REPRINT FROM
Calif. Fish and Game, 53 (1) : 49-62. 1967.

THE DIET OF JUVENILE AND ADULT STRIPED BASS, ROCCUS SAXATILIS, IN THE SACRAMENTO-SAN JOAQUIN RIVER SYSTEM[1]

JOHN L. THOMAS[2]
Inland Fisheries Branch
California Department of Fish and Game

More than 4,500 striped bass stomachs were examined during the period 1957-1961. About half contained natural food items. Comparisons were made between size of bass and size of organisms eaten. Major foods were northern anchovies, shiner perch, striped bass, king salmon, carp, crayfish, bay shrimp, mysid shrimp, isopods, scuds, and insect larvae.

INTRODUCTION

Previous reports in varying degree have described foods eaten by striped bass in California (Smith, 1896; Scofield, 1910; Scofield and Bryant, 1926; Scofield, 1928, 1931; Shapovalov, 1936; Hatton, 1940; Johnson and Calhoun, 1952; Skinner, 1962; and Heubach, Toth, and McCready, 1963). The present study was initiated in an attempt to obtain a wider picture.

Incidental collection of striped bass stomachs began in 1957 and continued through 1960. In 1961, monthly samples were obtained throughout the entire area inhabited by striped bass. Work on young-of-the-year bass was completed in 1962 (Heubach et al., 1963). Emphasis after 1962 was placed upon juvenile and adult bass.

Information in this report on the Sacramento-San Joaquin Delta was collected before 1962. The Delta Fish and Wildlife Protection Study of the California Department of Fish and Game has studied the diet of striped bass in the Delta since then and will soon publish the results. Hopefully, understanding of the bass' diet will help explain variations in bass migrations, growth, and year-class strength.

DESCRIPTION OF STUDY AREA

The Sacramento and San Joaquin rivers merge to form a vast network of channels, sloughs, and inland bays terminating in the Pacific Ocean at San Francisco. This inland water system, which comprises the study area, has been described and illustrated in a great number of earlier reports on California's striped bass fishery. For this reason, only a brief description is given in this paper.

Upstream from Carquinez Strait, the water is essentially fresh, depending upon the season. Seaward from the Strait the water becomes more saline and is essentially marine in character (Heubach et al., 1963).

[1] Submitted for publication October 1965. This work was performed as part of Dingell-Johnson Project California F-9-R, "A Study of Sturgeon and Striped Bass", supported by Federal Aid to Fish Restoration funds.
[2] Now with Inland Fisheries, Region 3, San Francisco.

Juvenile striped bass are found the year around in large numbers above San Francisco Bay, and apparently have no well defined migration pattern (Clark, 1936). Adult bass [4] have well defined migration patterns (Calhoun, 1952; H. K. Chadwick, MS). In the spring, adults disperse throughout the Delta and its tributary rivers to spawn. After spawning, bass return to the lower bays and adjacent coastal areas for the summer. In recent years, many have remained in the lower bays during fall and winter, while others have returned to the Delta.

METHODS

The striped bass habitat was divided into six separate food communities: (i) San Francisco Bay, (ii) San Pablo Bay, (iii) Sacramento River and bays from Crockett to Pittsburg, (iv) Delta, (v) lower Sacramento River, and (vi) upper Sacramento River.

Bass were obtained by angling, trawling, and gill netting in each area. They were separated into three size groups (6 to 10 inches--age I; 11 to 15 inches—age II; and 16 inches and larger—age III and older). The sampling goal was a minimum of 20 bass containing food in each size group present in each area every month.

In the field, stomach contents were individually wrapped in cheesecloth and preserved in 10% formalin. In the laboratory, these contents were identified (Table 1) and the volume of each item was measured in a graduated glass cylinder by water displacement.

[3] Bass less than 16 inches total length (the minimum legal size in California).
[4] Bass 16 or more inches total length.

TABLE 1

Common and Scientific Names of Organisms Cited in This Report

Vertebrates

American shad	Alosa *sapidissima*
Carp	Cyprinus carpio
Gobies	Gobiidae
Goldfish	Carassius auratus
Green sunfish	Lepomis cyanellus
Jacksmelt	Atherinopsis californiensis
King salmon	Oncorhynchus tshawytscha
Northern anchovy	*Engraulis mordax*
Northern midshipman	Porichthys notatus
Pacific herring	Clupea *pallasii*
Pile perch	Rhacochilus vacca
Pond smelt	*Hypomesus* transpacificus
River lamprey	Lampetra ayresii
Sacramento smelt	*Spirinchus thaleichthys*
Shiner perch	*Cymatogaster* aggregata
Splittail	*Pogonichthys* macrolepidotus
Staghorn sculpin	*Leptocottus* armatus
Starry flounder	Platichthys stellatus
Surf smelt	Hypomesus pretiosus
Threadfin shad	Dorosoma petenense
Tomcod	*Microgadus* proximus
White croaker	*Genyonemus* lineatus
White seaperch	Phanerodon furcatus

Invertebrates

Bay shrimps	*Crago* spp. and *Palaemon macrodactylus*
Black flies	Simuliidae
Caddisflies	Hydropsychidae
Cladocerans	Cladocera
Clam	*Macoma nasuta*
Copepods	Copepoda
Crayfish	*Pacifastacus leniusculus*
Ghost shrimp	*Callianassa californiensis*
Isopod	*Synidotea* sp.
Mayflies	Ephemeroptera
Market crab	*Cancer magister*
Midges	Tendipedidae
Moth flies	Psychodidae
Mysid shrimp	*Neomysis awatschensis*
Periwinkle	*Littorina* sp.
Scuds	*Corophium* spp.
True flies	Diptera

RESULTS

The results for each assigned locality were summarized on a seasonal basis by percentage frequency of occurrence (Tables 2-5) and percentage volume (Figures 1-4).

About half (2,259) of the 4,551 juvenile and adult striped bass stomachs examined contained natural food. Although the sample size seems large, some areas were not adequately sampled and in many cases samples within size groups were small.

TABLE 2

Food Items Eaten by Striped Bass During Spring, by Area,* in Percentage Frequency of Occurrence †

Food items	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Verterbrates						
Anchovy	29	15	10	‡		
Shiner perch	40	--		‡		
Herring			20	‡		
Staghorn sculpin	6			1		
Surf smelt			2	--		
Sacramento smelt			3		‡	‡
King salmon			3	--	22	62
Lamprey		--	--		9	--
Striped bass						
Pond smelt	‡	‡	--	--	7	--
Carp	‡	‡			16	
Unknown fishes	28	13	10		31	IR
Invertebrates						
Bay shrimps	8	69	19		1	
Crayfish		‡	1	--	7	
Isopod		16	30		‡	
Mysid shrimp		6	47	66	7	
Scuds	‡	1	6	11	--	--
Copepod	‡	1	--	7		--
Cladocerans	‡	1		7		
Mayflies		‡		--		1§
Midges	‡	‡	‡			13
Unknown Dipterans		‡	‡	--	--	7
Sample size	65	68	127	134	56	45

* Areas : 1—San Francisco Bay ; 2—San Pablo Bay ; 3—Crockett to Pittsburg ; 4—Delta ; 5—Lower Sacramento River ; 6—Upper Sacramento River.
† Organisms with a frequency of occurrence of 2 or less are omitted.
‡ This forage organism is not normally present.

Spring Diet (March 1—May 31)

San Francisco Bay

Stomachs of 65 adult bass taken by angling contained food. Shiner perch and northern anchovies were the two most important items. Shiner perch constituted 50% and anchovies 34% by volume. Staghorn sculpins and bay shrimps were minor items in the diet.

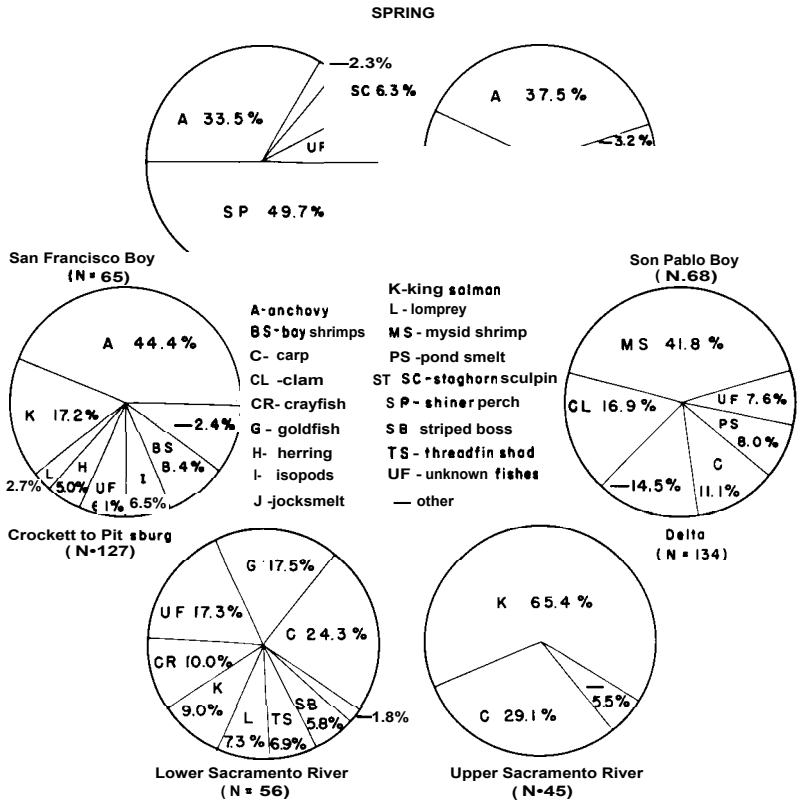

FIGURE 1—Food items found in striped bass stomachs during spring, in percentage of total volume and by area.

San Pablo Bay

Northern anchovies and bay shrimps constituted 67% by volume of the food eaten by 68 bass in all three size groups. Isopods occurred frequently ; however, because of their small size they were not important volumetrically.

Crockett to *Pittsburg*

In 127 stomachs containing food from all three size groups, northern anchovies were the major item by volume and king salmon were second. Mysid shrimp, isopods, Pacific herring, and bay shrimps occurred frequently, but added little volume.

Delta

Mysid shrimp occurred in 66% of 134 bass stomachs from all three size groups containing food. Mysids constituted 42% of the total volume. Copepods, cladocerans, and scuds were minor diet items. The stomachs of most adults were empty both here and in the next two areas.

Lower Sacramento *River*

Carp constituted the most important food in the stomachs of 56 bass of all three size groups from the lower Sacramento River. Several other fishes and crayfish were important by volume. Fingerling king salmon occurred in 22% of the stomachs and formed the principal diet of bass in the Courtland area.

Upper *Sacramento River*

In the upper Sacramento and lower American rivers, king salmon were the major diet item of 45 juvenile bass. Salmon comprised 65% of the stomach contents by volume and were found in 62% of the bass sampled. Aquatic insect larvae, particularly caddisflies and true flies, were the only other important foods.

TABLE 3

Food Items Eaten by Striped Bass During Summer, by Area,* in Percentage Frequency of Occurrence †

Food items	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Vertebrates						
Anchovy	46	31	34	‡	‡	
Shiner perch	28	--	--	‡	‡	
Herring	8	4		‡	‡	
Tomcod	6	--		‡	‡	
Staghorn sculpin	3		--	‡	1	
Starry flounder	3			‡		
Jacksmelt					‡	
Gobies	2			--	‡	
King salmon		--	2	--	30	4
Lamprey		--	--	--	--	
Striped bass			28	23	4	
Pond smelt	‡	‡	--	--	8	
Carp	‡					
Unknown fishes	23	5			1	
Invertebrates						
Ghost shrimp	3	--	--	‡	1	
Market crab	3	7	--	1	1	
Bay shrimps	10	45	25	--	1	
Crayfish	‡	‡	‡	--	12	
Isopod	5	26	23		1	
Mysid shrimp	‡	1	13	31	--	
Periwinkle		5	--		--	
Scuds					19	23
Mayflies	‡	‡	‡	--	--	3
Caddisflies					--	21
Midges					10	10
Black flies						2
Moth flies						11
Unknown Dipterans	‡			--	--	2
Sample size	196	74	127	173	104	184

* Areas : 1—San Francisco Bay ; 2—San Pablo Bay ; 3—Crockett to Pittsburg ; 4—Delta ; 5—Lower Sacramento River ; 6—Upper Sacramento River.
Organisms with a frequency of occurrence of 2 or less are omitted.
‡ This forage organism is [illegible].

Summer Diet (June 1—August 31)

San Francisco Bay

Northern anchovies and shiner perch were the principal dietary items found in 196 adult bass stomachs containing food. Anchovies were most important both in numbers and volume. Pacific herring and Pacific tomcod were less important but comprised 13% by volume. Bay shrimps appeared in 10% of the bass stomachs containing food.

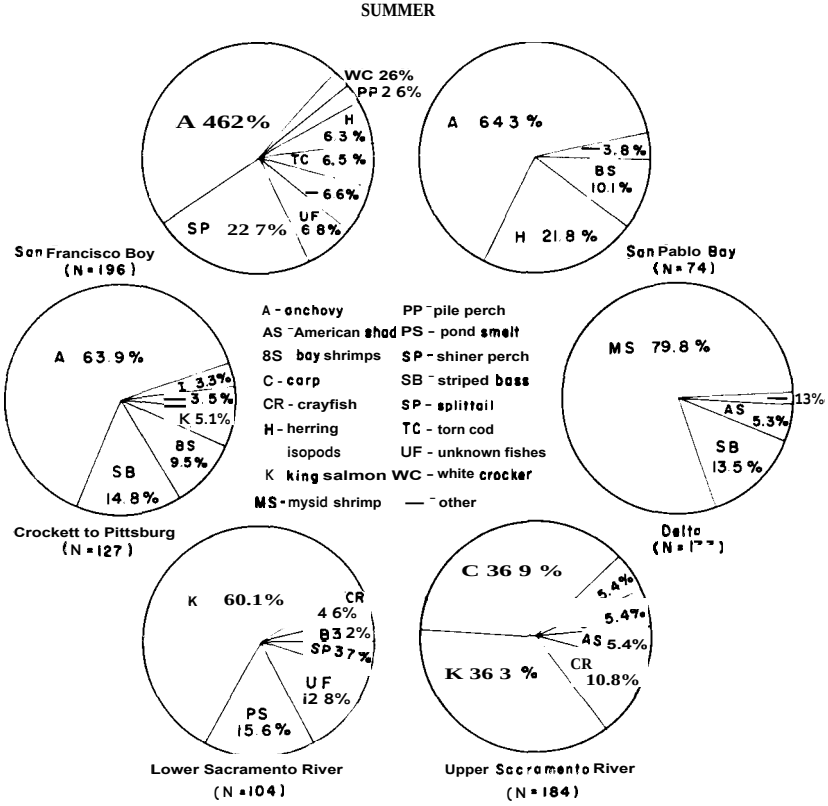

FIGURE 2—Food items found in striped bass stomachs during summer, in percentage of total volume and by area.

San Pablo Bay

Analysis of 74 bass stomachs of all three size groups showed that northern anchovies made up 64% of the diet by volume. Bay shrimps and isopods were the only other items that appeared frequently.

Crockett to *Pittsburg*

Northern anchovies were the major dietary item both in frequency and volume in 127 bass of all three size groups containing food. Striped bass and bay shrimps were less important, comprising one-fourth the total volume. Isopods and mysid shrimp were frequently present but did not add greatly to the total volume.

Delta

Mysid shrimp were the preferred food of 173 bass of all three size groups examined (169 bass were juveniles). Mysids were found in 91% of the sample and represented 80% of the total volume. The only other food item of significance consisted of small striped bass, which occurred in 23% of the stomachs and comprised 14% of the total volume.

Lower Sacramento *River*

King salmon occurred most often in the diet and comprised 60% by volume of all food consumed by 104 bass. Pond smelt and crayfish appeared in minor numbers and volume. The frequency of occurrence of scuds was second only to that of salmon; however, due to the scuds' small size they added very little to the total volume eaten.

Upper Sacramento River

King salmon and carp comprised 73% by volume of food eaten by 184 juvenile bass. Crayfish appeared in minor quantities and contributed 11% to the total volume. Scuds and the larvae of caddisflies and true flies occurred frequently in stomachs but contributed little to the volume.

Fall Diet (September 1—November 30)

San Francisco Bay

Northern anchovies and shiner perch occurred in almost equal volumes and together made up over half the volume of all food eaten by

TABLE 4

Food Items Eaten by Striped Bass During Fall, by Area,* in Percentage Frequency of Occurrence †

Food items	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Vertebrates						
Anchovy	30	15	8			
Shiner perch	26	--	--			
Herring	4	--				
Tomcod	8					
Staghorn sculpin	--	3	--			
Starry flounder	4	--				
Surf smelt	--	--	3	‡		
King salmon			--	--		
Lamprey			--			--
Striped bass		3	16	7	--	
Green sunfish	‡	‡	--	--	--	5
Carp	‡	‡				41
Unknown fishes	28	14	12		i	17
Invertebrates						
Ghost shrimp		9	--	‡		
Market crab	3	2		‡		
Bay shrimps	30	55	34	2	‡	
Crayfish	I	‡	‡	--	30	
Isopod	19	25	23	-	‡	
Mysid shrimp	‡	‡	25	8	--	
Periwinkle		5	--	--		
Scuds		I			a	4
Mayflies	‡	‡			--	10
Caddisflies					--	14
Midges					40	
Unknown Dipterans	‡	‡	‡	--	--	3
Sample size	106	183	119	138	31	103

Areas: 1—San Francisco Bay; 2—San Pablo Bay; 3—Crockett to Pittsburg; 4—Delta; 5—Lower Sacramento River; 6—Upper Sacramento River.

* Organisms with a frequency of occurrence of 2 or less are omitted.

‡ This forage organism is not normally present

106 adult bass. Pacific herring and Pacific tomcod comprised 22% by volume but did not occur frequently. Bay shrimps and isopods occurred often in stomachs but contributed little to the total volume.

San Pablo Bay

Bay shrimps made up 25% of the diet by volume, and appeared in over half of 183 stomachs containing food. Northern anchovies occurred more often than staghorn sculpins, but the sculpins, being larger, were more important in volume. Together, these two fishes constituted 38% of the volume. Isopods constituted the second most frequent item, although they were of little importance by volume.

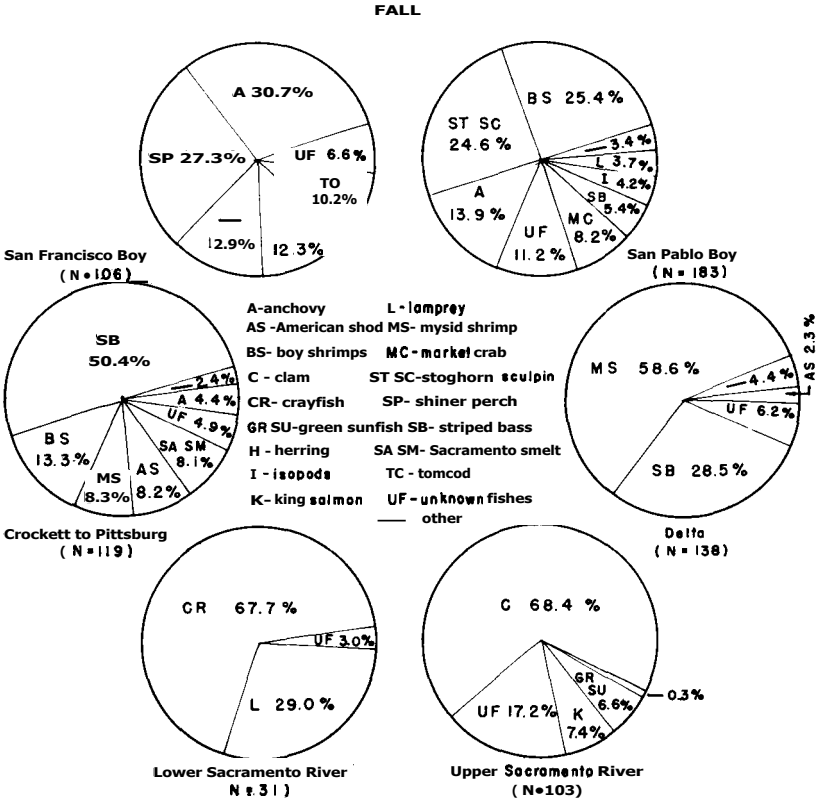

FIGURE 3—Food items found in striped bass stomachs during fall, in percentage of total volume and by area.

Crockett to *Pittsburg*

In 119 stomachs containing food, young striped bass constituted 50% of the diet by volume. Bay shrimps, mysid shrimp, and isopods occurred frequently, and the first two made up 22% of the diet by volume.

Delta

Mysid shrimp comprised the major portion of the diet by both number and volume. Young striped bass also appeared in significant volume. In the sample of 138 fish containing food, all but 6 were under 16 inches long.

Lower Sacramento River

Thirty-one of 109 fish contained food. The majority had scuds, midges, or both in their stomachs, but crayfish and river lampreys made up 97% of the total volume.

Upper *Sacramento River*

Carp accounted for 68% of the diet by volume and 41% by frequency of occurrence in 103 bass. Scuds and insect larvae occurred frequently but added an insignificant amount by volume because of their small size.

Winter Diet (December 1—February 28)

San Francisco Bay

In 16 adult bass containing food, white seaperch and Pacific herring comprised 64% of the diet by volume. Bay shrimps appeared most often but contributed little to the volume.

TABLE 5

Food Items Eaten by Striped Bass During Winter, by Area,* in Percentage Frequency of Occurrence †

Food items	Area 1	Area 2	Area 3	Area 4
Vertebrates				
Anchovy		4	--	‡
Herring	13	--	ii	‡
Sacramento smelt	--			‡
Lamprey				1
Striped bass	--	--	ii	8
Pond smelt	--			--
Threadfin shad				8
Unknown fishes	56		2i	15
Invertebrates				
Bay shrimps	19	70	39	--
Isopod		48	18	
Mysid shrimp	-	3	29	i
Periwinkle	--	3	--	--
Sample size	16	118	28	61

* Areas: 1—San Francisco Bay; 2—San Pablo Bay; 3—Crockett to Pittsburg; 4—Delta.
† Organisms with a frequency of occurrence of 2 or less are omitted.
‡ This forage organism is not normally present.

San Pablo Bay

Bay shrimps accounted for 47% of the diet by volume and occurred in 70% of the stomachs containing food. Isopods occurred in 48% of the bass containing food but accounted for less than 8% of the total volume. All but 15 of 118 fish containing food were less than 16 inches long.

Crockett to *Pittsburg*

Twenty-eight bass containing food were collected. Small striped bass constituted 34% of the diet by volume. Sacramento smelt and pond smelt accounted for 31%. Smaller organisms, such as bay and mysid shrimps and isopods, occurred frequently but added less than 13% by volume.

Delta

Mysids appeared in 74% of 61 bass containing food. Striped bass and threadfin shad comprised 51% of the stomach contents by volume.

Sacramento *River*

Six stomachs containing food from the lower Sacramento River near Rio Vista indicate that river lampreys, small striped bass, pond smelt and bay shrimps appear in the diet. However, the sample is too small to show the amounts reliably.

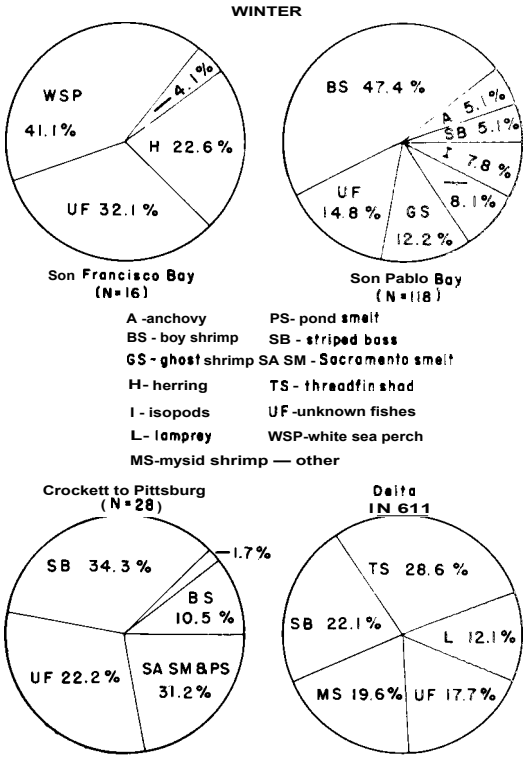

FIGURE 4—Food items found in striped bass stomachs during winter, in percentage of total volume and by area.

Food Selection

Although bass ate many different organisms occasionally, there were instances in which a minor item occurred in large numbers in one or two specimens and formed the only record of that item in the diet.

TABLE 6

A Comparison of Four Major Food Items Found in Small, Medium, and Large Bass by Mean Percentage Frequency of Occurrence. All Samples Were from the Area Between Crockett and Pittsburg.

Date	Fish 6 to 10 inches					Fish 11 to 15 inches					Fish over 16 inches				
	No. bass examined w/food	*Neomysis*	Isopods	Shrimps	Fishes	No. bass examined w/food	*Neomysis*	Isopods	Shrimps	Fishes	No. bass examined w/food	*Neomysis*	Isopods	Shrimps	Fishes
5/2/62	16	38	63	13	25	18	17	44	17	95	3	--	33	33	100
5/31/62	8	50	25	13	25	3		100	33	67	3		--	67	67
6/28/62	8	*	13	38	83	4		25		100	1				100
7/27/62	2	*			100	12		8	1	92	1	*			100
8/24/62	21	48	55	45	57	9		33	33	67	1	--	--		100
8/19/63	4	25	25		100	11	9	--	9	92	2			50	100
11/29/62	12	50	17	25	--	8	13	--	75	38	5	--	20	40	100
Totals	71	211	176	132	390	65	39	210	184	551	16	0	53	190	667
Mean percentage frequency of occurrence		42	25	19	55		8	30	26	79		0	8	27	95

* *Neomysis* excluded from the sample these days, since it did not occur in any size groups listed.

For example, 2 of 443 stomachs from San Pablo Bay contained northern midshipmen, a species found in the Bay all year. One stomach contained 9 midshipmen, and the other 19. No other food was present in these 2 bass. Apparently, these items were selected deliberately ; other bass caught at the same time in the same area contained different food items.

In the area between Crockett and Pittsburg, all three size groups of bass were collected at the same time, and significant differences were noted in the size and kind of food selected (Table 6). Smaller bass selected small food items such as mysid shrimp, while large bass generally ate larger items, such as fish. Isopods and shrimps were abundant medium-sized food items in the area and occurred frequently in stomachs of 11- to 15-inch bass. Shapovalov (1936) also noted size selectivity of bass in Waddell Creek lagoon. There, the diet of large bass consisted primarily of fishes, while smaller bass fed almost exclusively on small crustaceans.

DISCUSSION

Striped bass eat a wide variety of the foods available within their habitat. Important foods include both pelagic forms such as anchovies and bottom dwellers such as shrimps, but animals which live in the bottom, such as annelid worms and clams, seldom contribute significantly to their diet.

Factors other than overall abundance obviously affect an organism's availability to bass. For example, pond smelt, American shad, white catfish, and various native minnows are much more abundant in the Delta and Sacramento River than their occurrence in the diet indicates. Conversely, carp and king salmon are probably less abundant than their occurrence in the diet indicates. While identification of the factors controlling availability would be important in understanding ecological relationships, the necessary facts are not available.

The migrations of the bass are the primary factor causing seasonal variations in their food habits. However, diets in each area also varied significantly, reflecting migrations of forage organisms and seasonal fluctuations in abundance of endemic forms. Major seasonal variations were associated with the following :

1) The upstream migration by anchovies, which become most numerous in Carquinez Strait from June through August (Messersmith, 1966).

2) The distribution of young-of-the-year striped bass, which is related to the amount of runoff (Chadwick, 1964).

3) The downstream migration of young king salmon, which occurs primarily in the spring and early summer.

At times striped bass fed heavily on their own young and on young king salmon. The effects of this predation on these populations can not be determined from the available data.

Since most of this study 's collections from the Delta were made before 1962, and threadfin shad did not become abundant until after this, these collections do not reflect the present situation. Threadfin shad now make a substantial contribution to the bass' diet there (Don E. Stevens, unpublished data).

Throughout their range in the Sacramento-San Joaquin system young-of-the-year striped bass rarely eat fish (Heubach et al., 1963). The results of this study indicate that juveniles frequently eat fish, but the size at which they turn to a fish diet apparently varies with locality. In the Delta, juveniles ate invertebrates almost exclusively, while in other areas fish generally dominated their diet on a volume basis even though various invertebrates were eaten frequently. Since many of the fish eaten in other areas are abundant in the Delta and mysid shrimp, the primary invertebrate eaten in the Delta, are abundant immediately downstream from there, the most likely hypothesis for explaining the difference is that the greater turbidity in the Delta severely limits predation on fishes.

The results of this study are similar to an analysis of stomach samples obtained in 1947 and 1948 (Johnson and Calhoun, 1952). Both indicate that shrimp and anchovy are major food items during summer and fall in the San Pablo Bay area, but shrimp are apparently less important now. Both showed mysid shrimp were a major food of small bass in the Delta during winter and spring.

SUMMARY

The year-round diet of striped bass in the Sacramento-San Joaquin River system was described from 4,551 juvenile and adult bass, 2,259 of which contained food. Collections were combined by season and area to show variations in the bass' diet. Major food items in the diet of bass were found to be northern anchovies, shiner perch, striped bass, king salmon, carp, crayfish, bay shrimps, mysid shrimp, isopods, scuds, and insect larvae.

Limited data on selection of food by different ages of bass indicated that there is a positive correlation between size of fish and size of organisms eaten.

Diet varied seasonally in response to the migrations of food organisms, and fluctuations in the abundance of endemic foods. Bass ate a wide variety of pelagic and bottom animals, but animals living in the bottom seldom contributed significantly to their diet. Factors other than abundance obviously affected an organism's availability, but not enough is known to identify these factors.

Juvenile bass (less than 16 inches TL) seldom ate fish in the Delta, and it is hypothesized that this is due to the high turbidity there.

REFERENCES

Calhoun, A. J. 1952. Annual migrations of California striped bass. Calif. Fish and Game, 38 (3) : 391-403.

Chadwick, H. K. 1964. Annual abundance of young striped bass *(Roccus saxatilis)* in the Sacramento-San Joaquin Delta, California. Calif. Fish and Game, 50 (2) : 69-99.

Clark, G. H. 1936. A second report on striped bass tagging. Calif. Fish and Game, 22 (4) : 271-283.

Hatton, S. R. 1940. Progress report of the Central Valleys Fisheries Investigation. Calif. Fish and Game, 26 (4) : 335-373.

H[illegible], W., R. J. Toth, and A. M. McCready. 1963. Food of young-of-the-year striped bass *(Roccus saxatilis)* in the Sacramento-San Joaquin River system. Calif. Fish and Game, 49 (4) : 224-239.

Johnson, W. C., and A. J. Calhoun. 1952. Food habits of California striped bass. Calif. Fish and Game, 38 (4) : 531-534.

Messersmith, J. 1966. Fishes collected in Carquinez Strait in 1961-1962, p. 57-63. *In* D. W. Kelley [compiler] Ecological studies of the Sacramento-San Joaquin estuary. Part 1. Calif. Dept. Fish and Game, Fish Bull. 133.

Scofield, E. C. 1928. Striped bass studies. Calif. Fish and Game, 14 (1) : 29-37.

———. 1931. Striped bass of California. Calif. Div. Fish and Game, Fish. Bull., (29) : 1-82.

Scofield, N. B. 1910. Notes on the striped bass in California. Calif. Fish and Game Comm., 21st Bien. Rept., p. 104-109.

Scofield, N. B., and H. C. Bryant. 1926. The striped bass in California. Calif. Fish and Game, 12 (2) : 55-74.

Shapovalov, L. 1936. Food of striped bass. Calif. Fish and Game, 22 (4) : 261-271.

Skinner, J. E. 1962. An historical review of the fish and wildlife resources of the San Francisco Bay area, Water Projects Branch Rept., (1) : 80-82.

Smith, H. M. 1896. A review of the history and results of attempts to acclimatize fish and other water animals in the Pacific states. U. S. Fish Comm., Bull., (15) : 449-458.

85160—800 12-66 325