

CASE STUDY REPORT #32 & 33
FOLSOM-NIMBUS
AMERICAN RIVER

I. Project Description

Folsom Dam Project was authorized by the U.S. Congress in 1944 for flood control, hydroelectric power generation and some minor municipal and agricultural uses. The project originally consisted of five facilities: Folsom Dam, Folsom Powerhouse, Folsom Afterbay (Nimbus Dam), Nimbus Powerhouse, and Folsom-Ripon Canal. The Folsom-Ripon system was later constructed as part of the Bureau's Auburn Dam-Folsom South Canal Project. Folsom Afterbay (Nimbus Dam and powerhouse) were the first units constructed by the U.S. Bureau of Reclamation (USBR) in 1955. Folsom Dam and powerhouse were completed in 1956. The Folsom-South Canal was recently constructed. The Folsom Project is located about 25 miles east of the City of Sacramento below the confluence of the North and South Forks of the American River (Figure 1). Folsom Reservoir has a maximum storage capacity of 1,010,000 acre-feet and covers 11,450 acres.

Folsom Afterbay, Nimbus Dam, is 1.5 miles below Folsom Dam, and has a maximum capacity of 8,760 acre-feet and covers 540 acres. This reservoir re-regulates fluctuating power releases from Folsom Dam to provide uniform flows in the Lower American River.

Construction of the Folsom-Nimbus project cut off approximately 85% of the natural American River habitat of

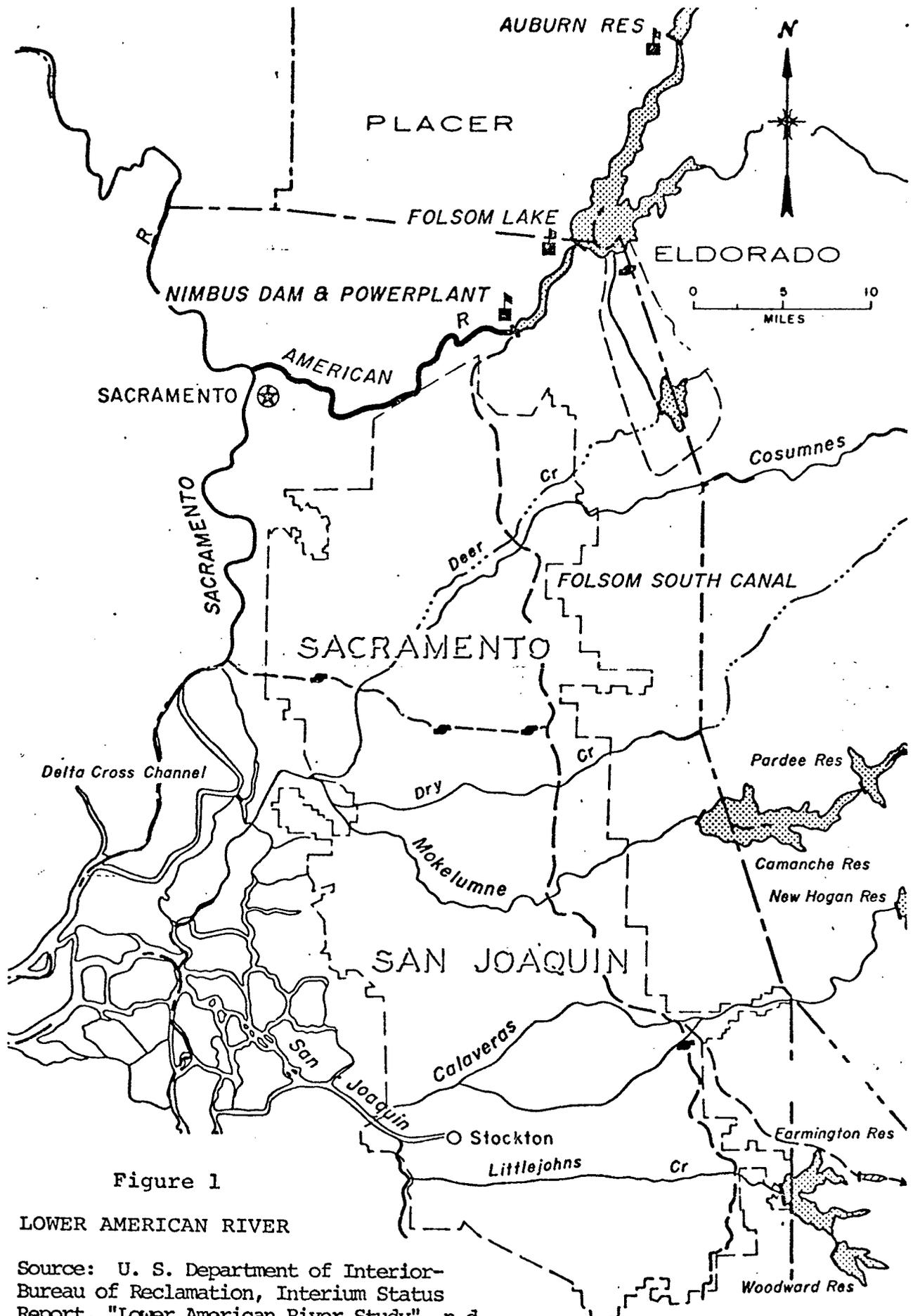


Figure 1

LOWER AMERICAN RIVER

Source: U. S. Department of Interior-
Bureau of Reclamation, Interim Status
Report, "Lower American River Study", n.d.

king salmon and steelhead trout. Nimbus Hatchery was constructed below Nimbus Dam to mitigate for this loss of habitat.

The hatchery was built by the Bureau of Reclamation, which pays the Department of Fish and Game for its cost of operation. The hatchery has a capacity of 30,000,000 salmon eggs. It is presently the only federally built hatchery in California operated by the State. Only salmon and steelhead are propagated at this facility.

II. Pre-Project Condition

The American River watershed includes an estimated 1,875 square miles. Runoff in the American River basin is highly variable (seasonally and from year to year). The average annual runoff, as determined from Fair Oaks gauge records maintained since 1904, is 2,698,500 acre-feet/year. The maximum annual runoff during this same period was 5,773,000 acre-feet in 1911, and the minimum annual runoff was 516,000 acre-feet in 1924. Maximum runoff leaves the drainage as flood crests which at times exceeded 140,000 cfs in the lower American River, by actual record. The USGS has estimated that flood crests as high as 280,000 cfs occurred prior to the 1904 period of record. In contrast to the floods, the minimum river discharge was occasionally less than 10 cfs. The minimum daily discharge of record at Fair Oaks, California was 4.6 cfs in 1924.

Maximum runoff usually occurred in late winter and early spring when warm rains and rapidly melting snow packs combined to cause floods. River flows dropped rapidly in June

and continued to decline slowly through September and October and sometimes into November, depending upon the start of winter rains (see Figure 2).

The American River has supported both warm water and cold water species of fish. Native anadromous fish which utilized the American River were king salmon and steelhead trout. After their introduction from the eastern United States, striped bass and American shad began to use the river. A list of species thought to be using the river before the Folsom project is given in Table 1.

Prior to the establishment of any dams on the American River at least 125 miles of streams, including the South, North and Middle Forks of the American River were available to spawning salmon. Upper limits of salmon and steelhead migration were located at Salmon Falls on the South Fork, Euchre Bar on the North Fork and near Duncan Creek on the Middle Fork (Sumner and Smith, 1940). The salmon that used the upper forks of the American River were undoubtedly of the spring race. The fall run salmon traditionally spawned in the lower reaches of the forks and in the main stem of the river. Sumner & Smith estimated that the American River may have supported runs of salmon exceeding 129,000 fish annually before the system was altered by white man.

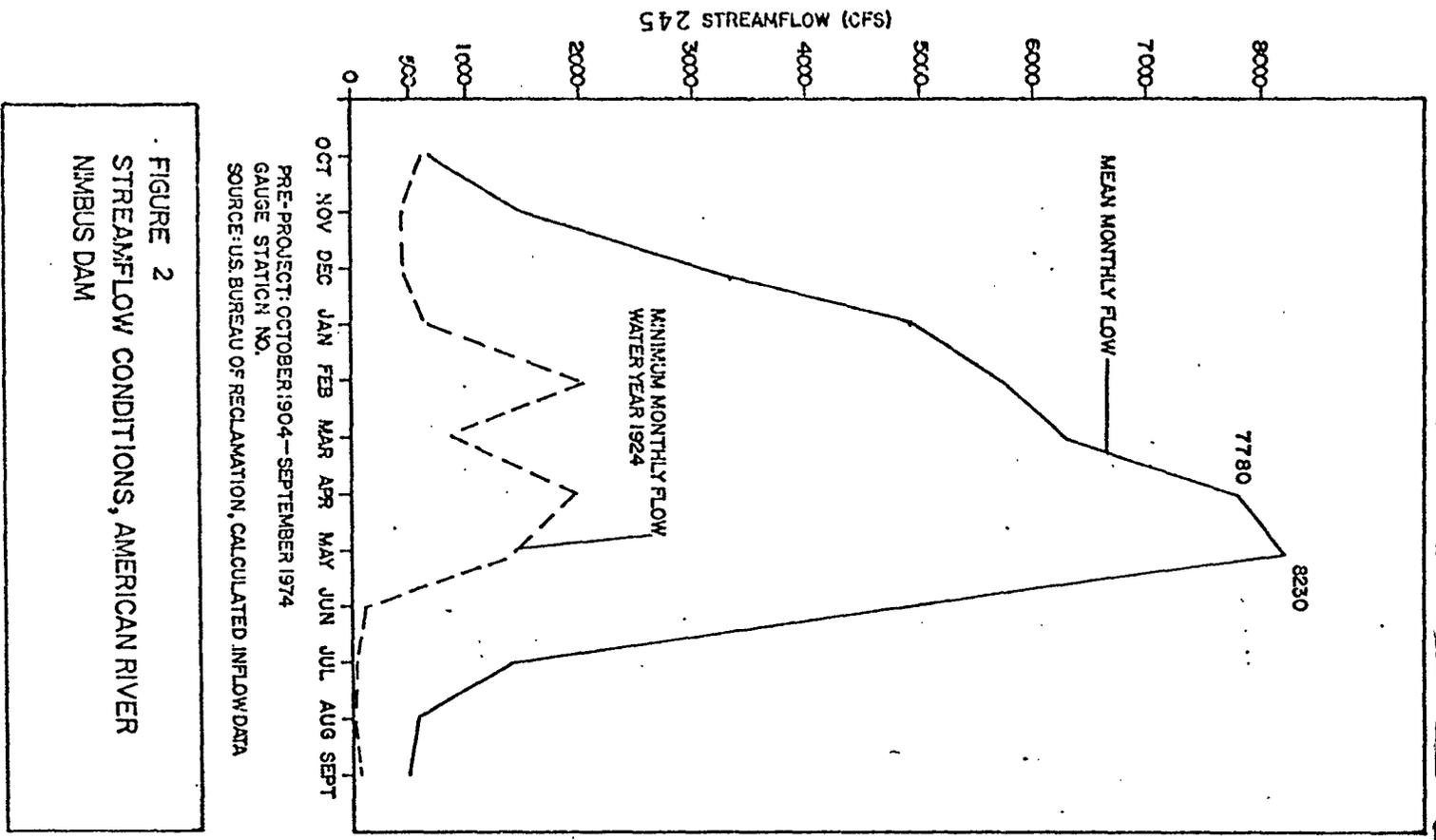


FIGURE 2
STREAMFLOW CONDITIONS, AMERICAN RIVER
NIMBUS DAM

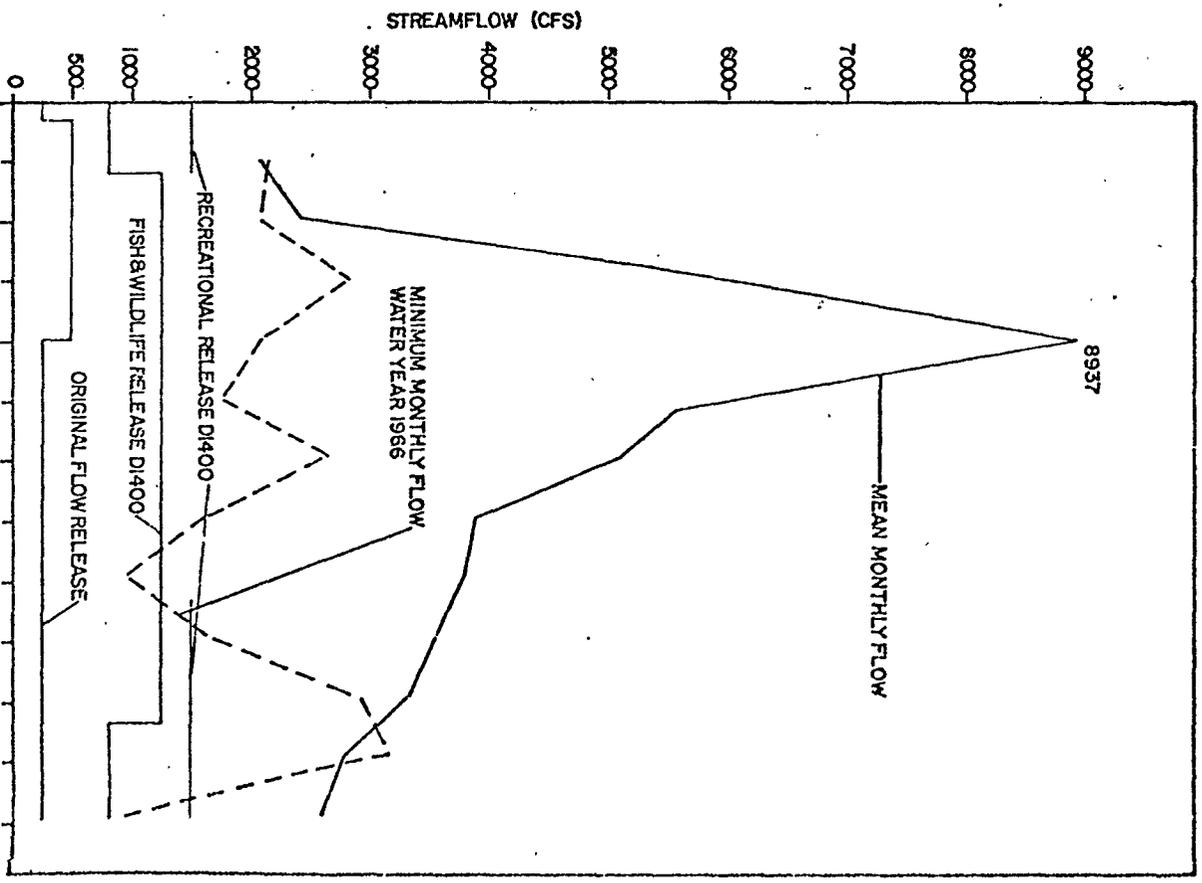


Table 1

FISHES FREQUENTING THE LOWER AMERICAN RIVER

<u>Anadromous Game Fish</u>	
King Salmon - <u>Oncorhynchus tshawytscha</u>	Numerous in fall
Silver Salmon - <u>Oncorhynchus kisutch</u>	Occasional
Pink Salmon - <u>Oncorhynchus gorbusha</u>	Rare
Chum Salmon - <u>Oncorhynchus keta</u>	Rare
White Sturgeon - <u>Acipenser transmontanus</u>	Uncommon
*Striped Bass - <u>Roccus saxatilis</u>	Numerous in summer
*American Shad - <u>Alosa sapidissima</u>	Numerous in spring
Steelhead Rainbow Trout - <u>Salmo gairdneri gairdneri</u>	Numerous
<u>Coldwater Game Fish</u>	
*Kokanee - <u>Oncorhynchus nerka nerka</u>	Numerous above Nimbus- Strays downstream
Rainbow Trout - <u>Salmo gairdneri</u>	Numerous
*Brown Trout - <u>Salmo trutta</u>	Rare
<u>Warmwater Game Fish</u>	
*Largemouth Bass - <u>Micropterus salmoides</u>	Common in backwaters
*Smallmouth Bass - <u>Micropterus dolioleui</u>	Common in backwaters
*Green Sunfish - <u>Lepomis cyanellus</u>	Common in backwaters
*Bluegill - <u>Lepomis machrochirus</u>	Common in backwaters
*Redear sunfish - <u>Lepomis microlophus</u>	Few in backwaters
*White Crappie - <u>Pomoxis annularis</u>	Few in backwaters
Sacramento Perch - <u>Archoplites interruptus</u>	Rare
*Channel Catfish - <u>Ictalurus catus</u>	Uncommon
*White Catfish - <u>Ictalurus catus</u>	Common in backwaters
*Brown Bullhead - <u>Ictalurus catus</u>	Few in backwaters
*Black Bullhead - <u>Ictalurus catus</u>	Few in backwaters
<u>Nongame Fish</u>	
Sacramento western sucker - <u>Castostomus occidentalis</u>	Numerous
*Carp - <u>Cyprinus carpio</u>	Numerous
*Goldfish - <u>Carassius auratus</u>	Numerous
Sacramento blackfish - <u>Orthodon microlepidotus</u>	Uncommon
Hardhead - <u>Mylopharodon conocephalus</u>	Occasional
Sacramento Hitch - <u>Lavinia exilicauda</u>	Occasional
Sacramento Squawfish - <u>Pytocheilus grandis</u>	Numerous
Splittail - <u>Pogonichthys macrolepidotus</u>	Occasional
*Mosquitofish - <u>Gambusia affinis</u>	Numerous in backwaters
Tule Perch - <u>Hysterochampus traskii</u>	Numerous
Riffle Sculpin - <u>Cottus gulosus</u>	Numerous
Pacific Lamprey - <u>Entosphenus tridentatus</u>	Common and anadromous
*Threadfin shad - <u>Dorosoma petenense</u>	Occasional
*Golden Shiner - <u>Notemigonus crysoleucas</u>	Present above Nimbus
*Fathead Minnow - <u>Pimephales promelas</u>	Present above Nimbus
Thicktail Chub - <u>Gila crassicauda</u>	Very rare
Western Roach - <u>Hesperoleucas symmetricus</u>	Uncommon
Sacramento Tui Chub - <u>Siphateles bicolor sp</u>	Uncommon
Speckled Dace - <u>Rhinichthys osculus sp</u>	Uncommon

*Introduced Species

Source: California Department of Fish and Game, 1971.

From 1850 through 1880 hydraulic mining operations on the American River so severely silted the streambed that salmon were nearly eliminated. During this period an estimated 257 million yards of gravel, silt and debris were washed into the American River (Gilbert, 1917). The following narrative is an excerpt from Gerstung (1971) which describes the pre-project salmon resources in the American River.

"In addition to mining pollution, artificial barriers also adversely affected the salmon runs in the American River. In 1895 a 68-foot power dam was erected on the American River at Folsom some 27 miles upstream from the river's confluence with the Sacramento River. A fish ladder was not provided until 1919, and an effective ladder was not constructed until 1931. Salmon were virtually excluded from the forks of the American River for a period of 38 years.

"In 1899 the North Fork Ditch Company built a 16-foot high dam on the North Fork American River several miles downstream from the Middle Fork. A rock chute fishway was added to the dam in 1912, but it proved to be only suitable for the passage of steelhead. The North Fork American River was blocked again in 1939 when the 140-foot high North Fork Debris Dam was constructed two miles above the confluence with the Middle Fork. No salmon run remained in the North Fork.

"Despite past mining pollution and fish passage problems, spring and fall-run salmon began to re-establish themselves in the American River above the Old Folsom Dam during the 1940's. A maximum of 1,138 spring salmon were counted in 1944 and a maximum fall salmon run of 2,246 fish were counted in 1945. Unfortunately, both of these runs were nearly decimated when the Old Folsom Dam fish ladder was destroyed in 1950. The remaining spring salmon runs were completely eliminated during the construction of Folsom and Nimbus Dams.

"Beginning in 1944, annual salmon carcass surveys were conducted on the river each fall. Between 1944 and the construction of Folsom and Nimbus dams in 1955, an estimated average of 26,500 king salmon spawned in the main stem of the American River below Folsom. During this eleven-year period, the salmon runs fluctuated between an estimated range of 12,000 to 38,652 spawners

annually. Approximately 73 percent of these spawners utilized gravels in the five-mile stretch of the American River between Old Folsom Dam and the Nimbus Dam site. The remaining fish spawned on main stem riffles as far downstream as the H Street bridge in Sacramento.

"After completion of the Nimbus Dam in 1955, salmon bound for gravels above Nimbus Dam were routed into Nimbus Salmon Hatchery located immediately below the new dam.

"At the time Nimbus Hatchery was completed in 1955 only a remnant of the fall and winter run steelhead remained. The once abundant summer run had completely disappeared. In 1950 the fish ladder over old Folsom Dam was washed out and summer steelhead no longer had access to the colder waters of the upstream canyons. Between 1944 and 1947 summer steelhead counts ranged between 400 and 1,246 fish. These fish passed through the old Folsom fish ladder during May, June, and July and remained in deep rocky pools until the following spring when they spawned. After 1950 the summer steelhead blocked below Folsom perished in the warm water. The destruction of the Folsom fish ladder also adversely affected fall and winter run steelhead by blocking access to tributary spawning streams above the dam. During the period 1955-1960 an average of only 94 adult steelhead per year entered the hatchery at Nimbus. This very small run was increased by releasing yearling steelhead into the river and by importing additional fall-run stock from the Sacramento River (Coleman Hatchery) and winter run stock from the Eel River."

III. Project Development

After the project was authorized in 1944 and prior to any appropriation for construction it was agreed that the project should be enlarged and built as a multi-purpose project for flood control, irrigation, power and other beneficial uses. The U.S. Corps of Engineers, the Bureau of Reclamation and the state water authorities all agreed that the initial plans for a reservoir of 355,000 acre-feet capacity should be enlarged to provide a reservoir of 1,000,000 acre-feet capacity. The

1,000,000 acre-feet capacity would provide more storage for flood control and would also provide the minimum storage required for irrigation and hydro-electric power generation.

In 1945 the Corps of Engineers and Bureau of Reclamation collaborated in water use studies that supported the desirability of 1,000,000 acre-feet as the capacity of Folsom Dam. Agreement on this enlarged capacity was reached in August 1947 among the U.S. Corps of Engineers, Bureau of Reclamation and the State of California.

The American River Act of October 14, 1949, (63 stat 852) Public Law 356, 81st Congress, authorized the American River Basin development as recommended by the U.S. Corps of Engineers, Bureau of Reclamation and the State of California in 1947.

In anticipation of water development on the American River several studies were undertaken by the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

Spawning gravels in the American River were surveyed by Smith and Payne in 1942, Hallock and Hacker in 1950, and by Slater and Warner in 1952. The 1942 and 1950 surveys involved only rough estimation of gravel riffle areas during a single flow. The 1952 study was more comprehensive and involved a one-mile long test section located 1.5 miles downstream from Fair Oaks bridge. Gravel composition was determined and water depths and surface velocities were recorded at flows of 400, 500, 900, 1100, 1300, 2700, 3400, and 4500 cubic feet per second. Results of this study are now considered invalid by

California Fish and Game since an upper water depth limit for spawning was used and water velocities were not measured near the stream bottom nor were the velocities determined by a current meter.

In 1944 the U.S. Fish and Wildlife Service and California Department of Fish and Game prepared a joint preliminary report which described the fishery resources of California's Central Valley. Proposed water development projects on the American River and their relation to anadromous fishery resources were discussed. The report evaluated previous studies which dealt with the requirements of the anadromous fishery in the lower American River. Osgood and Payne's spawning gravel report of 1942 was the basis for their recommendation of a minimum flow of 250 cfs in the lower American River. This recommendation was deemed sufficient to "accomplish the realization of the full potential value of the salmon crops".

In 1948 the California Department of Fish and Game prepared a report on the American River salmon population. This report, Estimate of the Salmon Runs of the American River, described the salmon run in the lower American River as follows:

"The Department of Fish and Game estimated the salmon population of American River each year of the 4-year period from 1943 to 1946. This was done by trapping and tagging the fall run salmon in the vicinity of Sacramento, then allowing them to proceed upstream and spawn naturally. Spawning grounds below Folsom were then carefully examined at frequent intervals for the tagged fish. From the ratio of tagged to untagged fish observed and recovered, it was possible to calculate the size of the population with greater accuracy than could have been obtained by counting the fish through a weir. It is practically impossible to construct a fish weir across a large river

so that it can be used to count fish during periods of flood. Only at an impassable dam with a fish ladder can counts be made at all times of the year. There is such a dam at Folsom Prison. Counts were made of fish going over its fish ladder, thus eliminating any need for additional surveys of the spawning grounds above Folsom. In 1943, these counts were made by convicts and were unsatisfactory. In 1944, permanent employees of the Department of Fish and Game made the counts and they were satisfactory.

"The figures given below are for the combined spring and fall runs.

	<u>Total Run</u>	<u>Salmon and Steelhead which Passed Dam at Folsom Prison</u>
1943	7,000*	700**
1944	31,000	4,000***
1945	33,000	2,500
1946	39,000	1,700

* Incomplete but probably represents 2/3 of total run.

** Count made in the fall only. This count was made by convicts.

*** Counting by Fish and Game employees started April 14; convicts counted January 20-29. No count January 1-19, January 30-April 13."

Spawning grounds in the American River have been surveyed several times since the late 1920's. The U.S. Fish and Wildlife Service briefly described these studies in their report on the fishery of the American River as related to the development plan. The following is their description of the historic studies:

"Spawning grounds in American River have been surveyed several times since studies of Central Valley salmon resources began. Clark, in Fish Bulletin 17, Department of Fish and Game, mentioned the barriers in American River in 1929. He placed the upstream limit of salmon migration at the Folsom Prison Dam although a fish ladder over that dam was operative. In 1942, Dr. Osgood M. Smith of the U.S. Fish and Wildlife Service, and William Payne of

California Department of Fish and Game surveyed the spawning gravels from Folsom downstream to Sacramento. They estimated the capacity of the river at 32,510 salmon nests. A subsequent survey in 1943 by the California Department of Fish and Game resulted in an estimated capacity of 'a little over 25,000 pairs of fish.' According to the State report of May 1948, the latter estimate is too low. State biologists conclude that between 75,000 and 100,000 salmon could spawn in American River without serious over-crowding. Generally speaking, the survey made by Smith and Payne agrees with the State's latest findings. For each salmon nest, about three and often more salmon are present. The sex ratio in Sacramento River has been close to 2 males to one female for some years. If three salmon were assumed to occupy each of the 32,510 nests found by Smith and Payne, then the capacity of the spawning beds would be 97,530 salmon.

"Resident fish as rainbow trout undoubtedly support a sport fishery in the sections of American River here under consideration. The present lack of knowledge concerning the extent and importance of this fishery dictates that it cannot be given the discussion it merits in this report."

The fishery investigations of the American River did not deal directly with the instream flow requirements of the River. In 1942 the Fish and Wildlife Service recommended the maintenance of a minimum flow of 250 cfs. This recommendation was formulated from information gathered in their survey of salmon spawning in the lower American River (U.S. Fish and Wildlife Service, 1972). However, the report did not evaluate flows other than the minimum requirement. There was no discussion of methods relating to how they arrived at the 250 cfs minimum flow.

The water rights agreement adopted the recommendation of the U.S. Fish and Wildlife Service and the Department of Fish and Game for a minimum instream flow release of 250 cfs from January 1 to September 15 and 500 cfs from September 16 through December 31.

IV. Post-Project

The lower American River contains at least 41 different species of fish. The most common gamefish include king salmon, steelhead trout, striped bass and American shad.

The lower American River receives an average annual run (1955-1974) of 31,000 king salmon. The steelhead run averages 12,000 fish annually. A few silver, pink and chum salmon occasionally stray into the American River; however, their numbers are insignificant.

All of the warmwater game fish in the lower American River, with the exception of the Sacramento perch, were introduced. Nongame fish are primarily: squawfish, carp, hardhead, hitch and Sacramento blackfish. A list of fishes which frequent the lower American River is found in Table 1.

Upon completion of Nimbus Dam in 1955, salmon bound for gravels above Nimbus Dam were routed into Nimbus salmon hatchery located immediately below the new dam.

"Originally a hatchery was proposed to accommodate average runs of 18,864 spawners per year. Females comprising 39.9 percent of this run (7,079) were expected to produce approximately 48,000,000 eggs annually. However, it was agreed that the hatchery would be built to accommodate only 30 million salmon eggs until it was proven that the larger size hatchery was needed. Numbers of salmon entering Nimbus hatchery have averaged 9,824 annually and have ranged from 875 to 29,166 per year. Over one-half of the salmon entering Nimbus hatchery each year are believed to be fish produced by natural river spawning. Most of the hatchery production has been released to the river as 'swim up' fry which generally produce little return. Fingerlings and yearlings produce the bulk of the estimated 2,000 to 4,000 returning adult salmon attributed to the hatchery" (California Department of Fish and Game, 1971).

Protection of fishery resources downstream from the Nimbus Dam was provided for by water releases required within Decision D893 of the State Water Rights Board (1957). This document incorporates an agreement between the California Department of Fish and Game and the U.S. Fish and Wildlife Service which provides stream flow releases at the mouth of the river of 250 cfs between January 1 and September 15 and 500 cfs from September 16 through December 31. During critical dry years fish maintenance releases may be reduced in the same proportions as the respective monthly deficiencies placed upon irrigation deliveries from the project.

A critically dry year is one in which the predicted April 1 to September 30 natural inflow into Folsom Reservoir is less than 600,000 acre-feet.

"This flow schedule was developed by Richard Van Cleave of the California Department of Fish and Game in 1944, and reaffirmed by James Moffet of the U.S. Fish and Wildlife Service in 1948 after cursory examination of the river. The recommended minimum releases were accepted by the Department of Fish and Game in 1952 with some modification after completion of a spawning flow evaluation study.

"Subsequent modification of spawning survey criteria, refinement in survey techniques, and recognition of physical changes in the streambed resulting from the Folsom Project operation caused fisheries investigators to question the validity of the 1952 study and the adequacy of the flow recommendations for spawning purposes. As a result, salmon requirements, including territorial and transportation needs of downstream migrants, were re-examined during studies conducted since 1966. In addition, little consideration was given initially to the needs of the other anadromous fish species such as American shad and striped bass, which at the time were not heavily fished" (California Department of Fish and Game, 1971).

California Department of Fish and Game initiated an extensive study in 1966 of spawning gravels using more refined techniques than had previous studies. As a result of about 15 years of regulated river flow the physical environment has altered from pre-project times. The Department of Fish and Game elected in the 1966 survey to take into account changes in the physical characteristics of the streambed resulting from the operation of the Folsom Project.

Five representative sections of river ranging from 400 feet to 2,000 feet in length were selected as test sections. Sections I, II, III, IV, and V were located at points 1.2, 1.7, 4, 4.3, and 13.5 miles, respectively, downstream from Nimbus Dam. The survey was conducted jointly by the California Department of Fish and Game and the U.S. Fish and Wildlife Service. The U.S. Bureau of Reclamation cooperated by regulating flow releases from Nimbus Dam at the desired levels and by providing assistance in collecting streamflow and spawning gravel data (Department of Fish and Game, 1971). The principal physical characteristics of the test sections are illustrated in Table 2.

"On each test riffle a staff gage and base line along one bank were established. Steel fenceposts were driven at 100-foot intervals along both banks (with the exception of Section IV where a 200-foot interval was used). The combined length of the five riffle sections was 5,500 feet.

"Measurements of depth and velocity commenced on September 9, 1966, at a flow of 1,000 cfs. Measurements were made by wading and from a boat at 10-foot intervals along a cable tag line stretched across the stream

Table 2

PHYSICAL CHARACTERISTICS OF AMERICAN RIVER TEST SECTIONS

<u>Test Section</u>	<u>Location</u>	<u>Riffle Length</u>	<u>Riffle Gradient</u>	<u>Average width at 1,000 c.f.s.</u>
I	Nimbus	900 ft.	--	230 ft.
II	PCA	900	.0019	308
III	Sacramento Bar	900	--	237
IV	Coloma	2,000	.00067	242
V	Watt Avenue	600	.0021	312

Source: California Department of Fish and Game, 1971.

between the paired fenceposts. Total water depth and velocity at 0.3 foot above the bottom, measured with Price current meters, were noted at each interval. This procedure was repeated during flows of 750 cfs and 500 cfs. A crew of eight men was required to complete the measurements at all sections during the short periods of equal flow. The survey was terminated on October 26, 1966. A number of gravel samples were collected from each test riffle and graded according to composition.

"The 1966 study included several reconnaissance surveys of the river from Nimbus Dam to the mouth by boat. Characteristics of the 45 major riffles were noted, including lengths, widths, gravel quality, gradient, and observed spawning use. Underwater observations were also made in the major spawning areas. Aerial photographs were taken of the river at flows of 500, 750, 1,000 and 1,500 cfs. On-the-ground observations were superimposed on the photographs and measurements of total wetted area and useable spawning gravel extent were calculated. Photographs taken at 1,500 cfs coincided with the salmon spawning peak, thus presenting a picture of salmon redd distribution." (California Department of Fish and Game, 1971)

An evaluation of the data gathered in 1966 indicates that the available spawning area in the American River increased substantially as flows rise from 500 cfs to 1,500 cfs (see Table 3).

These post-project investigations were conducted to establish a more accurate description of the American River fishery resources than what was developed for the Folsom Dam project. This new information was to be used as the basis of the Department of Fish and Game protest to the State Water Rights Board on the Bureau of Reclamation's Auburn-Folsom South Canal Project. The Department of Fish and Game submitted a report to the California State Water Rights Board on the Fish and Wildlife Resources of the American River to be

Table 3

RELATIONSHIP BETWEEN AMERICAN RIVER STREAM FLOW
AND EXPECTED AVERAGE SALMON PRODUCTION

<u>Sept -May Flow (cfs)</u>	<u>Total River Gravel (ft.²)</u>	<u>Gravel Used By Salmon¹</u>	<u>Average No. River Spawners²</u>	<u>Total Escape- ment to Hatchery and River⁴</u>	<u>Ocean Catch⁵</u>
250	972,000	390,000	0	0	0
500	1,670,000	670,000	3,750 ³	3,750	11,250
750	2,030,000	900,000	14,425	14,425	43,275
1000	2,270,000	1,160,000	18,275	22,650	67,950
1250	2,470,000	1,280,000	22,110	26,485	79,455
1500	2,620,000	1,700,000	35,000	39,375	118,125

¹Based on the 1966 gravel survey with correction for areas of river actually used for spawning by population of 20,000 salmon. Approximately 80 percent of the spawning occurs upstream of the Carmichael Bluffs.

²The average spawning population is assumed to equal one-half of peak population. Peak spawning capacity is based on the assumption that one redd is constructed for every 2.5 salmon and that a redd occupies 180 square feet. Three waves of spawners are assumed to be using gravels during peak runs.

³At flows of 250 cfs it is assumed that the salmon fishery would be eliminated. At flows of 500 cfs a 65 percent reduction factor was applied to reflect reduction in nursery areas increased predation, competition with resident fishes for resting and feeding areas, and stresses placed upon individual downstream migrants due to crowding.

⁴Present hatchery contribution is based on expected returns of 0.125 percent for 2.5 million smolts released annually. No hatchery contribution is anticipated below flows of 1,000 cfs.

⁵It is assumed that three salmon are caught in the ocean for every adult returning to the river.

Source: California Department of Fish and Game, 1971.

Affected by the Auburn Dam-Folsom South Canal and Measures Proposed to Maintain These Resources. Subsequent to the Water Rights hearing the California State Water Resources Control Board issued its Decision D1356 granting a water permit to the U.S. Bureau of Reclamation and reserved continuing jurisdiction over the matter for the purpose of formulating terms and conditions relative to flows to be maintained from Auburn Dam downstream to the mouth of the American River for recreational purposes and for protection and enhancement of fish and wildlife. This jurisdiction included the lower American River below Nimbus Dam.

"An investigation was initiated and continued to date [1971] to assess project effects on fish and wildlife resources and to develop recommendations for their protection. This cooperative study involved a number of Federal, State and local agencies. These agencies collected information to assist in a determination of flows necessary for the continued maintenance of historical fish, wildlife, recreational values, and acceptable water quality levels in the American River. Additional information was gathered to determine flows that would enhance these values. The results of the cooperative study are included in a preliminary interim status report published in February 1971 by the U.S. Bureau of Reclamation." (Department of Fish and Game, 1971)

In 1971, the Department of Fish and Game issued an updated report to the State Water Rights Board on the Auburn-Folsom South Canal Project. This update report presented an assessment of the resources affected by the proposed project development, the problems faced, and the investigations which were conducted. Recommendations were presented for the protection and enhancement of the fish and wildlife resources in the American River.

"As the result of information gathered from biological studies conducted since 1966 we [the Department of Fish and Game] have concluded that the following minimum conditions are necessary for maintenance of pre-Folsom Project fishery values in the lower American River:

(1) October 15 - July 15 1,250 cfs throughout the river (Nimbus Dam to the Mouth).

July 16 - October 14 800 cfs throughout the river (Nimbus Dam to the Mouth).

(2) Operation of existing Nimbus Hatchery at present level of production (salmon smolts at 90/lb size)."

"We have also concluded that flows higher than these minimum flows, will provide enhanced conditions for fishlife.

(3) In so far as possible the Bureau shall operate the project in such a manner as to minimize detrimental flow fluctuations in the American River below Nimbus Dam.

(4) In the reach of river from Auburn Dam to Folsom Reservoir a minimum flow of 75 cfs is required.

"It is assumed that existing water quality levels will be maintained and that no more than 250 cfs of water will be diverted from the river downstream from Nimbus Dam." (Department of Fish and Game, 1971)

Decision 1400 was issued on April 11, 1972 by the State of California Water Resources Control Board. This decision relates to the reserved jurisdiction set forth in Decision 1356. Following nine days of hearings between June 23 and August 12, 1971, evidence was presented by the Bureau of Reclamation and by prospective users of project water. Evidence regarding needs for recreational, fish and wildlife purposes was presented by various public agencies, private organizations and concerned individuals.

The order issued from the Decision 1400 proceedings which pertain to fish and wildlife minimum flow releases is as follows:

ORDER OF APRIL 11, 1972

IT IS HEREBY ORDERED THAT:

The Board continue the reservation of jurisdiction over these permits for the purpose of formulating terms and conditions relative to flows to be maintained from Nimbus Dam downstream to the mouth of the American River for recreational purposes and for protection and enhancement of fish and wildlife. This jurisdiction will not be exercised except after notice to the parties and a hearing.

IT IS FURTHER ORDERED THAT:

Permits issued on Applications 18721, 18723, 21636 and 21637 be amended to include the following terms and conditions:

1. Flows of not less than 75 cfs shall be maintained year-round from Auburn Dam to Folsom Reservoir.
2. Flows shall be maintained in the entire reach of the American River from Nimbus Dam to the Sacramento River for maintenance of fish and wildlife of not less than 1,250 cfs from October 15 of each year to the succeeding July 14, and not less than 800 cfs from July 15 to October 14. Reductions below these ordered amounts may be made in the same proportion as deficiencies are taken for irrigation purposes in project water delivered within the Folsom South service area, subject to the provisions of condition 4.
3. Flows shall be maintained in the entire reach of the American River from Nimbus Dam to the Sacramento River for recreational purposes of not less than 1,500 cfs from May 15 to October 14 of each year. The flows required by this condition and condition 2 are not cumulative. No flows shall be

required under this condition when any irrigation deficiencies are required in project water delivered within the Folsom South service area, subject to the provisions of condition 4.

4. The reduction in flows for fish, wildlife and recreational purposes authorized in conditions 2 and 3 shall not result in failure to bypass August, September and October flows to which permittee is not entitled. After completion of a Hood-Clay connection, no reduction in flows shall be made pursuant to conditions 2 or 3 which will result in American River flow into the Sacramento River less than the concurrent supply of water from American River to any areas which can be served through a Hood-Clay connection.

V. Conclusions

Historically salmon runs in the American River at Folsom may have exceeded 100,000 adults. Steelhead runs may have been of similar magnitude. Hydraulic mining in the 1880's destroyed and blocked from use large amounts of salmon and trout habitat. The operation of the original Folsom Dam further depleted the salmon and almost exterminated the steelhead fisheries resources upstream of the present-day Folsom Dam project. The very low pre-project flows allowed water to pool for longer periods and become warmer in the river downstream of Fair Oaks. During this period a rather good warm-water fishery for largemouth bass and catfish was developed.

During the project development period transect studies of spawning habitat were made to estimate appropriate minimum

releases which were subsequently set at 250 cfs (January 1 to September 15), and 500 cfs (September 16 to December 31).

Based on studies made in the mid 1960's the flow studies resulting in the 250-500 cfs release schedules were disavowed as invalid and not representative of the true situation.

Since implementation of the project the mean releases have greatly exceeded the agreed to minimum releases. The minimum dry year flow (1966) greatly exceeded the 250-500 cfs schedule. Low summer flows have generally exceeded 2,000 cfs (see Figure 2).

During this time a run of king salmon and steelhead has been established which exceeds in numbers the pre-project run but not the historical run. The present run consists of an average of about 30,000 river spawning salmon and 12,000 salmon spawning at the hatchery. The steelhead population has increased from a pre-project level of less than 100 to several thousand. A sizable striped bass and shad fishery exists in the river in addition to steelhead and salmon. There is also a smaller fishery for resident rainbow trout. The warmwater fishery that existed before the project has been greatly reduced by colder water temperatures associated with the greater flow and releases from the lower depths of Folsom Reservoir.

Project development for the Auburn-Folsom South Canal project opened the door for renegotiation of required minimum flow releases to be raised from the 250-500 cfs schedule to 800 cfs (July 15 to October 14) and 1,250 cfs for the remainder of the year. These flows are expected to maintain the present level of fishery development. Runs during recent years have been above pre-project levels due to enhanced flows, which will occur with reduced frequency in the future due to diversion into the Folsom South Canal.

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