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Spatial and temporal feeding patterns and dietary resource utilization of the sand flounder, *Scophthalmus aquosus* (Mitchill), from the inner New York Bight

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City University of New York, 1990

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SPATIAL AND TEMPORAL FEEDING PATTERNS AND DIETARY RESOURCE UTILIZATION OF THE SAND FLOUNDER, *SCOPHTHALMUS AQUOSUS* (MITCHILL), FROM THE INNER NEW YORK BIGHT.

by

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Abstract

SPATIAL AND TEMPORAL FEEDING PATTERNS AND DIETARY RESOURCE UTILIZATION OF THE SAND FLOUNDER, SCOPHTHALMUS AQUOSUS (MITCHELL), FROM THE INNER NEW YORK BIGHT.

by

Barbara E. Warkentine

Advisor: Professor Joseph W. Rachlin

To determine the dietary resource utilization for resident populations of the sand flounder of the New York Bight a series of stations, covering a span of 133.3 km, was established along the Bight's western arm. These stations extended from Absecon Inlet, N.J. in the south to Breezy Point, N.Y. in the north. The stations were sampled during June and November of 1984, April and July of 1985, and January 1986. This schedule allowed for the establishment of a sampling protocol designed to gain information on the spatial and temporal feeding patterns of this species.

Analysis revealed that the mysid shrimp, Neomysis americana, accounted for greater than 90% of the sand flounder's diet throughout the sampling range and during all seasons except January 1986. During January the dominant prey consumed was the mysid Mysidopsis bigelowi. Other important, but not dominant, food items consisted of sand shrimps, amphipods, nematodes, crabs and crab larvae, isopods, polychaetes and fish. Application of the Manly

preference index and the electivity index of Vanderploeg and Scavia determined that mysids were the preferred food item for this fish throughout its range and over all sampling seasons.

The resident sand flounder co-occurs, in this region with seasonally migrating flatfishes, i.e. the winter, summer, fourspot, smallmouth, and yellowtail flounder. A working hypothesis that the diet of the sand flounder would change as these other flatfish move into and out of its region was tested. This hypothesis was falsified. Mysids remained the dominantly preferred food item taken by the sand flounder regardless of the presence of other potentially competing flatfish in its foraging field. Although a seasonal difference in consumed mysids was observed this difference was found to reflect a seasonal change in the dominance of the species representing the mysid fauna rather than interspecific interactions between co-occurring flatfish. Further, these fish were found to have very little dietary overlap. There appears to be very little dietary competition between sand flounders and other co-occurring flatfish.

Ontogenetic dietary shifting was not observed for the sand flounder. Size classes of sand flounders examined in this study ranged from 3.0 to 27.0 cm standard length and all fish fed dominantly on small crustaceans; thus, no evidence of dietary gape-limitation was found.

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Special thanks are extended to the Institute of Marine and Atmospheric Sciences (IMAS) for their magnanimous generosity in chartering, for this project, the Research Vessel "ATLANTIC TWIN." I would also like to thank Mr. william Bolles, Marine Technician for IMAS, for his expertise in handling and setting up all the necessary field equipment, and for building a top rate fish sorting table.

Sincere appreciation is extended to the captain of the RV "ATLANTIC TWIN" Captain Walter Van Horn (now retired). Through his expertise and excellent navigational skills, we were able to keep equipment loss to a minimum and accurately relocate on each sampling station. In addition to the captain, I wish to thank the various crew members for their help in making each cruise a successful, safe and smooth one.

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Table of Contents

1- Abstract iii
2- Acknowledgement v
3- Table of Contents vii
4- List of Tables ix
5- List of Figures xiv
6- Introduction 1
7- Objectives 5
8- Background 7
  A- Dietary Resource Partitioning 7
  B- Buccal Morphology and Dentition 9
  C- Gill Structure 11
  D- Ontogenetic Dietary Shifts 11
9- Materials and Methods 14
  A- Collecting Sites and Physical Parameters 14
  B- Collecting Procedure 17
  C- Stomach Content Analysis 19
  D- Buccal Morphology 22
  E- Mathematical Treatment of Diet Data 23
    a- Diet Diversity 23
    b- Diet Preference 24
    c- Diet Overlap 26
    d- Diurnal Feeding Patterns 27
10- Results 28
  A- Species Distribution 28
  B- General Diet of <u>Scophthalmus</u> <u>aquosus</u> 30
  C- Dietary Preference 35
    1- Spatial 35
    2- Temporal 38
  D- Dietary Overlap and Similarity 39
    1- Spatial 39
    2- Temporal 42
  E- Diet Diversity 43
  F- Buccal Morphology and Diet 45
  G- Diurnal Feeding Pattern 48
11- Discussion 49

Table of Contents

12- Summary 60
13- Tables 61
14- Figures 146
15- Appendices 180
16- Literature Cited 183

List of Tables

Tables

1 Locations and physical properties of collecting sites. 61

2 Number of fish per species collected from the New York Bight during June 1984. 62

3 Number of fish per species collected from the New York Bight during November 1984. 63

4 Number of fish per species collected from the New York Bight during April 1985. 64

5 Number of fish per species collected from the New York Bight during July 1985. 65

6 Number of fish per species collected from the New York Bight during January 1986. 66

7a-g Diet of Scophthalmus aquosus and the combined diet of all fish collected from seven sampling sites during June 1984. 67

8a-d Diet of Scophthalmus aquosus and the combined diet of all fish collected from four sampling sites during November 1984. 74

9a-h Diet of Scophthalmus aquosus and the combined diet of all fish collected from eight sampling sites during April 1985. 78

10a-h Diet of Scophthalmus aquosus and the combined diet of all fish collected from eight sampling sites during July 1985. 86

11a-g Diet of Scophthalmus aquosus and the combined diet of all fish collected from seven sampling sites during January 1986. 94

List of Tables

Tables

12 Dietary preference of Scophthalmus aquosus collected from seven locations within the New York Bight during June 1984. 101

13 Dietary preference of Scophthalmus aquosus collected from four locations within the New York Bight during November 1984. 103

14 Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during April 1985. 104

15 Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during July 1985. 106

16 Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during January 1986. 109

17 Summary of the dietary preference of Scophthalmus aquosus collected from seven locations within the New York Bight during June 1984. 110

18 Summary of the dietary preference of Scophthalmus aquosus collected from four locations within the New York Bight during November 1984. 111

19 Summary of the dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during April 1985. 112

20 Summary of the dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during July 1985. 113

List of Tables

Tables

21 Summary of the dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during January 1986. 114

22 Dietary preference of Scophthalmus aquosus collected from Absecon Inlet during different seasons. 115

23 Dietary preference of Scophthalmus aquosus collected from Brigantine Inlet during different seasons. 116

24 Dietary preference of Scophthalmus aquosus collected from Little Egg Inlet during different seasons. 117

25 Dietary preference of Scophthalmus aquosus collected from Beach Haven Crest during different seasons. 118

26 Dietary preference of Scophthalmus aquosus collected from Seaside Heights during different seasons. 119

27 Dietary preference of Scophthalmus aquosus collected from Sea Girt during different seasons. 120

28 Dietary preference of Scophthalmus aquosus collected from Elberon Ground during different seasons. 122

29 Dietary preference of Scophthalmus aquosus collected from Breezy Point during different seasons. 123

30 Summary of the dietary preference of Scophthalmus aquosus collected from Absecon Inlet during five collecting seasons. 124

List of Tables

Tables

31 Summary of the dietary preference of Scophthalmus aquosus collected from Brigantine Inlet during five collecting seasons. 125

32 Summary of the dietary preference of Scophthalmus aquosus collected from Little Egg Inlet during five collecting seasons. 126

33 Summary of the dietary preference of Scophthalmus aquosus collected from Beach Haven Crest during five collecting seasons. 127

34 Summary of the dietary preference of Scophthalmus aquosus collected from Seaside Heights during five collecting seasons. 128

35 Summary of the dietary preference of Scophthalmus aquosus collected from Sea Girt during five collecting seasons. 129

36 Summary of the dietary preference of Scophthalmus aquosus collected from Elberon Ground during five collecting seasons. 130

37 Summary of the dietary preference of Scophthalmus aquosus collected from Breezy Point during five collecting seasons. 131

38 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from seven location within the New York Bight in June 1984. 132

39 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from four location within the New York Bight in November 1984. 133

List of Tables

Tables

40 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from eight location within the New York Bight in April 1985. 134

41 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from eight location within the New York Bight in July 1985. 135

42 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from seven location within the New York Bight in January 1986. 136

43 Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected over five collecting seasons. 137

44 Shannon diversity, variance and evenness of the diet of the sand flounder collected during June 1984. 141

45 Shannon diversity, variance and evenness of the diet of the sand flounder collected during November 1984. 142

46 Shannon diversity, variance and evenness of the diet of the sand flounder collected during April 1985. 143

47 Shannon diversity, variance and evenness of the diet of the sand flounder collected during July 1985. 144

48 Shannon diversity, variance and evenness of the diet of the sand flounder collected during January 1986. 145

List of Figures

Figure

1 The sand flounder, *Scophthalmus aquosus*. 146

2a Hypural plate of a typical bothoid fish. (redrawn from Hemsly and Ahlstom 1983). 148

2b Hypural plate of *Scophthalmus aquosus*. 148

3 Map of the New York Bight showing sampling locations. 150

4 Head of *Scophthalmus aquosus* showing mouth parts. 152

5 Gill arches of *Scophthalmus aquosus* showing the gill rakers and the branchial bones of the first gill arch. 154

6 Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during June 1984. 156

7 Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during November 1984. 158

8 Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during April 1985. 160

9 Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during July 1985. 162

10 Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during January 1986. 164

List of Figures

Figure

11 Curves showing the relationship between the diet diversity of the sand flounder and (A) the diet diversity of all fish collected; (B) the number of food types used by all fish; (C) the number of fish species collected. 166

12 Graphs depicting the relationships between (A) mouth length and fish length; (B) mouth width and fish length; (C) gill raker length and fish length; (D) spacing between gill rakers and fish length. 168

13 Graphs depicting the relationships between prey length and (A) fish length; (B) mouth length; (C) mouth width; (D) gill raker length; (E) spacing between gill rakers. 170

14 Graphs depicting the relationships between prey width and (A) fish length; (B) mouth length; (C) mouth width; (D) gill raker length; (E) spacing between gill rakers. 172

15 Percentage representation of major food items in the diet of sand flounders of different size classes. (A) % mysids; (B) % shrimps; (C) % crabs (D) % miscellaneous. 174

16 Cumulative number of food types plotted against the number of stomachs examined, for each time period sampled. 176

17 Relationship between stomach fullness and time of collection. 178

Introduction

Scophthalmus aquosus (Mitchill 1814) (Figure 1), the sand flounder, sand dab, or windowpane as it is commonly called, is a member of the family Bothidae, subfamily Scophthalminae. However, Hubbs (1945), in looking at character similarities among the Scophthalminae, proposed a classification scheme in which he elevated this subfamily to the family Scophthalmidae. Hensley and Ahlstrom (1984), in looking at relationships among the flounders, determined that there was no justification for the elevation of the subfamily to family status and therefore reject the proposed 1945 classification of Hubbs. Hensley and Ahlstrom (1984) state:

> Based on ventral-fin morphology, the Scophthalmidae appear to be monophyletic. There are certain similarities in ventral-fin morphology between this family and the achirines, but these are probably superficial. Scophthalmids were previously thought to be closely related to and derived from the Citharidae (Hubbs 1945). This hypothesis was based on certain symplesiomorphies (shared primitive character states), e.g., the low degree of fusion of the gill membranes and the presence of vomerine teeth.

Based on the pattern of the hypurals, Hensley and Ahlstrom (1984) state that the Scopthalmidae are members of the bothoid group (a typical bothoid hypural is shown in Figure 2a) and are thus placed in the family Bothidae. After I carefully examined the caudal skeleton of *Scophthalmus aquosus* (Figure 2b) it was quite apparent that its hypural pattern is typical of bothoid fish. Based on this observation, I would consider the sand flounder as a member of the family Bothidae.

Although much work needs to be done on the systematics of the flatfishes, the classification (based on synapomorphies, i.e. shared derived character states) of the scophthalmids, as members of the family Bothidae and not as members of the family Scophthalmidae has been widely accepted and is the one that is currently operative.

All members of this family are left eyed flounders (both eyes on the left hand side). Like most members of the Bothidae, the sand flounder has a large mouth. When the mouth is fully open it is nearly round and symmetrical with a slight upward orientation (Morris 1981). Scophthalmus aquosus is unlike any other northwestern Atlantic flatfish in that the first 10 to 12 rays of its dorsal fin are separated and fringed (Smith 1985). The body of this flounder is nearly round and is very thin, so much so that the body is translucent when held up to the light. As a result of this body thinness, S. aquosus has not been exploited by the commercial fishing industry and has been labelled as a "trash fish." However, during the 1940s plans were being made to exploit the sand flounder in order to alleviate fishing pressures on other species of flatfish. Because of this shift in the status of the sand flounder and the need to adequately exploit the population, a study on the life history of this species was deemed necessary and aspects were investigated by Moore (1947). Since this early study, very little attention has been focused on the sand flounder, due primarily to the fact that it was not exploited as a commercially important fish. Within recent years, however, many of the commercially important flatfish populations have been on a decline and as a result the sand flounder is once again being looked at as a viable alternative. With this in mind a current ecological evaluation of this species is desired.

The sand flounder inhabits the western Atlantic coast from the Gulf of St. Lawrence, Nova Scotia to South Carolina (Bigelow and Schroeder 1953; Scott and Scott 1988). Its seaward range rarely extends beyond water depths of 50 meters. The preferred bottom habitat for this fish is one of sand, although it has been known to frequent softer muddier grounds, such as the Minas Channel and the Bass River in Canada (Bousfield and Leim 1959). In the southern New England regions, adult members of the population exhibit no inshore/offshore seasonal migration cycle but do exhibit some north/south coastal movement (Moore 1947). Young fry, that settle to the bottom in shallow inshore waters will, however, move to deeper offshore waters as they grow. Jeffries and Johnson (1974) also observed little seasonal variation in the abundance of sand flounders in the Narragansett Bay area. Therefore, the sand flounder can be considered a year round resident of the marine coastal benthic fish community.

In the New York Bight, the sand flounder is the most abundant flatfish present throughout the year. Within this region the sand flounder co-occurres with a number of different flatfishes: summer flounder (Paralichthys dentatus); four spot flounder (Paralichthys oblongus); smallmouth flounder (Etropus microstomus); winter flounder (Pseudopleurnectus americanus); and yellowtail flounder (Limanda ferruginea) (Warkentine and Rachlin 1985, 1986). The first three of these flounders are also members of the Bothidae with the latter two species being members of the Pleuronectidae (right eyed flounders). All of these co-occurring species exhibit strong and different seasonal migratory cycles. As a result the flatfish community is constantly changing with the sand flounder remaining the only constant. This subsequently leads one to ask some very key ecological questions: What effect does this changing community structure have on the dietary feeding pattern of the resident sand flounder population; and what feeding patterns are exhibited by these co-occurring flatfishes that would mitigate against interspecific competition?

Objectives

There have been a number of studies describing the diet of *S. aquosus* (Moore 1947; de Sylva *et al*. 1962; Richards 1963; Stickney *et al*. 1974; Hickey 1975; Langton and Bowman 1981; Morris 1981). Although these studies provide elaborate data bases on the diet of the sand flounder, they provide no information about the seasonal and spatial dietary preferences of this flounder. A number of important ecological questions about the diet of the sand flounder have not been addressed. Does dietary preference of the sand flounder differ over a distributional range during any collecting season? How is the dietary preference of the sand flounder affected by seasonal change? How is the diet of the sand flounder affected by the migration of other flatfish into and out of its region? How is the dietary diversity of *S. aquosus* affected by the fish community structure and prey utilization? Is there correlation between buccal morphology and prey selection? What, if any, is the daily feeding periodicity of this flounder? A study of these questions formed the basis of this thesis. These questions have been addressed by attempting to falsify the following hypotheses:

1- Diet preference will vary spatially in response to the spatial variation in the co-occurrence of other members of the benthic flatfish community.

2- Diet preference will vary temporally in response to the temporal variation in the co-occurrence of other members of the benthic flatfish community.

3- Diet preference will not vary spatially in response to spatial variability of prey types.

4- Diet preference will not vary temporally in response to temporal variability of prey types.

5- Dietary overlap between the sand flounder and other co-occurring flatfish species will be at a minimum.

6- Dietary diversity of the sand flounder will be affected by the fish community structure.

7- Dietary diversity of the sand flounder will be affected by prey utilization by members of the fish community?

8- Assuming sufficient quantities of both small and large prey items, large fish will selectively forage on the larger prey items.

9- In an effort to mimimize competition for food, peak feeding for the sand flounder will not be coincident with that of co-occurring flatfishes.

Background

Studies investigating feeding patterns among fish species have shown that a number of factors play a key role in reducing intra- and interspecific competition.

A- Dietary Resource Partitioning: Werner (1977), Werner and Hall (1979) and Werner et al. (1981), in studying three species of centrarchids, demonstrated that all species when allopatric fed on similar food items but when sympatric sufficiently partitioned the available food resources, so as to avoid the consequences of competition. Schmitt and Coyer (1983) observed a parallel situation in their study of allopatric and sympatric species of embiotocids. Moyle and Senanayake (1984) observed significant resource partitioning among fishes in the streams of Sri Lanka only during times of food scarcity. When food became abundant, however, resource partitioning was mimimal. Likewise, Gillen and Hart (1980) observed maximum resource partitioning between two species of *Notropis* only when resources were limited. De Groot (1969), observed dietary differences among North Sea flatfishes of the families Bothidae, Pleuronectidae and Soleidae and, finding little dietary overlap, was able to classify them as being fish, crustacean, and polychaete-mollusc feeders respectively. Although de Groot (1969) characterized the pleuronectids as crustacean feeders, he observed greater dietary variability among members of this family than among members of the other two families. In an earlier study Moiseev (1953) observed this same variability in the diet composition among 27 pleuronectid flatfish species collected from the Far East. As a result, Moiseev (1953) divided the pleuronectid fishes into three catagories: "Benthophagous flounders," those feeding on small benthic animals; "mixed feeders," those consuming mostly benthic animals but also taking non-benthic organisms and fish; and "predatory flounders," feeding mainly on fish and large benthic animals. Similar results were found by Hatanaka et al. (1954) in examining the diet of 6 pleuronectid fishes from Japan; and based on their dietary differences was able to catagorized these fish as being annelid feeders, crustacean feeders and fish feeders. Livingston (1987a), analyzing the diet composition of five Pleuronectiform flatfish collected from Wellington Harbor, New Zealand, found that Rhombosolea plebeia fed extensively on ophiuroids while Rhombosolea leporina foraged on crustaceans. Both Peltorhamphus novaezealandiae and Pelotretis flavilatus fed primarily on polychaetes, however, the former species fed on infaunal polychaetes while the latter consumed epifaunal ones. Arnoglossus scapha had a diet consisting of small shrimps and fish, both of which were consumed in equal proportions. Using this information and the diet classification scheme of de Groot (1969), Livingston (1987a) catagorized these flatfishes as crustacean feeders, polychaete feeders and fish feeders. Jenkins (1987) in studying the diet of co-occurring greenback and long-snouted flounder larvae, observed resource partitioning among larvae of these fishes only when they co-occurred in large numbers. Under these conditions the dominant prey of the greenback flounder was cladocerans while that of the long-snouted flounder was copepods. Resource partitioning of food was also observed for flounders co-occurring in Narragansett Bay and Rhode Island Sound (Jeffries and Johnson 1974). In this study co-occurring sand flounders and winter flounders foraged on crustaceans and polycheates respectively, thus minimizing interspecific competition.

B- Buccal Morphology and Dentition: The diet of fishes has been shown to be correlated with buccal morphology and dentition. Van Dobben (1937) observed marked differences in the jaw symmetry among three flatfishes and, correlating these differences with feeding behavior, concluded that flatfishes with symmetrical jaw structures are more likely to take free-swimming prey, while those with asymmtrical jaws would primarily feed on benthic organisms. Yazdani (1969), in studying the jaw structure of Pleuronectiformes, confirmed the notion that the symmetry of the jaw plays an important role in the mode of feeding. He observed that turbot (*Scophthalmus maximus*), brill (*Scophthalmus rhombus*), and halibut (*Hippoglossus hippoglossus*), having large and more or less symmetrical jaws, foraged on large mid-water prey such as fish. However, the feeding behavior of the halibut differs from that of the turbot and brill in that the former species catches its prey between its teeth, while the latter species, having inward directed teeth, suck in their prey. The plaice (*Pleuronectes platessa*), witch flounder (*Glyptocephalus cynoglossus*), dab (*Limanda limanda*) and sole (*Microstomus kitt*), having small highly asymmetrical jaws, foraged on benthic and slow moving organisms such as molluscs, polychaete worms and echinoderms. Correlation between jaw symmetry and feeding behavior was also observed by Kravitz, *et al*. (1976) for five species of co-occurring flatfishes on Oregon's continental shelf. Morris (1981), in studying the mouth structures of seven Pleuronectiform fish species, determined that the American plaice, yellowtail, winter, sand, witch, and fourspot flounders have different mouth structures and showed no significant dietary overlap. Whereas, the summer flounder and the fourspot flounder, both having similar buccal morphology, exhibited significant dietary overlap. Dietary differences among five flatfish species in Wellington Harbor, New Zealand, as studied by Livingston (1987b), showed that among the pleuronectid flounders *Rhombosolea plebeia*, *Rhombosolea leporina*, *Peltorhamphus novaezeelandiae*, and *Pelotretis flavilatus*, all having asymmetric jaws and small teeth (characteristics associated with benthic feeding) had diets composed of benthic organisms. In contrast the bothid flounder, *Arnoglossus scapha*, having a symmetric jaw with large teeth (characteristics associated with mid-water feeding), foraged on fish and larval decapods. Keast (1978) showed that congeneric sunfish, because of their differences in buccal morphology, are able to forage on different food items thus avoid interspecific competition.

C- Gill Structure: With respect to gill structure and its correlation to diet composition of fish, it has been shown (de Groot 1971) that piscivirous flatfish tend to have very long and toothed gill rakers, while those flatfish which feed on less active benthic prey tend to have very small gill rakers. Kravitz *et al*. (1976) observed that the English sole, rex sole and rock sole, all having small gill rakers that are without teeth, heavily foraged on benthic invertebrates. The petrale sole and the Pacific sanddab, having sharp teeth and long toothed gill rakers, could be categorized as piscivores. Livingston (1987b) found similar relational patterns between the diet and gill structure of five flatfish species in Wellington Harbor, New Zealand.

D- Ontogenetic Dietary Shifts: Evidence supporting the notion that ontogenetic dietary shifting plays a role in reducing intra- and interspecific competition has been reported by a number of investigators. Stickney, *et al*. (1974) showed strong congruence between the size of the mouth, relative to body length, with the size of food organisms consumed by the ocellated flounder (*Ancylopsetta quadrocellata*), the bay whiff (*Citharichthys spilopterus*) and the fringed flounder (*Etropus crossotus*) all from coastal waters off Georgia. Hickey (1975) described a shift in the diet of the sand flounder (S. aquosus) from exclusively small crustaceans to crustaceans, fish and decapods with a gradual increase in predator size. Jenkins (1987) observed that larval greenback and long-snouted flounders foraged on larger prey as they grew. Takahashi (1987) in studying the diet of two flounder species (Limanda herzensteini and Limanda yokohamae) from Matsu Bay, Japan, found that during the spring the size of the prey consumed was independent of fish length for L. herzensteini but dependent on fish length for L. yokohamae. However, during the summer, the prey size ingested by both species increased with fish length. This study also showed that size selective predation was a function of prey availability and feeding activity. In studying the feeding ecology of the common sole, Solea vulgaris, from the French Atlantic Coast, Lagardere (1987) observed clear differences in the feeding of these fish with age. He observed that young-of-the-year sole consumed amphipods and young opisthobranchs averaging 3 mm, while 1+ sole consumed polycheates, ranging in size from 10 to 20 mm. Hatanaka et al. (1954) found one variation in the diet composition of seven species of flatfish and one species of gurnard with increased fish size. De Groot (1971) observed that juvenile turbot (length $\leq$ 10 cm) fed primarily on polychaetes and molluscs, turbot of 11 to 20 cm consumed mostly shrimps, and turbot larger than 20 cm foraged on fish. This pattern of dietary shifting with age was also observed for Lepidorhombus whiffiagonis (Bothidae) and *Reinhardtius hippoglossoides* (Pleuronectidae). Such ontogenetic dietary shifts have also been documented by Grossman (1980) and Grossman *et al* (1980) for the California bay goby, and by Schmitt and Holbrook (1984b) for the black surfperch.

Although there are many studies which show that fish exhibit ontogenetic dietary shifts, Langton (1982), in studying *Limanda ferruginea* and Moore and Moore (1976), in studying *Platichthys flasus* observed no such pattern. Rather, they observed that predator size had little effect on the diet composition of these two flounders.

It appears from the above cited literature that there are a number of factors operating within fish communities which tend to minimize intra- and interspecific competition. The question then becomes which, if any, of these factors are operating within the flatfish community of the Inner New York Bight.

Materials and Methods

A-- Collecting sites and physical parameters

Fish were collected from a series of locations in the New York Bight. The New York Bight is defined as a 24,139 km^2 region of offshore water in the bend of the Atlantic coastline from the eastern tip of Long Island, New York, to Cape May, New Jersey, and with a seaward extention to the edge of the continental shelf. The collection sites ranged from Absecon Inlet N.J. in the south to Breezy Point N.Y. in the North (Figure 3, Table 1), a span of 133.3 km. These sites were sampled during June and November 1984, April and July 1985, and January 1986. Physical data for each site and collecting date were obtained from unpublished EPA data and from Benway (1987).

Absecon Inlet, N.J.-- This station was sampled in June 1984, April 1985, July 1985 and January 1986. Distance from shore was 4.8 km; water depth 13 m; and bottom topography flat with sediment consisting of mud and sand. Bottom temperatures, per sampling cruise, were respectively 11.0° C; 15.6° C; 20.4° C and 5° C. Dissolved oxygen levels (mg/L) were respectively 5.6; 9.2; and 4.8. Dissolved oxygen was not measured for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Brigantine Inlet, N.J.-- This station was sampled in June 1984, April 1985, July 1985 and January 1986. Distance from shore was 4.8 km; water depth 13 m; and bottom topography flat with sediment consisting of sand. Bottom temperatures, per sampling cruise, were respectively 11.0° C; 15.6° C; 20.4° C and 5° C. Dissolved oxygen levels (mg/L) were respectively 5.6; 9.2; and 4.8. Dissolved oxygen was not measured for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Little Egg Inlet, N.J.-- This station was sampled in June 1984, April 1985, July 1985 and January 1986. Distance from shore was 4.8 km; water depth 12 m; and bottom topography flat with sediment consisting of mud and sand. Bottom temperatures, per sampling cruise, were respectively 11.0° C; 15.6° C; 20.4° C and 5° C. Dissolved oxygen levels (mg/L) were respectively 5.6; 9.2; and 4.8. Dissolved oxygen was not measured for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Beach Haven Crest, N.J.-- This station was sampled in June 1984, April 1985, July 1985 and January 1986. Distance from shore was 1.6 km; water depth 14 m; and bottom topography flat with sediment consisting of sand. Bottom temperatures, per sampling cruise, were respectively 15.7° C; 15.3° C; 20.0° C and 5° C. Dissolved oxygen levels (mg/L) were respectively 8.5; 8.0; and 5.5. Dissolved oxygen was not measured for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Seaside Heights, N.J.-- This station was sampled in June 1984, November 1984, April 1985, July 1985 and January 1986. Distance from shore was 1.6 km; water depth 14 m; and bottom topography flat with sediment consisting of sand. Bottom temperatures, per sampling cruise, were respectively 11.6° C; 9.0° C; 15.5° C; 15.8° C and 5° C. Dissolved oxygen levels (mg/L) were respectively 4.8; no data for November 1984; 8.3; 1.7; and no values available for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Sea Girt, N.J.-- This station was sampled in June 1984, November 1984, April 1985, July 1985 and January 1986. Distance from shore was 4.8 km; water depth 13 m; and bottom topography flat with sediment consisting of sand. Bottom temperatures, per sampling cruise, were respectively 12.3° C; 9.0° C; 14.0° C; 15.8° C and 5° C. Dissolved oxygen (mg/L) were respectively 6.0; no data for November 1984; 8.0; 3.2; and no values available for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Elberon Ground, N.J.-- This station was sampled in June 1984, November 1984, April 1985, July 1985 and January 1986. Distance from shore was 9.6 km; water depth 22 m; and bottom topography hilly and rocky. This station supports an active lobster fishery. Bottom temperatures, per sampling cruise, were respectively 11.7° C; 9.0° C; 11.5° C; 15.3° C and 5° C. Dissolved oxygen (mg/L) were respectively 6.6; no data for November 1984; 7.5; 4.0; and no values available for January 1986. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

Breezy Point, N.Y.-- This station was sampled in November 1984, April 1985, July 1985 and January 1986. Distance from shore was 4.8 km; water depth 11 m; and bottom topography smooth and sandy. Bottom temperatures, per sampling cruise, were respectively 9.0° C; 12.5° C; no data available for July 1985; and 5° C. Dissolved oxygen (mg/L), only available for April 1985, was measured to be 7.4. Salinity, during all collecting periods, was between 29 and 32 parts per thousand.

B-- Collecting procedure

These stations were selected in order to cover the range of *S. aquosus* in the western arm of the New York Bight. At the onset of this study plans were made to sample these stations every season during one calandar year. However, as one can see from the collecting site information given above this plan was not followed. Firstly, all eight stations were not sampled during each collecting cruise; and secondly, seasonal collections were not made in sequential order. This sampling pattern was the direct result of inadequate availability of ship time and scheduling problems. Scheduled cruises were constantly being delayed and at times postponed by the ship's company. Also, as a result of insufficient ship time, and the fact that during each cruise a 133.3 km span of the Bight was to be sampled, replicate samples per station were not taken. However, adequate numbers of fish were collected per sampling time to address all questions asked in this study.

The vessel used in this study was the 27.4 meter R/V ATLANTIC TWIN, owned and operated by Alpine Geophysical, N.Y. and under contract to the City University's Institute of Marine and Atmospheric Sciences. Loran A navigation was used to position the vessel at each sampling location.

Fish were collected with an 11 m otter trawl constructed of 5 cm (No. 15) stretched nylon mesh for the body, and 3.8 cm (No. 18) stretched nylon mesh in the cod end. The cod end was lined with a nylon minimum-minnow liner to ensure capture of small fish. The net was fished from the stern deck of the R/V ATLANTIC TWIN for 10 minutes bottom time at a speed of 3 knots.

All fish collected were identified to species using the fish identification keys of Bigelow and Schroeder (1953), Perlmutter (1974), Smith (1985) and with reference, where necessary, to the collections of the Department of Ichthyology of the American Museum of Natural History, New York City. The standard length (distance from the tip of the maxillary to the end of the hypural plate) of each fish was measured in cm and fish weight (g) was recorded. The entire gut from each fish was excised and placed individually in labelled whirl bags containing 10% formalin. In addition to this, heads from representative size classes of sand flounders were removed, labelled and placed individually in labelled whirl bags containing 10% formalin. The heads were severed just behind the operculars so as to keep the gills intact.

In order to determine any diurnal variations in the feeding intensity of the sand flounder, one representative station (Absecon Inlet) was sampled, during the July 1985 collecting cruise, approximately every 2 hours during the hours of 0900 and 2200. The fish collected during these times were treated in the same manner as previously stated.

At the end of each collecting cruise, the material was brought back to the laboratory for further processing and analysis. After one week, formalin preserved material were transferred either to whirl bags containing 50% 2-propanol or to glass jars containing 75% ethanol following conventional museum techniques. Those items stored in whirl bags had to be maintained in 50% 2-propanol, since ethanol diffuses through whirl bags causing materials to dry up making them useless for analysis.

C-- Stomach content analysis

The alimentary canal of the sand flounder shows clear morphological distinctions between esophagus, stomach, and intestine. In this study only the stomach portion of the digestive tract was used for analysis. In addition to analyzing the stomach content of sand flounders, the stomachs of all other fish collected were analyzed. Gut content analysis of fish, such as the silverside, sand lance and pipefish, which do not have clearly defined stomachs, involved identifying food organisms found in the expanded anterior section (foregut) of their digestive tract (Warkentine and Rachlin 1989).

The gut content material of each fish was washed into a petri dish and examined using an Olympus Model SZ binocular dissection microscope. The contents were identified (using the invertebrate keys of Pratt 1948; Minor 1950; Smith 1964; Schultz 1969; Bousfield 1973; Fauchald 1977; Gosner 1978 and the fish keys cited earlier) to species when possible. In many instances identification of food organisms were made from pieces of animals found in the gut. Although it was possible to identify most of them to the species level some could only be identified to the class or familial level. Parasitic tapeworms, found in many sand flounders, were excluded from the food data. Partially digested fish were identified after being cleared and stained using the method of Dingerkus and Uhler (1977). By comparing these preparations with reference collection, held on deposit in the Department of Ichthyology of The American Museum of Natural History, New York, many ingested fishes were easily identified to the species level.

After carefully identifying the diet of each fish, the contents were enumerated. Neither biomass nor volumetric displacement data were obtained. These methods were deemed inappropriate for this study as they imply a caloric value of each food item, and measurement of energetics was not an objective of this study.

In general most food items was in good condition, facilitating exact counting: however, fragments were found. In this study the convention used in handling fragmented material was as follows:

a) Crustaceans, such as Crangon, mysids and amphipods, were reconstructed, that is a head region was matched to a tail region. In the case of unmatched pieces each piece was counted as an organism.

b) Polychaetes, being the most difficult to identify because they are soft bodied and quickly digested, were highly fragmented. It was not possible to accurately reconstruct these fragments into whole organisms. A polychaete was considered as a whole organism by counting heads only.

Food items found in the stomach of sand flounders, in addition to being identified and enumerated, were also measured. The length of Crangon and mysid shrimps were measured from the tip of the rostrum to the apex of the telson (Daly and Holmquist 1986). The width of each of these organisms was measured at the widest point on the carapace. Length and width measurements were taken for all other organisms found in the stomach of this fish species. The average length and width of food items in the stomach of each sand flounder was calculated and plotted against the size of the fish.

D-- Buccal morphology

In order to determine relationships between diet and buccal morphology the following measurements were made. The mouth dimensions of width and length were measured for sand flounders ranging in size from 2.7 cm to 26 cm standard length, using precision dial calipers. Mouth width (mm) was measured as the distance across the inner sides of the open mouth at the jaw angles (Keast and Webb 1966). Mouth length (mm) was measured as the length of the upper jaw from the tip of the snout to the posterior end of the maxilla (Figure 4). Since sand flounders have symmetrical mouths, the jaw lengths on the blind side and ocular side are nearly equal. However, in order to standardize the measurement of mouth length, measurements were always made on the ocular side of the fish.

Gills were excised from various size classes of sand flounders. The lengths of the gill rakers on the ceratobranchial bone (Figure 5) of the first gill arch were measured and averaged. Also the average distance between these gill rakers was calculated.

Mouth length, mouth width, gill raker length, and distance between rakers were each plotted against the standard length of the fish in order to determine the relationship of these parameters to fish length. Each measurement was also plotted against the average length and width of food items, consumed by the different size classes of sand flounders, to determine if large fish consume larger prey than smaller fish.

E-- Mathematical treatment of diet data

a- Diet diversity: Dietary diversity of the sand flounder, collected from each sampling station during each collecting season, was determined using the Shannon information index (1962). Since this index is influenced by species evenness, the Heip (1974) evenness index was also computed. In order to determine any significant differences in dietary diversity between sampling sites variances were calculated, for each Shannon information index, and compared according to the procedure of Brower and Zar (1984). See Appendix I. Although the calculation of a variance on a derived index is not a standard practice, it does give a better notion as to whether values are different or not.

In order to determine if the diet diversity of the sand flounder is related to the diet diversity of the fish community at each station, the diet diversity of the sand flounder was compared to the diet diversity of all fish collected at the same station. Diet diversity of the fish community, at each station, was calculated by using the pooled stomach contents of all fish collected at that station (Rachlin and Warkentine 1987; Rachlin et al. 1987; Rachlin et al. 1989)

Diet diversity of the sand flounder was also plotted against the number of fish types in an area and against the number of food types consumed by the fish community.

b- Diet preference: Dietary preference of the sand flounder, collected from each sampling station during each collecting season, was determined using both the Manly (1974) preference index and the relativized electivity index of Vanderploeg and Scavia (1979). See Appendix II.

Although there are many preference and electivity indexes, Lechowicz (1982) concluded that the Manly (1974) (referred to as Chesson's alpha by Lechowicz) preference index and the relativized electivity index of Vanderploeg and Scavia (1979) are the best indexes to use. Lechowicz (1982) states that the Manly index has the advantage of being unaffected by the relative abundance of food types, allowing for between sample comparisons. This index ranges from 0 to 1 with values above 1/n (where n = the types of food items available) indicating preference, with those below 1/n indicating non-preference.

The Vanderploeg and Scavia electivity index (considered by Lechowicz to be the single best, but not perfect, electivity index) ranges from -1 to +1, where negative values indicate non-preference, positive values indicate preference, and a value of 0 indicates random feeding.

Both of these indexes evaluate the proportional representation of food items in the diet of the fish against the proportional representation of the same food items in the resource base. One of the major concerns about using these indexes, in evaluating dietary preference, is how does one adequately assess the food items being foraged on by the fish community. Independent sampling methods, such as Shipek bottom grabs, Peterson grabs and data from previous box core samples, were used in this study and were found to greatly underestimate the epibenthic and benthic fauna. In fact, these methods completely missed items that were found in large numbers in the stomachs of fish. This creates the problem of saying that a prey item is preferred by the predator when in fact it may not be. Also, as pointed out by Zaret (1980), many prey items may be found to be very abundant in the environment but may be unavailable to a predator due to such things as prey size, camouflage, refugia available to the prey, and the ability of the prey to avoid capture. As a result of this, one would conclude that a prey item is being avoided when in fact it is not available to the predator. Such over and under estimations of the environmental resource base create problems when one is trying to estimate preferential feeding in fish. Rachlin, et al. (1987) proposed an alternative method for determining the food base that is actually being used by the fish community. By using the pooled stomach contents of all fish collected at a particular station during a particular season, one can assess the food items of importance to the fish community. From these data the proportional representation of each food item being utilized by a community can be calculated. This method allows for comparisons to be made between the proportional representation of a food item in the gut of a fish to the proportional representation of the same food item being used by the fish community. It should be noted that the diet of the fish of concern is always included as part of the diet composition of the fish community.

Although the original design of the Manly index and the relativized index of Vanderploeg and Scavia is to relate what the fish is eating to what is "available" in the environment, this present study, using the method of Rachlin, et al. (1987), focused on the relationship between a fishes diet (i.e. the sand flounder) and the actual diet of the fish community.

c- Diet overlap: Diet overlap between sand flounders collected from different stations within a season was calculated using the overlap index of Morisita (1959) and the similarity index of Schoener (1970). See Appendix III. Biologically meaningful overlap is indicated when a value greater than 0.6 is generated by the Morisita index and a value of 60.0 is generated by the Schoener index. These values are based on the suggestion of Zaret and Rand (1971). Dietary overlap between sand flounders collected from the same station at different seasons was also calculated using these two indexes.

d- Diurnal feeding patterns: One station, Absecon Inlet, was sampled at approximately two hour intervals between 0900 and 2200 hrs in July 1985. The stomach contents of all fish collected were analyzed as previously stated. In order to determine the feeding intensity of sand flounders, stomach fullness values were calculated using the following relationship:

Stomach fullness = stomach weight / fish weight

Diurnal variation in the relationship between stomach weight and fish weight was investigated using a one-way ANOVA (Zar 1974).

The feeding periodicity of the sand flounder was compared to what is known about the feeding periodicity of other co-occurring flounder species.

Results

A- Species distribution: Tables 2 through 6 show the species composition of fish and the percentage representation of sand flounders collected from each site in the New York Bight during June 1984, November 1984, April 1985, July 1985, and January 1986. From these tables it can be seen that the species composition varies both spatially and temporally. One can see that during June 1984 (Table 2) sand, summer, winter, smallmouth and four-spot flounders were collected. Sand flounders were collected from all stations, summer flounders and smallmouth flounders were present at all stations except Station 2 and 7, winter flounders were collected only at stations 3, 6 and 7, and four-spot flounders were only taken at Station 7. The sand flounder was the only flatfish collected from Station 2 during this sampling season.

During the November 1984 (Table 3) collecting season the sand flounder was collected along with the summer flounder and the winter flounder. Summer flounders occurred with sand flounders at Stations 5 and 7, with winter flounders co-occurring at Stations 5, 6 and 7. No other flatfish species were taken with sand flounders from Station 8 during this sampling season.

As was observed for June 1984, the summer, winter, smallmouth, and four-spot flounders were collected along with the sand flounder during April 1985 (Table 4) and the sand flounders constituted the only flatfish collected from station 2. However, although the same flounder species were collected during June and April, the distributional patterns of these fishes were quite different.

July 1985 (Table 5) was the only collecting season in which no winter flounders were collected and in which one station (Station 7) yielded no sand flounders. During this season the summer flounder was collected at all locations where sand flounders were found. The smallmouth flounder co-occurred with sand flounders at Stations 1, 2, 5, 6 and 8, with the four-spot flounder being the only flatfish sampled from the deep water Station 7.

During January 1986 (Table 6) one observes a similar flounder species composition as seen in November 1984. The only flatfish collected were the sand, summer and winter flounders. During this sampling season Station 8 yielded no fish.

These data (Tables 2 - 6) show that while other flatfish are moving in and out of areas the sand flounder is exhibiting no such migratory action.

The sand flounder, although rarely the most abundant species caught, was the most abundant flatfish collected. This flounder species was collected from all stations, during all seasons, except Station 7 in July 1985 and Station 8 in January 1986. The lack of sand flounders at Station 7 (Elberon Ground) during July 1985, and their relatively low numbers at this station during all other collecting seasons, is due primarily to the fact that Station 7 is a deep water station (depth 22 m) and, although sand flounders have been taken in waters as deep as 50 meters, their abundance, in the New York Bight, at depths greater than 20 meters is usually very low. The scarcity of sand flounders at Elberon Ground was previously observed by Wilk, et al. (1977) in their survey of the fish fauna of the New York Bight during 1974-1975.

The lack of sand flounders, as well as all other fish species, at Station 8 during January 1986 can not be explained. However, physical conditions at this site could be ruled out as a possible factor, as temperature, salinity and dissolved oxygen levels were the same at all stations.

The fact that sand flounders were collected from virtually all locations during all collecting seasons indicates that it is the most consistently present member of the flatfish community in the New York Bight. The sand flounder is also the most abundant flatfish occupying these waters.

B- General diet of S. aquosus: Although the number of sand flounders collected from each station during the five collecting seasons was low (Tables 2 - 6), in most cases enough sand flounders was collected to make meaningful statements about the spatial and temporal diet of this species. Adequacy of the sample size of sand flounders used was tested by plotting the cumulative number of dietary categories against the number of stomachs examined (Gibson and Ezzi 1987; Warkentine and Rachlin 1989). These plots revealed that, in most cases, the number of fish examined exceeded that required for the curve to reach an asymptote. One can see from Figures 6 through 10 that in no case was more than eleven fish needed to reach the asymptote. Moreover, in some instances, the asymptote was reached with as few as four fish. There are, however, some instances in which no graphs could be generated (June 84 Station 7; April 85 Station 7; July 85 Station 7; January 86 Stations 5, 6, 7 and 8) because: (1) only one sand flounder was collected; (2) the sand flounders collected had empty stomachs, or (3) no sand flounders were collected. In these situations the real question can be raised as to how statements can be make about diet when the data set consists of only one or two specimens. Although one must be very cautious about making inferences from such weak data sets, one has a little more latitude when discussing the diet of the sand flounder. Unlike many other fish, the sand flounder seems to feed almost exclusively on mysids (greater than 90% of it's diet in most cases) with most other food items being incidental and not of great importance (Tables 7 - 11).

Tables 7a through 7g show the number and percentage representation of each food item consumed by sand flounders and by all fish collected from each sampling station during

June 1984. The mysid shrimp, Neomysis americana, was the dominant food item consumed by the sand flounder at all sampling locations. In fact this mysid was the dominant food item consumed by the fish community at each station except Station 7 (Table 7g), where the dominant item was hydroids. In addition to foraging on N. americana sand flounders, collected during this season, foraged on such things as the mysid shrimp, Mysidopsis bigelowi, the sand shrimp, Crangon septemspinosa, nematodes, gammarid amphipods, hydroids, shrimp zoea, crab megalops and fish. However, these food items rarely accounted for more than 10% of the diet of this flounder species.

Analysis of the diet composition of sand flounders, collected from four locations during November 1984, (Tables 8a - 8d) revealed that N. americana accounted for greater than 98% of their diet. This mysid also dominated the diet composition of the fish community at all locations except Station 8, where the dominant item consumed was the copepod Acartia sp. In addition to foraging on N. americana sand flounders, collected during this time, consumed M. bigelowi, C. septemspinosa, nematodes, crabs, hydroids, fish, the isopod Edotea montosa, and a calanoid copepod. It should be noted that at no time (Tables 8a - 8d) did these food items account for more than 1% of the sand flounder's diet.

During April 1985 N. americana contributed no less than 97% to the diet of S. aquosus from each sampling location

(Tables 9a - 9h). During this collecting season, sand flounders also foraged on M. bigelowi, C. septemspinosa, nematodes, fish, gammarid amphipods, the cumacean Leptocuma minor, shrimp zoea, and lobsters. However, these food items never accounted for more than 1% of the diet. Although the sand flounder's diet was primarily made up of N. americana, it is not always the dominant forage of the fish community. Only at Station 5 and 8 do we see mysids accounting for a major part of the diet composition of the fish community. At all other stations, the major food item foraged on was copepods.

During July 1985 we see the first indication of dietary shifting from the primary forage of mysids to crab megalops (Table 10a). At Station 1 crab megalops accounted for 62% of the diet, while mysids accounted for only 26%. At Station 2 (Table 10b) mysids make up 46% of the diet with crab megalops and shrimp zoea accounting for 30% and 18% respectively. At all the other sampling stations (Stations 3 - 8; Tables 10c - 10h) mysids return to being the primary forage of S. aquosus. Also, during this sampling season, the fish community foraged, to a lesser extent, on mysids and began to take more shrimp and crab larvae, and C. septemspinosa.

Sand flounders collected during January 1986 primarily consumed mysids. However, the dominant mysid foraged on was different from what was observed during the other collecting seasons. Diet analysis of sand flounders taken from the four southern most stations (Stations 1 - 4, Tables 11a - 11d) revealed that the mysid shrimp, Mysidopsis bigelowi, was fed on almost to the exclusion of N. americana. As a matter of fact at Stations 1 and 3 N. americana was not taken at all by this fish species. Lack of dietary information for sand flounders collected from Station 5 (Table 11e) was the result of fish having empty stomachs, a common occurrence during this season. In examining the diet composition of sand flounders collected from Stations 6 and 7 (Tables 11f - 11g) N. americana, once again, is the dominant forage. This mysid is foraged on to the exclusion of the mysid M. bigelowi in these more northern stations. During this winter season the sand flounders diet consisted of only two types of food organism, mysids and Crangon, while the fish community's diet continued to be much more diverse.

These data (Tables 7a-g through Tables 11a-g) clearly show that there is little variation in the dominant food items being consumed by the sand flounder. Sand flounders forage extensively on mysids, be it N. americana or M. bigelowi, regardless of the location of collection or time of year. Among the less dominant food items there is considerable variability from location to location and from season to season. These subtle dietary changes are more likely a function of a changing invertebrate fauna in an area or during a season than the result of dietary shifting brought on by the continually changing benthic fish population.

It should be noted that the nematodes found in the diet of the sand flounder were all free living. Based on identifications made by Dr. John Tietjen of City College of New York, the sand flounder is consuming nematodes, belonging to the families Oncholaimidae, Linhomoeidae, and Comesomatidae. Nematodes belonging to these families tend to be large in size and, although present in the New York Bight, they are not the dominant families found in the regions of this study. These families are however, dominant in regions of the New York Bight Apex, where the sediment is fine and silty (Tietjen 1980).

C- Spatial and temporal dietary preference:

1- Spatial: Table 12 through Table 16 show the calculated Manly preference values and the Vanderploeg and Scavia (E^*) electivity values for sand flounders collected during the five collecting seasons. For ease of comparison the dietary preference of the sand flounder, collected from each station during a sampling season, are presented (Tables 17 - 21)

Table 17 shows the preferred (P) and non-preferred (NP) food items taken by S. aquosus from the seven stations sampled in June 1984. The mysid shrimp N. americana was calculated to be the preferred food item taken by the sand flounder at all seven locations. In addition to preferring mysids at Station 1, sand flounders showed preference for the gammarid amphipod, Gammarus annulatus, and hydroids. Although consumed, Gammarus marinus, crab megalops, and nematodes, were not preferentially foraged on by sand flounders at this station. At Station 3, sand flounders preferred C. septemspinosa, G. annulatus, and nematodes while not preferring crab megalops. At Stations 4 and 5 all food items consumed were determined, by the models, to be preferred food items. Sand flounders collected from Station 6 preferred Mysidopsis bigelowi, C. septemspinosa, shrimp zoea, nematodes and hydroids. They showed no preference for Gammarus marinus and crab megalops. Only two types of food items, N. americana and sand lances, were consumed by sand flounders at Station 7 and both were preferred.

During November 1984 (Table 18) the mysid, N. americana is uniformly preferred by sand flounders at all stations. Sand flounders, collected from Station 5, showed a preference for C. septemspinosa and sand lances. The sand lance was also preferred by sand flounders collected from Station 6 along with the isopod, Edotea montosa. However, at this station and Station 8 C. septemspinosa was not preferred. In addition to not preferring C. septemspinosa sand flounders from Station 8 exhibited no preference for nematodes, but did show preference for such things as crabs, Calanus, E. montosa, hydroids, and fish.

In April 1985 (Table 19), sand flounders preferentially foraged on N. americana at all eight sampling locations. Sand flounders also preferred the mysid M. bigelowi at all stations where it was consumed. The sand shrimp, C. septemspinosa proved to be a non-preferred food item for fish collected at Stations 1, 3, 4, 5 and 8. At Station 2 the cumacean Leptocuma minor and the amphipod G. marinus are preferred forage. However, at Station 3 preference is not for G. marinus but for G. annulatus and shrimp zoea. Sand flounders from Station 4 also prefer the amphipod G. annulatus. Populations of sand flounders collected from Station 5 preferentially foraged on fish (sand lance). Fish were the preferred forage at Station 6 and 7 as well. In addition to fish, sand flounders from Station 6 preferred C. septemspinosa, nematodes and lobster. At Station 8 both gammarid amphipods were preferred.

During July 1985 (Table 20), sand flounders once again preferred the mysid Neomysis americana at all stations. At Station 1 M. bigelowi, shrimp zoea, crab megalops, the squid Loligo, and fish were calculated to be preferred food, with C. septemspinosa being the only non-preferred food item. Crangon septemspinosa was not preferred by sand flounders from any station except Station 6. At Station 2 preferred food items were M. bigelowi, shrimp zoea, G. annulatus, crab zoea and megalops, and nematodes. Sand flounders preferred M. bigelowi, G. marinus (but not G. annulatus) crab megalops, the lady crab *Ovalipes ocellatus*, *Loligo*, and fish, while not preferring the copepod *Acartia*, at Station 3. Dietary preference analysis of sand flounders collected from Station 4 revealed that *M. bigelowi*, shrimp zoea, crab megalops, *O. ocellatus*, *Loligo*, and fish were preferred, with hermit crabs being non-preferred. Sand flounders occupying Station 5 did not prefer *M. bigelowi* and fish, but did prefer crab megalops and *O. ocellatus*. At Station 6 all food items consumed, except for *O. ocellatus*, were preferred dietary items. Sand flounders from Station 8 only consumed *N. americana* and *C. septemspinosa* with only the former being the preferred forage.

Table 21 shows the preferred and non-preferred food item consumed by sand flounders collected during January 1986. The three types of mysids, *N. americana*, *M. bigelowi*, and *Heteromysis formosa* were preferred food items at all stations where they were consumed. The sand shrimp *C. septemspinosa* was preferred forage at Stations 3, 4, and 7 but not at Station 2.

These data (Tables 17 - 21) clearly show that the dietary preference of the sand flounders varies on a spatial basis. However, the greatest variability was found among those food items which account for a small percentage of the dietary composition of this flounder species. The most abundant food item, namely the mysid, was consistently preferred by the sand flounder over the entire sampled range during all five collecting seasons.

2- Temporal: Tables 22 through 29 show the calculated Manly preference values and the Vanderploeg and Scavia (E^*) electivity values for sand flounders taken from each station over the five collecting seasons. For ease of comparing the dietary preference of the sand flounder, collected from each station across sampling seasons, summary tables (Tables 30 - 37) are presented. The greatest temporal variation occurs among those items which account for the smallest percentage of the diet of the sand flounder. The mysids are preferred forage at each station across the five sampling seasons. The only exception occurred at Station 5 (Table 34) in which the mysid, *M. bigelowi*, was preferred during June 1984 and not preferred in July 1985.

D- Spatial and temporal dietary overlap and similarity:

1- Spatial: All possible pairwise comparisons of the dietary composition of the sand flounder, collected in June 1984, revealed little differences in the diet among stations. Dietary overlap between stations ranged from a minimum of 0.98 to 1.00, with similarity ranging from 84.32 to 98.78 (Table 38).

Maximum dietary overlap and similarity were also observed for sand flounders collected during November 1984 (Table 39). During this season there is complete dietary overlap across the sampling range (Morisita value = 1.00), and virtually complete dietary similarity (Schoener values ranging from 98.85 to 99.73).

During April 1985 sand flounders again exhibited maximum dietary overlap (Morisita value = 1.00) over the sampling range and significant dietary similarity (Schoener values ranging from 97.46 to 99.86 (Table 40).

An examination of the dietary overlap and similarity of sand flounders collected during July 1985 (Table 41) revealed that the diet composition of sand flounders collected from Station One differed significantly from that of sand flounders collected at all other sampling sites. This is attributed to the fact that at Station One (see Table 10a) the dominant forage of the sand flounder was crab megalops (62%) with mysids accounting for only 26% of the diet; while at all the other sampling locations (see Tables 10b - 10h) mysids were the dominant forage (ranging from 43% to 99%) with crab megalops accounting for only 0.02% to 30% of the diet. Furthermore, no overlap and similarity index values are presented in Table 41 for Station Seven against any other location because, during this collecting season, no sand flounders were collected from Station Seven.

During January 1986 dietary overlap and similarity of feeding for sand flounders collected from Stations 1, 2, 3, and 4 were significant (Table 42). Also very strong dietary overlap and similarity in feeding between sand flounders collected from Stations 6 and 7 were observed. When comparing the diet of sand flounders from Stations 1, 2, 3, and 4 to that of sand flounders collected from Stations 6 and 7 virtually no overlap and little or no similarity is observed. This apparent break in dietary congruence across the sampling range is attributed to the fact that sand flounders at Stations 1 to 4 (southern stations) foraged primarily on the mysid *M. bigelowi* (Tables 11a - 11d) while at Stations 6 and 7 (northern stations), the mysid *N. americana* dominated the diet (Tables 11f - 11g). It should be noted that this break would not have been realized if the dietary components were categorized under the broad taxonomic category of mysids. During this collecting season sand flounders collected from Station 5 had empty stomachs, thus no comparisons could be made between this station and the other locations (Table 42).

The data presented in Tables 38 to 42 clearly show that during June 1984, November 1984, April 1985, and July 1985 (with the exception of comparing station 1 fish with those from the other locations) there is little spatial variability in the diet composition of the sand flounder. However, in January 1986 sand flounders from those stations south of Seaside Heights (Station 5) foraged extensively on *M. bigelowi*, while those north of Seaside Heights foraged on *N. americana*. This obvious spatial dietary shifting was more likely a function of a change in the mysid populations in the areas and not the result of the fish selectively choosing one mysid over the other or the result of interspecific interactions.

2- Temporal: Sand flounders collected from Station 1 showed low dietary overlap and similarity between June 1984 and July 1985, April 1985 and July 1985, and between all sampling seasons and January 1986 (Table 43). These low overlap and similarity values are the result of mysid dominance in the sand flounder's diet in June 1984 and April 1985 at this location and the dominance of crab megalops during July 1985. The low values generated in comparing the diet of the sand flounder from each season against January 1986 is the obvious result of the difference in mysids being consumed during these periods of time.

Diet overlap and similarity in feeding is extremely low at Stations 2, 3, and 4 (Morisita values $\leq$ 0.34, Schoener values $\leq$ 26.08 Table 43) when comparing each sampling season against the January 1986 season. This again reflects the difference in mysids being foraged in January as opposed to those being foraged during other seasons.

Sand flounders from Stations 5, 6, 7, and 8 showed virtually complete dietary overlap and high similarity in feeding across all sampling seasons (Table 43); thus, at these stations, there is no indication of temporal dietary differences.

Based on dietary overlap and similarity indexes sand flounder show very little temporal dietary difference and little spatial difference in feeding, in the western arm of the New York Bight,

E- Diet diversity: Tables 44 through 48 show the diet diversity, variance, and evenness values for sand flounders collected during June 1984, November 1984, April 1985, July 1985, and January 1986 respectively. These data show that the diet diversity of this flounder species varies from location to location within a sampling season.

During June 1984 sand flounders, foraging at Station 4, had the greatest diet diversity (H' = 0.57; Table 44). It should be noted that although fish from Station 4 had the greatest dietary diversity it was not significantly different ($P > 0.05$) from the diet diversity (H' = 0.35) observed at Station 7. Sand flounders from Station 2 exhibited no diet diversity (H' = 0.00), as these fish fed only on *N. americana*. The diet composition of sand flounders from Station 7 was found to be the most homogeneous (evenness = 0.42).

Diet diversity of sand flounders collected during the November season (Table 45) was greatest at Station 5 (H' = 0.08) while those from station 7 (foraging only on *N. americana*) showed zero diversity. Evenness in feeding at all stations was very low. Also, during this season diet diversity, of fish collected from Station 5 and 6, was not significantly different ($P > 0.05$).

Table 46 shows that during April 1985 sand flounders from Absecon Inlet (Station 1) had the greatest diet diversity (H' = 0.13). This diversity was not significantly higher (P > 0.05) than the diet diversity for sand flounders collected from Station 2, 6, 7, and 8. At Little Egg (Station 3) sand flounders exhibited the lowest diet diversity (H' = 0.01), although not significantly lower (P > 0.05) than the diet diversity for this species from Stations 4, 5, and 7. During this collecting period the most homogeneous diet (evenness = 0.098) was found at Elberon Ground (Station 7).

During July 1985 (Table 47), as was observed in April 1985, diet diversity was greatest at Station 1 (H' = 1.17). These fish were also feeding more homogeneously (evenness = 0.37) than at the other locations. Lowest dietary diversity was found at Station 8 (H' = 0.06).

Table 48 shows that there is no diet diversity for sand flounders feeding at Stations 1 and 6 during January 1986. This is due to the fact that at each of these stations the sand flounder fed on only one food type. Diet diversity was highest at Station 3 (H' = 0.64), although not significantly higher (P > 0.05) than observed for Station 7 (H' = 0.34). At these two Stations (3 and 7) the fish fed more homogeneously than at the other locations.

The data presented in Tables 44 to 48 show at diet diversity is not uniform from location to location within each collecting season nor across sampling seasons. Also,

Figure 11A shows that there is little correlation between the diet diversity of the sand flounder and the diet diversity of the fish community ($r = 0.64$). Only 41% of the variation in diet diversity of the sand flounder is explained by the diet diversity of the fish community ($r^2 = 0.41$). In addition, there is no correlation between the diet diversity of the sand flounder and the number of food types being used by the community ($r = 0.1$) (Figure 11B) nor with the number of fish species in an area ($r = 0.1$) (Figure 11C). Thus the diet diversity of the fish community, the food types used by the community and the number of fish species in an area has little or no influence on the diet diversity of the sand flounder.

F- Buccal morphology and diet: Examination of the buccal morphology and gill structures of sand flounders, ranging in size from 2.7 to 26 cm S.L., showed that:

1- there is a corresponding increase in mouth length and width with increasing fish size (Figures 12A and 12B).

2- the length of the gill rakers on the ceratobranchial bone of the first gill arch increased with fish size (Figure 12C).

3- the spacing between gill rakers increased with fish size (Figure 12D).

That each of these four characters is positively correlated with fish size suggests that adult sand flounders are gape limited, and as such larger fish could take larger prey than smaller fish.

In examining the relationship between prey length and fish size it was observed that larger fish did not consume larger prey than smaller fish. In fact, there is no change in the size of the prey over the size range of fish examined (Figure 13A). Fish with larger mouth lengths foraged on smaller prey (Figure 13B). This same relationship was observed between prey length and predator mouth width (Figure 13C). No correlation ($r = 0.5$) was found between prey length and gill raker length (Figure 13D). However, the average prey length was smaller in those fish with longer gill rakers. Prey length was also not found to be correlated ($r = 0.2$) with the spacing between gill rakers (Figure 13E).

As was observed for prey length, prey width was not found to be strongly correlated ($r = 0.59$) with the size of the fish (Figure 14A). However, in this case the regression line indicates that there is a slight increase in prey width with increasing fish size. No correlation ($r = 0.33$) was observed between prey width and mouth length (Figure 14B). Unlike what was observed for prey length, fish with larger mouths seemed to consume bigger, that is wider, prey. Prey width, although showing an increase with mouth width, is not correlated ($r = 0.36$) with mouth width (Figure 14C). With respect to gill structures, prey width does not increase with gill raker length (Figure 14D) nor is there any correlation (r = 0.05) between the two. Prey width is likewise not correlated (r = 0.3) with the spacing between gill rakers (Figure 14E).

These relationships between prey length and prey width with fish size, buccal morphology and gill structures show that the sand flounder does not exhibit ontogenetic dietary shifting.

Further analysis of the dietary composition of the sand flounder indicates that this species does not exhibit strong ontogenetic dietary shifting in the types of food items being consumed. Figure 15A shows that the percentage of mysids in the diet does not change with increasing fish size. The percentage representation of shrimps in the diet of the sand flounder (Figure 15B), showed a slight increase with increasing fish size, while the percentage of crabs slightly decreased with increasing fish size (Figure 15C). With respect to miscellaneous food items (i.e. amphipods, nematodes and fish) there was a general trend towards increased representation with fish size. Although the regression curves (Figures 15A - 15D) show that there is trending towards increasing or decreasing the percentage representation of major food items in the diet of this fish, the diet composition for each size class is extremely variable. This variability can not be explained in terms of fish size (r^2 in all cases is ≤ 0.11) as there is no correlation between the percentage of each food item and the size of the fish (r $\leq$ 0.33). Large sand flounders are not taking comparably more or less of a food type than smaller fish. Therefore, these results show that sand flounder, over the size range studied, do not exhibit ontogenetic dietary shifting with respect to prey type.

G- Diurnal feeding pattern: In order to evaluate the diurnal feeding pattern of the sand flounder one station. Absecon Inlet, was sampled, during the July 1985 collecting cruise, at 0904, 1100, 1300, 1450, 1915, and 2220 hrs. The number of sand flounders collected during each time interval was more than adequate for evaluating feeding periodicity (Figure 16). The weight of the stomach relative to the weight of the fish did not vary significantly among the sampling times (F = 1.26, P = 0.28) (Figure 17), indicating that the sand flounder is feeding throughout this time period. The composition of the diet was similar over the sampled period, with mysids and crab megalops accounting for the greatest percentage.

Discussion

The diet composition of sand flounders from the western arm of the New York Bight suggests that this flounder feeds almost exclusively on free-swimming prey, predominantly mysids. Several investigators (de Sylva et al. 1962; Maurer and Bowman 1975; Hickey 1975) have found this same feeding pattern in other locations. Langton and Bowman (1981) observed a dominance of mysids in sand flounders taken from both the Middle Atlantic and Southern New England regions. Only at Georges Bank did they observe a deviation from this feeding pattern. At this location the sand shrimp, Crangon septemspinosa, accounted for 45.9% of the diet with mysids accounting for only 11%. Both Moore (1947) and Jeffries and Johnson (1974) found that the major food item of sand flounders in Rhode Island waters was the mysid Neomysis americana. Stickney, et al. (1974), found that N. americana accounted for 96% of the diet composition in coastal waters off Georgia, . These investigators attribute the highly selective diet of the sand flounder to its apparent ability to forage by sight. Although this feeding behavior has never been evaluated for the sand flounder it is implied because the sand flounder consistently selects one food item, mysids, to a greater extent than any other food item and many bothid fishes have been shown to respond to visual stimuli.

De Groot (1971), and Holmes and Gibson (1983, 1986) have shown that the turbot, Scophthalmus maximus, visually detect and capture actively swimming prey. Visual cues have also been shown (de Groot 1971) to determine prey selection by the brill. Stickney *et al*. (1974) stated that the highly selective diets of the ocellated flounder (*Anchlopsetta quadrocellata*); bay whiff (*Citharichthys spiloptherus*); and the fringed flounder (*Etropus crossotus*) are related to their ability to feed by sight.

In addition to the bothids, many members of the family Pleuronectidae have been observed to be visual feeders. These include the winter flounder, *Pseudopleuronectes americanus*, (Olla *et al*. 1969); the flounder, *Platichthys flesus*, (Moore and Moore 1976); and the yellowtail flounder, *Limanda ferruginea*, (Collie 1987b).

Diurnal feeding: In the New York Bight the sand flounder co-occurs with three bothid flatfishes (the summer, four-spot, and smallmouth flounders) and two pleuonectid flatfishes (the yellowtail, and winter flounder). As members of the families Bothidae and Pleuronectidae, these fishes should exhibit daytime feeding patterns (de Groot 1971).

My evaluation of the feeding pattern of the sand flounder revealed that this species fed throughout the day. Smith and Daiber (1977) observed that the summer flounder, *Paralichthys dentatus*, had the greatest volume of food in their stomachs during the daytime. The winter flounder has been shown to feed throughout the day with maximum fullness occurring between 0700 and 1400 hrs (Olla *et al*. 1969;

MacDonald and Waiwood 1987). Data on the feeding periodicity of the yellowtail flounder suggests that this flounder is a daytime feeder with peak feeding occurring between 0800 and 1500 hrs (Langton 1982; Collie 1987a). Although no data are available in the literature concerning the feeding periodicity of the four-spot and smallmouth flounders, it was observed in the course of the present study that both species had full stomachs during the day, indicative of a daytime feeder. These studies clearly show that the feeding periodicity of the sand flounder is the same as that of the other co-occurring flatfishes.

At the onset of this study I hypothesized that to minimize competition for food, peak feeding for the sand flounder will not be coincident with that of co-occurring flatfishes. Based on the information presented above this hypothesis has been falsified. However, although these fishes have overlapping feeding times, they utilize a very different resource base.

Diet overlap and similarity: It has been shown by Langton and Bowman (1981) and Bowman and Michaels (1984) that four spot flounders primarily consume three major taxa: arthropods (with pandalid shrimps being dominant) fish, and mollusks; and that the mysid shrimp never comprised more than 7% of the diet composition of this fish. The diet composition of the summer flounder, as reported by Poole (1964) and Smith and Daiber (1977), was found to consist primarily of sand shrimp and fish. Mysids, although consumed, were not found to be an important food item. The smallmouth flounder's diet has been observed by Warkentine and Rachlin (1987) to consist of polychaetes, crabs and mysids. Here again, as was the case with the summer flounder, mysids were not a dominant part of the diet composition of this fish. The winter flounder forages mostly on polychaetes and anthozoans (Maurer and Bowman 1975; Langton and Bowman 1981). The important prey species consumed by the yellowtail flounder are polychaetes, amphipods and sand shrimps (Collie 1987b).

These studies sustain the hypothesis that dietary overlap and similarity in feeding between the sand flounder and co-occurring flatfish species is minimal. Based on these findings it can further be hypothesized that the sand flounder's diet should be relatively unaffected by the migration of these flatfish species into and out of its habitat.

In the New York Bight, I have found that diet overlap and similarity in feeding of sand flounders almost always approached the maximum. Albeit not a surprising phenomenon, since the sand flounders diet consists almost exclusively of mysids, it does lead to the conclusion that the flatfish community structure has little impact on the diet composition of the sand flounder; as a result, the aforementioned hypothesis, that the fish community would impact on the sand flounder's diet, has been falsified.

Dietary preference: Dietary preference is conventionally determined by using an electivity index (Ivlev 1961; Jacobs 1974; Manly 1974; Strauss 1979; Vanderploeg and Scavia 1979). In using these indexes one measures the proportional representation of a given food item in the gut of an animal to the proportional representation of that same food item in the environment. Food items that are consumed in greater proportion to their availability are considered preferred, while those items consumed in lower proportions to their availability are designated as non-preferred. Food items are considered random forage when they are consumed in equal proportion to their availability (Lechowicz 1982). In evaluating the various electivity indexes Lechowicz (1982) states that the index of Vanderploeg and Scavia provides the best information. This electivity index has the advantages of ranging from plus one to minus one; and, although the index is nonlinear and asymmetrical, it is stable under changes in relative abundance in food types.

One of the major problems confronting aquatic ecologists, who use electivity indexes, is how to assess the resource available to the fish. By convention the environmental resource base of a marine system can be sampled by using independent sampling gear such as Shipek bottom grabs, box cores, plankton nets, etc. Although these methods may provide a reasonable evaluation of the organisms that occupy an area, they may sample prey that are unavailable to the predator. Zaret (1980) points out that many organisms are not available as prey due to such factors as: (1) coloration making them invisible to the predator; (2) the ability of the prey to take refuge; or (3) inability of the predator to consume the prey due to gape limitations. Another problem associated with independent sampling methods is that many food items consumed by the predator are often completely missed by the gear. Thus in both cases one can get an unrealistic picture of feeding preference due to an erroneous measure of the real "availability" of prey items. To address this concern, Rachlin et al. (1987) showed that independent samples of the resource base, taken by Surber nets and Hester/Dendy plates, missed a number of food items being consumed by a stream fish community. As a result these authors suggest that the resource base could be more appropriately defined by using the pooled stomach contents of all fishes collected. By doing this, dietary preference is determined by comparing the proportional representation of a food item in the gut of one fish species to the proportional representation of that same food item in the guts of all the fish collected at the same time as the fish species of concern. In this way one avoids the bias imposed by independent sampling gear and focuses on a different bias, one imposed by the fish themselves. In this study I have adopted this approach.

Despite a constantly changing fish community, sand flounders preference for mysids remains constant. There is, however, some variation in the preference for some of the lesser consumed food items such as amphipods, crabs, and fish. As these items are consumed in such low proportions it is unlikely that the observed preference and non-preference status changes were the result of interspecific interactions. Had interspecific interactions for food been operating one would expect to see a shift in the preference of mysids, the dominant food item. Furthermore, Warkentine and Rachlin (1987) have shown that dietary preference, as determined by the electivity indexes of Manly and Vanderploeg and Scavia, for mysids is not shared by co-occurring summer, winter, and smallmouth flounders in the New York Bight. They found that summer flounders preferred fish and nematodes; winter flounders preferred amphipods, crabs, polychaetes, isopods and hydroids; while smallmouth flounders preferentially foraged on polychaetes. Based on these observations it can be concluded that the hypotheses that: 1) diet preference will vary spatially in response to the spatial variation in the co-occurrence of other members of the benthic flatfish community; and 2) diet preference will vary temporally in response to the temporal variation in the co-occurrence of other members of the benthic flatfish community have been falsified.

The observed fluctuation in preference for minor food items more probably reflects a changing invertebrate fauna, thus falsifying the hypotheses that dietary preference will not vary temporally in response to temporal variability of prey types; and that dietary preference will not vary spatially in response to spatial variability of prey types.

Diet diversity: The Shannon diversity index has been extensively used by aquatic ecologists to analyze fish population structures (Copeland and Bechtel 1971), water quality (Balloch *et al*. 1976) and aquatic microecosystems (Reed 1978). Utilization of this index has been attributed to factors which run the gamut from ease of use to it's having been so deeply entrenched in the literature (Washington 1984). Despite the popularity of the Shannon index, it has not been without criticism. In 1971 Hurlbert concluded that by using the diversity index approach to community ecology, species diversity has become a non-concept. Hurlbert notes that species diversity should be a function of the number of species and the evenness of abundance of these species. Goodman (1975) states that results generated from the Shannon index do not lend themselves to direct biological interpretations. Goodman also says that this index lacks a means to correct for the effects of sample size and the non-random distributions of individuals within a sample.

Despite these criticisms this index continues to be widely used. Washington (1984) attributes this to its entrenchment and not to its biological relevance. However, he concludes that the use of this index, in aquatic ecosystem studies, is justified until better indexes are developed and tested.

In using this index to examine the diet diversity of the sand flounder, I have found no clear patterns. Both diet diversity and evenness of feeding varied greatly from location to location and across seasons. However, based on the results presented in this study, these variable patterns are not linked to a changing fish community structure nor to the communities use of prey items. Interspecific interactions are not affecting the diet diversity of the sand flounder.

Ontogenetic dietary feeding:

a- Selection for prey size: Zaret (1980) defines fish as being "gape-limited predators" since mouth gape can limit the maximum size of prey that a fish can ingest. Gape limited predation also exhibit strong ontogenetic dietary shifting (Zaret 1980). The prey size selected by these fish should increase as a function of predator size. In other words larger fish should consume larger prey. Zaret (1980) further noted that this so called "gape limiting" factor is strongest during the early stages of a fish's life.

Many investigators (Werner and Hall 1976; Ross 1977; Grossman 1980; Schmitt and Holbrook 1984b) have observed "gape-limiting" feeding patterns among fishes. Hansen and Wahl (1981) found yellow perch fry to be gape-limited. Likewise, Schmitt and Holbrook (1984a) observed that the juvenile black surfperch (Embiotoca jacksoni) were gape-limited, while adults were not. Ross (1982), in examining the feeding habits of the gray tilefish (Caulolatilus microps), found that as these fish grew they consumed larger prey. Likewise, both the greenback flounder and the long-snout flounder were observed to consume larger prey as they increased in size (Jenkins 1987). Correlations between prey size and mouth size was observed for the ocellated flounder and the bay whiff (Stickney et al. 1974).

In examining the ontogenetic feeding pattern of the sand flounder I observed no correlation between prey size and mouth size. Larger sand flounder did not consume larger prey. This is consistent with the findings of Stickney et al. (1974) in their examination of the diet of sand flounders from coastal waters off Georgia. Moore and Moore (1976) observed that the average length of ingested organisms did not increase with increased size of *Platichthys flesus*. Predator size was also found to be of little importance to the diet composition of yellowtail flounders (Langton 1982). Since these fish are not exhibiting ontogenetic dietary shifting it can be concluded that; these fish are not gape-limited, and larger fish will not necessarily consume larger prey.

b- Selection for prey type: Many fish species have been found to exhibit ontogenetic prey type selection. That is, larger fish forage on different prey types than smaller fish. Such ontogenetic changes in diet can be a very important factor in alleviating intra-specific competition for food, and, as noted by Keast (1974) can give young fish a greater chance for survival.

Ontogenetic prey type selection is not uncommon in fishes (Ross 1978; Stoner 1980). Gibson and Ezzi (1987) observed that the difference in diet between large and small individual Merlangius merlangus was so great that the two size groups might be regarded as different species from a dietary point of view. Richards et al. (1979) found that young-of-the-year sea robins foraged on copepods, young mysids and young sand shrimps, while adults concentrated on amphipods, crabs, large mysids and large sand shrimps. Hickey (1975) found that 0+ sand flounders (size range 6.8 - 12.4 cm), from Long Island Sound, N.Y., ate almost exclusively mysids and copepods, while larger 2+ to 4+ fish (size range 18.9 - 22.2 cm) foraged on mysids, fish and decapods.

I did not find a strong indication of ontogenetic prey type selection in the diet of the sand flounder (size range 5 cm - 27 cm), from the New York Bight. Mysids dominated the diet of small and large fish. Fish and shrimps were incidental to the diet of larger fish. Stickney et al. (1974) found this same pattern for sand flounders ranging in size from 2.5 cm to 17.4 cm. The findings of the present study and that of Stickney, et al (1974) are contradictory to that of Hickey (1975). Due most likely to differences in the available resource bases of the fish. Hickey (1975) states that the increase of fish in the diet of sand flounders was coincident with a decrease in small prey. This suggests that sand flounders, in order to minimize intra-specific competition during times of food scarcity, may exhibit ontogenetic dietary shifting in terms of the types of prey being consumed.

Summary

Dietary differences between the sand flounder and other members of the benthic flatfish community are such that interspecific competition for food is at a minimum. The sand flounder's diet appears to be unaffected by the migration of other flatfishes into and out of its range. This is supported by the fact that mysids remain the preferred food item of this fish over its entire range and during all seasons. There are some seasonal differences in the mysids being consumed by this species, (*Mysidopsis bigelowi* in winter and *Neomysis americana* during all other seasons.) These differences merely reflect a response to a seasonal change in the mysid fauna and not to interspecific interactions.

The sand flounder shows very little dietary similarity with that of co-occurring flatfish. Therefore, competition for food between this species and other flatfish is at a minimum.

Ontogenetic dietary shifting has not been observed for the sand flounder, coincident with the fact that this species does not exhibit gape-limitation. Sand flounders, of all sizes examined, appear to primarily forage on small crustaceans. There is, however, some indication that sand flounders may exhibit some ontogenetic dietary shifting, with respect to the types of prey being consumed, when small food items become limited. A further point of interest is that when large numbers of crab megalops larvae and shrimp zoea become available, the sand flounder will opportunistically incorporate these items into its diet.

Table 1: New York Bight field station locations.

#	Station name	latitude	longitude	depth (m)
1	Absecon Inlet	39°22.6'N	74°19.8'W	13
2	Brigantine Inlet	39°26.7'N	74°16.3'W	13
3	Little Egg Inlet	39°28.3'N	74°15.4'W	12
4	Beach Haven Crest	39°37.1'N	74°10.4'W	14
5	Seaside Heights	39°55.7'N	74°03.7'W	14
6	Sea Girt	40°08.0'N	74°00.9'W	13
7	Elberon Ground	40°18.6'N	73°53.1'W	22
8	Breezy Point	40°34.0'N	73°48.3'W	11

Table 2: Number of fish per species collected from the New York Bight during June 1984.

Fish species	Station number* 1	2	3	4	5	6	7
Sand flounder	10	2	6	7	8	37	3
Summer flounder	3	--	1	2	6	32	--
Winter flounder	--	--	3	--	--	14	17
Smallmouth flounder	1	--	2	5	2	2	--
Four-spot flounder	--	--	--	--	--	--	20
Common sea robin	4	1	--	6	4	6	3
Striped sea robin	--	--	1	--	--	--	--
Whiting	1	--	--	--	1	1	40
Red hake	1	--	3	4	--	--	30
Spotted hake	47	7	43	51	2	2	--
Little skate	1	--	1	3	2	15	5
Black sea bass	--	--	--	1	--	--	--
Rock eel	--	--	--	--	--	--	2
Ocean pout	--	--	--	--	--	--	1
Sand lance	--	--	--	--	2	--	--
Porgy/Scup	5	--	3	47	2	1	--
Anchovy	--	--	--	--	--	1	--
Total	73	10	63	126	29	111	121
% representation of sand flounders	13.7	20.0	9.5	5.6	27.6	33.3	2.5

* Station 1 = Absecon Inlet; 2 = Brigantine Inlet; 3 = Little Egg Inlet; 4 = Beach Haven Crest; 5 = Seaside Heights; 6 = Sea Girt; 7 = Elberon Ground

Table 3: Number of fish per species collected from the New York Bight during November 1984.

	Station number*			
Fish species	5	6	7	8
Sand flounder	12	10	7	46
Summer flounder	2	--	1	--
Winter flounder	2	1	7	--
Striped sea robin	48	6	--	8
Red hake	12	--	--	--
Spotted hake	6	2	--	--
Little skate	12	3	4	18
Smooth dogfish	--	--	--	1
Cunner	1	--	--	--
Cusk eel	1	--	--	--
Kingfish	1	--	--	--
Weakfish	3	2	--	1
Puffer	2	--	--	--
Sea raven	--	--	1	--
Butterfish	--	--	162	15
Sand lance	3	--	--	--
Anchovy	3	17	--	--
Total	108	41	182	89
% representation of sand flounders	11.1	24.4	3.8	51.7

* Station 5 = Seaside Heights; 6 = Sea Girt; 7 = Elberon Ground; 8 = Breezy Point

Table 4: Number of fish per species collected from the New York Bight during April 1985.

Fish species	Station number* 1	2	3	4	5	6	7	8
Sand flounder	23	20	39	4	8	19	1	16
Summer flounder	1	--	--	1	2	--	--	--
Winter flounder	--	--	2	--	4	11	--	1
Smallmouth flounder	--	--	--	1	1	2	1	--
Four-spot flounder	--	--	--	--	--	1	--	--
Common sea robin	--	--	1	--	--	2	--	--
Porgy/Scup	--	--	--	1	1	--	--	--
Little skate	3	3	10	3	1	3	1	3
Spiny dogfish	1	--	--	--	--	--	--	--
Whiting	28	12	9	2	12	10	4	5
Red hake	9	8	35	--	2	19	--	--
Spotted hake	--	--	--	--	2	19	--	--
Common pipefish	--	2	2	--	1	7	--	--
Seahorse	--	--	1	--	1	1	--	--
Cusk eel	1	--	2	--	--	1	--	--
Blueback herring	--	1	1	1	--	--	--	1
Alewife	--	--	--	1	--	--	--	--
Blackfish	1	1	--	--	2	1	--	--
Sea bass	--	--	--	--	--	1	--	--
Butterfish	--	--	1	9	--	--	--	--
Ocean pout	--	--	--	--	2	--	--	--
Sand lance	--	--	--	--	--	30	55	--
Anchovy	49	21	156	9	2	143	--	--
Total	116	68	259	32	41	270	62	26
% representation of sand flounders	19.8	29.4	15.0	12.5	19.5	7.0	1.6	61.5

* Station 1 = Absecon Inlet; 2 = Brigantine Inlet; 3 = Little Egg Inlet; 4 = Beach Haven Crest; 5 = Seaside Heights; 6 = Sea Girt; 7 = Elberon Ground; 8 = Breezy Point

Table 5: Number of fish per species collected from the New York Bight during July 1985.

Fish species	Station number* 1	2	3	4	5	6	7	8
Sand flounder	5	8	18	43	25	45	--	16
Summer flounder	2	1	4	2	1	10	--	1
Smallmouth flounder	1	1	--	--	1	1	--	2
Four-spot flounder	--	--	--	--	--	--	4	--
Common sea robin	5	--	--	--	32	3	--	2
Striped sea robin	--	2	3	1	1	2	1	--
Porgy/Scup	--	--	--	--	--	2	--	--
Smooth dogfish	1	1	4	--	1	--	--	1
Brier skate	--	--	--	1	1	--	--	--
Little skate	--	--	--	--	--	--	1	1
Anchovy	--	--	5	--	--	3	--	--
Whiting	--	--	--	--	--	--	3	--
Red hake	--	1	--	--	--	--	--	--
White hake	--	--	4	--	--	3	--	--
Spotted hake	4	5	12	--	--	21	1	83
Weakfish	1	--	--	--	--	--	--	--
Common pipefish	--	5	3	--	--	--	--	--
Cusk eel	--	2	--	--	--	--	--	--
Butterfish	17	11	3	--	--	9	62	25
Four-beard rockling	--	1	--	--	--	--	--	--
Snapper bluefish	--	--	1	--	--	--	--	--
Round herring	--	--	--	--	--	--	--	1
Total	36	38	57	47	62	99	72	132
% representation of sand flounders	13.9	21.0	31.6	91.5	40.3	45.4	--	12.1

* Station 1 = Absecon Inlet; 2 = Brigantine Inlet; 3 = Little Egg Inlet; 4 = Beach Haven Crest; 5 = Seaside Heights; 6 = Sea Girt; 7 = Elberon Ground; 8 = Breezy Point

Table 6: Number of fish per species collected from the New York Bight during January 1986.

Fish species	Station number* 1	2	3	4	5	6	7
Sand flounder	5	13	11	5	1	4	1
Summer flounder	--	--	1	--	--	--	--
Winter flounder	1	--	2	4	1	1	--
Whiting	1	4	1	--	2	1	2
Red hake	2	--	--	1	11	31	--
Spotted hake	--	1	--	--	--	--	--
Little skate	--	1	3	2	8	1	--
Conger eel	--	--	--	1	--	--	--
3-spine stickleback	--	1	--	--	--	--	--
Atlantic silverside	44	9	11	1	--	--	--
Black fish	--	--	2	--	--	--	--
Atlantic herring	--	--	--	--	--	--	1
Blueback herring	--	--	1	3	--	--	--
Shad	--	--	--	1	1	--	--
Alewife	--	--	--	2	--	--	--
Northern pipefish	--	--	--	--	--	1	1
Ocean pout	--	--	--	--	--	--	2
Sand lance	--	1	--	2	--	--	1
Anchovy	9	--	--	--	--	--	--
Total	62	30	31	22	24	39	8
% representation of sand flounders	8.1	43.3	35.5	22.7	4.2	10.2	12.5

* Station 1 = Absecon Inlet; 2 = Brigantine Inlet; 3 = Little Egg Inlet; 4 = Beach Haven Crest; 5 = Seaside Heights; 6 = Sea Girt; 7 = Elberon Ground

Table 7a: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Absecon Inlet, N. J. (Station 1) June 1984.

Food item	Diet of *S. aquosus* N	Diet of *S. aquosus* %	Diet of all fish collected N	Diet of all fish collected %
Neomysis americana	503	90.47	856	74.11
Gammarus annulatus	42	7.55	91	7.88
Gammarus marinus	8	1.44	95	8.22
Crab megalops	1	0.18	47	4.07
Nematodes	1	0.18	8	0.69
Hydroids	1	0.18	1	0.09
Crangon septemspinosa	----	----	10	0.86
Unid. polychaetes	----	----	3	0.26
Gammarus sp.	----	----	16	1.38
Leptocuma minor	----	----	2	0.17
Cancer borealis	----	----	16	1.38
Libinia dibia	----	----	4	0.35
Edotea montosa	----	----	3	0.26
Unid. amphipods	----	----	3	0.26
TOTAL	556		1155	

Table 7b: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Brigantine Inlet, N. J. (Station 2) June 1984.

Food item	Diet of *S. aquosus* N	Diet of *S. aquosus* %	Diet of all fish collected N	Diet of all fish collected %
Neomysis americana	150	100.00	195	91.12
Crab megalops	----	----	10	4.67
Leptocuma minor	----	----	7	3.27
Edotea montosa	----	----	1	0.47
Unid. amphipods	----	----	1	0.47
TOTAL	150		214	

Table 7c: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Little Egg Inlet, N. J. (Station 3) June 1984.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	1577	98.56	2116	87.01
Gammarus annulatus	14	0.86	38	1.56
Crab megalops	2	0.12	102	4.19
Nematodes	4	0.25	40	1.65
Crangon septemspinosa	3	0.19	20	0.82
Hydroids	----	----	53	2.18
Unid. polychaetes	----	----	5	0.20
Gammarus marinus	----	----	16	0.66
Caprella linearis	----	----	6	0.25
Aeginella longicornis	----	----	3	0.12
Erichtonius difformis	----	----	1	0.04
Amphitoe longimana	----	----	1	0.04
Unid. amphipodes	----	----	5	0.20
Cancer borealis	----	----	10	0.41
Edotea montosa	----	----	11	0.45
Leptocuma minor	----	----	2	0.08
Unid. cumaceans	----	----	1	0.04
Unid. Mollusks	----	----	1	0.04
White hake	----	----	1	0.04
TOTAL	1600		2432	

Table 7d: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Beach Haven Crest, N. J. (Station 4) June 1984.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	226	84.33	1694	67.04
Gammarus annulatus	18	6.72	56	2.22
Gammarus marinus	21	7.84	46	1.82
Nematodes	3	1.12	18	0.71
Crab megalops	----	----	460	18.20
Crangon septemspinosa	----	----	6	0.24
Lumbrineris fragilis	----	----	2	0.08
Unid. polychaetes	----	----	18	0.71
Gammarus sp.	----	----	1	0.04
Leptocuma minor	----	----	2	0.08
Cancer borealis	----	----	8	0.32
Cancer irroratus	----	----	11	0.44
Unid. crabs	----	----	1	0.04
Cirolana concharum	----	----	1	0.04
Siphons	----	----	1	0.04
Sand lance	----	----	1	0.04
Unid. fish	----	----	1	0.04
TOTAL	268		2527	

Table 7e: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Seaside Heights, N. J. (Station 5) June 1984.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	1426	98.28	1647	92.79
Mysidopsis bigelowi	12	0.83	12	0.68
Gammarus annulatus	1	0.07	1	0.06
Nematodes	5	0.34	11	0.62
Hydroids	5	0.34	5	0.28
Sand lance	2	0.14	8	0.45
Loligo	----	----	1	0.06
Crab megalops	----	----	53	2.98
Cancer borealis	----	----	3	0.17
Cancer irroratus	----	----	12	0.68
Crangon septemspinosa	----	----	8	0.45
Shrimp zoea	----	----	1	0.06
Unid. polychaetes	----	----	3	0.17
Gammarus marinus	----	----	1	0.06
Leptocuma minor	----	----	2	0.11
Corophium volutator	----	----	1	0.06
Erichthonius difformis	----	----	1	0.06
Acartia	----	----	2	0.11
Red hake	----	----	1	0.06
Unid. fish	----	----	2	0.06
TOTAL	1451		1775	

Table 7f: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Sea Girt, N. J. (Station 6) June 1984.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	5286	98.23	8156	73.40
Mysidopsis bigelowi	1	0.02	2	0.02
Gammarus marinus	1	0.02	156	1.40
Nematodes	13	0.24	84	0.76
Hydroids	16	0.30	45	0.40
Crangon septemspinosa	9	0.17	43	0.39
Shrimp zoea	24	0.45	81	0.73
Crab megalops	30	0.56	2200	19.80
Unid. fish	1	0.02	14	0.13
Cancer borealis	----	----	36	0.32
Cancer irroratus	----	----	20	0.18
Carcinus maenus	----	----	1	0.01
Pagurus longicarpus	----	----	2	0.02
Unid. crabs	----	----	4	0.04
Corophium volutator	----	----	1	0.01
Jassa marmorata	----	----	5	0.04
Calliopius laeviusculus	----	----	5	0.04
Gammarus annulatus	----	----	154	1.39
Aeginella longicornis	----	----	1	0.01
Unid. amphipods	----	----	1	0.01
Unid. polychaetes	----	----	41	0.37
Edotea montosa	----	----	41	0.37
Edotea triloba	----	----	5	0.04
Cyclaspis varians	----	----	1	0.01
Unid. Mollusks	----	----	2	0.02
Siphons	----	----	1	0.01
Red hake	----	----	1	0.01
Bay anchovy	----	----	3	0.03
Sand lance	----	----	4	0.04
TOTAL	5381		11110	

Table 7g: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Elberon Grounds, N. J. (Station 7) June 1984.

Food item	Diet of S. aquosus N	Diet of S. aquosus %	Diet of all fish collected N	Diet of all fish collected %
Neomysis americana	8	88.89	79	7.12
Sand lance	1	11.11	81	7.30
Nematodes	----	----	18	1.62
Hydroids	----	----	575	51.85
Crangon septemspinosa	----	----	42	3.79
Crab megalops	----	----	225	20.29
Cancer irroratus	----	----	6	0.54
Hermit crab	----	----	1	0.09
Gammarus annulatus	----	----	3	0.27
Phoxocephalus holbolli	----	----	19	1.71
Erichthonius brasiliensis	----	----	4	0.36
Unid. amphipods	----	----	1	0.09
Lumbrineris fragilis	----	----	17	1.53
Unid. polychaetes	----	----	3	0.27
Edotea montosa	----	----	16	1.44
Leptocuma minor	----	----	9	0.81
Unid. Mollusks	----	----	3	0.27
Siphons	----	----	1	0.09
Unid. fish	----	----	6	0.54
TOTAL	9		1109	

Table 8a: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Seaside Heights, N. J. (Station 5) November 1984.

Food item	Diet of S. aquosus		Diet of all fish collected	
	N	%	N	%
Neomysis americana	2691	98.64	3208	69.72
Crangon septemspinosa	9	0.32	139	3.02
Sand lance	28	0.92	398	8.65
Calliopius laeviusculus	----	----	1	0.02
Unid. amphipodes	----	----	1	0.02
Cancer irroratus	----	----	28	0.61
Cancer borealis	----	----	1	0.02
Ovalipes ocellatus	----	----	10	0.22
Unid. crabs	----	----	4	0.09
Temora	----	----	1	0.02
Acartia	----	----	501	10.89
Nematodes	----	----	22	0.48
Pherusa affinis	----	----	5	0.11
Unid. polychaetes	----	----	2	0.04
Oxyurostylis smithi	----	----	3	0.06
Unid. cumaceans	----	----	2	0.04
Siphons	----	----	270	5.87
Hake	----	----	1	0.02
Unid. fish	----	----	4	0.09
TOTAL	2728		4601	

Table 8b: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Sea Girt, N. J. (Station 6) November 1984.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	1761	99.04	2950	95.84
Crangon septemspinosa	5	0.28	21	0.68
Sand lance	11	0.62	17	0.55
Edotea montosa	1	0.06	1	0.03
Nematodes	----	----	12	0.39
Ovalipes ocellatus	----	----	4	0.13
Cancer irroratus	----	----	4	0.13
Unid. crabs	----	----	3	0.10
Acartia	----	----	65	2.11
Unid. fish	----	----	1	0.03
TOTAL	1778		3078	

Table 8c: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Elberon Ground, N. J. (Station 7) November 1984.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	13	100.00	13	0.32
Crangon septemspinosa	----	----	15	0.37
Shrimp zoea	----	----	1	0.02
Caprella geometrica	----	----	1	0.02
Hyperia galba	----	----	1	0.02
Hyperia medusarum	----	----	1	0.02
Lucifer sp.	----	----	1	0.02
Unid. amphipods	----	----	6	0.15
Spionidae	----	----	308	7.60
Pherusa affinis	----	----	7	0.17
Unid. polychaetes	----	----	3	0.07
Cancer irroratus	----	----	4	0.10
Unid. crabs	----	----	1	0.02
Nematodes	----	----	2	0.05
Temora	----	----	7	0.17
Acartia	----	----	3672	90.67
Hydroids	----	----	4	0.10
Siphons	----	----	1	0.02
Sand lance	----	----	2	0.05
TOTAL	13		4050	

Table 8d: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Breezy Point, N. Y. (Station 8) November 1984.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	18633	99.74	18959	96.78
Mysidopsis bigelowi	4	0.02	4	0.02
Crangon septemspinosa	30	0.16	583	2.98
Nematodes	7	0.04	28	0.14
Edotea montosa	1	0.01	1	0.01
Calanus	1	0.01	1	0.01
Unid. fish	1	0.01	1	0.01
Unid. crabs	1	0.01	1	0.01
Hydroids	3	0.02	3	0.02
Cancer borealis	----	----	3	0.02
Cancer irroratus	----	----	2	0.01
Ovalipes ocellatus	----	----	1	0.01
Glycera dibranchiata	----	----	1	0.01
Sand flounder	----	----	1	0.01
Sand lance	----	----	1	0.01
TOTAL	18681		19590	

Table 9a: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Absecon Inlet, N. J. (Station 1) April 1985.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	153	97.45	186	31.74
Mysidopsis bigelowi	3	1.91	3	0.51
Crangon septemspinosa	1	0.63	66	11.26
Shrimp zoea	----	----	1	0.17
Crab zoea	----	----	1	0.17
Cancer irroratus	----	----	1	0.17
Unid. crabs	----	----	3	0.51
Temora	----	----	140	23.89
Acartia	----	----	141	24.06
Nematodes	----	----	2	0.34
Edotea montosa	----	----	1	0.17
Erichthonius brasiliensis	----	----	1	0.17
Leptocuma minor	----	----	1	0.17
Unid. polychaetes	----	----	1	0.17
Sand flounder	----	----	1	0.17
Common sea robin	----	----	1	0.17
Small mouth flounder	----	----	4	0.68
Red hake	----	----	9	1.54
Sea bass	----	----	6	1.02
Bay anchovy	----	----	14	2.39
Unid. fish larvae	----	----	3	0.51
TOTAL	157		586	

Table 9b: Diet of <u>Scophthalmas aquosus</u> and the combined diet of all fish collected from Brigantine Inlet, N. J. (Station 2) April 1985.

Food item	Diet of *S. aquosus* N	Diet of *S. aquosus* %	Diet of all fish collected N	Diet of all fish collected %
Neomysis americana	1182	99.33	1281	7.37
Mysidopsis bigelowi	6	0.50	6	0.03
Gammarus marinus	1	0.08	3	0.02
Leptocuma minor	1	0.08	1	0.01
Crangon septemspinosa	----	----	14	0.08
Hippolyte zostericola	----	----	1	0.01
Shrimp zoea	----	----	9	0.05
Crab zoea	----	----	4	0.02
Ovalipes ocellatus	----	----	2	0.01
Gammarus annulatus	----	----	2	0.01
Stenothoe cypris	----	----	1	0.01
Edotes montosa	----	----	2	0.01
Unid. polychaetes	----	----	1	0.01
Temora	----	----	6771	38.97
Acartia	----	----	9270	53.36
Shad	----	----	1	0.01
Sand flounder	----	----	3	0.02
Unid. fish	----	----	2	0.01
TOTAL	1190		17374	

Table 9c: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Little Egg Inlet, N. J. (Station 3) April 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	6117	99.84	6605	20.30
Crangon septemspinosa	1	0.02	57	0.18
Shrimp zoea	2	0.03	22	0.07
Gammarus annulatus	3	0.05	23	0.07
Gammarus marinus	4	0.06	123	0.38
Mysidopsis bigelowi	----	----	2	0.01
Caprella geometrica	----	----	1	0.00*
Amphithoe longimana	----	----	1	0.00
Unciola irrorata	----	----	1	0.00
Calliopius laeviusculus	----	----	1	0.00
Unid. amphipods	----	----	1	0.00
Glycera sp	----	----	1	0.00
Lumbrineris fragilis	----	----	2	0.01
Unid. polychaeta	----	----	4	0.01
Metridium senile	----	----	2	0.01
Siphons	----	----	5	0.02
Unid. mollusks	----	----	2	0.01
Nematodes	----	----	8	0.02
Cirolana concharum	----	----	1	0.00
Edotea montosa	----	----	88	0.27
Crab zoea	----	----	91	0.28
Ovalipes ocellatus	----	----	5	0.02
Hermit crab	----	----	1	0.00
Unid crab	----	----	1	0.00
Temora	----	----	25388	78.01
Acartia	----	----	89	0.27
Bay anchovy	----	----	4	0.01
Sand flounder	----	----	4	0.01
Unid. fish	----	----	10	0.03
TOTAL	6127		32543	

* percentage less than 0.006

Table 9d: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Beach Haven Crest, N. J. (Station 4) April 1986.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	714	99.72	718	2.96
Crangon septemspinosa	1	0.14	14	0.06
Gammarus annulatus	1	0.14	4	0.02
Crab zoea	----	----	10	0.04
Temora	----	----	23297	95.99
Acartia	----	----	219	0.90
Nereis sp	----	----	1	0.00*
Unid. polychaetes	----	----	5	0.02
Sand lance	----	----	2	0.01
Unid. fish	----	----	1	0.00
TOTAL	716		24271	

* percentage less than 0.006

Table 9e: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Seaside Heights, N. J. (Station 5) April 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	2730	99.78	2769	69.50
Crangon septemspinosa	5	0.18	42	1.05
Sand lance	1	0.04	1	0.02
Cancer irroratus	----	----	2	0.05
Corophium sp.	----	----	3	0.08
Temora	----	----	17	0.43
Acartia	----	----	10	0.25
Hydroids	----	----	3	0.08
Nematodes	----	----	1	0.02
Siphons	----	----	1128	28.31
Bay anchovy	----	----	2	0.05
Unid. fish	----	----	6	0.15
TOTAL	2736		3984	

Table 9f: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Sea Girt, N. J. (Station 6) April 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	5926	99.56	7199	17.36
Crangon septemspinosa	22	0.37	63	0.15
Nematodes	1	0.02	5	0.01
Lobster	2	0.03	2	0.00*
Unid. fish	1	0.02	8	0.02
Mysidopsis bigelowi	----	----	4	0.01
Heteromysis formosa	----	----	1	0.00
Shrimp zoea	----	----	33	0.08
Unciola irrorata	----	----	4	0.01
Microdeutopus gryllotolpa	----	----	3	0.01
Corophium sp.	----	----	3	0.01
Jassa marmorata	----	----	1	0.00
Gammarus marinus	----	----	1	0.00
Unid. amphipods	----	----	7	0.02
Scolelepis squamata	----	----	34	0.08
Pherusa affinis	----	----	26	0.06
Unid. polychaetes	----	----	1	0.00
Siphons	----	----	124	0.30
Cyprid barnacle larvae	----	----	71	0.17
Crab zoea	----	----	2321	5.60
Crab megalops	----	----	2	0.00
Temora	----	----	2480	5.98
Acartia	----	----	29056	70.09
Harpacticoid copepod	----	----	1	0.00
Oxyurostylis smithi	----	----	1	0.00
Unid. Cumaceans	----	----	2	0.00
Edotea montosa	----	----	1	0.00
Bay anchovy	----	----	1	0.00
TOTAL	5952		41455	

* percentage less than 0.006

Table 9g: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Elberon Grounds, N. J. (Station 7) April 1985.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	52	98.11	134	0.24
Sand lance	1	1.89	7	0.01
Crangon septemspinosa	----	----	11	0.02
Shrimp zoea	----	----	17	0.03
Cancer irroratus	----	----	2	0.00*
Crab zoea	----	----	3429	6.18
Phoxocephalus holbolli	----	----	3	0.00
Ericthomius difformia	----	----	3	0.00
Hyperia galba	----	----	1	0.00
Arabella iricolor	----	----	1	0.00
Edotea montosa	----	----	1	0.00
Temora	----	----	2160	3.89
Acartia	----	----	49608	89.39
Cyprid barnacle larvae	----	----	114	0.20
Nematodes	----	----	4	0.01
TOTAL	53		5549	

* percentage less than 0.006

Table 9h: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Breezy Point, N. Y. (Station 8) April 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	1181	98.58	1235	92.23
Mysidopsis bigelowi	1	0.08	1	0.07
Crangon septemspinosa	2	0.17	16	1.19
Gammarus annulatus	4	0.33	5	0.37
Gammarus marinus	10	0.83	11	0.82
Shrimp zoea	----	----	1	0.07
Cancer irroratus	----	----	2	0.15
Nematodes	----	----	3	0.22
Unid. polychaetes	----	----	12	0.90
Temora	----	----	46	3.44
Siphons	----	----	7	0.52
TOTAL	1198		1339	

Table 10a: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Absecon Inlet, N. J. (Station 1) July 1985.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	76	22.75	87	16.42
Mysidopsis bigelowi	12	3.59	16	3.02
Crangon septemspinosa	10	2.99	34	6.42
Shrimp zoea	13	3.89	13	2.45
Crab megalops	206	61.67	227	42.83
Unid. fish	6	1.80	6	1.13
Loligo	11	3.29	11	2.08
Nematodes	----	----	2	0.38
Cancer irroratus	----	----	8	1.51
Ovalipes ocellatus	----	----	108	20.38
Limulus	----	----	1	0.19
Pherusa affinis	----	----	1	0.19
Unid. polychaetes	----	----	1	0.19
Edotea montosa	----	----	6	1.13
Oxyurostylis smithi	----	----	9	1.70
TOTAL	334		530	

Table 10b: Diet of <u>Scophthalmus</u> <u>aquosus</u> and the combined diet of all fish collected from Brigantine Inlet, N. J. (Station 2) July 1985.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	1607	43.06	1676	39.10
Mysidopsis bigelowi	110	2.95	110	2.57
Crangon septemspinosa	4	0.11	240	5.60
Shrimp zoea	665	17.82	709	16.54
Crab megalops	1107	29.66	1230	28.70
Crab zoea	207	5.55	207	4.83
Cancer irroratus	1	0.03	15	0.35
Loligo	7	0.19	7	0.16
Unid. fish	24	0.64	25	0.58
Gammarus annulatus	----	----	4	0.09
Acanthohaustorius millsi	----	----	1	0.02
Nematodes	----	----	1	0.02
Ovalipes ocellatus	----	----	1	0.02
Callinectes sapidus	----	----	1	0.02
Edotes montosa	----	----	1	0.02
Oxyurostylis smithi	----	----	2	0.05
Unid. polychaetes	----	----	2	0.05
Unid. mollusks	----	----	1	0.02
Bay anchovy	----	----	2	0.05
Temora	----	----	8	0.19
Acartia	----	----	43	1.00
TOTAL	3732		4286	

Table 10c: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Little Egg Inlet, N. J. (Station 3) July 1985.

	Diet of <u>S. aquosus</u>		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	3697	87.52	3932	60.78
Mysidopsis bigelowi	2	0.05	3	0.05
Crangon septemspinosa	7	0.16	226	3.49
Crab megalops	491	11.62	491	7.59
Ovalipes ocellatus	3	0.07	5	0.08
Gammarus annulatus	3	0.07	9	0.14
Gammarus marinus	4	0.09	11	0.17
Acartia	12	0.28	1652	25.54
Loligo	1	0.02	1	0.02
Unid. fish	4	0.09	4	0.06
Shrimp zoea	----	----	9	0.14
Crab zoea	----	----	16	0.25
Cancer irroratus	----	----	41	0.63
Barnacle nauplii	----	----	14	0.22
Unid. polychaetes	----	----	1	0.02
Temora	----	----	51	0.79
Bay anchovy	----	----	3	0.05
TOTAL	4224		6469	

Table 10d: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Beach Haven Crest, N. J. (Station 4) July 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	9859	98.60	10427	98.43
Mysidopsis bigelowi	6	0.06	6	0.06
Crangon septemspinosa	3	0.03	14	0.13
Shrimp zoea	1	0.01	1	0.01
Crab megalops	71	0.71	71	0.67
Ovalipes ocellatus	49	0.49	53	0.50
Hermit crab	1	0.01	1	0.01
Loligo	7	0.07	7	0.07
Unid. fish	2	0.02	2	0.02
Cancer irroratus	----	----	11	0.44
TOTAL	268		2527	

Table 10e: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Seaside Heights, N. J. (Station 5) July 1985.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	4182	96.38	4260	74.28
Mysidopsis bigelowi	2	0.05	17	0.30
Crangon septemspinosa	34	0.78	799	13.93
Crab megalops	1	0.02	3	0.05
Ovalipes ocellatus	119	2.74	606	10.57
Unid. fish	1	0.02	7	0.12
Cancer irroratus	----	----	2	0.03
Unciola irrorata	----	----	3	0.05
Nematodes	----	----	28	0.49
Siphons	----	----	10	0.17
TOTAL	4339		5735	

Table 10f: Diet of <u>Scophthalmus aquosus</u> and the combined diet of all fish collected from Sea Girt, N. J. (Station 6) July 1985.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	10009	89.85	10300	85.65
Crangon septemspinosa	1090	9.78	1568	13.04
Hippolyte zostericola	10	0.09	10	0.08
Crab megalops	13	0.12	14	0.12
Crab zoea	4	0.04	4	0.03
Ovalipes ocellatus	12	0.11	91	0.76
Temora	1	0.01	1	0.01
Loligo	1	0.01	1	0.01
Cancer irroratus	----	----	10	0.08
Unciola irrorata	----	----	1	0.01
Acartia	----	----	2	0.02
Nematodes	----	----	4	0.03
Unid. polychaetes	----	----	1	0.01
Bay anchovy	----	----	10	0.08
Sand flounder	----	----	1	0.01
Unid. fish	----	----	8	0.07
TOTAL	11140		12026	

Table 10g: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Elberon Grounds, N. J. (Station 7) July 1985.

	Diet of S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	----	----	81	41.75
Crangon septemspinosa	----	----	103	53.09
Cancer irroratus	----	----	4	2.06
Loligo	----	----	2	1.03
Sand lance	----	----	1	0.52
Unid. fish	----	----	3	1.55
TOTAL	0		194	

* no S aquosus collected at this station.

Table 10h: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Breezy Point, N. Y. (Station 8) July 1985.

Food item	Diet of *S. aquosus* N	Diet of *S. aquosus* %	Diet of all fish collected N	Diet of all fish collected %
Neomysis americana	2480	98.84	2755	73.84
Crangon septemspinosa	29	1.16	904	24.23
Cancer irroratus	----	----	10	0.27
Cancer borealis	----	----	1	0.03
Ovalipes ocellatus	----	----	51	1.37
Gammarus annulatus	----	----	1	0.03
Edotea montosa	----	----	4	0.11
Loligo	----	----	1	0.03
Nereis sp.	----	----	1	0.03
Unid. polychaetes	----	----	1	0.03
Unid. fish	----	----	2	0.05
TOTAL	2509		3731	

Table 11a: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Absecon Inlet, N. J. (Station 1) January 1986.

Food item	Diet of S. aquosus N	Diet of S. aquosus %	Diet of all fish collected N	Diet of all fish collected %
Mysidopsis bigelowi	54	100.00	542	67.83
Neomysis americana	----	----	5	0.62
Acartia	----	----	25	3.13
Temora	----	----	197	24.66
Dexaminidae	----	----	2	0.25
Unid amphipods	----	----	1	0.12
Oxyurostylis smithi	----	----	8	1.00
Barnacle nauplii	----	----	6	0.75
Crangon septemspinosa	----	----	12	1.50
Notocirrus sp.	----	----	1	0.12
TOTAL	54		799	

Table 11b: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Brigantine Inlet, N. J. (Station 2) January 1986.

Food item	Diet of S. aquosus N	Diet of S. aquosus %	Diet of all fish collected N	Diet of all fish collected %
Mysidopsis bigelowi	225	96.15	558	93.78
Neomysis americana	5	2.14	11	1.85
Heteromysis formosa	1	0.43	1	0.17
Crangon septemspinosa	3	1.28	24	4.03
Atlantic silverside	----	----	1	0.17
TOTAL	234		595	

Table 11c: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Little Egg Inlet, N. J. (Station 3) January 1986.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Mysidopsis bigelowi	74	71.84	146	57.25
Heteromysis formosa	1	0.97	1	0.39
Crangon septemspinosa	28	27.18	73	28.63
Gammarus sp.	----	----	1	0.39
Nematodes	----	----	6	2.35
Photidae	----	----	1	0.39
Unid. crabs	----	----	2	0.78
Oxyurostylic smithi	----	----	5	1.96
Barnacle nauplii	----	----	7	2.74
Unid. insects	----	----	1	0.39
Temora	----	----	11	4.31
Acartia	----	----	1	0.39
TOTAL	103		255	

Table 11d: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Beach Haven Crest, N. J. (Station 4) January 1986.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Mysidopsis bigelowi	164	97.62	552	60.39
Neomysis americana	2	1.19	13	1.42
Crangon septemspinosa	2	1.19	12	1.31
Ampelisca macrocephala	----	----	18	1.97
Unid. polychaetes	----	----	316	34.57
Unid. mollusks	----	----	3	0.33
TOTAL	168		914	

Table 11e: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Seaside Heights, N. J. (Station 5) January 1986.

	Diet of *S. aquosus**		Diet of all fish collected	
Food item	N	%	N	%
Mysidopsis bigelowi	----	----	5	1.92
Neomysis americana	----	----	13	4.98
Heteromysis formosa	----	----	3	1.15
Crangon septemspinosa	----	----	128	49.04
Unciola irrorata	----	----	17	6.51
Unid. amphipods	----	----	1	0.38
Acartia	----	----	1	0.38
Temora	----	----	49	18.77
Pherusa affinis	----	----	1	0.38
Notocirrus sp.	----	----	1	0.38
Unid. polychaetes	----	----	1	0.38
Idotea baltica	----	----	3	1.15
Edotea montosa	----	----	2	0.77
Siphons	----	----	27	10.34
Nematodes	----	----	6	2.30
Oxyurostylis smithi	----	----	1	0.38
Unid. crabs	----	----	2	1.15
TOTAL	0		261	

* no *S. aquosus* collected at this station

Table 11f: Diet of *Scophthalmus aquosus* and the combined diet of all fish collected from Sea Girt, N. J. (Station 6) January 1986.

	Diet of *S. aquosus*		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	2	100.00	6	2.79
Heteromysis formosa	----	----	2	0.93
Crangon septemspinosa	----	----	178	82.79
Nephthys ingens	----	----	1	0.46
Ninoe nigripes	----	----	2	0.93
Notocirrus sp	----	----	5	2.32
Cancer irroratus	----	----	1	0.46
Temora	----	----	4	1.86
Unciola irrorata	----	----	15	6.98
Edotea montosa	----	----	1	0.46
TOTAL	2		215	

Table 11g: Diet of Scophthalmus aquosus and the combined diet of all fish collected from Elberon Grounds, N. J. (Station 7) January 1986.

	Diet of S. aquosus		Diet of all fish collected	
Food item	N	%	N	%
Neomysis americana	17	89.47	18	3.18
Crangon septemspinosa	2	10.53	2	0.35
Unid. crabs	----	----	1	0.18
Unciola irrorata	----	----	3	0.53
Unid. mollusks	----	----	345	60.95
Foraminifera	----	----	2	0.35
Edotea montosa	----	----	183	32.33
Acartia	----	----	10	1.77
Barnacle nauplii	----	----	2	0.35
TOTAL	19		566	

Table 12: Dietary preference of Scophthalmus aquosus collected from seven locations within the New York Bight during June 1984.

Food item	Manly Preference	E*	
Absecon Inlet (39°23'N:74°20'W)			
Neomysis americana	0.258	0.566	P
Gammarus annulatus	0.202	0.478	P
Gammarus marinus	0.037	-0.318	NP
Crab megalops	0.009	-0.769	NP
Nematodes	0.055	-0.131	NP
Hydroids	0.439	0.720	P
Brigantine Inlet (39°27'N:74°16'W)			
Neomysis americana	1.000	0.667	P
Little Egg Inlet (39°28'N:74°15'W)			
Neomysis americana	0.539	0.822	P
Crangon septemspinosa	0.108	0.346	P
Gammarus annulatus	0.266	0.670	P
Crab megalops	0.014	-0.576	NP
Nematodes	0.072	0.157	P
Beach Haven Crest (39°37'N:74°10'W)			
Neomysis americana	0.094	0.233	P
Gammarus annulatus	0.228	0.590	P
Gammarus marinus	0.324	0.682	P
Nematodes	0.354	0.715	P
Seaside Heights (39°56'N:74°04'W)			
Neomysis americana	0.189	0.582	P
Mysidopsis bigelowi	0.219	0.628	P
Gammarus annulatus	0.219	0.628	P
Nematodes	0.099	0.331	P
Hydroids	0.219	0.628	P
Sand lance	0.055	0.045	P

Table 12 (continued): Dietary preference of Scophthalmus aquosus collected from seven locations within the New York Bight during June 1984.

Food item	Manly Preference	E*	
Sea Girt (40°08'N:74°01'W)			
Neomysis americana	0.291	0.788	P
Mysidopsis bigelowi	0.224	0.734	P
Crangon septemspinosa	0.094	0.463	P
Shrimp zoea	0.133	0.588	P
Gammarus marinus	0.003	-0.846	NP
Crab megalops	0.006	-0.699	NP
Nematodes	0.069	0.336	P
Hydroids	0.160	0.644	P
Unid. Fish	0.020	-0.257	NP
Elberon Ground (40°19'N:73°53'W)			
Neomysis americana	0.891	0.888	P
Sand lance	0.109	0.347	P

Note: P = preferred; NP = nonpreferred

Table 13: Dietary preference of <u>Scophthalmus aquosus</u> collected from four locations within the New York Bight during November 1984.

Food item	Manly Preference	E*	
Seaside Heights (39°56'N:74°04'W)			
Neomysis americana	0.861	0.885	P
Crangon septemspinosa	0.066	0.116	P
Sand lance	0.072	0.157	P
Sea Girt (40°08'N:74°01'W)			
Neomysis americana	0.240	0.413	P
Crangon septemspinosa	0.096	-0.021	NP
Edotea montosa	0.403	0.602	P
Sand lance	0.261	0.446	P
Elberon Ground (40°19'N:73°53'W)			
Neomysis americana	1.000	0.900	P
Breezy Point (40°34'N:73°48'W)			
Neomysis americana	0.135	0.339	P
Mysidopsis bigelowi	0.137	0.346	P
Crangon septemspinosa	0.007	-0.808	NP
Unid. crab	0.137	0.346	P
Nematodes	0.034	-0.320	NP
Calanus	0.137	0.346	P
Edotea montosa	0.137	0.346	P
Hydroids	0.137	0.346	P
Unid. Fish	0.137	0.346	P

Note: P = preferred; NP = nonpreferred

Table 14: Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during April 1985.

Food item	Manly Preference	E*	
Absecon Inlet (39°23'N:74°20'W)			
Neomysis americana	0.448	0.808	P
Mysidopsis bigelowi	0.544	0.839	P
Crangon septemspinosa	0.008	-0.701	NP
Brigantine Inlet (39°27'N:74°16'W)			
Neomysis americana	0.283	0.672	P
Mysidopsis bigelowi	0.307	0.694	P
Gammarus marinus	0.102	0.296	P
Leptocuma minor	0.307	0.694	P
Little Egg Inlet (39°28'N:74°15'W)			
Neomysis americana	0.773	0.915	P
Crangon septemspinosa	0.015	-0.404	NP
Shrimp zoea	0.076	0.375	P
Gammarus annulatus	0.109	0.519	P
Gammarus marinus	0.027	-0.119	NP
Beach Haven Crest (39°37'N:74°10'W)			
Neomysis americana	0.756	0.766	P
Crangon septemspinosa	0.054	-0.296	NP
Gammarus annulatus	0.190	0.310	P
Seaside Heights (39°56'N:74°04'W)			
Neomysis americana	0.468	0.698	P
Crangon septemspinosa	0.057	-0.191	NP
Sand lance	0.475	0.702	P

Table 14 (continued): Dietary preference of *Scophthalmus aquosus* collected from eight locations within the New York Bight during April 1985.

Food item	Manly Preference	E^*	
Sea Girt (40°08'N:74°01'W)			
Neomysis americana	0.330	0.804	P
Crangon septemspinosa	0.140	0.593	P
Nematodes	0.080	0.383	P
Lobster	0.400	0.836	P
Unid. Fish	0.050	0.167	P
Elberon Ground (40°19'N:73°53'W)			
Neomysis americana	0.731	0.833	P
Sand lance	0.269	0.603	P
Breezy Point (40°34'N:73°48'W)			
Neomysis americana	0.252	0.470	P
Mysidopsis bigelowi	0.264	0.487	P
Crangon septemspinosa	0.033	-0.568	NP
Gammarus annulatus	0.211	0.398	P
Gammarus marinus	0.240	0.450	P

Note: P = preferred; NP = nonpreferred

Table 15: Dietary preference of <u>Scophthalmus</u> <u>aquosus</u> collected from eight locations within the New York Bight during July 1985.

Food item	Manly Preference	E*	
Absecon Inlet (39°23'N:74°20'W)			
Neomysis americana	0.150	0.384	P
Mysidopsis bigelowi	0.129	0.318	P
Crangon septemspinosa	0.050	-0.138	NP
Shrimp zoea	0.172	0.441	P
Crab megalops	0.156	0.401	P
Loligo	0.172	0.441	P
Unid. Fish	0.172	0.441	P
Brigantine Inlet (39°27'N:74°16'W)			
Neomysis americana	0.140	0.201	P
Mysidopsis bigelowi	0.149	0.319	P
Crangon septemspinosa	0.018	-0.617	NP
Shrimp zoea	0.149	0.318	P
Gammarus annulatus	0.099	0.127	P
Crab zoea	0.149	0.318	P
Crab megalops	0.147	0.314	P
Nematodes	0.149	0.318	P
Little Egg Inlet (39°28'N:74°15'W)			
Neomysis americana	0.158	0.458	P
Mysidopsis bigelowi	0.112	0.312	P
Crangon septemspinosa	0.005	-0.837	NP
Gammarus annulatus	0.056	-0.024	NP
Gammarus marinus	0.061	0.020	P
Crab megalops	0.168	0.482	P
Ovalipes ocellatus	0.101	0.264	P
Loligo	0.168	0.482	P
Acartia	0.001	-0.959	NP
Unid. Fish	0.168	0.482	P

Table 15 (continued): Dietary preference of *Scophthalmus aquosus* collected from seven locations within the New York Bight during July 1985.

Food item	Manly Preference	E*	
Beach Haven Crest (39°37'N:74°10'W)			
Neomysis americana	0.125	0.110	P
Mysidopsis bigelowi	0.132	0.137	P
Crangon septemspinosa	0.028	-0.559	NP
Shrimp zoea	0.132	0.137	P
Crab megalops	0.132	0.137	P
Ovalipes ocellatus	0.122	0.099	P
Hermit crab	0.066	-0.205	NP
Loligo	0.132	0.137	P
Unid. Fish	0.132	0.137	P
Seaside Heights (39°56'N:74°04'W)			
Neomysis americana	0.541	0.688	P
Mysidopsis bigelowi	0.065	-0.213	NP
Crangon septemspinosa	0.023	-0.620	NP
Crab megalops	0.184	0.295	P
Ovalipes ocellatus	0.108	0.040	P
Unid. Fish	0.079	-0.119	NP
Sea Girt (40°08'N:74°01'W)			
Neomysis americana	0.144	0.396	P
Crangon septemspinosa	0.103	0.246	P
Hippolyte zostericola	0.149	0.408	P
Crab zoea	0.149	0.408	P
Crab megalops	0.138	0.377	P
Ovalipes ocellatus	0.020	-0.522	NP
Loligo	0.149	0.408	P
Temora	0.149	0.408	P
Elberon Ground (40°19'N:73°53'W)			
No *S. aquosus* collected at this station.			

Table 15 (continued): Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during July 1985.

Food item	Manly Preference	E^*	
	Breezy Point (40°34'N:73°48'W)		
Neomysis americana	0.966	0.828	P
Crangon septemspinosa	0.034	-0.451	NP

Note: P = preferred; NP = nonpreferred

Table 16: Dietary preference of Scophthalmus aquosus collected from eight locations within the New York Bight during January 1986.

Food item	Manly Preference	E*	
Absecon Inlet (39°23'N:74°20'W)			
Mysidopsis bigelowi	1.000	0.818	P
Brigantine Inlet (39°27'N:74°16'W)			
Neomysis americana	0.203	0.008	P
Mysidopsis bigelowi	0.229	0.068	P
Heteromysis formosa	0.504	0.432	P
Crangon septemspinosa	0.080	-0.430	NP
Little Egg Inlet (39°28'N:74°15'W)			
Mysidopsis bigelowi	0.268	0.526	P
Heteromysis formosa	0.529	0.728	P
Crangon septemspinosa	0.203	0.418	P
Beach Haven Crest (39°37'N:74°10'W)			
Neomysis americana	0.481	0.485	P
Mysidopsis bigelowi	0.249	0.198	P
Crangon septemspinosa	0.270	0.236	P
Seaside Heights (39°56'N:74°04'W)			
Stomachs from S. aquosus collected from this station were empty.			
Sea Girt (40°08'N:74°01'W)			
Neomysis americana	1.000	0.818	P
Elberon Ground (40°19'N:73°53'W)			
Neomysis americana	0.486	0.658	P
Crangon septemspinosa	0.514	0.674	P
Breezy Point (40°34'N:73°48'W)			
No fish collected at this station.			

Note: P = preferred; NP = nonpreferred

Table 17: Summary of the dietary preference of *Scophthalmus aquosus* collected from seven locations within the New York Bight during June 1984.

	Station number						
Taxon	1	2	3	4	5	6	7
Neomysis americana	P	P	P	P	P	P	P
Mysidopsis bigelowi	--	--	--	--	P	P	--
Crangon septemspinosa	--	--	P	--	--	P	--
Shrimp zoea	--	--	--	--	--	P	--
Gammarus annulatus	P	--	P	P	P	--	--
Gammarus marinus	NP	--	--	P	--	NP	--
Crab megalops	NP	--	NP	--	--	NP	--
Nematodes	NP	--	P	P	P	P	--
Hydroids	P	--	--	--	P	P	--
Sand lance	--	--	--	--	P	--	P
Unid. Fish	--	--	--	--	--	NP	--

Table 18: Summary of the dietary preference of Scophthalmus aquosus collected from four locations within the New York Bight during November 1984.

	Station number			
Taxon	5	6	7	8
Neomysis americana	P	P	P	P
Mysidopsis bigelowi	--	--	--	P
Crangon septemspinosa	P	NP	--	NP
Unid. crab	--	--	--	P
Nematodes	--	--	--	NP
Calanus	--	--	--	P
Edotea montosa	--	P	--	P
Hydroids	--	--	--	P
Sand lance	P	P	--	--
Unid. Fish	--	--	--	P

Table 19: Summary of the dietary preference of *Scophthalmus aquosus* collected from eight locations within the New York Bight during April 1985.

	Station number							
Taxon	1	2	3	4	5	6	7	8
Neomysis americana	P	P	P	P	P	P	P	P
Mysidopsis bigelowi	P	P	--	--	--	--	--	P
Crangon septemspinosa	NP	--	NP	NP	NP	P	--	NP
Shrimp zoea	--	--	P	--	--	--	--	--
Gammarus annulatus	--	--	P	P	--	--	--	P
Gammarus marinus	--	P	NP	--	--	--	--	P
Leptocuma minor	--	P	--	--	--	--	--	--
Nematodes	--	--	--	--	--	P	--	--
Lobster	--	--	--	--	--	P	--	--
Sand lance	--	--	--	--	P	--	P	--
Unid. Fish	--	--	--	--	--	P	--	--

Table 20: Summary of the dietary preference of *Scophthalmus aquosus* collected from eight locations within the New York Bight during July 1985.

	Station number							
Taxon	1	2	3	4	5	6	7*	8
Neomysis americana	P	P	P	P	P	P	--	P
Mysidopsis bigelowi	P	P	P	P	NP	--	--	--
Crangon septemspinosa	NP	NP	NP	NP	NP	P	--	NP
Hippolyte zostericola	--	--	--	--	--	P	--	--
Shrimp zoea	P	P	--	P	--	--	--	--
Gammarus annulatus	--	P	NP	--	--	--	--	--
Gammarus marinus	--	--	P	--	--	--	--	--
Crab zoea	--	P	--	--	--	P	--	--
Crab megalops	P	P	P	P	P	P	--	--
Ovalipes ocellatus	--	--	P	P	P	NP	--	--
Hermit crab	--	--	--	NP	--	--	--	--
Loligo	P	--	P	P	--	P	--	--
Temora	--	--	--	--	--	P	--	--
Acartia	--	--	NP	--	--	--	--	--
Nematodes	--	P	--	--	--	P	--	--
Lobster	--	--	--	--	--	P	--	--
Unid. Fish	P	--	P	P	NP	--	--	--

* No sand flounders collected at this station

Table 21: Summary of the dietary preference of *Scophthalmus aquosus* collected from eight locations within the New York Bight during January 1986.

Taxon	Station number 1	2	3	4	5*	6	7	8**
Neomysis americana	--	P	--	P	--	P	P	--
Mysidopsis bigelowi	P	P	P	P	--	--	--	--
Heteromysis formosa	--	P	P	--	--	--	--	
Crangon septemspinosa	--	NP	P	P	--	--	P	--

* No prey consumed by the sand flounder collected from this station.

** No fish collected at this station.

Table 22: Dietary preference of <u>Scophthalmus aquosus</u> collected from Absecon Inlet during different seasons.

Food item	Manly Preference	E*	
	June 1984		
Neomysis americana	0.258	0.566	P
Gammarus annulatus	0.202	0.478	P
Gammarus marinus	0.037	-0.318	NP
Crab megalops	0.009	-0.769	NP
Nematodes	0.055	-0.131	NP
Hydroids	0.439	0.720	P
	April 1985		
Neomysis americana	0.448	0.808	P
Mysidopsis bigelowi	0.544	0.839	P
Crangon septemspinosa	0.008	-0.701	NP
	July 1985		
Neomysis americana	0.150	0.384	P
Mysidopsis bigelowi	0.129	0.318	P
Crangon septemspinosa	0.050	-0.138	NP
Shrimp zoea	0.172	0.441	P
Crab megalops	0.156	0.401	P
Loligo	0.172	0.441	P
Unid. Fish	0.172	0.441	P
	January 1986		
Mysidopsis bigelowi	1.000	0.818	P

Table 23: Dietary preference of Scophthalmus aquosus collected from Brigantine Inlet during different seasons.

Food item	Manly Preference	E*	
	June 1984		
Neomysis americana	1.000	0.667	P
	April 1985		
Neomysis americana	0.283	0.672	P
Mysidopsis bigelowi	0.307	0.694	P
Gammarus marinus	0.102	0.296	P
Leptocuma minor	0.307	0.694	P
	July 1985		
Neomysis americana	0.140	0.201	P
Mysidopsis bigelowi	0.149	0.319	P
Crangon septemspinosa	0.018	-0.617	NP
Shrimp zoea	0.149	0.318	P
Gammarus annulatus	0.099	0.127	P
Crab zoea	0.149	0.318	P
Crab megalops	0.147	0.314	P
Nematodes	0.149	0.318	P
	January 1986		
Neomysis americana	0.203	0.008	P
Mysidopsis bigelowi	0.229	0.068	P
Heteromysis formosa	0.504	0.432	P
Crangon septemspinosa	0.080	-0.430	NP

Table 24: Dietary preference of <u>Scophthalmus aquosus</u> collected from Little Egg Inlet during different seasons.

Food item	Manly Preference	E*	
	June 84		
Neomysis americana	0.539	0.822	P
Crangon septemspinosa	0.108	0.346	P
Gammarus annulatus	0.266	0.670	P
Crab megalops	0.014	-0.576	NP
Nematodes	0.072	0.157	P
	April 1985		
Neomysis americana	0.773	0.915	P
Crangon septemspinosa	0.015	-0.404	NP
Shrimp zoea	0.076	0.375	P
Gammarus annulatus	0.109	0.519	P
Gammarus marinus	0.027	-0.119	NP
	July 1985		
Neomysis americana	0.158	0.458	P
Mysidopsis bigelowi	0.112	0.312	P
Crangon septemspinosa	0.005	-0.837	NP
Gammarus annulatus	0.056	-0.024	NP
Gammarus marinus	0.061	0.020	P
Crab megalops	0.168	0.482	P
Ovalipes ocellatus	0.101	0.264	P
Loligo	0.168	0.482	P
Acartia	0.001	-0.959	NP
Unid. Fish	0.168	0.482	P
	January 1986		
Mysidopsis bigelowi	0.268	0.526	P
Heteromysis formosa	0.529	0.728	P
Crangon septemspinosa	0.203	0.418	P

Table 25: Dietary preference of *Scophthalmus aquosus* collected from Beach Haven Crest during different seasons.

Food item	Manly Preference	E^*	
	June 1984		
Neomysis americana	0.094	0.233	P
Gammarus annulatus	0.228	0.590	P
Gammarus marinus	0.324	0.682	P
Nematodes	0.354	0.715	P
	April 1985		
Neomysis americana	0.756	0.766	P
Crangon septemspinosa	0.054	-0.296	NP
Gammarus annulatus	0.190	0.310	P
	July 1985		
Neomysis americana	0.125	0.110	P
Mysidopsis bigelowi	0.132	0.137	P
Crangon septemspinosa	0.028	-0.559	NP
Shrimp zoea	0.132	0.137	P
Crab megalops	0.132	0.137	P
Ovalipes ocellatus	0.122	0.099	P
Hermit crab	0.066	-0.205	NP
Loligo	0.132	0.137	P
Unid. Fish	0.132	0.137	P
	January 1986		
Neomysis americana	0.481	0.485	P
Mysidopsis bigelowi	0.249	0.198	P
Crangon septemspinosa	0.270	0.236	P

Table 26: Dietary preference of *Scophthalmus aquosus* collected from Seaside Heights during different seasons.

Food item	Manly Preference	E*	
	June 1984		
Neomysis americana	0.189	0.582	P
Mysidopsis bigelowi	0.219	0.628	P
Gammarus annulatus	0.219	0.628	P
Nematodes	0.099	0.331	P
Hydroids	0.219	0.628	P
Sand lance	0.055	0.045	P
	November 1984		
Neomysis americana	0.861	0.885	P
Crangon septemspinosa	0.066	0.116	P
Sand lance	0.072	0.157	P
	April 1985		
Neomysis americana	0.468	0.698	P
Crangon septemspinosa	0.057	-0.191	NP
Sand lance	0.475	0.702	P
	July 1985		
Neomysis americana	0.541	0.688	P
Mysidopsis bigelowi	0.065	-0.213	NP
Crangon septemspinosa	0.023	-0.620	NP
Crab megalops	0.184	0.295	P
Ovalipes ocellatus	0.108	0.040	P
Unid. Fish	0.079	-0.119	NP
	January 1986		
Stomachs from *S. aquosus* collected from this station were empty.			

Table 27: Dietary preference of <u>Scophthalmus</u> <u>aquosus</u> collected from Sea Girt during different seasons.

Food item	Manly Preference	E*	
	June 1984		
Neomysis americana	0.291	0.788	P
Mysidopsis bigelowi	0.224	0.734	P
Crangon septemspinosa	0.094	0.463	P
Shrimp zoea	0.133	0.588	P
Gammarus marinus	0.003	-0.846	NP
Crab megalops	0.006	-0.699	NP
Nematodes	0.069	0.336	P
Hydroids	0.160	0.644	P
Unid. Fish	0.020	-0.257	NP
	November 1984		
Neomysis americana	0.240	0.413	P
Crangon septemspinosa	0.096	-0.021	NP
Edotea montosa	0.403	0.602	P
Sand lance	0.261	0.446	P
	April 1985		
Neomysis americana	0.330	0.804	P
Crangon septemspinosa	0.140	0.593	P
Nematodes	0.080	0.383	P
Lobster	0.400	0.836	P
Unid. Fish	0.050	0.167	P
	July 1985		
Neomysis americana	0.144	0.396	P
Crangon septemspinosa	0.103	0.246	P
Hippolyte zostericola	0.149	0.408	P
Crab zoea	0.149	0.408	P
Crab megalops	0.138	0.377	P
Ovalipes ocellatus	0.020	-0.522	NP
Loligo	0.149	0.408	P
Temora	0.149	0.408	P

Table 27 (continued): Dietary preference of *Scophthalmus aquosus* collected from Sea Girt during different seasons.

Food item	Manly Preference	E*	
	January 1986		
Neomysis americana	1.000	0.818	P

Table 28: Dietary preference of <u>Scophthalmus aquosus</u> collected from Elberon Ground during different seasons.

Food item	Manly Preference	E*	
	June 1984		
Neomysis americana	0.891	0.888	P
Sand lance	0.109	0.347	P
	November 1984		
Neomysis americana	1.000	0.900	P
	April 1985		
Neomysis americana	0.731	0.833	P
Sand lance	0.269	0.603	P
	July 1985		
No S. aquosus collected at this station.			
	January 1986		
Neomysis americana	0.486	0.658	P
Crangon septemspinosa	0.514	0.674	P

Table 29: Dietary preference of Scophthalmus aquosus collected from Breezy Point during different seasons.

Food item	Manly Preference	E*	
	Novermber 1984		
Neomysis americana	0.135	0.339	P
Mysidopsis bigelowi	0.137	0.346	P
Crangon septemspinosa	0.007	-0.808	NP
Unid. crab	0.137	0.346	P
Nematodes	0.034	-0.320	NP
Calanus	0.137	0.346	P
Edotea montosa	0.137	0.346	P
Hydroids	0.137	0.346	P
Unid. Fish	0.137	0.346	P
	April 1985		
Neomysis americana	0.252	0.470	P
Mysidopsis bigelowi	0.264	0.487	P
Crangon septemspinosa	0.033	-0.568	NP
Gammarus annulatus	0.211	0.398	P
Gammarus marinus	0.240	0.450	P
	July 1985		
Neomysis americana	0.966	0.828	P
Crangon septemspinosa	0.034	-0.451	NP
	January 1986		
No fish collected at this station.			

Table 30: Dietary preference of Scophthalmus aquosus collected from Absecon Inlet N.J. (station 1) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84*	4/85	7/85	1/86
Neomysis americana	P		P	P	--
Mysidopsis bigelowi	--		P	P	P
Crangon septemspinosa	--		NP	NP	--
Shrimp zoea	--		--	P	--
Gammarus annulatus	P		--	--	--
Gammarus marinus	NP		--	--	--
Crab megalops	NP		--	P	--
Nematodes	NP		--	--	--
Hydroids	P		--	--	--
Loligo	--		--	P	--
Unid. Fish	--		--	P	--

* This station was not sampled during this time.

Table 31: Dietary preference of <u>Scophthalmus aquosus</u> collected from Brigantine Inlet N. J. (station 2) during five collecting seasons.

Taxon	Collecting dates 6/84	11/84*	4/85	7/85	1/86
Neomysis americana	P		P	P	P
Mysidopsis bigelowi	--		P	P	P
Heteromysis formosa	--		--	--	P
Crangon septemspinosa	--		--	NP	NP
Shrimp zoea	--		--	P	--
Gammarus annulatus	--		--	P	--
Gammarus marinus	--		P	--	--
Crab zoea	--		--	P	--
Crab megalops	--		--	P	--
Nematodes	--		--	P	--
Leptocuma minor	--		P	--	--

* This station was not sampled during this time.

Table 32: Dietary preference of Scophthalmus aquosus collected from Little Egg Inlet N. J. (station 3) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84*	4/85	7/85	1/86
Neomysis americana	P		P	P	--
Mysidopsis bigelowi	--		--	P	P
Heteromysis formosa	--		--	--	P
Crangon septemspinosa	P		NP	NP	P
Shrimp zoea	--		P	--	--
Gammarus annulatus	P		P	NP	--
Gammarus marinus	--		NP	P	--
Crab megalops	NP		--	P	--
Ovalipes ocellatus	--		--	P	--
Loligo	--		--	P	--
Acartia	--		--	NP	--
Nematodes	P		--	--	--
Unid. Fish	--		--	P	--

* This station was not sampled during this time.

Table 33: Dietary preference of Scophthalmus aquosus collected from Beach Haven Crest N. J. (station 4) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84*	4/85	7/85	1/86
Neomysis americana	P		P	P	P
Mysidopsis bigelowi	--		--	P	P
Crangon septemspinosa	--		NP	NP	P
Shrimp zoea	--		--	P	--
Gammarus annulatus	P		P	--	--
Gammarus marinus	P		--	--	--
Crab megalops	--		--	P	--
Ovalipes ocellatus	--		--	P	--
Hermit crab	--		--	NP	--
Loligo	--		--	P	--
Nematodes	P		--	--	--
Unid. Fish	--		--	P	--

* This station was not sampled during this time.

Table 34: Dietary preference of Scophthalmus aquosus collected from Seaside Heights N. J. (station 5) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84	4/85	7/85	1/86*
Neomysis americana	P	P	P	P	
Mysidopsis bigelowi	P	--	--	NP	
Crangon septemspinosa	--	P	NP	NP	
Gammarus annulatus	P	--	--	--	
Crab megalops	--	--	--	P	
Ovalipes ocellatus	--	--	--	P	
Nematodes	P	--	--	--	
Hydroids	P	--	--	--	
Sand lance	P	P	P	--	
Unid. Fish	--	--	--	NP	

* No prey consumed by the sand flounder collected from this station.

Table 35: Dietary preference of Scophthalmus aquosus collected from Sea Girt N. J. (station 6) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84	4/85	7/85	1/86
Neomysis americana	P	P	P	P	P
Mysidopsis bigelowi	P	--	--	--	--
Crangon septemspinosa	P	NP	P	P	--
Hippolyte zostericola	--	--	--	P	--
Shrimp zoea	P	--	--	--	--
Gammarus marinus	NP	--	--	--	--
Crab zoea	--	--	--	P	--
Crab megalops	NP	--	--	P	--
Ovalipes ocellatus	--	--	--	NP	--
Nematodes	P	--	P	P	--
Hydroids	P	--	--	--	--
Edotea montosa	--	P	--	--	--
Lobster	--	--	P	P	--
Loligo	--	--	--	P	--
Temora	--	--	--	P	--
Sand lance	--	P	--	--	--
Unid. Fish	NP	--	P	--	--

Table 36: Dietary preference of Scophthalmus aquosus collected from Elberon Ground N. J. (station 7) during five collecting seasons.

	Collecting dates				
Taxon	6/84	11/84	4/85	7/85*	1/86**
Neomysis americana	P	P	P		
Sand lance	P	--	P		

* No sand flounders collected at this station
** No fish collected at this station

Table 37: Dietary preference of Scophthalmus aquosus collected from Breezy Point N. Y. (station 8) during five collecting seasons.

Taxon	6/84*	11/84	4/85	7/85	1/86**
Neomysis americana		P	P	P	
Mysidopsis bigelowi		P	P	--	
Crangon septemspinosa		NP	NP	NP	
Gammarus annulatus		--	P	--	
Gammarus marinus		--	P	--	
Unid. crab		P	--	--	
Nematodes		NP	--	--	
Hydroids		P	--	--	
Calanus		P	--	--	
Edotea montosa		P	--	--	
Unid. Fish		P	--	--	

* This station was not sampled during this time.

** No fish collected at this station.

Table 38: Pairwise comparisons of diet overlap and similarity for *Scophthalmus aquosus* collected from seven locations within the New York Bight in June 1984.

Locations	Morisita Overlap Index	Schoener Similarity Index
1 vs 2	0.99	90.47
1 vs 3	0.99	91.64
1 vs 4	0.99	92.67
1 vs 5	0.99	90.90
1 vs 6	0.99	91.02
1 vs 7	0.99	88.89
2 vs 3	1.00	98.57
2 vs 4	0.98	84.32
2 vs 5	1.00	98.28
2 vs 6	1.00	98.22
2 vs 7	0.99	88.89
3 vs 4	0.98	85.44
3 vs 5	1.00	98.61
3 vs 6	1.00	98.76
3 vs 7	0.99	88.90
4 vs 5	0.98	84.74
4 vs 6	0.98	84.58
4 vs 7	0.98	84.32
5 vs 6	1.00	98.78
5 vs 7	0.99	89.03
6 vs 7	0.99	88.89

Table 39: Pairwise comparisons of diet overlap and similarity for *Scophthalmus aquosus* collected from four locations within the New York Bight in November 1984.

Locations	Morisita Overlap Index	Schoener Similarity Index
5 vs 6	1.00	99.60
5 vs 7	1.00	98.70
5 vs 8	1.00	98.85
6 vs 7	1.00	99.04
6 vs 8	1.00	99.20
7 vs 8	1.00	99.73

Table 40: Pairwise comparisons of diet overlap and similarity for Scophthalmus aquosus collected from four locations within the New York Bight in April 1985.

Locations	Morisita Overlap Index	Schoener Similarity Index
1 vs 2	1.00	97.96
1 vs 3	1.00	97.48
1 vs 4	1.00	97.60
1 vs 5	1.00	97.64
1 vs 6	1.00	97.82
1 vs 7	1.00	97.46
1 vs 8	1.00	97.71
2 vs 3	1.00	99.40
2 vs 4	1.00	99.34
2 vs 5	1.00	99.34
2 vs 6	1.00	99.34
2 vs 7	1.00	98.12
2 vs 8	1.00	98.75
3 vs 4	1.00	99.74
3 vs 5	1.00	99.80
3 vs 6	1.00	99.58
3 vs 7	1.00	98.11
3 vs 8	1.00	98.72
4 vs 5	1.00	99.86
4 vs 6	1.00	99.70
4 vs 7	1.00	98.11
4 vs 8	1.00	98.72
5 vs 6	1.00	99.74
5 vs 7	1.00	98.13
5 vs 8	1.00	98.76
6 vs 7	1.00	98.11
6 vs 8	1.00	98.76
7 vs 8	1.00	98.12

Table 41: Pairwise comparisons of diet overlap and similarity for *Scophthalmus aquosus* collected from four locations within the New York Bight in July 1985.

Locations	Morisita Overlap Index	Schoener Similarity Index
1 vs 2	0.46	36.36
1 vs 3	0.44	34.73
1 vs 4	0.32	23.66
1 vs 5	0.32	23.64
1 vs 6	0.33	25.88
1 vs 7	----	-----
1 vs 8	0.32	23.92
2 vs 3	0.91	73.92
2 vs 4	0.88	65.27
2 vs 5	0.88	65.04
2 vs 6	0.90	65.12
2 vs 7	----	-----
2 vs 8	0.88	64.97
3 vs 4	0.99	88.44
3 vs 5	0.99	87.86
3 vs 6	0.98	87.89
3 vs 7	----	-----
3 vs 8	0.98	87.70
4 vs 5	1.00	97.00
4 vs 6	0.99	90.12
4 vs 7	----	-----
4 vs 8	1.00	98.63
5 vs 6	0.99	90.75
5 vs 7	----	-----
5 vs 8	1.00	97.16
6 vs 7	----	-----
6 vs 8	0.99	91.00
7 vs 8	----	-----

Table 42: Pairwise comparisons of diet overlap and similarity for *Scophthalmus aquosus* collected from four locations within the New York Bight in January 1986.

Locations	Morisita Overlap Index	Schoener Similarity Index
1 vs 2	1.00	96.34
1 vs 3	0.90	71.84
1 vs 4	1.00	97.62
1 vs 5	0.00	50.00
1 vs 6	0.00	00.00
1 vs 7	0.00	00.00
2 vs 3	0.92	73.36
2 vs 4	1.00	98.72
2 vs 5	0.00	50.20
2 vs 6	0.02	2.33
2 vs 7	0.02	3.61
3 vs 4	0.91	73.04
3 vs 5	0.00	50.00
3 vs 6	0.00	00.00
3 vs 7	0.04	10.54
4 vs 5	0.00	50.00
4 vs 6	0.01	1.19
4 vs 7	0.01	2.38
5 vs 6	0.00	50.00
5 vs 7	0.00	50.00
6 vs 7	0.99	89.47

Table 43: Pairwise comparisons of diet overlap and similarity for S. aquosus collected over five collecting seasons.

Absecon Inlet (station 1)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	----	-----
" vs Apr. 85	0.99	90.48
" vs Jul. 85	0.33	22.94
" vs Jan. 86	0.00	00.00
Nov. 84 vs Apr. 85	----	-----
" vs Jul. 85	----	-----
" vs Jan. 86	----	-----
Apr. 85 vs Jul. 85	0.32	25.30
" vs Jan. 86	0.02	1.92
Jul. 85 vs Jan. 86	0.05	3.60

Brigantine Inlet (station 2)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	----	-----
" vs Apr. 85	1.00	99.34
" vs Jul. 85	0.87	64.46
" vs Jan. 86	0.02	2.33
Nov. 84 vs Apr. 85	----	-----
" vs Jul. 85	----	-----
" vs Jan. 86	----	-----
Apr. 85 vs Jul. 85	0.88	64.96
" vs Jan. 86	0.03	2.84
Jul. 85 vs Jan. 86	0.34	26.08

Table 43 (continued): Pairwise comparisons of diet overlap and similarity for S. aquosus collected over five collecting seasons.

Little Egg Inlet (station 3)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	----	-----
" vs Apr. 85	1.00	98.64
" vs Jul. 85	0.98	87.90
" vs Jan. 86	0.0007	00.20
Nov. 84 vs Apr. 85	----	-----
" vs Jul. 85	----	-----
" vs Jan. 86	----	-----
Apr. 85 vs Jul. 85	0.98	87.67
" vs Jan. 86	0.02	0.00007
Jul. 85 vs Jan. 86	0.05	0.23

Beach Haven Crest (station 4)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	----	-----
" vs Apr. 85	0.98	84.46
" vs Jul. 85	0.98	84.32
" vs Jan. 86	0.01	1.18
Nov. 84 vs Apr. 85	----	-----
" vs Jul. 85	----	-----
" vs Jan. 86	----	-----
Apr. 85 vs Jul. 85	1.00	98.63
" vs Jan. 86	0.01	1.33
Jul. 85 vs Jan. 86	0.01	1.28

Table 43 (continued): Pairwise comparisons of diet overlap and similarity for S. aquosus collected over five collecting seasons.

Seaside Heights (station 5)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	1.00	98.48
" vs Apr. 85	1.00	98.32
" vs Jul. 85	1.00	96.44
" vs Jan. 86	----	----- *
Nov. 84 vs Apr. 85	1.00	98.92
" vs Jul. 85	1.00	96.76
" vs Jan. 86	----	----- *
Apr. 85 vs Jul. 85	1.00	96.56
" vs Jan. 86	----	----- *
Jul. 85 vs Jan. 86	----	----- *

* January sand flounders (station 5) had empty stomachs.

Sea Girt (station 6)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	1.00	98.40
" vs Apr. 85	1.00	98.44
" vs Jul. 85	0.99	90.13
" vs Jan. 86	1.00	98.00
Nov. 84 vs Apr. 85	1.00	99.32
" vs Jul. 85	0.99	90.12
" vs Jan. 86	1.00	99.04
Apr. 85 vs Jul. 85	0.99	90.22
" vs Jan. 86	1.00	99.56
Jul. 85 vs Jan. 86	1.00	89.84

Table 43 (continued): Pairwise comparisons of diet overlap and similarity for S. aquosus collected over five collecting seasons.

Elberon Ground (station 7)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	0.99	88.89
" vs Apr. 85	0.99	90.78
" vs Jul. 85	----	----- *
" vs Jan. 86	0.98	88.89
Nov. 84 vs Apr. 85	1.00	98.11
" vs Jul. 85	----	----- *
" vs Jan. 86	0.99	89.47
Apr. 85 vs Jul. 85	----	----- *
" vs Jan. 86	1.00	98.11
Jul. 85 vs Jan. 86	----	----- *

* No sand flounders were collected in July.

Breezy Point (station 8)

Collecting Seasons	Morisita Overlap Index	Schoener Similarity Index
June 84 vs Nov. 84	----	----- *
" vs Apr. 85	----	----- *
" vs Jul. 85	----	----- *
" vs Jan. 86	----	----- **
Nov. 84 vs Apr. 85	1.00	98.76
" vs Jul. 85	1.00	98.99
" vs Jan. 86	----	----- **
Apr. 85 vs Jul. 85	1.00	98.76
" vs Jan. 86	----	----- **
Jul. 85 vs Jan. 86	----	----- **

* This station was not sampled in June.
** No fish collected from this station during January.

Table 44: Shannon diversity, variance, and evenness of the diet of the sand flounder collected during June 1984.

Station location	Shannon Diversity	Variance	Evenness
1- Absecon Inlet	0.3809	0.0015	0.0927
2- Brigantine Inlet	0.0000	0.0000	------
3- Little Egg	0.0908	0.0002	0.0238
4- Beach Haven Crest	0.5749	0.0034	0.2590
5- Seaside Heights	0.1099	0.0003	0.0232
6- Sea Girt	0.1179	0.0001	0.0156
7- Elberon Ground	0.3488	0.0474	0.4174

All possible pairwise comparisons of the June 1984 diet diversity of the sand flounder.

Station #	t-statistic	degrees of freedom
1 vs 2	---	---
1 vs 3	7.04	710
1 vs 4	2.77	508
1 vs 5	6.39	788
1 vs 6	6.58	632
1 vs 7	0.14 N.S.	10
3 vs 4	8.07	300
3 vs 5	0.85 N.S.	2873
3 vs 6	1.56 N.S.	3351
3 vs 7	1.18 N.S.	9
4 vs 5	7.64	317
4 vs 6	7.72	284
4 vs 7	1.00 N.S.	10
5 vs 6	0.40 N.S.	2504
5 vs 7	1.09 N.S.	9
6 vs 7	1.06 N.S.	9

Table 45: Shannon diversity, variance, and evenness of the diet of the sand flounder collected during November 1984.

Station location	Shannon Diversity	Variance	Evenness
5- Seaside Heights	0.0753	0.0001	0.0391
6- Sea Girt	0.0617	0.0002	0.0212
7- Elberon Ground	0.0000	0.0000	---
8- Breezy Point	0.0212	0.0000	0.0027

All possible pairwise comparisons of the November 1984 diet diversity of the sand flounder.

Station #	t-statistic	degrees of freedom
5 vs 6	0.79 N.S.	3440
5 vs 7	---	---
5 vs 8	5.23	3121
6 vs 7	---	---
6 vs 8	2.82	1904
7 vs 8	---	---

Table 46: Shannon diversity, variance, and evenness of the diet of the sand flounder collected during April 1985.

Station location	Shannon Diversity	Variance	Evenness
1- Absecon Inlet	0.1330	0.0028	0.0711
2- Brigantine Inlet	0.0453	0.0002	0.0154
3- Little Egg	0.0142	0.0000	0.0036
4- Beach Haven Crest	0.0212	0.0002	0.0107
5- Seaside Heights	0.0166	0.0000	0.0084
6- Sea Girt	0.0307	0.0000	0.0077
7- Elberon Ground	0.0936	0.0054	0.0981
8- Breezy Point	0.0897	0.0003	0.0234

All possible pairwise comparisons of the April 1985 diet diversity of the sand flounder.

Station #	t-statistic	degrees of freedom
1 vs 2	1.60 N.S.	180
1 vs 3	2.24	159
1 vs 4	2.05	176
1 vs 5	2.19	160
1 vs 6	1.92 N.S.	160
1 vs 7	0.44 N.S.	112
1 vs 8	0.79 N.S.	192
2 vs 3	2.10	1437
2 vs 4	1.25 N.S.	1850
2 vs 5	1.89 N.S.	1558
2 vs 6	0.96 N.S.	1566
2 vs 7	0.64 N.S.	57
2 vs 8	1.99	2299
3 vs 4	0.51 N.S.	892
3 vs 5	0.34 N.S.	6341
3 vs 6	2.33	11548
3 vs 7	1.08 N.S.	53
3 vs 8	4.22	1362
4 vs 5	0.32 N.S.	983
4 vs 6	0.67 N.S.	987
4 vs 7	0.97 N.S.	56
4 vs 8	3.16	1912
5 vs 6	1.82 N.S.	7497
5 vs 7	1.04 N.S.	53
5 vs 8	4.02	1443
6 vs 7	0.85 N.S.	54
6 vs 8	3.25	1447
7 vs 8	0.05 N.S.	59

Table 47: Shannon diversity, variance, and evenness of the diet of the sand flounder collected during July 1985.

Station location	Shannon Diversity	Variance	Evenness
1- Absecon Inlet	1.1704	0.0034	0.3706
2- Brigantine Inlet	0.9926	0.0008	0.2426
3- Little Egg	0.4231	0.0002	0.0585
4- Beach Haven Crest	0.0906	0.0000	0.0119
5- Seaside Heights	0.1794	0.0001	0.0393
6- Sea Girt	0.3497	0.0000	0.0598
7- Elberon Ground	------	------	------
8- Breezy Point	0.0630	0.0001	0.0651

All possible pairwise comparisons of the July 1985 diet diversity of the sand flounder.

Station #	t-statistic	degrees of freedom
1 vs 2	2.74	502
1 vs 3	12.46	374
1 vs 4	18.41	342
1 vs 5	16.75	354
1 vs 6	13.97	344
1 vs 7	---	---
1 vs 8	18.74	352
2 vs 3	18.01	1810
2 vs 4	31.12	1299
2 vs 5	27.11	1486
2 vs 6	22.05	1330
2 vs 7	---	---
2 vs 8	31.16	1450
3 vs 4	21.46	5981
3 vs 5	14.07	7644
3 vs 6	4.64	6447
3 vs 7	---	---
3 vs 8	21.15	6623
4 vs 5	7.50	7952
4 vs 6	27.31	21090
4 vs 7	---	---
4 vs 8	2.42	4988
5 vs 6	13.90	8896
5 vs 7	---	---
5 vs 8	8.44	6524
6 vs 7	---	---
6 vs 8	24.23	5676
7 vs 8	---	---

Table 48: Shannon diversity, variance, and evenness of the diet of the sand flounder collected during January 1986.

Station location	Shannon Diversity	Variance	Evenness
1- Absecon Inlet	0.0000	0.0000	------
2- Brigantine Inlet	0.1990	0.0028	0.0734
3- Little Egg	0.6366	0.0033	0.4451
4- Beach Haven Crest	0.1290	0.0027	0.0688
5- Seaside Heights	------	------	------
6- Sea Girt	0.0000	0.0000	------
7- Elberon Ground	0.3365	0.0227	0.4000
8- Breezy Point	------	------	------

All possible pairwise comparisons of the January 1986 diet diversity of the sand flounder.

Station #	t-statistic	degrees of freedom
Comparisons between station 1 and all other stations could not be calculated.		
2 vs 3	5.60	267
2 vs 4	0.94 N.S.	393
2 vs 5	---	---
2 vs 6	---	---
2 vs 7	0.86 N.S.	24
3 vs 4	6.55	241
3 vs 5	---	---
3 vs 6	---	---
3 vs 7	1.86 N.S.	25
4 vs 5	---	241
4 vs 6	---	---
4 vs 7	1.30 N.S.	24
5 vs 6	---	---
5 vs 7	---	---

Figure 1: The sand flounder, *Scophthalmus aquosus*.

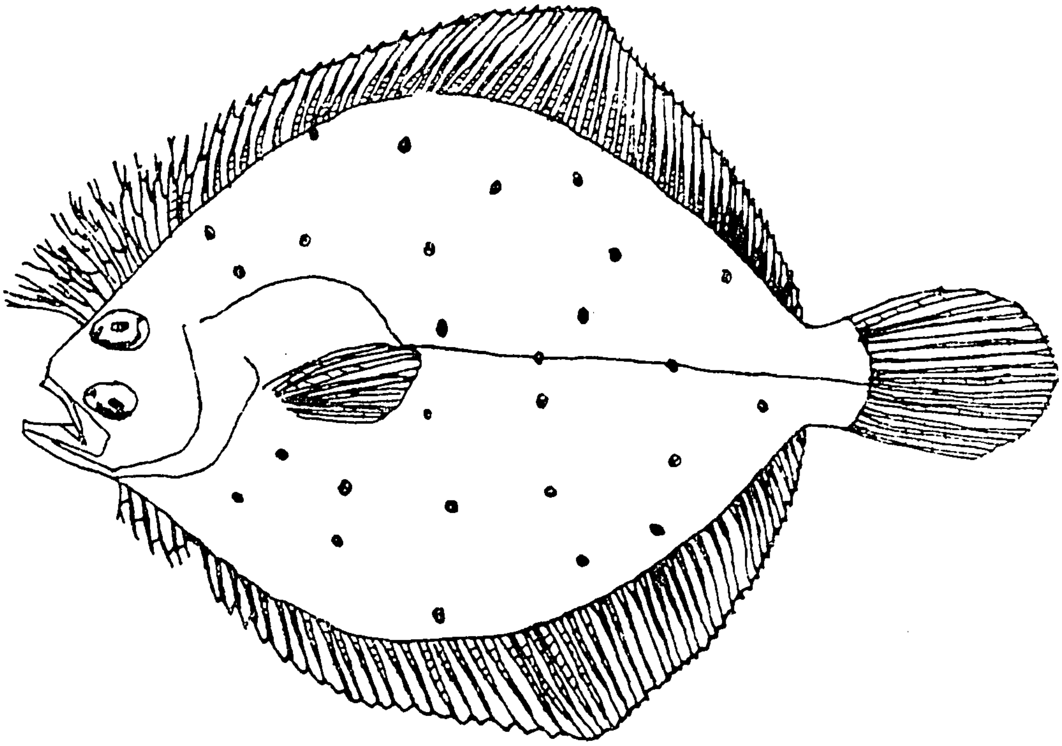
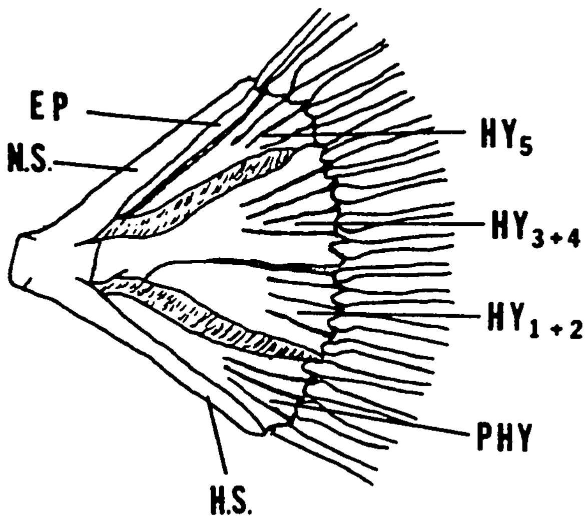


Figure 2A: Hypural plate of a typical bothoid fish. (redrawn from Hemsly and Ahlstom 1984). EP = epural, HY 1-5 = hypurals 1-5, H.S. = haemal spine, N.S. = neural spine, PHY = parhypural,

Figure 2B: Hypural plate of *Scophthalmus aquosus*.

A



B

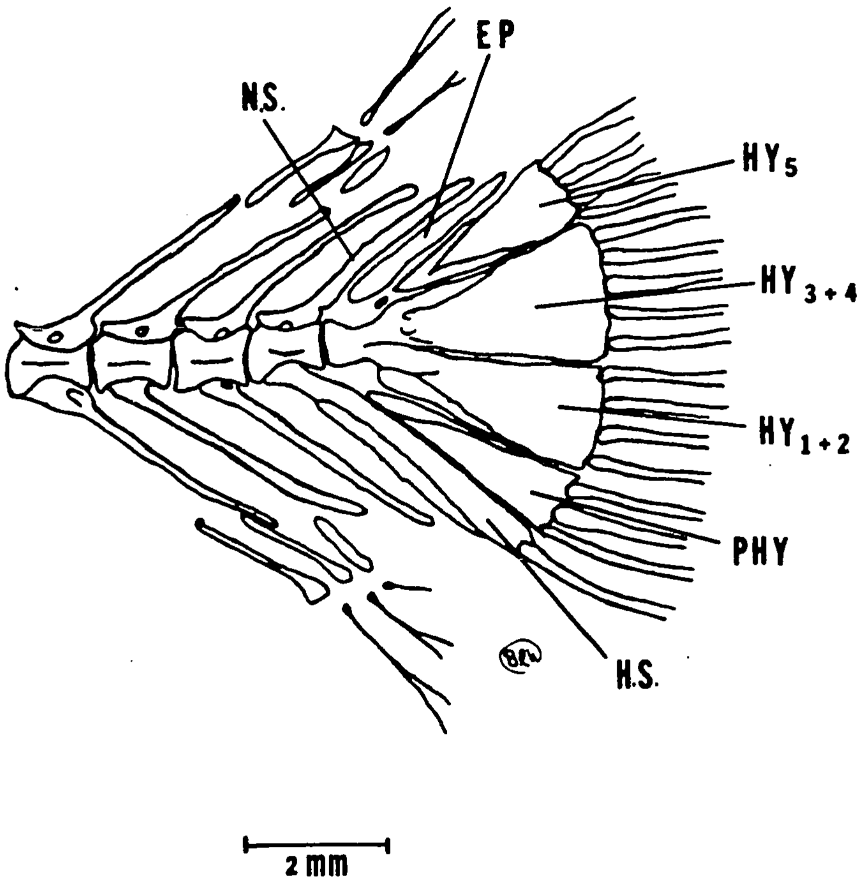


Figure 3: Map of the New York Bight showing sampling locations.

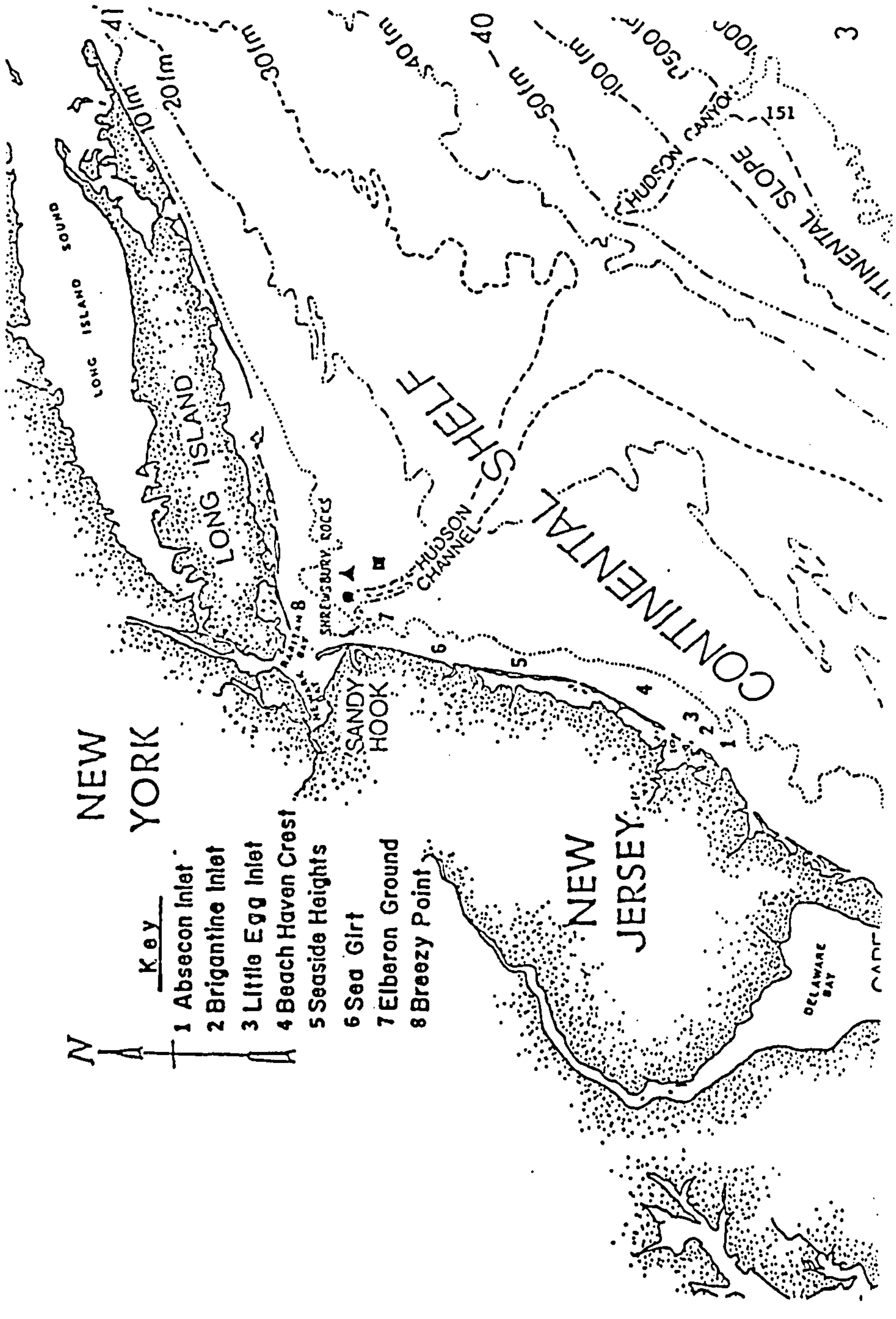

N
Key
1 Absecon Inlet
2 Brigantine Inlet
3 Little Egg Inlet
4 Beach Haven Crest
5 Seaside Heights
6 Sea Girt
7 Elberon Ground
8 Breezy Point
NEW YORK
NEW JERSEY
LONG ISLAND
LONG ISLAND SOUND
SANDY HOOK
SHREWSBURY ROCKS
HUDSON CHANNEL
HUDSON CANYON
CONTINENTAL SHELF
CONTINENTAL SLOPE
DELAWARE BAY
10m
20m
30m
40m
50m
100m
500m
1000m
151

Figure 4: Head of *Scophthalmus aquosus* showing mouth parts. ART = articular, D.F.R. = dorsal fin ray, DN = dentary, MX = maxilla, NA = nasal, PMX = premaxilla

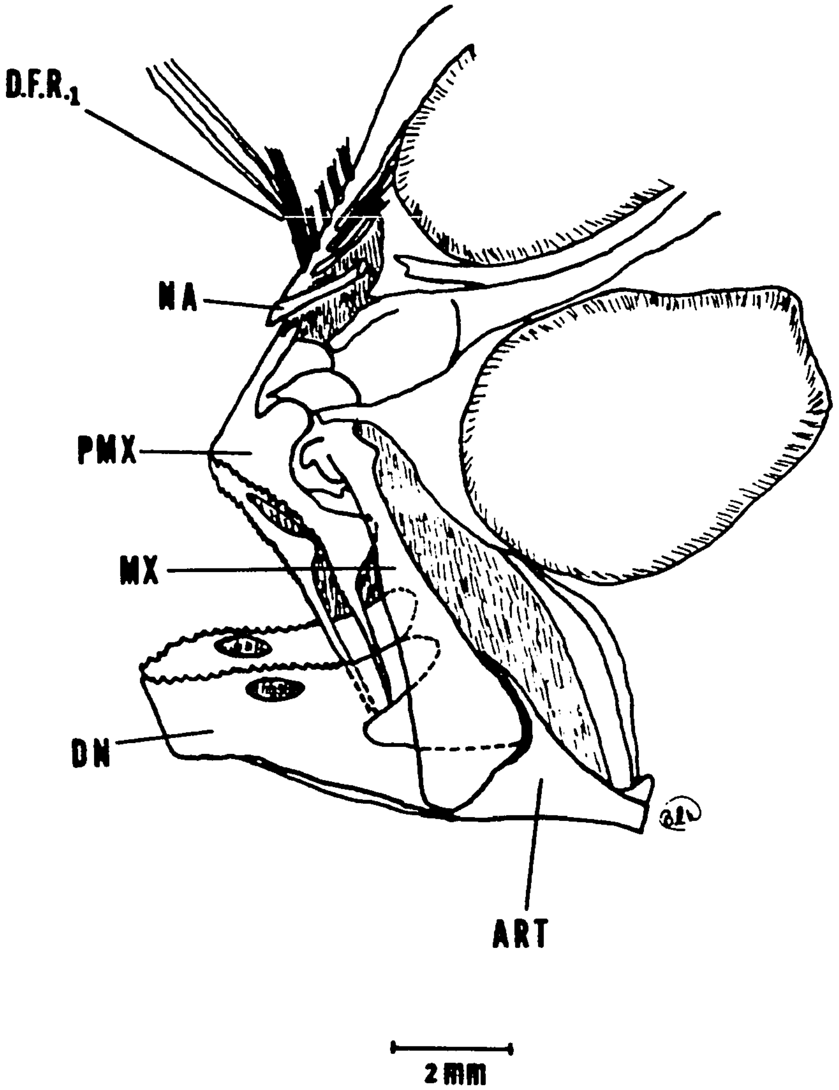

D.F.R.1
NA
PMX
MX
DN
ART
2mm

Figure 5: Gill arches of _Scophthalmus aquosus_ showing the gill rakers and the branchial bones of the first gill arch. BB = basibranchial, CB = ceratobranchial, EB = epibranchial, HB = hypobranchial, G.R. = gill raker

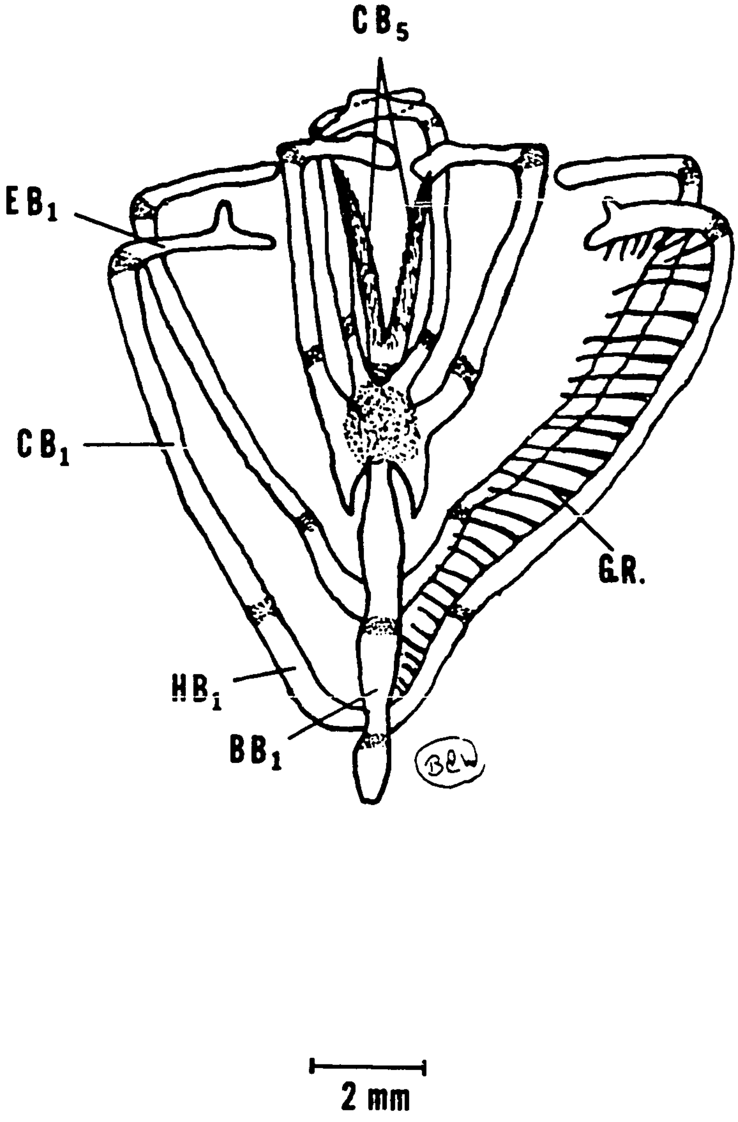

CB5
EB1
CB1
G.R.
HB1
BB1
BCW
2 mm

Figure 6: Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during June 1984.

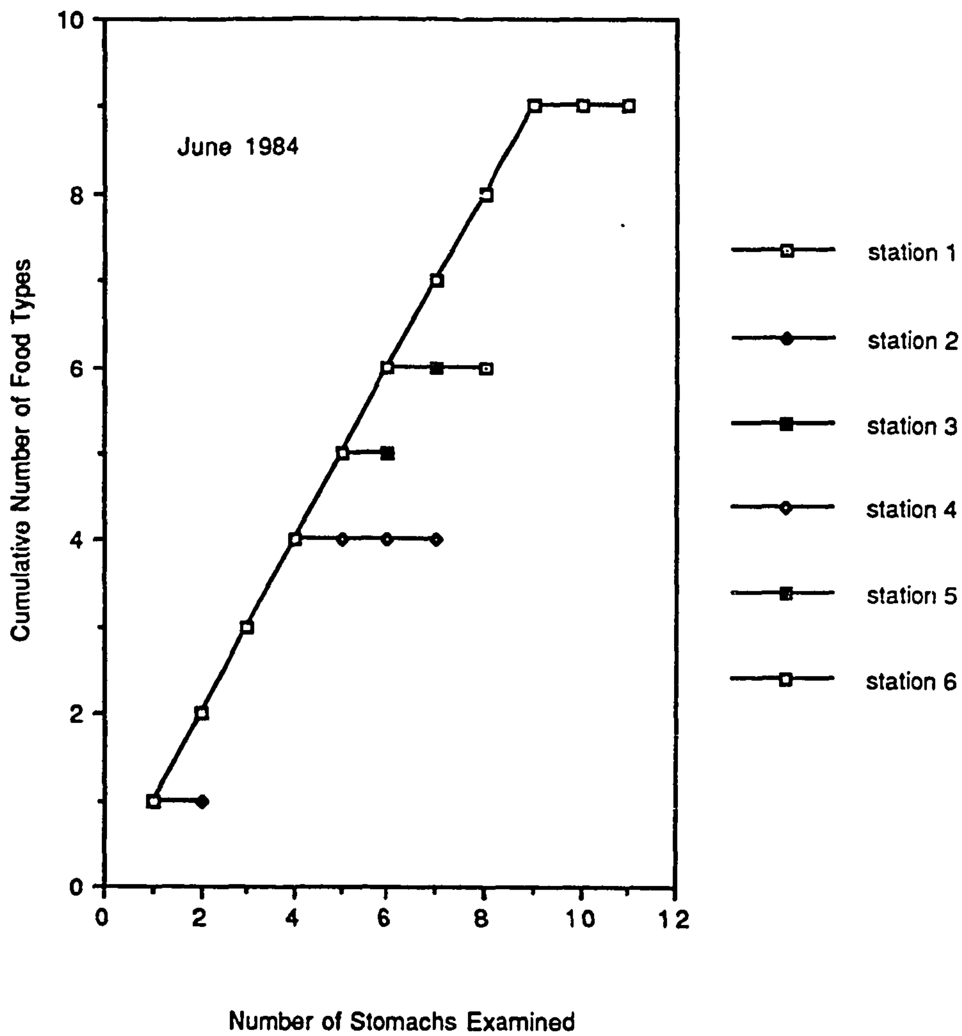
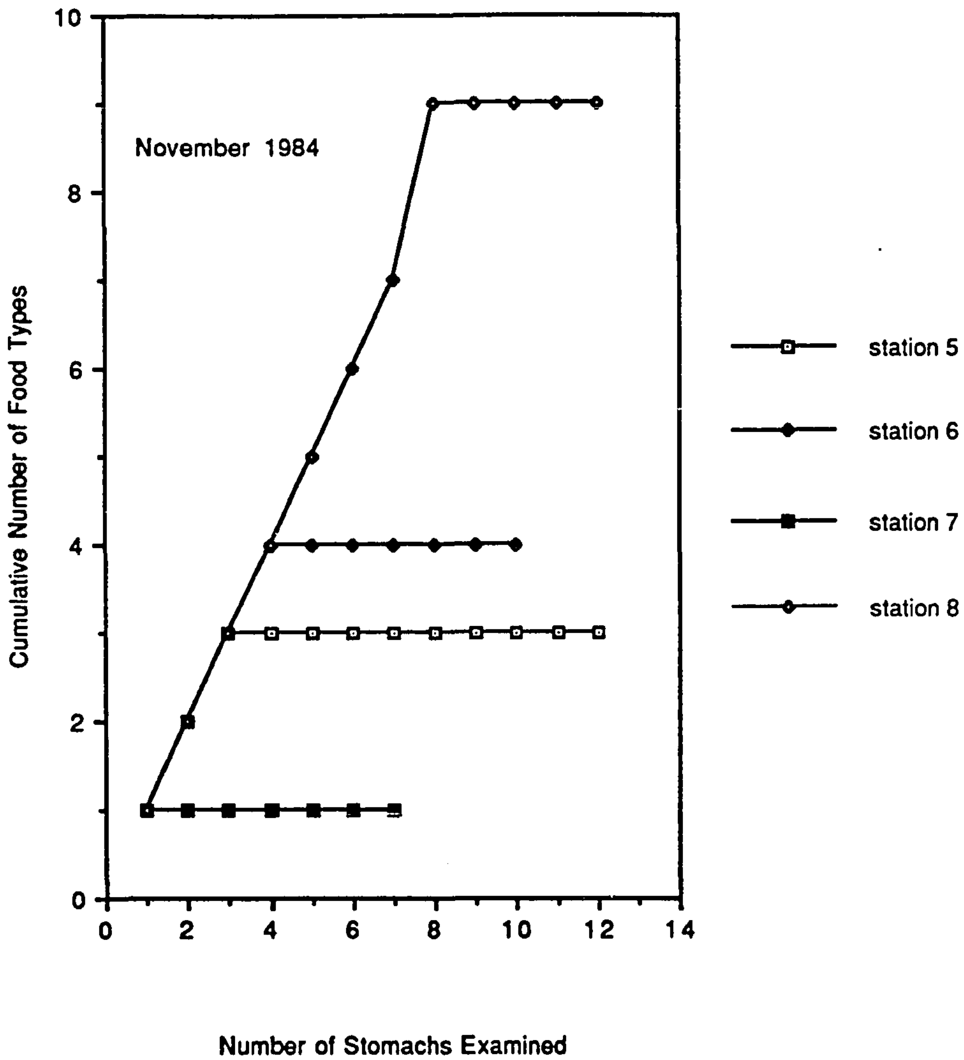

June 1984
Cumulative Number of Food Types
Number of Stomachs Examined
0
2
4
6
8
10
12
station 1
station 2
station 3
station 4
station 5
station 6

Figure 7: Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during November 1984.



November 1984
Cumulative Number of Food Types
Number of Stomachs Examined
0
2
4
6
8
10
12
14
station 5
station 6
station 7
station 8

Figure 8: Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during April 1985.

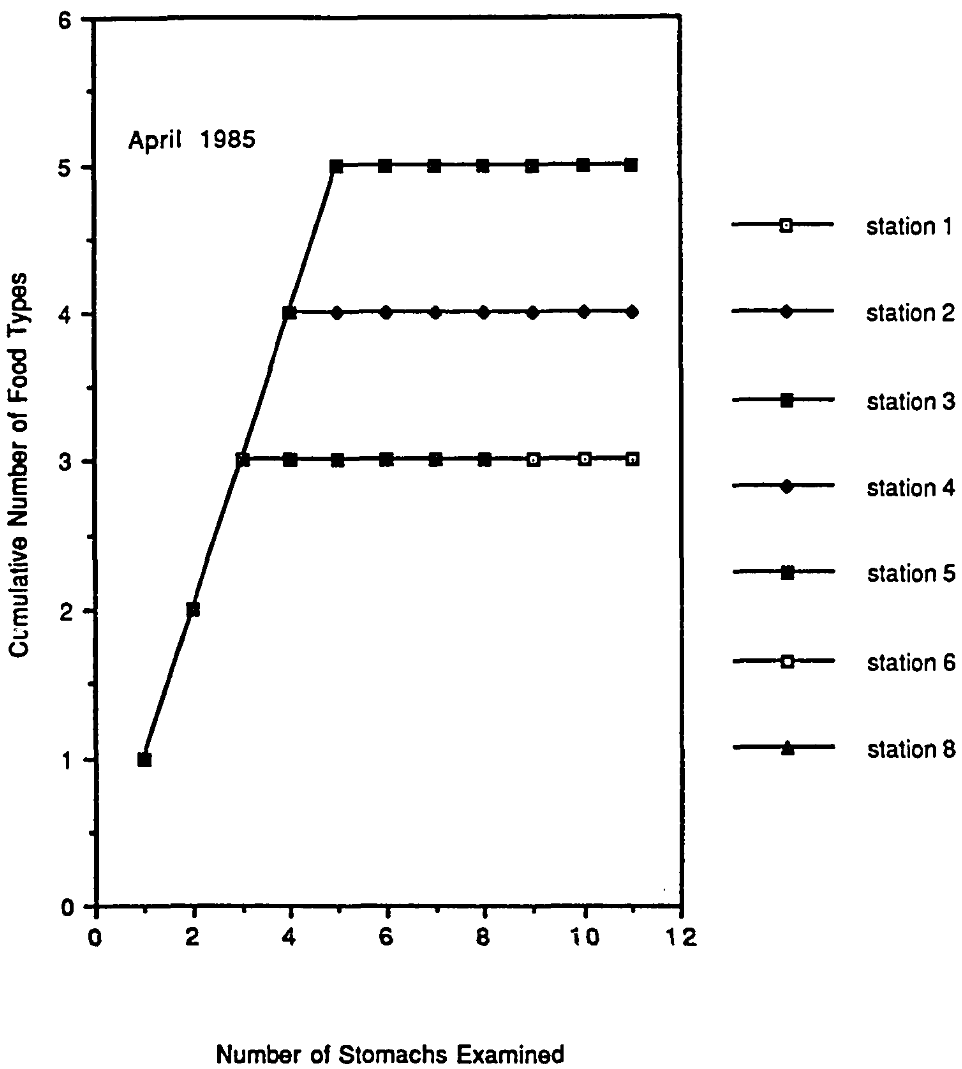
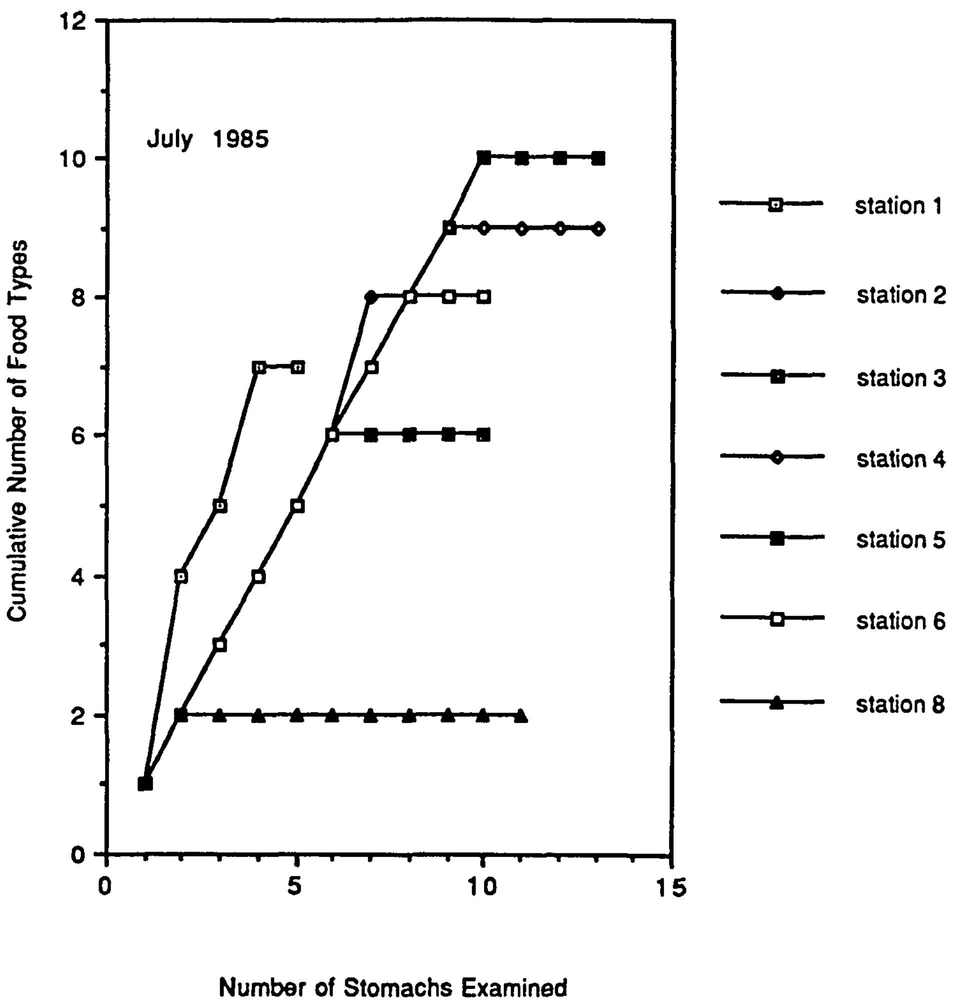

April 1985
Cumulative Number of Food Types
0
1
2
3
4
5
6
0
2
4
6
8
10
12
Number of Stomachs Examined
station 1
station 2
station 3
station 4
station 5
station 6
station 8

Figure 9: Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during July 1985.



12
10
8
6
4
2
0
0
5
10
15
July 1985
Cumulative Number of Food Types
Number of Stomachs Examined
station 1
station 2
station 3
station 4
station 5
station 6
station 8

Figure 10: Cumulative number of food types plotted against the number of stomachs examined, for each station sampled during January 1986.

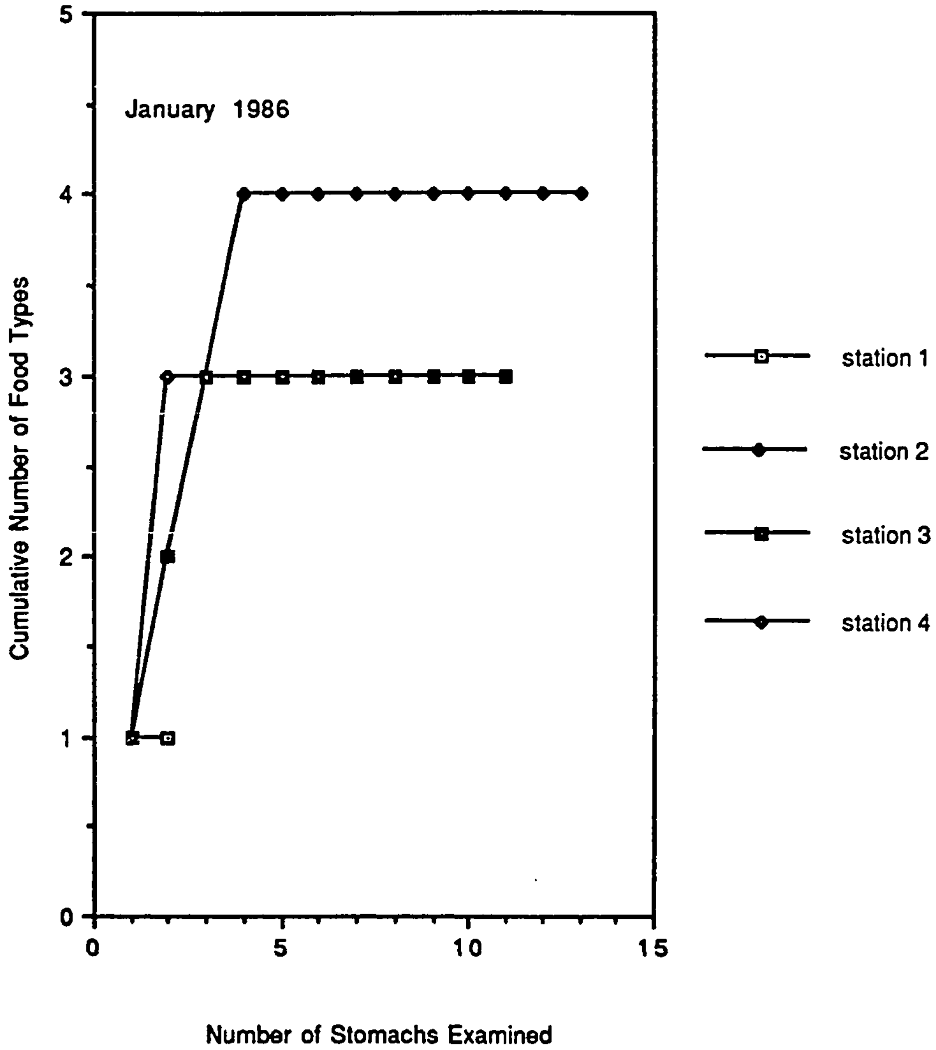

January 1986
Cumulative Number of Food Types
Number of Stomachs Examined
0
1
2
3
4
5
0
5
10
15
station 1
station 2
station 3
station 4

Figure 11: Curves showing the relationship between the diet diversity of the sand flounder and (A) the diet diversity of all fish collected; (B) the number of food types used by all fish; (C) the number of fish species collected.

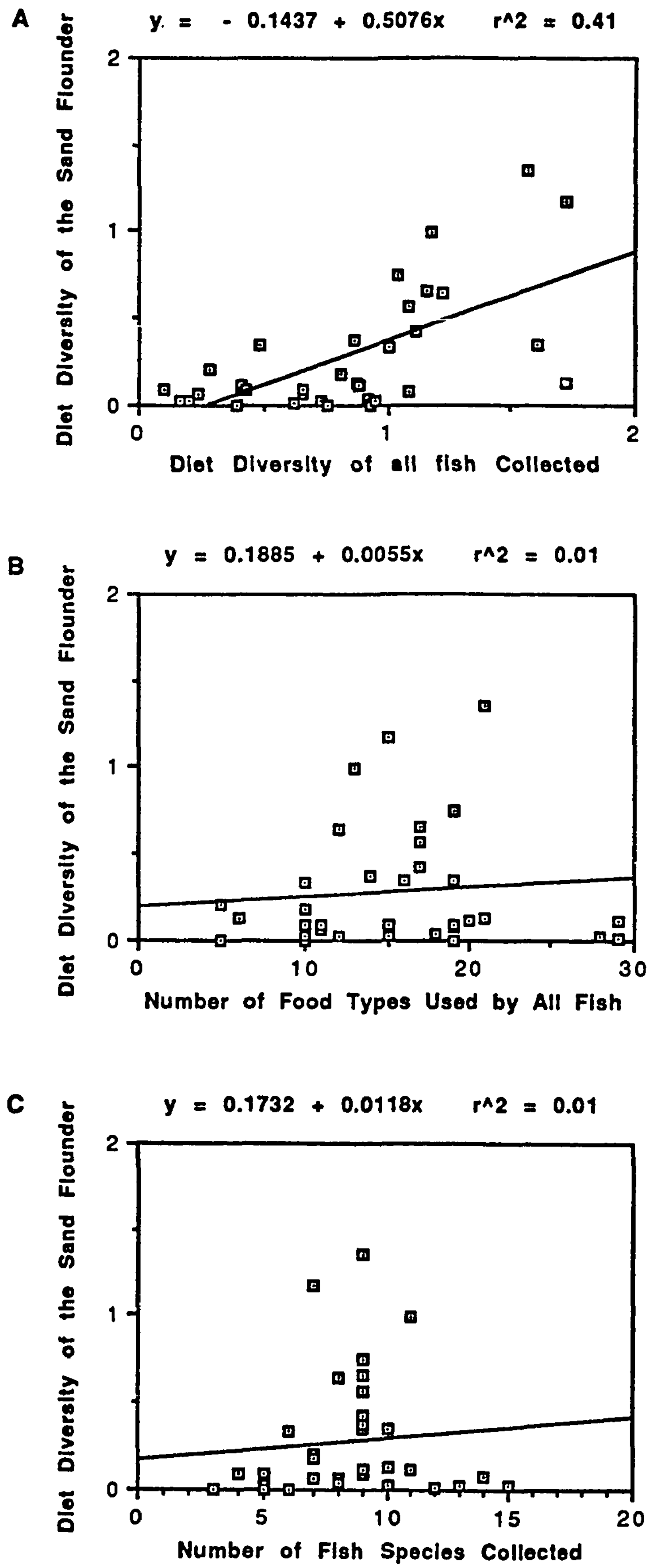

A
y. = - 0.1437 + 0.5076x r^2 = 0.41
Diet Diversity of the Sand Flounder
Diet Diversity of all fish Collected
0
1
2
B
y = 0.1885 + 0.0055x r^2 = 0.01
Diet Diversity of the Sand Flounder
Number of Food Types Used by All Fish
0
10
20
30
C
y = 0.1732 + 0.0118x r^2 = 0.01
Diet Diversity of the Sand Flounder
Number of Fish Species Collected
0
5
10
15
20

Figure 12: Graphs depicting the relationships between (A) mouth length and fish length; (B) mouth width and fish length; (C) gill raker length and fish length; (D) spacing between gill rakers and fish length.

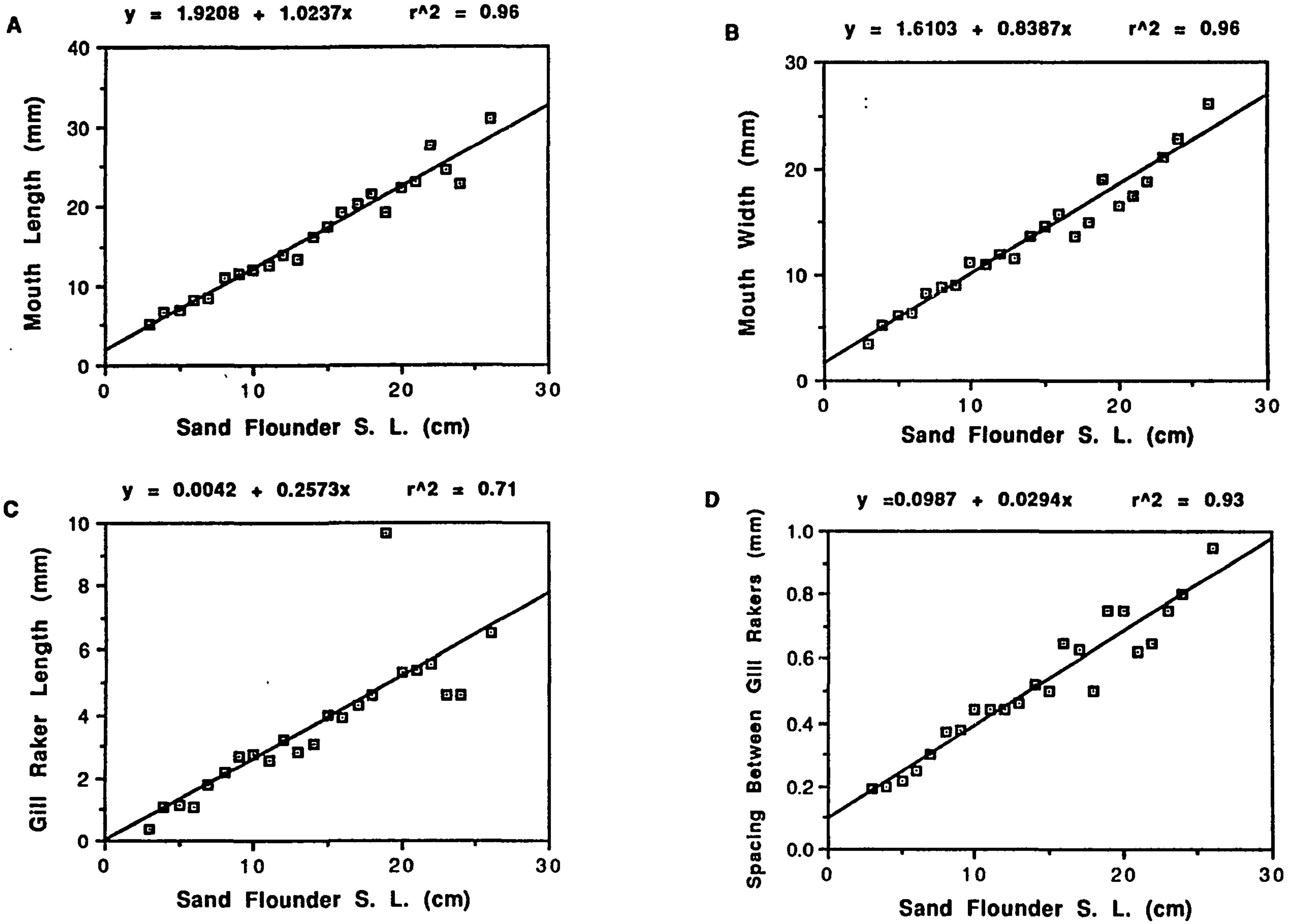

A
y = 1.9208 + 1.0237x r^2 = 0.96
Mouth Length (mm)
Sand Flounder S. L. (cm)
B
y = 1.6103 + 0.8387x r^2 = 0.96
Mouth Width (mm)
Sand Flounder S. L. (cm)
C
y = 0.0042 + 0.2573x r^2 = 0.71
Gill Raker Length (mm)
Sand Flounder S. L. (cm)
D
y =0.0987 + 0.0294x r^2 = 0.93
Spacing Between Gill Rakers (mm)
Sand Flounder S. L. (cm)

Figure 13: Graphs depicting the relationships between prey length and (A) fish length; (B) mouth length; (C) mouth width; (D) gill raker length; (E) spacing between gill rakers.

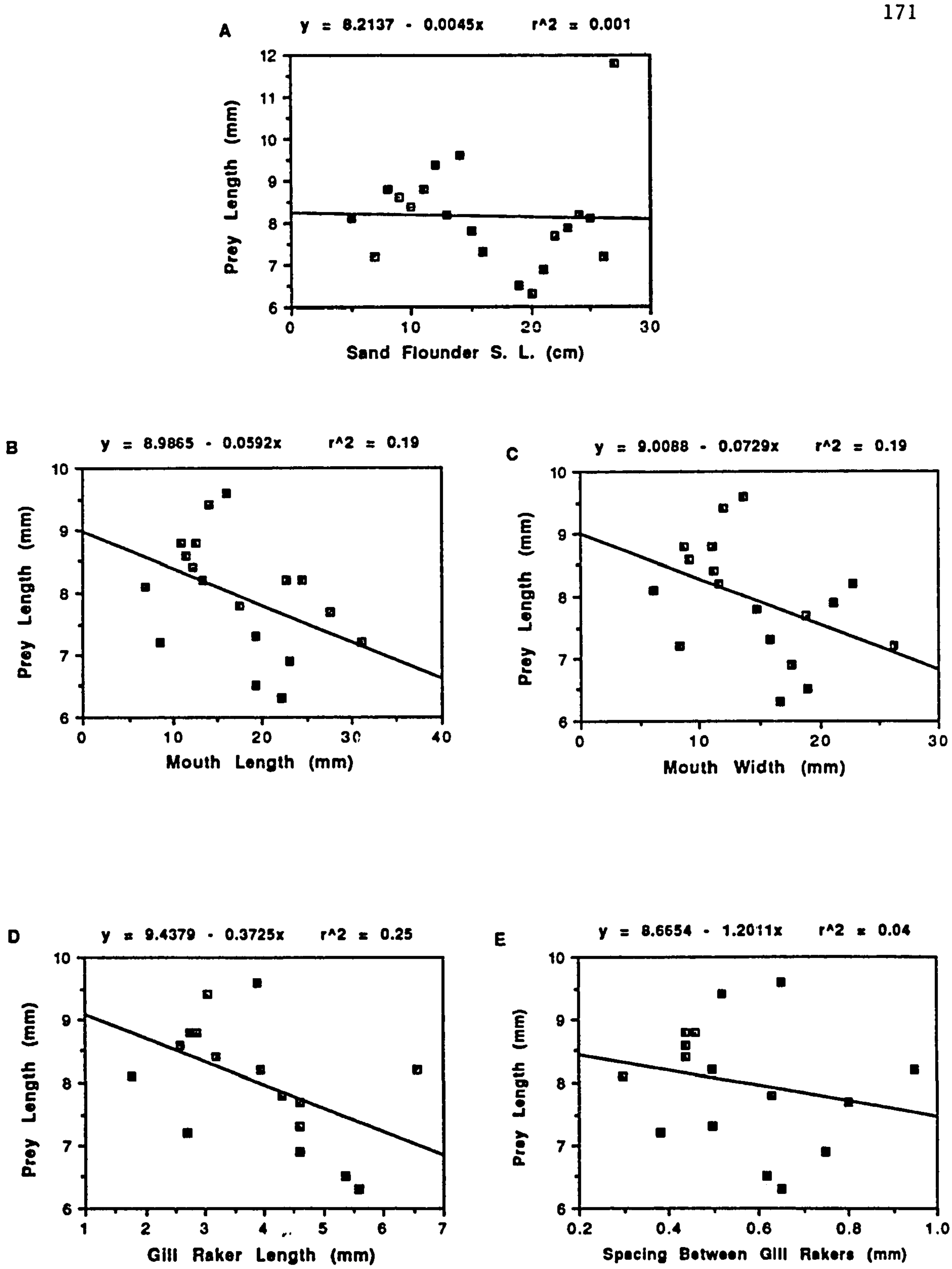

A
y = 8.2137 - 0.0045x
r^2 = 0.001
Prey Length (mm)
Sand Flounder S. L. (cm)
B
y = 8.9865 - 0.0592x
r^2 = 0.19
Prey Length (mm)
Mouth Length (mm)
C
y = 9.0088 - 0.0729x
r^2 = 0.19
Prey Length (mm)
Mouth Width (mm)
D
y = 9.4379 - 0.3725x
r^2 = 0.25
Prey Length (mm)
Gill Raker Length (mm)
E
y = 8.6654 - 1.2011x
r^2 = 0.04
Prey Length (mm)
Spacing Between Gill Rakers (mm)

Figure 14: Graphs depicting the relationships between prey width and (A) fish length; (B) mouth length; (C) mouth width; (D) gill raker length; (E) spacing between gill rakers.

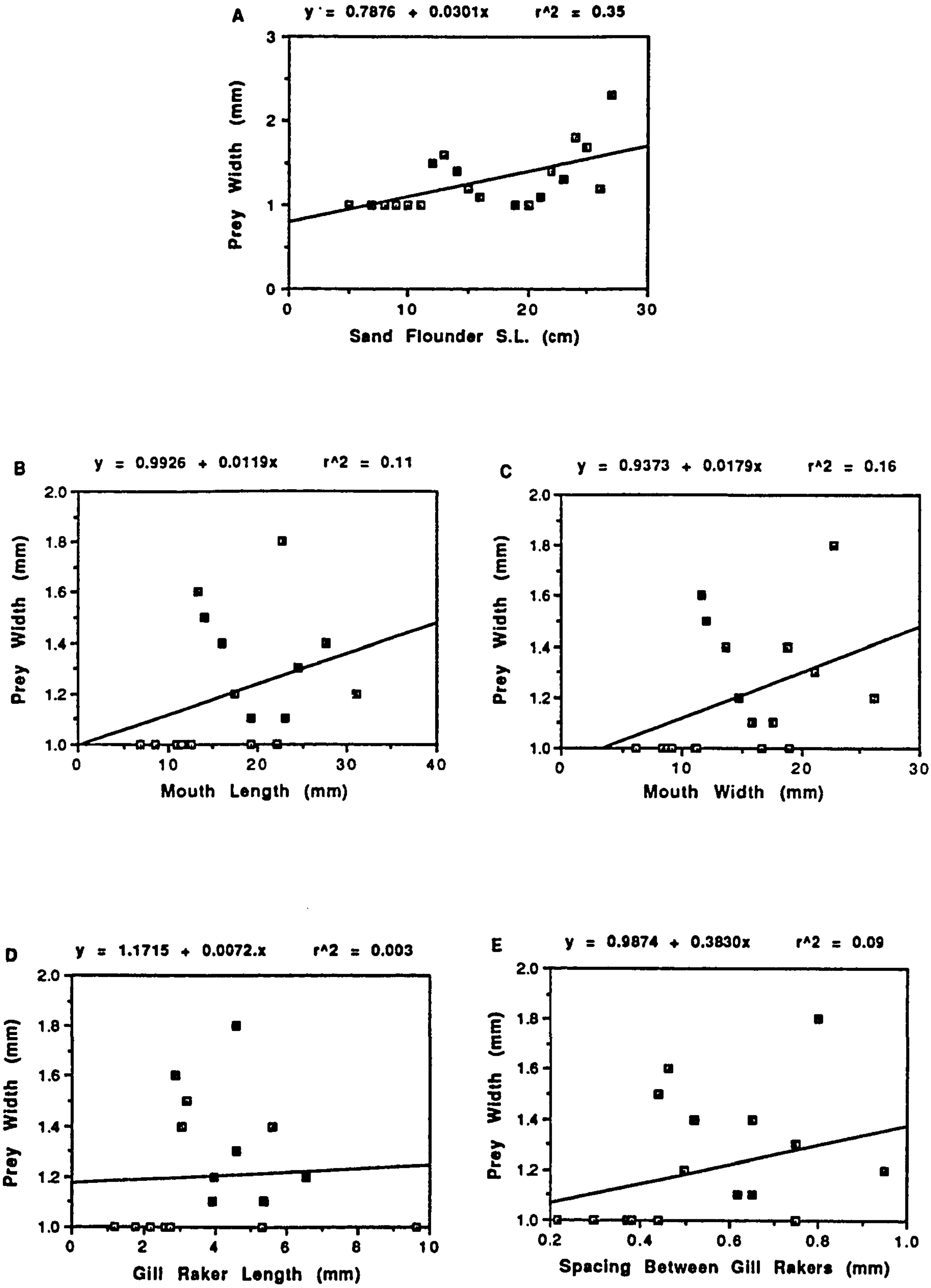

A
y = 0.7876 + 0.0301x r^2 = 0.35
Prey Width (mm)
Sand Flounder S.L. (cm)
B
y = 0.9926 + 0.0119x r^2 = 0.11
Prey Width (mm)
Mouth Length (mm)
C
y = 0.9373 + 0.0179x r^2 = 0.16
Prey Width (mm)
Mouth Width (mm)
D
y = 1.1715 + 0.0072.x r^2 = 0.003
Prey Width (mm)
Gill Raker Length (mm)
E
y = 0.9874 + 0.3830x r^2 = 0.09
Prey Width (mm)
Spacing Between Gill Rakers (mm)

Figure 15: Percentage representation of major food items in the diet of sand flounders of different size classes. (A) % mysids; (B) % shrimps; (C) % crabs (D) % miscellaneous.

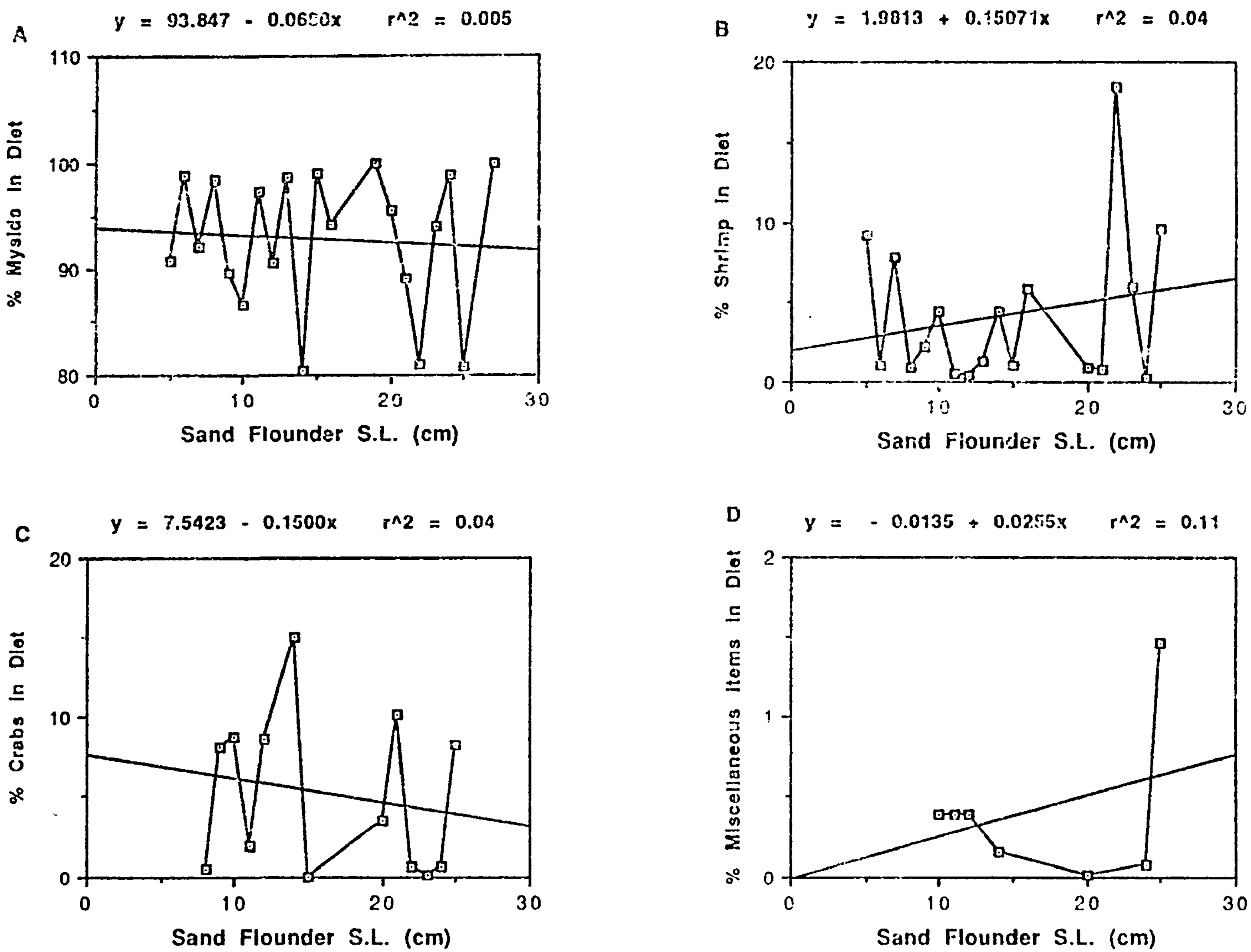

A
y = 93.847 - 0.0680x r^2 = 0.005
% Mysids In Diet
Sand Flounder S.L. (cm)
B
y = 1.9813 + 0.15071x r^2 = 0.04
% Shrimp In Diet
Sand Flounder S.L. (cm)
C
y = 7.5423 - 0.1500x r^2 = 0.04
% Crabs In Diet
Sand Flounder S.L. (cm)
D
y = - 0.0135 + 0.0255x r^2 = 0.11
% Miscellaneous Items In Diet
Sand Flounder S.L. (cm)

Figure 16: Cumulative number of food types plotted against the number of stomachs examined, for each time period sampled.

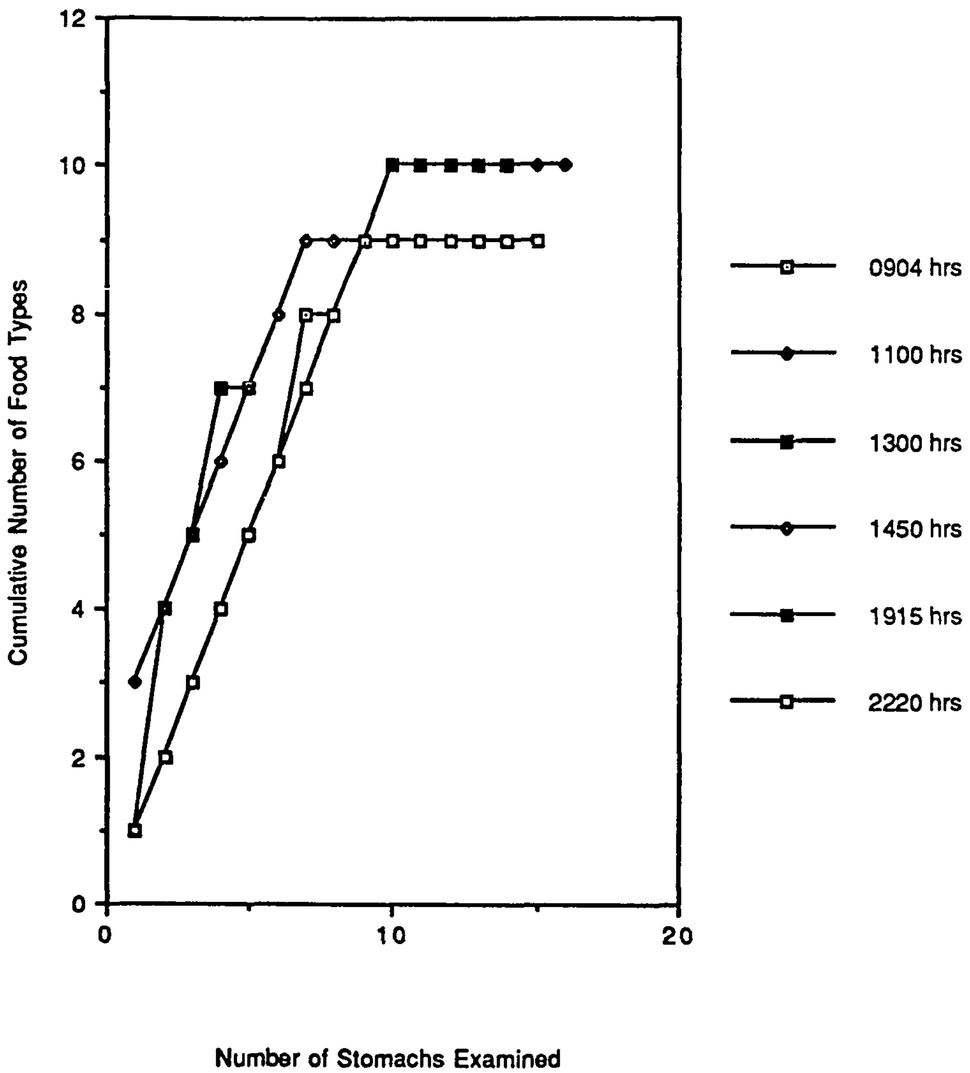
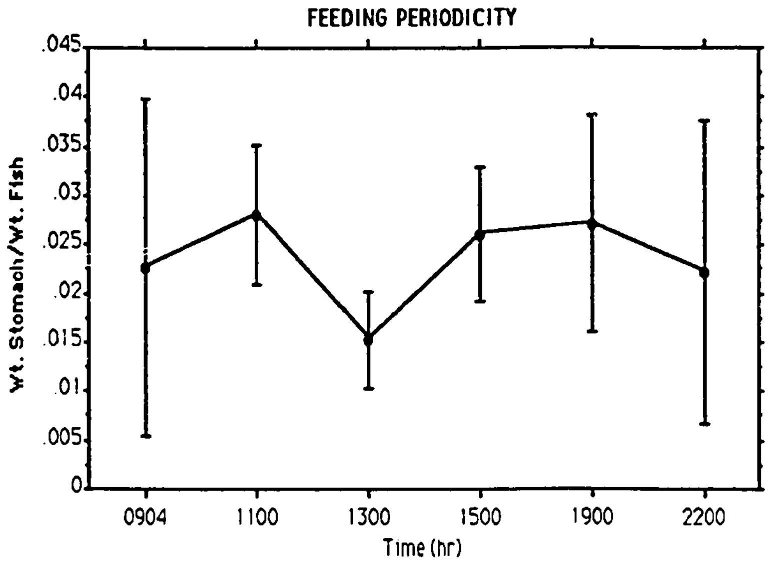

12
10
8
6
4
2
0
Cumulative Number of Food Types
0
10
20
Number of Stomachs Examined
0904 hrs
1100 hrs
1300 hrs
1450 hrs
1915 hrs
2220 hrs

Figure 17: Relationship between stomach fullness and time of collection.


FEEDING PERIODICITY
Wt. Stomach/Wt. Fish
.045
.04
.035
.03
.025
.02
.015
.01
.005
0
0904
1100
1300
1500
1900
2200
Time (hr)

APPENDIX I

Shannon Index of Diversity

$$H' = -\sum_{i=1}^{\infty} p_i \ln p_i$$

Where p = n/N, n is the number of organisms in the ith species,
and N is the total number of organisms in all species present.

Variance of H'

$$s^2 = \frac{\Sigma f_i \log^2 f_i - \frac{(\Sigma f_i \log f_i)^2}{n}}{n^2}$$

Where f_i = the frequency of the ith item,
and n = numbers.

Then:

$$t = \frac{H'_1 - H'_2}{(s_1^2 + s_2^2)^{\frac{1}{2}}}$$

And Degrees of Freedom:

$$DF = \frac{(s^2_{H'_1} + s^2_{H'_2})^2}{\frac{(s^2_{H'_1})^2}{n_1} + \frac{(s^2_{H'_2})^2}{n_2}}$$

Heip Evenness Index

$$E = \frac{[e^{H'} - 1]}{[S - 1]}$$

Where H' = The Shannon Index, and
S = # of species.

APPENDIX II

Manly Index

$$\alpha_i = W_i = \frac{\frac{r_i}{p_i}}{\sum_i \left(\frac{r_i}{p_i}\right)}$$

Where r_i is the proportion of the ith food item in the diet of the species of interest, and p_i is the proportion of the ith food item in the environment.

Relativized Electivity of Vanderploeg & Scavia

$$E_i^* = \frac{W_i - \left(\frac{1}{n}\right)}{W_i + \left(\frac{1}{n}\right)}$$

Where :-

$$W_i = \frac{\frac{r_i}{p_i}}{\sum_i \frac{r_i}{p_i}}$$

And:-

r_i is the proportion of the ith food item in the diet of the species of interest,
p_i is the proportion of the ith food item in the environment,
and n is the number of kinds of food items.

APPENDIX III

Schoener % Overlap

$$\alpha_i = 100\left(1 - \frac{1}{2}\sum_i |p_{x_i} - p_{y_i}|\right)$$

Where p_{xi} and p_{yi} are the proportions of the ith item in x and y respectively.

Morisita Overlap Index

$$\hat{c}\lambda = \frac{2\sum_{i=1}^{s} X_i Y_i}{\sum_{i=1}^{s} X_i^2 + \sum_{i=1}^{s} Y_i^2}$$

Where X_i and Y_i are the proportions of the ith item in X and Y respectively.

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