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Ecological Studies of The Sacramento-San Joaquin Delta
Part II: Fishes of The Delta**



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8. DISTRIBUTION AND FOOD HABITS OF KING SALMON, ONCORHYNCHUS TSHAUYTSCHA, AND STEELHEAD RAINBOW TROUT, SALMO GAIRDNERII, IN THE SACRAMENTO-SAN JOAQUIN DELTA

SHOKEN SASAKI

Young king salmon from the Sacramento River system moved downstream toward the sea through all channels of the north Delta. Most of the young king salmon caught in the south Delta probably also originated from the Sacramento River.

The downstream migration of young king salmon through the Delta peaked in May and June in 1964. There is some, but not conclusive, evidence that this migration is later now than it was in past years.

The adult king salmon and steelhead did not feed while in the Delta, but the young of both fed primarily on adult insects during their downstream journey.

8.1. KING SALMON

8.1.1. Adults

Adult king salmon pass through the Delta en route to their spawning grounds in the upper rivers and tributaries. They are abundant in the Delta only when this movement is in progress.

Our nets were neither designed nor set to take adult king salmon and only 50 were taken during the entire year of sampling. All were caught in the gill nets. The highest catches were in the Sacramento River during the fall when the large fall run of king salmon is migrating up the Sacramento River to spawn.

Migration of king salmon in the Sacramento-San Joaquin River system has been found at one time to occur in two distinct runs, fall and spring (Rutter, 1903; Needham, et. al., 1940; Hallock, et al., 1957). There was some evidence that a small winter run occurred, overlapping that of the spring (Needham, et al., 1940; Hallock, et al., 1957) but in recent years the winter run has expanded and its importance has increased (Dept. Fish and Game, Marine Resources Branch, pers. commun.). Hallock, et al. (1957) found peak numbers of king salmon at Fremont Weir on the Sacramento River above the Delta in September 1953. Van Woert (1955) reported highest numbers of adult king salmon at Fremont during the months of September and October 1954.

Forty-six of the 47 adult king salmon stomachs examined were empty. The stomach of one collected in lower San Joaquin River during July of 1964 contained eight *Neomysis awatschensis*.

8.1.2. Young

After spawning in the tributaries above the Delta, the adult king salmon die. The young hatch and eventually migrate downstream. These are the fish that were caught as they passed through the Delta on their way to the sea.

No young king salmon were taken in the gill nets. The smallest mesh used in the gill nets (2½" stretch mesh) was too large to catch them.

Only 67 young king salmon were caught with the otter trawl, but 1,205 were collected with the midwater trawl. Since the midwater trawl fishes about the upper 10 feet of water, this indicates that young king salmon migrate downstream near the surface. Hallock and Van Woert (1959) found in their sampling of fingerling king salmon in the Sacramento River near Red Bluff that the greatest numbers occurred only 2 to 4 feet under the surface. Hatton (1940), sampling at Hood in the Sacramento River, found the young to occur in the upper 8 feet of water.

The largest concentrations of young king salmon occurred at Mokelumne River, Sacramento River, and lower San Joaquin River stations (Figure 1). King salmon were found throughout the year at these stations but most were taken during May and June (Figures 1 and 2). It is suspected that the majority of the king salmon taken at the Mokelumne River stations, the lower San Joaquin River stations and even the stations in Old River and Indian Slough were from the Sacramento River system. At that time of the year (May–June) the cross channel at Walnut Grove was open and most of the water in the North Fork, and about half of the water in the South Fork of the Mokelumne River, came from the Sacramento River (Dept. of Water Resources, Delta Studies Section, pers. commun.). At this time, water in Old River was also Sacramento River water flowing south (upstream) to the U. S. Bureau of Reclamation pumping plant.

Concentrations of young salmon were very low in the southern and eastern parts of the Delta (Figure 1). Almost all of the few king salmon that were caught in these areas were taken in April, May, and June.

The peak downstream movement of king salmon through the Delta occurred in May and June (Figure 2). This peak appears to occur later than it did in the past (Table 1). Rutter (1903), Hatton (1940), and Erkkila, et al. (1950) reported that the peak migration occurred in March. The U. S. Bureau of Reclamation fish collection facility, which screens water entering the Delta-Mendota Canal from Old River, reported peak catches of fingerling king salmon in April during 1957, 1959, and 1960, and in May during 1961, 1962, and 1964. Data from the Carquinez Strait (Messersmith, 1966) and that of our study show peak catches in May and June of 1962 and 1964, respectively.

These apparent changes may only reflect the sampling gear used. King salmon young that migrate downstream in May and June are larger, and this size fish may have avoided the nets used in the earlier studies. Evidence from Tracy fish collection facility is contrary to this. The peaks of king salmon collection there have been progressively later in recent years.

The increased average length of king salmon (Table 1) and the fact that they appear to migrate downstream later than they did several years ago do not suggest any change in the timing of the adult spawning, but rather a delay in the young moving downstream.

Hatchery king salmon releases may also affect the size of the salmon and time of runs although we do not know if the number of young

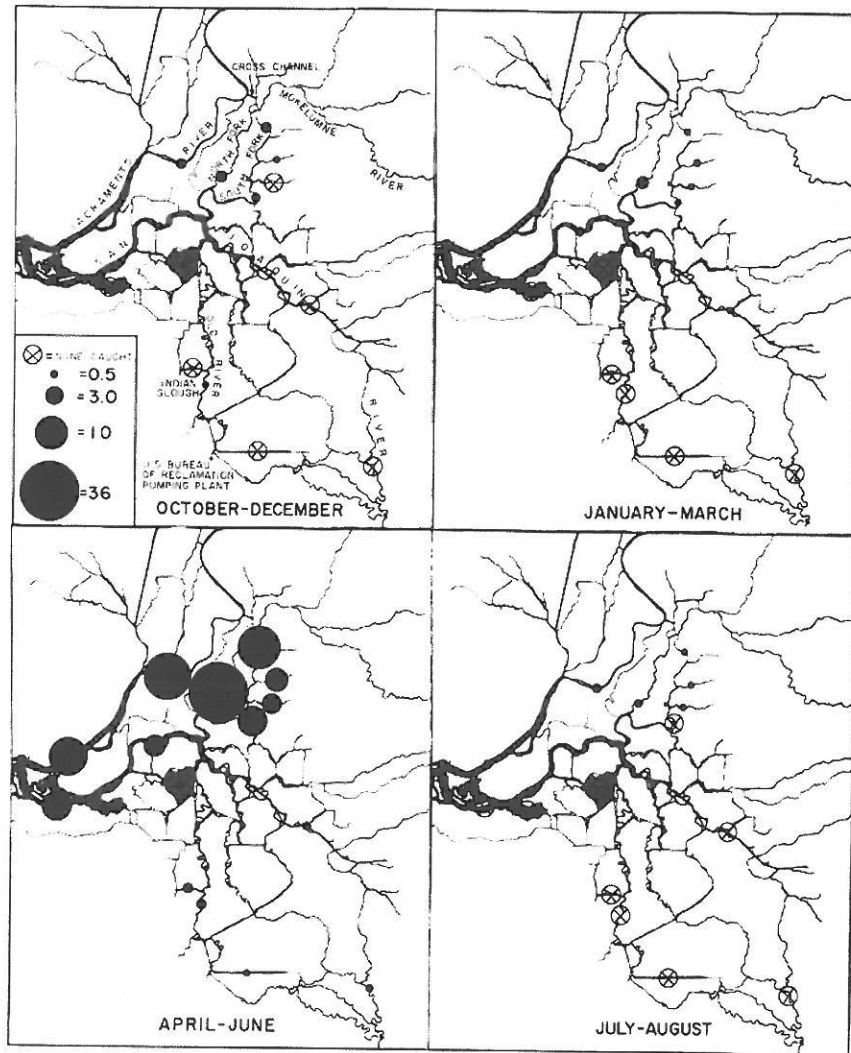


FIGURE 1. Average midwater trawl catches of king salmon downstream migrants in the Sacramento-San Joaquin Delta during 1963-1964.

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salmon released from hatcheries could cause changes in the natural migration picture.

The concentration of the San Joaquin River king salmon downstream migrants was very low in comparison to that of the Sacramento River migrants in 1964 (Figure 3).

Erkkila, et al. (1950) collected young king salmon migrating down both the Sacramento and the San Joaquin Rivers in 1949 (Figure 3). The migration down the San Joaquin River was one to two months later than that in the Sacramento. Our catches are not comparable to

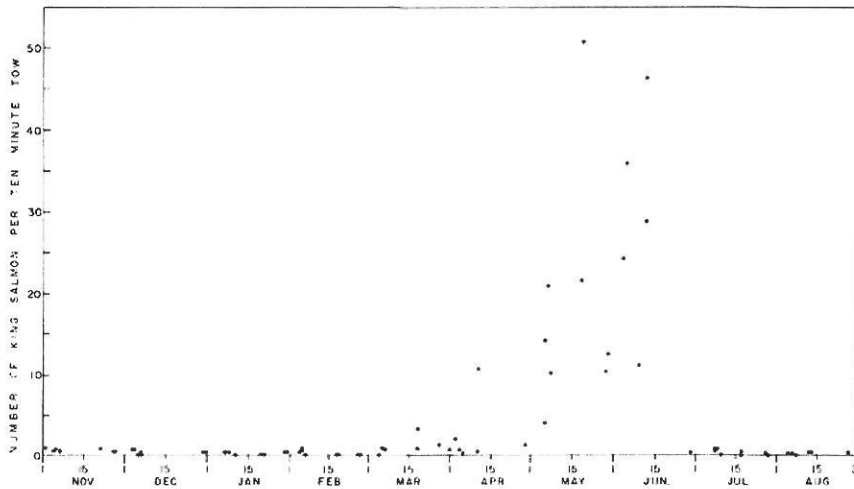


FIGURE 2. Average midwater trawl catches of king salmon downstream migrants in the Sacramento River, Mokelumne River, and lower San Joaquin River from November 1, 1963 to August 31, 1964.

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Erkkila's, but the proportion of fish taken in the two rivers each year is comparable. The catch of young king salmon in the San Joaquin River during 1949 was much higher compared to that of the Sacramento River catch than it was in 1964. This reflects the well documented decline (Table 2) of the San Joaquin River runs of adult king salmon.

TABLE 1
Comparison of Peak Migration of Young King Salmon Migrants for Different Years Through the Sacramento-San Joaquin Delta

Year	Reference	Sampling Gear	Mesh Size	Station Location	Peak Migration Period	Ave. Length During Peak
1899	Rutter (1903).....	Circular bag, 4 feet in diameter	1/2" stretch	Walnut Grove	March	4.4 cm TL
1939	Hatton (1940).....	Fyke net, 5 feet in diameter	1/2" stretch	Hood	March	3.9 cm TL
1949	Erkkila, et al. (1950) ..	Tow net, 5 feet in diameter at mouth	1/2" stretch	Five stations on Sacramento River from Walnut Grove to Pittsburg	March	3.8 cm FL
1957	U.S. Bureau of Reclamation fish collecting facility (unpub. records)	Louver screen at pumping plant	-----	Old River at U.S. Bureau of Reclamation pumping plant	April	-----
1959	"	"	-----	"	April	-----
1960	"	"	-----	"	April	-----
1961	"	"	-----	"	May	-----
1962	"	"	-----	"	May	-----
1962	Messersmith (1966)....	25' x 25' midwater trawl	1/2" stretch	Carquinez Strait	May-June	8.5 cm
1964	U.S. Bureau of Reclamation fish collecting facility (unpub. records)	Louver screen at pumping plant	-----	Old River at U.S. Bureau of Reclamation pumping plant	May	-----
1964	Delta Study.....	15' x 15' midwater trawl	3/4" stretch	Two stations on Sacramento River	May-June	8.3 cm FL

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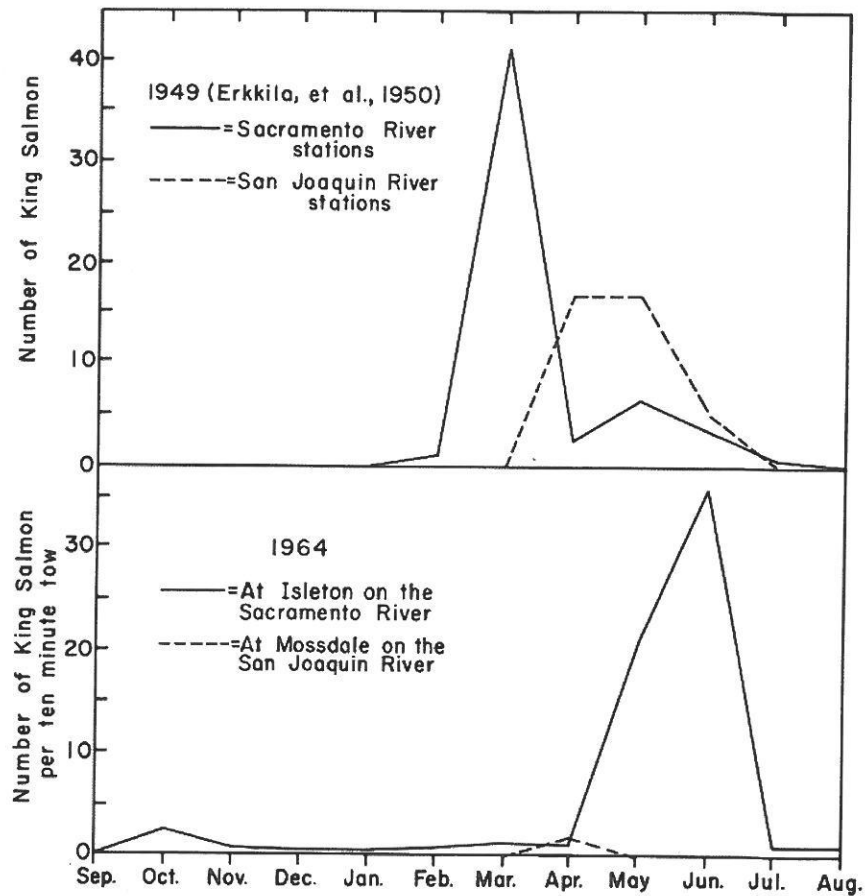


FIGURE 3. King salmon downstream migrants in the Sacramento and San Joaquin rivers for 1949 and 1964.

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TABLE 2

Fall Run Adult King Salmon Population Estimates for San Joaquin River Tributaries above Mossdale in Thousands of Fish¹

Year	Stanislaus	Tuolumne	Merced	Total
1953.....	35	45	*	80
1954.....	22	40	4	66
1955.....	7	20	*	27
1956.....	5	6	*	11
1957.....	4	8	*	12
1958.....	6	32	*	38
1959.....	4	46	*	50
1960.....	8	45	*	53
1961.....	2	0.5	*	2.5
1962.....	*	*	*	0.5
1963.....	*	*	*	*
1964.....	4	2	*	6

* Less than 500.

¹ Compiled by Marine Resources Branch, Calif. Dept. of Fish and Game.

TABLE 2

Fall Run Adult King Salmon Population Estimates for San Joaquin River Tributaries above Mossdale in Thousands of Fish

Out of 469 young king salmon stomachs examined, 322 contained food. Insects were the primary food of young king salmon. They were found in 74 percent of the stomachs containing food (Table 3). No aquatic organism was in more than 19 percent of the stomachs. Aquatic organisms were of some local importance, however, especially tendipedid larvae and pupae in the Sacramento River at Isleton, *Neomysis awatschensis* in the lower Sacramento River, lower San Joaquin River and flooded islands, and *Corophium* spp. in the lower San Joaquin River and flooded islands. Rutter (1903) and Scofield (1913) also found insects to be the most important food item of young king salmon.

TABLE 3
Stomach Contents of Young King Salmon

Food Item	Percent Frequency of Occurrence					Average and Total
	Sacramento River at Isleton	Sacramento River at Sherman Isl.	Lower San Joaquin River	Flooded Islands	Other Areas	
Microplankton.....	5.0	--	10.9	22.2	0.7	5.0
Mysid shrimp (<i>Neomysis awatschensis</i>).....	5.0	31.4	31.2	61.1	0.7	14.0
Amphipods (<i>Corophium</i>).....	16.7	8.6	34.4	61.1	11.0	18.9
Terrestrial Arachnids.....	1.7	2.9	4.7	--	--	3.1
Tendipedids.....	46.7	2.9	6.2	11.1	9.7	16.1
Other insects.....	70.0	60.0	67.2	33.3	89.0	73.9
Fishes.....	--	8.6	1.6	--	2.1	1.9
Seeds.....	--	--	--	--	0.7	0.3
Stomachs examined.....	75	68	88	22	216	469
Stomachs containing food.....	60	35	64	18	145	322

TABLE 3
Stomach Contents of Young King Salmon

8.2. STEELHEAD RAINBOW TROUT

As with the king salmon, the steelhead young and adults are only present in the Delta when they are migrating to or from the sea. Only 30 adult steelhead were caught, all with the gill net, and 15 young steelhead, mostly with the midwater trawl, during the entire year of sampling in the Delta.

Past work indicates that peak runs of adult steelhead in the Sacramento River occur in the fall as they migrate upstream to spawn (Van Woert, 1955; Hallock, et al., 1957). Yearling steelhead migrate through the Delta in the largest numbers during spring. The Marine Resources Branch trawl operations in Carquinez Strait in 1961 and 1962 show peak numbers in April and May, indicating a downstream migration at that time (Messermith, 1966).

Adult steelhead probably do not feed in the Delta. Eighteen stomachs out of 19 examined were empty. The stomach of one steelhead caught in Big Break (a flooded island) contained two *Corophium* spp. Only 5 of 14 stomachs of yearling steelhead examined contained food. of these five stomachs, four contained adult insects, two contained tendipedid larvae and pupae, and one contained a *Corophium* spp.

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