

HISTORY OF SALMON SPAWNING ESCAPEMENT AND GOALS
IN THE SAN JOAQUIN RIVER SYSTEM

By

Robert S. Menchen^{1/}Main Stem San Joaquin River

The San Joaquin salmon runs above the mouth of the Merced were the southernmost in North America. The run is now dead as a result of Friant Dam constructed in 1942 resulting in no water releases for salmon. To re-create them will require many years of planting of fish whose ancestors were adapted to more northern waters. If conditions are made as suitable as is practical and if we are lucky the succeeding generations of fish should adapt to conditions in the San Joaquin. It will take time, and doing it quickly will be much less important than doing it right (Fry 1971).

Merced River

Only sparse and incomplete estimates of runs in this river were made prior to 1953. In 1940 and 1941 the runs were at least 1,000 fish, and estimated at 4,000 fish in 1954.

Due to increased irrigation demands, the Merced River runs continued to dwindle until less than 100 fish were recorded in six consecutive years (1961-1966).

Enlargement of Exchequer Dam from 281,000 acre feet to 1,026,000 acre feet in the late 1960's opened the door for negotiations to increase water releases for salmon. These negotiations resulted in minimum flows of from

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180 to 220 cfs into the Merced River at Crocker-Huffman Dam from October through March of each water year. These releases began in the fall of 1967. Prior to 1967, the flow was as low as 20 cfs during the spawning season.

In addition to the flow commitment three additional features were included: 1) a salmon spawning channel, 2) screening of six irrigation diversions, and 3) ponds for rearing salmon to yearling size.

The salmon spawning channel and one rearing pond were completed in 1970. A second pond was constructed in 1972. These facilities were constructed in the gravel mining tailings at the base of Crocker-Huffman Dam near the town of Snelling.

The channel provides spawning area for 10,000 fish (6,000 females). The spawning channel was first operated in the fall of 1970 when 100 adult salmon used it for spawning. Thirty-eight females deposited an estimated 147,000 eggs in the gravel. From these, 60,000 juvenile salmon left the channel. Since then as many as 1,000 salmon have used the channel.

The rearing ponds (250 feet long and 20 feet wide) are adjacent to the lower end of the channel. They have a capacity to rear 200,000 salmon to yearlings for release into the Merced River. Until 1973, broodyear eggs were acquired from the Stanislaus River salmon run and hatched at Moccasin Creek Hatchery for transfer to the ponds. Since 1973 fry have been trapped in the Merced River and transferred to the ponds.

Yearling salmon planting in the Merced River is a continuation of a program started by California Department of Fish and Game in 1965. In 10 years (1967 through 1976), the number of yearlings released varied from 32,000 to 286,000.

The last major feature of the salmon improvement program on the Merced River, screening of irrigation diversions, was completed just before the 1970 spring irrigation season started.

Returns to the river from yearling plants are considerably higher compared to fingerling releases. The run was expected to build up to a high level quickly resulting in the natural run increasing to a point that yearling plants could be discontinued. Because of low spring outflow in the Merced and main San Joaquin the expected buildup did not occur, and yearling plants will be needed if the run is expected to continue at present level.

Tuolumne River

In some years the Tuolumne River had fall runs larger than those of any other Central Valley stream except the Sacramento (Fry 1961). California Department of Fish and Game counted salmon at the Modesto Dam fish ladder in 1940, 1941, 1942 and 1944. The U. S. Fish and Wildlife Service counted salmon there in 1946. After the dam was condemned in 1947 all estimates have been made based on carcass recovery and redd counts. The largest run on record was 130,000 in 1944, and the smallest was 100 fish in 1963.

Prior to 1970 there were extreme flow fluctuations in the salmon spawning area because the size of Don Pedro Dam provided relatively low capacity storage. In wet years, high runoff and flood conditions prevailed below the dams and in dry years irrigation season started early and most of the flow was diverted from the stream. This condition led to extreme fluctuations in the salmon runs. Fall flows have been adequate most of the time. However, we have demonstrated that salmon runs in this river have been influenced primarily by the amounts of flow in the spring months, March through June.

The primary reason for such small runs in the early 1960's was therefore low spring outflow.

Since 1970 Don Pedro Dam was enlarged resulting in the Tuolumne River being completely controlled in most years.

A Davis-Crunsky Grant was obtained by the Modesto and Turlock Irrigation Districts for salmon improvement below La Grange Dam on the Tuolumne River. Main requirements for this grant were three: 1) maintain minimum streamflows, 2) maintain minimum amount of spawning gravel, and 3) finance a fishery study.

The present term for this agreement will last 20 years, starting in the fall of 1970. At the end of this period, the Federal Power Commission will reconsider the operating terms.

The flow schedule from New Don Pedro Dam was set up for a normal and dry year condition, (FPC 2299 1964) for the 20-year period. These releases began on November 10, 1970. Prior to 1969 the flows in the Tuolumne River fluctuated from about 7 cfs to flood conditions. The flow agreement specifies an annual allotment of 123,000 acre feet. This reduced the chance of having a run failure after a real dry season such as those in the early 1960's but it also reduced the chance of large runs in very wet years. The end result is a leveling off of the San Joaquin salmon run at a considerably lower population than in the past, and in normal years the run is expected to be about 2,000 spawners with present environmental conditions.

Spawning gravel area requirements for runs of 32,000 to 52,000 spawners are fairly straightforward. An area of 1,000,000 square feet will accommodate 32,000 spawners on the Tuolumne. Fifty thousand spawners require 1,562,000 square feet.

The spring outflow-adult survival relationship which controls populations was observed under more or less continuously variable flow rates during the spring months.

These indicate that outflows during March through June of around 4,000 cfs are required to produce 32,000 adults and of around 7,500 cfs are required for runs of 50,000 adults (Fry 1965).

The generally accepted concept of a hatchery, where juvenile fish are released at sizes and time of natural outmigration, is not likely to prove successful on the Tuolumne River under anticipated flow schedules. Hatchery outmigrants have flow requirements similar to those of their natural counterparts. Flows which do not provide for adequate natural survival of naturally-produced outmigrants will also fail to meet the survival requirements of hatchery-produced fish. This also applies to Merced and Stanislaus Rivers.

Water requirements for juvenile emigration can, in some instances, be overcome by trucking hatchery-produced fish to downstream locations. Our experience on the Sacramento River, however, indicates that this practice interferes with the returning adult's ability to locate its stream of origin. A hatchery operating under such a procedure would be faced with an unpredictable adult return and an unreliable egg supply.

Rearing fish to yearling size has the potential to successfully circumvent the problem of low spring outflow. Salmon can be reared for a period of around 9 months, and be released during the winter when streamflows are higher. This technique is proving successful on the Merced River.

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Although we now have sufficient spawning gravel to accommodate salmon runs greater than those anticipated with the existing spring fishery flows, we intend to continue to search for additional water for spring release. If through these efforts, or any others, we should succeed in generating runs in excess of 32,000 spawners, additional gravel rehabilitation will be required.

Stanislaus River

New Melones' Project Report 1972 describes the salmon resource in this river. Presently, spawning occurs only in the mainstream from Riverbank to Goodwin Dam with the main spawning area between Orange Blossom Bridge and Knight's Ferry Bridge. Since records have been kept the largest run was 35,000 fish in 1953; the smallest run was 200 in 1963.

In recent years conditions for salmon have been degraded by very low streamflows, high water temperatures, encroachment on spawning riffles by willows and other aquatic plants, siltation and physical removal of gravel bars. These adverse conditions have caused a severe decline in the salmon runs.

Pollution and fluctuating releases for hydroelectric power during spawning and egg incubation periods have further reduced spawning success and survival of fish.

Runs in the Stanislaus River have held up better than the other two San Joaquin streams until 1973. Much of this is probably due to a real desire on the part of the Oakdale and South San Joaquin Irrigation Districts to provide a water release schedule, when possible, that corresponds to requirements of the salmon.

At present, water storage capacity in this drainage is limited. Some phases of construction for New Melones Dam are underway, but it will be several years before it is completed. The main feature affecting salmon will be a minimum controlled flow release in the Stanislaus River.

Mokelumne River

Pardee Dam was the upper limit of salmon migration on the Mokelumne from 1929 to 1963 until Camanche Dam was constructed in 1963 downstream of Pardee.

Escapement has shown extreme fluctuations over the years. Very small runs have been attributed mostly to a large proportion of water being diverted from the stream in low flow years. In some years the flow below Woodbridge Dam has been less than 50 cfs in critical migration periods for salmon.

In most years from 1940 through 1971, the Department of Fish and Game counted adult salmon over Woodbridge Dam. Since 1972 we estimated escapement from carcass recovery and redd counts. Since 1940 the escapement has varied from 137 fish in 1961 to over 12,000 in both 1941 and 1942 (Fry 1961). The Mokelumne River salmon run in the post-Camanche period (1967 through 1974) has averaged 2,900 fish (Taylor 1976).

Cosumnes River

The upper limit of spawning is about one mile below Latrobe Bridge. A natural barrier stops the fish at this point. The Department of Fish and Game has made estimates of the escapement since 1953. During this period estimates of runs have ranged from 5,000 fish in 1954 to none in 1959. The run has averaged 1,200 fish from 1964 through 1974.

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AVERAGE ESCAPEMENT GOALS

The average escapement goal for the San Joaquin River system is 11,000 king salmon. We expect that under environmental conditions that have existed for the last 6 years the spawning stocks will fluctuate around this number depending on the amount of runoff each spring. The following is a breakdown by river. Table 1 lists the goals and recent escapement for the Mokelumne and Merced spawning channels.

Merced River

Studies of wild juvenile salmon in the Merced show that fish begin to reach smolting size (75 mm or larger) in late March to early April (Menchen 1974). Similar results were shown on the Tuolumne River. Juveniles were shown to smolt earlier when parent population was small than when it was large. The present theory is that when the nursery area is not over-saturated with fish they grow to smolting size quicker. This appears to be an important factor for their survival. In normal or below normal flow years, conditions in the lower tributaries and main San Joaquin may become unsuitable for salmonids as early as late April but usually sometime in May. Not all fish smolt at the same time; they are spawned at different times and grow at different rates. The ones that are not large enough to migrate from the upper tributaries prior to the time the environment becomes unsuitable are lost. High water temperatures (above 70° F), large amounts of irrigation return water, irrigation diversions, and pollution limit the number of downstream migrants. In the early days, salmon populations were programmed to large volumes of cold fresh water from spring runoff which presently will only be available in extreme wet years.

CALIFORNIA HATCHERY ESCAPEMENT GOALS
AND RECENT ADULT RETURNS

Hatchery	Goals ^{1/}	1969	1970	ADULT RETURNS						
				1971	1972	1973	1974	1975	1976	1977
Mad River										
King Salmon	4,200		0 ^{2/}	323	1,050	619	231	278	661	163
Silver Salmon	500		0	337	466	327	160	2,103	1,193	451
Steelhead	560		0	0	42	52	2,872	2,138	438	315
Iron Gate										
King Salmon	5,500	1,012	10,325	10,461	3,120	8,774	9,414	7,727	12,608	4,313
Silver Salmon	150	202	1,387	125	56	841	456	82	1,376	251
Steelhead	400	370	1,194	2,365	3,757	1,286	1,865	3,227	1,523	1,941
Trinity										
King Salmon	9,200	1,256	1,498	8,293	11,042	3,635	7,387	6,363	4,746	3,160
Silver Salmon	875	285	2,806	39	58	7,595	55	177	2,585	645
Steelhead	800	554	241	67	242	271	162	372	175	13
Tehama-Colusa Channel										
King Salmon	5,000 ^{3/}			5,935 ^{2/}	2,360	3,536	3,522	4,367	3,312	4,811
Coleman										
King Salmon	9,000	6,838 ^{4/}	7,743	4,298	3,225	4,540	3,673	3,304	4,727	2,446
Steelhead	2,000		3,967	3,680	1,486	2,578	1,834	1,099	2,162	1,270
Feather										
King Salmon	5,000	4,611	3,581	2,852	3,891	8,682	5,626	5,743	5,800	8,546
Steelhead	275	361	224	78	288	1,000	715	758	573	156
Nimbus										
King Salmon	2,500	2,549	7,854	7,877	5,447	10,859	7,508	6,567	4,342	6,505
Steelhead	400	3,066	1,734	3,033	2,256	2,506	3,157	2,164	2,992	582
Yokelumne River Channel										
King Salmon	4,000	615	925	366	352	389	222	399	18	0 ^{5/}
Merced River Channel										
King Salmon	10,000		100 ^{2/}	235	128	375	1,000	700	650	45

- / Goals based on juvenile hatchery capacity or adult channel capacity.
 / First year of operation.
 / Present goal maximum capacity is 40,000 - most spawners trucked from Sacramento River.
 / Hatchery plus Keswick Trap.
 / River dry because of drought.

The problem today is providing large enough flows to maintain fresh cold water throughout the fishes entire migration route primarily in the smolting period from early April until late June.

We get good survival from our yearling plants since they migrate to the sea in late fall and winter when environmental conditions are more favorable than in the spring.

As a result of the salmon improvement features incorporated with construction of New Exchequer Dam, the run in the Merced River appears to have leveled off at about 2 to 3 thousand spawners annually. About one-half or more of the escapement has been attributable to the yearling program. Return of yearling plants has averaged about 1% of the number planted. With present environmental conditions and maintenance programs, the average escapement goal is 2,000 adults. The 6-year average (1971-76) is 2,000 fish.

Tuolumne River

This river suffers from the same limiting factor as does the Merced and Stanislaus--lack of spring outflow. Examination of past flow and escapement data shows that large parent populations have not resulted in large numbers of returning adults, and that small numbers of spawners resulted in a returning population of up to 20 times the parent population size.

Based on information to date with the present management plan and with present environmental conditions, the average escapement goal is 2,000 spawners and the 6-year average (1971-76) is 6,000 fish.

Stanislaus River

The Stanislaus suffers from the same limiting factor as does the Tuolumne and Merced--lack of spring outflow. The relationship of spring outflow to number of spawning females 2-1/2 years later is shown in Figure 1. The flow in the Stanislaus is much less controlled than the other two rivers

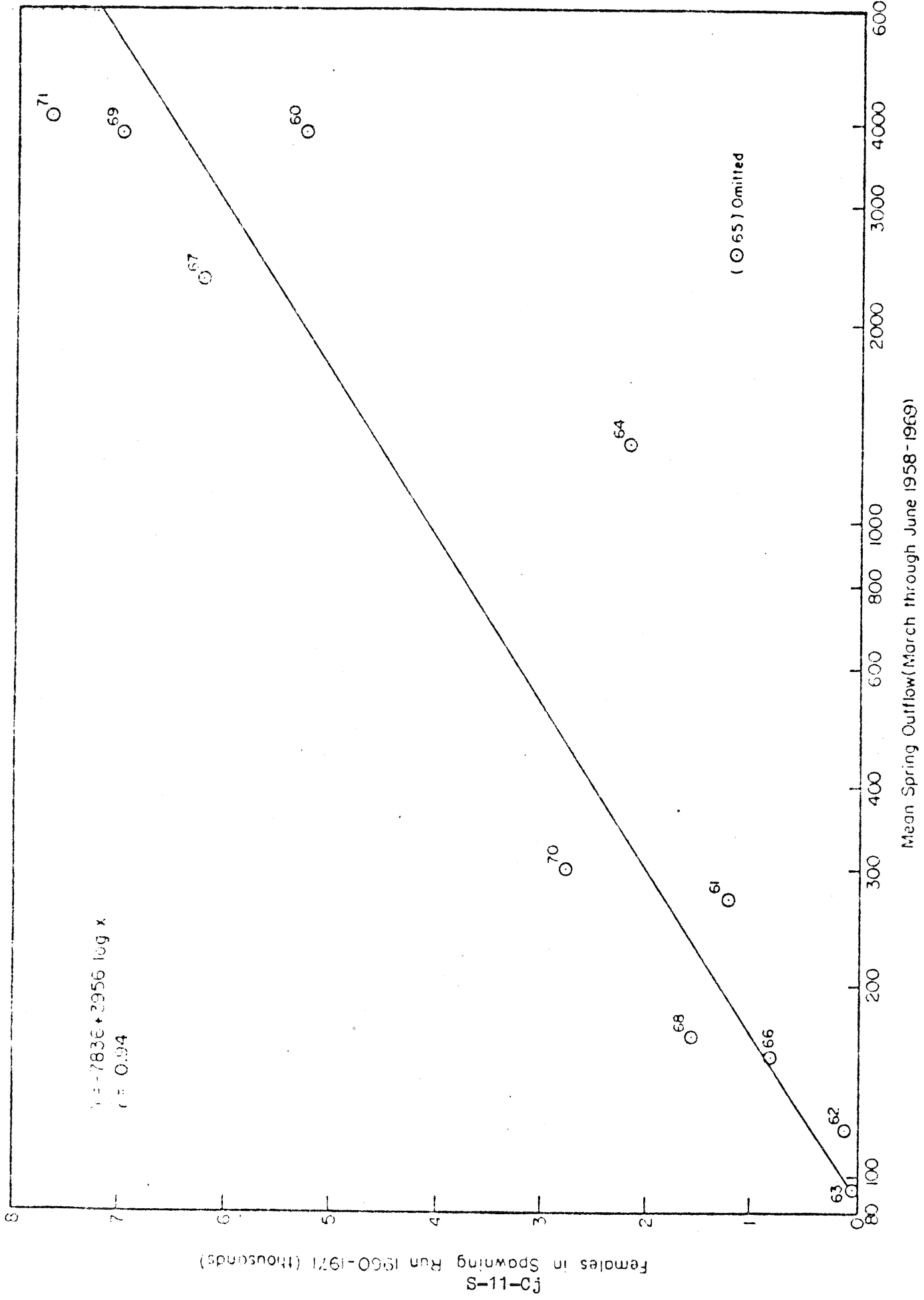


Figure 1 Relationship between spring outflow of Stanislaus River at Ripon and number of spawning females 2 1/2 years later (circled numbers indicate year of spawning).

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Females in Spawning Run 1960-1971 (Thousands)

and the run is expected to fluctuate more until New Melones Dam is completed. Without the dam it would be advantageous to maintain a run of 6,400 fish so that when above normal rainfall occurs sufficient numbers of young can be produced to take advantage of the increased nursery area and improved environmental conditions. This number is based on inventory data since 1953. It shows that the highest 3 years of escapement, with known parent population, were produced by an escapement of between 2,900 and 6,400 adults; therefore, a reasonable average escapement goal appears to be 3,000 spawners, and the 6-year average (1971-76) is 4,000 fish.

Mokelumne River

With construction of Camanche Dam in 1963 the East Bay Municipal Utility District constructed a salmon spawning channel and agreed to set aside a small amount of water for fish. This effort was to compensate for loss of spawning area above the dam. To date the flow commitment has been grossly inadequate to obtain production at optimum levels. The spawning channel has not received the number of spawners expected.

A major achievement in the protection of the salmon resource was the construction of the Woodbridge Fish Screen in 1968. Prior to this date most of the production was lost in the irrigation diversion with the loss especially large in dry years.

The largest run since 1963 was 5,000 fish in both 1970 and 1971. The returning runs from their progeny were 3,000 and 1,400 fish. The escape-ments which produced the 5,000 fish runs were 3,000 and 1,700 fish. With the present management plan on the Mokelumne River, it appears that 5,000 fish will be expected in peak runs. Therefore, an average escapement goal

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of 3,000 fish seems reasonable and should produce sufficient offspring, when conditions are favorable, to return the maximum numbers. The 6-year average (1971-76) is 2,000 fish.

Cosumnes River

The largest run in recent years was 4,000 fish in 1969 and it developed from a parent population of 600 spawners. A successful spawn in the Cosumnes depends on sufficient flows in October and November. Until a reliable water supply is provided, 600 spawners will be adequate to maintain runs at present levels, and the 6-year average (1971-76) is 1,000 fish.

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