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INVENTORY OF NEW HAMPSHIRE'S MARINE COASTAL FISHERIES

Prepared for

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by

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INVENTORY OF NEW HAMPSHIRE'S MARINE COASTAL FISHERIES

ABSTRACT

This study was conducted to gather information on the seasonal fluctuation, habitat and food sources of the marine fisheries resources of coastal New Hampshire. Monthly sampling consisted of gill netting at four sites and the use of an otter trawl at three sites.

Of the 23 species captured in the gill nets, pollock, Atlantic cod, cunner and Atlantic herring were the most common. In the trawl 34 species were captured with longhorn sculpin, rainbow smelt, Atlantic herring and winter flounder most prevalent. Atlantic cod (*Gadus morhua)*, stomachs were examined and were found to contain primarily crab, shrimp and fish.

A relatively large number of American lobster were captured as a by-product of the two sampling methods. It was found that only 8.4% were of legal size ($\geq$ 79.4 mm).

INTRODUCTION

New Hampshire's coastal area, though only 18 miles long, has supported a number of fisheries since colonial times. Jackson (1944) provides several descriptions of New Hampshire's coastal fisheries conducted in the 17th and 18th centuries. Species mentioned included: cod, haddock, bass, mackerel, herring, pollock, salmon, flounder, lobsters and crabs, among others. In the late 1600's according to Clark (1970), the Isles of Shoals were inhabited by as many as 1500 fishermen, attesting to the importance of the fishery. Historical catch statistics for New Hampshire, with records beginning in 1880, show cod, cusk, alewives, haddock, white hake, mackerel and lobster as major fisheries (Lyles, 1965).

Limited information is available on the current marine fisheries resources of New Hampshire. The available information (NAI, 1983; TRIGOM-PARC, 1974) is inadequate to properly determine seasonality, condition of the fisheries or develop management plans. Also the presence of New Hampshire's only deep water port, Portsmouth Harbor, with its barge and tanker traffic make these areas vulnerable to contamination by oil and other pollutants. Limited information is available for New Hampshire's coastal areas to mitigate or assess pollution damage.

The objective of this project is to develop and implement an inventory program to provide necessary information on seasonal fluctuation, habitat and food sources of important finfish and shellfish in the inshore waters of New Hampshire.

METHODS

Two types of sampling methods were used during this program - gill nets and trawls. A description of each technique appears below.

Gill Nets

Gill nets were used to sample pelagic finfish species inhabiting the nearshore coastal waters of New Hampshire. Horizontal monofilament gill nets (38 m X 1.8 m)*, consisting of five panels (7.6 m X 1.8 m) of variable square mesh sizes (1.3 cm, 1.9 cm, 3.2 cm, 6.4 cm and 10.2 cm) were set for a 24 hour period, monthly (October, 1982 - August, 1983) at four stations (Table 1 and Figure 1). One net array, consisting of near-surface, mid-depth and near-bottom nets, was set at each station. The three gill nets were attached to lines held vertical in the water column by anchors and buoys, in water depths of approximately 15 m - 18 m.

Otter Trawls

Trawling was used to sample demersal finfish inhabiting the nearshore coastal waters of New Hampshire. Replicate (2) five minute trawls, using a shrimp try net (12.2 m head rope; 13.7 m foot rope; 3.8 cm square mesh nylon body; 0.3 cm square mesh cod end liner; 0.5 m X 0.9 m oak otter doors), were conducted monthly (October, 1982 - August, 1983) at three stations (Table 1 and Figure 1). Trawls were conducted on bottom in approximately 6 m of water at stations T1 and T2 and on bottom in approximately 27 m of water at T3.

Sample Processing and Data Analysis

Finfish captured by each method were identified and measured for total length (to the nearest one-half centimeter). The total weight of each species captured was recorded to the nearest gram. Stomachs were removed from Atlantic cod (*Gadus morhua)* and placed in 10% buffered formalin for laboratory analysis. In the laboratory, stomach contents were separated, identified and the wet weight was determined (to the nearest one-tenth gram) for each taxon present.

* See Appendix Table I for English conversion.

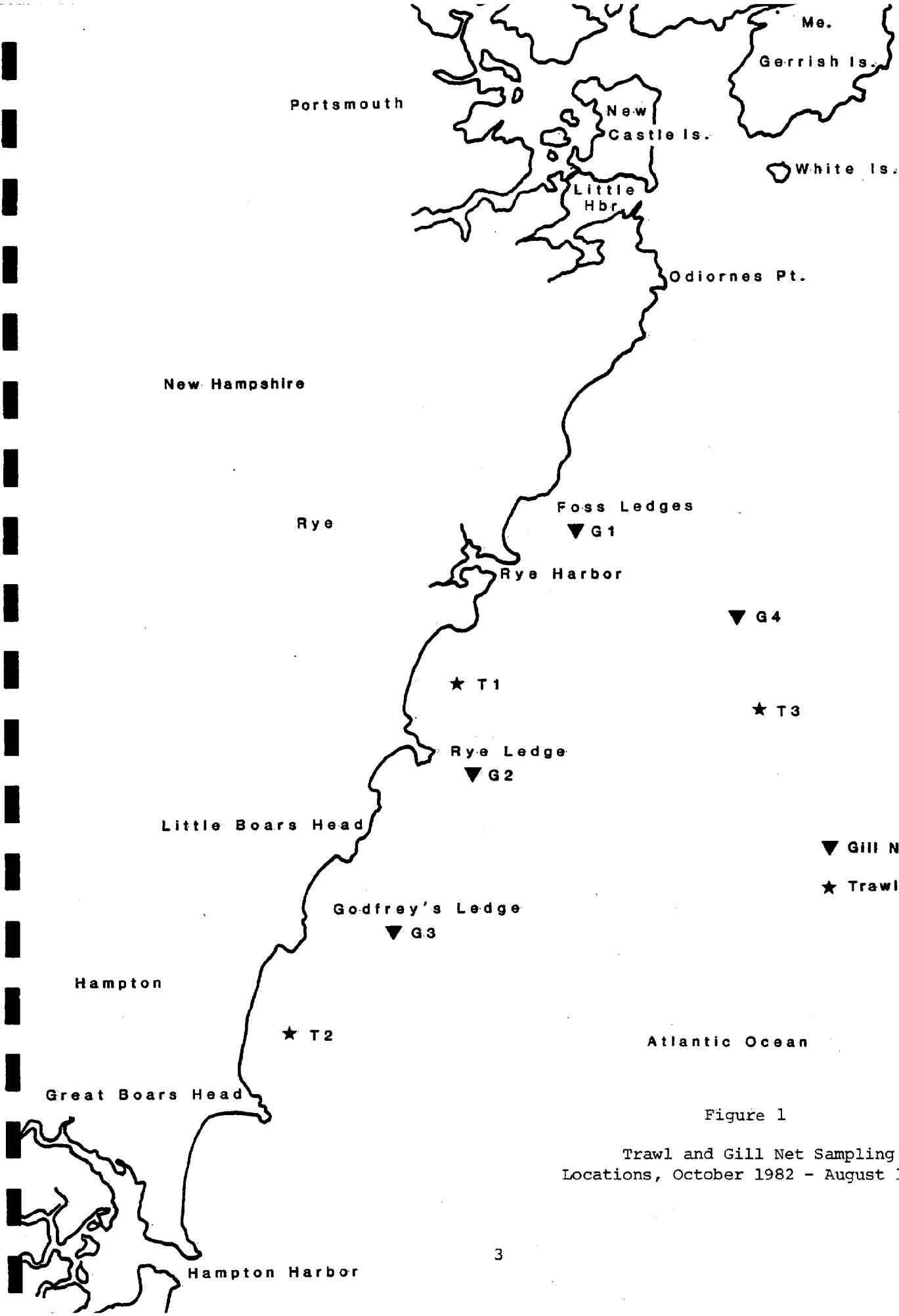


Figure 1

Trawl and Gill Net Sampling Locations, October 1982 - August 1983

Table 1. Coastal Nearshore Fisheries Sampling Schedule, October 1982 - August 1983.

		1982			1983							
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.
Gill Net Stations												
Foss Ledge	-G1	X	X	X	X	X	X	X	X	X	X	X
Rye Ledge	-G2	X	X	X	X	*	X	X	X	X	X	X
Godfrey's Ledge	-G3	X	X	X	X	*	X	X	X	X	X	X
In-Shore	-G4	X	X	X	X	*	X	X	X	X	X	X
Trawl Stations												
Jenness Beach	-T1	X	X	X	X	X	X	X	X	X	X	X
North Beach	-T2	X	X	X	X	X	X	X	X	X	X	X
In-Shore	-T3	X	X	X	X	X	X	X	X	X	X	X

* = Not sampled due to inclement weather.

Selected species were chosen for discussion based on their abundance, value and/or importance. Catch indices were calculated for the selected species and compared for seasonal trends and spatial distribution.

Crustacea

The American lobster *(Homarus americanus)* and the Jonah crab *(Cancer borealis)* were captured as a by-product of each sampling method. Lobsters were measured for carapace length (from the rear of the eye socket along a parallel line to the carapace center line to the posterior edge of the carapace) to the nearest millimeter. Jonah crabs were measured laterally at the widest point of the carapace, also to the nearest millimeter. Total weight was taken for each species to the nearest gram.

Incidental catches of shrimp and other invertebrates by trawling were preserved in 10% buffered formalin or frozen. In the laboratory, species were separated and enumerated. Major species were measured using an ocular micrometer from the rear of the eye socket along a parallet line to the carapace center line to the posterior edge of the carapace. Identifications were aided by Williams (1974) and Gosner (1971).

RESULTS

Gill Nets

During the sampling period (October, 1982 - August, 1983) twenty-three species of finfish were identified from a total gill net catch of 640 individuals (Table 2 and Appendix Table 2). Maximum catch (191) occurred in October and the minimum catch (3) in February.

Species composition was variable during the sampling period. In order of their total abundance, the major species captured were: pollock *(Pollachius virens)* [145], Atlantic cod *(Gadus morhua)* [79], cunner *(Tautogolabrus adspersus)* [75], and Atlantic herring *(Clupea harengus)* [73] (Appendix Table 2).

Pollock, Atlantic cod and cunner were found at all gill net stations with no apparent station differences, while Atlantic herring, though found at all stations, were most abundant at Station G1 (Figure 1 and Appendix Table 3).

No significant differences could be determined in catch data between months; however, some generalizations can be made. Atlantic cod and cunner were present all sampling months, except January and February. Atlantic cod were most abundant during the fall while cunner were most prevalent during May. Atlantic herring were present October through January and in April, but highest abundances occurred during October and November. Pollock, present all sampling months except March, June and July, were most abundant in October (Figure 2).

Table 2. Finfish Species List, October 1982 - August 1983

Common Name	Scientific Name	Gill Net	Trawl
Spiny dogfish	*Squalus acanthias*	X	
Little skate	*Raja erinacea*	X	X
Winter skate	*Raja ocellata*		X
Thorny skate	*Raja radiata*		X
Blueback herring	*Alosa aestivalis*	X	X
Alewife	*Alosa pseudoharengus*	X	X
Atlantic menhaden	*Brevoortia tyrannus*	X	
Atlantic herring	*Clupea harengus harengus*	X	X
Bay anchovy	*Anchoa mitchilli*		X
Rainbow smelt	*Osmerus mordax*	X	X
Atlantic cod	*Gadus morhua*	X	X
Haddock	*Melanogrammus aeglefinus*		X
Silver hake	*Merluccius bilinearis*	X	X
Pollock	*Pollachius virens*	X	X
Red hake	*Urophycis chuss*	X	X
Spotted hake	*Urophycis regius*		X
White hake	*Urophycis tenuis*		X
Ocean pout	*Macrozoarces americanus*	X	X
Atlantic silverside	*Menidia menidia*		X
Northern pipefish	*Syngnathus fuscus*		X
Black sea bass	*Centropristis striata*	X	X
Cunner	*Tautogolabrus adspersus*	X	X
Rock gunnel	*Pholis gunnellus*		X
Atlantic wolffish	*Anarhichas lupus*	X	X
American sand lance	*Ammodytes americanus*		X
Atlantic mackerel	*Scomber scombrus*	X	
Northern searobin	*Prionotus carolinus*		X
Sea raven	*Hemitripterus americanus*	X	X
Grubby	*Myoxocephalus aenaeus*		X
Longhorn sculpin	*Myoxocephalus octodecemspinosus*	X	X
Shorthorn sculpin	*Myoxocephalus scorpius*	X	X
Alligatorfish	*Aspidophoroides monopterygius*		X
Lumpfish	*Cyclopterus lumpus*	X	
Seasnail	*Liparis atlanticus*		X
Summer flounder	*Paralichthys dentatus*	X	
Fourspot flounder	*Paralichthys oblongus*		X
Windowpane	*Scophthalmus aquosus*		X
Yellowtail flounder	*Limanda ferruginea*	X	X
Winter flounder	*Pseudopleuronectes americanus*	X	X
Total Species 39		23	34

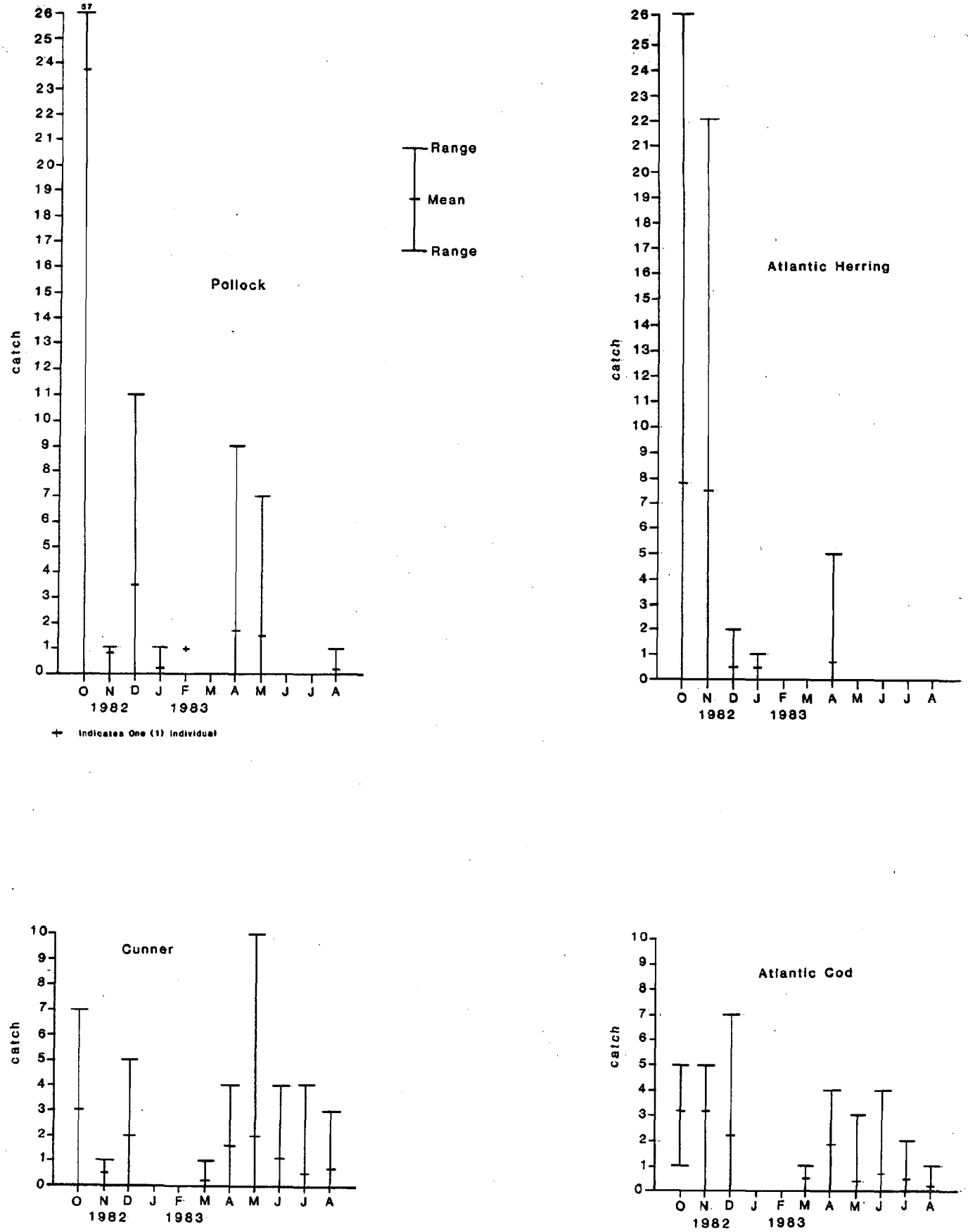


Figure 2

Monthly Mean and Range of Selected Finfish Species
Captured by Gill Net, October 1982 - August 1983

Catch differential at the various net depths was apparent (Appendix Table 4). Atlantic herring catch in the near-surface nets was 56.2% of the total. Near-bottom nets caught 51.9%, 54.5% and 65.3% of Atlantic cod, pollock and cunner, respectively.

Total length data for the species discussed above are relatively constant, with no distinctive patterns emerging (Figure 3). Range of total lengths of the selected species indicated that gill nets caught more adults than juveniles.

Other species captured during the sampling period varied widely in abundance and occurrence (Appendix Table 2). Silver hake (*Merluccius bilinearis)*, red hake (*Urophycis chuss)* and longhorn sculpin *(Myoxocephalus octodecemspinosus)* were found at all gill net stations. Silver hake and red hake were more abundant during the fall and summer, respectively, while longhorn sculpin were found in low but constant numbers during most months.

Otter Trawls

Thirty-four species of finfish were captured by otter trawls, from October, 1982 through August, 1983 (Table 2 and Appendix Table 5). Maximum catch (215) occurred in March and the minimum catch (22) was in January.

During the sampling period the species composition of the trawl catch varied. The most common species in order of their total abundance were: longhorn sculpin (287), rainbow smelt (*Osmerus mordax)* [272], Atlantic herring (171) and winter flounder (*Pseudopleuronectes americanus)*[161] (Appendix Table 4).

Rainbow smelt and winter flounder were present at all trawl stations, but were most abundant at Stations T2 and T3, respectively (Appendix Table 4, and Figure 1). Atlantic herring, present at Stations T1 and T2, were most abundant at the latter station. Longhorn sculpin were found at Stations T2 and T3, with all but one (1) being captured at Station T3.

Longhorn sculpin and winter flounder were found during all sampling months, with peak abundances occuring in June and August, respectively (Figure 4). Rainbow smelt were present October through April, with highest numbers occurring during December. Atlantic herring were present November, December, March and April, but were most common during April.

Total length data were fairly consistent, with no apparent seasonal trends (Figure 5). The range of total lengths for longhorn sculpin and winter flounder, indicates the presence of both pre-adults and adults, in the catch at various times of the year. Total length data show only young-of-the-year and juveniles

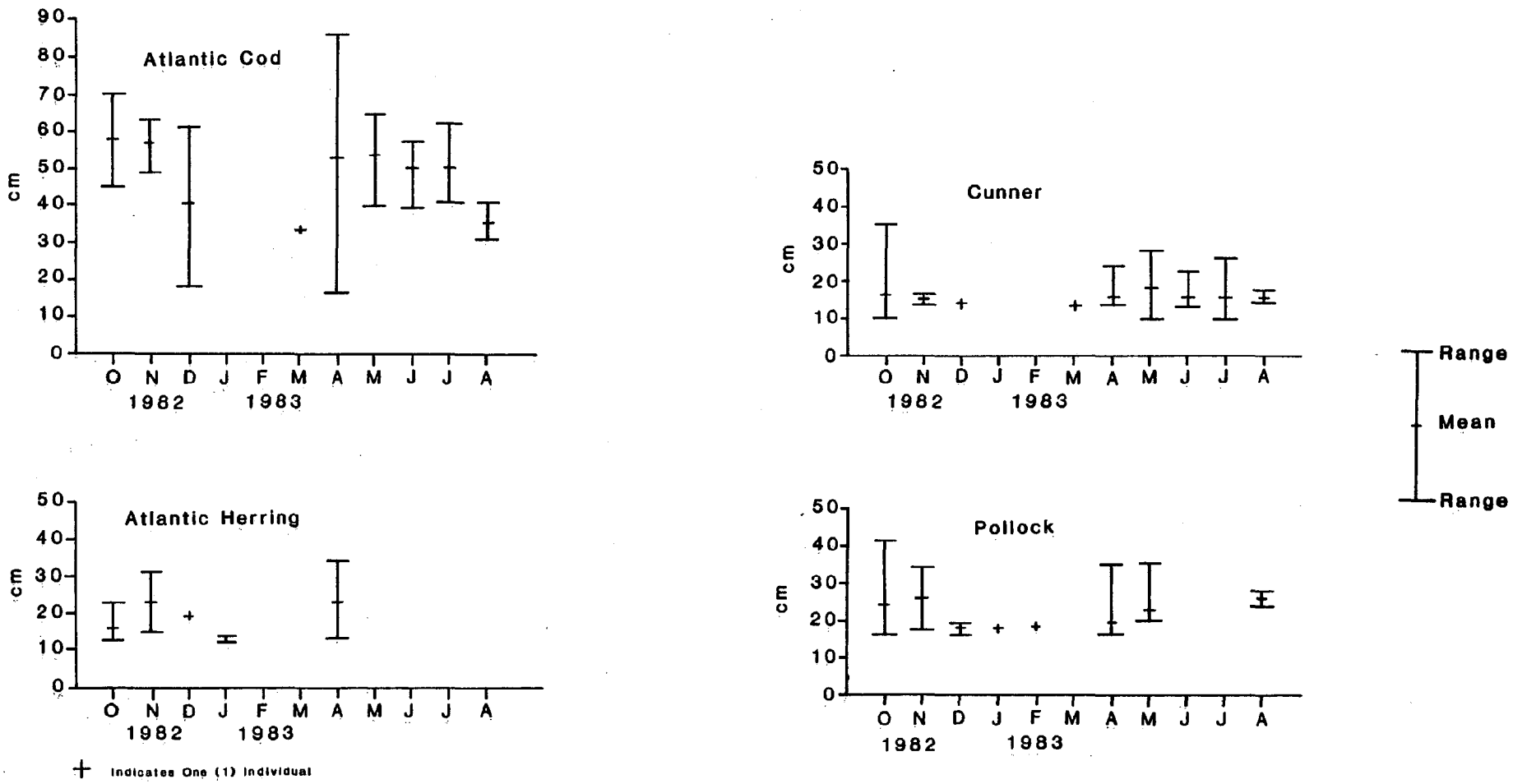


Figure 3

Monthly Mean and Range of Selected Finfish Total Lengths (cm)
Captured by Gill Net, October 1982 - August 1983

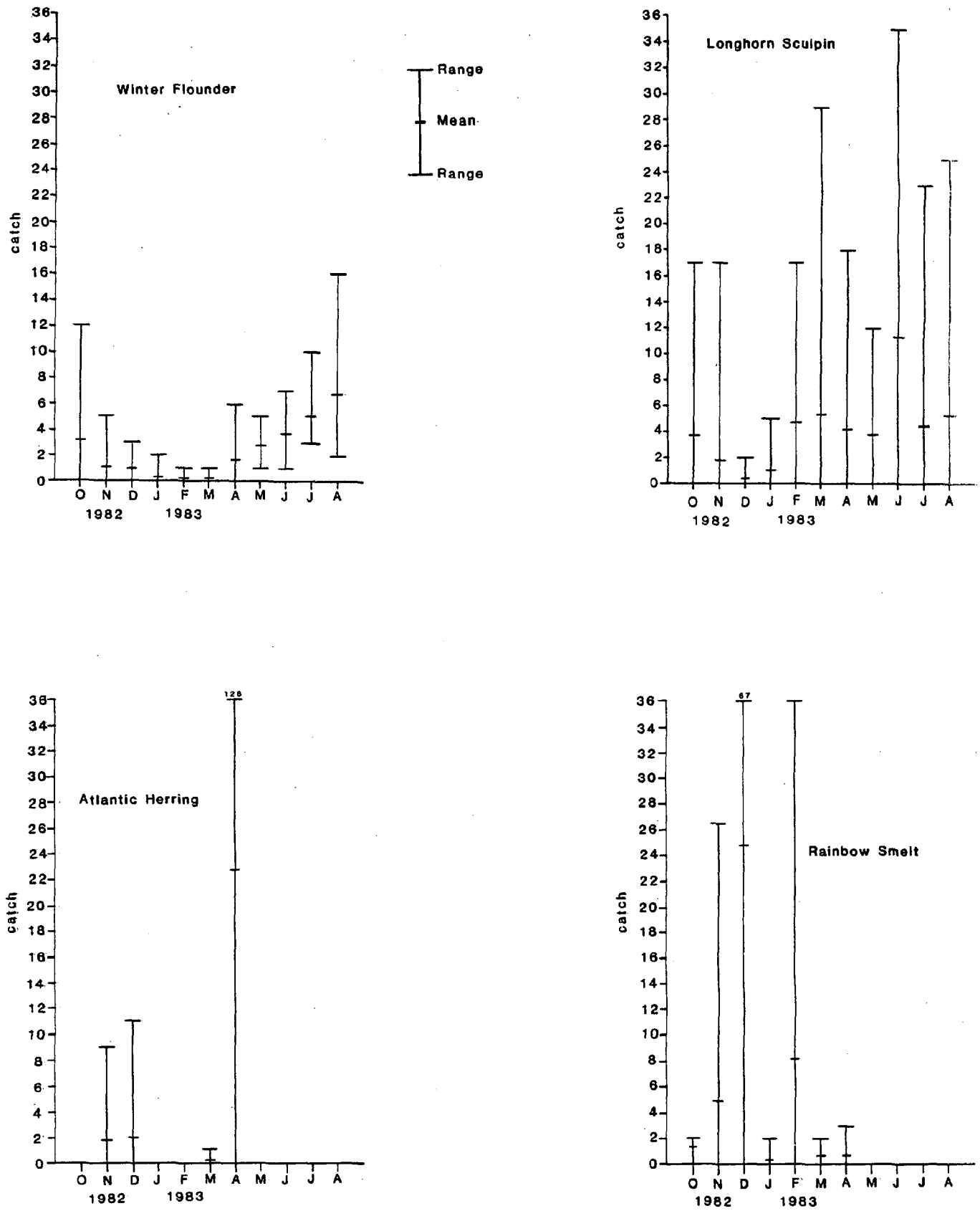


Figure 4

Monthly Mean and Range of
Selected Finfish Species Captured by
Trawl, October 1982 - August 1983

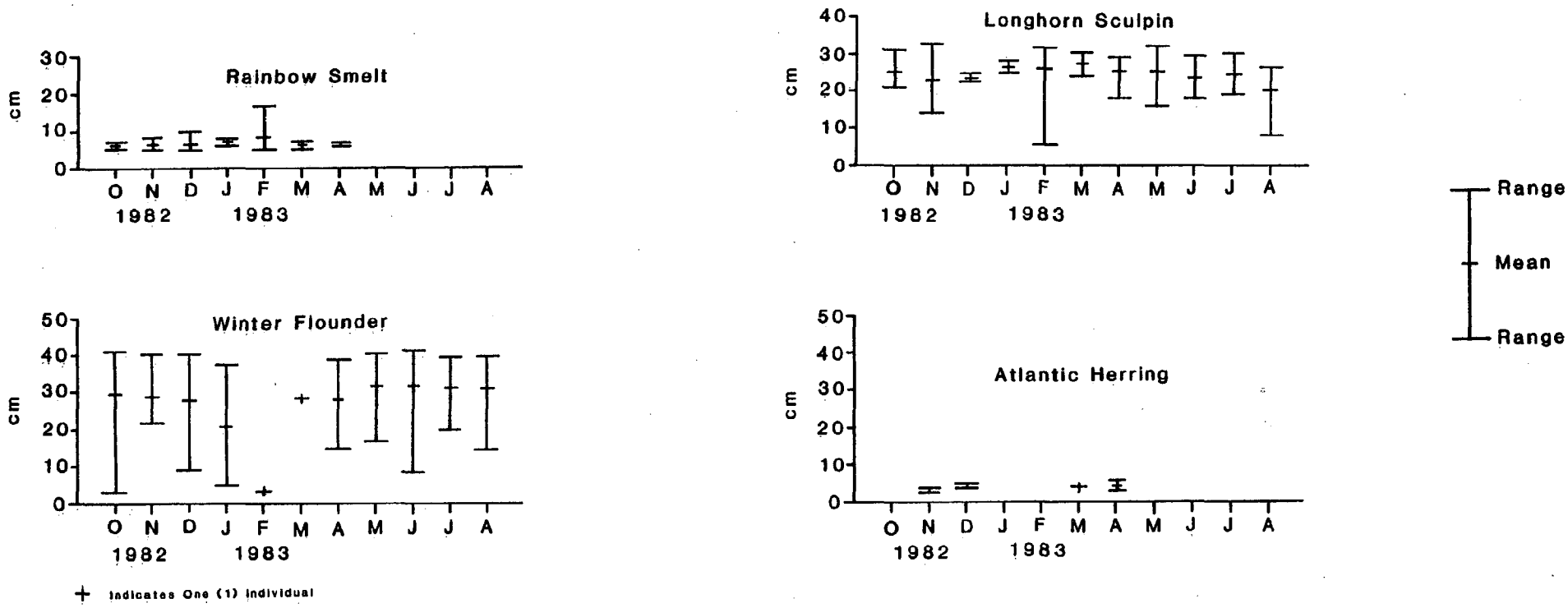


Figure 5

Monthly Mean and Range of Selected Finfish Total Lengths (cm)
Captured by Trawl, October 1982 - August 1983

of Atlantic herring and rainbow smelt present in the catch. The only exception was when adult smelt were captured in February.

Other species captured varied in abundance and occurrence (Appendix Table 5). Little skate *(Raja erinacea)* and windowpane *(Scophthalmus aquosus)* were present at all trawl stations and were abundant during the warmer months.

Crustacea

The American lobster *(Homarus americanus)* and Jonah crab *(Cancer borealis)* were incidental to the gill net and trawl catch.

Two hundred fifty-one lobsters were captured during the sampling period, with 79.3% caught in the otter trawl (Table 3). Lobsters were caught at all gill net and trawl stations, but were most prevalent at G2, G3, T1 and T2 (Figure 1).

The sex ratio of lobsters (females:males) varied in the monthly catch, but overall was 1.00:1.16 (Table 3). The mean monthly carapace length for all lobsters captured was relatively consistent during the sampling period (Figure 6). The most abundant size class captured were those lobsters with a carapace length between 61 - 65 mm, for both females and males (Figure 7). For all lobsters captured 8.4% were legal size ($\geq$ 79.4 mm).

Sixty-one Jonah crabs were captured during the sampling period, with 57.4% caught in trawls. Jonah crabs were present at all gill net stations and all trawl stations, except T3 (Figure 1). The most abundant size class captured were those Jonah crabs with a carapace length between 101 - 105 mm (Figure 8).

Incidental Invertebrates

The incidental invertebrate catch consisted of crustacea, including: six species of isopods, 14 species of amphipods, two mysid species and nine species of decapods (Table 4). *Strongylocentrotus droebachiensis,* a sea urchin and *Ischnochiton ruber,* a chiton were also present. The two mysids were present in the highest concentrations, followed by the sand shrimp *Crangon septemspinosa* and *Dichelopandalus leptocerus* (Table 5).

C. septemspinosa was present in 16 out of 17 samples examined. Ovigerous *C. septemspinosa* were present in one-half (8) of the samples for less than 5% of their total number. Ovigerous individuals of *Dichelopandalus leptocerus* were also found but in very low numbers. With the exclusion of *C. septemspinosa,* the other shrimp species were primarily present November through January (Table 5). The mysids occurred in most months with highest numbers in April. Low numbers of brooding *Neomysis americana* occurred during the study.

Table 3 Total Monthly Lobster Catch, October 1982 - August 1983.

	1982			1983								
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
Females	9	10	1	0	0	1	5	42	13	14	21	116
Males	3	13	1	0	1	0	8	62	12	12	23	135
Total	12	23	2	0	1	1	13	104	25	26	44	251

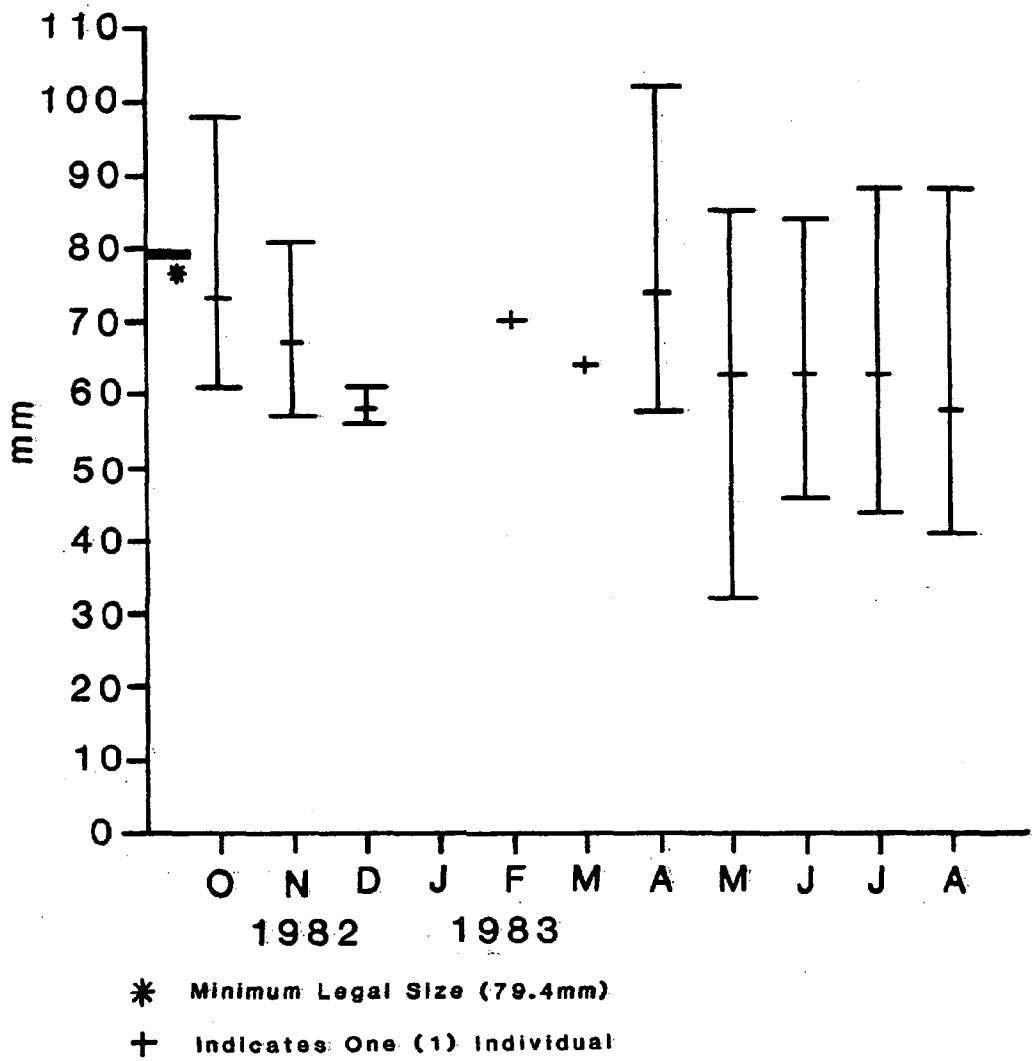
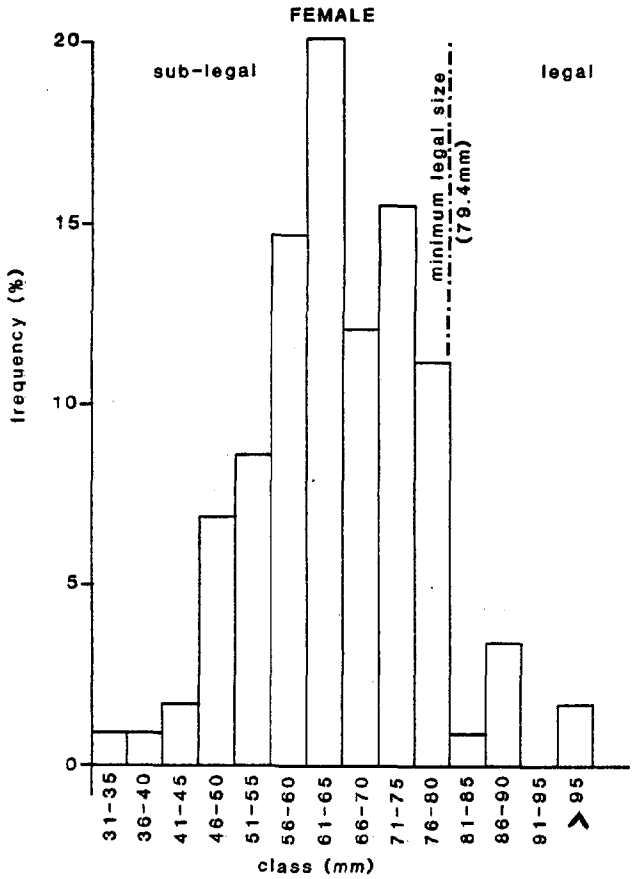
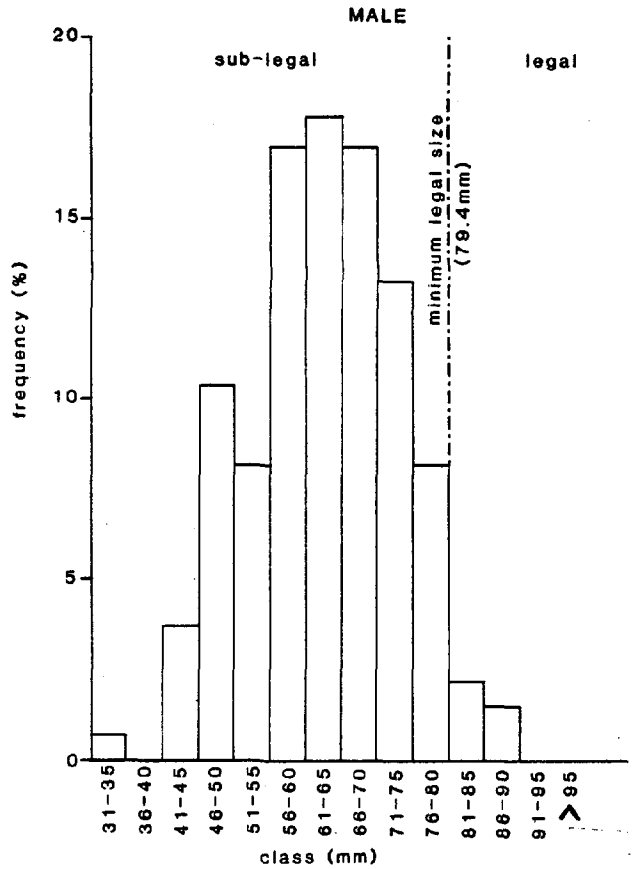


Figure 6

Monthly Mean and Range of Carapace Length (mm) for American Lobster *(Homarus americanus)*, October 1982 - August 1983





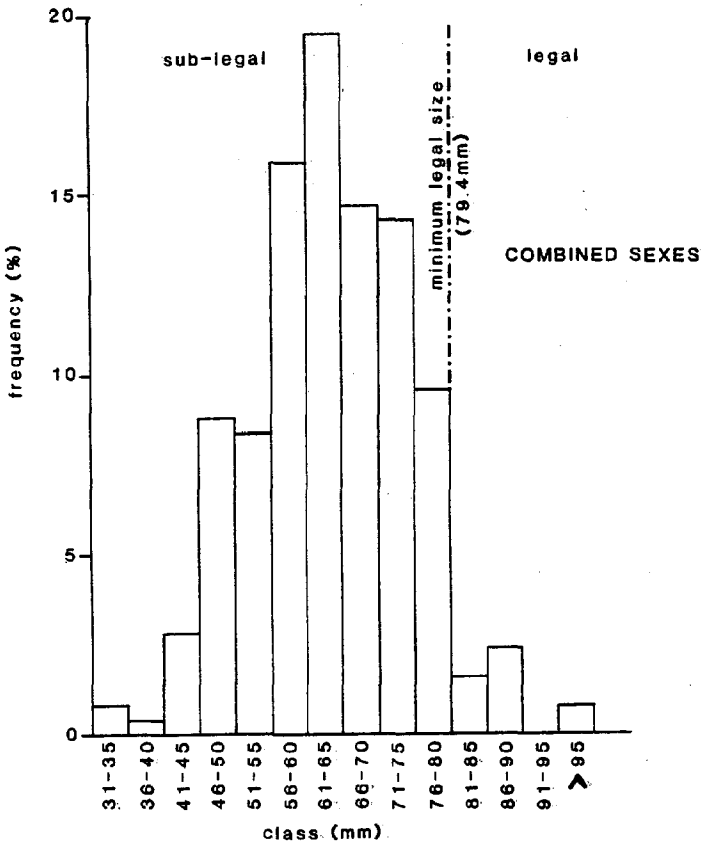


Figure 7
Length Frequency Distribution of American Lobster
(Homarus americanus) Captured, October 1982 - August 1983

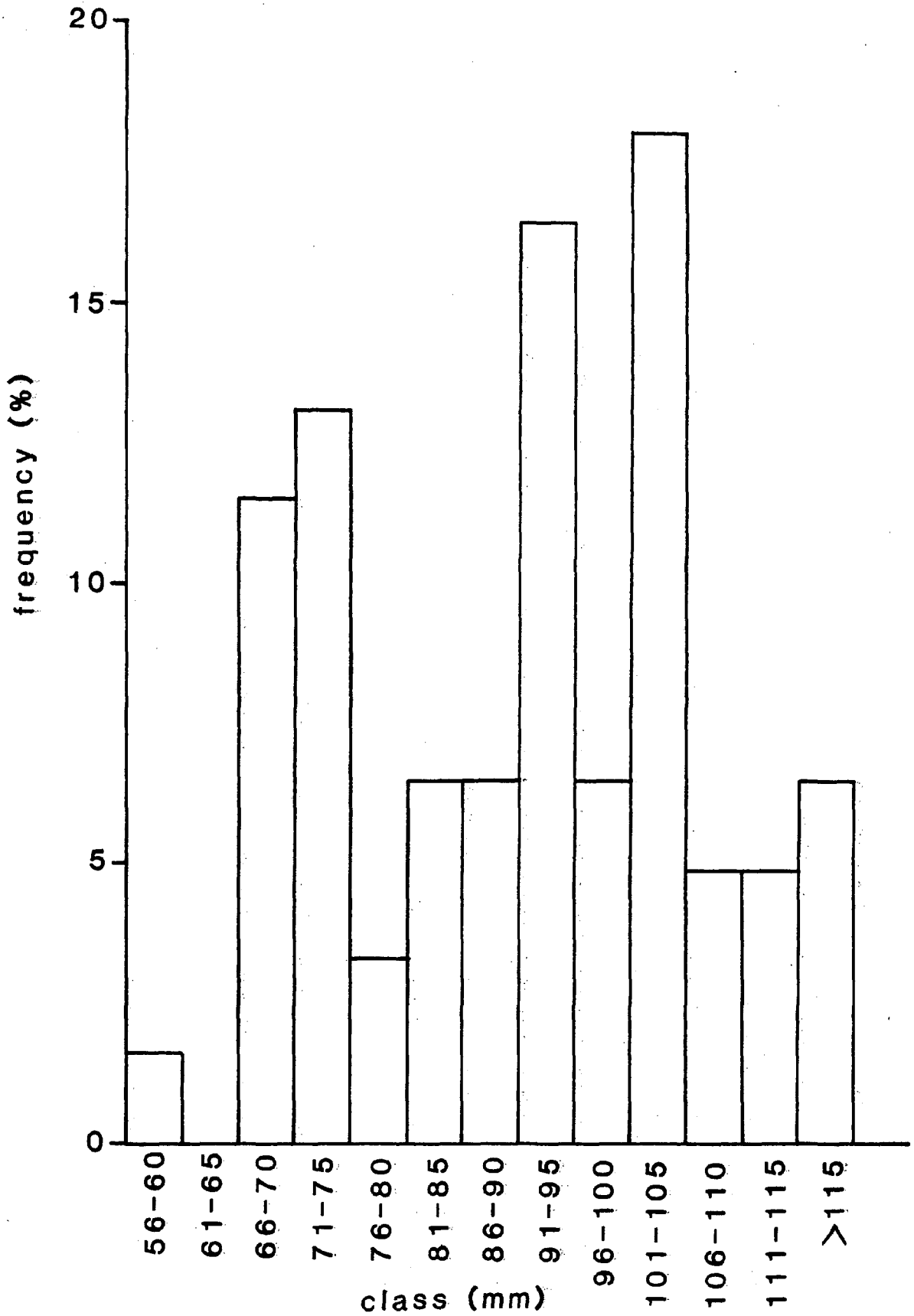


Figure 8

Length Frequency Distribution of Jonah Crab *(Cancer borealis)* Captured, October 1982 - August 1983

Table 4 Incidental Invertebrate Species List and Total Numbers Captured
October 1982 - August 1983

		Total
Arthropoda		
Crustacea		
Isopoda		
	Chiridotea tuftsi	6
	Edotea montosa	54
	Edotea triloba	9
	Erichsonella filiformis	1
	Idotea balthica	72
	Idotea phosphorea	3
Amphipoda		
	Aeginina longicornis	1
	Anonyx lilljeborgi	15
	Batea catharinensis	1
	Calliopius laeviusculus	67
	Corophium sp.	1
	Gammarus lawrencianus	5
	Gammarus oceanicus	36
	Gammarus setosus	1
	Jassa sp.	2
	Maera danae	1
	Pontogeneia inermis	19
	Psammonyx nobilis	7
	Rhachotropis sp.	1
	Unciola irrorata	2
Mysidacea		
	Mysis mixta	1,547
	Neomysis americana	1,716
Decapoda		
Caridea		
	Crangon septemspinosa	553
	Dichelopandalus leptocerus	455
	Eualus fabricii	3
	Eualus pusiolus	18
	Lebbeus groenlandicus	1
	Pandalus montagui	111
	Pandalus propinquus	121
Brachyura		
	Cancer irroratus	5
	Hyas araneus	3
Echinodermata		
Echinoida		
	Strongylocentrotus droebachiensis	33
Mollusca		
Neoloricata		
	Ischnochiton ruber	3

TABLE 5 Numbers of Decapod and Mysid Crustacea by Month with Mean Carapace Length, October 1982 - August 1983.

	Total Numbers/Month											Mean Carapace Length (mm)
DECAPODA (Caridea)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
Crangon septemspinosa	0	1	141	95	19	0	197	0	53	0	22	5.69
Brooding *Crangon*	0	0	4	2	8	0	10	0	0	0	1	9.09
Dichelopandalus leptocerus	7	372	0	1	0	0	0	0	0	0	75	6.89
Eualus pusiolus	0	0	4	14	0	0	0	0	0	0	0	2.20
Eualus fabricii	0	0	0	1	0	0	0	0	0	0	0	4.27
Lebbeus groenlandicus	0	0	0	1	0	0	0	0	0	0	0	6.11
Pandalus propinquus	0	0	121	0	0	0	0	0	0	0	0	5.26
Pandalus montagui	0	0	0	80	0	0	0	0	30	0	1	6.07
MYSIDACEA												
Mysis mixta	1	115	130	80	0	0	1,084	0	0	0	137	3.57
Neomysis americana	0	0	7	4	0	0	1,703	0	2	0	0	3.21

Table 5 contains the mean size of various decapod and mysid species. No estimates of growth were attempted due to the limited data.

Stomach Analysis

A total of sixty-one Atlantic cod stomachs were examined and analyzed for content. Fourteen food categories occurred with varying frequency, during the stomach analysis sampling period (October, 1982 - July, 1983)(Figure 9). Insufficient numbers of stomachs were available for examination during February and March.

Crab, shrimp and fish constituted the major portion of the stomach contents (Figure 9). Shrimp were found all months, as were crabs except during January. Fish were present in the stomachs October through December, and April through June. Other food categories varied widely in occurrence and abundance.

DISCUSSION

Finfish

A total of thirty-nine finfish species were captured by gill net and otter trawl within the study area. Mean monthly catch, for both sampling methods, was 175.2 $\pm$ 54.1, with a low of 29 individuals being caught in February and a high in April, of 288 individuals. The catch consisted of demersal, pelagic and anadromous finfish species. A discussion of selected species follows.

Longhorn Sculpin *(Myoxocephalus octodecemspinosus)*

The longhorn sculpin is a ubiquitous resident bottom fish, found in the shallow marine and estuarine waters close to the coast (Bigelow and Schroeder, 1953; Fefer and Schettig, 1980). Because of its abundance and bottom habitat, it is an important part of the benthic food web (TRIGOM-PARC, 1974). Longhorn sculpins are of limited commercial importance used only as baitfish in the lobster fishery. Spawning activity occurs from November through February, with chief production in December and January (Bigelow and Schroeder, 1953). Sexual maturity is attained at Age III (24.3 cm) (Morrow, 1951). Eggs are demersal and adhesive.

Longhorn sculpin ranked number one (333) in abundance and were caught primarily by otter trawl (86.2%). They were captured all sampling months, with peak trawl abundance occurring in June. Similar observations were made in other Gulf of Maine studies (Howe et al 1981; NAI, 1983). For example, Howe and co-workers (1981) found that post-spawning concentrations of longhorn sculpins were a major spring component of trawl catches north of Cape Cod.

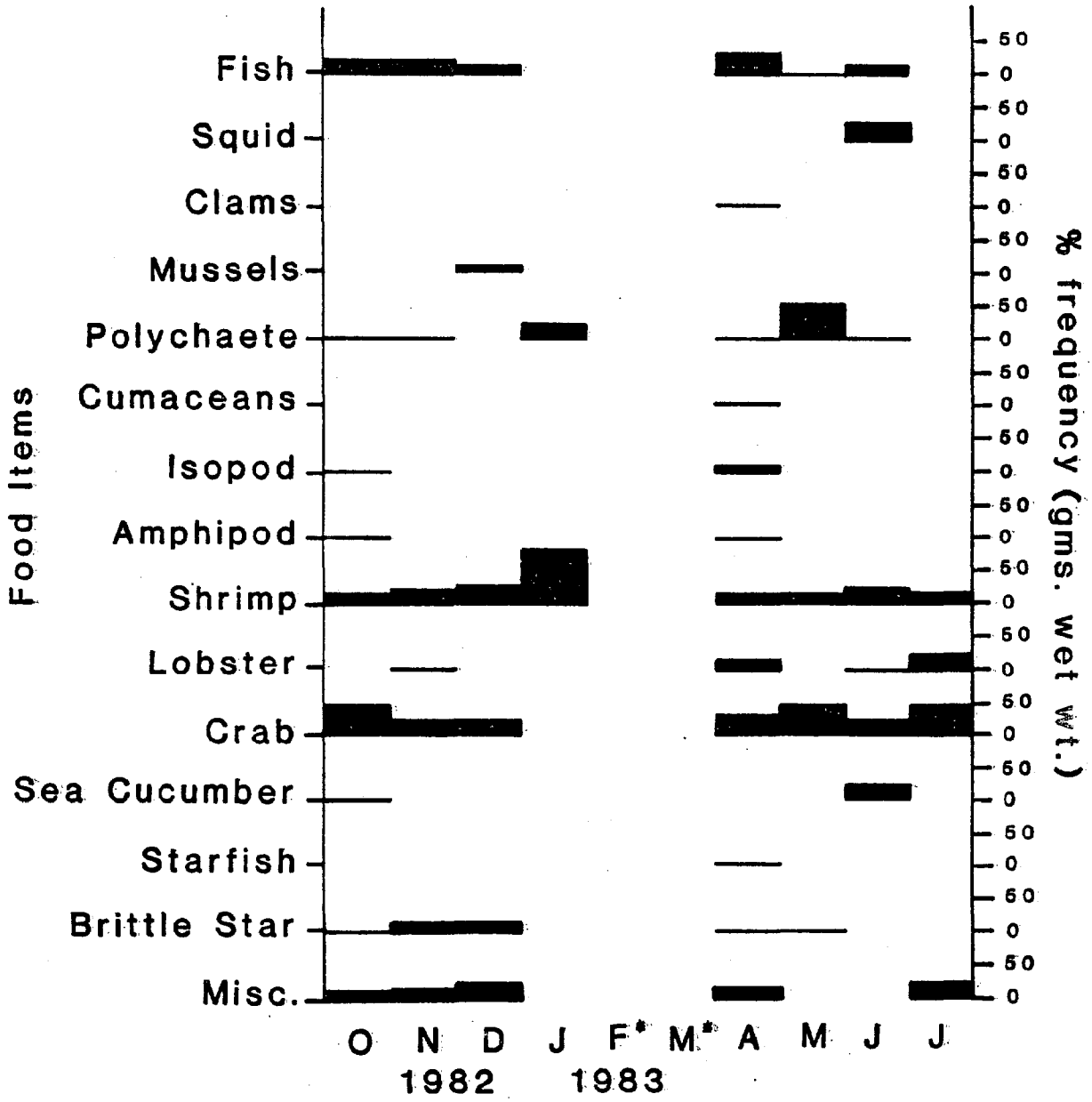


Figure 9

Stomach Content Analysis of Atlantic Cod *(Gadus morhua)*, Percent Frequency Wet Weight in Grams, October 1982 - August 1983

* Insufficient numbers of stomachs available for examination

Longhorn sculpins were evenly distributed at all gill net stations, while 99.6% of the trawl catch was at Station T3. A majority of longhorn sculpins were caught near-bottom which is consistent with their demersal habits. The longhorn sculpin catch consisted of both sexually mature and immature individuals.

Rainbow Smelt *(Osmerus mordax)*

Rainbow smelt are a pelagic species which inhabit estuarine and inshore coastal waters (Bigelow and Schroeder, 1953). Smelt are important both commercially and recreationally. They are an anadromous species, ascending rivers and tributaries in the spring to spawn. Both males and females mature at Age II - III. Fertile eggs are demersal and adhesive (Bigelow and Schroeder, 1953). Spent fish drop back to brackish or salt water immediately after spawning (Hildebrand, 1963).

Rainbow smelt were second (287) in abundance, with 94.8% being caught by otter trawl. Rainbow smelt were caught October through April, with the highest number occurring in December. NAI (1983) found similar results in their study and New Hampshire Fish and Game (1981 and 1982) found rainbow smelt were second in abundance in catch totals in the Great Bay estuarine system, which serves as an important nursery ground.

Rainbow smelt were caught at all gill net stations, except G4. Station T2 accounted for 62.0% of the smelt caught in the trawl. Gill net catches showed rainbow smelt were well distributed throughout the water column. Both sexually mature and immature individuals were present in the samples, although young-of-the-year ($<$10 cm) dominated the trawl catch.

Atlantic Herring *(Clupea harengus)*

Atlantic herring are a pelagic, schooling species found essentially offshore in deep water, but with some of the population moving shoreward during the spawning season (Hildebrand, 1963). The activity of Atlantic herring is controlled largely by water temperature (active between 4.4° - 6.1°C) (Bigelow and Schroeder, 1953). Fefer and Schettig (1980) report that Atlantic herring are the most important commercial finfish in Maine waters and Hildebrand (1963) suggest that they may be the most economically important fish in the world. They are used as food (fresh, salted or smoked), as fish meal and the juveniles support the sardine industry. Atlantic herring are also an important forage species.

Spawning activity is year-round in the coastal Gulf of Maine, but with peak activity in September and October (Mansueti and Hardy, 1967). On the coast of Maine, some individuals reach sexual maturity at Age III - IV (23.5 cm), but they usually do not spawn until Age V - VI (25.0 - 26.2 cm)(Hildebrand, 1963). After reaching sexual maturity they spawn annually on rocky, pebbly or gravel bottom, in 4 - 55 m depths. Eggs are demersal and attach by a coating of mucus, in layers or clumps (Bigelow and Schroeder, 1953).

Atlantic herring were the third (244) most abundant species, with 70.1% being captured by otter trawl. Atlantic herring were present in the catch October through January, and March and April. Peak abundances occurred during October and November in the gill net, and April in the otter trawl. Atlantic herring were found at trawl stations T1 and T2, with 97.1% captured at the latter. They were found at all gill net stations, although 74.0% were caught at station G1. Atlantic herring were caught at all gill net depths, with a majority (56.2%) captured in the near-surface net. NAI (1983) reported Atlantic herring comprised 63% of their gill net catch. Herring were reported being present most months, but having peak abundance during November and December. A majority of Atlantic herring were caught in their near-surface gill net. Howe and co-workers (1981) found Atlantic herring were a common component of their spring catches north of Cape Cod. Their autumn survey catch was insignificant because it preceded the inshore arrival of Atlantic herring stocks. In this survey, adult Atlantic herring were present in the gill net catch October, November and April, while pre-adults ($<$ 23.0 cm) were present October through January and April; only juveniles ($<$ 11.0 cm) were present in the trawl catch.

Winter Flounder *(Pseudopleuronectes americanus)*

Winter flounder, a major inshore groundfish, is the most common shoal water flounder in the Gulf of Maine (Bigelow and Schroeder, 1953 and TRIGOM-PARC, 1974). They exhibit a wide tolerance of temperature and salinity, and are found from inland estuaries to Georges Bank. Winter flounder are an important commercial and sport fish. In 1977 in Maine, winter flounder ranked fifth in pounds landed and third in dollar value (Lewis, 1979).

Winter flounder are a resident species that occur in discrete local populations which exhibit slight seasonal movements (Bigelow and Schroeder, 1953). Adults leave shoal areas when the water temperature is greater than 15°C, they move to cooler waters offshore and return inshore in the fall.

In Maine, spawning occurs in late March and April, in shoal waters 2-5 m in depth (Bigelow and Schroeder, 1953; TRIGOM-PARC, 1974; Briggs, 1978). Winter flounder are sexually mature at Age III, with adhesive, demersal eggs.

Winter flounder ranked fourth (170) in abundance, with 94.7% being captured in the otter trawl. They were present in the catch all sampling months, with peak abundance occurring in August. Both pre-adults (< 20.0 cm) and adults were captured most months. Winter flounder were well distributed, occurring at all gill net and otter trawl stations. A majority of the winter flounder catch was near-bottom, which is consistent with its demersal habits. In the Massachusetts coastal region, winter flounder were consistently the dominant inshore demersal fish in the spring (Howe et al, 1981) NAI (1983) found that winter flounder were present in their trawl catch year-round, with peak numbers occurring in December. New Hampshire Fish and Game Department (1981 and 1982) found winter flounder a dominant component of the catch in the Great Bay estuary. They were present year-round, with maximum numbers occurring during the warmer months.

Pollock (*Pollachius virens*)

Pollock are cool-water fish, found throughout the water column to depths of 73 m (Bigelow and Schroeder, 1953; Briggs, 1980). They are year-round residents, with populations moving inshore in the spring and offshore in the fall and winter. Pollock are an important commercial fishery, ranked third in pounds landed and fifth in dollar value, in Maine during 1977 (Lewis, 1979). They also provide a recreational fishery (Bigelow and Schroeder, 1953; Brownell, 1977; Fefer and Schettig, 1980). Pollock spawn in late autumn and early winter, as water temperatures decline (Bigelow and Schroeder, 1953). Spawning seems to be restricted to the Massachusetts Bay region and between Cape Ann and the Isles of Shoals (Steele, 1963). Pollock mature sexually at Age IV to VII (50.0 - 70.0 cm) and eggs are buoyant.

One hundred and fifty-two (152) pollock were captured placing them fifth in abundance, with 95.4% captured by gill net. They are present in the catch most sampling months, but were at peak abundance during October. NAI (1983) found pollock present in their catch year-round, with highest numbers occurring October through December. New Hampshire Fish and Game Department (1981) found the highest abundance of pollock in Great Bay estuary was during the fall months.

Pollock were found at all gill net and trawl stations. They were found at all depths, but a majority were caught near-bottom. The NAI (1983) study reported

similar results. Howe et al (1981) reported Age I (16.0 - 27.0 cm) pollock were predominant in their catch, with some Age 0 (3.0 - 7.0 cm) and Age II(30.0 - 39.0 cm) present. These results are similar to what was found during this study. Pollock caught by gill net had total lengths between 16.0 cm and 41.0 cm, while the total lengths of pollock captured by otter trawl were between 2.6 cm and 3.4 cm. New Hampshire Fish and Game Department (1982) found juvenile pollock (<10.0 cm) abundant at coastal seine stations, in the spring months.

Atlantic Cod *(Gadus morhua)*

Atlantic cod are demersal, year-round residents in the Gulf of Maine (Bigelow and Schroeder, 1953). They range from the surface down to 450 meters. Adult cod prefer a temperature range of 0° - 12.8°C. Cod are important commercially as well as recreationally (Bigelow and Schroeder, 1953; Jensen 1968; Fefer and Schettig, 1980). Lewis (1979) reported Atlantic cod ranked fourth in pounds landed and dollar value, in Maine in 1977. Spawning occurs at small, regular, well-defined areas (TRIGOM-PARC, 1974). According to Bigelow and Schroeder (1953), the most important spawning area of the inner Gulf of Maine extends from a few miles south of the Isles of Shoals to the Merrimack River, between 9.0 - 46.0 m in depth. Cod spawn during the winter, with most becoming sexually mature at Age V to Age VI.

Atlantic cod ranked sixth (119) in abundance, with 66.4% caught in gill nets. They were present during all sampling months. Gill nets caught the highest number of cod in the fall, while peak otter trawl catches occurred in March and August. NAI (1983) show similar results for both their gill net and trawl catch. Atlantic cod were captured at all gill net and trawl stations, with 87.5% of the trawl catch at station T3. Atlantic cod were caught throughout the water column, but a majority were taken near-bottom. This is consistent with their demersal habitat. Adult Atlantic cod were captured during all sampling months, while pre-adults (<37.0 cm) were caught in most months. Juveniles (<5.0 cm) were captured by trawl January through June and August. New Hampshire Fish and Game Department (1981 and 1982) found juvenile Atlantic cod present in the Great Bay estuary March through May.

Cunner *(Tautogolabrus adsperus)*

Cunner are non-schooling, demersal, inshore fish, inhabiting rocky bottoms (Bigelow and Schroeder, 1953; TRIGOM-PARC, 1974; Briggs, 1978). They are found to depths of 73 m. Bigelow and Schroeder (1953) report a historical commercial fisheries for cunner, but they are no longer commercially important. They do

have some importance as a sport fish, but because of their abundance, they are important components of the demersal community. Cunner mature at Age II, and spawn inshore from late spring to early summer. Eggs are buoyant.

Cunner ranked seventh (81) in abundance, with 92.6% being caught by gill net. They were present in the catch October through December and March through August, with peak abundance occurring in May. The absence of the cunner during the winter months could be associated with a winter lethargic condition reported by Green and Farwell (1971). They found cunners retired to rocky crevices or muddy areas when the water temperature fell below 5°C. NAI (1983) reported similar results. Cunner were found at all gill net stations and at trawl stations T2 and T3, with 83% of the trawl catch coming at the latter station. They were encountered throughout the water column although the majority were caught near-bottom.

Adults were present all months except January and February. One juvenile (3.0 cm) cunner was captured by trawl in August.

Crustacea

American Lobster *(Homarus americanus)*

The American lobster is found along the east coast of North America, from Labrador to North Carolina, being most abundant from Nova Scotia to New York (Herrick, 1911). The major population centers are located within the Gulf of Maine and in the New Brunswick and Nova Scotian coastal waters (Cooper and Uzmann, 1977). American lobster occur from intertidal depths to the edge of the Continental Shelf (Gosner, 1971). Two major populations of American lobster exist, described as inshore and offshore. The inshore lobster occur within a 50 km wide band of coastal water, offshore lobster are outside of this range (Cooper and Uzmann, 1977). Brownell (1977) reported that the American lobster has been the mainstay of New Hampshire's commercial fisheries for many years. New Hampshire Fish and Game Department (1983) estimated that 1982 landed lobster value equaled 2.8 million dollars. Total landings (combined total of annual reports and monthly record of catch data) in New Hampshire in 1982 was 743,311 pounds, 1% of which were recreational landings.

American lobster breed during the summer months (Phillips and Cobb, 1980). Mating must occur shortly after the female molts, during a soft-shelled condition. Females usually spawn only every other year. The eggs are carried 10-11 months, cemented to the pleopods under the tail of the female.

The size at which sexual maturity is attained varies greatly with geographic location. Spurr (1974) found that in New Hampshire coastal waters, the minimum size at which female lobsters sexually matured was 74 mm carapace length (CL), although this was a low percentage of occurrence.

The ratio of female lobsters to male lobsters captured during this survey was found to be 1.00:1.16. This sex ratio is similar to those found in various other studies (Drouse, 1973: Spurr, 1974; Pecci et al., 1978; Howe et al., 1981; NAI, 1983). The most abundant size class encountered was 61-65 mm whereas Spurr (1974) found the 71-75 mm CL size class most prevalent. The percentage of sublegal (< 79.4 mm) lobsters has risen since the 84.2% reported by Spurr (1974) to 89.8% by NAI (1983) and 91.6% in this study.

SUMMARY

Pollock, Atlantic cod, cunner and Atlantic herring were the most common of the 23 species captured in gill nets. Longhorn sculpin, rainbow smelt, Atlantic herring and winter flounder were most prevalent in trawls.

Species such as longhorn sculpin, Atlantic cod, cunner, winter flounder and pollock were generally found year-round throughout the sampling area. Young-of-the-year and juvenile rainbow smelt were present October through April with the highest abundance occurring during December. Atlantic herring also occurred as young-of-the-year or juveniles in trawls and as adults in the gill nets. These were captured in cooler months with highest abundance in April.

A depth differential was evident in the gill net catch. Atlantic herring were captured primarily in near surface nets while near bottom nets caught the larger number of Atlantic cod, pollock and cunner.

Stomach analysis of cod indicated crab, shrimp and fish constituted the major portion of their diet. Other categories such as squid, small crustacea, lobster and polychaetes were also present.

Of the incidental catch of lobster, 8.4% were legal size (79.4 mm) and the sex ratio was 1.00:1.16 females:males. The most abundant size class was 61-65 mm (CL) for both male and females.

The study results indicate a diverse nearshore fishery. The area is utilized by juvenile fish and crustacea as well as adults of the same species. Adults of migrants were also evident. Further study is recommended to investigate habitat for juveniles and the relationship of the nearshore fishery to offshore fisheries.

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APPENDIX

Appendix Table 1 Metric Conversion Table

Length

one millimeter (mm) = 0.04 inch

one centimeter (cm) = 0.39 inch

one meter (m) = 3.28 feet

Temperature Conversion - °C to °F

Temp. °C	0	1	2	3	4	5	6	7	8	9
0	32.0	33.8	35.6	37.4	39.2	41.0	42.8	44.6	46.4	48.2
10	50.0	51.8	53.6	55.4	57.2	59.0	60.8	62.6	64.4	66.2
20	68.0	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.2
30	86.0	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.4	102.2

Appendix Table 2 Total Number of Finfish Captured in Gill Nets, October 1982 - August 1983.

Species	1982 Oct.	Nov.	Dec.	1983 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
Spiny dogfish	0	0	0	0	0	0	0	0	0	0	10	10
Little skate	1	0	0	0	0	0	0	1	0	2	3	7
River herring	2	15	0	0	0	0	8	2	1	0	0	28
Atlantic menhaden	0	1	0	0	0	0	0	0	0	0	0	1
Atlantic herring	31	30	2	2	0	0	8	0	0	0	0	73
Rainbow smelt	0	0	9	3	0	3	0	0	0	0	0	15
Atlantic cod	13	13	9	0	0	2	20	5	8	6	3	79
Silver hake	17	12	0	0	0	0	0	2	0	7	0	38
Pollock	95	3	14	1	1	0	19	10	0	0	2	145
Red hake	0	0	0	1	0	0	0	2	8	17	24	52
Ocean pout	0	0	1	0	0	1	0	0	0	1	0	3
Black sea bass	0	0	0	0	0	0	0	1	0	1	0	2
Cunner	12	2	1	0	0	1	8	24	13	6	8	75
Atlantic wolffish	0	0	0	0	0	0	1	0	0	0	0	1
Atlantic mackerel	10	2	0	0	0	0	0	0	7	3	0	22
Sea raven	3	1	2	0	1	1	5	2	0	1	1	17
Longhorn sculpin	6	4	8	0	0	2	4	5	6	9	2	46
Shorthorn sculpin	0	0	8	0	1	2	0	0	2	1	0	14
Lumpfish	0	0	0	0	0	0	0	1	0	0	0	1
Summer flounder	0	0	0	0	0	0	0	0	0	1	0	1
Yellowtail flounder	0	0	0	0	0	0	0	0	0	1	0	1
Winter flounder	1	0	0	0	0	2	0	0	3	2	1	9
Total catch	191	83	54	7	3	14	73	55	48	58	54	640
Number of species	11	10	9	4	3	8	8	11	8	14	9	22

* Stations G2, G3, and G4 were not sampled.

Appendix Table 3 Finfish Captured in Gill Nets, by Station, October 1982 - August 1983.

Species	G1	G2	G3	G4
Spiny dogfish	3	6	1	0
Little skate	0	1	4	2
River herring	20	3	2	3
Atlantic menhaden	0	1	0	0
Atlantic herring	54	11	4	4
Rainbow smelt	7	6	2	0
Atlantic cod	23	24	18	14
Silver hake	9	8	14	7
Pollock	32	43	57	13
Red hake	21	6	14	11
Ocean pout	0	2	0	1
Black sea bass	0	1	1	0
Cunner	30	19	10	16
Atlantic wolffish	1	0	0	0
Atlantic mackerel	3	4	3	12
Sea raven	3	9	2	3
Longhorn sculpin	12	6	12	16
Shorthorn sculpin	6	7	0	1
Lumpfish	0	0	0	1
Summer flounder	0	0	0	1
Yellow flounder	0	0	0	1
Winter flounder	3	1	2	3
Totals	227	158	146	109
Number of species	15	18	15	17

Appendix Table 4 Finfish Captured in Gill Nets, by Depth, October 1982 - August 1983.

Species	Near-Surface	Mid-Depth	Near-Bottom
Spiny dogfish	3	1	6
Little skate	1	1	5
River herring	7	4	17
Atlantic menhaden	1	0	0
Atlantic herring	41	22	10
Rainbow smelt	6	6	3
Atlantic cod	9	29	41
Silver hake	18	10	10
Pollock	10	56	79
Red hake	4	11	37
Ocean pout	0	1	2
Black sea bass	1	0	1
Cunner	8	18	49
Atlantic wolffish	0	0	1
Atlantic mackerel	17	5	0
Sea raven	2	4	11
Longhorn sculpin	9	14	23
Shorthorn sculpin	2	5	7
Lumpfish	1	0	0
Summer flounder	0	0	1
Yellowtail flounder	0	0	1
Winter flounder	1	1	7
Totals	141	188	311
Number of species	18	16	19

Appendix Table 5 Total Number of Finfish Captured by Trawling, October 1982 - August 1983.

Species	1982 Oct.	Nov.	Dec.	1983 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Totals
Little skate	9	3	1	0	7	0	5	12	16	5	10	68
Winter skate	0	1	0	0	0	0	4	8	14	8	8	43
Thorny skate	0	0	0	0	0	0	2	0	0	0	1	3
River herring	0	0	0	0	0	0	3	0	0	0	0	3
Atlantic herring	0	22	12	0	0	1	136	0	0	0	0	171
Bay anchovy	1	1	0	0	0	0	0	0	0	0	0	2
Rainbow smelt	5	59	149	2	49	4	4	0	0	0	0	272
Atlantic cod	2	0	0	3	8	10	4	1	3	0	9	40
Haddock	0	0	0	0	0	0	0	0	0	1	0	1
Silver hake	1	0	0	0	0	0	0	0	0	0	2	3
Pollock	1	0	0	0	0	4	2	0	0	0	0	7
Red hake	5	5	0	0	0	0	0	0	0	13	2	25
Spotted hake	0	0	1	0	0	0	0	0	0	0	0	1
White hake	0	0	0	0	0	0	0	3	3	0	0	6
Ocean pout	0	0	0	6	1	5	5	5	8	1	5	36
Atlantic silverside	0	0	7	0	0	0	0	0	0	0	0	7
Northern pipefish	2	0	0	0	0	0	0	0	0	0	0	2
Black sea bass	0	1	0	0	0	0	0	0	0	0	0	1
Cunner	3	0	0	0	0	0	0	0	1	1	1	6
Rock gunnel	0	0	0	0	1	0	1	0	0	0	0	2
Atlantic wolffish	0	0	0	0	0	0	0	0	1	0	0	1
American sand lance	0	0	0	1	0	0	0	0	0	0	0	1
Northern searobin	0	1	0	0	0	0	0	0	0	0	0	1
Sea raven	3	0	0	0	0	2	2	0	2	2	2	13
Grubby	0	0	0	0	1	0	0	0	0	0	0	1
Longhorn sculpin	22	22	2	6	28	32	25	23	68	27	32	287
Shorthorn sculpin	0	0	0	1	0	1	0	0	0	0	0	2
Alligatorfish	0	0	1	1	5	4	4	4	1	0	0	20
Seasnail	0	0	1	0	0	0	0	0	0	0	0	1
Fourspot flounder	1	0	0	0	0	0	0	0	0	0	0	1
Windowpane	5	1	0	0	0	0	5	17	15	12	12	67
Yellowtail flounder	2	5	2	0	3	1	3	1	5	4	6	32
Winter flounder	19	13	6	2	1	1	10	17	22	30	40	161
Total Catch	81	134	182	22	104	65	215	91	159	104	130	1,287
Number of species	15	12	10	8	10	11	16	10	13	11	13	33

Appendix Table 6 Finfish Captured by Trawling, by Station, October 1982 - August 1983.

Species	T1	T2	T3
Little skate	21	28	19
Winter skate	22	19	2
Thorny skate	0	0	3
River herring	0	3	0
Atlantic herring	5	166	0
Bay anchovy	1	1	0
Rainbow smelt	45	178	49
Atlantic cod	1	4	35
Haddock	0	0	1
Silver hake	0	1	2
Pollock	2	4	1
Red hake	3	2	20
Spotted hake	0	1	0
White hake	3	3	0
Ocean pout	2	0	34
Atlantic silverside	2	5	0
Northern pipefish	1	1	0
Black sea bass	0	0	1
Cunner	0	1	5
Rock gunnel	0	2	0
Atlantic wolffish	0	0	1
American sand lance	1	0	0
Northern searobin	0	0	1
Sea raven	0	1	12
Grubby	1	0	0
Longhorn sculpin	0	1	286
Shorthorn sculpin	2	0	0
Alligatorfish	0	0	20
Seasnail	1	0	0
Fourspot flounder	0	0	1
Windowpane	36	22	9
Yellowtail flounder	2	2	28
Winter flounder	41	40	80
Totals	192	485	610
Number of species	19	21	21

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