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Summer Foods, Length-Weight Relationship, and Condition Factor of Juvenile Ladyfish, *Elops saurus* Linnaeus, from Louisiana Coastal Streams

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ABSTRACT

A total of 295 juvenile ladyfish *Elops saurus* Linnaeus were collected with surface trawls from Louisiana coastal streams in June 1968 and June 1969. The fish ranged from 45 to 201 mm in fork length. Of the 295 ladyfish stomachs examined, 229 (77.6%) contained food. Fish constituted 94.5% by occurrence of the food organisms and decapod crustaceans 5.5%. Gulf menhaden comprised 72.0% of the fish identified. The calculated length-weight relationship for juvenile ladyfish in the size range 45–201 mm (fork length) was $\log_{10} W = -5.3295 + 3.1123 \log_{10} L$, and the mean condition coefficient was 8.1.

During surface trawl surveys to estimate relative abundance of juvenile Gulf menhaden, *Brevoortia tyrannus*, in Gulf coast estuaries, other species of fish also were captured. Enough juvenile ladyfish, *Elops saurus*, were collected to study their summer food habits and to determine their length-weight relationship and coefficient of condition.

The ladyfish is a recognized sportfish in many areas of the southern Atlantic and Gulf coasts of the United States. Ecologically, it is similar to the tarpon, *Megalops atlantica* Valenciennes. It is not important commercially and composes only a small percentage of the fish population in most waters where it occurs.

There is little published information on the life history and general ecology of ladyfish. Larvae metamorphose to juveniles at about 50 mm (Gehringer 1959) and adults may reach 900 mm (Hildebrand 1963). Food habits have been noted by a number of investigators (Linton 1904; Gunter 1945; Knapp 1949; Darnell 1958; Gehringer 1959; Hildebrand 1963), but no intensive studies have been done.

STUDY AREA AND METHODS

The Louisiana estuaries where ladyfish were collected are characterized by numerous natural and man-made bayous, lagoons, and tidal ponds. Dominant vegetation is salt marsh cord grass, *Spartina* sp., black rush, *Juncus*

roemerianus, and three-cornered grass, *Scirpus robustus*. Daily tidal amplitude varies from about 15 to 50 cm and the water depth ranges from about 0.7 to 1.2 m.

Collection stations were evenly spaced from the mouth of each stream to as far upstream as a surface trawl could be towed. The distance between stations varied and depended on the length of the stream, being greater on long streams than on short ones. The number of stations per stream ranged from 3 to 11. At each station a surface trawl (6.1 m long, with a mouth opening 6.7×0.9 m, constructed of knotted nylon mesh 6.3 mm bar measure) was towed in midchannel between two outboard motor boats for 5 min or about 740 m (0.4 nautical mi). Mean water temperatures, salinities, and sechi disc readings between streams ranged from 26.0 to 35.5 C, 0.7 to 20.9‰, and 11 to 29 cm.

In 18 Louisiana estuaries from Sabine Lake to Lake Pontchartrain, 222 ladyfish were collected in June 1968 and 73 in June 1969 (Table 1, Fig. 1). The fish were preserved in 10% formalin and later weighed and measured. Although the fish were not slit, there was no evidence of internal decomposition. Before they were weighed, external moisture was removed and excess formalin was shaken from the gills. No adjustments were made for possible differences between weights of preserved and fresh fish. After the fish had been taken to the Laboratory, the stomachs were weighed to the nearest 0.1 g, wrapped in cheesecloth, and stored in 40% isopropanol.

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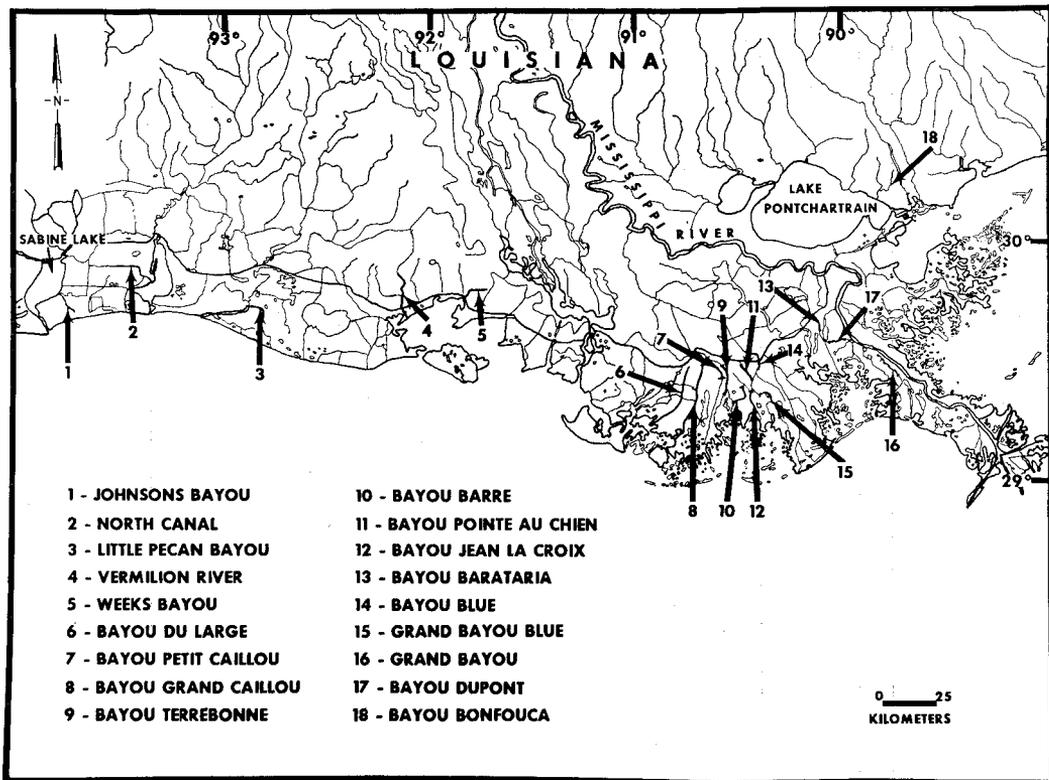


FIGURE 1.—Map of Louisiana showing the collecting sites for ladyfish used in this study.

Stomach contents were examined under a binocular dissecting microscope. Items were identified to species, if possible, and were weighed to the nearest 0.1 g and measured to the nearest 1.0 mm. The frequency of each item was recorded. The degree of fullness and the relative state of digestion were noted.

The ladyfish were divided into three size classes: 45–97 mm, 98–149 mm, and 150–201 mm (FL). For each size class the number, frequency of occurrence, percentage frequency, weight, and percentage weight of each food item was recorded.

To determine if feeding habits changed with size, the data for the more numerous items were arranged in a contingency table (Snedecor and Cochran 1967) and chi-square values were calculated.

To detect feeding trends of ladyfish, the stomach contents were given a numerical value according to the stage of digestion

TABLE 1.—Number of ladyfish collected in Louisiana streams, 1968 and 1969

Locality	Date	Number of tows	Number of ladyfish collected
Johnsons Bayou	6-18-69	8	2
North Canal	6-19-68	3	5
Little Pecan Bayou	6-19-69	6	43
Vermilion River	6-19-69	7	4
Weeks Bayou	6-20-69	8	6
Bayou Du Large	6-22-68	8	36
	6-23-69	8	2
Bayou Petit Caillou	6-24-68	8	1
Bayou Grand Caillou	6-22-68	10	17
Bayou Terrebonne	6-24-68	8	14
	6-24-69	8	3
Bayou Barre	6-25-69	6	2
Bayou Pointe au Chien	6-24-68	5	10
	6-24-69	5	6
Bayou Jean La Croix	6-24-68	6	1
Bayou Barataria	6-26-68	11	17
	6-26-69	11	1
Bayou Blue	6-25-68	7	90
Grand Bayou Blue	6-26-68	6	19
Grand Bayou	6-27-68	6	2
	6-27-69	7	1
Bayou Dupont	6-28-68	7	10
Bayou Bonfouca	6-23-69	5	3

TABLE 2.—Number, frequency, and weight of food items contained in stomachs of various size classes of ladyfish from Louisiana streams during June 1968 and 1969

Food Item	45-97 mm				98-149 mm				150-201 mm			
	Number	Frequency of occurrence	Weight g	Weight %	Number	Frequency of occurrence	Weight g	Weight %	Number	Frequency of occurrence	Weight g	Weight %
<i>Brecoortia patronus</i>	48	25	6.0	61.9	168	77	39.5	63.0	83	30	27.4	64.6
<i>Gambusia affinis</i>	15	8	12.3	11.3	12	6	1.4	2.2	— ^b	— ^b	— ^b	— ^b
<i>Dorosoma petenense</i>	1	1	1.5	— ^a	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Astroscopus y-gracum</i>	1	1	1.5	— ^a	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Anchoa hepsetus</i>	3	3	4.6	6.2	8	6	0.9	1.4	— ^b	— ^b	— ^b	— ^b
<i>Anchoa mitchilli</i>	3	3	4.6	2.1	18	13	2.1	3.3	— ^b	— ^b	— ^b	— ^b
<i>Anchoa</i> spp.	6	6	9.2	3.1	10	8	1.3	2.1	— ^b	— ^b	— ^b	— ^b
<i>Poecilia latipinna</i>	1	1	1.5	1.0	6	4	2.0	3.2	4	2	2.4	5.7
<i>Poecilia</i> spp.	— ^b	— ^b	— ^b	— ^b	2	2	0.7	1.1	— ^b	— ^b	— ^b	— ^b
<i>Membras martinica</i>	— ^b	— ^b	— ^b	— ^b	9	1	0.9	1.4	— ^b	— ^b	— ^b	— ^b
<i>Menidia menidia</i>	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	2	2	2.6	6.1
<i>Menidia</i> spp.	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Cyprinodon variegatus</i>	— ^b	— ^b	— ^b	— ^b	10	4	5.3	8.5	1	1	2.0	4.7
<i>Fundulus grandis</i>	— ^b	— ^b	— ^b	— ^b	1	1	— ^a	— ^a	— ^b	— ^b	— ^b	— ^b
<i>Mugil cephalus</i>	— ^b	— ^b	— ^b	— ^b	1	1	0.5	0.8	— ^b	— ^b	— ^b	— ^b
<i>Cynoscion</i> spp.	— ^b	— ^b	— ^b	— ^b	1	1	0.4	0.6	— ^b	— ^b	— ^b	— ^b
Unidentified fish	9	5	7.7	1.0	36	30	5.8	9.3	17	12	4.3	10.1
<i>Acetes americanus</i>	6	1	1.5	— ^a	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Palaeomonetes pugio</i>	2	2	3.1	3.1	3	3	0.9	1.4	7	2	2.5	5.9
<i>Sicyonia</i> spp.	1	1	1.5	2.1	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Macrobrachium ohione</i>	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
<i>Penaeus setiferus</i>	— ^b	— ^b	— ^b	— ^b	1	1	0.1	0.2	— ^b	— ^b	— ^b	— ^b
<i>Penaeus</i> spp.	— ^b	— ^b	— ^b	— ^b	2	1	0.1	0.2	— ^b	— ^b	— ^b	— ^b
<i>Mysidacea</i>	1	1	1.5	— ^a	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
Unidentified decapods	4	4	6.2	8.2	7	7	0.4	0.6	5	2	1.2	2.8
Stomachs examined	65				180				50			
Empty stomachs	17				43				6			

^a Less than 0.1 g.^b Item did not occur in any stomachs.

TABLE 3.—Percentage of food, by digestive stage, of ladyfish captured at two time intervals

Time period	Number of ladyfish examined	Digestive stage			
		1	2	3	4
0600–1159	179	0	12.7	48.4	38.9
1200–1759	50	0	10.6	51.5	37.9

(Goodyear 1967). Fish whose stomach contents were undigested were assigned stage 1, those whose contents were softened, stage 2, those whose contents were deteriorated but recognizable, stage 3, and those whose contents were unrecognizable or whose stomachs were empty, stage 4. The stage to which a stomach was assigned was determined by the least digested items. Two time periods were compared: 0600–1159 hr and 1200 to 1759 hr.

The variation between size class of fish and degree of stomach fullness was examined. Stomachs were classified as empty, stage I; food trace to 25% full, stage II; 25 to 50% full, stage III; and more than 50% full, stage IV. The number and percentage of stomachs of each stage was calculated for each size class of fish and arranged in a contingency table. Differences were tested by chi-square.

SUMMER FOODS OF LADYFISH

Ladyfish feed principally on fish (Table 2). Of the 295 stomachs examined, 66 were empty and 229 contained food remains. Of the 439 items counted, 415 (94.5%) were fish. Sixteen species were represented. Since only pelagic prey fish occurred, ladyfish probably are mid-water feeders. Other investigators also found that fish were the principal item in the diet. Darnell (1958) observed that fish composed 82% of the diet in ladyfish from Lake Pontchartrain and Knapp (1949) found fish in 34% of the ladyfish stomachs he examined. Hildebrand (1963) reported that ladyfish preyed on fish and Gunter (1945) found that they ate pinfish, *Lagodon rhomboides*. Feeding on fishes apparently begins even before ladyfish metamorphose to the adult form, since the stomach of the smallest one examined (45 mm) was full of fish.

Ladyfish preyed heavily on juvenile Gulf menhaden. These composed 72.0% (299) of

TABLE 4.—Variation of relative degree of stomach fullness in three size classes of ladyfish. The table illustrates the number and percentage (%) of stomachs with or without food

Degree of fullness	45–97 mm		98–149 mm		150–201 mm	
	number	%	number	%	number	%
Stage I	17	26.2	43	23.8	6	12.0
Stage II	0	0	3	1.7	3	6.0
Stage III	2	3.0	16	8.8	8	16.0
Stage IV	46	70.8	118	65.7	33	66.0
Total	65		180		50	

the 415 identifiable fish in the stomachs. Individuals often contained as many as five menhaden, and one contained eight menhaden weighing a total of 2.3 g. Chi-square tests suggested that the percent frequency of menhaden in the diet increased as the size of the ladyfish increased ($P < 0.05$). Knapp (1949), however, stated that he found no menhaden in stomachs of ladyfish he examined.

Chi-square tests for the frequency of other prey species in relation to ladyfish size showed no relationship except for the mosquitofish, *Gambusia affinis*. For this species, the frequency in the diet decreased as the size of the ladyfish increased ($P < 0.01$).

Decapod crustaceans, the only other important food, were represented by 23 items (5.5%). Six species occurred. Gehringer (1959) observed that early metamorphic ladyfish larvae ate brine shrimp, *Artemia* sp., in great quantity and that late metamorphic larvae readily took pieces of shrimp, *Penaeus*

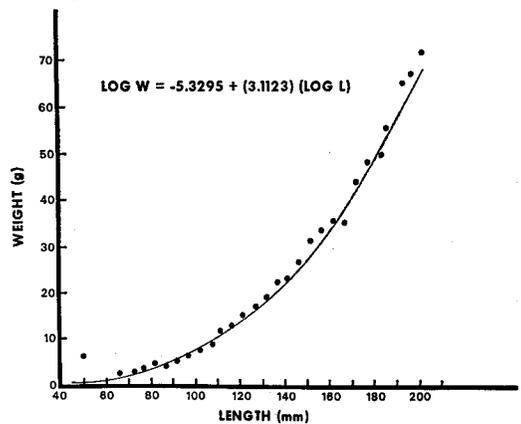


FIGURE 2.—Length-weight relationship of ladyfish in Louisiana. Length (FL) is to the nearest 1.0 mm and weight is to the nearest 0.01 g.

sp. Linton (1904) found that a dozen ladyfish from North Carolina had fed exclusively on shrimp; Gunter (1945) found penaeid shrimp eaten by ladyfish; Darnell (1958) found that penaeid shrimp made up 10% of the food of ladyfish; and Knapp (1949) found that ladyfish from the Texas coast ingested 78.2% crustaceans.

Ladyfish probably are primarily night feeders, but the results are inconclusive. No fresh, or undigested food was found in any of the stomachs, (Table 3), all of which were taken from fish captured in daylight. It is possible, but improbable, that ladyfish regurgitate freshly ingested food when they are captured. There was no significant difference in the percentages of the various stages between fish captured in the morning and afternoon. Differences should be expected if the fish were mainly night feeders, since most of the food should be digested by afternoon. Perhaps some digestion continued after the fish were captured, since the fish were not slit before being preserved.

A chi-square test revealed significant differences ($P < 0.05$) between degree of stomach fullness and size classes of ladyfish (Table 4). Stomachs from the smallest size class (45–97 mm) were generally either empty or full. In the intermediate (98–149 mm) and largest size class (150–201 mm) the percentage of Stage II and III degrees of fullness increased, but most stomachs were full.

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTORS

All 295 fish were used to derive the length-weight relationship (Fig. 2). Length class intervals of 5 mm rather than continuous data were used for convenience of computation.

For ladyfish in the 45–201 mm size range the formula is:

$$\text{Log}_{10} W = -5.3295 + 3.1123 \log_{10} L$$

Coefficient of condition values were determined according to the formula by Lagler (1956):

$$K_L = W(10^6)/L^3$$

where W is the weight in g and L is the total length in mm. The coefficients ranged from 6.6 in the small length classes to 8.9 in the larger length classes. For all data combined the mean coefficient was 8.1. These are the first reported K values for ladyfish.

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