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

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9. DISTRIBUTION OF SMELT, JUVENILE STURGEON, AND STARRY FLOUNDER IN THE SACRAMENTO-SAN JOAQUIN DELTA WITH OBSERVATIONS ON FOOD OF STURGEON

LARRY D. RADTKE

9.1. SMELT

Two species of smelt occur in the Sacramento-San Joaquin Delta. They are the pond smelt, Hypomesus transpacificus, and the Sacramento smelt, Spirinchus thaleichthys. The former is found along the Pacific Coast from San Francisco to Alaska and Japan. The latter occurs primarily in the San Francisco Bay area and the lower Sacramento-San Joaquin Delta. Fish of both species move into the Delta in the winter and spring to spawn.

9.1.1. Pond Smelt

A total of 1,960 pond smelt was caught in the midwater trawl and 461 in the otter trawl during our year of sampling. A single size group, probably the 1963 year-class, dominated the catch from September through May (Figure 1). From June through August, this group diminished and young-of-the-year (1964 year-class) began to enter the catch.

In the fall of 1963, we caught few pond smelt except in the Sacramento River at Sherman Island (Figure 2). During the winter, catches at Sherman Island were lower than they had been in the fall but catches at most other stations were higher. In the spring, pond smelt were caught at all stations. Pond smelt had apparently become widely distributed in the Delta during the winter and remained so during the spring. This movement may be associated with spawning. A total of 11 ripe females were caught in February, 6 in March, 24 in April, and 8 in May. One spent female was caught in March, 6 in April, and 3 in May. In Japan, Shiraishi (1952) found that a lacustrine population of pond smelt ascended tributaries from January to March to spawn. Sato (1950) states that in the spring, pond smelt along the coast of Alaska, Siberia, and Japan ascend estuaries as far as fresh water to spawn.

In the summer catches were low except for the station in the Sacramento River at Sherman Island. About 70 percent of the pond smelt caught during June, July, and August were young of the year (Figure 1).

9.1.2. Sacramento Smelt

A total of 45 Sacramento smelt was caught in the midwater trawl and 51 in the otter trawl. Like pond smelt, the fish caught from December to May were predominantly of a single size group, probably the 1963 year-class (Figure 3). During the summer, the number of older fish diminished and young-of-the-year (1964 year-class) entered the catch.

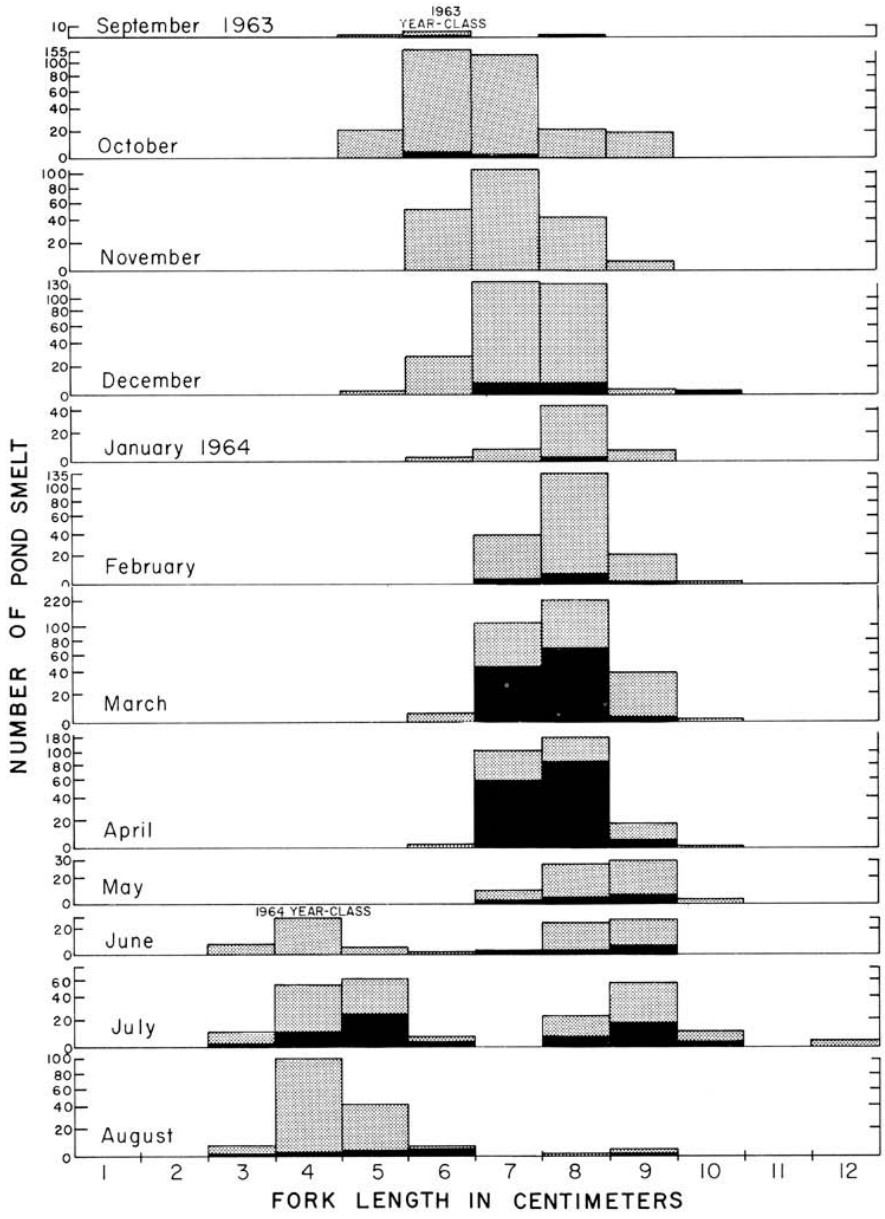

FIGURE 1. Length-frequency distribution of pond smelt caught in the Delta with midwater trawl (black) and otter trawl (shaded) from September 1963 through August 1964.

FIGURE 1. Length-frequency distribution of pond smelt caught in the Delta with midwater trawl (black) and otter trawl (shaded) from September 1963 through August 1964

No Sacramento smelt were caught in the Delta in the fall (Figure 4). Highest catches during the rest of the year were in the western Delta.

The spawning season appears to extend from midwinter to early spring. Two ripe females were taken in December, four in January, eight in February, four in March, and one in April. One spent female

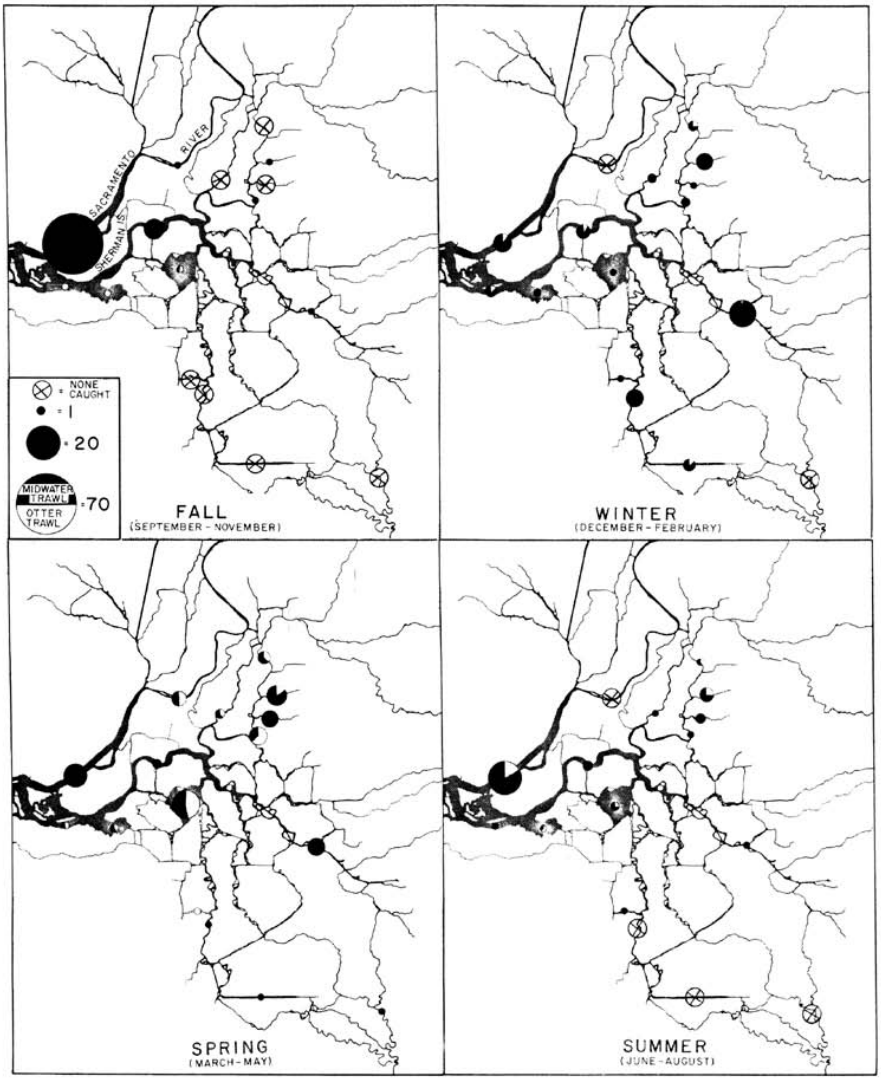

FIGURE 2. Distribution of pond smelt in the Delta. The area of each circle represents the sum of mean midwater and otter trawl catches.

FIGURE 2. Distribution of pond smelt in the Delta. The area of each circle represents the sum of mean midwater and otter trawl catches

was found in March. Ganssle (1966) found ripening Sacramento smelt below the Delta in San Pablo and western Suisun bays in March and April 1963.

About 87 percent of the fish caught in the Delta during June, July, and August 1964 were young-of-the-year (Figure 3).

9.1.3. Discussion

Our catches suggest that both species of smelt migrated upstream from the bay into the Delta during the winter. Ganssle (op. cit.) found concentrations of both pond and Sacramento smelt just below the Delta in Suisun Bay in the fall of 1963. The comparatively large catch

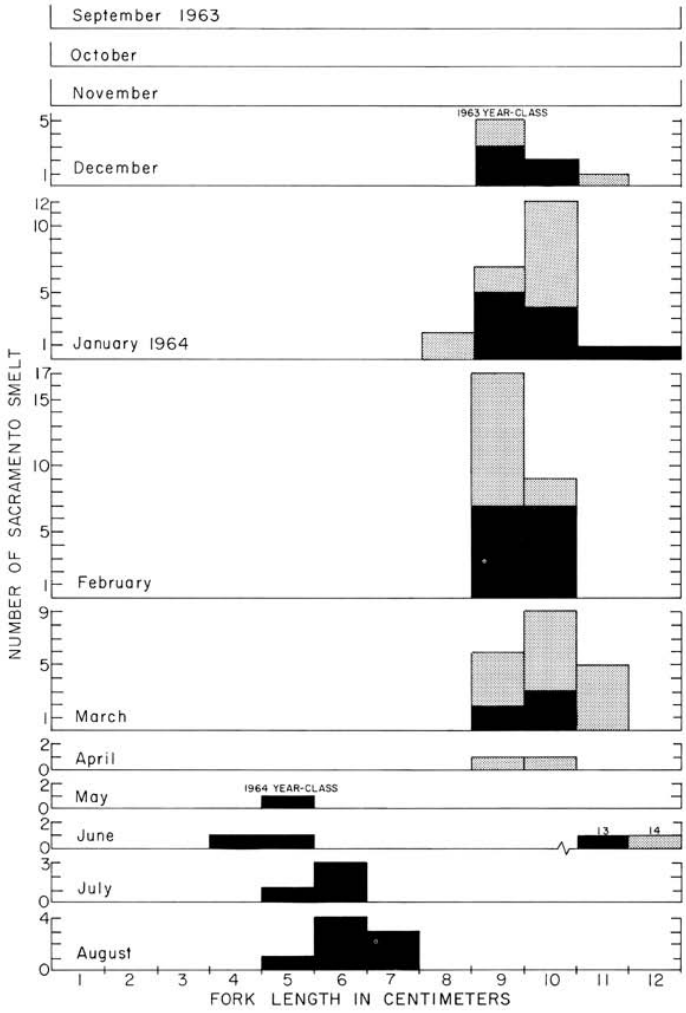

FIGURE 3. Length-frequency distribution of Sacramento smelt caught in the Delta with midwater trawl (black) and otter trawl (shaded) from December 1963 through August 1964. None were caught from September through November.

FIGURE 3. Length-frequency distribution of Sacramento smelt caught in the Delta with midwater trawl (black) and otter trawl (shaded) from December 1963 through August 1964. None were caught from September through November

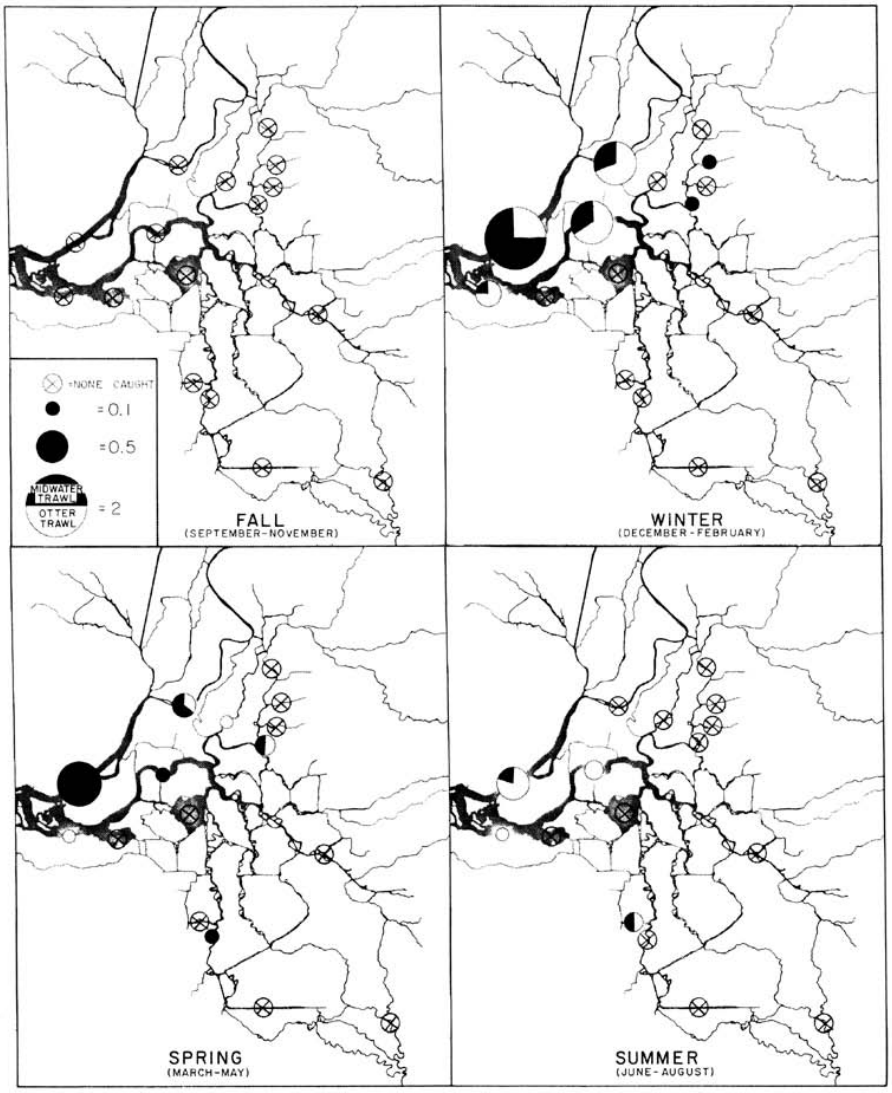

FIGURE 4. Distribution of Sacramento smelt in the Delta. The area of each circle represents the sum of mean midwater and otter trawl catches.

FIGURE 4. Distribution of Sacramento smelt in the Delta. The area of each circle represents the sum of mean midwater and otter trawl catches

of pond smelt in the Sacramento River at Sherman Island in the fall probably represents part of the same concentration Ganssle found in Suisun Bay.

The fact that catches of both species of smelt were predominantly of single size groups during the spawning migration suggests that heavy adult mortality occurs sometime during the year. Few large smelt were caught in the Delta in the summer of 1964, and Ganssle (op. cit.) found few large smelt below the Delta in Suisun Bay then, although he caught many small fish. Erkkila, et al. (1950) report high numbers of young pond smelt in the Sacramento River near Sherman Island in July and August 1948. They found few adults in the Delta at that time. If most

smelt lived to spawn more than once, larger size groups, or at least a wider size range, should have been found during the spawning migration and adult fish should have been caught in the Delta or bay after the spawning season.

Hart and McHugh (1944) state that there is evidence that the eulachon, Thaleichthys pacificus, and the surf smelt, Hypomesus pretiosus, die after spawning. Pond and Sacramento smelt are closely related to these species and may undergo similar mortality.

9.2. STURGEON

Two species of sturgeon are found in the Sacramento-San Joaquin Delta. They are the white sturgeon, Acipenser transmontanus, and the green sturgeon, A. medirostris. Both species are generally regarded as being anadromous, but little is known about the time or location of spawning in the Sacramento-San Joaquin River systems.

This paper deals with distribution of juvenile sturgeon only, because we did not catch adults. Juvenile sturgeon were present throughout the year in the Delta. Both species were most common in the western Delta. The major food items of both were the mysid shrimp, Neomysis awatschensis, and the amphipod, Corophium.

9.2.1. White Sturgeon

A total of 75 white sturgeon was caught in gill nets and 35 in the otter trawl. Three size groups were distinguishable in the catch (Figure 5). The largest individual was a 102 cm male taken in the San Joaquin near Mossdale in April. According to the growth rates measured by Pycha (1956), fish of the three distinguishable size groups were 1, 2, and 4 years old, and the largest individual was about 11 years old. No ripe sturgeon were caught. All but the largest fish were probably juveniles.

Juvenile white sturgeon were caught in most areas of the Delta, but the catches did not indicate a systematic movement (Figure 6). Over 60 percent of the total were caught in the Sacramento River.

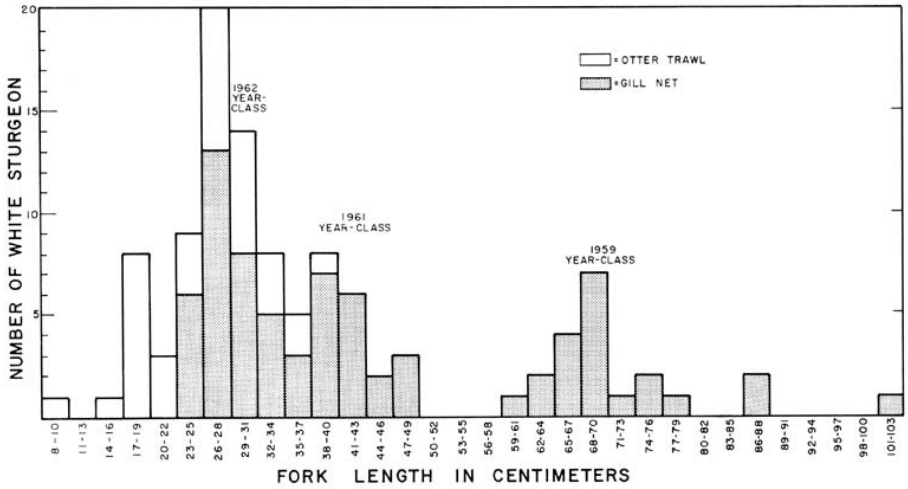

FIGURE 5. Length-frequency distribution of white sturgeon caught in the Delta with gill nets and otter trawl from September 1963 through August 1964.

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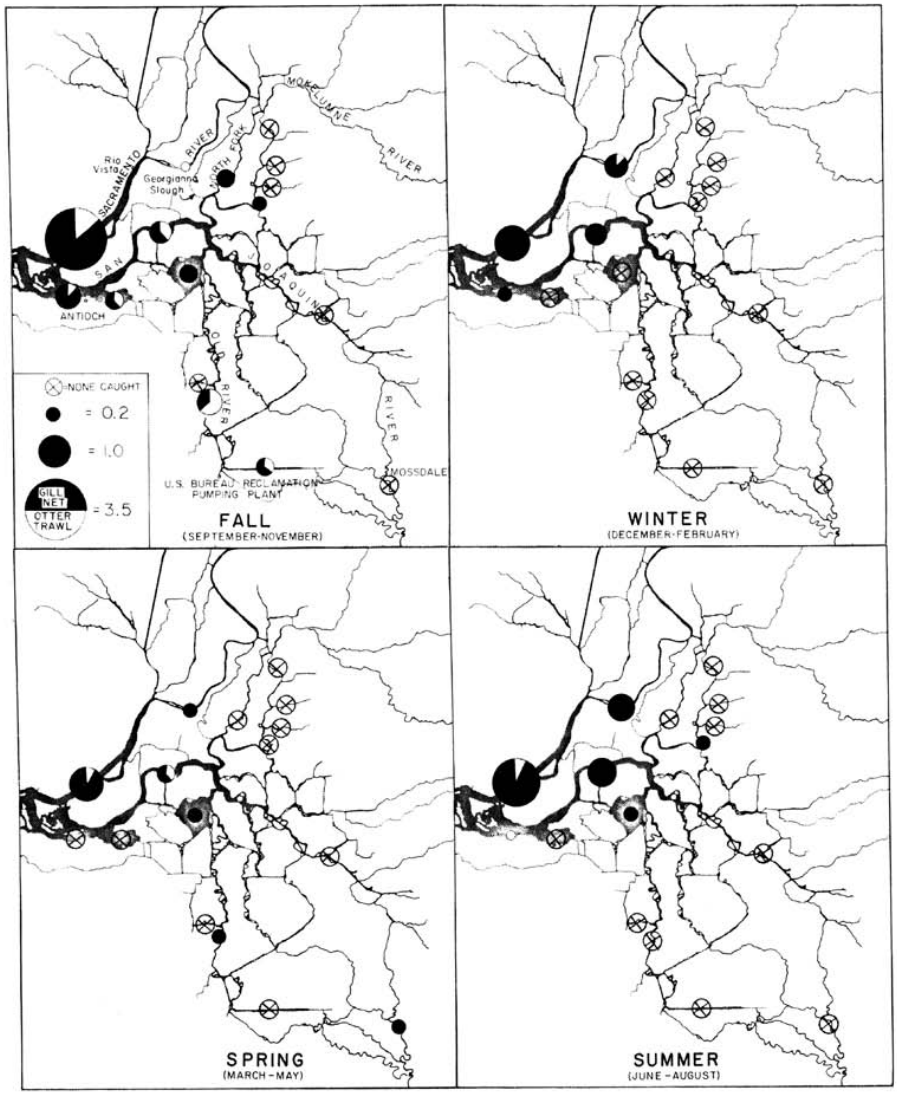

FIGURE 6. Distribution of juvenile white sturgeon in the Delta. The area of each circle represents the sum of mean gill net and otter trawl catches.

FIGURE 6. Distribution of juvenile white sturgeon in the Delta. The area of each circle represents the sum of mean gill net and otter trawl catches

In May 1965, William Heubach (pers. commun.) caught two very small white sturgeon in a plankton net towed on the bottom at a depth of about 35 feet. One was 22 mm TL, caught in the North Fork of the Mokelumne River near its junction with Georgiana Slough, and the other was 62 mm TL, caught in the Sacramento River near Rio Vista. Turner (see page 141) reports the occurrence of sturgeon roe in the stomach of a white catfish caught in the lower San Joaquin River in April 1964.

9.2.2. Food Habits

Food habits of white sturgeon were determined by examining stomach contents of 105 fish caught with gill nets and the otter trawl. Corophium and Neomysis awatschensis were probably the most important foods of smaller white sturgeon (Table 1). Other foods of smaller sturgeon were polychaete worms, tendipedids, and small American shad, Alosa sapidissima.

Larger white sturgeon (40–102 cm) utilized N. awatschensis heavily throughout the year. Corophium were found in their stomachs in winter, spring, and summer. The only other foods found were the shrimp, Paleomon macrodactylus, and the Asiatic clam, Corbicula fluminea; both were found only in the fall.

9.2.3. Green Sturgeon

We caught 138 green sturgeon in gill nets and 28 in the otter trawl. Two size groups were distinguishable in the catch (Figure 7). Little is known about the growth characteristics of green sturgeon, but all those taken were probably juveniles.

Few juvenile green sturgeon were caught until summer when fairly large catches were taken with gill nets in the San Joaquin River at Santa Clara Shoal (10.5 per gill net unit on June 25, 35.5 on July 22, and 20.5 on August 26; Figure 8). Nearly all of these were caught in a shoal area where the water was about 3 to 8 feet deep.

9.2.4. Food Habits

Food habits were determined by examining 74 green sturgeon caught with the gill nets and the otter trawl. Corophium appeared to be the most important food of smaller green sturgeon. It was the only item found in the eight smaller green sturgeon (19–39 cm) examined in the fall (Table 2). None were examined in the winter. All those examined in the spring and summer had eaten Corophium, which made up over half the volume of their diet during these seasons. N. awatschensis was also utilized heavily during spring and summer. One fish examined in the spring had eaten shrimp that we could not identify.

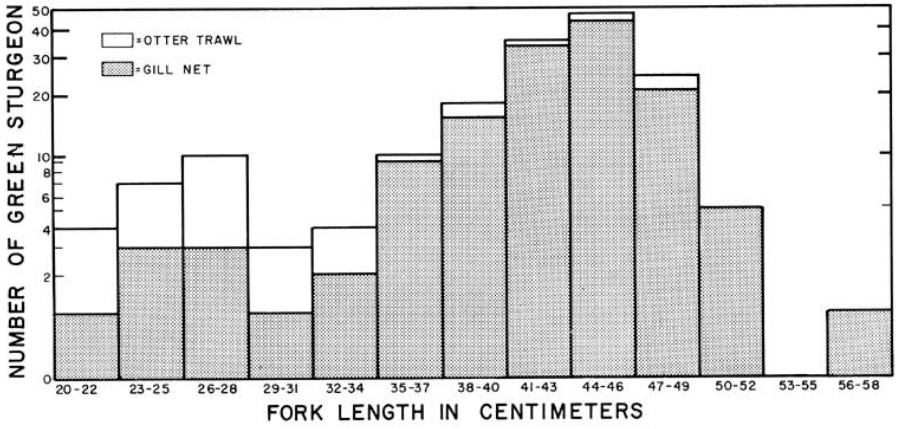

FIGURE 7. Length-frequency distribution of green sturgeon caught in the Delta with gill nets and otter trawl from September 1963 through August 1964.

FIGURE 7. Length-frequency distribution of green sturgeon caught in the Delta with gill nets and otter trawl from September 1963 through August 1964

TABLE 1

Stomach Contents of White Sturgeon

Food Item	19–39 cm White Sturgeon										40–102 cm White Sturgeon									
	Fall		Winter		Spring		Summer		All year		Fall		Winter		Spring		Summer		All year	
	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.
Polychaetes	--	--	20.0	7.8	--	--	--	--	1.8	0.5	--	--	--	--	--	--	--	--	--	--
Mysid shrimp (*Neomysis awatschensis*)	17.2	41.2	60.0	35.1	61.5	33.6	100.0	92.9	44.6	45.9	80.0	96.4	100.0	26.7	85.7	29.5	100.0	71.6	92.0	83.7
Amphipods (*Corophium*)	96.6	58.8	100.0	57.1	76.9	51.0	44.4	7.1	83.9	50.9	--	--	25.0	23.3	71.4	20.5	22.2	28.4	32.0	14.7
Oriental shrimp (*Paleomon macrodactylus*)	--	--	--	--	--	--	--	--	--	--	20.0	3.5	--	--	--	--	--	--	4.0	1.6
Tendipedids	--	--	--	--	7.7	0.1	--	--	1.8	Tr.	--	--	--	--	--	--	--	--	--	--
Asiatic clam (*Corbicula fluminea*)	--	--	--	--	--	--	--	--	--	--	20.0	0.1	--	--	--	--	--	--	4.0	Tr.
American shad (*Alosa sapidissima*)	--	--	--	--	7.7	15.3	--	--	1.8	2.7	--	--	--	--	--	--	--	--	--	--
Stomachs examined	35		7		18		11		71		7		9		9		12		36	
Stomachs containing food	29		5		13		9		56		5		4		7		9		19	

TABLE 1
Stomach Contents of White Sturgeon

TABLE 2

Stomach Contents of Green Sturgeon

Food Item	10-39 cm Green Sturgeon										40-57 cm Green Sturgeon									
	Fall		Winter		Spring		Summer		All year		Fall		Winter		Spring		Summer		All year	
	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.	Pct. Freq. Occ.	Pct. Tot. Vol.
Mysid shrimp (*Neomysis awatschensis*)	--	--	--	--	40.0	38.3	75.0	43.0	50.0	33.2	--	--	--	--	100.0	99.0	78.4	86.6	78.0	86.4
Amphipods (*Corophium*)	100.0	100.0	--	--	100.0	54.7	100.0	57.0	100.0	63.9	100.0	100.0	--	--	33.3	1.0	81.1	13.4	78.0	13.6
Unidentified shrimp	--	--	--	--	10.0	7.0	--	--	3.8	2.8	--	--	--	--	--	--	--	--	--	--
Stomachs examined	8		0		10		12		30		1		0		3		40		44	
Stomachs containing food	4		0		10		12		26		1		0		3		37		41	

TABLE 2
Stomach Contents of Green Sturgeon

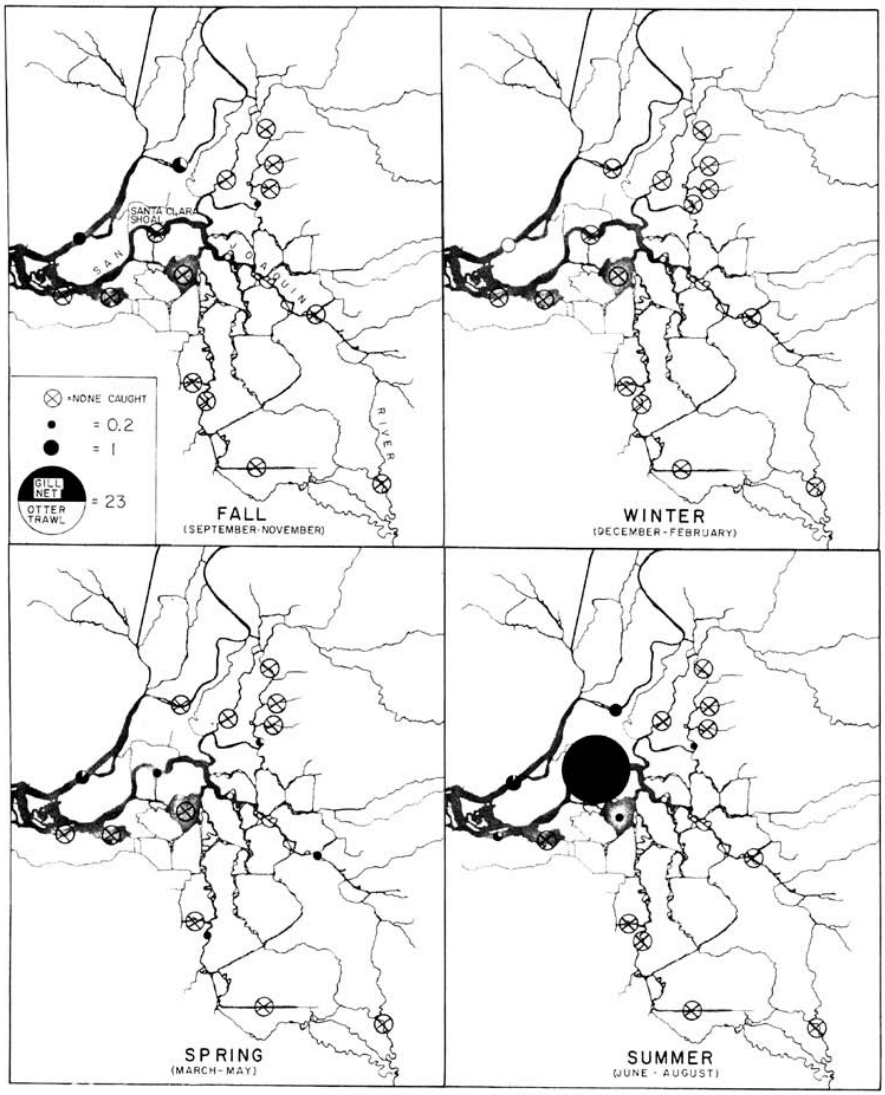

FIGURE 8. Distribution of juvenile green sturgeon in the Delta. The area of each circle represents the sum of mean gill net and otter trawl catches.

FIGURE 8. Distribution of juvenile green sturgeon in the Delta. The area of each circle represents the sum of mean gill net and otter trawl catches

Only one green sturgeon of the larger size group (40–57 cm) was examined in the fall; it had eaten only Corophium. None were examined in the winter. N. awatschensis was utilized by all fish examined in the spring, and it made up nearly the entire bulk of their diet. In the summer more fish had eaten Corophium than had eaten N. awatschensis, but the latter made up a much greater volume of the diet than the former.

9.2.5. Discussion

Juvenile white sturgeon were present in the Delta all year. They were particularly common in the lower Sacramento River. Ganssle (1966) found that white sturgeon in Suisun Bay, just below the Delta,

were generally smaller than those in San Pablo Bay. Pycha (op. cit.) states that white sturgeon less than 40 inches long seem to be present throughout the Delta the year round.

Bajkov (1951) analyzed tag returns and catch records from the commercial and sport fisheries in the Columbia River from Bonneville Dam to the mouth. He concluded that small and medium-size fish migrate upstream during fall and early winter and downstream during late winter and spring. He suggests that the upstream movement is a feeding migration related to the availability of salmon and lamprey carcasses in the upstream areas, and the downstream movement is associated with an abundance of smelt in the lower river during late winter and spring.

The relatively high catch of green sturgeon in the San Joaquin River at Santa Clara Shoal in the summer suggests an abrupt movement into this area. These fish probably moved upriver from the bay, perhaps to feed.

In general, bottom feeders such as sturgeon utilize food items most readily available to them. The general lack of organisms larger than Neomysis awatschensis in the diet in the Delta is probably due to a lack of suitable larger organisms in the environment (Hazel and Kelley, 1966). However, the Asiatic clam, which is abundant over most of the Delta, was nearly absent from our samples. In other areas, where large food organisms are available, sturgeon utilize them. For example, Ganssle (op. cit.) found larger invertebrates such as clams, Macoma sp., and the isopod, Synidotea laticauda, to be the important foods of sturgeon in San Pablo Bay, and anglers have found the bay shrimp, Crago franciscorum, an effective bait for sturgeon in San Pablo and Suisun bays.

The only previous study of sturgeon food habits in the Delta above the City of Antioch is that by Schreiber (1962). He collected 30 young-of-the-year white sturgeon averaging 20.3 cm FL, at the fish screens of the Bureau of Reclamation pumping plant on Old River (see Figure 6) during August, September, and October of 1956 and 1958. of 21 stomachs containing food, Corophium spinicorne were in 90 percent, Neomysis mercedis (now N. awatschensis) in 10 percent, tendipedid larvae in 19 percent, and tendipedid adults in 5 percent.

9.3. STARRY FLOUNDER

The starry flounder, Platichthys stellatus, occupies the bays, inlets, and sounds of the Pacific Coast from the Santa Ynez River, California, to the Alaskan Peninsula. It is common in San Pablo and Suisun bays below the Sacramento-San Joaquin Delta. The role of this species in the Delta appears to be a minor one. It is euryhaline and probably ranges into the Delta from the bay area. Some spawning may occur in the Delta, and there is evidence that striped bass feed upon some of the young there (see Stevens, p. 73).

A total of 273 starry flounder was caught in the otter trawl and 2 in the gill net. Assuming that the growth rate of the fish in the Delta was similar to that of fish in Monterey Bay (Orcutt, 1950), the fish caught in the Delta from October through April were probably 1 or 2 years old. None were sexually mature.

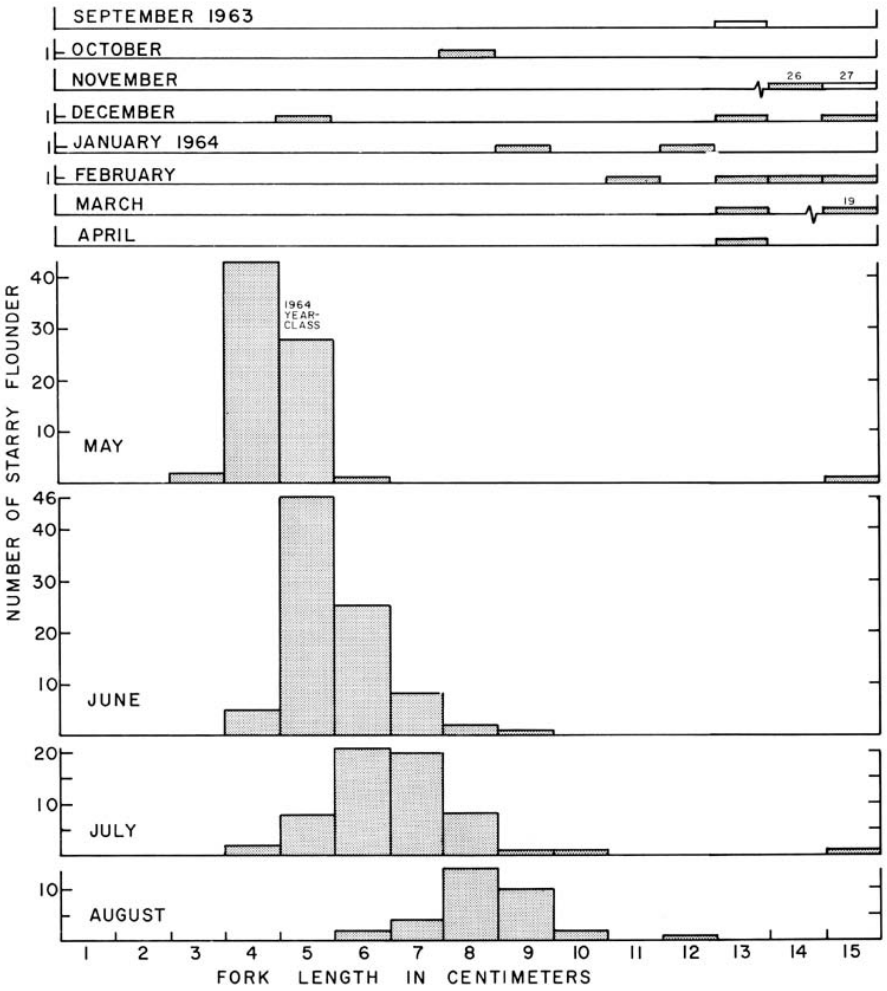

FIGURE 9. Length-frequency distribution of starry flounder caught in the Delta with otter trawl (shaded) and gill net (white) from September 1963 through August 1964.

FIGURE 9. Length-frequency distribution of starry flounder caught in the Delta with otter trawl (shaded) and gill net (white) from September 1963 through August 1964

From May through August a group of smaller fish, ranging from 3 to 10 cm TL, dominated the catch (Figure 9). Since starry flounder spawn in the winter, these were probably young-of-the-year (1964 year-class). Starry flounder occurred in most parts of the Delta, but most were taken in the San Joaquin River, the Sacramento River, the South Fork of the Mokelumne River at Terminous, and in the flooded islands, Franks Tract and Big Break in spring and summer (Figure 10). Timothy C. Farley (pers. commun.) collected some very small juveniles (8–15 mm TL) in plankton nets while towing for striped bass eggs and larvae in the lower San Joaquin River in April and May 1963 and 1964.

The starry flounder has long been regarded as being euryhaline. It is common below the Sacramento-San Joaquin Delta in Suisun and San Pablo bays (Ganssle, op. cit.) where salinities range from nearly

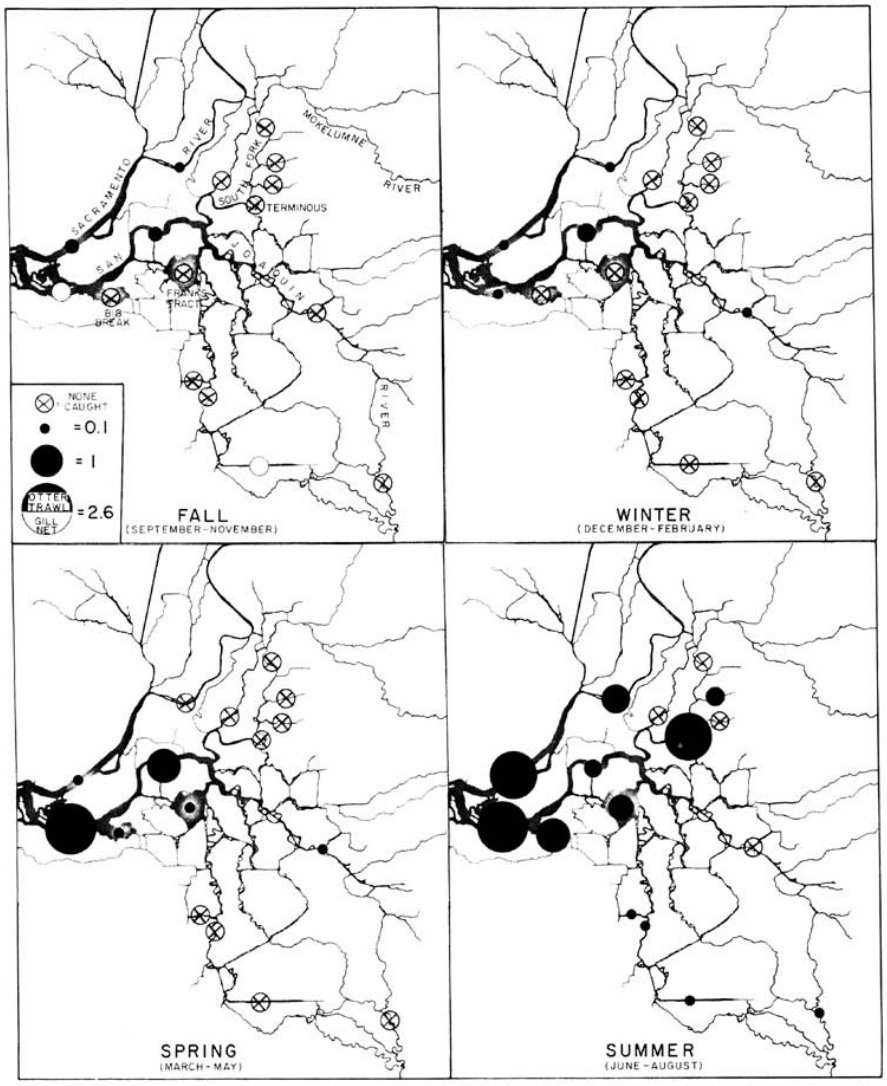

FIGURE 10. Distribution of starry flounder in the Delta. The area of each circle represents the sum of mean otter trawl and gill net catches.

FIGURE 10. Distribution of starry flounder in the Delta. The area of each circle represents the sum of mean otter trawl and gill net catches

sea water to fresh water. Carl (1937) found a small population in a brackish water lagoon in British Columbia. Gunter (1942) reports the occurrence of starry flounder 75 miles up the Columbia River.

Most of the starry flounder we caught in the Delta were young-of-the-year, but whether the adults spawn there or not is unknown.

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