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Diel Otter Trawl Catch of Atlantic Croaker, *Micropogonias undulatus*, in a Louisiana Estuary

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DIEL OTTER TRAWL CATCH OF ATLANTIC CROAKER, *Micropogonias undulatus,* IN A LOUISIANA ESTUARY

The otter trawl has been used widely as the main sampling gear in many estuarine studies of nekton. For logistical reasons it has been used mostly during the daytime, even though many biologists are aware that there may be diel variations in trawl catch. The few studies that have been conducted during both day and night suggest such a diel variation. For example, Miller (1965), who examined only one day-night pair of trawl hauls off Port Aransas, Texas, reported that of the 20 species taken in the night sample, 12 were not taken during the corresponding daytime sample, although they were taken during the day on other dates. Atlantic croaker, *Micropogonias undulatus,* catch was higher at night (108) than during the day (45). Similarly, Roessler (1965) found that night collections in two of three habitats in Biscayne Bay, Florida, yielded higher numbers of individuals than did daytime collections.

Livingston (1976) reported that numerous species, including Atlantic croaker, were found predominantly or exclusively at night in his Florida trawl study. The objective of our study was to determine diel variation in trawl catch of Atlantic croaker in the upper Barataria Bay Basin, Louisiana.

METHODS AND PROCEDURE

The Barataria Bay Basin is a deltaic estuary created by channel changes of the Mississippi River (Frazier 1967). It is bordered on the north and east by the Mississippi River, on the west by Bayou Lafourche, and on the south by the Gulf of Mexico. Basin water grades from freshwater in the northern reaches to saline in the southern part. Three stations were chosen for diel catch comparisons in fairly open water (Rogers 1979). These stations were on a 12-km north to south transect and were approximately 2 m deep and 0.5 km from shore. Salinities ranged from 0 to 1 ppt at Station 1, 0 to 4 ppt at Station 2, and 0 to 11 ppt at Station 3, (the southernmost station).

Each station was sampled with a 4.9-m flat otter trawl on 19-20 May, 24-25 June, 2-3 July, and 17-18 August 1978. The trawl bar mesh was 15 mm in the wings, 12 mm in the cod end, and 6 mm in the sock covering the cod end. Each tow was for 10 minutes at a speed of about 3 knots. With two exceptions, two trawls (first haul, second haul) were taken for both day and night within a 24-hour period for each station.

The randomized block design analysis of variance (ANOVA) with a factorial arrangement of treatments was used to test for differences due the effects of station, diel (day or night), and month. Trawl order (first haul, second haul) was treated as a repeated measure (split plot). Since trawl data are of the negative binomial distribution (Green 1979), all data were log transformed before analysis.

RESULTS AND DISCUSSION

Of the total 2,434 juvenile croaker taken during the study, 2,246 (92%) were taken at night (Table 1), even though there were two fewer night samples. Night catches ($\bar{x}$ = 110.8, $s_{\bar{x}}$ = 19.0) exceeded the corresponding day ($\bar{x}$ = 8.5, $s_{\bar{x}}$ = 1.8) trawl catches on every occasion (night/day ratio = 13:1). The overall ANOVA model (Table 2) indicated that the experimental error term (Station

Gulf of Mexico Science, Vol. 9 [1987], No. 2, Art. 10

Table 1. Numbers of Atlantic croaker (first and second trawl hauls combined) caught in the otter trawl during day-night sampling.

Station	May		June		July		August	
	Day	Night	Day	Night	Day	Night	Day	Night
1	2	386	11	603	34	190	3	85
2	20	73	33	70[a]	38	224	10	56
3	b	b	2	10[a]	30	331	5	218
TOTAL	22	459	46	683	102	745	18	359

a — Only one trawl haul.
b — No trawl hauls taken.

x Diel x Month) was significant; therefore this term was used as the error term to test the main effects (Steele and Torrie 1980). The difference between day and night (diel) was highly significant ($P > F$, .0001).

Our higher croaker catches occurred between 2100 and 0600 hours (Figure 1). Hoese *et al.* (1968) reported a higher catch of fishes and invertebrates at night than during the day offshore from Aransas Pass, Texas. Their daytime catches of croaker were highest in August, when turbidity was high, whereas no croaker were taken during the day in February, when the water was exceptionally clear. Dugas (1975) noted high catch during a period of high turbidity; also, Kjelson and Johnson (1978) found that turbidity lowered diurnal net avoidance for spot, *Leiostomus xanthurus.* Thus, reduction in net avoidance because of reduced visibility seems the most plausible explanation for our higher nighttime catches.

Croaker could avoid a trawl by moving laterally or vertically. For croaker, Hoese *et al.* (1968) suggested net avoidance as an explanation for their higher nighttime catches. Since they were working in waters from 5 to 27 m, they felt croaker may have also migrated vertically above the corkline during the day. Blancher (1972) concluded that most croaker in his study area stayed in the deeper locations (5-7 m) during the entire daily cycle, with only a little lateral movement into shallow-water areas (1-2 m) in the afternoon and evening. Neither vertical nor lateral movement seems a likely explanation in our study, however, since the water was of nearly uniform 2-m depth almost to the shoreline, and the sample stations were about 0.5 km from shore.

Table 2. Analysis of variance for randomized block design with a factorial arrangement of treatments.

Source	df	sum of squares	F	P > F
Model	23	103.38	12.37	.0001**
Station	2	1.7	.5	.6179
Diel	1	64.6	38.0	.0001**
Month	3	9.04	1.8	.2059
Diel X Month	3	1.03	0.2	.8929
Station X Diel X Month[a]	12	20.72	4.75	.0016**
Trawl Order	1	.02	.06	.8037
Diel X Trawl Order	1	.46	1.28	.2734
Residual Error	18	6.54		
Corrected Total	41	109.9		

a — Since this term was highly significant, it was used to test the main effects.

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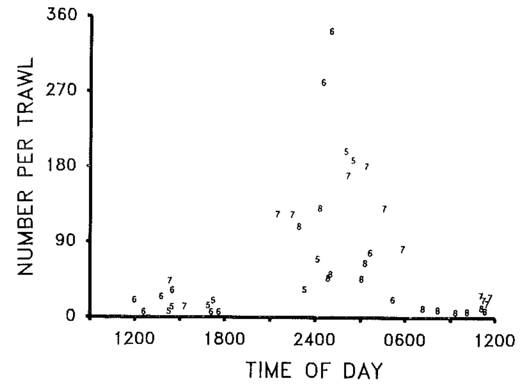

Figure 1. Trawl catch of Atlantic croaker by time of day. The month the sample was taken is indicated by the numerical symbol of the month (i.e., 5 = May).

Diel variations in trawl catches are probably due to changes in net avoidance resulting from changing light conditions. The amount of ambient light may vary between 24-hour periods, or within a period, depending on the cloud cover, phase of the moon, and turbidity, as well as declination of the sun and moon. Behavioral changes such as vertical or horizontal movement, or changing degrees of alertness, may also account for some day-night differences. Diel catch variations may be different for various habitats and species. For example, in this study we consistently took more species at night ($\bar{x} = 12$, $s_{\bar{x}} = .20$) than during the day ($\bar{x} = 5.3$, $s_{\bar{x}} = .20$). However, if it is important that the numbers of biomass or a species not be underestimated, nocturnal sampling should be considered. Night sampling is logistically more difficult, but a sufficient effort should be expended to evaluate diel variations for each study.

Catches of croaker did not differ significantly in length-frequency distributions, or in mean numbers, between paired trawl hauls. Our croaker were in the 35- to 120-mm size classes (Tables 3-5). In the 15 pairs of duplicate trawls with enough catches to use the Kolmogorov-Smirnov (K-S) two-sample, two-tailed test (Marasculo and McSweeney 1977, Siegel 1956) for differences in cumulative length-frequency distribution, only one was found significant (June, Station 1 at night, Table 3). Differences in mean numbers of croaker between first and second trawl hauls were nonsignificant (Table 2, Trawl Order). Available resources usually limit the number of samples that can be taken. Therefore, we conclude that one haul may normally be sufficient to represent Atlantic croaker numbers and length-frequency at a particular site. Multiple trawl hauls may be needed, however, if station or other differences are to be tested. For example, multiple trawl hauls would produce greater degrees of freedom and reduced variance, which would allow statistical tests to detect smaller differences.

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Table 3. Length-frequency of Atlantic croaker caught at Station 1 during the day-night sampling (1 = first trawl haul, 2 = second trawl haul).

Length Class (mm)	MAY				JUNE				JULY				AUGUST			
	Day		Night		Day		Night		Day		Night		Day		Night	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
35			2	1												
40			8	5												
45			16	15												
50		1	27	35												
55			37	48			3									
60		1	43	40	1		30	2								
65			31	35			37	3								
70			22	9	2		65	62								
75			4	2	4		67	81								
80			3		1		50	87		1	2	3				
85			2		1		3	87		1	14	7				
90			1		1			22	1	4	23	16			1	
95					1			4	4	7	41	23			8	8
100									5	6	29	19	1		13	18
105									3	1	5	6		1	11	15
110										1		1	1		2	9
115																
120												1				
Total	0	2	196	190	11	0	255	348	13	21	114	76	2	1	35	50

Table 4. Length-frequency of Atlantic croaker caught at Station 2 during the day-night sampling (1 = first trawl haul, 2 = second trawl haul).

Length Class (mm)	MAY				JUNE				JULY				AUGUST			
	Day		Night		Day		Night		Day		Night		Day		Night	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
35	1															
40			1	2												
45	1	1	2	2												
50	4	3	3	4												
55		1	1	12		2	6									
60		3	2	11	2		4									
65		3	1	14	1	2	18									
70	1	2	5	10		10	12									
75			2	1	2	2	14	a								
80					5	4	10				4					
85					3		4		2	2	12	12				
90							2		6	4	24	20			2	
95									6	2	28	38			2	2
100									6	6	30	22	2		10	6
105										2	14	16		2	8	8
110									2			2			4	4
115												2	4	2	6	4
120																
Total	7	13	17	56	13	20	70	a	22	16	112	112	6	4	32	24

a — No trawl haul.

Table 5. Length-frequency of Atlantic croaker caught at Station 3 during the day-night sampling (1 = first trawl haul, 2 = second trawl haul).

Length Class (mm)	MAY				JUNE				JULY				AUGUST			
	Day		Night		Day		Night		Day		Night		Day		Night	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
35																
40																
45																
50																
55																
60																
65							2									
70	a	a	a	a		1	1	a	1	1	20	8				
75							3		4		25	32			1	
80							1		1	1	42	48			1	5
85					1				2		37	48		1	14	10
90							2		7		17	29		1	26	20
95							1		6		9	5	1		33	46
100									6	1	8		1		17	23
105												3		1	6	15
110															1	
115																
120																
Total	a	a	a	a	1	1	10	a	27	3	158	173	2	3	99	119

a — No trawl haul.

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Gulf of Mexico Science, Vol. 9 [1987], No. 2, Art. 10

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