585
1989	31	49	80	16	66	82	47	115	162
1990	43	25	68	12	37	49	55	62	117
1991				9	32	41	9	32	41
Average	352	503	856	152	416	568	470	847	1,317

APPENDIX 10. **Returns of spring-run chinook salmon to Feather River Hatchery and returns of late-fall-run chinook salmon to Coleman National Fish Hatchery during 1967 through 1991.**

Year	Feather River Hatchery Spring-run Chinook Salmon			Coleman National Fish Hatchery Late-fall-run Chinook Salmon		
	grilse	adults	total	grilse	adults	total
1967	3	143	146			
1968	0	216	216			
1969	1	111	112	37	750	787
1970	0	235	235	291	2,769	3,060
1971	0	484	484	192	1,017	1,209
1972	0	256	256	42	507	549
1973	0	205	205	13	390	403
1974	0	198	198	36	669	705
1975	0	691	691	73	1,425	1,498
1976	14	699	713	23	586	609
1977	0	121	121	73	683	756
1978	0	202	202	200	1,653	1,853
1979	0	50	50	4	825	829
1980	0	122	122	63	804	867
1981	113	356	469	274	2,331	2,605
1982	210	1,700	1,910	307	1,579	1,886
1983	72	1,640	1,712	88	870	958
1984	251	1,311	1,562	251	377	628
1985	39	1,593	1,632	85	303	388
1986	191	1,242	1,433	58	730	788
1987	287	926	1,213	43	760	803
1988	280	6,553	6,833	90	367	457
1989	693	4,385	5,078	26	856	882
1990	0	1,306	1,306	43	149	192
1991	155	4,148	4,303	38	241	279
Average	92	1,156	1,248	102	898	1,000