

# SPECIES ASSEMBLAGES, DISTRIBUTION, AND ABUNDANCE OF FISHES AND DECAPOD CRUSTACEANS FROM THE WINYAH BAY ESTUARINE SYSTEM, S.C. 1/

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BY

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#### ABSTRACT

Fishes and decapod crustaceans were collected along the salinity gradient in the Winyah Bay estuary, South Carolina with a 6-m otter trawl over a twoyear period. A total of 77 species of fishes and 20 decapod crustaceans were collected. Species diversity was greatest at stations in the bay near the mouth.

Seven fish species comprised > 90% of the total number of individuals collected: <u>Stellifer lanceolatus</u>, <u>Micropogonias undulatus</u>, <u>Trinectes maculatus</u>, <u>Ictalurus catus</u>, <u>Cynoscion regalis</u>, <u>Brevoortia tyrannus</u>, and <u>Leiostomus xanthurus</u>. The decapod crustaceans were not as important as the fishes in abundance or biomass. <u>Callinectes sapidus</u>, <u>Penaeus duorarum</u>, <u>P. aztecus</u>, and <u>P. setiferus con-</u> stituted > 90% of the decapod catch by number.

Most species and individuals were collected in the fall when <u>Trinectes</u> <u>maculatus</u> and <u>Stellifer lanceolatus</u> were abundant and an influx of stenohaline marine transient species occurred. The fall peak in diversity was followed by a sharp decrease in winter when several stenohaline and transient euryhaline species left the estuary. In spring, numbers of species and individuals increased, although stenohaline marine species were still not very abundant and were patchy in their occurrence. In summer, the number of stenohaline marine transients entering Winyah Bay peaked and transient euryhaline species were most abundant.

Juvenile fishes dominated catches in the Winyah Bay system. The suitability of the area as a nursery habitat is probably enhanced by freshwater input. However, density and biomass estimates for fishes and decapods were low compared to other S.C. estuarine systems studied. νí

#### ACKNOWLEDGEMENTS

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#### INTRODUCTION

The Winyah Bay estuarine system of South Carolina, which includes the Waccamaw, Peedee, Black, and Sampit Rivers as well as Winyah Bay itself, has experienced rapid industrialization and municipal development over the past decade. As a result, sedimentation, loss of critical habitat, and pollution have lowered water quality in the Winyah Bay system, yet the estuary is still being considered as a site for further development.

Although Winyah Bay is an important habitat for penaeid shrimp, blue crabs, and numerous finfishes, its importance as a nursery area and its fishery potential in terms of abundance of fishes and decapod Crustacea have never been assessed. This paper provides information on the species assemblages, spatial and temporal abundance, and distributional patterns of fishes and decapod crustaceans from the Winyah Bay estuarine system.

#### STUDY AREA

The Winyah Bay estuarine system is bounded to the north by the Cape Fear River Basin, North Carolina, and to the south by the Santee River Basin of South Carolina (Figure 1). Winyah Bay connects with the Atlantic Ocean and is bounded at the mouth on the north by North Island, an arcuate spit, and on the south by a barrier island (Sand Island) connected to the mainland by an eastwest jetty.

The bay itself is about a mile (1.6 km) wide at either end and about four miles (6.4 km) wide at its center. Waters at the seaward end reflect the higher



FIGURE 1. STATION LOCATIONS IN THE MINYAH BAY ESTUARINE SYSTEM, S.C.

salinity of the ocean, but upstream, the bay receives considerable freshwater from four major sources:

- the Waccamaw River which forms at Lake Waccamaw, N.C., and flows into the Great Peedee River near Georgetown, S.C.,
- (2) the Black River which enters the Great Peedee River near Georgetown, S.C.,
- (3) the Great Peedee River which receives waters of the Black River and then enters Winyah Bay at Georgetown, S.C., and
- (4) the Sampit River which is a short coastal river that lacks a large drainage basin.

About 60% of the freshwater input to Winyah Bay is supplied by the Peedee River (Conservation Foundation<sup>1</sup>). Despite the strong freshwater influence, the Winyah Bay estuarine system may best be classified as partially mixed, although this condition does fluctuate greatly, especially at the extreme ends of the estuary. Conditions at the mouth may range from nearly stratified to partially mixed, while the head of the estuary is either nearly homogeneous or partially mixed, depending on tidal stage (Bloomer, 1973). Fluctuating freshwater input also changes the distance over which saltwater intrusion occurs. During average runoff conditions of about 15,000 cfs (Johnson, 1970), saltwater intrusion, as measured from the river's mouth, reaches mile 2.0 on the Black River and mile 5.0 on the Peedee and Waccamaw Rivers (Bloomer, 1973).

The freshwater influence of the major source rivers also affects the amount of coastal marshlands in the Winyah Bay system. Within this region are 129 km  $^2$ of coastal marshlands, 80% of which are freshwater marshes (Tiner, 1977). Freshwater marshes are located on the northern side of Winyah Bay and along the upper reaches of the Waccamaw, Peedee, and Black Rivers. Brackish marshes

<sup>&</sup>lt;sup>1</sup>The Conservation Foundation, 1980. Winyah Bay Reconnaissance Study, Summary Report. Washington, D.C. 75 p.

compose 18% of the wetlands, and salt marshes < 1% of Winyah Bay wetlands. Most of the intertidal areas of Winyah Bay, including South Island, North Island, and the shores of the lower reaches of the tributaries to Winyah Bay, consist of salt marsh dominated by saltmarsh cordgrass (<u>Spartina alterniflora</u>) (Tiner, 1977).

#### METHODS AND MATERIALS

#### Data Collection

We sampled monthly from January 1977 to December 1978 at nine fixed stations located in the channel of Winyah Bay estuary (Figure 1): YOO1 (Winyah Bay), YBO2 (Buoy N "16"), YBO5 (Buoy C "19A"), YBO8 (Buoy R "24"), YB11 (Buoy R "30"), YLO5 (Black River), YPO5 (Peedee River), YSO7 (Sampit River), and YWO6 (Waccamaw River).

All collections were made with a 6-m (20-ft.) semi-balloon otter trawl of 2.5-cm (1-inch) stretch mesh throughout. A twenty-minute tow was made at each station against flood tide during daylight hours. Tow speed was 1.3 m sec<sup>-1</sup> (2.5 knots), which resulted in a coverage of 1.5  $\pm$  0.4 km during a tow.

Bottom-water samples were collected with 6-liter capacity Van Dorn bottles 0.3 m above the bottom at each station prior to trawling. Water temperature was read from stem thermometers mounted within the Van Dorn bottles. Salinity was measured in the laboratory with a Beckman RS7B induction salinometer. Dissolved oxygen was determined by the Winkler-Carpenter method (Strickland and Parsons, 1968). Turbidity was determined with a Hach Model 2100A Turbidimeter. Specimens were either processed in the field or preserved in 10% formalin and returned to the laboratory for identification, measuring, and weighing. Specimens were weighed to the nearest 0.1 g and counted. We also recorded measurements (total length for fishes, carapace width for crabs, and total length for shrimp) for all species numbering  $\leq 50$  specimens per tow. At stations where the trawl caught larger numbers of organisms, we subsampled each species in the catch as follows: if  $\geq 50$  to  $\leq 250$  individuals were collected, then a minimum of 50 randomly-selected specimens were measured and weighed; if > 250 to  $\leq 500$  individuals were caught, then 20% of the catch was measured and weighed.

Seasons are consistent with other paper on S.C. estuaries (Wenner <u>et</u> <u>a1</u>.<sup>2</sup>): Winter encompases January, February, and March; Spring encompasses April, May, and June; Summer encompasses July, August, and September; and Fall includes October, November, and December.

#### Data Analysis

Similarity among collections and among species was determined with the Bray-Curtis similarity coefficient (Clifford and Stephenson, 1975), using a log transformation and flexible sorting with  $\beta = -0.25$ . Prior to calculation of similarity matrices, we reduced the data set by elimination of species which occurred in only one or two collections and by elimation of collections which contained only one species. Separate matrices were then constructed for each season on combined data from the two-year sampling period with collections as entities and species as attributes (normal analysis) and with species as entities and collections as attributes (inverse analysis). Two separate dendrograms were constructed for each season: a dendrogram which indicated association of all collections by season during the two-year sampling period based on their species

<sup>&</sup>lt;sup>2</sup>Wenner, E.L., M.H. Shealy, Jr. and P.A. Sandifer. Profile of the fish and decapod crustacean community in a South Carolina estuarine system prior to flow alteration. (in press, NOAA Special Scientific Report).

composition, and another which indicated association of all species for each season over the two-year sampling period based on the collections in which they occurred. We then used post-clustering techniques of nodal analysis (Williams and Lambert, 1961; Lambert and Williams, 1962) to examine species and station coincidences, based on patterns of constancy and fidelity.

An index of abundance (Musick and McEachran, 1972; Elliott, 1977) was used to discern spatial and temporal patterns of abundance for dominant species and is expressed as:

Index of Abundance = 
$$\frac{1}{n} = \frac{1}{\sum_{n=1}^{n} \log_{10}} (x + 1)$$

where x = number of individuals of a given species and n = number of collections in a chosen time frame.

We determined biomass and density estimates for fishes and decapod crustaceans from computations of area swept for the 6-m trawl. Estimates of area swept (a) were determined by the following equation given by Roe (1969):

$$a = K \times M \times (0.6 \text{ H})$$

$$\frac{10,000 \text{ m}^2/\text{hectare}}{1000 \text{ m}^2/\text{hectare}}$$

where K is speed in meters per hour, M is time in hours fished, and H is headrope length in meters (Klima<sup>3</sup>). Roe (1969) assumed an effective swath of about 60% of the headrope length as established by Wathne (1959). The area swept by our 6-m otter trawl was estimated to be 0.72 hectare/tow by this method.

<sup>&</sup>lt;sup>3</sup>Klima, E.F. 1976. A review of the fishery resources in the western central Atlantic. Western Central Atlantic Fishery Comm. Publ., No. 3.

#### RESULTS AND DISCUSSION

#### Hydrographic Parameters

Bottom water temperatures in Winyah Bay estuarine system were fairly uniform from station to station. Seasonal bottom water temperatures fluctuated from a low ( $\leq 5^{\circ}$ C) throughout the study area in February to a high during July 1977 ( $\sim 30^{\circ}$ C) and August 1978 ( $\sim 29^{\circ}$ C) (Figure 2). The most distinct differences in temperature occurred from winter to spring, and from summer to fall. Average temperatures were slightly lower in 1978 than in 1977.

Application of the Venice system of salinity classification (Symposium on the Classification of Brackish Waters, 1958) showed that upriver stations (YLO5, YPO5, YWO6) ranged from limmetic (<  $0.5^{\circ}/\circ\circ$ ) to mesohaline ( $5-18^{\circ}/\circ\circ$ ) depending on season (Figure 3). At these stations, winter and spring salinity conditions were low and stable for both years, whereas highest salinities occurred in summer and fall. Bottom water salinity never exceeded  $4^{\circ}/\circ\circ$  at station YWO6 during the sampling period. Salinities at stations YSO7 and YB11 ranged from 0.14- $11.65^{\circ}/\circ\circ$  and from 0.06- $18.24^{\circ}/\circ\circ$ , respectively. Bottom water salinities were highest at these stations during the fall and were lowest during winter and spring. Stations YBO8, YBO5, YOO1, and YBO2 were highly variable with respect to salinity. Their extremes over the two-year sampling period were: YBO8 ( $0.11-25.87^{\circ}/\circ\circ$ ), YBO5 ( $0.06-28.44^{\circ}/\circ\circ$ ), YOO1 ( $0.14-24.86^{\circ}/\circ\circ$ ), and YBO2 (0.71- $32.72^{\circ}/\circ\circ$ ). Average salinities at these stations were also highest in fall and lowest in spring.

Average dissolved oxygen concentrations were greatest at all stations in winter and lowest in summer (Table 1). Dissolved oxygen concentrations below



Bay estuarine system, 1977 - 1978,



FIGURE 3, Bottom water salinity variations at nine fixed sampling locations in the Minnah Bay estuarine system, 1977 - 1978,



FIGURE 3, (CONTINUED),





TABLE 1. Average depth and dissolved orygen conditions at stations in the Winyah Bay estuarine system, S.C. from 1977 - 1978.

Matrix										5		5	208	Ŕ	001	-	52	1	205
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	-	5.5	10.1	4.2	6.01	0.0		r		1	•		4 F	с г	5	1.0	• 8, 6	4,0	8.1
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6       5.0       4.2       7.5       3.9       8.0       4.8       3.0       3.5       5.0       5.5       5.6       4.5       5.9       5.5       5.8         7       5.0       4.2       7.5       3.9       8.0       4.8       7.0       5.0       3.5       5.6       4.0       5.7       2.5       5.4         7       5.0       4.6       5.0       4.6       7.0       5.0       3.5       5.3       5.0       5.5       5.6       4.0       5.7       2.5       5.4         8       4.5       4.0       4.1       3.5       5.5       5.5       5.5       5.5       5.6       4.0       5.7       2.5       5.5         9       5.5       4.1       3.5       5.5       5.5       5.6       4.0       5.7       5.0       5.5         9       5.5       4.2       4.0       5.6       4.0       5.7       2.5       5.4       5.0       5.5         10       5.5       5.0       5.1       4.0       5.6       4.0       6.7       5.5       5.4       5.0       5.5       5.4       5.0       5.5         10       5.5		u U	с т С	4.0	5.6	9.8	6.2	4.0	5.4	5 <b>.</b> 5	6.1	6.5	6.4	2.5	£,6	4.5	ę.ę	5.0	6.B
7       5.0       4.6       5.0       4.6       7.0       5.0       3.6       6.0       5.5       5.0       5.6       4.0       5.2       2.5       5.4         8       4.5       4.0       4.4       7.0       4.7       3.5       3.5       5.5       5.5       5.5       5.5       5.5       5.5       5.5       5.0       4.5       4.8       4.5       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0       5.5       5.4       5.0 </td <td>n v</td> <td></td> <td></td> <td>1-</td> <td><b>.</b></td> <td>6.0</td> <td>4.8</td> <td>3.0</td> <td>3.9</td> <td>3.5</td> <td>5.0</td> <td>5.5</td> <td>5.6</td> <td>2.5</td> <td>5.6</td> <td>ê.5</td> <td>5.9</td> <td>5.5</td> <td>5,8</td>	n v			1-	<b>.</b>	6.0	4.8	3.0	3.9	3.5	5.0	5.5	5.6	2.5	5.6	ê.5	5.9	5.5	5,8
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8       4.5       4.8       6.0       4.4       7.0       6.7       3.5       4.7       5.5       5.4       5.0       5.5         9       5.5       4.2       4.0       4.3       9.0       5.0       5.0       5.2       6.0       5.4       2.5       5.4       5.0       5.5         10       5.5       6.0       5.0       5.0       5.6       4.0       6.8       4.0       6.3       3.5       5.4       5.0       5.5         10       5.5       6.0       5.0       5.6       4.0       6.8       4.0       6.3       3.5       6.0       6.2       4.5       6.6         11       5.5       7.1       8.0       6.6       4.0       5.8       4.5       7.4       5.0       7.3         12       4.5       7.1       4.0       7.6       5.5       7.4       5.0       7.4       5.0       7.4       5.0       5.5       7.2         12       4.5       7.4       5.5       7.4       5.5       7.4       5.0       7.4       5.0       7.4       5.0       7.4       5.0       7.4       5.0       7.4       5.0       7.4       5.0	~	5.0	4.6	2.0	4	0.7	2		, , , ,		2	ی د	5 7	4.0	6.4	4.5	4.8	4.5	5.0
9       5.5       4.2       4.0       4.1       9.0       5.0       5.0       5.2       6.0       5.4       2.5       5.6       5.5       5.6       5.7       5.7       5.1       5.5       7.4       5.6       5.7       5.7       5.7       5.7       5.7       5.7       5.7       5.7       5.7       5.7	æ	5.4	4.8	4.0	4.4	1.0	- J	3.5	4	•••		2						i I	
10       5.5       6.0       5.0       5.8       8.0       5.6       4.0       5.8       4.0       6.8       4.0       6.3       3.5       6.6       4.0       6.5       4.5       6.6         11       5.5       7.2       5.0       7.1       8.0       6.6       4.0       5.8       4.5       7.4       5.0       7.1       6.8       5.5       7.2         12       4.5       7.1       4.5       7.6       5.5       7.8       5.5       7.8       5.0       7.4       4.0       6.8       5.5       7.2         12       4.5       7.4       5.6       5.5       7.8       5.5       7.8       3.0       7.6       5.0       7.4       4.0       6.8       5.5       7.2         12       4.5       7.6       5.5       7.8       3.0       7.6       5.0       7.4       4.0       7.3	đ		4.2	4.0	6.ł	0.0	5.0	5.0	3.8	5.0	5.2	6.0	5.4	2.5	5.4	5.5	4.0 4	a A	<u>.</u>
11 5.5 7.2 5.0 7.1 8.0 6.6 4.0 5.8 4.5 7.4 6.0 7.4 3.0 6.9 4.0 6.8 5.5 7.2 11 5.5 7.2 5.0 7.1 8.0 6.6 4.0 5.8 4.5 7.6 5.5 7.8 3.0 7.6 5.0 7.4 4.0 7.3 12 4.5 7.3 4.0 7.6 8.5 8.2 3.0 6.9 4.5 7.6 5.5 7.8 3.0 7.6 5.0 7.4 4.0 7.3	· ș		0 v	e s	5,8	8.0	5.7	4.D	5.6	4.0	6.8	4-0	6.3	3.5	6.6	4.0	6.2	4.5	6.6
11 5.5 /.2 5.0 /.1 5.0 /.1 6.9 4.5 7.6 5.5 7.8 3.0 7.6 5.0 7.4 4.0 7.3 12 4.5 7.3 4.0 7.6 8.5 8.2 3.0 6.9 4.5 7.6 5.5 7.8 3.0 7.6 5.0 7.4 4.0 7.3	3		5 r		-	Ú K	6.6	4.0	5.8	4.5	7.4	6.0	7.4	3.0	6.9	4.0	6.8	5.5	7.2
12 4.5 7.3 4.0 7.6 8.5 8.2 3.0 0.9 4.0 7.6 1.	11		7.1		;;	2			•	-	4	U U	4. F	3.0	7.6	5.0	7.4	4.0	7.3
	12	4.5	E.7	4.0	7.6	8.5	8.2	3.0	6.4	- -			2	1					

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4 mg/l were encountered only at stations YSO7 and YPO5 during late spring and summer.

## Diversity and Community Composition

A total of 77 species of fishes were collected from the Winyah Bay system during the 1977-1978 sampling period (Table 2). The length, bottom salinity, and bottom temperature ranges, along with relative abundance of all species collected are found in Appendix I. Of the fishes collected, seven comprised > 90% of the total number of individuals taken during the study period: star drum (<u>Stellifer lanceolatus</u>), Atlantic croaker (<u>Micropogonias undulatus</u>), hogchoker (<u>Trinectes maculatus</u>), white catfish (<u>Ictalurus catus</u>), weakfish (<u>Cynoscion regalis</u>), Atlantic menhaden (<u>Brevoortia tyrannus</u>), and spot (<u>Leiostomus</u> <u>xanthurus</u>). Although <u>S. lanceolatus</u> was the most abundant species collected, constituting 29% of the total fish catch numerically, <u>I. catus</u> contributed most to the total biomass, being about 16% of the total catch by weight.

Twenty identifiable species of decapod crustaceans were collected (Table 3). The decapod crustaceans were neither as abundant nor weighed as much as the fishes. The blue crab, <u>Callinectes sapidus</u>, constituted the greatest portion of the decapod catch numerically and by weight throughout the two-year sampling period. Other dominants included the pink shrimp (<u>Penaeus duorarum</u>), the brown shrimp (<u>P. aztecus</u>), and the white shrimp (<u>P. setiferus</u>), which with the blue crab, constituted > 90% of the decapod catch by number.

Species richness, expressed as number of decapod and fish species, was lowest at station YBO8 during both years of sampling (Table 4). Stations YBO2, YWO6, and YOO1 had the richest fish fauna, while more decapod species were caught

### TABLE 2. Total number and total biomass (kg) of fishes from 1977 - 1978 in the Winyah Bay estuary. Species are listed in order of abundance and data are pooled over the two-year sampling period.

OPECTS         TOTAL NUMBER         PECETN TOTAL         PECETN STORASS (sg)         TOTAL EXCMASS           SHI1/67 Lanceplatus         11356         29-22         37.399         6.55           Microsopolis         undulifun         9706         24.98         60.089         13.94           Firefores         accolation         75.32         19.38         40.0524         9.20           Totalinung attas         3133         8.06         69.155         15.81         15.81           Totalinung attas         1322         1.64         12.376         2.87         1.453           Transcing accolation         22         1.64         12.376         2.87         1.83           Bartatical a chryseurg         133         0.66         8.077         1.85         0.30         1.023         0.28           Bartatical a chryseurg         133         0.66         3.077         1.54         0.28           Menticitud a chartas         106         0.277         0.154         0.28         1.89           Menticitud a chryseurg         73         0.19         0.187         0.18         0.127           Anguilla costrata         70         0.13         1.127         2.89         0.45 <tr< th=""><th></th><th></th><th></th><th></th><th></th></tr<>					
Scalifer incerlation         1135         29.22         37.395         6.55           Microgramias undulatus         7302         12.4.98         60.395         13.4           Increasing undulatus         7332         18.3.6         40.155         13.4           Increasing undulatus         1333         4.36         61.35         13.4           Increasing undulatus         1332         1.6.67         4.4.55         13.1           Increasing undulatus         122         1.66         12.376         2.85           Increasing undulatus         122         1.66         12.376         2.85           Increasing undulatus         122         1.66         12.376         2.85           Increasing undulatus         123         0.466         8.023         1.85           Increasing undulatus         124         1.06         4.463         1.02           Increasing undulatus         133         0.66         8.023         4.86           Increasing undulatus         133         0.36         1.28         0.28           Increasing undulatus         133         0.36         0.29         0.33           Increasing undulatus         13         0.37         0.13         0.36     <	SPECIES	TOTAL NUMBER	PERCENT NUMBER	TOTAL BIOMASS(kg)	PERCENT BIOMASS
Stellifer lancedatus         1478         24.66         00.669         11.94           Micropagnics         3133         8.06         69.155         13.81           Trinspag macunics         3133         8.06         69.155         13.81           Trinspag macunics         3133         8.06         69.155         13.81           Demonsing tespelia         130         3.43         19.467         4.453           Demonsing tespelia         131         1.08         1.075         1.84           Demonsing tespelia         131         1.08         1.075         1.84           Demonsing tespelia         11         1.08         1.075         1.85           Symbus Jelatist         100         1.03         0.465         0.023           Amacas mitchili         118         0.30         1.1228         0.28           Maralletring         17         0.35         1.037         0.9           Maralletring tespelia         18         0.30         1.1228         0.28           Maralletring tespelia         17         0.35         1.037         0.8           Maralletring tespelia         16         0.27         0.18         1.1228         0.86		1106/		77 300	8.55
<u>Hicrospection</u> updulates 9706 47.32 40.722 7.00 Triaction machines 1333 6.06 67.156 13.81 Tetaliums mathematical 1333 6.06 67.156 13.81 Tetaliums mathematical 1333 7.43 19.467 4.03 Triaction machines 1334 7.43 19.467 4.03 Supports results 1.00 Machine microfibili 400 1.03 0.0897 0.00 mathematical 1.00 Machine microfibili 400 0.077 0.154 0.08 Machine microfibili 400 0.077 0.154 0.08 Machine microfibili 7.00 0.08 Machi	<u>Stellifer</u> <u>lanceolatus</u>	11356	29.22	40 080	13.94
Trincics         mail	Micropogonias undulatus	9706	24.50	40.354	9 20
Internet attres         1133         8.00         09.156         1.00           Cronscint resolution         133         1.00         1.01         1.01         1.02           Cronscint resolution         133         1.03         1.03         1.04         1.02           Structure finition         1.02         1.03         0.866         1.02           Structure finition         400         1.03         0.866         0.20           Structure finition         1.03         0.866         0.20         0.28           Structure finition         1.80         0.30         1.228         0.28           Structure finition         1.06         0.4         0.025         6.86           Structure finition         1.06         0.27         0.144         0.05           Structure finition         1.06         0.27         0.144         0.05           Structure finition         1.0         0.18         1.128         0.28           Structure finition         1.0         0.18         1.1278         2.58           Marcina guerricure         0         0.18         0.122         0.03           Marcina guerricure         0         0.13         1.112         0.28     <	Trinectes maculatus	7532	19.38	40,204	15 81
Crossing regals         1905         4.80         0.8.21         1.80           Reveoring (yranes)         1334         1.43         1.666         4.80           Laisstows katthurus         722         1.53         1.766         4.81           Symphuter playing         400         1.03         0.866         0.20           Andrea michang         118         0.46         30.025         6.86           Partificity by thisating         178         0.46         30.025         6.86           Periodus antisang         178         0.46         30.025         6.86           Periodus antisang         178         0.46         30.022         0.30           Anguilla rokocasi         79         0.20         2.302         0.31           Anguilla rokocasi         73         0.18         11.728         0.18           Prinostus antisang         70         0.18         11.246         0.18           Orgony in Lindons         30         0.14         2.772         0.63           Prinostus antisang         32         0.93         0.13         1.112         0.25           Marons garrides abing         30         0.14         2.772         0.63 <td< td=""><td>Ictalurus catus</td><td>3133</td><td>8.06</td><td>09.130</td><td>2.02</td></td<>	Ictalurus catus	3133	8.06	09.130	2.02
Environtis tyrantos         1334         3.43         19.457         4.45           Leiostows Aschburg         722         1.86         12.756         2.65           Symphuts Jasties         40         1.03         5.765         1.02           Anches mitchill         400         1.03         6.866         0.20           Anches mitchill         400         1.03         6.866         0.20           Anches mitchill         400         1.03         6.866         0.20           Anches mitchill         400         1.03         6.866         0.22           Prinnstue (Tibulus         106         0.27         0.154         0.02           Prinnstue (Tibulus         76         0.20         7.499         2.17           Registion (Stata         71         0.18         1.038         2.58           Morens anoritant         70         0.18         1.038         2.68           Morens anoritant         70         0.18         1.038         0.046         0.18           Morens anoritant         70         0.13         1.112         0.255         0.65           Morens anoritant         20         0.14         2.772         0.63         0.046 <t< td=""><td>Cynoscion regalis</td><td>1905</td><td>4.90</td><td>8.831</td><td>2,02</td></t<>	Cynoscion regalis	1905	4.90	8.831	2,02
Leiostoms karthurs         22         1.86         12.37         21.37           Symphotics plagiusa         211         1.33         5.728         1.33           Symphotics plagiusa         421         1.08         4.683         1.02           Symphotics plagiusa         421         1.08         4.683         1.02           Sandradicis         0.097         1.83         0.046         8.097         1.85           Parallichtys lethosilges         118         0.30         1.228         0.84           Mentifitribalits         79         0.20         2.332         0.53           Response         73         0.19         0.829         0.19           Dessaws tas         71         0.18         17.037         3.89           Morene assatilian         70         0.18         0.644         0.109           Morene assatilian         70         0.18         0.122         0.03           Morene assatilian         52         0.15         0.122         0.03           Morene assatilian         52         0.16         0.122         0.03           Morene assatilian         52         0.06         0.144         0.722         0.16           D	Brevoortia tyrannus	1334	3.43	19.46/	4.43
Trophysis         Fighturg         517         1.33         5.28         1.33           Symphutg         Jaffallia         400         1.03         0.866         0.20           Anchea         Stridfellia         400         1.03         0.866         0.20           Stridfellia         Anchea         0.16         5.28         0.86           Parallichtys         Iethoryseura         333         0.86         8.097         1.68           Parallichtys         Stridfellia         0.16         0.22         0.134         0.68           Parallichtys         106         0.20         0.302         0.53           Arguilla rostrate         73         0.19         0.899         0.17           Dessue that         70         0.18         11.272         0.83           Dessue that         70         0.18         0.12         0.13           Prionaus that         40         0.12         0.13         0.12         0.23           Scores statulis         53         0.14         2.289         4.63           Scores statulis         34         0.09         3.755         6.06           Cableost strungsug         32         0.06         0.180	Leiostomus xanthurus	722	1.86	12.576	2.0/
Symphonus         Distribution         Constraint         Constraint <thconstraint< th="">         Constraint         Constra</thconstraint<>	Urophycis regia	517	1.33	5.726	1.31
Acadea miliniti         4000         1.03         0.866         0.20           Derificila furgeorra         333         0.86         8.097         1.85           Paralichty lethositigma         178         0.46         30.023         6.85           Paralichty seriianus         118         0.30         1.224         0.25           Princis tribulus         79         0.27         0.154         0.26           Anguilla rostrats         79         0.20         2.492         2.13           Anguilla rostrats         70         0.19         0.422         0.19           Desaus fac         70         0.18         11.275         2.86           Desaus fac         70         0.18         11.275         2.66           Olascodificer:         53         0.15         0.120         0.63           Drephysis Horidana         49         0.13         1.112         0.25           Desaus satina         34         0.09         8.756         8.82           Cobiscog strumosus         32         0.08         0.100         0.06           Scophtalmis aquosus         24         0.05         0.23         0.06           Actas aspidiadana         20	Symphurus plagiusa	421	1.08	4,483	1.02
arisistis         chypeours         333         0.86         8.097         1.88           Derailstrive         118         0.30         1.228         0.28           Menicitrive americanus         118         0.30         1.228         0.28           Paralistrive         79         0.20         2.302         0.35           Paralistrive         76         0.20         2.499         2.117           Paralistrive         76         0.20         2.499         2.117           Paralistrive         76         0.20         2.499         2.117           Perineux         10.18         17.037         2.89         0.15         0.120         0.499         0.13         1.112         0.20         0.23         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20         0.20	Anchoa mitchilli	400	1.03	0.866	0.20
Serielicitry lationstigns         178         0.46         30.025         6.85           Perionicus intibutes         106         0.27         0.134         0.08           Perionicus intibutes         79         0.20         2.302         0.53           Anguille rostrats         76         0.20         9.499         2.17           Opsinus fau         71         0.18         17.28         2.58           Morine sericiona         70         0.18         17.28         2.58           Obside Sericiona         70         0.18         17.27         3.89           Prinonicus intrins         59         0.15         0.100         0.033           Morene solutilis         10.112         0.135         0.136         0.122         0.235           Morene solutilis         59         0.15         0.130         0.123         0.135         0.050         0.050         0.050         0.050         0.050         0.050         0.050         0.050         0.050         0.050         0.050         0.060         0.120         0.05         0.050         0.060         0.040         0.05         0.06         0.050         0.06         0.050         0.050         0.06         0.05         0	Bairdiella chrysoura	333	0.86	8.097	1.85
Sected Litric and Litric Linear         118         0.30         1.228         0.28           Construction Linear         106         0.27         0.134         0.04           Spring Construction         76         0.20         2.302         0.33           Spring Construction         76         0.20         9.499         2.11           Spring Construction         73         0.19         0.829         0.18           Deparate Law         71         0.18         11.278         2.58           Deparate Law         70         0.18         0.684         0.16           Princatus Carolinus         59         0.15         0.120         0.63           Brone Santilis         53         0.14         2.772         0.63           Brone Santilis         53         0.15         0.120         0.63           Brone Santilis         53         0.14         2.722         0.63           Drophycis Horidana         49         0.13         1.112         0.25           Dayatis Satina         34         0.09         38.756         8.86           Gobiesos strumesus         32         0.08         0.120         0.16           Dayatis Satina         34	Paralichthys lethostigma	178	0.46	30,025	6.86
Description         Description <thdescription< th=""> <thdescription< th=""></thdescription<></thdescription<>	Manti dirthus americanus	118	0,30	1.228	0.28
Principica         Lindards         Principica         Lindards         Principica         Lindards           Argalithiy         76         0.20         9.499         2.17           Argalithiy         73         0.19         0.839         0.19           Drasmas         10         0.18         11.788         2.89           Drasmas         10         0.18         11.28         2.90           Drasmas         10         0.18         0.684         0.16           Drasmas         10         0.13         1.112         0.23           Drasmas         10.14         2.772         0.63         0.08           Drasmas         48         0.12         0.336         0.08           Drasmas         42         0.11         2.029         4.63           Drasmas         32         0.88         0.100         0.08           Calabras         0.06         0.148         0.00         0.00 <tr< td=""><td>Price tribulus</td><td>106</td><td>0.27</td><td>0.154</td><td>0.04</td></tr<>	Price tribulus	106	0.27	0.154	0.04
Arraichtyg startatus         76         0.20         9.499         2.17           Arguille Startatus         76         0.20         9.499         2.17           Perritos alprican         70         0.18         17.037         3.89           Morens gasrican         70         0.18         1.278         2.58           Morens gasrican         70         0.18         0.644         0.16           Prionctus carritus         50         0.15         0.120         0.03           Morens gasricus         64         0.13         1.11         0.25           Myrons gasses         48         0.12         0.336         0.08           Myrons gasses         64         0.09         38.756         8.86           Dagratis gassas         24         0.06         0.148         0.03           Calculors portatus         25         0.06         0.148         0.03           Scophthalmug gassas         24         0.06         0.140         0.03           Alses aspidiasing         20         0.05         0.100         0.02           Carlanting probleming gassas         20         0.05         0.100         0.03           Alses aspidiasing         20	Prionotus tributus	79	0.20	2.302	0.53
Anguille rostrats         Disous tau         Disous tau <thdisou< th="">         Disous tau         Disou</thdisou<>	Paralichtnys dentatus	76	0 20	9.499	2.17
Perfilos aleptéctus         73         0.12         0.000         3.89           Morone gnericant         70         0.18         11.000         0.000 <td>Anguilla rostrata</td> <td>70</td> <td>0.10</td> <td>0.829</td> <td>0.19</td>	Anguilla rostrata	70	0.10	0.829	0.19
Opsamp         La         La <th< td=""><td>Peprilus alepidotus</td><td>73</td><td>0.19</td><td>17 037</td><td>3.89</td></th<>	Peprilus alepidotus	73	0.19	17 037	3.89
Morons gnoricans         /0         0.18         0.164         0.164         0.17           Chaetadipterus faber         70         0.18         0.664         0.19           Prionatus carolinus         59         0.13         0.100         0.63           Borons saxilis         53         0.14         2.772         0.63           Drophysis floridans         49         0.13         1.112         0.25           Dayatis saxilis         62         0.11         20.269         4.63           Dayatis saxin         42         0.11         20.269         4.63           Cobsects ortunes basin         62         0.08         0.100         0.02           Dayatis saxin         30         0.08         0.120         0.16           Peprily triacnthus         25         0.06         0.148         0.03           Aloss splidesing         21         0.05         3.242         0.74           Etropue crosselus         21         0.05         0.100         0.02           Ictalurus petentes         20         0.05         0.106         0.02           Ictalurus ententes         20         0.05         0.100         0.02           Ictalurus petentes	<u>Opsanus tau</u>	/1	0.10	11 279	2 58
Chartodipterus faber         70         0.18         0.404         0.404           Prinoctus carolinus         59         0.15         0.120         0.03           Morong saxatilis         53         0.14         2.772         0.63           Morong saxatilis         53         0.14         2.772         0.63           Myraphienius hentzi         48         0.12         0.336         0.08           Dasyatis sabina         34         0.09         38.756         8.66           Oblissos frumsus         30         0.08         0.120         0.02           Oblissos frumsus         24         0.06         0.130         0.04           Scophthalmus aguosus         24         0.06         0.130         0.04           Alosa sapidissina         21         0.05         0.100         0.02           Alosa sapidissina         21         0.05         0.100         0.02           Drosons presentes         20         0.05         0.100         0.02           Orisons presentes         20         0.04         0.10         0.03           Lepcnic guidrosins         9         0.02         0.034         0.04           Lepcnic microlopus         14	Morone americana	70	0.18	11,270	0.16
princuss carolinus         59         0.15         0.120         0.120           Worne saviilis         53         0.14         2.772         0.63           Worne saviilis         53         0.13         1.112         0.23           Myrableming hentri         48         0.12         0.336         0.08           Myrableming hentri         42         0.11         20.269         4.63           Marxis abine         32         0.08         0.100         0.02           Columna         32         0.08         0.120         0.16           Jerspinstrus rumanus         32         0.08         0.720         0.16           Scophthalmus aucosus         24         0.06         0.148         0.03           Alosa saridistana         21         0.05         0.100         C.02           Porsosotus         21         0.05         0.100         C.02           Porsosotus petenense         20         0.35         0.100         C.02           Porsosotus petenense         17         0.04         1.071         0.70           Ciclaurus petulosus         17         0.04         1.039         0.24           Leponis microlophus         14         0	Chaetodipterus faber	70	0.18	0.684	0.10
Spring         statilis         53         0.14         2.772         0.53           Urpsphyle         Ibright         1112         0.25         0.25           Urpsphyle         05800         0.09         38.756         8.86           Oblessiz         Strumssus         32         0.08         0.100         0.02           Dasyatis         sabins         34         0.09         38.756         8.86           Oblessiz         Strumssus         32         0.08         0.100         0.02           Scrphralming         200.08         0.180         0.04         0.04         0.06         0.180         0.04           Scrphralming aquesus         24         0.06         0.148         0.03         0.02         0.05         0.100         0.02           Aloss sapidiesting         21         0.05         0.100         0.02         0.02         0.05         0.100         0.02           Ictalurus nebulosus         17         0.04         0.110         0.70         0.10         0.02           Ictalurus nebulosus         9         0.02         0.03         0.01         0.02         0.03         0.01           Ictalurus nebulosus         9         <	Prionotus carolinus	59	0.15	0.120	0.03
Trophysis         Initiana         49         0.13         1.112         0.23           Byrashlematia         48         0.12         0.336         0.08           Baryatis         abine         42         0.11         20.269         4.63           Basyatis         abine         32         0.08         0.100         0.02           Cobieson         strumesus         30         0.08         0.720         0.16           Ictalurus punctarus         25         0.06         0.180         0.03           Scophthalmus aguosus         24         0.06         0.299         0.03           Acisenseidistas         21         0.05         0.100         C.02           Derosona petanetiss         20         0.05         0.100         C.02           Derosona petanetiss         20         0.05         0.100         C.02           Ictalurus rebulosus         17         0.04         3.071         0.70           Citalurus rebulosus         17         0.04         1.039         0.24           Leponis microlophus         14         0.04         1.039         0.24           Leponis microlophus         14         0.04         0.02         0.023	Morone saxatilís	53	0.14	2.772	0.63
Symposition stup bentzi         48         0.12         0.336         0.08           Lepisoneux osseus         42         0.11         20.269         4.63           Bayatis sabina         32         0.08         0.100         0.02           Gobiesox strumcus         32         0.08         0.100         0.02           Scophtalmus quosus         32         0.06         0.148         0.03           Scophtalmus quosus         24         0.06         0.148         0.03           Alosa sapidistina         24         0.06         0.148         0.03           Alosa sapidistina         24         0.06         0.148         0.03           Alosa sapidistina         21         0.05         0.100         0.02           Ictalurus pathemense         20         0.05         0.100         0.02           Ictalurus networs spitopterus         16         0.04         0.117         0.04           Legodign ricolophus         14         0.04         0.10         0.03           Legodign ricolophus         14         0.04         0.179         0.04           Acyclosecta quadrocellats         9         0.02         0.33         0.04           Acyclopsetta quadro	Urophycis floridana	49	0.13	1.112	0.25
Drive         Gamma Solution         Gamma Solution </td <td>Hynsohlennius hentzi</td> <td>48</td> <td>0.12</td> <td>0.336</td> <td>0.08</td>	Hynsohlennius hentzi	48	0.12	0.336	0.08
Deparation         34         0.09         38.756         8.86           Gabiesox         317usceue         32         0.08         0.100         0.02           Gabiesox         317usceue         30         0.08         0.100         0.04           Scophtalmins         300         0.06         0.130         0.04           Scophtalmins         310         0.06         0.130         0.04           Aloss asglidisting         24         0.06         0.209         0.05           Aloss asglidisting         21         0.05         0.100         0.02           Drossong Petenense         20         0.05         0.100         0.02           Ictalurus nebulosus         17         0.04         3.071         0.70           Githarichthys spilopterus         16         0.04         0.110         0.03           Lagodon rhouboldes         11         0.03         0.100         0.02           Conscient rebulosus         9         0.02         0.33         0.02           Choroscombrus chrystrus         7         0.02         0.033         0.01           Acylopetta quadrocallats         9         0.02         0.033         0.01           Ch	Lanicosteus osseus	42	0.11	20.269	4.63
Dasyning Satura         Dots         C.100         0.02           Gobiesos Struassus         20         0.08         0.720         0.16           Ictalurus punctarus         30         0.08         0.720         0.16           Scophtalmus guosus         24         0.06         0.148         0.03           Aloss sapidasina         24         0.06         0.299         0.03           Aloss sapidasina         24         0.06         0.209         0.03           Aloss sapidasina         24         0.05         0.100         0.02           Acipenser oxythynchus         21         0.05         0.100         0.02           Doroscas pelemense         17         0.04         3.011         0.70           Icratorus metolosus         14         0.04         0.100         0.03           Leponis microlophus         14         0.04         0.179         0.04           Lagadon rhomboldes         14         0.04         0.179         0.02           Ophidien margioarum         8         0.02         0.33         0.02           Ophidien margioarum         8         0.02         0.33         0.01           Chicroscombrus chrysurus         7 <td< td=""><td>Desustia aphing</td><td>34</td><td>0.09</td><td>38.756</td><td>8.86</td></td<>	Desustia aphing	34	0.09	38.756	8.86
GODIESUA SITURISANS         1         0         0.08         0.720         0.16           Pertilus triacanthue         25         0.06         0.180         0.04           Scopitalius squesus         24         0.06         0.144         0.03           Alesa sapidisaina         24         0.06         0.299         0.05           Alesa sapidisaina         24         0.05         3.242         0.74           Atisenser syxthynchus         21         0.05         0.100         0.02           Dorosca peteness         20         0.05         0.100         0.02           Dorosca peteness         17         0.04         3.071         0.70           Citharichtivs Spilopterus         16         0.04         0.110         0.03           Leponis microluphus         14         0.04         1.039         0.24           Lagodan rhomboldes         14         0.04         0.179         0.02           Aneylopsetra quadrocellars         9         0.02         0.343         0.06           Cynoscion mebulosus         9         0.02         0.333         0.01           Aneylopsetra quadrocellars         9         0.02         0.333         0.01	California Abound	32	0.08	0.100	0.02
Ictatords         Differential         Differentia         Differential         Differential	Goblesox sclubosus	30	0.08	0.720	0.16
Pertilis         Classical and a constraint of the second anot a consecon a constraint of thesecond and a constraint of the	Ictaturus punctatus	25	0.06	0 180	0.04
Scopintalmus aquosus         24         0.00         0.700         0.06           Acipas asplifishma         24         0.06         0.209         0.076           Acipanser oxythynchus         21         0.05         0.106         0.02           Drosoma petenense         20         0.05         0.106         0.02           Octosoma petenense         20         0.04         3.071         0.70           Ictaliurus nebulosus         17         0.04         3.071         0.70           Ictaliurus nebulosus         16         0.04         0.110         0.03           Lepomis matcrolophus         14         0.04         0.179         0.04           Fomatomus saltatrix         11         0.03         0.100         0.02           Ancylophetta quadrocellats         9         0.02         0.343         0.08           Vynoscion mebulosus         9         0.02         0.333         0.01           Chloroscombrus chrysurus         7         0.02         0.033         0.01           Ancylophetta guadrocellats         3         0.01         0.553         0.13           Chloroscombrus chrysurus         7         0.02         0.095         0.02 <td< td=""><td>Peprilus triacantnus</td><td>20</td><td>0.06</td><td>0 148</td><td>0.03</td></td<>	Peprilus triacantnus	20	0.06	0 148	0.03
Alosa sapidisting       24       0.00       0.00       0.00         Acigenses (oxythynchus)       21       0.05       0.100       0.02         Dorosona petenense       20       0.05       0.100       0.02         Icraluus inscrolophus       17       0.04       0.010       0.03         Citharichtys spilopterus       16       0.04       0.100       0.03         Lagodon incoholdes       14       0.04       0.03       0.02         Ancylopaetra quadrocellats       9       0.02       0.034       0.01         Fomatomus saltatrix       11       0.03       0.100       0.02         Ancylopaetra quadrocellats       9       0.02       0.034       0.01         Cynoscion nebulosus       9       0.02       0.033       0.01         Cynoscion nebulosus       9       0.02       0.033       0.01         Chioresconbrus chrysurus       7       0.02       0.033       0.01	Scophthalmus aquosus	24	0.00	0,209	0.05
Actpenser oxyrhynchus         21         0.03         3.222         0.02           Etropus crossotus         21         0.05         0.100         0.02           Doussom petenense         20         0.05         0.106         0.02           Ictalurus nebulosus         17         0.04         3.071         0.70           Ictalicutive spilopterus         16         0.04         0.110         0.03           Lepomis microlophus         14         0.04         0.179         0.04           Lagodon rhomboides         14         0.04         0.179         0.04           Cynoscion nebulosus         9         0.02         0.33         0.06           Mugil caphalus         8         0.02         0.237         0.05           Ophidion marginatum         8         0.02         0.237         0.05           Ophidion marginatum         7         0.02         0.033         0.01           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Chilowycterus sch	<u>Alosa sapidissima</u>	24	0.06	3 262	0.74
Etropic crossotias         21         0.005         0.100         0.02           Dorosona petenense         20         0.05         0.100         0.02           Decosona petenense         20         0.05         0.100         0.02           Cicharichtys spilopterus         16         0.04         0.110         0.03           Cicharichtys spilopterus         14         0.04         1.039         0.24           Lagodon rhomboides         14         0.03         0.100         0.02           Fomatomus saltatrix         11         0.03         0.100         0.02           Ancylopaetra quadrocellata         9         0.02         0.343         0.08           Cynoscion nebulosus         9         0.02         0.237         0.05           Chloroscombrus chrysurus         7         0.02         0.033         0.01           Chilowscentrus         7         0.02         0.033         0.01           Chilowscentrus         7         0.02         0.033         0.01           Lagodon marginatum         8         0.01         0.553         0.13           Chilowscentrus         7         0.02         0.033         0.01           Chilowscentrus	Acipenser oxyrhynchus	21	0.05	3.242	0.02
Decosona petenense         20         0.05         0.10b         0.02           Ictalurus nebulosus         17         0.04         3.071         0.70           Citharicchiys spilopterus         16         0.04         0.110         0.03           Legomis microlophus         14         0.04         1.039         0.24           Lagodon Iromboides         14         0.04         0.179         0.04           Fomatomus saltatrix         11         0.03         0.100         0.02           Ancylopaetta quadrocellats         9         0.02         0.343         0.08           Cynoscion nebulosus         9         0.02         0.343         0.08           Mugil cephalus         8         0.02         0.237         0.05           Chloroscombrus chrysurus         7         0.02         0.033         0.01           Dagre marinus         7         0.02         0.033         0.01           Chiloroscombrus chrysurus         7         0.02         0.033         0.01           Chiloroscombrus chrysurus         7         0.02         0.095         0.02           Chiloroscombrus chrysurus         7         0.02         0.033         0.01           Lepomi	Etropus crossotus	21	0.05	0.100	0.02
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Dorosoma petenense	20	0.05	0.106	0.02
Citharicathys spilopterus         16         0.04         0.110         0.03           Legomis microlophus         14         0.04         1.039         0.24           Lagodon fromboides         14         0.04         0.179         0.04           Pomatomus saltatrix         11         0.03         0.100         0.02           Ancylopsetta quadrocellata         9         0.02         0.343         0.06           Gynoscion mebulosus         9         0.02         0.343         0.06           Mugil cephalus         8         0.02         0.237         0.05           Chloroscombrus chrysurus         7         0.02         0.033         0.01           Chilomycretrus schnepfi         5         0.01         0.054         0.01           Lepomis gulosus         4         0.01         0.553         0.11           Lepomis gulosus         3         0.01         0.168         0.04           Selene vomer         3         0.01         0.013         <001	Ictalurus nebulosus	17	0.04	3.071	0.70
Leponis microlophus         14         0.04         1.039         0.24           Lagodon fromboides         14         0.04         0.179         0.04           Fomatomus saltatrix         11         0.03         0.100         0.02           Ancylopsetta guadrocellata         9         0.02         0.343         0.06           Cynoscion nebulosus         9         0.02         0.343         0.08           Mugil cephalus         8         0.02         0.237         0.29           Ophidion marginatum         8         0.02         0.237         0.05           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Dagre marinus         7         0.02         0.035         0.02           Chilomycrerus schopfi         5         0.01         0.553         0.13           Aloga activalis         3         0.01         0.064         <0.01	Citharichthys spilopterus	16	0.04	0.110	0.03
Lagodor         Thomboildes         14         0.04         0.179         0.04           Formatomus saltatrix         11         0.03         0.100         0.02           Ancylopsetta quadrocallata         9         0.02         0.343         0.08           Mugil cephalus         8         0.02         0.237         0.29           Ophidion marginatum         8         0.02         0.237         0.05           Ophidion marginatum         8         0.02         0.237         0.05           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Dagre marinus         7         0.02         0.095         0.02           Chilomycterus schoepfi         5         0.01         0.054         0.01           Alosa aestivalis         3         0.01         0.553         0.13           Alosa aestivalis         3         0.01         0.013         <0.01	Lepomis microlophus	14	0.04	1.039	0.24
Instruction         Instruction         Instruction         0.03         0.100         0.02           Ancylopsetta quadrocallata         9         0.02         0.034         0.01           Cynoscion nebulosus         9         0.02         0.343         0.08           Cynoscion nebulosus         9         0.02         0.343         0.08           Ophidion marginatum         8         0.02         0.237         0.05           Chioroscombrus chrysurus         7         0.02         0.033         0.01           Darge marinus         7         0.02         0.095         0.02           Chiomycterus schoepfi         5         0.01         0.553         0.01           Lepomis guiosus         4         0.01         0.553         0.01           Alosa acetivalis         3         0.01         0.013         <0.01	Lagodon rhomboides	14	0.04	0.179	0.04
International structure         9         0.02         0.034         0.01           Cynoscion nebulosus         9         0.02         0.343         0.08           Mugil caphalus         8         0.02         0.237         0.05           Chlorescombrus chrysurus         7         0.02         0.033         0.01           Bagre marinus         7         0.02         0.033         0.01           Chlorescombrus chrysurus         7         0.02         0.095         0.02           Bagre marinus         7         0.02         0.095         0.02           Chilomycheruis schoepfi         5         0.01         0.054         0.01           Lepomis gulosus         4         0.01         0.553         0.13           Alosa aestivalis         3         0.01         0.044         0.01           Selene vomer         3         0.01         0.067         0.02           Astroscopus y-graeum         3         0.01         0.067         0.02           Astroscopus y-graeum         3         0.01         0.033         <0.01	Econotomus saltatrix	11	0.03	0.100	0.02
Alley hopsetric         0         0.02         0.343         0.08           Mugil cephalus         8         0.02         1.277         0.29           Ophidion merginatum         8         0.02         0.333         0.01           Dagre marinus         7         0.02         0.033         0.01           Bagre marinus         7         0.02         0.033         0.01           Chiorescombrus chrysurus         7         0.02         0.095         0.02           Chilomycterus schoepfi         5         0.01         0.553         0.13           Alosa aestivalis         3         0.01         0.168         0.04           Selene vomer         3         0.01         0.064         <0.01	<u>inarloncatta quadrocellata</u>		0.02	0.034	0.01
Cyningston         Learning         Description         Learning         Description         Learning         Description         Learning         Description         Description         Learning         Description         Descripti	Ancytopsetta doadtocariate	q	0.02	0.343	0.08
Mugil caphalus         0         0.02         0.237         0.05           Chloros marginatum         8         0.02         0.237         0.05           Chloros combrus chrysurus         7         0.02         0.033         0.01           Dagre marinus         7         0.02         0.095         0.02           Chloros combrus chrysurus         7         0.02         0.095         0.01           Chilomycterus schoepfi         5         0.01         0.0553         0.13           Alosa mestivalis         3         0.01         0.168         0.04           Selene vomer         3         0.01         0.067         0.02           Ictalurus evolans         3         0.01         0.067         0.02           Ictalurus platvcephalus         3         0.01         7.767         1.78           Cobionellus shufeldri         2         0.01         7.767         1.78           Cataenops ocellata         2         0.01         0.006         <0.01	Gynoscion neodiosus	8	0.02	1,277	0.29
Opinidicing marginations         o         0.02         0.03         0.01           Chloroscombrus chrysurus         7         0.02         0.033         0.01           Gagre marinus         7         0.02         0.095         0.02           Chloroscombrus chrysurus         7         0.02         0.095         0.02           Chlomycrerus schoepfi         5         0.01         0.054         0.01           Lepomis gulosus         4         0.01         0.553         0.13           Alosa aestfvalis         3         0.01         0.168         0.04           Selene vomer         3         0.01         0.013         <0.01	Mugil capitalus	0	0.02	0 237	0.05
Chloroscombrus         Chrystrus         7         0.02         0.033         0.02           Bagre marinus         7         0.02         0.095         0.02           Chilomycrerus schoepfi         5         0.01         0.054         0.01           Alosa aestivalis         3         0.01         0.553         0.13           Alosa aestivalis         3         0.01         0.0188         0.01           Selene vomer         3         0.01         0.067         0.02           Prionotus evolans         3         0.01         0.067         0.02           Astroscopus y-graecum         3         0.01         0.067         0.02           Cyprinus carpio         2         0.01         0.033          0.08           Gobionellus shufeldri         2         0.01         0.033          0.01           Rypsohennius ionthas         2         0.01         0.033          0.01           Regeneration scitulus         2         0.01         0.033          0.01           Rypsohennius ionthas         2         0.01         0.005          0.01           Rypsohennius ionthas         2         0.01 <th< td=""><td>Uphidion marginatum</td><td>8</td><td>0.02</td><td>0.033</td><td>0.01</td></th<>	Uphidion marginatum	8	0.02	0.033	0.01
Bagre marinus7 $0.02$ $0.073$ $0.073$ Chilomycterus schoepfi5 $0.01$ $0.054$ $0.01$ Lepomis gulosus4 $0.01$ $0.553$ $0.13$ Alosa acestivalis3 $0.01$ $0.168$ $0.04$ Selene vomer3 $0.01$ $0.004$ $<0.01$ Prionotus evolans3 $0.01$ $0.064$ $<0.01$ Astroscopus y-graecum3 $0.01$ $0.064$ $<0.02$ Ictalurus platycephalus3 $0.01$ $0.331$ $0.08$ Cyptinus carpio2 $0.01$ $7.767$ $1.78$ Cobionellus shufeldri2 $0.01$ $0.003$ $<0.01$ Hypsoblennius ionthas2 $0.01$ $0.006$ $<0.01$ Sciaenops ocellata2 $0.01$ $0.005$ $<0.01$ Prionotus scitulus2 $0.01$ $0.005$ $<0.01$ Lutjanus griseus2 $0.01$ $0.021$ $<0.01$ Arius felis2 $0.01$ $0.021$ $<0.01$ Arius felis2 $0.01$ $0.014$ $<0.01$ Myrophis punctatus1 $<0.01$ $0.005$ $<0.01$	Chloroscombrus chrysurus	1	0.02	0.005	0.02
Chilomycterus schoepfi         5         0.01         0.034         0.03           Lepomis guiosus         4         0.01         0.553         0.13           Alosa aestivalis         3         0.01         0.168         0.04           Selene vomer         3         0.01         0.013         <0.01	Bagre marinus	/	0.02	0.055	0.01
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	<u>Chilomycterus</u> <u>schoepfi</u>	5	0.01	0.034	0.01
Alosa aestivalis3 $0.01$ $0.168$ $0.04$ Selene vomer3 $0.01$ $0.013$ $<0.01$ Prionotus evolans3 $0.01$ $0.064$ $<0.01$ Astroscopus y-graecum3 $0.01$ $0.067$ $0.32$ Ictalurus platvcephalus3 $0.01$ $0.067$ $0.32$ Ictalurus platvcephalus3 $0.01$ $0.067$ $0.32$ Ictalurus platvcephalus3 $0.01$ $0.067$ $0.32$ Cyprinus carpio2 $0.01$ $7.767$ $1.78$ Cybionellus shufeldri2 $0.01$ $0.003$ $<0.01$ Rypsoblennius ionthas2 $0.01$ $0.006$ $<0.01$ Sciaenops ocellata2 $0.01$ $0.005$ $<0.01$ Prionotus scitulus $2$ $0.01$ $0.002$ $<0.01$ Monacanthus hispidus $2$ $0.01$ $0.002$ $<0.01$ Lutjanus griseus $2$ $0.01$ $0.233$ $0.01$ Centropomus sp. $2$ $0.01$ $0.203$ $0.01$ Arius felis $2$ $0.01$ $0.001$ $0.001$ Myrophis punctatus $1$ $<0.01$ $0.064$ $0.01$ Myrophis punctatus $1$ $<0.01$ $0.065$ $<0.01$	Lepomís gulosus	4	0.01	0.553	U.13
Selene vomer         3         0.01         0.013         <0.01           Prionotus evolans         3         0.01         0.004         <0.01	Alosa aestívalis	3	0.01	0.158	0.04
Prion tus evolans3 $0.01$ $0.004$ $<0.01$ Astroscopus y-graecum3 $0.01$ $0.067$ $0.02$ Ictalurus platycephalus3 $0.01$ $0.331$ $0.08$ Cyprinus carpio2 $0.01$ $7.767$ $1.78$ Gobionellus shufeldri2 $0.01$ $0.003$ $<0.01$ Hypsoblennius ionthas2 $0.01$ $0.006$ $<0.01$ Sciaenops ocellata2 $0.01$ $0.006$ $<0.01$ Pogonias cromis2 $0.01$ $0.005$ $<0.01$ Monacanthus hispidus2 $0.01$ $0.002$ $<0.01$ Lutjanus griseus2 $0.01$ $0.023$ $0.01$ Arius felis2 $0.01$ $0.215$ $0.05$ Leponis punctatus1 $<0.01$ $0.014$ $<0.01$ Myrophis punctatus1 $<0.01$ $0.005$ $<0.01$	Selene vomer	3	0.01	0.013	<0.01
Astroscopus y-graecum3 $0.01$ $0.067$ $0.02$ Astroscopus y-graecum3 $0.01$ $0.331$ $0.08$ Ictalurus platycephalus3 $0.01$ $0.331$ $0.08$ Cyprinus carpio2 $0.01$ $7.767$ $1.78$ Cobionellus shufeldri2 $0.01$ $0.003$ $<0.01$ Hypsoblennius ionthas2 $0.01$ $0.006$ $<0.01$ Sciaenops ocellata2 $0.01$ $0.006$ $<0.01$ Pogonias cromis2 $0.01$ $0.005$ $<0.01$ Prionotus scitulus2 $0.01$ $0.002$ $<0.01$ Lutjanus griseus2 $0.01$ $0.002$ $<0.01$ Lutjanus griseus2 $0.01$ $0.001$ $<0.01$ Arius felis2 $0.01$ $0.014$ $<0.01$ Lutis pluctatus1 $<0.01$ $0.064$ $<0.01$ Myrophis punctatus1 $<0.01$ $0.005$ $<0.01$	Prionotus evolans	3	0.01	0.004	<0.01
Astrobusput       3       0.01       0.331       0.08         Ictalurus platycephalus       2       0.01       7.767       1.78         Gobionellus shufeldri       2       0.01       0.003       <0.01		3	0.01	0.067	0.02
Iteratives proveenances         2         0.01         7.767         1.78           Cyprinus carpio         2         0.01         0.003         <0.01	Tatalurus platucophalus	3	0.01	0.331	0,08
Cypering         Carpino         Control         Contro         Control <thcontrol< th=""> <th< td=""><td>Teraturus pratvcepharus</td><td>2</td><td>0.01</td><td>7.767</td><td>1.78</td></th<></thcontrol<>	Teraturus pratvcepharus	2	0.01	7.767	1.78
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Cyprinus carbio	5	0.01	0.003	<0.01
Hypoolennius ioninas         2         0.01         0.006         <0.01           Sciaenops ocellata         2         0.01         0.006         <0.01	Gobionellus snurelaci	2	0.01	0.010	<0.01
Sciaenops ocellata         2         0.01         0.05         2.46           Pogonias cromis         2         0.01         10.757         2.46           Prionotus scitulus         2         0.01         0.005         <0.01	hypsoblennius lonthas	2	0.01	0.006	<0.01
Pogonias cromis         2         0.01         0.07         2000           Prionotus scitulus         2         0.01         0.005         <0.01	Sciaenops ocellata	2	0.01	10 757	2.46
Prionotus scitulus         2         0.01         0.005         <0.01           Monacanthus hispidus         2         0.01         0.002         <0.01	Pogonias cromis	2	0.01	0.005	<0.03
Monacanthus hispidus         2         0.01         0.002         (0.01)           Lutjanus griseus         2         0.01         0.023         0.01           Centropomus sp.         2         0.01         0.023         0.01           Arius felis         2         0.01         0.215         0.05           Lepomis punctatus         1         <0.01	Prionotus scitulus	2	0.01		20.01
Lutjanus griseus         2         0.01         0.023         0.01           Centropomus sp.         2         0.01         0.001         <0.01	Monacanthus hispidus	2	0.01	0.002	VU.UI
Centropomus sp.         2         0.01         0.001         (0.01)           Arius felis         2         0.01         0.215         0.05           Lepomis punctatus         1         <0.01	Lutjanus griseus	2	0.01	0.023	10.01
Arius felis         2         0.01         0.215         0.05           Lepomis punctatus         1         <0.01	Centropomus sp.	2	0.01	0.001	SU.UI
Leponis punctatus         1         <0.01         0.014         <0.01           Myrophis punctatus         1         <0.01	Arius felis	2	0.01	0.215	0.05
Myrophis punctatus         1         <0.01         0.064         0.01           Anchoa hepsetus         1         <0.01	Lepomis punctatus	l	<0.01	0.014	<0.01
Anchoa hepsetus 1 <0.01 0.005 <0.01	Myrophis punctatus	1	<0.01	0.064	0.01
	Anchoa hepsetus	1	<0.01	0.005	<0.01

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## Table 2 (continued)

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SPECIES	TOTAL NUMBER	PERCENT NUMBER	TOTAL BIOMASS (kg)	PERCENT BIOMASS
		<u></u>	0.395	0.09
Dorosoma cepedianum	1	<0.01	0.051	0.01
Morone chrysops	1	<0.01	0.092	0.02
Archosargus probatocephalus	1	<0.01	0.052	0.01
Centropristis striata	Ţ	<0.01	0.044	0.01
Centropristis philadelphica	1	<0.01	0.000	<0.01
Syngnathus fuscus	1	<0.01	0.002	0.16
Acipenser brevirostrum	1	<0.01	0.715	0.10
Raja eglanteria	1	<0.01	0.265	0.00
Scorpsena calcatata	1	<0.01	0.005	<0.01
Josimus fasciatus	1	<0.01	0.009	<0.01
hairman haloariam	1	<0.01	0.013	<0.01
Ariosoma Dalearicom	Ť	<0.01	0.062	0.01
<u>Micropterus salmoides</u>	1	<0.01	0.153	0.03

Total

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38862

437.463

TABLE 3. Total number and total biomass (kg) of decapod Crustacea from 1977 - 1978 in the Winyah Bay estuary. Species are listed in order of abundance and data are pooled over the twoyear sampling period.

SPECIES	TOTAL NUMBER	PERCENT' NUMBER	TOTAL BIOMASS(kg)	PERCENT BIOMASS
	4075	39,49	159.572	74.91
Callinectes sapidus	3972	31.53	17.617	8.27
Penaeus duorarum	1745	13.85	19.543	9.17
Penaeus aztecus	1/4J 922	6.52	12.005	5.64
Penaeus setiferus	022	3 57	0.187	0.09
Palaemonetes vulgaris	430	1 52	3.126	1.47
Callinectes similis	192	0.98	0.086	0.04
Trachypenaeus constrictus	123	0.90	0.489	0,23
Macrobrachium ohione	109	0.07	0.047	0.02
Palaemonetes pugio	66	0.52	0 135	0.06
Panopeus herbstii	52	0.41	0.037	0.02
Rhithropanopeus harrisii	49	0.39	0.057	0.03
Portunus gibbesii	23	0.18	0.065	0.01
Portunus spinimanus	4	0.03	0.030	0.01
Panopeus occidentalis	4	0.03	0.012	0.01
Palaemonetes sp. 8	3	0.02	0.0	0.0
Ovalines ocellatus	2	0.02	0.012	0.02
Xiphopenaeus kroveri	2	0.02	0.005	0.01
Ovalipes stephensoni	1	0.01	0.001	0.01
Alphaus beterochaelis	1	0.01	0.001	0.01
Hexananoneus angustifrous	1	0.01	0.001	0.01
Callinectes ornatus	1	0.01	0.045	0.02
Vanthidaga	1	0.01	0.001	0.01
<u>Callinectes</u> sp. <sup>a</sup>	ō	0.0	0.0	0.0
Total	12598		213.017	

<sup>a</sup> Field identification

Total

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SAMPLING SITE	NUMB INDIV	ER OF IDUALS	NUMB	ER OF CLES	NUMBER OF COLLECTIONS
	FISHES	DECAPODS	FISHES	DECAPODS	
1977					
YB02	2299	2044	33	11	12
YB05	1524	683	27	12	12
YB08	1654	65	11	3	12
YBI1	2803	742	25	10	12
YL05	1638	59	21	12	12
YP05	837	69	26	8	12
YS07	1116	1187	21	9	12
YW06	2803	2870	33	11	12
Y001	1546	423	34	10	12
1078					
<u>1970</u> XB02	4458	492	31	9	12
V205	1193	511	23	8	12
2009	2117	89	12	5	12
1500	2690	657	26	10	12
IDII VI 05	1792	159	20	6	12
VEOS	1492	202	22	8	12
1105 NG07	1298	742	24	10	12
1307	3764	972	31	7	12
1000	3838	632	35	14	12
TUUL	000	022			

TABLE 4. Total number of individuals and species of fishes and decapod Crustacea collected at otter-trawl sampling locations in the Winyah Bay estuarine system, S.C. during 1977 and 1978.

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at stations YB05 and YL05 in 1977 and Y001 in 1978. The number of decapod specimens collected was lowest during both years of sampling at stations YB08, YL05, and YP05. Fewest fish specimens were collected in 1977 at station YP05. Generally, species richness and the logarithmically-transformed number of individuals were lowest during winter and highest in the fall (Figure 4).

The numbers of species of fishes and decapod crustaceans and numbers of decapod crustacean individuals (log<sub>e</sub> transformed) were positively correlated with bottom temperature and salinity and negatively correlated with oxygen and depth (Table 5). The numbers of individual fish, however, were positively correlated with bottom temperature and salinity and negatively correlated only with oxygen.

Although not absolute indicators of stress, species richness (total number of species) and evenness (total number of individuals) are useful in determining nursery potential and productivity of the estuary. In the Winyah Bay estuarine system, those stations characterized by unstable yet generally high salinity conditions (YBO2, YOO1, YBO5, YB11) were the richest in species and supported the most individuals. In contrast, fewest species and individuals were collected at stations on the Black (YLO5), Peedee (YPO5) and Waccamaw (YWO6) Rivers which underwent less drastic salinity changes and exhibited low annual mean salinities. The Sampit River supported a richer fauna than the other distributaries entering Winyah Bay. This higher diversity may be related to the higher overall salinity of the Sampit River. However, all distributaries had a lower salinity and lower species richness than Winyah Bay. Increased diversity of higher salinity waters is a usual occurrence in estuaries and is attributable to the presence of a diverse assemblage of stenohaline marine species and euryhaline species.

Numerical classification analysis showed that collections made at limneticoligonaline stations which experienced little fluctuation in salinity (YWO6, YLO5,



FIGURE 0. MONTHLY FLUCTUATIONS IN NUMBER OF SPECIES AND NUMBER OF INDIVIDUALS (LOG TRANSFORMED) FOR FISHES AND DECAPOD CRUSTACEANS AT SAMPLING SITES IN THE MINYAH BAY ESTUARINE SYSTEM, 1977 - 1978.

Correlation between numbers of species and log (x + 1) transformed values of number of individuals of fishes and decapods in relation to environmental factors. Data are pooled for the two-year study period. r = Pearson product-moment correlation coefficient; n = number of observations; x = number of individuals. . س TABLE

		Number of Speci	68			Transformed Number of Individual	ls	
Environmental	Fishe	8	Decapo	ls	Fishe	38	Decapo	υ,
Factors	H	c;	L.	u	L.	q	ц	н
Bottom Temperature (°C)	0.242**	209	0.279**	194	**60€.0	209	**06E °O	192
Salinity ( <sup>0</sup> /00)	0.480**	209	0.442**	194	0.183*	209	0.468**	192
Oxygen (mg/l)	-0.179*	209	-0.254**	194	-0,303**		-0.343**	192
Turbidity (FTU)†	0.122	209	0.002	194	0.045	209	0.074	192
Depth (m)	-0.351**	209	-0.194**	194	-0.053	209	-0.283**	192

- \* Significant ( $p \neq 0$ ) at  $\alpha = 0.05$
- \*\* Significant ( $\rho \neq 0$ ) at  $\approx = 0.01$
- + Formazin Trubidity Units

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YP05, YS07) were least similar in species composition to collections made at stations (YB02, YB05, Y001, YB08, YB11) which were limnetic-euhaline and experienced wide salinity fluctuations during a season. Site groups formed during cluster analysis did overlap, however, with regard to station location. This overlap was especially noticeable for collections from stations in the meso- polyhaline and poly-euhaline range. Because collections did not clearly cluster according to salinity regimes within the estuary, we compared collections from each fixed station, rather than collection groups as determined from cluster analysis with the species groups resulting from inverse analysis (Table 6). Thus, we made seasonal comparisons of species assemblages among collections from fixed stations (Figures 5-8).

The Winyah Bay estuarine system is similar in species composition to other estuaries of the southeastern United States such as the Cape Fear River, N.C. and Santee System, S.C. which receive considerable freshwater input. These systems are usually dominated by euryhaline species which primarily use the estuary as a nursery ground; however, the success of these species in the estuary is subject to spatial and temporal variation as well as interaction with resident estuarine species and stenohaline marine transients.

The numerically-dominant fishes and decapod crustaceans such as <u>Ictalurus</u> <u>catus</u>, <u>Trinectes maculatus</u>, <u>Micropogonias undulatus</u>, and <u>Callinectes sapidus</u> were ubiquitous in the Winyah Bay system. In the fall, these species formed group A and were consistently encountered from collections at stations Y001, YB08, YB11, YL05, YP05, YS07, and YW06 but were not restricted in their distribution to collections from these stations, as shown by low fidelity values (Table 6, Figure 5). Group B consisted of numerically abundant but transient

	SUMMER	Croup A Cynoscion regalis Penaeus aztecus Micropogonias undulatus Calificectes sapidus Trinecces maculatus Calificectes sapidus Frainiterinus autorarum Symphurus plagius a Minticirrinus americanus Peprilus alepidotus Penaeus seriferus Penaeus seriferus Penaeus seriferus Peraeus seriferus Penaeus seriferus Peraeus seriferus Peraeus Peraeus seriferus Peraeus seriferus Peraeus seriferus Pera
verse cluster analyses of species a collected in the Winyah Bay '8.	SPRING	Group A Ictalurus catus Trinectes maculatus Micropogonias undulatus Micropogonias undulatus Angulla rostrata Lepisosteus cseus Rhithropanopeus harristi Angulla rostrata Lepisosteus cseus Rhithropanopeus harristi Angulla rostrata Lepisosteus cseus Rhithropanopeus harristi Corone americana Morone americana Morone americana Morone americana Morone americana Morone americana Morone americana Morone antristi Callurus nebulosus Coron C Panopeus herbstil Cololesox strumosus Trachypenaeus constrictus Opiatus tau Coron D Bairdiella chrysoura Cynoscion regalis Fiorophycis regal Cynoscion regalis Fiorophycis regal Bairdiella chrysoura Cynoscion regalis Ervoortia trionan Morone attronus Fioronius tribulus Coron ficerili trionan Morone attronus Coron ficerili trionnus
TABLE 6. Groups formed from seasonal fr of flahes and decapod Crustace estuarine system from 1977-197	WINTER	Group A Scophthalmus aquosus Urophycis floridana Ancylopsetta quadrocellata Panopeus herbstif Panalaemonetes vuigaris Panopeus herbstif Paralaemonetes vuigaris Paralaemonetes vuigaris Croup B Anchoa mitchilli Paralichithys dentatus Cynoscion nebulosus Cynoscion nebulosus Cynoscion nebulosus Croup C Ictalurus catus Trinectes sapidus Bairdialla chrysoura Lagodon rhomboides Croup E Althroparopeus undulatus Stalli cephalus Group F Althroparopeus harrisil Morone americana Morone americana Maguil a rostrata Dorosona petenense
	FALL	Group A Califinectes sapidus Trinectes maculatus Micropogenias undulatus Icralurus carus Micropogenias undulatus Icralurus carus Group B Paralichthys lethostigma Lelostomus xanthurus Symphurus plagiusa Menticirrhus americanus Penaeus duorarum Stellifer lanceolatus Penaeus acrecua Menticirrhus mericanus Penaeus setiferus Cynoscion regalis Penaeus setiferus Cynoscion regalis Penaeus setiferus Penaeus setiferus Palaenonetes vulgaris Etropus crossotus Croup D Croup D Croup D

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(continued)
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Table

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FALL	WINTER	SPRING	SUMMER
Group E	Croup G	Group F	Group F
Anguilla rostrata Cynoscion nebulosus Rhithropanopeus harrisii Norone americana Lepisosteus osseus Morone saxatilis Palaemonetes pugio Alosa sapidissima	Ictalurus punctatus Macrobrachium ohione Acipenser oxyrhynchus	Lelostomus xanthurus Penacus aztecus Paralichthys dentatus Paralichthys lethostigna Palaemonetes vulgaris Palaemonetes pugio	Prionotus tribulus Chloroscombrus chrysurus Lepisosteus osseus Anguilla rostrata Citharichthys spilopterus Bairdfella chrysoura Palaemonetes puglo
Group F			
Brevocttia tyranus Peprilus alepidotus Macrobrachium ohione Dorosoma petenense Acipenser oxyrhynchus			

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FALL



FIGURE 5. Two-way coincidence tables of constancy and fidelity which compare species associations with collections from each station sampled in the Minyah Bay estuarine system for Fall, 1977 - 1978 (years combined). The species groups, designated alphabetically, resulted from cluster analysis of species (dendrogram not shown) collected from the Minyah Bay system. Species comprising these associations are listed in Table 6.

WINTER



FIGURE 6. Two-way coincidence tables for Minter, 1977 - 1978 (years combined). Other information same as for Figure 5.
# **SPRING**



FIGURE 7. Two-way coincidence tables for Spring, 1977 - 1978 (years combined). Other information same as for Figure 5.

SUMMER



FIGURE 8. Two-way coincidence tables for Summer, 1977 - 1978 (years combined). Other information same as for Figure 5.

species such as sciaenid fishes and penaeid shrimps, which spend only a portion of their life within estuaries. These species were most consistently collected at higher salinity stations and were similar in distribution to group A species. In winter, only group C species consisting of <u>I</u>. <u>catus</u> and <u>T</u>. <u>maculatus</u> were consistently found throughout much of the Winyah Bay system. The numericallyabundant species found in group D (<u>Callinectes sapidus</u> and <u>Micropogonias undulatus</u>) were most consistently collected in samples from stations YB02 and YB05, but they were not restricted to any station (Figure 6). During spring and summer, species in group A were ubiquitous and unrestricted in their distribution (Figures 7 and 8). In summer, group B consisted mostly of transient species which were most consistently encountered at stations Y001 and YB11.

Stenohaline marine assemblages of species were not found further upestuary than station YB11. In fall, group D consisted mostly of stenohaline marine species which were infrequently encountered and not restricted to stations YOO1, YBO2, YBO5, and YB11. In winter, species group A contained stenohaline marine species as well as estuarine transients such as <u>Leiostomus xanthurus</u> and estuarine endemics such as <u>Palaemonetes vulgaris</u>. These species displayed high constancy and very high fidelity for station YBO2. Species of group C in spring were similarly distributed. Group E species in spring also were most frequently taken in collections at station YBO2 but were not restricted spatially in their distribution. In summer, species in group C were restricted to station YBO2, while group D contained species which were infrequently collected from stations YBO2-YB11.

Species found in the upper reaches of the Winyah Bay estuarine system (stations YL05, YP05, YS07, and YW06) included predominantly freshwater species

such as <u>Macrobrachium ohione</u> and <u>Ictalurus punctatus</u>, transients, and catadromous and anadromous species. In fall, species in group E were collected at stations YL05, YP05, and YS07 where they displayed moderate to low constancy with high fidelity to station YS07. In winter, species in groups F and G displayed low to high constancy for stations YB11, YL05, YP05, YS07, and YW06. In addition, group G species were restricted to station YW06. In spring, group B species extended downriver to YB08 but were infrequently encountered and not restricted to any station. Group E species in summer had highest constancy and fidelity at YW06.

Other assemblages defined by our analyses included species which were relatively euryhaline but were generally captured in low numbers and were not restricted to any station location. These assemblages included groups C and F in fall, groups B and E in winter, groups D and F in spring, and group F in summer.

Most species associations were highly seasonal, and species seldom cooccurred within the same assemblage throughout the year (Figure 9); however, there were several species which occurred together year-round. Among these were the estuarine transient species, <u>Micropogonias undulatus</u> with <u>Callinectes sapidus</u>; <u>Leiostomus xanthurus</u> with <u>Paralichthys lethostigma</u>; and <u>Panopeus herbstii</u> and <u>Opsanus tau</u>. Estuarine resident species which co-occurred together or with catadromous or anadromous species year-round included <u>Ictalurus catus</u> with <u>Trinectes maculatus</u>; <u>Lepisosteus osseus with Anguilla rostrata</u>; <u>Morone americana</u> with Morone saxatilis; and Macrobrachium ohione with <u>Acipenser oxyrhynchus</u>.

Our description of community composition for Winyah Bay is applicable for the channel reaches and cannot be extended to include the tidal creeks and near-shore marsh habitat. The importance of tidal salt marshes as a nursery



habitat has been documented for several southeastern estuaries: Cape Fear, N.C. (Weinstein, 1979); North Inlet Estuary, S.C. (Cain and Dean, 1976; Shenker and Dean, 1979; Bozeman and Dean, 1980), and Port Royal Sound, S.C. (Turner and Johnson, 1972). A comparison of the channel communities defined by us with those of shallow marsh habitats in the Cape Fear River, an estuary which undergoes considerable fluctuations in salinity, revealed interesting differences in species composition and abundance patterns. For example, <u>Fundulus heteroclitus</u>, <u>Mugil cephalus</u>, <u>M. curema</u>, and <u>Menidia menidia</u> were the most abundant species reported from tidal creeks by Weinstein (1979). Interestingly, <u>Micropogonias</u> <u>undulatus</u> was absent from marsh shallows of these creeks, and Weinstein (1979) hypothesized that their absence was due to minimum temperatures in the shoal areas during winter recruitment.

In addition to habitat-related differences in species composition and abundance, our survey of the Winyah Bay fishes was biased by our gear which emphasized capture of juveniles. The large amount of coastal marshland and freshwater input which characterizes the Winyah Bay system provides physiological suitability, an abundant food supply, and a refuge from predators, criteria which determine ideal estuarine nursery grounds (Van Engel and Joseph<sup>4</sup>). However, fishes of commercial importance, such as <u>Alosa sapidissima</u>, <u>A. mediocris</u>, and <u>Acipenser oxyrynchus</u>, were not readily vulnerable to our gear and, hence, were not adequately sampled by us.

# Temporal and Spatial Distribution of Numerically-Dominant Species

Most of the numerically-abundant fishes and decapod crustaceans were seasonal inhabitants of the estuary and were abundant in specific areas of the

<sup>&</sup>lt;sup>4</sup> Van Engel, W.A. and E.B. Joseph. 1968. Characterization of coastal and estuarine fish nursery grounds as natural communities. Final Report to U.S. Fish and Wildlife Service. 43 p.

Winyah Bay system.

Star drum, <u>Stellifer lanceolatus</u>, were most numerous from September to January at stations YB02, YB05, YB08, YB11, and Y001 within Winyah Bay (Figure 10). In addition, log-transformed catches of <u>Stellifer</u> were similar during the two-year sampling period, although more individuals were collected in 1978 (Table 7). Length-frequency polygons indicated that small star drum (< 70 mm), which may be new recruits, were prevalent in summer and fall (Figure 11). These fishes may have resulted from summer spawning which occurs along the Atlantic coast from late spring through summer (Welsh and Breder, 1923; Hildebrand and Cable, 1934). Larger, possibly one-year-old fish, were present in winter and spring, along with young-of-the-year. Thus, overlapping in size classes of Stellifer occurred during these seasons.

Atlantic croaker, <u>Micropogonias undulatus</u>, were common throughout the estuary during most of the year, although catches were greatest during May, June, and July (Figure 10). Croaker also appeared to be more numerous at stations YB11 and Y001. Annual catches of croaker did not differ appreciably during the two-year study period (Table 7). The smallest croakers ( $\leq$  60 mm) were present in the Winyah Bay system during fall and winter (Figure 12), suggesting that young croakers may over-winter in the estuary. Similar results were obtained by Van Engel and Joseph<sup>4</sup> for croakers from the Chesapeake Bay system. Modal length of juvenile croakers increased from 70 mm in spring to 90 mm in summer. Although one-year old fish (> 123 mm) were also present in the Winyah Bay system during all seasons, they were not very plentiful in our samples, probably reflecting bias of our sampling gear.

Hogchoker, Trinectes maculatus, were found at all stations during every



Fishes	<u>1977</u>	<u>1978</u>
Stellifer lanceolatus	0.514	0.627
Micropogonias undulatus	0.904	0.978
Trinectes maculatus	0.975	0.959
Ictalurus catus	0.621	0.723
Cynoscion regalis	0.278	0.435
Brevoortia tyrannus	0.245	0,238
Leiostomus xanthurus	0.271	0.247
Decapod Crustaceans		
Callinectes sapidus	0.708	0.871
Penaeus duorarum	0.284	0.398
Penaeus aztecus	0.315	0.350
Penaeus setiferus	0.317	0.158

TABLE 7. Annual differences between means of logarithmically (log<sub>10</sub>) transformed counts of the number of individuals for numerically-dominant species of fishes and decapod crustaceans.



FIGURE 11. Seasonal and annual length-frequency distribution of <u>Stellifer Lanceolatus</u> collected from the channel of the Winyah Bay estuarine system



FIGURE 12. Seasonal and annual length-frequency distribution of <u>Micropogonias</u> <u>undulatus</u> collected from the channel of the <u>Minyah</u> Bay estuarine system.

season of the year; however, hogchokers were most numerous in the upper estuary, especially at stations in the Black (YLO5) and Waccamaw (YWO6) Rivers and during spring and fall (Figure 10). Catches did not differ appreciably from one year to the next (Table 7). Van Engel and Joseph<sup>4</sup> noted a winter and summer decrease in hogchoker abundance for Chesapeake Bay. They speculated that the decrease in summer was due to emigration of spawning adults, while the winter decrease was related to lessened activity and concentration of the fish in deeper holes. Length-frequency distributions (not shown) indicated that average size of hogchokers was smallest in spring, when we observed a modal peak at 50 mm for both years of study. Sizes of hogchokers increased to a modal length of 60 mm by fall.

Ictalurus catus, which are permanent residents of the estuary, were most plentiful at lower salinity stations, especially YW06 (Figure 10). These catfish also appeared to be most numerous in the spring but decreased in number by summer. Annual catches were stable during the course of study (Table 7). Mean length of catfish were least in spring, but smallest individuals, those < 40 mm, were collected only in summer and fall.

Weakfish, <u>Cynoscion regalis</u>, were not captured in the estuary from January until May. This absence is probably related to a seaward migration from the estuary (Lunz and Schwartz, 1970). Catches of these fishes were greatest at stations within Winyah Bay, especially YOO1 and YB11 (Fig. 10). Lunz and Schwartz (1970) noted that seaward migration of weakfish usually begins in late fall in South Carolina, but Shealy et al. (1974) found that weakfish abundance did not markedly decrease until January and proposed that unusually warm temperatures in fall may have influenced their emigration. Catches of weakfish

decreased considerably from 1977 with a subsequent decrease in year-class strength in 1978. Small fish (modal length of 40 mm) were present in spring; by summer, the modal length increased to 70 mm, with a subsequent increase to 80-90 mm in fall (Figure 13).

Atlantic menhaden, <u>Brevoortia tyrannus</u>, are pelagic and generally not vulnerable to capture by bottom trawl gear. Therefore, count and distribution estimates are minimal. Menhaden appeared to be most numerous at station Y001 in Winyah Bay (Figure 10). Temporally, catches were greatest in March and annual fluctuations were slight (Table 7). Sizes of menhaden did not differ noticeably among winter, spring, and summer. Scarcity of menhaden in fall collections precluded analysis of length-frequency distributions during that time. Smallest individuals ( $\leq$  40 mm) were collected in spring and summer, while fish > 210 mm were collected only in winter and fall.

Spot, <u>Leiostomus xanthurus</u>, were not very numerous anywhere within the Winyah Bay system, although catches were higher at station YOOl (Figure 10). Most spot were caught during the summer, but fish were present at stations in the estuary during most months of the year. Dawson (1958) noted that spot also occur in the coastal zone from September through November and eventually spawn in offshore waters during the winter. Catches did not differ greatly from one year to the next (Table 7). The smallest fish (modal length 50-60 mm) were present in spring (Figure 14). Fish > 100 mm were probably one year old (Chao and Musick, 1977) and were collected during all seasons but were not abundant.

Blue crab, <u>Callinectes sapidus</u>, were found throughout the Winyah Bay system during all months but catches were greatest from September to December. Their numbers were greatestat stations Y001, YS07, YB08, and YB11 (Figure 15). Catches did not



FIGURE 13. SEASONAL AND ANNUAL LENGTH-FREQUENCY DISTRIBUTION OF <u>CYNOSCION REGALIS</u> COLLECTED FROM THE CHANNEL OF THE <u>VINYAH</u> BAY ESTUARINE SYSTEM.



FIGURE 14, SEASONAL AND ANNUAL LENGTH-FREQUENCY DISTRIBUTION OF LEIOSTOMUS XANTHURUS COLLECTED FROM THE CHANNEL OF THE MINYAH BAY ESTUARINE SYSTEM.

Callinectes sapidus

Penaeus duorarum



FIGURE 15. Abundance, expressed as the antilog of the transformed log (x + 1) mean number of individuals at each station each month, of the four major species of decapod crustaceans collected at each station monthly in the channel of the Minyah Bay estuarine system, 1977 - 1978 (years combined). Legend indicates four arbitrary levels of abundance from rare or absent (9-1) to maximum abundance (75-1392).

differ greatly between years. Size-frequency distributions showed that catches consisted of a wide range of blue crabs (Figure 16). Individuals < 40 mm were prevalent in summer and fall.

Penaeid shrimps, Penaeus duorarum, P. aztecus, and P. setiferus, were limited seasonally but not spatially in occurrence. Individuals were caught at every station, except YWO6, in the Winyah Bay estuarine system (Figure 15). Both P. duorarum and P. setiferus were most numerous in September and October whereas P. aztecus were most plentiful during the summer months of July and August. All three species were plentiful at stations within Winyah Bay, especially at station Y001. Catches of Penaeus durorarum and P. aztecus were about equal over the twoyear study, but fewer P. setiferus were collected in 1978. This decrease may have been influenced by the low winter temperatures observed in February and March 1978. Most Penaeus duorarum collected in the Winyah Bay system were within the size range of 60-90 mm. Sizes of pink shrimp changed very little seasonally (Figure 17); however, total length of brown shrimp, P. aztecus, increased from a modal length of 70 mm in spring to 100 mm in summer (Figure 18). White shrimp, P. setiferus, covered a wide size range during all seasons of occurrence. Seasonal changes in length of P. setiferus were not obvious because of the overlap in sizes of shrimp collected during the fall and summer (Figure 17). Distinguishable bimodal lengths of 80 and 160 mm were noted in Fall 1977, whereas shrimp with modal lengths of 120 and 140 mm were collected in Summer 1977 and Fall 1978, respectively.

The percent of total catch calculated for dominant species was generally not consistent annually or seasonally, except for relative dominance of the catches by Micropogonias undulatus in spring and <u>Stellifer lanceolatus</u> in fall of both



FIGURE 16. SEASONAL AND ANNUAL LENGTH-FREQUENCY DISTRIBUTION OF <u>CALLINECTES</u> <u>SAPIDUS</u> COLLECTED FROM THE CHANNEL OF THE MINYAH BAY ESTUARINE SYSTEM.



FIGURE 17. Seasonal and annual length frequency distribution of <u>Penaeus</u> settiferus and <u>Penaeus</u> <u>puorarum</u> collected from the channel of the Hinyah Bay estuarine system.



FIGURE 18. SEASONAL AND ANNUAL LENGTH-FREQUENCY DISTRIBUTION OF <u>PENAEUS AZTECUS</u> COL-LECTED FROM THE CHANNEL OF THE <u>HINYAH BAY ESTUARINE SYSTEM</u>.

years (Figure 19). Catches in winter were dominated by <u>Brevoortia tyrannus</u>, <u>M. undulatus</u>, and <u>Ictalurus catus</u>. In summer, <u>Penaeus duorarum</u>, <u>Callinectes</u> <u>sapidus</u>, and <u>S. lanceolatus</u> were a major portion of the number of individuals collected.

Spatial and temporal abundance patterns indicated that the numericallydominant species, except for <u>letalurus catus</u>, were most prevalent at stations nearest the mouth of Winyah Bay. In addition, the influx of stenohaline marine species, which were limited physiologically to high salinity waters of Winyah Bay, enhanced the number of species and individuals occurring there.

## Biomass and Population Density Estimates

Biomass and population density estimates for fishes were highest at stations YB02 and YB05 during fall and Y001 during summer (Table 8). These high estimates reflected abundance of <u>S</u>. <u>lanceolatus</u> and <u>I</u>. <u>maculatus</u> during fall and of <u>M</u>. <u>undulatus</u>, <u>S</u>. <u>lanceolatus</u>, and <u>C</u>. <u>regalis</u> in summer. Decapod biomass was highest during summer and fall, especially at stations in Winyah Bay itself (Y001 and YB08) and during fall at station YS07 in the Sampit River. These high biomass estimates were due to large catches of blue crabs and brown shrimp during these periods.

Total biomass and density estimates for the Winyah Bay estuarine system during our study period were:

	<u>Biomass (kg/ha)</u>	Density (No./ha)
FISHES	2.77	248.7
DECAPODS	1.36	80.63

These estimates are lower than those reported from other South Carolina estuaries by Wenner et al.<sup>2</sup> and Shealy et al (1974). Lower biomass and density



FIGURE 19. Seasonal and annual relative importance, expressed as  $^{0}$ /o of total catch, for most common fishes and decapod crustaceans collected in the Minyah Bay estuarine system for 1977 and 1978. Average biomass (kg/ha) and density (no./ha) of fishes and decapod crustaceans in the Winyah Bay estuarine system by station and season. TABLE 8.

								STATION									4	
F <u>fshes</u>			Udv	2	VBO	8	YB1	1	ALC	5	YPO	5	YSC		IOMĂ	9	YDO	1
	kg/ha	12 no./ha	kg/ha	nu. /ha	kg/ha	no./ha	kg/ha	no./ha	kg/ha	no./ha	kg/ha	no./ha	kg/ha	no./ha	kg/ha	no./ha	kg/ha	no./ha
Fall	6.39	-21,15	4.85	793.75	2.28	297.92	2.60	377.55	3,68	456.02	2.09	175.46	2,16	95.14	2.80	538.88	2.46	382.18
Winter	4.73	261.28	4,07	130.32	1.24	55.78	3.10	237.27	1.26	69.21	1.02	112.50	3.54	94.67	0.61	70.60	4.18	223.15
Spring	5.70	373.84	76.2	287.96	2.20	137.04	2.59	376,85	0.56	88.88	0.97	78.93	2.22	231.71	76.0	131.71	2.28	376.39
Summer	1.37	145.60	1,94	352,08	6.11	138.19	3.11	279.86	1.61	179,86	3.28	172.22	2.73	137.27	1.23	131.71	5.89	538.43
Decapod	ch l																	
Fall	0.91	87.73	1.87	97.22	5.02	145.83	1.29	87.73	0.38	31.02	0.69	36.34	6,11	234.26	0.30	14.12	3.01	145.83
Winter	0.67	41.61	0.28	10.18	0.06	7.17	0.01	3.00	0.00	1.15	0.00	3.703	0.07	5.09	0.00	3.93	0.13	12.03
Spring	1.55	49.54	0.33	25.46	0.69	19.21	0.41	18.29	0.04	3.24	0.09	2.77	0.86	60.65	0.08	13.88	0.60	35.18
,	2		16 7	454 16	6.53	105.32	2.47	214.81	0.24	15,04	1.22	20.14	2.86	146.53	0.07	5.55	5.77	696,30

696,30

5.77

5.55

214.81

2.47

105.32

6.52

454.16

4.31

54.16

0.86

Summer

48

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estimates for Winyah Bay may reflect mortality of <u>Penaeus setiferus</u> and other estuarine species during the extremely cold winters of 1977 and 1978. In addition, salt marsh acreage is much less in Winyah than in other major S.C. estuarine systems and may affect the total number of individuals which can be supported in the food web.

## CONCLUSIONS

Most species and individuals of fishes and decapod crustaceans were collected in fall when catches of <u>Trinectes maculatus</u> and <u>Stellifer lanceolatus</u> were large, and an influx of stenohaline marine transients moved into Winyah Bay. These stenohaline species were broadly distributed throughout Winyah Bay waters during fall. The general abundance of resident estuarine species and <u>Penaeus</u> spp. was reflected by an increase in biomass and density estimates in fall.

The fall peak in diversity was followed by a sharp decrease in winter, which was caused by the exodus of several stenohaline and euryhaline transient species, such as <u>Chaetodipterus faber</u>, <u>Prionotus tribulus</u>, <u>Dasyatis sabina</u>, <u>Menticirrhus americanus</u>, <u>Penaeus duorarum</u>, <u>Penaeus setiferus</u>, <u>Penaeus aztecus</u>, and <u>Cynoscion regalis</u>. Those stenohaline marine species which were present in the estuary during winter were usually caught at stations near the mouth of the bay. The total catches of fishes and decapod crustaceans, as well as biomass and density, were also lowest in winter.

In spring, numbers of species and individuals increased, although stenohaline marine species were still not very abundant and were patchy in their occurrence throughout Winyah Bay. Trawl catches were dominated by <u>Micropogonias</u> undulatus and Trinectes maculatus.

The diversity and number of individuals increased from spring to late summer, with the exception of August 1977. In summer, the number of stenohaline marine transients entering Winyah Bay peaked and transient euryhaline species such as <u>M. undulatus</u>, <u>Cynoscion regalis</u>, and <u>Penaeus</u> spp. were most abundant.

Although the status of Winyah Bay fisheries is dependent on the extent and type of future development on and around the Bay and its distributaries, we cannot presently distinguish any aspect of the estuarine fish and decapod community which would indicate a stressed system. Like the Santee and Cooper River estuarine systems, Winyah Bay appears significant as a nursery area and supports a relatively rich fauna near its mouth. The Winyah system supports resident populations as well as stenohaline marine species and euryhaline transients which utilize the estuary during a portion of their life cycle.

The future development plans for the Winyah Bay system deserve serious consideration to insure that the estuary does not deteriorate. Factors which affect water quality within the Winyah Bay system, such as increases in turbidity, reduction in dissolved oxygen levels, and resuspension of pollutants previously entrapped through adsorption to or absorption by bottom sediments, could substantially affect fish and invertebrate communities (Conservation Foundation<sup>1</sup>).

This paper has addressed some of the basic biological, physical and chemical characteristics of the Winyah Bay estuary, the seasonal changes in these characteristics, and how they interact. The study was designed initially to gather and analyze baseline data and was not structured to assess impact of development projects which have been proposed, e.g. an oil refinery, riverside industrial

park, and expansion of the port facilities at Georgetown. In order to detect and possibly remedy any detrimental effects to fishes and decapods which might result from these developments in the Winyah Bay estuarine system, it is necessary to describe the community in terms of its structure, its members, and their temporal and spatial relationships. The present paper represents a contribution toward that goal. While not designed to specifically assess impacts of an oil refinery, these base-line results could be used, to some extent, to compare with future studies which will be necessary once any of the proposed Winyah Bay development projects are implemented. Only then can the stability and flexibility of the Winyah Bay estuarine ecosystem be assessed.

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-	otal length, bottom salinity, and temperature ranges, and relative abundance by station	or fish and decaped crustacean species captured by 6-m trawl in the Winyah Bay estuarine	iystem, South Carolina from 1977 - 1978. Legend: 🔟 < 1; 번 2~50; 또 51-100; 🚺 >100
	APPENDIX I.		

pecies	Total Length Range (mm)	Bottom Salinity Range( <sup>0</sup> /00)	Bottom Temperature Range ( C)	YB02	YB05	YBOß	YB11 Y	х <b>Т.05</b> У	P05 YS	307 YI	406 Y	100
ISHES												
<u> Raja eglanteria</u>	375.0	21.98	23.40	٥								
lasyatis sabina	395.0-975.0	2.06-25.92	17.90-28.30	0	0	0			0			0
Actpenser bravirostrum	0.864	0.11	19.40			o						
Acipenser oxyrhynchus	23.0-965.0	0.05- 7.16	3.20-30.00		·	0	-	0	0			
Lepisosteus ossens	111.0-755.0	0.05+11.36	4,00-29,90				0	0	• •	0		o
Anguilla rostrata	48.0-660.0	0.03-25.87	5,80-29,20		٥	o	0	o	0	+		o
<u> Yyrophis punctatus</u>	404.0	0.06	4.80		0							
<u>Alosa sapidissima</u>	29.0-208.0	0.06-23.91	5.10-28.80	o	0	D			0	0		0
<b>Brevoortia tyrannus</b>	31.0-241.0	0.29-30.39	5.10-29.90	+	+	*	+	0	0	•		+
Anchoa hepsetus	30.0-125.0	28.44	28.0		o		. <u> </u>					
Anchoa mitchilli	19.0- 90.0	0.31-32.72	5,80-29,40	0	+	+		a	0	0	•	+
<u>Lepomis punctatue</u>	0*06	0.20	12.10						0			
Ictalurus catus	15.0-460.0	0.03-21.08	3.00-30.90	o	+	+	+	+	+	+	+	+

Appendix I (continued												
Species	Total Length B Range (mm)	dottom Salinity Range( <sup>0</sup> /oo)	Bottom Temperature Range (_C)	YB02	YB05	YB08	YB11	YLO5	(P05	YS07	XW06	1001
Arius felis	75.0-283.0	14,40-18.47	22.00-23.50	0								0
Bagre marinus	83.0-147.0	7.40-16.60	27.90-29.50				o					0
Cpsanus tau	42.0-345.0	0.29-28.96	4.60-29.20	+	٥							•
Gobiesox strumosus	44.0-71.0	2.07-30.39	7.60-28.30	0		0	ľ				Ì	
Urophycis floridana	69.0-215.0	0.64-27.60	7.60-21.70	+			0					
Urophycis regia	51.0-197.0	0.14-27.60	6,20-21,80	+	+	D	+			٥		+
<u>Ophidion marginatum</u>	155.0-190.0	8.60-27.60	11,00-28,30	¢	0	0						0
Cobionellus shufeldt1	57.0- 65.0	0.16- 0.34	5.00- 6.50					0	0			
Morone americana	75.0-385.0	0.03-11.65	3.80-30.80					0	0	+	0	
Morone saxatilis	35.0-382.0	0.03-11.65	3.00-28.40				0	0	0	D	0	
Centropristis philadelphica	136.0	15.15	15.20	0							:	
Centropristis striata	148.0	22.74	11.00	0								
Dorosoma cepedianum	358,0	6.40	28.90	_						0		
Syngnathus fuscus	77.0	13.95	16.50									٥
Lutjanus griseus	88.0~105.0	3.41-18.47	17.90-22.00	0							0	-
Mortone chrysops	L58.0	3.41-18.47	L7.90-22.00						0			

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Species	Total Length Range (mm)	Bottom Salinity Range( <sup>0</sup> /00)	Bottom Temperature Range (°C)	YB02	YB05	YB08	YB11	¥1.05	۲ <u>۳</u> 05	702Y	¥W06	TOOL
Chloroscombrus chrysurus	45.0-123.0	7.40-14.40	23.50-29.10			•	0					•
Archosargus probatocephalus	165.0	19.09	16.30	0								-
Lagodon rhomboides	82.0-112.0	8,00-16,40	7.60-12.80	¢	0	0	o					0
Bairdiella chysoura	46.0-200.0	0.41-30.39	7.00-30.90	+	0	٥	0	0	0	0	0	0
<u>Cynoscion</u> nebulosus	131.0-195.0	8.00-25.87	8,00-18,20		0	0	o					o
Cynoscion regalis	23.0-378.0	0.47-28.44	12.80-30.90	+	+	+	+	o	+	+	0	+
Larimus fasciatus	89.0	16.40	12.50	0								
Leiostomus xanthurus	33.0-267.0	0.14-32.72	7.60-30.80	+	р	+	+	0	0	+		+
Menticirrhus americanus	47.0-176.0	5.37-25.87	, 15.00-29.60	0	D	0	0					+
Micropogonias undulatus	19.0-350.0	0.05-30.39	5.10-30.90	*	*	+	4	+	+	+	+	*
Pogonias cromis	49,3- 88,2	0.29-18.47	19,70-22,00	0	0							
Stellifer lanceolatus	15.0-170.0	0.29-30.39	4,60-29,90	Ā	Ā	*	+	+	o	0	+	*
Chaetodipterus faber	27.0-136.0	7.77-24.86	17,90-29.70	٥	+	0	o	0				0
<u>Hypsoblennius</u> hentzi	42.0~104.0	15.15-25.92	11.00-28.30	+	0							
Hypsoblennius ionthas	59.0- 88.0	15.60-27.60	17.50-27.30	٩								

Species	Total Length Range (um)	Bottom Salinity Range( <sup>0</sup> /oo)	Bottom Temperature Range (°C)	YB02	YB05	YB08	<u>YB11</u>	<u>XI 02 X</u>	05 YS	07 YA	06 Y	001
Peprilus alepidotus	27.0-120.0	6.35-27.14	15,20-29.70	0	0	0	<u>م</u>				• 	
Peprilus tricanthus	50.0-110.0	5.88-19.94	21,70-29,50	0	0	0	0				¢	
Astroscopus <u>y-graecum</u>	43.0-127.0	8.47-18.24	24.40-27.40				0				0	
Mugil cephalus	102.0-328.0	0,06- 5,32	4.00- 7.60		0		-					Ţ
Scorpaena calcarata	56.0	25.92	18,00	o								T
Prionotus carolinus	34.0- 82.0	9,13-16,60	27.30-28.00	+	0			<u> </u>			0	
Prionotus evolans	38.0- 52.0	14.95-19.94	21.70-22.00	0	0							Ĩ
Prionotus scitulus	55.0- 66.0	0.29- 2.07	19.70-20.40	o	٥							ļ
Prionotus tribulus	27.0- 86.0	5.88-24.86	12.50-28.80	o	2	0	o				+	
Ancylopsetta quadrocellata	51.0- 78.0	8.40-16.40	7.40-12.50	D	0		0					
Etropus crossotus	49.0-125.0	5.37-25.87	15.70-23.60	۵	0	0	0	0				
Paralichthys dentatus	47.0-340.0	0.36-24.86	7.00-29.20	0	0	0	0	0	0	0		
Paralichthys lethostigma	65.0-534.0	0.06-30.39	4.80-30.90	0	o	0	c	0	0		-	
Scophthalmus aquosus	35.0-140.0	0.64-24.86	7.60-27.90	0	٥	o	٥		<u></u>			_
Trinectes maculatus	20.0-186.0	0.03-32.72	3.00-30.90	0	+	+	+	*	+	 +		+
				_		-						ľ

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Species	Total Length Range (mm)	Bottom Salinity Range( <sup>0</sup> /00)	Bottom Temperature Range (C)	YB02	YBOS	YB08	YB11	VL05	YP05	Y307	YW06	TOOY
Symphurus plagiusa	36.0-195.0	1.46-30.39	5.20-29.70	•	+	+	+	*	+	+	*	+
Monacanthus hispidus	18.0- 38.0	6.99-14.22	24.90-26.20		0							0
Ictalurus plarycephalus	156.0-246.0	.20	12.20					0				
Ictalurus nebulosus	86.0-380.0	0.03- 0.51	3,80-30,00					0	0		0	
Ictalurus punctatus	42.0-285.0	0.04- 3.23	4.00-27.90					•	٥	0	0	
Dorosoma petenense	63.0-130.0	0.20-19.27	5.0 -15 <b>.</b> 80		0	0		0	0	0	0	¢
Ariosoma balearicum	207.0	0.71	4.60	0								
Alosa aestivalis	25.0-286.0	0.48- 5.32	5.10-20.40		0			,				0
Sciaenops ocellata	59.0- 80.0	3.46- 8.92	7.40-15.70		0					0		
Citharichthys spilopterus	53.0-115.0	3.71-24.86	23.30-29.10		٥	2	0					0
Pomatomus saltatrix	68.0-175.0	6.35- 6.99	26.20-29.10			٥				o		۰
Selene vomer	55.0- 71.0	10.28-12.07	28,20-28,40			0			- 1			o
Cyprinus carpio	575.0-730.0	1.40- 4.42	28,20-30,80						٥			
Lepomis microlophus	95.0-191.0	0.36- 0.66	6.00- 7.60						•	0		
Lepomis auritus	141.0	0.66	7.60							0		

Sperles	Total Length B Range (mm)	ottom Salinity ) Range (°/00)	Bottom Temperature Range (ĈC)	YB02	YB05	IB08 YI	311 YL	IX 507	P05 Y	S07 YK	406 Y	1001
	(mark) - Greene											
<u>Micropterus</u> salmoides	220.0	0,66	7.60							0		
Leponis gulosus	123.0-218.0	0.20-11.16	6,00-28,20						¢			
Chilomycterus schoepfi	37.0-58.0	16,60	28.00									
DECAPOD CRUSTACEANS											-	
Penaeus aztecus	34.0-164.0	1.31-28.44	1.7.50-29.90	+	+	+	+		•	+		+
Penaeus duorarum	22.0-117.0	2.06-28.96	11.00-29.60	+	*	+		0	+	+	- * - 0	*
Penaeus setiferus	27.0-180.0	0.46-28.96	9.50-29.90	+	+	+	+	0	 o	+		+
Trachypenaeus constrictus	25.0- 75.0	0.46~28.96	12.50-29.60	+	0	0		0	0	0		0
Palaemonetes pugio	22.0- 43.0	0.23- 8.92	4.60-30.90	0	0	•	0			0		0
<u>Palaemonetes</u> vulgaris	15.0- 41.0	0.29-30.39	4.60-29.50	+	+	 0	0		0	+		+
Alpheus heterochaelis	40.0	19.09	16.30	0								
Ovalipes stephensoni	18.0	19.94	21,70	o								
<u>Portunus gibbes11</u>	22.0- 60.0	10.00-25.87	16,60-29,60	0	0	0	D					
Portunus spinimanus	40.0-52.0	19,09-21,98	16.30-23.40	0								-

pectes	Total Length Range (mm)	Bottom Salinity Range(°/oo)	Bottom Temperature Range (°C)	YB02	¥1005	YBOB	YB11	X1.05	YPO5	YS07	790£	1001	
<u> Callinectes sapidus</u>	10.0-200.0	0.03-30.39	4,80-30,90	+	+	+	+	+	+	*	+	*	
<u>Panopeus herbstii</u>	8.0- 33.0	2.07-30.39	7.60-29.50		0	0						0	
Panopeus occidentalis	15,0- 30,0	0.48-14.05	7.60-20.40	0		-		0					
Callinectes similis	21,0-106,0	0.48-32.72	15.80-29.20	0		٥	0	0					
Callinectes ornatus	112.0	19.96	27.80		o			ļ	: :	1			
<u>Xiphopenaeus</u> kro <u>ver</u> l	58.0	20,55-24,86	24,10-25.00			-					_	0	
Macrobrachium ohione	40.0-106.0	0.05-12.07	5.30-30.80			0	٥	a	o	0		0	
Rhithropenopeus harrisii	6.0- 20.0	0.03-19.28	4.00-29.90			0	0	0	0	0	0	0	
<u>Hexapanopeus</u> angustifrons	14.0	10,0	29.60				٥						
Ovalipes ocellatus	33.0	8.55	18.50							۰			
