

2. INFORMATION ON CALIFORNIA SALMON FISHERIES AND STOCKS

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Editor's Preface: This report was provided by the U.S. National Section in partial response to a 1966 request of the Japanese National Section for, "Explanation of the changes in the salmon fisheries in recent years and evaluation of the condition of the salmon stocks in recent years by major region . . .". It is INPFC Doc. 1537, received in October 1972. In October 1975, the U.S. Section provided data to update and revise information given in Doc. 1537. These data (INPFC Doc. 1838) have been incorporated in tables in this paper where they appear in italics. No changes have been made in the text or figures of the original document. The original language is English.

INTRODUCTION

This report on California salmon fisheries and stocks is another in a series of documents prepared by the United States Section of the International North Pacific Fisheries Commission for the Commission's Ad Hoc Committee on Abstention in response to a request made by Japan for information on recent changes in United States salmon fisheries and the condition of its salmon stocks in recent years.

DESCRIPTION OF THE FISHERIES

In ocean waters adjacent to the coast of California, salmon are taken consistently by commercial fishermen as far south as Monterey and less consistently to the vicinity of Avila (Fig. 1). In two recent years, there was some sport fishing for salmon in the Santa Barbara area.

Trolling in ocean waters is the only form of commercial salmon fishing permitted in California. Gill-netting was permitted in the Klamath and Smith River until the early 1930s and in the Sacramento-San Joaquin River system until 1957.

Sport fishing for salmon is permitted in the ocean and in some part of every river system that has a salmon run. Upper parts of some rivers and the entire lengths of some tributary streams are closed to sport fishing for salmon.

All five North American species of Pacific salmon have been recorded in California waters but only two—chinook and coho salmon—are of importance to

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commercial or sport fishermen.

Except for 1967, chinook salmon, which are taken in all areas and months open to commercial fishing, have always been dominant in numbers of salmon caught. Prior to 1963, the catch of this species ranged from 81% to 97% of the total. Coho salmon, most of which were taken incidentally in the troll fishery for chinooks, make up all or almost all the remainder of the catch. Starting in 1963, the catch of coho increased rapidly and peaked in 1966 and 1967. In 1967 the coho catch exceeded that of chinooks in numbers but did not equal it in weight. Since 1967 the coho catch has dropped but is still above its pre-1963 level.

In some odd-numbered years, pink salmon are taken in small numbers; by far the largest pink salmon catch was in 1967 when 30,000 were taken (nearly 4% of the total catch of salmon in the state that year). In California it is probable that the total pink salmon spawning escapement is less than 200 fish per year. Most pinks landed in California are presumed to come from streams north of California.

FISH PROTECTION AND ARTIFICIAL PROPAGATION FACILITIES

Numerous large scale water development projects in California, such as the transporting of water over distances of several hundred miles to population centers and the pumping of water for irrigation purposes, have for many years placed the salmon runs of California in jeopardy. Most of the water for these projects has come from salmon streams. On most of these streams, and many of their tributaries, high dams have been built. In many instances, water flows below the dams are severely reduced during much of

the year, resulting in high water temperatures and worsening of pollution problems. In the Sacramento-San Joaquin Delta, pumping of water for irrigation frequently reverses the direction of water flow, interfering with the downstream migration of young salmon to the sea.

Maintenance of the salmon runs under adverse and changing conditions associated with water development projects has required considerable expenditures of money. Hatcheries, spawning channels, fishways,

and fish screens, completed and under construction, have involved a capital outlay of over \$50,000,000 (Table 1). This figure does not include the cost of installing multiple level outlets in dams for temperature regulation of the water released.

Locations and capacities of the salmon hatcheries and spawning channels in California are listed in Table 2. In addition to the hatcheries listed, several California trout hatcheries occasionally use part of their capacity to hatch and rear salmon.

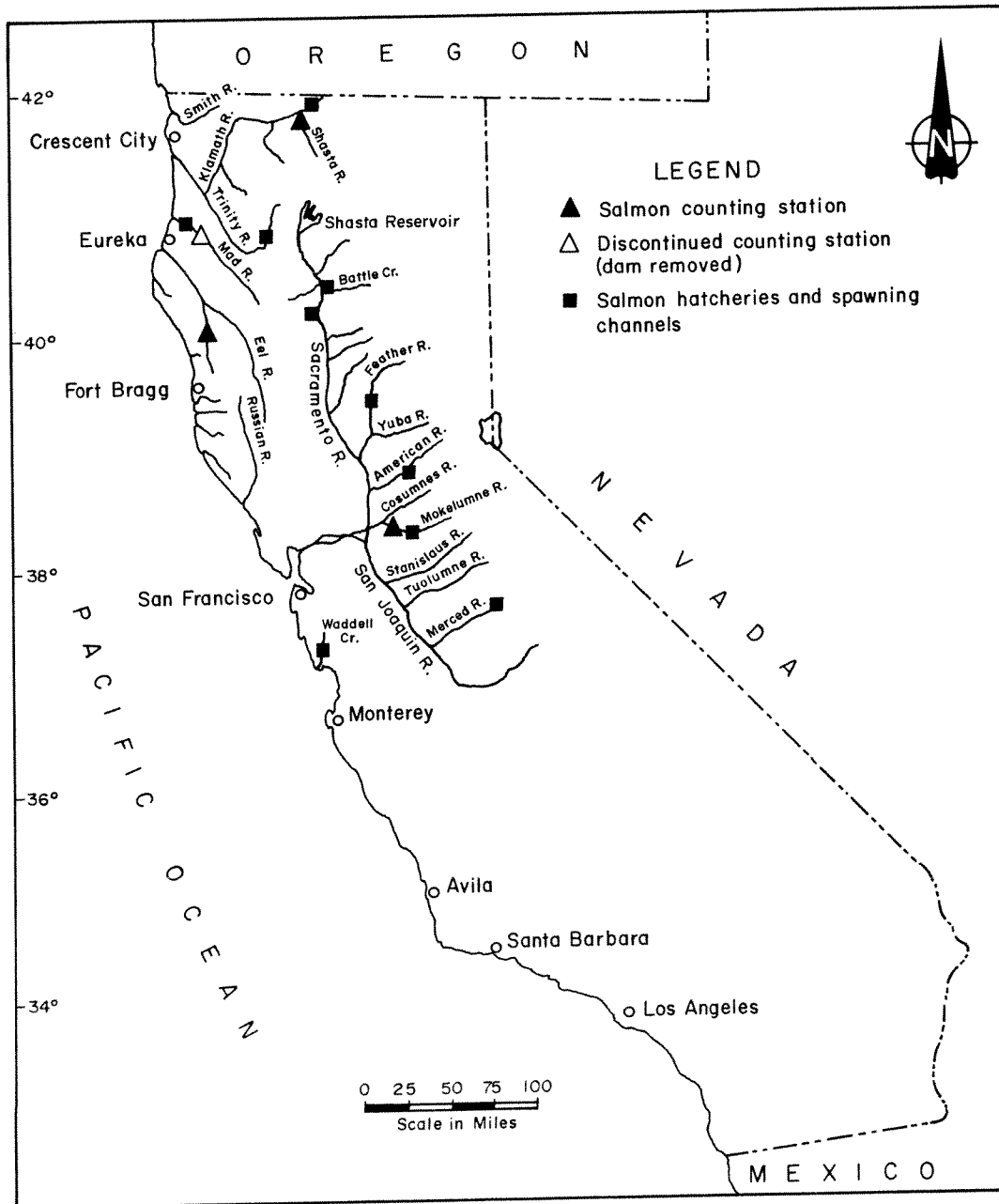


FIG. 1. Major salmon streams and salmon ports of California.

TABLE 1. Fish facilities, flow regulation and temperature regulation in California salmon streams.

Stream	Fish facilities			Approx. development and construction cost (\$1,000)	Water regulation	
	Fishways	Fish screens	Hatcheries and spawning channels		Min. stream flow for salmon	Temp. regulation for salmon
SACRAMENTO-SAN JOAQUIN SYSTEM						
Sacramento main stem	4	2	1	24,475	yes	—
Sacramento tributaries						
Battle Creek	6	1	1	3,159		
Feather River			1	7,000	yes	yes
Yuba River	2	1		70		
American River			1	1,207	yes	yes
Other tributaries	18	6		240		
Mokelumne River	1	2	1	1,299	yes	yes
Cosumnes River	2	1		2	yes	yes
Sacramento-San Joaquin Delta		3		8,000		
San Joaquin main stem		3		385		
San Joaquin tributaries						
Stanislaus River					yes	
Tuolumne River					yes	
Merced River	1	6	1	385	yes	
COASTAL STREAMS						
Smith River						
Klamath R. and minor tributaries	4	29	1	1,570	yes	
Major Klamath tributaries						
Shasta River		2		9		
Scott River		2		70		
Salmon River	2					
Trinity River	5	11	1	2,840	yes	
Prairie Creek			1			
Mad River			1	2,800		
Eel River System	2			100		
Russian River System					yes	
Other coastal streams	9	1				

TABLE 2. Salmon hatcheries and spawning channels in California.

Name	River	Operated by	Capacity (thousands)			
			Eggs	Chinook 90/pound	Coho Yearlings	Yearlings
Iron Gate Salmon and Steelhead Hatchery	Klamath	Calif.	12,000	10,000	50	20
Prairie Creek Hatchery	Prairie Cr.	Humboldt Co.	500			350
Mad River Hatchery	Mad	Calif.	10,000	5,000		300
Trinity R. Salmon and Steelhead Hatchery	Trinity	Calif.	25,000	10,000	500	500
Coleman National Fish Hatchery	Battle Cr.	U.S.	25,000	20,000		
Tehama Colusa Fish Facility (Sp. Chan.)	Sacramento	U.S.	100,000 ^a			
Feather R. Salmon and Steelhead Hatchery	Feather	Calif.	13,000	9,000	900	
Feather R. Spawning Channel	Feather	Calif.	3,000			
Nimbus Salmon and Steelhead Hatchery	American	Calif.	20,000	2,500	200	
Mokelumne R. Fish Installation (Sp. Chan.)	Mokelumne	Calif.	10,000		50	
Merced River Spawning Channel	Merced	Calif.	22,600		200	100

^a This is the channel's eventual capacity. It first operated in the fall of 1971, but only at a fraction of its capacity.

RESEARCH

A substantial portion of the salmon research in California has been directed toward the solution of a broad spectrum of problems arising from water development projects on salmon streams.

Annual spawning stock surveys (including an estimate of escapement) are made in all salmon streams of any importance in the Sacramento-San Joaquin River system. In the coastal streams such estimates are usually made when and where proposed water development projects make it important to plan for the preservation of the runs in question.

Marking experiments are used to determine when,

where, and at what size hatchery-reared salmon should be released to obtain optimum returns. A major experiment now underway should provide information on oceanic movements and catch-to-escape-ment ratios for chinooks from the Sacramento River and its tributaries and for cohos from the Trinity River.

Commercial and sport catches are sampled to determine species composition, average weights, growth, and the proportion of marked fish in the catch. Fishing boat logs are studied to determine areas of catch, sea surface temperatures and the proportion of fish below the legal size limit returned to the water. Experimental trolling is being used to try to find trolling lures which will catch fewer undersized salmon but

TABLE 3. California ocean salmon landings, 1947-74.

Year	Commercial troll fishery, state total					Commercial Chinook gillnet landings, state total ^a		Sport fishery, state total	
	1,000 lbs.		1,000 fish		Effort in deliveries 100's	1,000 lbs.	1,000 Fish ^b	Thousands of fish	
	Chinook	Coho	Chinook	Coho				Chinook	Coho ^c
1947	—	—	610	87	—	3,380	(188)	5	0.4
1948	—	—	421	93	—	1,940	(108)	11	1
1949	—	—	400	89	—	899	(50)	23	2
1950	—	—	430	85	—	1,203	(67)	57	5
1951	—	—	416	58	—	1,343	(75)	103	8
1952	5,785	752	474	92	—	738	38	123	10
1953	6,336	801	493	102	—	870	43	141	11
1954	8,168	432	771	64	—	901	58	171	14
1955	9,246	411	763	56	—	2,321	121	184	15
1956	9,814	461	958	66	—	1,140	68	163	13
1957	4,641	536	474	89	—	322	18	64	5
1958	3,576	80	375	13	—	Fishery closed Sept. 1957		74	6
1959	6,543	225	514	35	—			76	8
1960	6,096	125	540	18	—			50	6
1961	8,101	537	774	79	—			53	6
1962	6,302	371	556	48	330			120	13
1963	6,829	1,020	662	162	377			84	33
1964	7,562	1,919	687	247	376			101	40
1965	8,102	1,572	705	217	437			60	21
1966	5,979	3,467	554	446	380			74	32
1967	3,866	3,376	338	414	382			73	50
1968	4,612	2,338	472	362	445			154	40
1969	4,895	1,235	551	193	437			156	28
1970	5,269	1,342	517	183	437			148	15
1971	4,926	3,184	434	442	386			188	67
1972	5,372	1,050	492	158	378			200	45
1973	7,587	1,994	816	348	556			198	32
1974 ^d	4,400	4,400	450	780	600			170	90

^a All netting was in the Sacramento-San Joaquin River system and took nearly 100% chinooks.

^b Figures for 1947-51 based on average weight of 18 lbs. per fish.

^c The sport coho catch was estimated to be 7.4% of the total sport catch for the years 1947-58 and 10% for the year 1959.

^d Preliminary figures.

remain effective for catching legal sized fish.

REGULATIONS

Regulations affecting commercial fishing are nearly all in the form of laws passed by the state legislature. The most important act in recent decades was the closure of the Sacramento-San Joaquin gill-net fishery. This closure increased the escapement in a year when the run was small and made trolling the only legal way a salmon could be taken commercially in California.

The commercial salmon fishing season is open from April 15 to September 30 and the minimum sizes which may be retained are 26-and 25-inches total length for chinook and coho respectively.

Sport fishing regulations are enacted by the California Fish and Game Commission. In the ocean south of Tomales Point (38° 14'N) the open season for all salmon is from February 15 to November 15. North of Tomales Point there is no closed season (but almost no one fishes there in the winter). In the ocean, sportsmen are allowed a daily bag limit of 3 salmon of which 2 must be 22 inches total length or over and one must be 20 inches or over. There are additional restrictions in the streams, the most important of which involve closed seasons and the closure of salmon spawning areas during the spawning season.

Laws require the construction of fishways and fish screens where needed. Public hearings provide for

the maintenance of minimum flows and water quality required to protect the salmon runs.

CHINOOK SALMON

Most of the chinook salmon caught in the ocean off California come from the Sacramento-San Joaquin River system. Other streams of importance are the Klamath, Smith, and Eel Rivers. Some small coastal streams have a few chinooks, but most have none. Except for significant contributions of chinooks from Oregon coastal streams to early season landings off northern California, few California caught chinooks come from the Columbia or other rivers north of California. Some Sacramento chinooks are caught off Oregon, Washington, and southern British Columbia. Returns of marked fish of the 1949 brood year indicated that about 60% of the Sacramento chinooks of that year class were taken north of California. A marking experiment in the late 1950s showed an average of only 10.9% were taken north of California. Another marking experiment is currently in progress.

Relatively little information on the oceanic movements of chinook salmon of the northern California coastal streams (Smith, Klamath, Eel, etc.) is available. Presumably a high proportion of the fish migrate north and are caught off Oregon or Washington, but marking experiments have been few and give no precise data on the matter.

In former decades fourth year chinooks were the

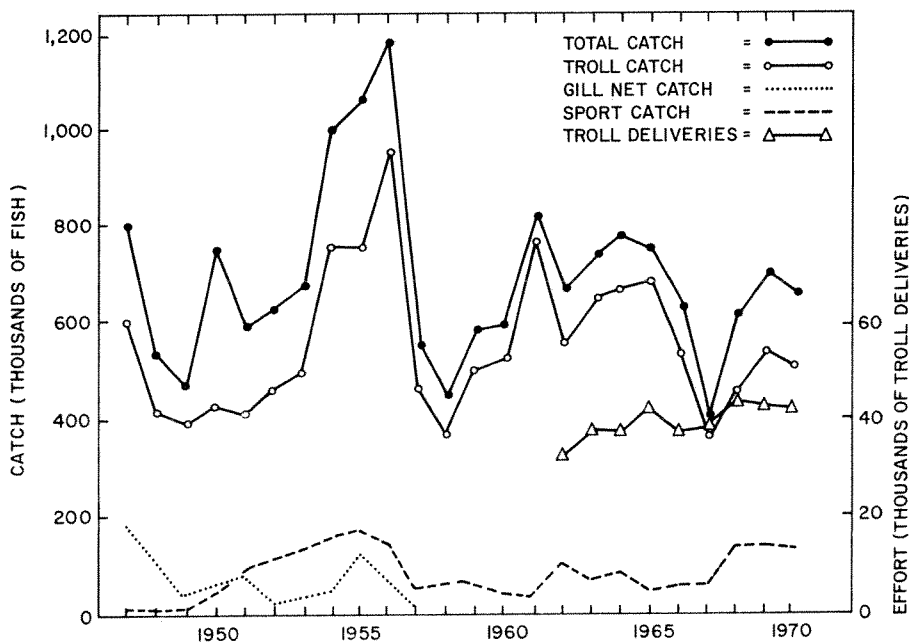


Fig. 2. Chinook salmon catches in California, 1947-70, and troll fishing effort, 1962-70.

most numerous in the commercial catches and most spawners were at the end of their fourth year of life although third and fifth year spawners were common. This has changed gradually and in recent years most of the fish caught have been in their third year. Spawners have been about equally divided between third and fourth year fish; older individuals are much less common than formerly.

CATCH. Annual catches of chinook salmon by commercial and sport fisheries of California since 1947 and number of deliveries by commercial trollers each year since 1962 are shown in Table 3 and Fig. 2.

Except for 1954–56, when over one million fish were caught each year, the annual total catch has fluctuated about an average of approximately 640,000 fish. Troll fishing effort has had a slight upward

trend over the past 9 years.

ESCAPEMENT. Estimates of the total escapement of fall run chinook salmon in the Sacramento-San Joaquin system extend back to 1953 (Table 4 and Fig. 3). Incomplete surveys of escapements in the system were made in the late 1940s and early 1950s. Those surveys indicated escapements considerably below the size of the peak escapement of nearly 600,000 fish in 1953.

The sharp drop in escapements of fall run chinook in the Sacramento-San Joaquin system from 1953 to 1956 (Fig. 3) is associated with the greatly increased numbers of chinooks caught by the troll fishery between 1953 and 1956 (Fig. 2). The escapement declined further in 1957 in spite of sharp drops in catches by the troll, gillnet and sport fisheries. Fortunately, water conditions were excellent and the survival of the 1957 brood was high.

Escapements improved in 1958–60, reaching a level of approximately 470,000 fish in 1959 and 1960. The drop in escapement to about 250,000 fish in 1961 was partly due to a larger catch by trollers in that year and partly to the collapse of the run to the San Joaquin system. The collapse and extremely small escapements to the system over a period of several years appear to have been due to poor water conditions.

Since 1961, escapements of fall run chinook to the Sacramento-San Joaquin system have ranged from 180,000 to 320,000 fish, being toward the lower end of the range in most years.

In addition to the fall run of chinooks, the Sacramento River has a winter run which has increased in size since the construction of Shasta Dam (in 1942) changed the temperature regime of the river. We do not have yearly estimates of the size of this run, but in recent years it has appeared to average about 60,000 fish. A spring run of chinooks in the Sacramento has averaged about 30,000 fish per year, but appears to be declining gradually.

Elsewhere in California, chinook salmon spawn in several of the larger coastal streams, mostly from the Eel River northward. Counting stations on a number of these coastal streams provide index counts of spawners (Table 5). The counts do not represent total escapements since some chinooks spawn downstream from the counting stations. Altogether, the total escapement of chinook salmon to all coastal streams is estimated to average about 250,000 fish annually. The catch of chinooks from the coastal streams off the coast of California appears to be much smaller than the catch of Sacramento-San Joaquin chinooks. Presumably chinooks from the coastal streams move northward and out of California waters.

TABLE 4. Sacramento-San Joaquin River system fall-run^a chinook salmon escapement, in thousands of fish, 1953–74.

Year	Sacramento Main Stem	Sacramento Tributaries	Total Sacramento River System	San Joaquin River System ^b	Grand Total Sacramento-San Joaquin System
1953	408	105	513	84	597
1954	276	136	412	75	487
1955	231	138	369	31	400
1956	94	60	154	12	166
1957	68	34	102	15	117
1958	128	106	234	47	281
1959	267	154	421	52	473
1960	233	182	415	56	471
1961	149	102	251	2.7	254
1962	139	112	251	1.8	253
1963	146	146	292	1.8	294
1964	148	156	304	10	314
1965	103	86	189	7	196
1966	115	73	188	9	197
1967	92	66	158	23	181
1968	110	81	191	19	210
1969	133	135	268	52	320
1970	71	126	197	38	235
1971	82	112	194	45	239
1972	51	87	138	15	153
1973	61	202	263	8	271
1974 ^c	78	138	216	5	221

^a Estimates of the winter, late fall, and spring runs are available since 1971. These three runs combined have averaged about 60,000 fish.

^b Includes the Mokelumne and Cosumnes Rivers.

^c Preliminary figures.

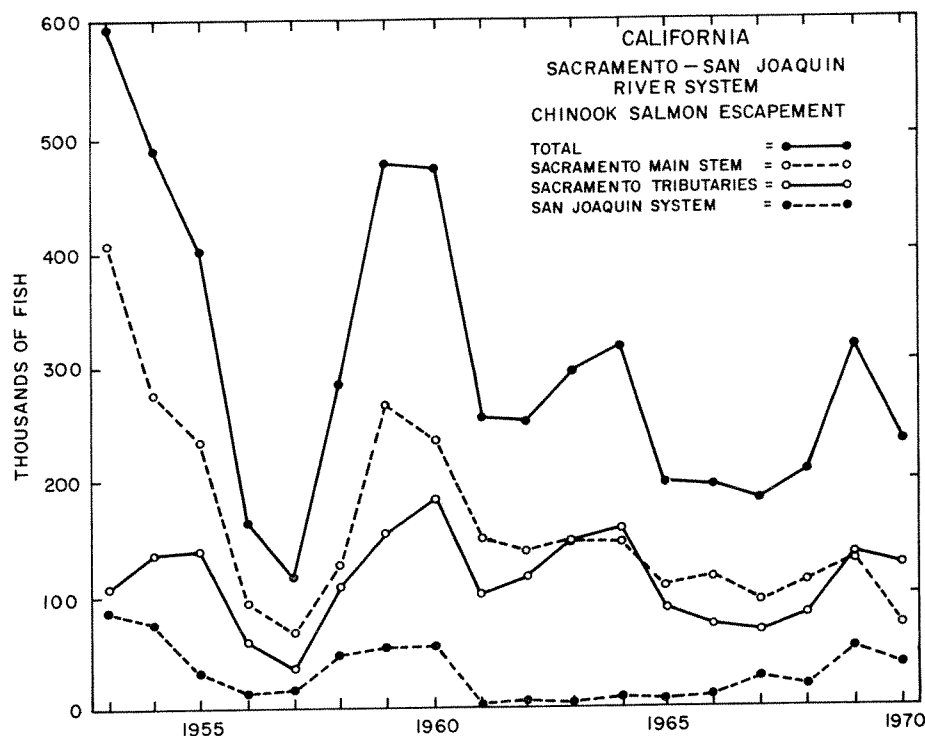


FIG. 3. Chinook salmon, fall run spawning escapement, Sacramento-San Joaquin River system.

A recently started marking program should give evidence on the extent of the northward movement in the next few years.

CATCH/ESCAPEMENT RATIOS. A marking experiment involving the 1949 brood of Sacramento River hatchery reared fall chinooks yielded a catch/escapement ratio of 3/1, indicating a high degree of utilization. As mentioned previously, a major experiment now underway should provide information on catch/escapement ratios.

COHO SALMON

Most of the coho salmon taken off California originate in Oregon and Washington streams, with the Columbia River a major contributor. There are many small coho streams in California (from Lat. 37° northward), but none produces a large run, and their collective contribution to the California commercial fishery is far less than that of Oregon and Washington streams. The Sacramento-San Joaquin River system produces no coho whatever.

High summer temperatures were presumed to be the controlling reason for the absence of natural coho runs in the Sacramento-San Joaquin Valley. After dams lowered the summer temperatures of the Sacramento and American Rivers, attempts were made in the 1950s to establish coho runs in the American

River and two small tributaries of the upper Sacramento. Planted fish returned and spawned naturally in good numbers, but as soon as the planting stopped the coho runs disappeared. The experiment was dropped.

CATCH. Ocean troll and sport fisheries catches of coho salmon from 1947-70 are given in Table 3 and Fig. 4. Most of the catch is taken along the northern coast of California (north of 39°N) from late June to mid-August. After mid-August, the coho schools return to Oregon and Washington waters.

Annual total catches of coho salmon in California ranged from 66,000 to 113,000 fish during 1947-57; dropped to 19,000 to 24,000 fish in 1958-60; and were 89,000 and 61,000 fish, respectively, in 1961 and 1962. During the next 4 years, catches increased to 478,000 fish. They remained at over 400,000 fish in 1967 and 1968, falling off to approximately 200,000 fish in 1969 and 1970.

We attribute the higher level of catch since the early 1960s primarily to increased hatchery production of coho salmon in Oregon and Washington and improved hatchery diets and techniques. In addition, it appears that in recent years coho salmon of Oregon and Washington origins moved farther south along the coast during their ocean life than formerly.

ESCAPEMENT. Index counts of coho spawners in the Trinity and Mad Rivers and the south fork of the

TABLE 5. California coastal streams index counts of salmon, 1929-73.

Year	Klamath R.	Shasta R.	Trinity River		Mad River		South Fork of Eel River	
	Chinook	Chinook	Chinook	Coho	Chinook	Coho	Chinook	Coho
1929*	4,031	—	—	—	—	—	—	—
1930	2,392	19,338	—	—	—	—	—	—
1931	12,611	81,844	—	—	—	—	—	—
1932	13,740	34,689	—	—	—	—	—	—
1933	—	11,570	—	—	—	—	—	—
1934	10,340	48,668	—	—	—	—	—	—
1935	14,051	74,537	—	—	—	—	—	—
1936	10,398	46,115	—	—	—	—	—	—
1937	33,144	33,255	—	—	—	—	—	—
1938	16,340	9,090 ^a	—	—	1,273	498	6,051	7,370
1939	—	28,167	—	—	1,257	725	3,424	8,629
1940	14,965	55,155	—	—	1,293	73	14,691	11,073
1941	11,204	13,252	—	—	3,139	308	21,011	13,694
1942	13,038	11,425	195 ^b	—	1,676	378	10,612	15,037
1943	—	10,022	—	—	1,236	259	7,264	13,030
1944	—	11,498	9,925 ^b	—	—	—	13,966	18,309
1945	—	18,191	7,510 ^b	—	—	—	12,488	16,731
1946	—	7,590	274 ^b	—	1,181	415	16,024	14,109
1947	—	341	—	—	717 ^b	510	13,160	25,289
1948	5,821	37	—	—	672	515	16,312	12,872
1949	11,504	193	—	—	484	512	3,803	7,495
1950	21,584	248	—	—	1,505	147	14,357	12,050
1951	17,857	2,024	—	—	1,519	414	12,476	11,441
1952	6,591	1,666	—	—	401	72	7,256	3,711
1953	6,267	1,605	—	—	847	91	7,948	3,052
1954	2,042	2,625	—	—	409	59	5,367	5,952
1955	14,946	1,817	—	—	390	2	3,974	5,977
1956	6,770	—	—	—	129	21	1,530	5,717
1957	2,436	2,234 ^c	—	—	494	11	3,050	5,433
1958	1,950	6,089	3,891	616	478	3	1,472	3,344
1959	3,568	9,875	7,250	119	19	541	473	2,119
1960	6,363	10,698	8,595	208	55	244	2,665	3,184
1961	2,930 ^b	8,764	5,397	355	40	710	2,046	8,479
1962	1,339 ^d	14,898 ^b	9,451	16	238	3,580	3,688	10,031
1963	2,171	31,837	6,735	83	232	1,419	2,918	14,316
1964	2,598	34,363	6,303	50	492	332 ^b	8,315	4,468 ^b
1965	678	7,911	3,075	12	—	—	2,455	3,804
1966	3,064	6,062	4,840	1,025	—	—	8,649	1,480
1967	2,687	12,314	4,616	865	—	—	3,006	2,461
1968	2,764	14,042	4,771	38	—	—	2,278	1,289
1969	2,879	13,625	2,586	1,996	—	—	3,200 ^e	3,170 ^e
1970	10,492	13,405	4,444	3,147	—	—	9,367 ^e	2,070 ^e
1971	10,846	6,619	9,221	47	—	—	5,026	1,509
1972	3,684	3,641	11,381	2,670	—	—	2,640	750
1973	8,729	9,418	5,212	8,081	—	—	5,006	3,993

* 1929 refers to counting year 1929-30, etc.

^a Counting station moved 7 miles upstream from original location.

^b Incomplete.

^c Counting station moved back to original location near mouth.

^d Counting station moved upstream from Klamathon Racks to Iron Gate Dam.

^e This figure is an estimate—station was closed before the end of the run.

— (dash) indicates no count was made.

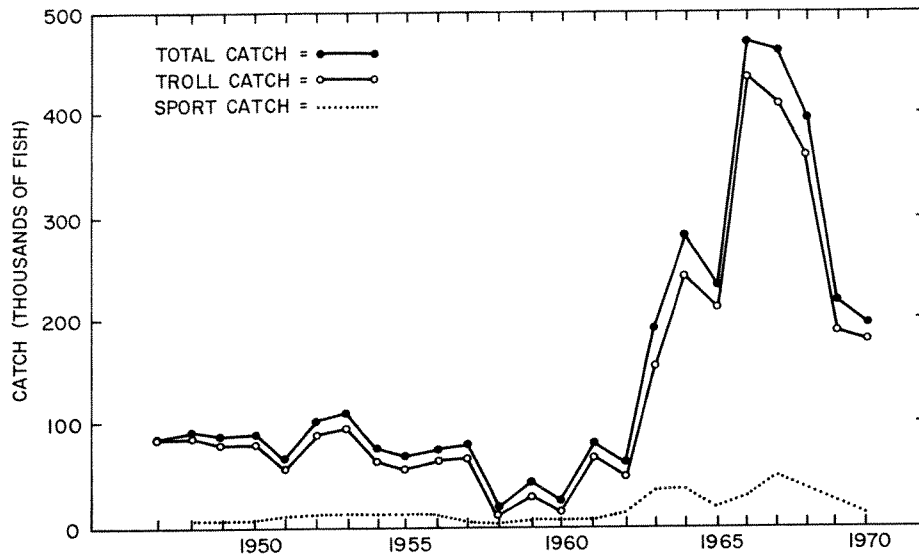


FIG. 4. Coho salmon catches in California, 1947-70.

Eel River are given in Table 5. Except for these systems, estimates or indices of escapement of coho salmon to California streams do not cover an extended period of years. The reason for this is that assessment of spawning populations of coho in the coastal streams is often hindered by high, muddy water during the time when the coho enter the streams to spawn. Carcasses settle in quiet areas where they are hidden by silt. Notwithstanding such difficulties, estimates of spawning populations of coho salmon are made for samples of typical coastal streams. These are used to estimate total (statewide) escapements. Estimates for recent years indicate total escapements of approximately 100,000 fish annually.

SUMMARY

Chinook and coho are the only salmon of import-

ance in California. The commercial fishery is restricted to trolling in ocean waters. There are sport fisheries in both salt and fresh water; the ocean catches are much the larger.

Water projects affect so many major salmon streams that the runs can be maintained only by considerable expenditures of money for flow maintenance, fish facilities, and artificial propagation. The fishery must be and is closely regulated.

Chinook dominate the fishery. Coho were relatively unimportant until 1964, when a marked upswing in coho catches started. This is attributed to greatly increased hatchery production in Oregon and Washington and to a tendency of coho to migrate farther south than formerly.