THE ORANGEMOUTH CORVINA, *Cynoscion xanthulus* Jordan and Gilbert

RICHARD R. WHITNEY

INTRODUCTION

The orangemouth corvina promises to become the gamefish long sought for the Salton Sea by the California Department of Fish and Game. They apparently spawned for the first time in the Salton Sea in 1952, and continued to spawn successfully each year up to and including 1957, when our observations terminated. Each new year-class was more abundant in the samples than its predecessors. Spawning in 1956 and 1957 produced year-classes which seemed abundant enough to support sport fishing. The 1955 year-class, which was not abundant in our samples, yielded at least five hook and line captures to a fishing effort which was understandably slight. The effort was so slight, in fact, that at no time during the study was it practical to survey it quantitatively. A close contact was maintained, however, with operators of access points on the shore of the Sea, with local sportsmens groups, sporting goods stores, and newspapers, in order to obtain authentic records of catches by hook and line. The nature of the five reports received emphasized the slight effort for corvina, only three of the five having been taken by individuals who were fishing specifically for corvina. A fishing contest sponsored by a local resort in the spring of 1957 brought 39 registrants but no success for corvina.

Very little is known about orangemouth corvina. Their spawning habits and growth rates have apparently not been studied. Skogsberg (1939) mentions that they played a minor role in the Mexican catch of corvina which is brought into California. Berdegue (1956) stated that the major portion of the Mexican catch was exported into California.

The orangemouth corvina has been observed making runs at times up the Colorado River, at least in tidal waters (personal observation, observation of L. J. Hendricks, and verbal communication from J. B. Kimsey). Kimsey also found small orangemouth corvina, 82 to 114 mm long, in tidal waters of the Colorado River in mid-March 1957, giving some indication that spawning might occur in nearby areas. The corvina have not been observed in the rivers or canals emptying into the Salton Sea, but do seem to congregate near the mouths of these freshwater inlets in the spring months.

INCREASE IN POPULATION IN THE SALTON SEA AS INDICATED BY CATCHES IN GILL NETS AND SEINES

Although it was not practical to set standard amounts of gill nets at periodic intervals, as was done with seines, the total gill-net effort in the Salton Sea was in the same order of magnitude each year (Table 51). The catch of corvina increased considerably each year, however, due to increased catches of the later year-classes.

Nylon and linen gill nets of four-inch and five-inch stretch mesh were used primarily. Two-inch mesh nets and experimental gill nets with various mesh sizes were used to a lesser extent. The nets longest employed were of the four- and five-inch mesh sizes, since these reduced somewhat the nuisance catches of bairdiella. Because of the many snags from submerged trees and brush in the Sea, the gill nets used in 1954 and 1955 had to be replaced at the end of 1955. The replacement nets were of about the same mesh sizes as the others but of heavier twine. They were about 340 feet long, 12 feet deep and of No. 288 twine. The usual overnight set consisted of three of these nets and 100 feet of two-inch mesh net set in the same vicinity. Experimental gill nets were usually set for short periods and specifically for bairdiella or threadfin shad. Their small mesh sizes were not efficient for catching corvina.

Figure 71 shows locations where overnight sets of gill net were made in the Salton Sea and the number of corvina captured is shown in Table 52. Certain locations were fished more heavily than others. This might have affected the total catch, especially in 1956 when considerable effort was expended in the vicinity of the mouth of the Alamo River, where the largest catches of corvina were made. In 1957, however, the catch was greater in that areá — 144 fish compared to 102 in 1956 — even though there was much less effort than in 1956.

The most successful corvina fishing was in the vicinity of the former mouth of the Alamo River, a straight, dredged channel whose banks had become overgrown with brush and trees and subsequently submerged by rising water. The tops of the dead trees extended from the water and marked this old channel which ran about three miles into the body of the Sea where the water was six to eight feet deep. A very strong current of water, moving from west to east across the end of the old channel, was observed on many occasions, even when winds were light. No freshwater ran through the channel, because the river had been diverted by a dike. Catches of corvina were highest in the spring and fall months in this area.

In other areas, it was our impression that catches near the canals were highest in the spring and fall months. The fish seemed to spread out

TABLE 51

Yearly Gill Net Catches of Orangemouth Corvina of Various Year-Classes in the Salton Sea

Year-Class	Catch in Numbers of Fish by Year				Total Catch
	1954	1955	1956	1957	
1952	3	5	4	---	12
1953	--	--	4	1	5
1954	--	2	44	6	52
Early 1955	--	--	43	17	60
Late 1955	--	--	111	108	219
1956	--	--	---	30	30
1957	--	--	---	2	2
Total Catch	3	7	206	201*	417
Gill Net Effort in Hundred Foot Hours	3,383	2,993	4,668	3,292	

somewhat in the summer, July, August, and September, and catches were generally lower. Winter catches were uniformly low, a result, perhaps, of dormancy among the corvina.

The uniform catch of 1952 year-class fish each year except 1957 was a reflection of the roughly uniform fishing effort. The gill-net catch for 1957 did not reflect the real abundance of fish of the 1956 or 1957 year-classes, since they did not become susceptible to capture in our large-mesh nets until just before sampling was curtailed. The first high catches of 1955 year-class fish, for instance, came in the fall of 1956. Certainly, an increase from year to year in availability of corvina is indicated by the gill-net catches, undoubtedly due to increases in abundance of the 1954 and 1955 year-classes. The 1953 year-class did not appear to have been as successful as the others.

An idea of the relative abundance of the 1956 and 1957 year-class of orangemouth corvina can be derived from catches of young-of-the-year in the 50-foot seines used each month from October 1954 to May 1957.

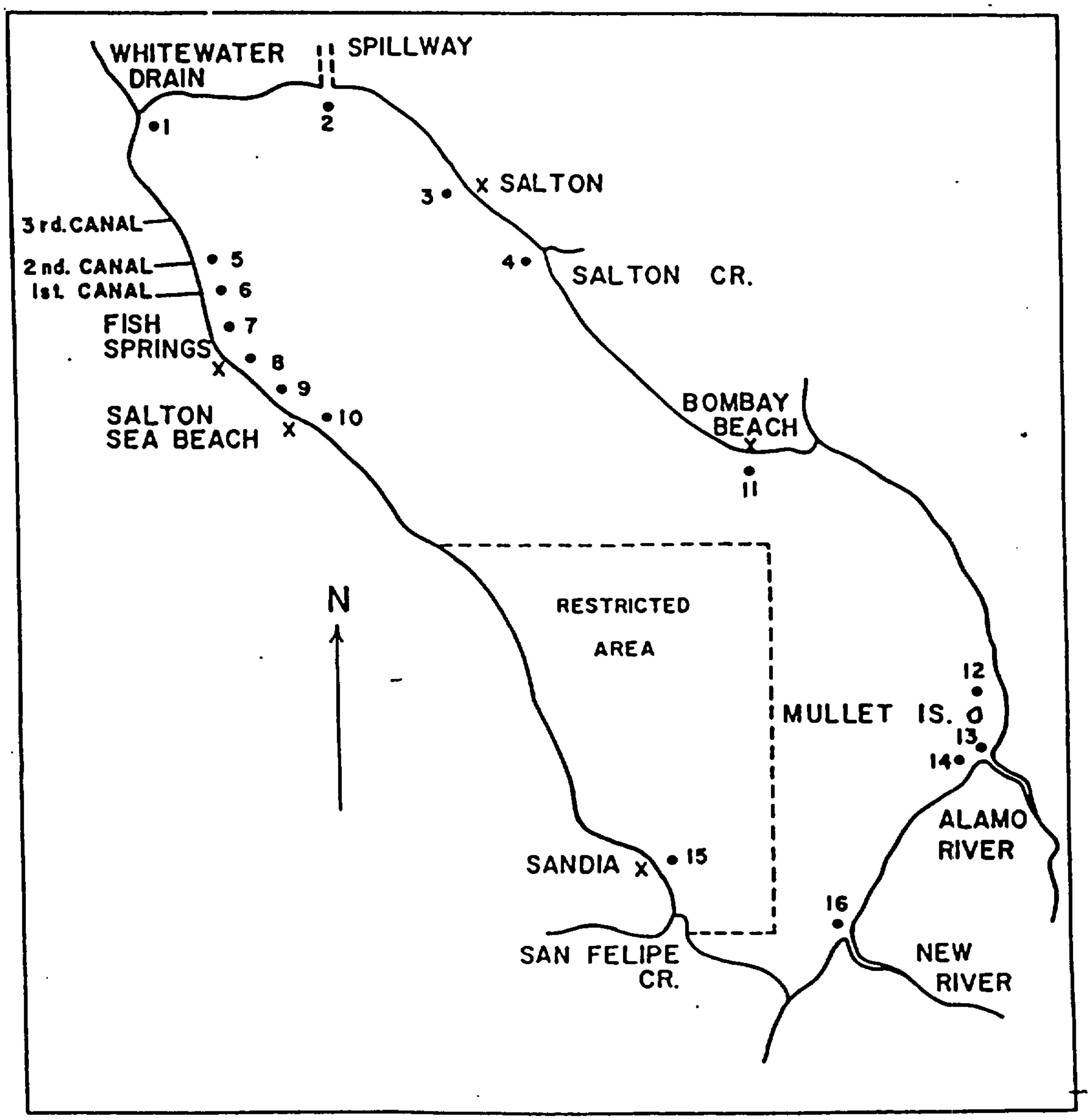

FIGURE 71. Locations of gill-net sets for orangemouth corvina in the Salton Sea

Location, Catch, Total Effort and Number of Gill Net Sets for Orangemouth Corvina in the Salton Sea, 1954-1957

Station Number*	Number of Gill Net Sets (Numbers of fish caught shown in parentheses) January-March	April-June	July-September	October-December	Effort in 100 Foot-Hours**
1954					
1	--	--	--	--	--
2	--	2	--	--	150
3	--	1 (1)	1	--	100
4	--	1	--	--	100
5	--	--	1	2	400
6	--	3 (2)	1	3	1,000
7	--	--	--	--	--
8	--	2	2	2	800
9	--	--	--	1	100
10	--	1	1	1	300
11	--	--	--	1	100
12	--	--	2	1	250
13	--	--	--	--	--
14	--	--	--	1	100
15	--	--	--	--	--
16	--	--	--	--	--
1956					
1	--	1	--	--	100
2	1	3 (12)	1	2 (14)	850
3	--	1 (1)	2 (3)	--	300
4	--	--	--	--	--
5	--	2 (8)	1 (1)	--	150
6	--	--	2 (3)	3 (27)	850
7	--	1	--	--	100
8	--	2 (8)	3 (12)	3 (8)	1,100
9	--	--	--	--	--
10	--	--	1	1	250
11	--	--	--	--	--
12	5	--	2 (1)	--	500
13	3 (3)	1 (1)	2 (3)	1 (2)	500
14	1	1 (3)	2 (18)	2 (71)	450
15	--	--	--	--	--
16	--	1	--	--	150

Station Number*	Number of Gill Net Sets (Numbers of fish caught shown in parentheses) January-March	April-June	July-September	October-December	Effort in 100 Foot-Hours**
1955					
1	--	--	1	1	150
2	1 (1)	1	--	2	200
3	1	1 (1)	--	--	150
4	--	--	--	--	--
5	1	1	1	1	400
6	2	--	2	--	550
7	--	--	--	--	--
8	2	--	2 (1)	1	400
9	--	--	--	--	--
10	--	--	--	--	--
11	--	--	1	--	100
12	--	--	--	--	--
13	--	2 (1)	--	3	300
14	1 (2)	--	1	1 (1)	350
15	--	--	--	--	--
16	--	1	--	1	100
1957					
1	--	--	--	--	--
2	2 (2)	1	--	--	500
3	1	1 (10)	1 (25)	--	300
4	--	--	--	--	--
5	1 (2)	--	--	--	100
6	2	1 (7)	1 (10)	1 (14)	950
7	--	--	--	--	--
8	1	--	--	1 (6)	200
9	--	--	--	--	--
10	--	--	--	--	--
11	--	--	--	--	--
12	1	--	--	--	100
13	1 (9)	1 (15)	--	--	150
14	2 (6)	3 (114)	--	--	1,100
15	--	--	--	--	--
16	--	--	--	--	--

* See Figure 76 for localities.

** 100 feet of gill net fished for one hour

No corvina were caught in seines until 1956 when one member of the 1955 year-class was taken in June. Routine seining in 1957 brought 16 corvina of the 1956 year-class and eight of the 1957 year-class, though the monthly sampling had to be discontinued after August while the fish were still available to seines. Catches in 1957 were made at six of the eight locations where 50-foot seines were used around the shore of the Sea.

POPULATION ESTIMATE

Considerable importance was attached to the possibility of estimating the number of corvina in the Salton Sea, because of their potentialities as gamefish. Marking a sufficient number from catches made in the Sea seemed to be impractical because of the apparent small size of the population relative to the area of water. A prohibitive amount of effort would have had to be expended to mark enough to expect recaptures. In view of the demonstrated ability of the orangemouth corvina to survive in the Salton Sea, additional plants were made. Marking the fish brought from the Gulf of California offered the possibility of introducing a large enough number so that recaptures might be expected. A total of 1,263 corvina, marked by removing one or both pelvic fins, was planted in the Salton Sea in April and May 1956.

Unfortunately, only a few orangemouth corvina were captured in the Gulf of California for planting in 1956. Most of the fish were shortfin corvina, *Cynoscion parvipinnis*. Of the 1,263 fish marked, 1,20[illegible] were shortfin corvina and only 59 were orangemouth corvina. The total plant in 1956 consisted of 1,604 corvina. This of course raises a question as to the validity of using recaptures predominantly o[f] shortfin corvina to estimate a population of predominantly orangemouth corvina. If it can be assumed that differences in their habit[s] would not lead to a differential rate of capture in gill nets in the Salton Sea, then this difficulty can be overlooked. Unfortunately very littl[e] is known about the habits of these species. They were often taken together in seining operations in the Gulf of California, so they mus[t] be similar in some habits. The possibility exists that the two specie[s] school separately. If it can be assumed that the schools were sample[d] at random, this difficulty can also be overlooked. It must also b[e] assumed that mortality of the planted fish was the same as the mortality of fish already present.

It is possible that fish newly introduced into the Salton Sea migh[t] be more, or less, active than those already present. It seems reasonabl[e] to suppose that a predatory fish, such as the corvina, would becom[e] more active on being transported to a place where food is more abundant and competition slight, and this would make it more likely to b[e] caught in gill nets. This would result in too many recaptures, an[d] tend to lower the population estimate. If the estimate can be regarde[d] as too low, then it is of more use in the present case than it otherwis[e] might be.

The planted fish apparently became well-distributed in the Sea or a[t] least ranged widely. They were captured in all areas where nets we[re] set. A total of 12 fin-clipped fish, 11 shortfin and one orangemout[h] was taken in a catch of 385 (not including 1956 or 1957 year-cla[ss] lation of 40,000 corvina, with a 95 percent confidence interval of 20,000 to 120,000, in the Salton Sea in 1956. This estimate refers to both species and includes introduced fish and native-spawned fish of the 1952, 1953, 1954 and 1955 year-classes. The wide and asymmetrical confidence interval certainly reflects the crudity of the estimate. It was apparent, nevertheless, that the nearly 2,000 fish planted, amounted to at most 10 percent of the population. Considering the continued success of spawning each year in the Salton Sea, the planting operations were discontinued.

Judging from the catch in seines, the 1956 and 1957 year-classes were more than 20 times as abundant as the 1954 or 1955 year-classes, so an estimate of 800,000 corvina in the Sea in 1957 was probably conservative.

GROWTH

The fish were measured and weighed in the laboratory as soon after netting as possible. This varied from two to six hours after capture, depending on the distance from the laboratory and the number of fish in the catch. If air temperatures were high, the fish were transported in ice. One large sample of 80 fish was subsampled, and only 43 were taken into the laboratory. Scales were removed from an area just below the lateral line and near the end of the pectoral fin when it was flattened against the body. Otoliths were taken from each fish, fin rays were counted, and notes made of any abnormalities. The viscera and gills were then removed from each fish and preserved in 10 percent formalin. These were later examined for gill-raker counts, stomach contents, and gonad condition. No parasites were observed during the examinations.

Lengths, in the discussion which follows, refer to standard length in all cases. Standard length was chosen because the caudal fin is much more pointed and longer in relation to the rest of the body in the small corvina (Figure 72) than the larger ones. Measurements of total length would therefore not give a true picture of increases in body length.

Description of growth of the individual year-classes was complicated by the appearance of a double brood in 1955 and 1957. Though only small samples of young-of-the-year fish were available, it appeared that in those years two groups of fish developed from spawning in the spring, and that each was characterized by its own growth rate. The

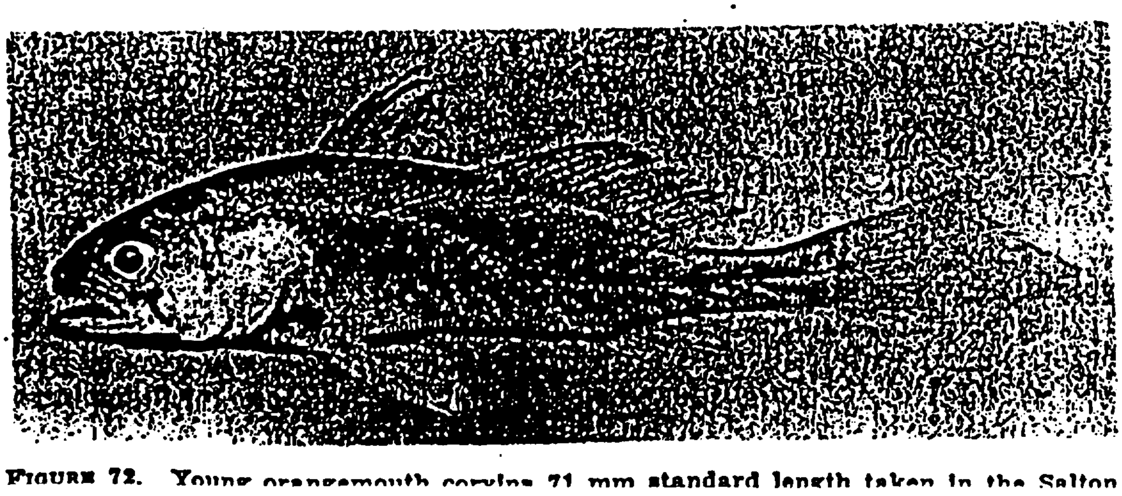

FIGURE 72. Young orangemouth corvina 71 mm standard length taken in the Salton

young-of-the-year corvina fed on *Neanthes* for a time, and therefore were competing for food with bairdiella. As a result, growth was slow at first. It is possible that corvina which hatched earlier in the spring were able to reach a size by September or October where they could feed on bairdiella, and as a result showed rapid growth. Perhaps corvina that hatched somewhat later found their growth paralleling that of the young bairdiella and were unable to feed on fish, and therefore did not grow rapidly until the following spring, after bairdiella had spawned and produced a new supply of small fish.

The indication of a double brood came from tracing the growth of a group of young-of-the-year corvina which were sampled first in August of 1957. The eight specimens taken in seines at that time had an average length of 43 mm, and ranged from 20 to 77 mm. They were clearly young-of-the-year, since none showed any signs of a mark or annulus on the scales. It appears, however, that differences in growth were already separating them into two groups, their lengths being 20, 21, 27, 30, 38, 64, 71, and 77 mm. Table 53 shows the average lengths of these fish taken through October 1957. The average length of four taken in September 1957 was 58 mm, though again their lengths of 32, 42, 57, and 100 mm suggest two groups with different growth rates. The corvina of this year-class taken in October 1957 were probably all representatives of the faster-growing segment of the population which were large enough to feed on bairdiella and other fish. This would account for the sudden increase in average length between September and October 1957. Possibly, the corvina of the slower-growing segment of the population moved away from shore in the fall so that they were not available to the seines.

The existence of a slower-growing part of the population would explain the small corvina in the seines in February 1957 (Table 53). Ten corvina taken at that time averaged 68 mm and had quite uniform lengths, these being 56, 57, 59, 65, 67, 68, 71, 82, and 90 mm. The

TABLE 53

Average Lengths and Scale Characteristics of Small Orangemouth Corvina Caught in the Salton Sea, 1957

Month	Fish With a Mark Near the Focus of the Scales				Fish With No Marks or Annuli Anywhere on the Scales			
	Average Standard Length in mm	Range in mm	No. of Fish	Method of Capture	Average Standard Length in mm	Range in mm	No. of Fish	Method of Capture
Feb. & March	68	56–90	10	50′ seine				
April & May	88	67–111	6	50′ seine				
June	257	–	1	gill net				
July	290	–	1	gill net				
August					43	20–77	8	50′ seine
Sept.	303	338–392	11	gill net	58	32–100	4	50′ seine
Oct. 4	337	325–358	6	gill net				
Oct. 11					179	–	1	hook and line
Oct. 23	304	310–436	11	gill net	266	241–291	2	gill net

scales of these fish showed signs of an annulus or mark developing near their edges. All of the members of this group taken several months later, in April and May, showed this mark near the edge of their scales. They apparently were members of the 1956 year-class, all of which were slow-growing during their first year.

Also bearing on this problem was the growth of two groups of fish sampled in 1956. Two fish taken in January and one in May were 282, 308, and 300 mm long, respectively, and showed no marks or annuli on the scales, except the one taken in May. It had an annulus very near the margin of each scale. These fish clearly represented the 1955 year-class, and had obviously shown no retardation of growth; probably they grew as did the group sampled late in 1957, with length increases in the fall of their first year. A group of fish then appeared in the June 1956 samples which showed an annulus-like mark near the focus of the scales. Their standard lengths were 223, 231, and 249 mm—at least 50 mm shorter than the fish taken earlier whose scales showed no annuli. These were apparently slow-growing members of the 1955 year-class that had remained small through the winter and then suddenly increased in the spring.

The appearance of the double brood might also be explained by spring and fall spawning. However, the gonads of the corvina indicated that maturation took place in the spring. Unfortunately the study had to be discontinued at a time when the young-of-the-year corvina were becoming abundant enough to provide samples that would have answered this question. A larger sample of adult fish in the fall would also have made it possible to state definitely whether some corvina matured in the fall or winter.

The most likely explanation of the double broods seemed to be the first one given, since there was no indication of a fall-spawning population. The designation of year-classes in the following discussion therefore was based on the interpretations that corvina spawning took place in the spring and that a double brood might or might not develop, depending on the availability of small fish as food for the young-of-year corvina.

Apparently only one brood was produced in 1952, 1954, and 1956, since members of these year-classes all had marks near the centers of their scales, but no clear annulus, when first taken in 1954, 1955, and 1957 respectively. The 1952 year-class fish were forming an annulus at the edge of the scales. These would all be slow-growing, or late-spawned fish in the present interpretation. There was little doubt as to the identification of the 1955 year-class (early-spawned), or the 1957 year-class, since there were no marks of any sort on the scales of the 1957 year-class fish in 1957, and only one rather clear annulus on the scales of the 1955 year-class fish when they were first taken in 1956. The designation of the other year-classes would be correct even if some of the groups originated from fall spawning. It could only be incorrect if the origin of the fish with marks near the focus of the scales were spawned earlier than April to June. This does not seem likely, because the fish collected in February 1957 were 56 to 90 mm long and must have been spawned either in the fall of 1956 or, as assumed here, in the late spring of 1956.

The mark near the focus of the scales which identified the late-spawned year-classes was usually quite clear and distinct, though as the scales increased in size it became difficult to consider it as being equivalent to the large and conspicuous annuli appearing farther out on the scales. In some of the 1954 year-class fish the mark or first annulus was rather indistinct. Six fish caught in 1956 and one caught in 1957 were included in this year-class on the basis of the great distance to the first annulus, even though an inner mark was not clearly seen.

Growth did not seem unusually rapid until a length of about 100 mm (3.9 in) was reached, when a period of spectacular growth began (Figure 73). The late-spawned groups apparently reached a standard length of about 380 mm (15.0 in) by their second winter. Early-spawned groups reached a length of about 300 mm (11.8 in) by their first winter. Growth slowed or stopped in each group during the winter and increased in the spring. In the older year-classes in 1956 and 1957 there was a period of little or no growth in June and July followed by an increase in August and September. This spring and fall growth brought the orangemouth corvina to standard lengths near 500 mm (19.7 in) by their third winter, judging by the performances of the 1952, 1954, and 1955 year-classes. Four fish of the 1952 year-class averaged 646 mm (25.4 in) in length when caught in May of their fifth year, 1956. One fish, probably of the 1953 year-class was 612 mm long when taken in May 1957. No 1952 year-class fish were taken in 1957.

Weight increases followed a pattern similar to that for length. The late-spawned groups reached weights of about 2½ pounds by the second winter, 5½ pounds by the third, and 11 pounds by the fourth. Early-

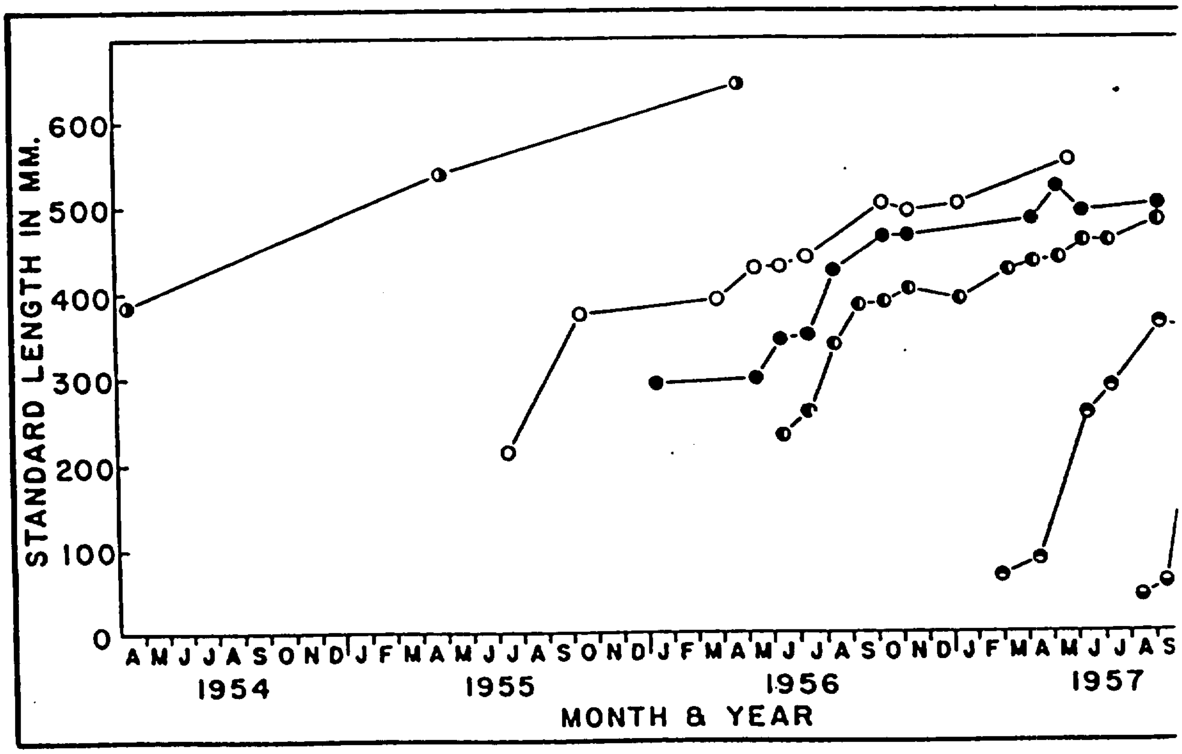

FIGURE 73. Average lengths of age-groups of orangemouth corvina from the Salton Sea. (Sample sizes in Table 54. ◑ = 1952 year-class (late); ○ 1954 year-class (late ● = early 1955 year-class; ◐ = late 1955 year-class; ◒ = 1956 year-class (late

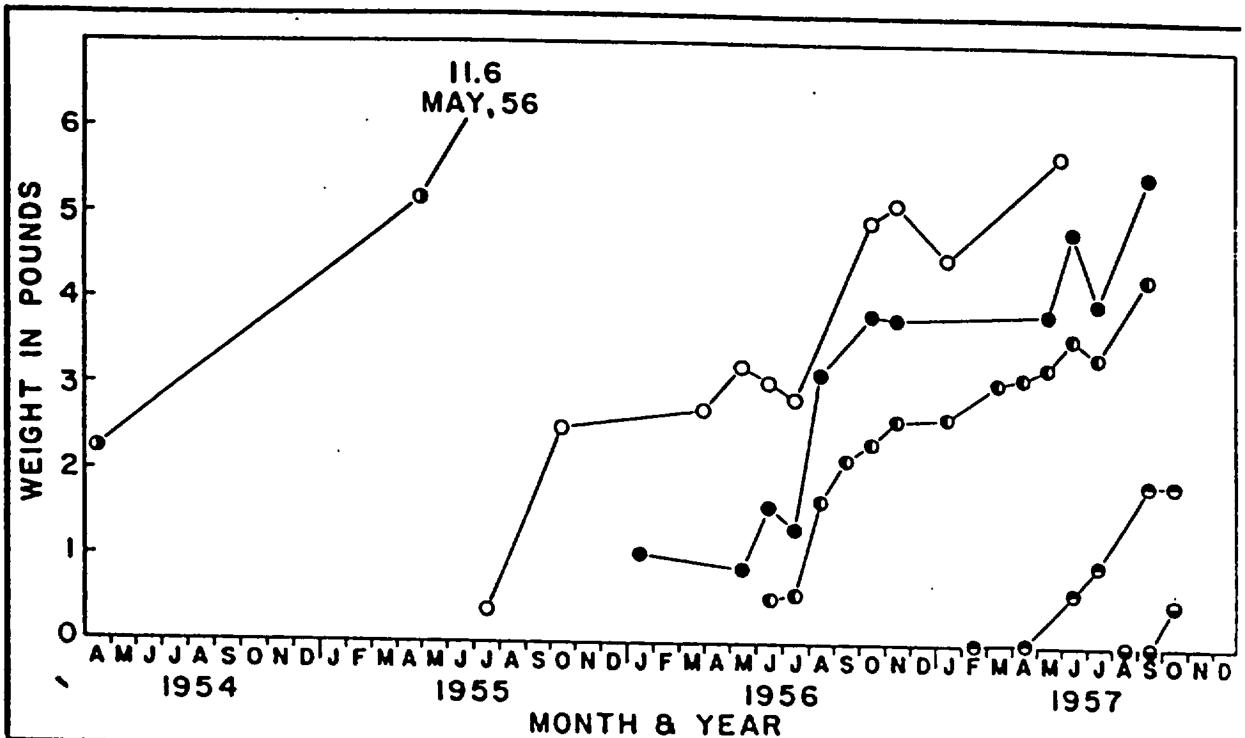

FIGURE 74. Average weights of age-groups of orangemouth corvina in the Salton Sea. ◑ = 1952 year-class (late); ○ = 1954 year-class (late); ● = early 1955 year-class; ◐ = late 1955 year-class; ⊖ = 1956 year-class (late); ⊖ = early 1957 year-class.

spawned groups, as shown by the 1955 year-class, reached 1 pound by the end of their first year, and 3¾ by the end of their second.

Abrupt weight loss might give some indication of spawning time, particularly where length increases continued. The loss of weight of the 1954 and early 1955 year-classes in June and July 1956, for instance might have been associated with spawning (Figure 74). Also, the loss of weight of the late 1955 year-class fish, which occurred between June and July 1957 was probably the result of spawning. In this case, the time apparently corresponded to the time of origin of the 1957 year-class corvina. Sample sizes are indicated in Table 54.

LENGTH-WEIGHT RELATIONSHIP

The relationship of weight to length in orangemouth corvina is curvilinear (Figure 75). As has been pointed out, the length-weight relationship probably differed during the year. Nevertheless, the variations seem to be within rather narrow limits, so that, on the average, estimates of weight from length using this curve are satisfactory for general purposes.

ESTIMATES OF GROWTH FROM THE SCALES

No corvina shorter than 200 mm standard length were taken before 1957, so the scale method was used to estimate the length of all of the age groups at the time the first annulus was formed. Considering also the small size of most of the samples, and the fact that they were spread over a period of several years, the samples were pooled by using the annuli on the scales as reference points. In this way, larger samples re-

TABLE 54

Mean Lengths and Weights of Orangemouth Corvina From the Salton Sea, 1952-1957

Date	YEAR-CLASS 1952 Std. Lgth. mm	1952 (No.)	1952 Wt. Lbs.	1953 Std. Lgth. mm	1953 (No.)	1953 Wt. Lbs.	1954 Std. Lgth. mm	1954 (No.)	1954 Wt. Lbs.	Early 1955 Std. Lgth. mm	Early 1955 (No.)	Early 1955 Wt. Lbs.	Late 1955 Std. Lgth. mm	Late 1955 (No.)	Late 1955 Wt. Lbs.	1956 Std. Lgth. mm	1956 (No.)	1956 Wt. Lbs.	Early 1957 Std. Lgth. mm	Early 1957 (No.)	Early 1957 Wt. Lbs.
1954																					
Spring	385	(5)	2.3																		
1955																					
Spring	538	(5)	5.2				215	(1)	0.4												
July							375	(1)	2.5												
Oct.																					
1956										295	(2)	1.0									
Jan.							392	(2)	2.7												
Apr.	646	(4)	11.6				429	(13)	3.2	300	(12)	0.9									
May							430	(8)	3.0	344	(3)	1.6	234	(3)	0.5						
June							441	(10)	2.8	350	(5)	1.3	261	(4)	0.6						
July				557	(4)	6.3				425	(4)	3.1	339	(9)	1.7						
Aug.													385	(2)	2.2						
Sept.							503	(10)	4.9	463	(14)	3.8	338	(80)	2.3						
Oct.							494	(1)	5.1	465	(3)	3.8	403	(13)	2.6						
Nov.																					
1957							502	(2)	4.5				391	(12)	2.6						
Jan.													425	(1)	3.1	68	(10)	0.01			
Mar.										484	(10)	3.9	434	(41)	3.1						
Apr.				612	(1)	8.9				521	(1)	4.0	439	(34)	3.3	88	(6)	0.02			
May							554	(3)	5.7	492	(1)	4.0	458	(5)	3.6	257	(1)	0.6			
June													458	(8)	3.4	290	(1)	0.9			
July																			43	(8)	0.004
Aug.							507	(1)	5.0	501	(5)	5.5	483	(8)	4.3	363	(11)	1.9	58	(4)	0.01
Sept.																354	(17)	1.9	237	(3)	0.76

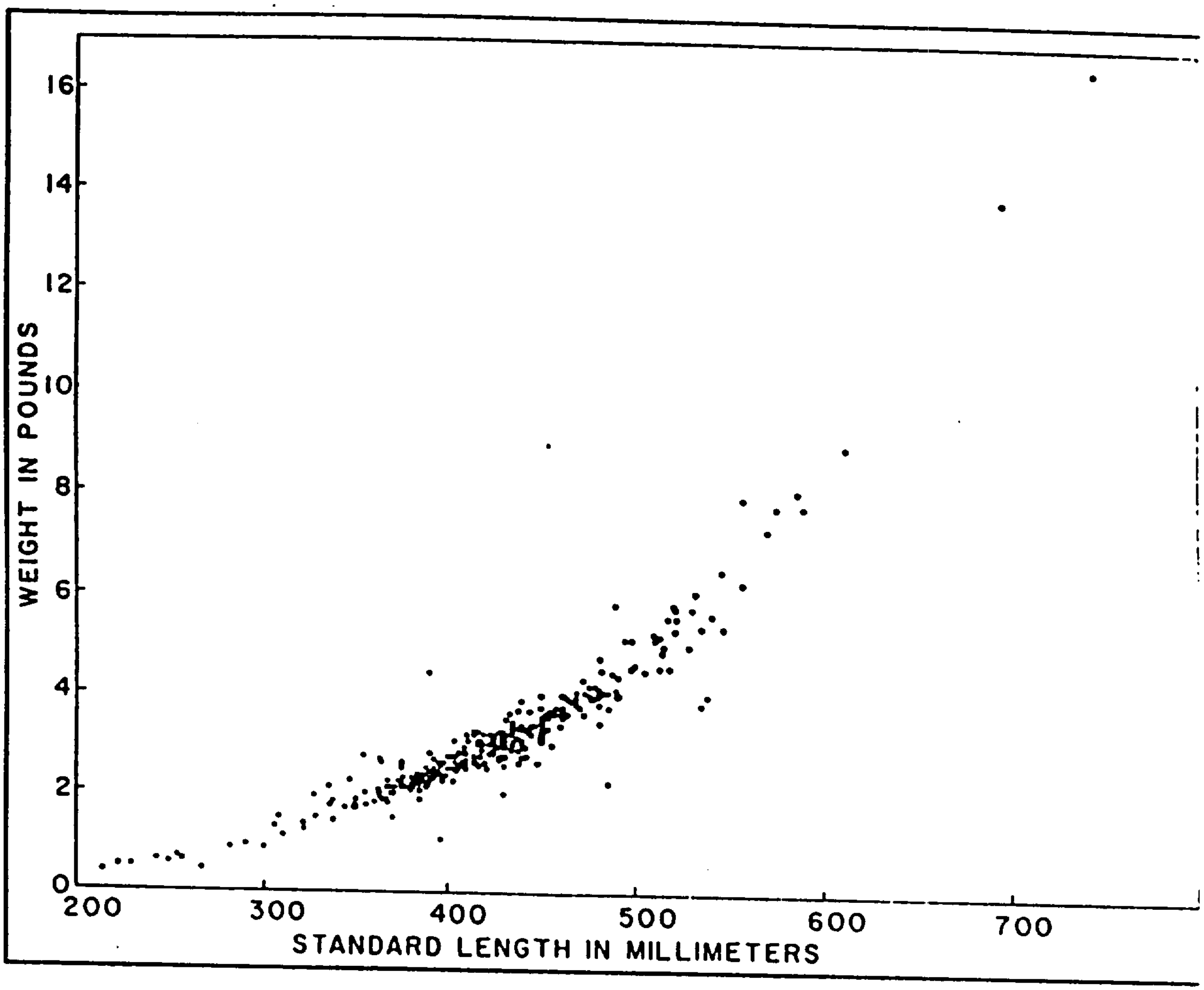

FIGURE 75. Length-weight relationship of orangemouth corvina in the Salton Sea.

ferring to restricted periods could be obtained and used to check the growth described at monthly intervals from the small, scattered samples.

Figure 76 shows the relationship of body length to scale length. The regression equation $\hat{Y} = 47.26 + 60.99\ X$, where X is scale length in inches times 29 and $\hat{Y}$ is the estimated body length, fails to pass through the points at the lower end of the distribution, where scale lengths times 29 are less than two inches. Possibly a curvilinear equation could be derived which would project a line through these points. Such a procedure might lead to further error in estimating the past growth of the larger fish because of possible differences in the body-scale relationship between year-classes. The points at the lower end of the distribution are from 1956 and 1957 year-class fish, which were not represented at the upper end of the distribution. Use of separate regressions for the year-classes would accomplish little, since it would still be necessary to project estimates beyond the parts of the lines for which observed points were available. It therefore seems best to rely on the linear regression derived from the combined sample, realizing that body lengths might be overestimated at early points on the scale by as much as 25 mm.

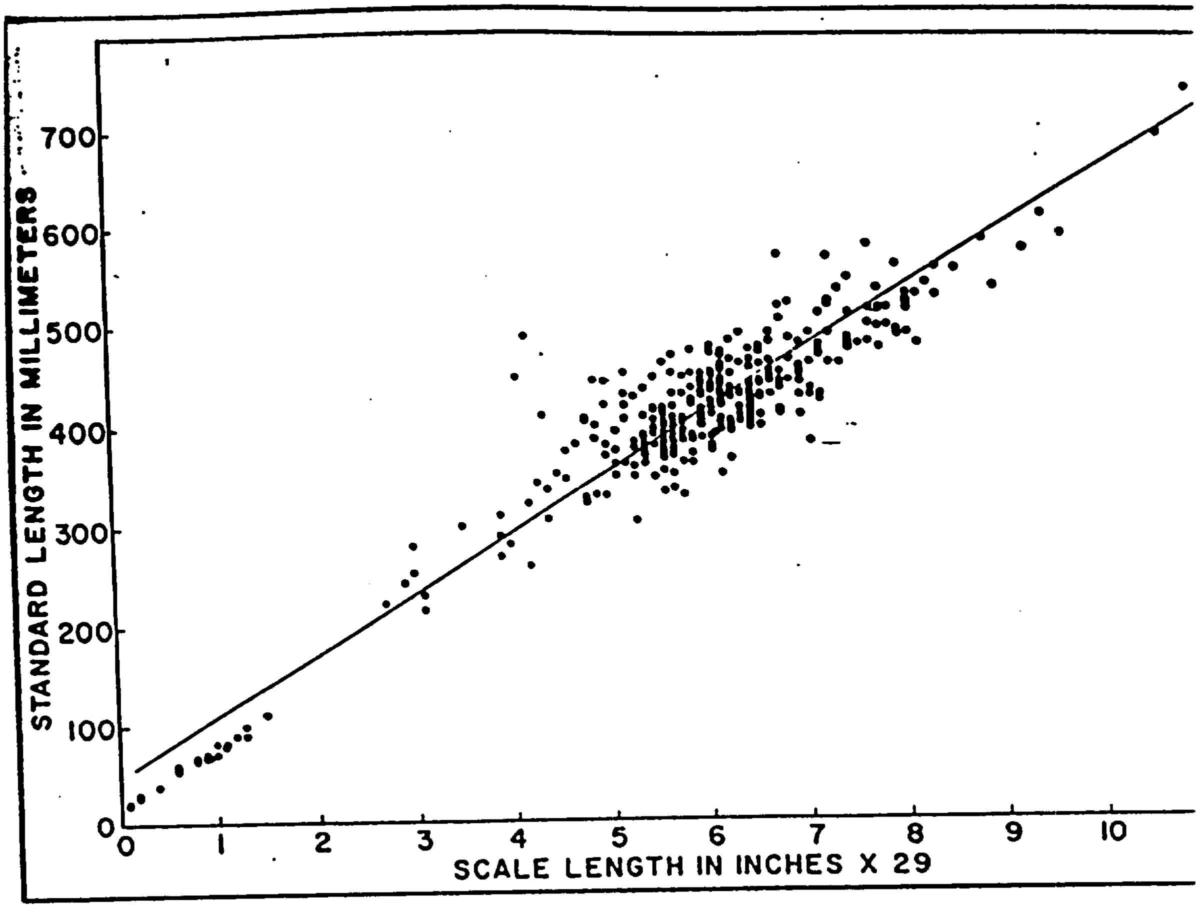

FIGURE 76. Relationship of body length and scale length of orangemouth corvina i the Salton Sea. (Regression equation $\hat{Y} = 47.26 + 60.90\,X$).

Table 55 shows the estimates of body length at the time of annulu formation on the scales of the various groups of corvina. The averag distance to each annulus of each group was used in the regression equa tion to estimate the body lengths. Specimens collected through Jul 1957 were included.

TABLE 55

Estimated Body Lengths at Time of Annulus Formation of Orangemouth Corvina in the Salton Sea

Year-Class	Standard Length in mm (Number of Specimens in Parentheses)			
	At First Annulus	At Second Annulus	At Third Annulus	At Fourth Annulus
1952	111 (12)	371 (12)	512 (6)	589 (4)
1953	109 (5)	358 (5)	456 (5)	560 (1)
1954	80 (42)	380 (47)	558 (3)	----
Early 1955	----	231 (47)	473 (21)	----
Late 1955	116 (208)	410 (88)	----	----
1956	101 (8)	----	----	----
Totals				
Late-Spawned Groups	110 (275)	396 (152)	502 (14)	583 (5)
Early-Spawned Groups	----	231 (47)	473 (21)	----

It would not be appropriate to determine an average length at each annulus for all the groups because of the known differences in their performance, due possibly to differences in actual age at the time of annulus formation. For this reason, the average lengths in Table 55 were separated into estimates for early- and late-spawned groups. The estimated lengths were in good agreement with the actual lengths of corvina taken in the late fall and winter (Figure 73). The average length reached by late-spawned corvina when the first annulus was formed was estimated as 110 mm (4.3 in.), at the second annulus as 396 mm (15.6 in.); at the third annulus, 502 mm (19.8 in.); and at the fourth, 583 mm (23.0 in.). The early- and late-spawned groups might have grown at the same rate after they reached about 100 mm, though the annuli appeared at different stages in the process. The slopes of the lines in Figure 73, for instance, seem to be very nearly the same. The 558 mm estimated length for 1954 year-class fish at the third annulus seemed high compared to the observed lengths, although this was perhaps not an unusual difference for so small a sample.

The mark near the focus of the scales apparently formed when the corvina (late-spawned) were between 75 and 100 mm long, though, for reasons discussed previously, this estimate is subject to the greatest error. The mark was considered a true annulus.

FOOD

Young-of-the-year corvina first fed on copepods, barnacle nauplii, and other plankters, and then changed to *Neanthes*. The change apparently came when the fish reached a length between 30 and 60 mm (1.2 to 2.4 in.). The young-of-the-year taken in August 1957 had either copepods, barnacle nauplii and cyprids, or *Neanthes* in their stomachs. Three of the smaller corvina, 21, 28, and 30 mm in standard length, had mostly copepods in their stomach, and a few larval barnacles. Four larger corvina, 57, 64, 68, and 71 mm long, had fed only on *Neanthes*. Young-of-the-year bairdiella were too large for these small corvina. Of 16 small corvina, 56 to 111 mm long, seined in the early spring of 1957, 10 had *Neanthes* in their stomachs. The other six had empty stomachs, but two of these had *Neanthes* remains in their intestines.

Undoubtedly, young corvina began feeding on bairdiella as soon as they became available. Bairdiella spawned from April through June each year, so that numbers of small fish became available in May. The late-spawned corvina, apparently passed the winter at a length of about 70 mm, and were able to feed on small bairdiella beginning in May each year. A specimen 81 mm in standard length, taken in May 1957, had its stomach bulging with young-of-the-year bairdiella.

Since the young corvina depended on *Neanthes* for food, they competed for a time with bairdiella. This competition has probably been quite severe, judging by the effects which have already been described within the bairdiella population. This was probably the reason for the rather slow increase in the population of corvina in the Salton Sea, as compared to the sudden population burst of the bairdiella.

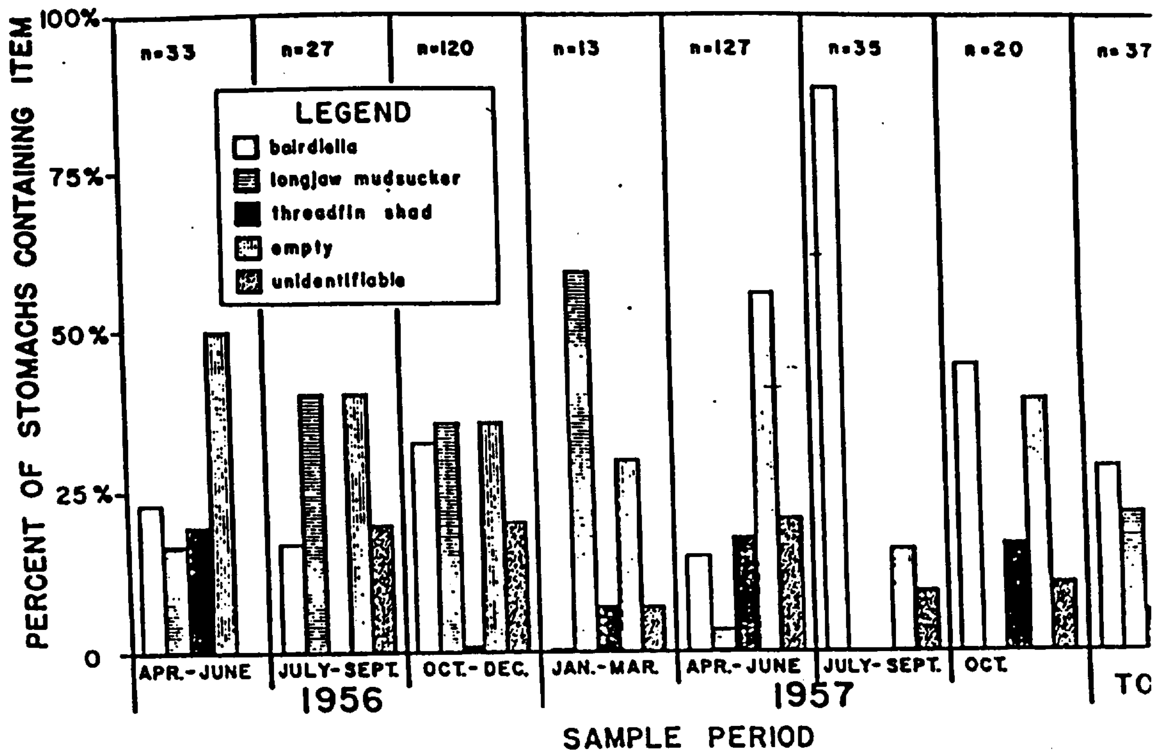

FIGURE 77. Relative percentages of various forage fishes in the stomachs of orange mouth corvina from the Salton Sea. Since more than one species may have bee present, the bars in some cases add to more than 100 percent. The high percentag of empty stomachs and unidentified fish remains were mainly due to the fact that th nets were usually set for 24 hours.

The bairdiella was the most common food item of larger orangemout corvina, followed by the longjaw mudsucker and threadfin shad (Figur 77). One corvina, caught near the mouth of the Alamo River, had th remains of a crayfish in its stomach.

It seems likely that the corvina will feed on any fish of appropria size. A school or concentration of any of the forage species in the Se might attract and hold a school of corvina until they have fed heavil For instance, all 14 corvina in a sample caught on October 18, 1956, ha their stomachs unusually full of mudsuckers: one contained five, a other four, and the others from one to three. Obviously they ha recently discovered a concentration of mudsuckers and had fed heavi on them. On the other hand, a sample of 52 corvina taken on October 1956, included three which had three bairdiellas in their stomachs, with one bairdiella and only two with mudsuckers.

It is probably not safe to generalize about seasonal changes in di because of the wide variation between the samples due to differen in locality and because of their small size. It would appear, howev that threadfin shad were eaten most heavily in the spring. The sh were attracted to the mouths of freshwater inlets at that time, as we the corvina, and were thus most available to the corvina. Since th was no repetition in the pattern of mudsucker occurrence in the sto achs, the decline in the latter part of 1957 could be explained sampling variability.

GONAD MATURATION AND SEX RATIOS

The greatest number of ripe and nearly ripe corvina were caught in April and May during 1956 and 1957 (Table 56). The sample consisted primarily of 1955 year-class fish which were maturing for the first time in 1957, and their development might not have been representative of the population. It appears certain, however, that the 1955 year-class corvina spawned in late May or early June in 1957. Additional evidence came from the loss of weight which occurred at that time.

Gonads from 332 corvina were examined to determine sex and degree of development. Of the 261 fish whose sex could be determined, 130 were females and 131 were males. Where sex could not be determined most were 1955 year-class corvina, taken in the fall of 1956. To determine if any error had been introduced due to differences in recognizability of the sexes, samples taken in April, May, June, and July 1957 were investigated. A total of 76 males and 60 females was noted in these, while the sex of only one fish could not be determined. The observed numbers did not differ significantly from a 50:50 ratio (Chi-square = 1.8, df 1). It thus appeared that the sexes were in equal numbers in the Salton Sea.

NUMBER OF EGGS

The number of eggs in the ovaries of three corvina were estimated using the volumetric method. The volume of the ovary was determined by water displacement. Three samples of 0.5 cc each were then separated and the eggs in each were counted. The total volumes of the ovaries were 112, 130, and 135 cc. In all three there were smaller, undeveloped eggs along with the larger eggs which were free in the ovary. Enlarged, free eggs were estimated as 380,000; 970,000; and 1,200,000

TABLE 56

Gonad Condition by Month of Orangemouth Corvina From the Salton Sea, 1956-1957

	Gonad Condition					
Date	Reabsorbing	Very Poorly Developed	Poorly Developed	Fairly Well Developed	Well Developed	Very Well Developed or Ripe
1956						
May	--	--	1	1	3	1
June	--	--	1	1	4	1
August	--	5	6	1	--	1
October	--	25	11	--	--	--
November	--	5	8	--	--	--
1957						
January	--	6	5	--	--	--
April	--	8	15	11	29	6
May	--	4	6	12	6	16
June	--	--	--	3	2	1
July	7	2	--	--	--	--
September	15	10	--	--	--	--
October	4	2	--	--	--	--

respectively. The ovaries were removed from females caught on April 30, 1957 and May 28, 1956.

MERISTIC COUNTS

The first dorsal fin usually contains nine spines and the second dorsal fin one spine followed by 20 rays. The number of rays may vary from 18 to 23, but is most commonly 19, 20, or 21 (Table 57). Three fish had two spines in the second dorsal fin. There was no deviation from two anal spines in 305 specimens. The number of anal rays varied from 6 to 10, but was usually eight. These counts agree with those given by Jordan and Evermann (1898), for *Cynoscion xanthulus*, though they made no mention of the number of specimens examined nor of the variability encountered. They gave the fin formulas as D IX — I,20; A II, 8.

Gill-rakers were counted in 285 of the Salton Sea corvina. The rakers were often difficult to count because they diminished in size anterior to the angle of arch. Some were reduced to knob-like processes. Only those were counted which extended in a flap or filament from the arch. The most common counts were 3 or 4 rakers on the upper limb of the arch, and 7 on the lower (Table 57).

ABNORMALITIES

A fairly high percentage of abnormal individuals occurred in the population of orangemouth corvina in the Salton Sea. This was somewhat unexpected, considering their competition with bairdiella during their early development. In general, however, the corvina abnormalities were as severe as those of the bairdiella. Two members of the late-spawned 1955 year-class had sharply upturned heads (Figure 78). Three others with less severely upturned heads were also observed. Three fish with upturned heads were taken together in a sample of 14 corvina. This was probably an indication of the common origin of a school which was sampled by the gill nets.

Seventeen (8.0 percent) of the late-spawned 1955 year-class were abnormal in some way (Table 58). Eleven (8.5 percent) in the samples of the other year-classes were also abnormal. Because of the small

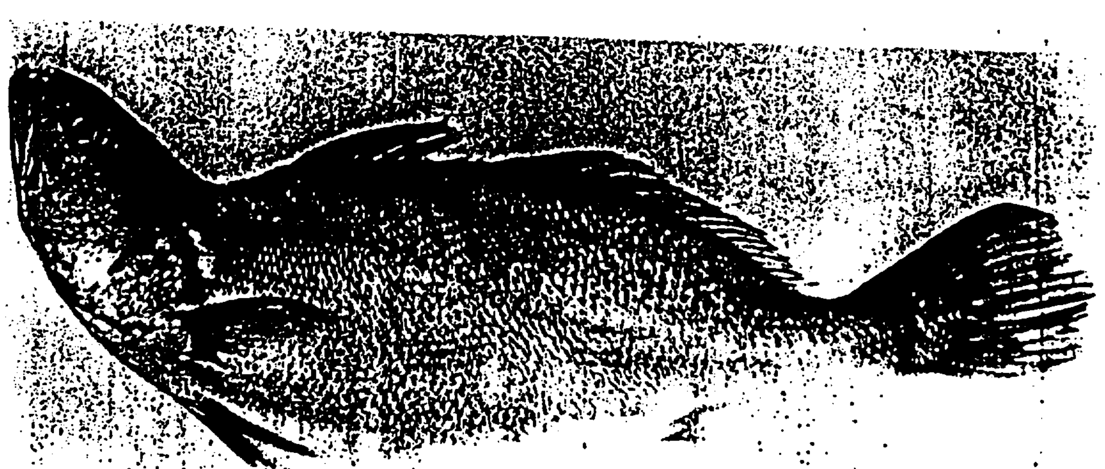

FIGURE 78. Orangemouth corvina with upturned head, Salton Sea. Photo by R. H.

TABLE 57
Fin-Ray and Gill-raker Counts of Orangemouth Corvina From the Salton Sea

	Number of Elements																Sample Size
	1	2	3	4	5	6	7	8	9	10 –	18	19	20	21	22	23	
First Dorsal Spines	--	--	--	--	--	--	--	5	274	25	--	--	--	--	--	--	304
Second Dorsal Spines	301	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	304
Second Dorsal Rays	--	--	--	--	--	--	--	--	--	--	13	95	138	52	5	1	304
Anal Rays	--	--	--	--	--	1	76	219	7	1	--	--	--	--	--	--	304
Gill-rakers on First Arch																	
Upper Limb	--	4	156	122	3	--	--	--	--	--	--	--	--	--	--	--	285
Lower Limb	--	--	--	--	5	29	210	40	1	--	--	--	--	--	--	--	285

TABLE 58
Occurrence of Abnormal Orangemouth Corvina in the Salton Sea

Abnormality	Combined 1952, 1953, 1954, Early 1955 Year-Classes		Late Spawned 1955 Year-Class	
	Number Abnormal	Percent Abnormal	Number Abnormal	Percent Abnormal
Hunchback	9	6.9	3	1.4
Skewed Lower Jaw[1]	2	1.5	5	2.4
Upturned Head[2]	--	---	5	2.4
Missing Gill Arch	--	---	3	1.4
Snub-nose (pug-headed)[3]	1	0.8	2	0.9
Receding Lower Jaw	1	0.8	2	0.9
Twisted Spine	1	0.8	1	0.5
Missing Dorsal Fin	--	---	1	0.5
Malformed Opercle	--	---	1	0.5
Twisted Maxillary	1	0.8	--	---
Total Abnormal*	11	8.5	17	8.0
Total Sample	129	---	211	---

* The total abnormal may be fewer than the sum of the column above because some fish showed more than one abnormality.
[1] Figure 79.
[2] Figure 78.
[3] Figure 80.

samples, it could not be determined if there were any differences between the year-classes with respect to the frequency of particular kinds of abnormalities.

The abnormalities were in general much the same as those described for bairdiella. Two corvina had the first gill arch on the left side missing or reduced to a vestige, and one had the first arch on the right side missing. No blind corvina were ever observed. The frequency of abnormal individuals probably will decrease as the population increases. This has been the pattern, at least, in the case of bairdiella.

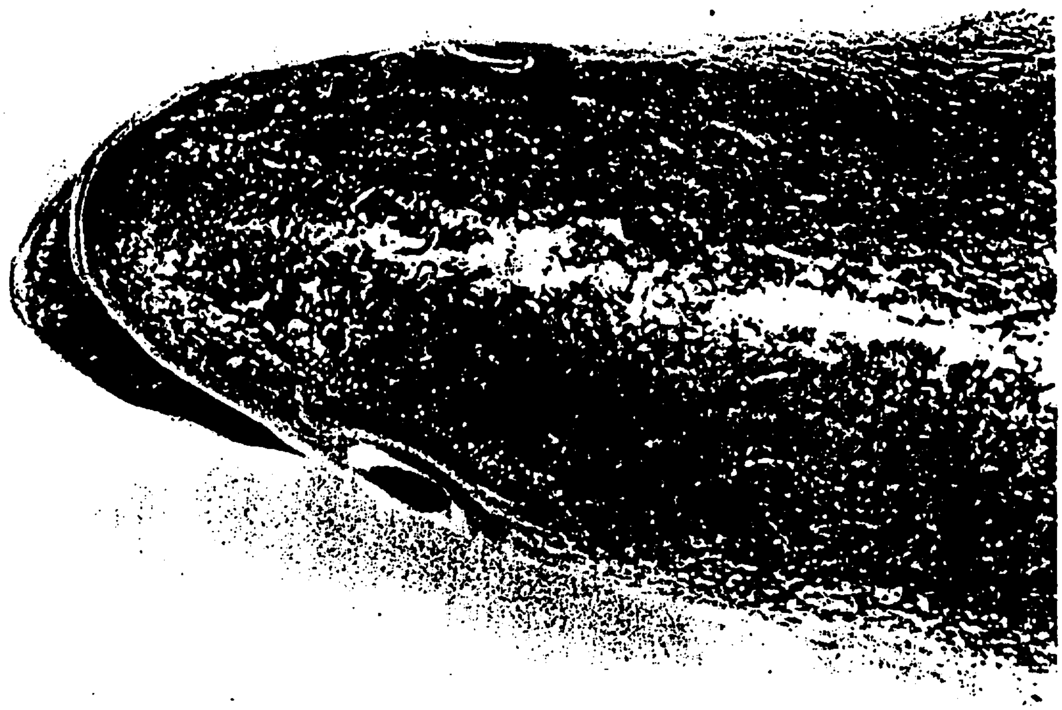

FIGURE 79. Orangemouth corvina with skewed lower jaw, Salton Sea. Photo by R. H. Linsley.

FIGURE 80. Orangemouth corvina with snub-nose (pug-headed), Salton Sea. Photo by R. H. Linsley.