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FOOD HABITS OF CALIFORNIA STRIPED BASS¹

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An opportunity arose recently to add to the fragmentary knowledge of the diet of the striped bass (*Roccus saxatilis*) in and around San Francisco Bay. Two anglers, Leon and Emil Adams, collected 387 stomachs for us in the course of a year's fishing. This report discusses their contents.

The sample is unusual, having been collected on successive Saturdays throughout the year. It should indicate in a general way what the bass population was eating at the principal times and places that the fish were being caught. The collection localities followed the principal bass migrations (Calhoun, 1952).

The stomachs were removed from the fish at the end of the day and preserved in formalin. Subsequently the contents were sorted and identified, and the numbers and volumes of food organisms were determined.

All stomachs were from fish over the minimum legal length of 12 inches. No differences of any consequence were found in the kinds of foods in large (esophagus diameter more than 0.55 inches) and small (esophagus diameter less than 0.55 inches) stomachs in this sample.

The stomachs have been divided into two groups on the basis of fishing seasons. One lot of 229 was collected during the summer and fall of 1947, in the region between San Rafael and Martinez. The other lot of 158 was from the delta portion of the San Joaquin River between Antioch and the mouth of Middle River. It was collected between November, 1947, and June, 1948. The two will be referred to subsequently simply as the "summer sample" and "winter sample," respectively.

The foods in the summer sample are shown in Table 1. They represent the principal feeding and growing season (Seefield, 1931). The uniformity was a surprise for striped bass are reputedly voracious and rather indiscriminating feeders (Shapovalov, 1936; Merriman, 1941).

Food of some sort was found in 72 percent of the sample. Shrimp (*Crango*)² were present in 35 percent. They represented 53 percent of all identifiable organisms by volume. They are clearly a major food of the bass population.

The individual shrimp are small, but they support a minor commercial fishery with a total annual catch currently fluctuating between 500,000 and 1,000,000 pounds. A progressive decline from about 2,500,000 pounds during the 1930's (Young and Withycombe, 1949) to the present comparatively small catch suggests a possible decrease in abundance. Perhaps there is some relationship here with the recent minor decline in striped bass abundance since about 1944, indicated by catch records

¹ Submitted for publication June, 1952.

² No attempt was made to distinguish the three species of San Francisco Bay shrimp, *C. franciscorum*, *C. nigricauda*, and *C. nigromaculata*.

TABLE 1
Stomach Contents of 229 Striped Bass From the Summer and Fall Fishery

Item	Incidence		Volume (cc.)	
	Times found	Percentage occurrence (in total sample)	Total in all stomachs	As percentage of identifiable material ¹
Shrimp (<i>Crango</i>).....	50	35	557	53
Anchovy (<i>Engraulis mordax</i>).....	26	11	410	39
Isopods.....	14	6	12	1
Crabs.....	6	3	24	2
Mysid shrimp (<i>Neomysis</i>).....	4	2	14	1
Bullhead (<i>Leptocottus armatus</i>).....	2	1	18	2
Flatfish.....	1	0.5	14	1
Smelt.....	1	0.5	3	0.3
Total identifiable natural food.....	--	--	1,032	--
Sardine bait.....	53	23	750	--
Unidentifiable digested material.....	69	30	692	--
Empty stomachs.....	65	28	--	--

¹ Sardine bait not included.

(Calhoun, 1949). A study of these shrimp now being made by Dr. E. S. Herald of the California Academy of Sciences promises to clarify the matter.

Next to shrimp in importance in this summer sample were anchovies (*Engraulis mordax*), found in 11 percent of the stomachs. Their volume approached that of the shrimp, amounting to 39 percent of the total.

Other foods were isopods, mysid shrimp (*Neomysis*), bullheads (*Leptocottus armatus*), flatfish, and smelt. They confirm the striped bass's readiness to eat almost any available fishes or invertebrates of appropriate size.

Let us turn now to the winter series of 158 stomachs. Feeding and growth are at a minimum in winter. Angling is normally poor then even in areas where fish can be taken readily in nets.

The contents of these stomachs are outlined in Table 2. Almost half (42 percent) were empty. The remains of small fish were the most important food, comprising 64 percent of the total volume. Mysid shrimp (*Neomysis*) were present in more stomachs than any other food. This is not surprising, in view of their abundance throughout the Delta. In spite of their frequent occurrence, however, the individual organisms are so small that they could scarcely be a major food for large striped bass, although they are known to be important for small fish in their first year (Hatton, 1940).

TABLE 2
Stomach Contents of 158 Striped Bass From the Winter and Spring Fishery

Item	Incidence		Volume (cc.)	
	Times found	Percentage occurrence (in total sample)	Total in all stomachs	As percentage of identifiable material ¹
<i>Neomysis</i>	31	20	74	20
Shrimp (<i>Crango</i>).....	12	8	48	13
Isopods.....	5	3	1	<1
Smelt.....	3	2	6	2
Stickleback (<i>Gasterosteus aculeatus</i>) ..	1	1	<1	<1
Remains of small fish.....	14	9	235	64
Tule fragments.....	1	1	3	<1
Total identifiable natural food.....	--	--	367	100
Sardine bait.....	45	28	803	--
Unidentifiable digested material.....	50	32	333	--
Empty stomachs.....	66	42	--	--

¹ Includes remains of small fish but excludes sardine bait.

The tule fragments (*Scirpus*) were probably swallowed incidentally, along with other food, although it is not unusual to find vegetable material in striped bass stomachs (Shapovalov, 1936; Hatton, 1940).

These two series of stomachs are indicative of feeding habits in and around the principal fishing grounds. Unfortunately, there is no way to sample the many fish which are foraging widely during the summer in areas where few or none are caught.

Another limitation of our sample stems from the inclination of schools of striped bass to feed intermittently (Merriman, 1941). Many of the bass caught by anglers have just begun to feed on chum or bait, after thoroughly digesting their previous natural meal. The large quantities of sardine bait found confirms this. It is of interest in this connection that 31 of 43 stomachs from angling-caught bass taken previously in the same general area were empty (Shapovalov, 1936). Similarly, Hatton (1940) found 57 percent empty stomachs in 224 gill-net caught bass from the mouth of the Delta in the spring.

It is apparent that the striped bass stomachs which can be obtained are not going to provide an adequate picture of the food sources of the adult population, no matter how large the sample is. Work with them has accordingly been discontinued.

SUMMARY

Shrimps (*Crango*) and anchovies (*Engraulis mordax*) were the predominant foods in 229 striped bass stomachs from the summer and fall fishery in San Francisco Bay and adjacent waters. Small fish predominated in 158 stomachs from the winter fishery.

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