DREDGED MATERIAL MANAGEMENT PLAN
FISHERIES RESOURCES SURVEY FOR
GLOUCESTER
FINAL REPORT

Prepared for

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1.0 INTRODUCTION

Fisheries and lobster sampling were conducted in Gloucester Harbor from June 1998 through May 1999 in support of the development of Dredged Material Management Plans. The purpose of these surveys was to provide data that can be used to evaluate the effects of dredging and aquatic disposal on fisheries resources.

2.0 METHODS AND MATERIALS

Fisheries sampling (seine and trawl) was conducted twice per month from June through October 1998, and in May 1999 and once per month in November 1998 through April 1999 (Table 2-1). Lobster sampling was conducted twice per month from June through November 1998 and May 1999 (Table 2-1). The gear and methods used in this project were developed in consultation with Massachusetts Division of Marine Fisheries to be consistent with previous studies including Jerome et al. (1969) and the Salem Sound 2000 project.

2.1 FISHERIES SAMPLING

A 50-foot seine with 3/16 inch delta mesh was used to sample the fish resources of the nearshore habitat and a 30-foot trawl was used to sample deeper water in Gloucester Harbor (Table 2-2). The trawl had 2-inch stretch mesh in the body and 1-inch stretch mesh in the cod end with a 1/4 inch liner. Sample locations (Figure 2-1) for each of these gears were fixed and located with differential GPS (Global Positioning System). To sample the nearshore habitat, the seine was positioned parallel to shore in approximately 1 m of water, and then hauled directly to shore covering a rectangular area. The offshore habitat was sampled using the trawl towed for approximately 400 m. The location of the beginning and end of each trawl sample was recorded with differential GPS.

Catch per unit effort (CPUE) was calculated as catch per haul for the seine. Tow length varied slightly in the trawl samples, and the CPUE was standardized to a 400 m tow length using the following method:

$$CPUE_{S,T} = (CATCH_{S,T}/TOW_T)\ 400$$

where,

$CPUE_{S,T}$ = Catch per unit effort for species S in sample T
$CATCH_{S,T}$ = Catch of species S in sample T
TOW_T = Tow length in m of sample T

Table 2-1. Sampling Dates for Fisheries and Lobster Sampling in Gloucester Harbor, June 1998 Through May 1999.

Sampling Dates Gloucester	
Fisheries	**Lobster**
12 June 1998	12 June
25 June	25 June
9 July	9 July
22 July	23 July
6 August	6 August
19 August	20 August
2 September	3 September
19 September	17 September
8 October	8 October
23 October	22 October
11 November	5 November
	19 November
9 December	---[a]
25 January 1999	---
18 February	---
18 March	---
22 April	---
12 May	---
26 May	13 May
	27 May

[a] No lobster sampling December 1998 through April 1999.

Table 2-2. Specifications for Sampling Gear Used in the Gloucester Harbor Fisheries Investigations.

Seine	
Length	50 ft.
Height	4 ft.
Mesh	3/16 in. square Delta 35
Bag	4x4x6 ft.
Trawl	
Foot rope length	30 ft.
Head rope length	27 ft.
Mesh size body cod end	 2 in. stretch mesh 1 ½ in. stretch mesh
Cod end liner	¼ in. knotless
Legs	5 ft.
Doors	32x16 in. oak with steel runners

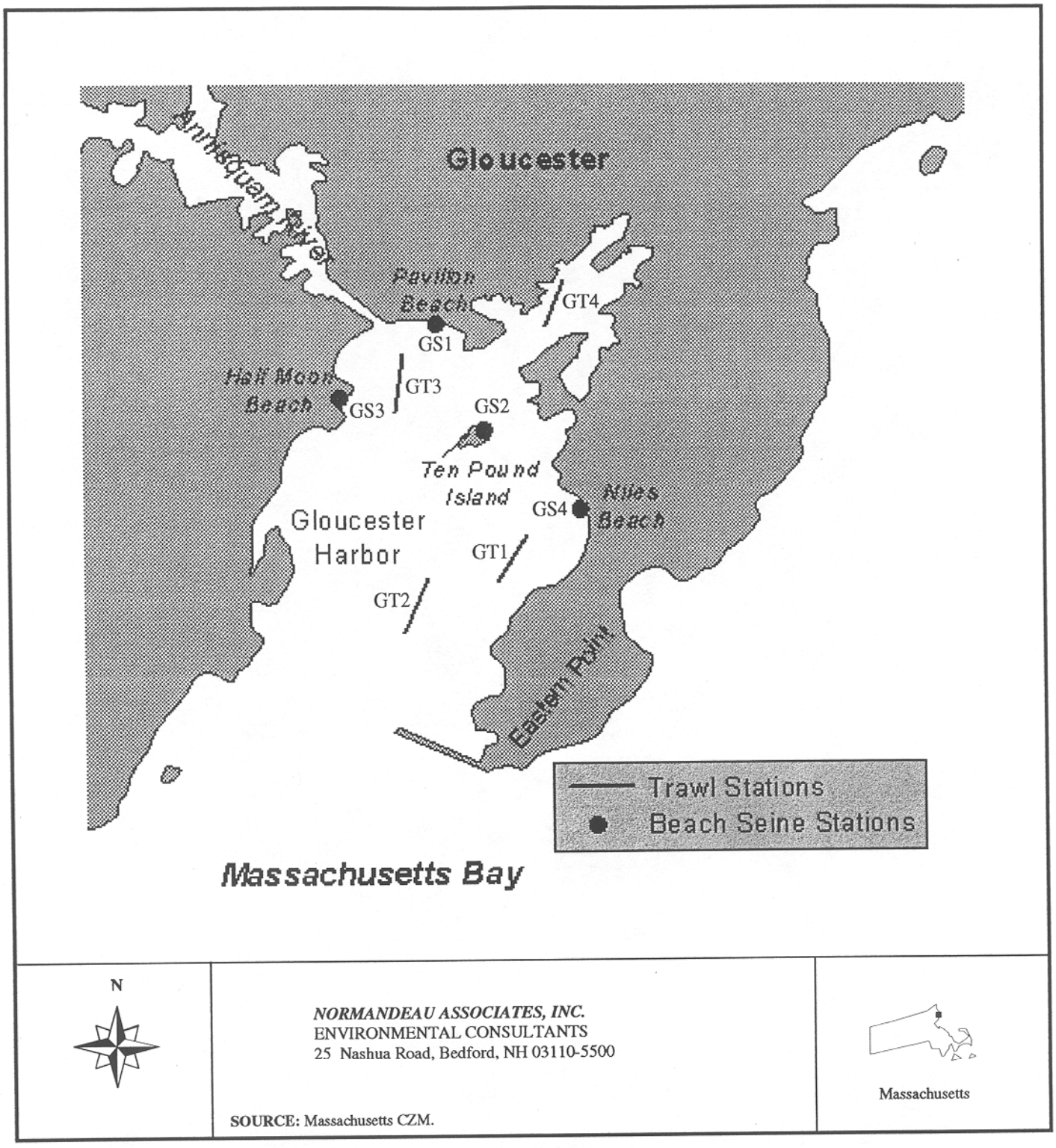

Figure 2-1. Location of fish sampling stations in Gloucester Harbor, June 1998 through May 1999.

For each seine and trawl sample, all fish were identified to species, counted and measured for total length to the nearest mm. Length frequency diagrams for winter flounder and Atlantic cod captured at individual stations are presented as appendix figures. Total biomass of each species was measured to the nearest gram. Biomass data are presented in Appendix Tables 6 through 10 and 16 through 20. If catches were exceptionally large, the total count was estimated through volumetric subsampling, and a minimum of 20 fish were measured. Ages of fish were estimated based on their lengths. Fish less than one year old were termed young-of-the-year (YOY) and fish one year old were termed yearlings. Bottom water temperature (°C), dissolved oxygen (mg/l), and salinity (ppt) were recorded at each seine and trawl sample.

Catch data from each station (catch/haul for seine; catch/400 m tow for trawl) were $\log_{10}(x+1)$ transformed prior to the calculation of monthly and annual means. After means were calculated in the log scale, data were back transformed to the arithmetic scale for presentation as geometric means. The $\log_{10}(x+1)$ data transformation and subsequent calculation of geometric means is appropriate for data sets with many zero catches, and a few samples with large catches (Green 1979). Geometric means tend to normalize data, and de-emphasize large catches. As a result, they are usually smaller than arithmetic means calculated from the same data set.

2.2 LOBSTER SAMPLING

The lobster resources of Gloucester Harbor were sampled by monitoring the catch of a commercial lobsterman. Twice a month lobster trawls consisting of 5 to 20 baited traps were set in Gloucester Harbor. Approximately 150 traps were set in each sampling event. At least one trawl was set in the inner harbor, and the remaining trawls were set in the outer harbor during each sampling event (Figure 2-2). Sampling locations were chosen by the lobsterman to maximize catch, and therefore varied among trips. Lobsters were measured for carapace length (CL) to the nearest mm. Lobsters less than or equal to 82 mm CL were classified as sublegal, and lobsters greater than or equal to 83 mm CL were classified as legal-sized. Observations were also made as to the sex, reproductive condition (gravid, not gravid), molt condition, presence or absence of claws, and any pathology present. Soak time for the traps was always three set-over days. Catch per unit effort was calculated as catch per trap per three set-over days (CTH_3).

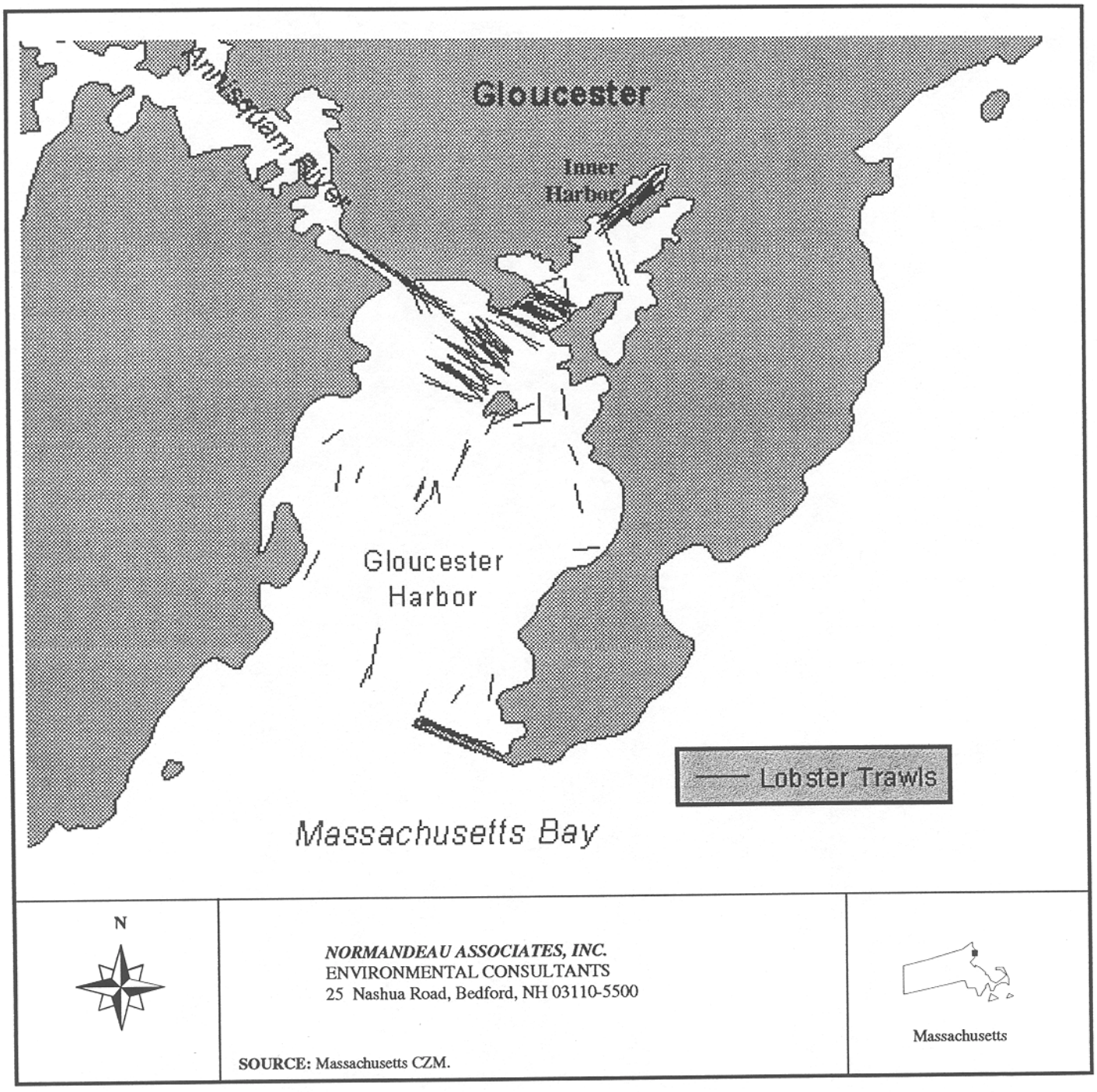

Figure 2-2. Location of lobster sampling stations in Gloucester Harbor, June 1998 through May 1999.

3.0 RESULTS

Seine sampling occurred at four stations in Gloucester Harbor and described the shallow-water inshore fish community. Trawl sampling also took place at four stations and described the deeper water fish community in Gloucester Harbor. Descriptions of the habitat at each sampling station are provided in Table 3-1.

Table 3-1. Descriptions of Sampling Stations in Gloucester Harbor.

Station	Location	Depth (ft)	Substrate	Comments
GS1	Pavilion Beach	–	sand	shallow slope
GS2	NE side of Ten Pound Island	–	sand, gravel, shells	steep slope
GS3	Half Moon Beach	–	sand	moderate slope, ledge on either side
GS4	Niles Beach	–	sand	moderate slope, eelgrass offshore
GT1	Southeast Harbor	30-36	sand-silt	*Laminaria, Agarum, Ulva* present
GT2	Outer Harbor	29-35	silt-shells	small amounts of macroalgae
GT3	Blynman Canal	18-25	silt-mud	no macroalgae
GT4	Inner Harbor	25-28	soft mud	frequent snags

3.1 SEINE CATCHES

The seine catches in Gloucester Harbor were dominated by large catches of a few species and several sampling dates when no fish were caught. The most numerous fish captured by the seine in Gloucester Harbor was Atlantic silverside, accounting for 43% of the total catch at all stations combined (Table 3-2; page 8). Winter flounder (8%), lumpfish, blueback herring, mummichog (all at 6%) were the remaining common fishes in Gloucester Harbor.

When data from all stations are averaged, the seasonal changes in the abundance of the shore fishes in Gloucester Harbor are apparently a reflection of variations in the abundance of the most abundant fish, Atlantic silverside (Table 3-2). CPUE generally rose throughout the summer to an annual peak in abundance in September and October, primarily due to increases in CPUE of Atlantic silverside. Monthly geometric mean CPUE was lowest in November through March and began to increase in April. Catches of Atlantic silverside were highest from September through October, and based on their lengths, most of these fish were YOY (Conover and Ross 1982). Winter flounder ranked second in overall geometric mean CPUE. CPUE was highest in September, and most of these fish were YOY less than 100 mm. CPUE decreased to zero in January through April as YOY fish moved to deeper water. Lumpfish ranked third in overall mean CPUE and were captured primarily at Station GS3 during one sampling event (2 September) when large amounts of debris occurred in the haul. Based on their lengths, most of the fish captured were probably YOY. Blueback herring were present in June and July at Stations GS2 and GS3. Most of these fish were between 55 and 92 mm

and probably were YOY (Mullen et al. 1986). Mummichog were present in August, October, and November, primarily at Station GS3 at lengths less than 60 mm.

3.1.1 Station GS1

Annual geometric mean CPUE at Station GS1, located at Pavilion Beach (Figure 2-1), was the second highest (1.08/haul) among seine stations and was dominated by Atlantic silverside (Table 3-3). Smaller catches were made of windowpane, winter flounder, mummichog and northern pipefish. Annual mean CPUE at this station ranked second among the four stations. Monthly trends in total CPUE generally paralleled that of Atlantic silverside as this fish was overwhelmingly dominant at this station. Monthly geometric mean CPUE was highest in September and October due to relatively large catches of Atlantic silverside. Monthly mean CPUE decreased to near zero during the winter months and increased in April and May. Lengths of Atlantic silverside ranged from 60 to 103 mm. Windowpane ranked second in abundance, but made up only 11% of the catch. Windowpane were captured in June and September, and lengths ranged from 99 to 104 mm. Winter flounder occurred in June and December at lengths of 90 mm and 108 mm.

3.1.2 Station GS2

Annual geometric mean CPUE at Station GS2 (0.34/haul), located on the northeast side on Ten Pound Island (Figure 2-1), was the lowest among the four stations. Annual geometric mean CPUE was highest for blueback herring, followed by Atlantic silverside, grubby, cunner, and northern pipefish (Table 3-4). Monthly geometric mean CPUE was highest at this station in June, due to the capture of YOY blueback herring between 55 and 60 mm. No fish were captured in July, August, and November through April. Atlantic silverside and grubby ranked second in annual mean CPUE due to the capture of YOY silverside in September (77 to 95 mm), and YOY grubby in June (30 to 40 mm). Cunner were captured in June, and northern pipefish occurred in October.

3.1.3 Station GS3

Station GS3, located near Half Moon Beach (Figure 2-1), had the highest annual geometric mean CPUE (2.26/haul) among the four seine stations (Table 3-5; page 10). Atlantic silverside was the most common fish captured followed by lumpfish, winter flounder, mummichog, and blueback herring. Monthly geometric mean CPUE was highest in September and October due to large catches of YOY and yearling Atlantic silverside between 63 and 132 mm. Monthly mean CPUE declined in the fall and winter, and no fish were captured between December and April. Lumpfish ranked second in abundance due to relatively large catches in September that were associated with beach wrack. These fish were primarily YOY between 17 and 35 mm. Winter flounder occurred in September and October at lengths less than 100 mm, and again in May. Blueback herring were captured in July at lengths less than 92 mm.

Table 3-2. Geometric mean catch per unit effort (catch/haul) for seine samples (n=72) at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic silverside	0.00	0.00	0.44	4.55	2.55	0.00	0.19	0.00	0.19	0.19	0.50	0.19	0.45	0.17	42.99
Blueback herring	0.22	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	5.69
Lumpfish	0.09	0.00	0.09	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	6.08
Mummichog	0.00	0.00	0.09	0.00	0.19	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	5.87
Winter flounder	0.09	0.00	0.00	0.36	0.19	0.00	0.19	0.00	0.00	0.00	0.00	0.09	0.07	0.03	8.04
Other Species	2.21	0.19	0.09	0.86	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.31	0.13	31.33
Total	2.89	0.50	0.62	6.85	4.76	0.41	0.32	0.00	0.19	0.19	0.50	0.62	0.93	0.21	100.00

Table 3-3. Geometric mean catch per unit effort (catch/haul) for seine samples (n=18) at station GS1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic silverside	0.00	0.00	0.00	6.28	3.80	0.00	1.00	0.00	0.00	0.00	4.00	0.41	0.68	0.25	55.81
Mummichog	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	6.24
Northern pipefish	0.00	0.00	0.00	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04	6.24
Windowpane	1.45	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.08	11.18
Winter flounder	0.41	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.09	0.06	9.36
Other Species	1.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.07	11.18
Total	3.47	0.00	0.00	11.61	4.39	0.00	2.00	0.00	0.00	0.00	4.00	0.41	1.08	0.30	100.00

Table 3-4. Geometric mean catch per unit effort (catch/haul) for seine samples (n=18) at station GS2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic silverside	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	14.82
Blueback herring	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	17.21
Cunner	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	11.75
Grubby	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	14.82
Northern pipefish	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	11.75
Other Species	1.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.12	0.07	29.65
Total	4.92	0.00	0.00	1.24	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.34	0.17	100.00

3.1.4 Station GS4

Station GS4 was located at Niles Beach (Figure 2-1), and annual geometric mean CPUE (0.55/haul) was the second-lowest among the stations (Table 3-6). Atlantic silverside was the most common fish at this station followed by grubby. Atlantic menhaden, northern pipefish, and northern puffer, ranked next in abundance and made minor contributions to the annual mean CPUE. Monthly mean CPUE was highest in October due to relatively high CPUE of Atlantic silverside, Atlantic menhaden, and northern pipefish. No fish were captured in July, November through January, and April. YOY Atlantic silverside were captured in August through October, and February and March at lengths of 33 to 75 mm. YOY Grubby were captured in June at lengths between 26 and 31 mm.

3.2 TRAWL CATCHES

The trawl catches characterized the fish community of the deeper, offshore areas of Gloucester Harbor (Table 3-7). Descriptions of the habitat at each station are found in Table 3-1. Catches were numerically dominated by winter flounder (27%), skates (20%), and Atlantic cod (12%) (Table 3-7). Red hake and rock gunnel (both 7%) made smaller contributions to the total catch. Monthly geometric mean CPUE was relatively consistent from June through November, and then decreased during December through February as water temperatures decreased and most fish moved to deeper water. Monthly geometric mean CPUE began to increase in March and reached the highest levels in April and May. Winter flounder and Atlantic cod contributed to the high CPUE in April, and high catches of cod and skates resulted in the high CPUE in May.

When sampling began in June of 1998, the 1997 year class of winter flounder was present between 60 and 139 mm (Figure 3-1). In addition, several older fish, greater than 259 mm were also captured. The 1998 year class was first recruited to the trawl in August at 20 to 39 mm. This year class was present in greater abundance in September through November. Size at recruitment was about 20 to 40 mm, but the upper size limit of the 1998 year class was not as well defined, as it overlapped with the 1997 year class in the fall. Nevertheless, the upper size limit of the 1998 year class appeared to be 60-79 mm in September, and 100-119 mm in October through December. CPUE decreased to near zero in February and March as water temperature reached its minimum. The 1998 year class moved back into the sampling area in April at 40 to 119 mm, and by May larger winter flounder (>260 mm) were present.

Several species potentially comprise the taxonomic group "skates", but the predominant species in this group are probably big skate (*Raja binoculata*), and little skate (*Raja erinacea*) (Bigelow and Schroeder 1953). These two species are extremely difficult to separate in the field as the diagnostic character is the number of upper teeth. Hence, all skates were grouped into the term "skates". Skates were the second most abundant fish in Gloucester, and because of their relatively large size, they ranked first in biomass (Appendix Table 16).

Table 3-5. Geometric mean catch per unit effort (catch/haul) for seine samples (n=18) at station GS3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic silverside	0.00	0.00	1.45	45.17	15.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.46	35.81
Blueback herring	0.00	3.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	7.34
Lumpfish	0.41	0.00	0.41	5.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.16	11.93
Mummichog	0.00	0.00	0.41	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.12	8.23
Winter flounder	0.00	0.00	0.00	2.46	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.18	0.11	9.19
Other Species	2.16	1.00	0.41	2.46	4.29	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.62	0.19	27.51
Total	2.87	4.00	3.00	76.59	23.12	3.00	0.00	0.00	0.00	0.00	0.00	1.45	2.26	0.50	100.00

Table 3-6. Geometric mean catch per unit effort (catch/haul) for seine samples (n=18) at station GS4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic menhaden	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	9.28
Atlantic silverside	0.00	0.00	0.73	0.41	1.00	0.00	0.00	0.00	1.00	1.00	0.00	0.41	0.32	0.09	56.13
Grubby	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	13.60
Northern pipefish	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	9.28
Northern puffer	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	5.86
Other Species	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	5.86
Total	1.24	0.00	0.73	0.73	3.90	0.00	0.00	0.00	1.00	1.00	0.00	0.41	0.55	0.15	100.00

Table 3-7. Geometric mean catch per unit effort (catch/400-m tow) for trawl samples (n=72) at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.09	0.00	0.25	0.00	0.94	0.19	0.00	0.00	0.00	2.13	6.12	4.49	0.64	0.23	11.83
Red hake	0.62	0.52	0.19	0.30	0.54	1.51	0.00	0.00	0.00	0.00	0.32	0.49	0.32	0.08	6.68
Rock gunnel	0.09	0.18	0.00	0.42	0.25	0.57	0.20	0.00	0.41	1.34	0.19	0.61	0.32	0.07	6.58
Skate sp.	3.25	1.56	2.99	3.84	4.79	0.86	0.19	0.00	0.00	0.00	0.74	3.60	1.30	0.22	19.84
Winter flounder	3.31	1.70	1.21	2.27	2.85	3.53	1.83	1.45	0.00	0.73	9.98	2.79	2.08	0.18	26.86
Other Species	1.35	1.47	0.87	2.58	2.51	4.94	2.79	0.57	0.20	2.00	12.17	5.38	2.26	0.21	28.22
Total	9.63	5.79	6.09	10.60	15.34	14.39	4.85	2.35	0.57	8.77	33.12	22.15	8.17	0.27	100.00

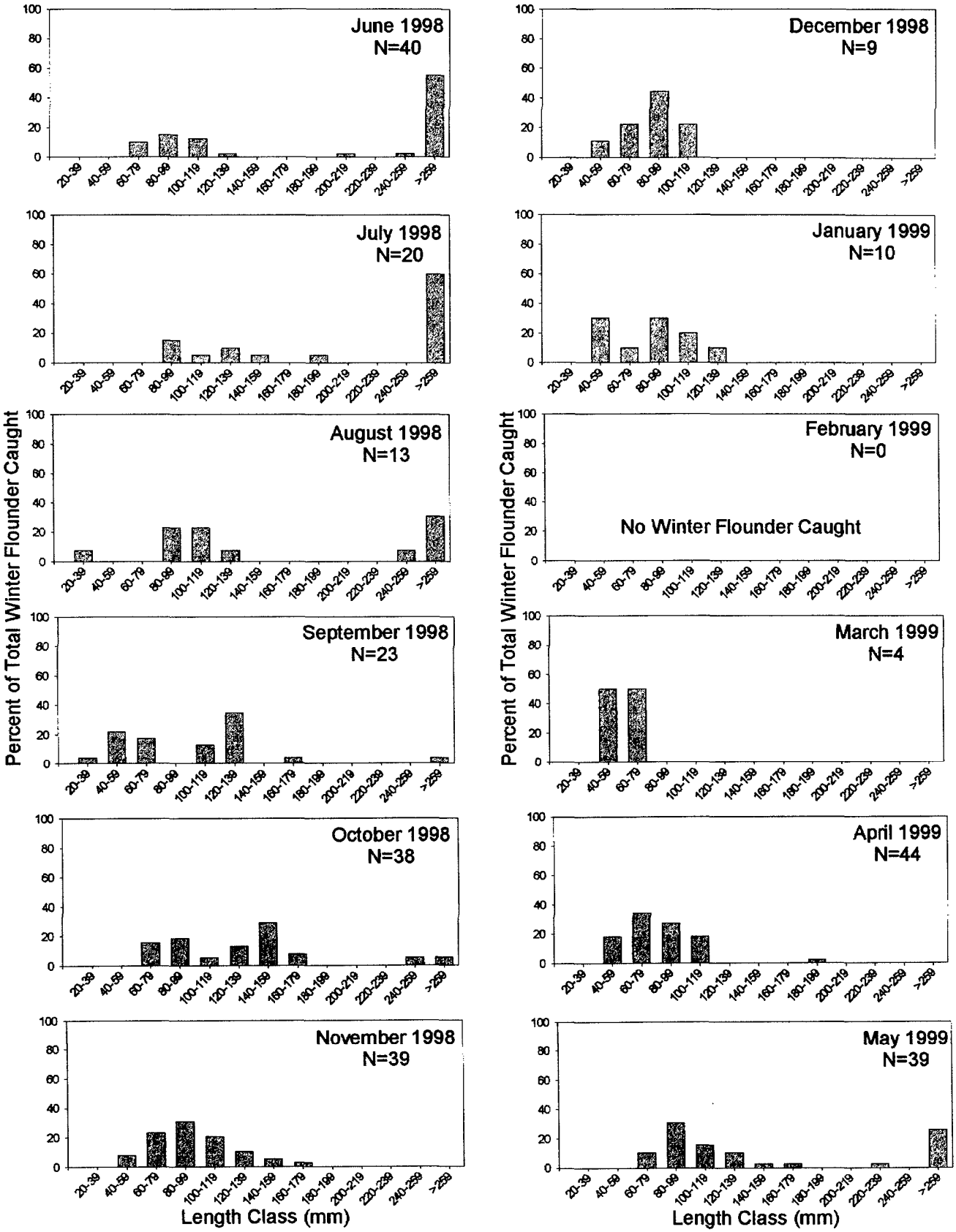

Figure 3-1. Length-frequency diagram for winter flounder captured in the trawl at all stations combined in Gloucester Harbor, June 1998 through May 1999 (N = number of fish).

The 1998 year class of Atlantic cod was first recruited to the trawl in October at 21 to 29 mm (Figure 3-2). Prior to October older cod were occasionally captured. CPUE decreased to near zero from November through February, and YOY were recruited to the trawl again in March through May.

The peak in red hake spawning typically occurs in June and July (Smith et al. 1979). The recruitment of small YOY red hake at about 30 mm in September is consistent with this spawning period. Rock gunnel was the fifth most abundant fish captured in Gloucester Harbor and were captured every month except August and January.

3.2.1 Station GT1

Station GT1 was located in Southeast Harbor at a depth of 30-36 feet (Figure 2-1). Total geometric mean CPUE (7.31/trawl) was the third highest among the four stations. The fish community at this station was dominated by winter flounder, skates, rock gunnel, Atlantic cod, and pollock (Table 3-8; page 15). Monthly geometric mean CPUE was highest in April due to relatively high catches of Atlantic cod and pollock. Monthly CPUE was lowest in December through February, and no fish were caught in January.

The 1997 year class of winter flounder was present at Station GT1 in June 1998 at lengths between 60 and 119 mm (Appendix Figure 1). By October of 1998, the 1997 year class was present at lengths of 120 to 159 mm. The 1997 year class was not present at this station during the winter months (November through March) and probably moved into deeper waters. YOY fish from the 1998 year class first appeared in catches in September at lengths less than 59 mm (Appendix Figure 1). The 1998 year class was not present from December 1998 through March 1999, presumably because they moved into deeper water. By April 1999 the 1998 year class moved back into shallower waters and was present in the samples at lengths of 40 to 119 mm.

Skates were captured in June through November and again in May. This seasonal pattern is consistent with a movement to deeper water in the winter. Rock gunnel were present every month except August, December through January and April. Lengths were predominantly less than 80 mm indicating that these fish were probably YOY (Bigelow and Schroeder 1953). The 1999 year class of Atlantic cod was recruited to the trawl at Station GT1 in April and May at lengths between 30 and 59 mm (Appendix Figure 5). No cod were captured at any other time at Station GT1. Pollock were only captured in April and May, and these fish were YOY less than 50 mm.

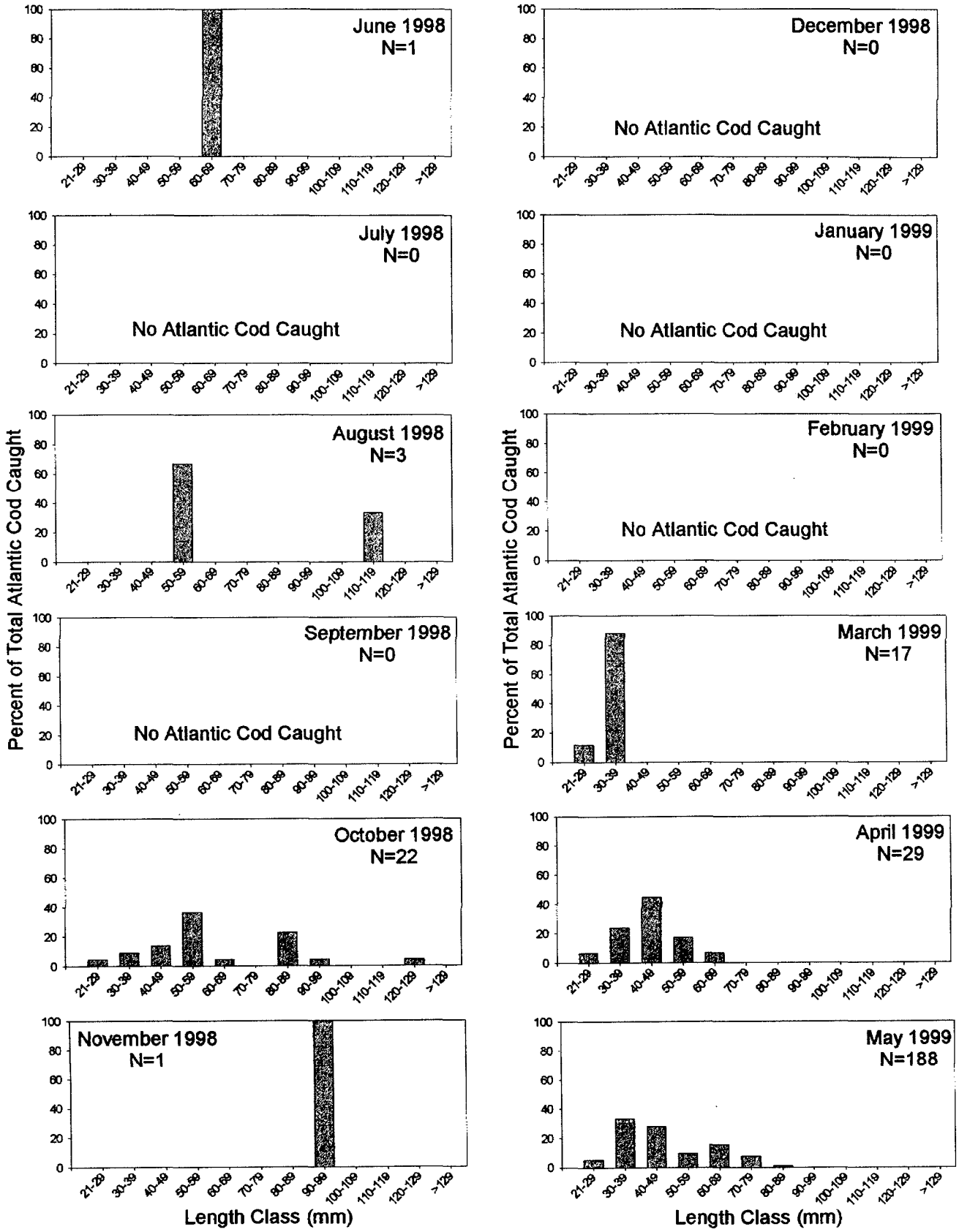

Figure 3-2. Length-frequency diagram for Atlantic cod captured in the trawl at all stations combined in Gloucester Harbor, June 1998 through May 1999 (N = number of fish).

3.2.2 Station GT2

Station GT2 was located in the outer harbor at a depth of 29-35 feet (Figure 2-1). Winter flounder was the dominant fish at this station followed by Atlantic cod, skates, cunner, and shorthorn sculpin (Table 3-9). Total annual geometric mean (5.08/tow) was the lowest among the four trawl stations. Monthly geometric mean CPUE was highest in October and April due to high catches of Atlantic cod in October and winter flounder in April. Monthly mean CPUE was lowest in January through February.

The 1997 year class of winter flounder was apparent in the catch data in June through August at lengths between 60 to 119 mm (Appendix Figure 2). A single member of the 1998 year class was first recruited to the trawl in September 1998 at a length of 45 mm. Both year classes apparently moved to deeper waters from January through March and the 1998 year class appeared again in April at lengths between 40 and 99 mm.

The fall spawn of the 1998 year class of Atlantic cod was apparent in the catch data for October at minimum lengths between 21 and 29 mm (Appendix Figure 6). As with winter flounder, cod probably moved to deeper water in the winter, and the 1998 year class was present in March through May 1999 at lengths between 30 and 69 mm.

Skates were present in June through October and December and did not reappear in the catch the following spring (Table 3-9). Cunner were present September through November, and May, and most of these fish were YOY or yearlings between 29 and 87 mm (Serchuk and Cole 1974). Shorthorn sculpin were captured in June, and March through May. In June and March lengths were less than 95 mm, and these fish were probably YOY and yearlings. In April and May, older fish between 100 and 160 mm were captured.

3.2.3 Station GT3

Station GT3 was located at the entrance to the Blynman Canal at depths of 18-25 feet (Appendix Figure 2-1). Total annual geometric mean CPUE (12.67/tow) was highest at this station (Table 3-10). Skates were the dominant fish at this station followed by winter flounder, and Atlantic cod. Red hake and windowpane made smaller contributions to the total catch. Monthly geometric mean CPUE followed a regular seasonal pattern at this station. CPUE was relatively consistent between June and November, dropped to low levels in December through February, and then increased in March through May. The high CPUE in April was due to large catches of winter flounder. Skates and Atlantic cod contributed to the high CPUE in May (Table 3-10).

Table 3-8. Geometric mean catch per unit effort (catch/400-m tow) for trawl samples (n=18) at station GT1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	4.10	0.44	0.29	8.51
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.00	2.00	0.39	0.28	7.72
Rock gunnel	0.41	0.39	0.00	0.41	0.41	5.00	0.00	0.00	0.95	4.00	0.00	5.71	0.84	0.23	14.19
Skate sp.	4.73	1.42	2.58	3.47	7.37	1.00	0.00	0.00	0.00	0.00	0.00	3.47	1.25	0.26	18.80
Winter flounder	3.57	2.37	2.28	5.48	4.48	2.00	0.00	0.00	0.00	0.00	8.00	5.32	1.87	0.27	24.43
Other Species	3.48	2.34	2.26	2.46	1.83	2.00	1.00	0.00	0.00	2.00	15.00	5.00	2.11	0.24	26.35
Total	12.74	8.39	7.54	11.85	14.49	10.00	1.00	0.00	0.95	6.00	55.00	28.29	7.31	0.40	100.00

Table 3-9. Geometric mean catch per unit effort (catch/400-m tow) for trawl samples (n=18) at station GT2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.73	0.00	9.10	0.00	0.00	0.00	0.00	1.00	2.93	1.80	0.64	0.24	15.55
Cunner	0.00	0.00	0.00	1.00	1.00	3.00	0.00	0.00	0.00	0.00	0.00	2.44	0.40	0.16	10.47
Shorthorn sculpin	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.95	0.73	0.29	0.13	8.09
Skate sp.	0.41	0.40	0.41	2.16	2.74	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.42	0.15	10.95
Winter flounder	1.91	2.01	2.12	2.16	3.12	0.00	3.00	0.00	0.00	0.00	16.59	0.73	1.44	0.28	27.90
Other Species	0.44	0.96	0.00	1.00	3.58	1.00	3.00	2.00	0.00	1.00	3.90	4.15	1.37	0.18	27.05
Total	3.38	3.03	2.95	6.42	26.11	4.00	7.00	2.00	0.00	4.00	25.37	10.41	5.08	0.30	100.00

Table 3-10. Geometric mean catch per unit effort (catch/400-m tow) for trawl samples (n=18) at station GT3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.40	0.00	0.40	0.00	0.41	0.00	0.00	0.00	0.00	15.00	4.00	11.33	0.93	0.35	12.19
Red hake	0.40	1.71	0.00	1.00	0.98	4.00	0.00	0.00	0.00	0.00	2.00	0.41	0.62	0.17	8.89
Skate sp.	7.75	7.90	10.91	7.72	14.88	5.00	0.00	0.00	0.00	0.00	2.00	16.70	3.31	0.40	27.03
Windowpane	0.00	2.32	0.92	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	3.85	0.49	0.17	7.43
Winter flounder	11.76	4.22	1.34	1.45	2.41	3.00	2.00	5.00	0.00	0.00	14.00	3.87	2.71	0.27	24.28
Other Species	1.41	0.68	1.33	2.87	1.79	6.00	1.00	1.00	0.00	3.00	9.00	3.22	1.97	0.20	20.18
Total	22.43	17.42	15.02	13.42	21.82	19.00	3.00	6.00	0.00	19.00	31.00	51.39	12.67	0.36	100.00

Skates were present at a relatively consistent CPUE every month except December through March. The absence of skates in the winter is probably due to a migration to deeper water. The 1997 year class of winter flounder was present when sampling started in June of 1998 at lengths between 60 and 119 mm (Appendix Figure 3). The 1998 year class first appeared in August at lengths less than 39 mm, and was also present in the December and January sampling. No winter flounder were captured in February and March. The small winter flounder may have been a mixture of the 1997 and 1998 year classes in April and May.

Indications of a fall spawn of Atlantic cod were apparent in the length frequency data as a small cod less than 39 mm was present in the October sampling (Appendix Figure 7). The 1999 year class of Atlantic cod was present in the March through May sampling at lengths less than 49 mm. A large catch of YOY Atlantic cod (151) was made in early May at Station GT3. Red hake were present every month except August, and December through March. Based on the length and age data of Musick (1974), YOY and juvenile red hake were present each month red hake were captured. Windowpane were captured in July and August, November, March and May. In July though August, yearling and older windowpane were captured at lengths between 199 and 270 mm. YOY windowpane appeared November, March and May at lengths less than 100 mm.

3.2.4 Station GT4

Station GT4 was located in the Inner Harbor near the entrance to the North Channel at depths of 25-28 feet (Appendix Figure 2-1). Total annual geometric mean CPUE (9.24/tow) at this station ranked second (Table 3-11). Winter flounder was the dominant species with skates, Atlantic cod, shorthorn sculpin, and rainbow smelt making smaller contributions (Table 3-11). Monthly geometric mean CPUE was relatively consistent from June through October 1998, and increased to the highest mean CPUE of 50.00/tow in November due to large catches of winter flounder. CPUE decreased in January through February, and then increased in March through April due to large catches of Atlantic cod, winter flounder, and shorthorn sculpin.

Table 3-11. Geometric mean catch per unit effort (catch/400-m tow) for trawl samples (n=18) at station GT4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.00	7.18	4.15	0.59	0.24	10.45
Rainbow smelt	0.00	0.00	0.00	0.00	0.42	4.00	4.32	0.00	0.00	0.00	1.03	0.00	0.44	0.20	8.19
Shorthorn sculpin	0.41	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.00	3.08	1.93	0.47	0.17	8.72
Skate sp.	3.58	0.41	3.22	3.46	1.26	0.00	0.00	0.00	0.00	0.00	2.05	4.67	1.03	0.23	15.99
Winter flounder	1.04	0.00	0.00	1.28	1.86	34.00	4.32	5.00	0.00	8.00	5.13	2.87	2.48	0.36	28.26
Other Species	1.88	1.49	0.73	6.32	4.54	10.00	8.65	0.00	2.11	0.00	9.23	1.00	2.50	0.29	28.39
Total	8.05	2.05	3.66	12.17	6.44	50.00	17.30	5.00	2.11	12.00	27.69	15.39	9.25	0.28	100.00

The 1997 year class of winter flounder was present at lengths between 80 and 139 mm when sampling began in June 1998 (Appendix Figure 4). The 1998 year class was recruited to the trawl at lengths between 40 and 79 mm in September 1998. No winter flounder were captured in February 1999 as both year classes apparently moved to deeper water. In March and April 1999, the 1998 year class was present at 40-79 mm.

Atlantic cod were captured in November 1998, and March through May 1999 at Station GT4 (Appendix Figure 8). The 1999 year class of Atlantic cod was recruited to the trawl at 21 to 29 mm in March 1999. By May this year class was between 30 and 69 mm.

Skates were present from June through October 1998, and April and May 1999. The disappearance of skates from this station from November through March is consistent with an offshore movement to deeper water during the colder months. Shorthorn sculpin were present in June, November, and March through May. YOY shorthorn sculpin were recruited to the trawl in April at lengths less than 25 mm. YOY and yearling fish were present in the catches in May. Rainbow smelt were present in October through December, and April. Lengths in October through December ranged from 84 to 185 mm and these fish were probably a combination of YOY and older fish. In April all smelt were less than 100 mm, and were probably YOY fish approaching the end of the first year (Murawski and Cole 1978).

3.3 LOBSTER MONITORING

3.3.1 Trap Sampling

Lobster monitoring occurred twice per month from June through December 1998 and in May 1999. Data in Table 3-12 are presented as lobster catch per trap per three day set-over days (CTH_3). Total CTH_3 (legal and sublegal) in the Inner Harbor was more than twice that of the Outer Harbor, primarily due to high catches of legal-size lobsters in the Inner Harbor. Annual mean CTH_3 of legal-size lobsters in the Inner Harbor (2.9) was almost six times higher than in the Outer Harbor (0.5). Annual mean CTH_3 of sublegal lobsters was identical in the Inner and Outer Harbors (1.1).

In the Inner Harbor total CTH_3 was relatively consistent from June through September, and then decreased in October through November and was again low in May (Figure 3-3). Both legal and sublegal-size lobsters followed the same general monthly pattern as total CTH_3. In the Outer Harbor, total CTH_3 followed the same general pattern as the Inner Harbor. CTH_3 for sublegal lobsters decreased in late October, while legal-size lobster CTH_3 decreased in early October (Table 3-12).

3.3.2 Trawl Sampling

Lobsters were also captured in the trawl samples. Geometric mean CPUE of total lobsters (legal and sublegal) at all stations combined was highest in September, and then decreased rapidly in

Table 3-12. CTH_3 (Catch per trap per three set-over-days) for legal and sublegal lobsters captured in Gloucester Harbor, June through November 1998, and May 1999.

	12JUN98	25JUN98	09JUL98	23JUL98	06AUG98	20AUG98	03SEP98	17SEP98	08OCT98	22OCT98	05NOV98	19NOV98	13MAY99	27MAY99
Inner Harbor														
Legal	3.2	3.8	3.0	3.6	4.2	3.3	4.0	4.0	1.6	2.8	2.6	1.5	1.4	1.8
Sublegal	1.8	1.1	1.9	1.4	1.3	0.7	1.3	1.5	1.2	0.5	1.0	0.4	0.3	0.5
Total	5.0	4.9	4.9	5.0	5.5	4.0	5.4	5.6	2.7	3.4	3.6	1.9	1.7	2.3
Outer Harbor														
Legal	0.5	0.7	0.8	0.2	0.4	0.5	0.5	0.7	0.4	0.4	0.5	0.6	0.4	0.3
Sublegal	1.3	1.8	1.4	1.0	1.7	1.3	1.4	2.0	1.0	0.6	0.5	0.5	0.7	0.4
Total	1.8	2.5	2.3	1.2	2.1	1.8	1.9	2.7	1.4	1.0	1.0	1.1	1.1	0.7
Gloucester Harbor														
Legal	0.9	1.2	1.2	0.8	1.0	1.0	1.1	1.3	0.6	0.8	0.8	0.8	0.6	0.7
Sublegal	1.4	1.7	1.5	1.1	1.6	1.2	1.4	1.9	1.0	0.6	0.6	0.5	0.6	0.4
Total	2.3	2.9	2.7	1.8	2.6	2.1	2.4	3.2	1.6	1.4	1.4	1.3	1.2	1.1

	Total	
	Annual Mean CTH3	S.E.
Inner Harbor		
Legal	2.9	0.3
Sublegal	1.1	0.1
Total	4.0	0.4
Outer Harbor		
Legal	0.5	0.0
Sublegal	1.1	0.1
Total	1.6	0.2
Gloucester Harbor		
Legal	0.9	0.1
Sublegal	1.1	0.1
Total	2.0	0.2

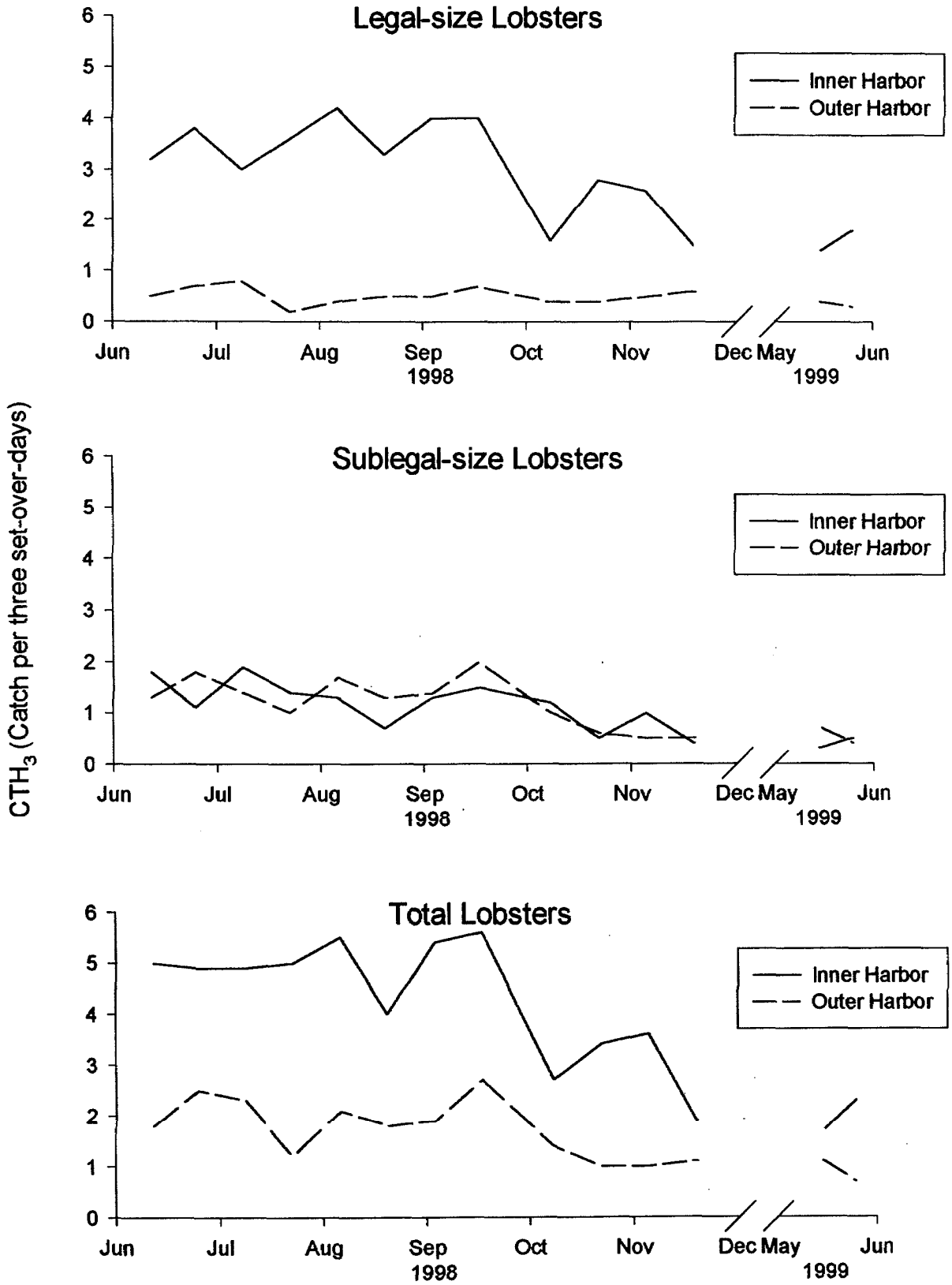

Figure 3-3. CTH_3 (Catch per three set-over-days) for lobsters in Inner and Outer Gloucester Harbor, June through November 1998 and May 1999.

October and November (Table 3-13). No lobsters were captured in December through March, and CPUE began to increase in April and May. Sublegal lobsters showed the same seasonal pattern as total lobsters, as none were collected from December through March. Legal-size lobsters were less abundant than sublegal lobsters and none were collected in July, and November through April.

Each of the four trawl stations showed similar patterns of monthly mean abundance, with catch per haul relatively high in June through November, low catches from December through March, and slight increases in April and May. Annual geometric mean catch per haul at Stations GT1 (0.86/haul) and GT2 (0.88/haul) was lowest among the four stations. Catch per haul at both stations of legal and sublegal lobsters was highest in September. No lobsters were captured in December through February at GT1 and none were captured at GT2 in December through March.

Catch per haul of lobsters was higher at Stations GT3 (1.76/haul) and GT4 (4.54/haul). As with the other stations, catch per haul was highest in September for both legal and sublegal lobsters. Catch per haul was exceptionally high at Station GT4 in August and September.

3.4 WATER QUALITY

Water temperature, salinity and dissolved oxygen (DO) were collected during most sampling efforts from June 1998 through May 1999 (Table 3-14). At both the seine and trawl stations, monthly mean water temperature followed a predictable seasonal pattern. Water temperatures were generally highest in September (seine: 17.4°C; trawl: 15.3°C) and lowest in March (seine: 3.2°C; trawl: 2.8°C). Salinity did not vary much during the months sampled. In the seine, monthly mean salinity ranged from 29.1 ppt at GS1 in May, to 32.1 ppt at GS2 and GS3 in January. Monthly mean salinity in the trawl ranged from 30.4 ppt at GT3 May to 32.9 ppt at GT1 in May. These salinities are very similar to oceanic salinities and reflect the limited freshwater input and strong tidal influence in Gloucester Harbor. Monthly mean dissolved oxygen was never lower than 8.8 mg/l in the seine samples (GS3 in October) and 9.8 mg/l in the trawl samples (GT4 in May). These levels of DO were near saturation during the months collected and were not limiting to fish distribution.

4.0 DISCUSSION

4.1 SEINE

Seine sampling described the shallow water, inshore fish community of Gloucester Harbor. This community was dominated by Atlantic silverside at all stations, and variations in the abundance of this community were a reflection of changes in the abundance of Atlantic silverside. CPUE was highest at Stations GS3 (2.26/haul) and GS1 (1.08/haul) and lower at Stations GS4 (0.55/haul) and GS2 (0.34/haul). Seine catches decreased in the fall, probably as Atlantic silverside started their migration to offshore overwintering areas (Conover and Murawski 1982).

Table 3-13. Catch Per Unit Effort (catch/400-m tow) of American Lobster in Gloucester June 1998 Through May 1999.

Station		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.
GT1	Sublegal	1.97	1.39	0.98	4.48	1.83	1.00	0.00	0.00	0.00	0.00	0.00	4.29	0.85	0.23
	Legal	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
	Total[a]	1.97	1.39	0.41	4.74	1.83	1.00	0.00	0.00	0.00	0.00	0.00	4.29	0.86	0.21
GT2	Sublegal	0.44	0.37	0.73	6.42	3.58	2.00	0.00	0.00	0.00	0.00	1.95	0.73	0.87	0.21
	Legal	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
	Total	0.44	0.37	0.73	7.12	3.58	2.00	0.00	0.00	0.00	0.00	1.95	0.73	0.88	0.22
GT3	Sublegal	9.35	3.07	0.92	14.97	1.79	1.00	0.00	0.00	0.00	0.00	3.00	4.94	1.73	0.32
	Legal	0.70	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.07
	Total	10.06	3.07	0.92	15.97	1.79	1.00	0.00	0.00	0.00	0.00	3.00	4.94	1.76	0.33
GT4	Sublegal	6.32	2.94	19.75	76.32	10.00	15.00	0.00	0.00	0.00	0.00	4.10	11.57	4.33	0.52
	Legal	0.43	0.00	2.43	4.97	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.47	0.19
	Total	6.53	2.94	22.22	83.19	12.70	15.00	0.00	0.00	0.00	0.00	4.10	12.01	4.54	0.53
ALL STATIONS															
	Sublegal	3.24	1.69	2.14	13.97	3.46	2.72	0.00	0.00	0.00	0.00	1.79	4.12	1.66	0.28
	Legal	0.25	0.00	0.36	1.21	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.15	0.07
	Total	3.34	1.69	2.23	15.07	3.72	2.72	0.00	0.00	0.00	0.00	1.79	4.16	1.70	0.28

[a]Geometric means are not additive on the arithmetic scale. Therefore the "Total" will not always be the sum of the sublegal and legal categories.

Table 3-14. Water Quality Data for Fisheries Sampling in Gloucester Harbor June 1998 Through May 1999[a].

Station	Parameter	June	July	August	September	October	November[b]	December[b]	January	February	March	April	May
GS1	Temperature (°C)	18.5	18.9	13.0	17.2	11.0	NS [c]	7.2	4.5	3.4	3.9	8.5	11.8
	Salinity (ppt)	–	–	–	–	31.1	NS [c]	–	31.3	31.3	30.6	30.3	29.1
	Dis. Ox. (mg/l)	–	–	–	–	9.9	NS [c]	–	10.5	11.7	11.1	10.7	10.3
GS2	Temperature (°C)	17.8	19.0	14.4	17.4	10.9		7.1	4.5	3.3	3.2	8.5	11.9
	Salinity (ppt)	–	–	–	–	31.3	31.3	–	32.1	31.3	31.0	30.4	29.3
	Dis. Ox. (mg/l)	–	–	–	–	9.5	10.4	–	10.9	12.6	11.9	11.3	11.0
GS3	Temperature (°C)	17.8	18.2	14.0	17.2	11.2	–	7.1	4.5	3.4	4.0	8.4	11.7
	Salinity (ppt)	–	–	–	–	31.5	–	–	32.1	31.4	30.8	30.6	29.3
	Dis. Ox. (mg/l)	–	–	–	–	8.8	–	–	10.6	11.7	11.3	10.9	10.4
GS4	Temperature (°C)	–	19.5	14.6	16.3	11.4		7.0	4.4	3.3	3.9	8.4	12.0
	Salinity (ppt)	–	–	–	–	31.3	31.3	–	31.4	31.3	30.3	30.4	29.3
	Dis. Ox. (mg/l)	–	–	–	–	9.0	9.6	–	10.6	12.4	11.6	10.7	11.0
GT1	Temperature (°C)	17.3	11.2	10.1	12.5	11.4	–	7.5	4.6	3.3	2.9	4.7	4.9
	Salinity (ppt)	–	–	–	–	–	–	–	31.9	31.7	31.6	31.6	32.9
	Dis. Ox. (mg/l)	–	–	–	–	–	–	–	11.1	11.5	12.1	11.3	11.0
GT2	Temperature (°C)	8.5	9.7	9.6	12.4	11.7	–	7.6	4.6	3.4	2.8	4.6	5.6
	Salinity (ppt)	–	–	–	–	–	–	–	32.0	31.9	31.7	31.6	31.7
	Dis. Ox. (mg/l)	–	–	–	–	–	–	–	10.5	12.1	11.8	11.2	10.3
GT3	Temperature (°C)	9.3	10.8	11.0	15.2	11.3	–	7.7	4.6	3.4	3.0	4.8	7.9
	Salinity (ppt)	–	–	–	–	–	–	–	32.3	31.9	31.6	31.5	30.4
	Dis. Ox. (mg/l)	–	–	–	–	–	–	–	10.5	12.6	11.7	11.1	11.2
GT4	Temperature (°C)	9.5	13.5	9.9	15.3	11.5	–	7.5	4.8	3.3	2.8	7.4	8.0
	Salinity (ppt)	–	–	–	–	–	–	–	31.9	31.8	31.3	30.7	31.0
	Dis. Ox. (mg/l)	–	–	–	–	–	–	–	10.0	11.2	11.5	11.4	9.8

[a] Salinity and dissolved oxygen not requested to be collected until October
[b] Water quality meter malfunctions in November and December
[c] Not sampled due to high waves

Winter flounder, lumpfish, mummichog, and blueback herring were also common fishes in the seine samples. The occurrence of these fishes was consistent with their described seasonal movements and habitat preferences. YOY winter flounder were most common in the shallow water in September, prior to their movement to deeper water as they mature (Buckley 1989). Lumpfish are often associated with floating rockweed (Bigelow and Schroeder 1953) and the large catch of YOY lumpfish on one sampling effort associated with floating debris could be viewed as an unusual event that is not representative. Mummichog is one of the most abundant fishes in Atlantic coast estuaries, but was not exceptionally abundant in this study. Mummichogs prefer salt marsh habitat compared to open water (Javonilla et al. 1997), and the open beaches sampled in this study may not have been a preferred habitat. Blueback herring were captured in June and July, probably as they began their downstream migration to oceanic waters (Mullen et al. 1986).

4.2 TRAWL

The trawl sampling described the deeper water (18-36 ft) fish community of Gloucester Harbor. The fish community in the deeper waters was more variable than the shallow waters, and several species were dominant. CPUE was highest at Station GT3 (12.67/ tow) where skates and YOY winter flounder and Atlantic cod were dominant. CPUE was also relatively high at Station GT4 (9.25/tow) where YOY winter flounder, skates and Atlantic cod were the most common species. CPUE was lower at Stations GT1 (7.31/tow) and GT2 (5.08/tow). At Station GT1, winter flounder and skates were dominant, and at GT2, winter flounder and Atlantic cod were most common.

The seasonal pattern of abundance of the most common fishes captured in the trawl (winter flounder, skates, Atlantic cod, red hake, rock gunnel) was consistent with the published literature, with the possible exception of Atlantic cod. The monthly pattern of abundance of winter flounder was reflection of the 1997 year class occurring in April through June, followed by the recruitment of the 1998 year class in September through November. The seasonality of skates was consistent with the offshore movement in the winter to warmer, deeper waters (Table 3-7), that was similar to that described for little skate (Bigelow and Schroeder 1953).

Atlantic cod are reported to spawn from December through April (Smith et al. 1979), which is not consistent with the recruitment of small YOY cod in October. However, our data and reports from other monitoring programs (NAI 1993) suggest that in the western Gulf of Maine, there are two peaks in cod larvae abundance, and presumably spawning. One peak occurs from April through July, and a second smaller peak occurs from November through February. The recruitment of small YOY cod in October may be a result of the April through July peak in larval abundance, and the recruitment of YOY in March could be the result of the November through February peak in larval abundance. The recruitment of YOY cod in this study is consistent with a bimodal peak in spawning and larval abundance.

Young red hake are generally unavailable to trawls because the YOY are pelagic and juveniles are inquiline with sea scallops (Musick 1974). These behaviors may explain why so few

young red hake were captured. Red hake were absent from trawl samples in Gloucester Harbor from December through March, consistent with their published life history of moving offshore in the winter to warmer waters (Musick 1974). Red hake were most abundant at Station GT3, where they ranked fourth in abundance. Rock gunnel appear to prefer sandy, gravelly and stony substrates and are often found among seaweed (Bigelow and Schroeder 1953). They were most abundant at Station GT1 where the sandy substrate and the presence of macroalgae may provide a preferred habitat.

4.3 COMMUNITY COMPARISONS

The fish community in Gloucester Harbor is typical of the Acadian (north of Cape Cod) zoogeographic province. The domination of the inshore fish community by a relatively few species has been found in other ichthyofaunal surveys in the Acadian Province (Ayvazian et al. 1992; Lazzari et al. 1999). The relatively high catches of Atlantic silverside also occurred in the Wells estuary in southwestern Maine (Ayvazian et al. 1992) where they were the dominant fish using the estuary as nursery habitat. In contrast to the Gloucester sampling, mummichog and ninespine stickleback were also very common in Wells Harbor. These species are more common in estuarine and saltmarsh habitats such as Wells Harbor, as opposed to the open-beach ocean- influenced habitat of Gloucester Harbor. Lazzari et al. (1999) sampled an open beach habitat at Kennebec Point, Maine. The fish community was similar to that at Gloucester with Atlantic silverside a dominant member. American sand lance and Atlantic herring were also common at Kennebec Point, but these fishes were not dominant in Gloucester.

The deeper-water fish community sampled by the trawl in Gloucester Harbor was also similar to that of the deeper-water habitat of Wells Harbor. Winter flounder were numerically important in both harbors, but abundance of American sand lance was much higher in Wells Harbor due to a single very large catch in the summer. Skates were very abundant in Gloucester Harbor, but not abundant in Wells Harbor, possibly due to the estuarine influence.

The monthly patterns of abundance were also very similar among Gloucester Harbor, Wells Harbor, and Kennebec Point. Abundance of fishes at all sites was highest in the warmer months and decreased to near zero in the winter (Ayvazian et al. 1992; Lazzari et al. 1999). Abundance began to increase in the spring, primarily due to the appearance of YOY fish. At Kennebec Point, abundance of fishes was positively correlated with water temperature (Lazzari et al. 1999).

The fisheries resources of Gloucester Harbor were sampled in 1966 and 1967 by the Massachusetts Division of Marine Fisheries (Jerome et al. 1969). These data provide an opportunity to evaluate changes in the fish community over more than 20 years. Several fish sampling stations of Jerome et al. (1969) were located either at or near sampling stations in this study. Although there were differences in the fishing gear used between Jerome et al. (1969) and the present study that affect the catch, making qualitative comparisons is possible.

Station GS4, was located at Niles Beach where Jerome et al. (1969) sampled in 1966-67. Atlantic silverside was the most abundant fish in both surveys. American sand lance ranked second in abundance in the earlier study, although they all were captured in a single sampling event in July that might not be truly representative of the fish community at this station. No American sand lance were captured in this study at Station GS4.

The Blynman Canal connects the Annisquam River to Gloucester Harbor. Station GS1, was located near the Gloucester Harbor end of the canal at Pavilion Beach, and a station was occupied by Jerome et al. (1969) at the Annisquam River end of the canal. Atlantic silverside was most abundant at Station GS1, while mummichogs were overwhelmingly dominant in the earlier study. No mummichogs were captured at GS1. Mummichogs are more likely to be found near saltmarsh habitat, which is common in the Annisquam River, and did not occur at GS1.

Trawl samples were collected in both studies at near Niles Beach (Station GT1). At Station GT1 winter flounder and skates were most abundant. In the earlier study, Atlantic cod and winter flounder were most abundant, and no skates were captured. Station GT2, was located in open water in the southeast part of the harbor near a station of Jerome et al. (1969). Winter flounder, Atlantic cod, skates and cunner were the dominant species. In 1966-67, winter flounder, yellowtail flounder, and Atlantic cod were the most abundant species. No skates were captured in 1966-67, and no yellowtail flounder were captured in this study.

The differences between these two sampling efforts may be illustrative of the larger changes in the demersal fish fauna of the Gulf of Maine that have occurred over the past 20 years. Among the trawl stations that were comparable between the present study and Jerome et al. (1969), skates did not occur in the earlier study and were among the dominants in the present study. Skates are now a much larger component of the fish community of the Gulf of Maine than they were previously. Biomass of skates in the Gulf of Maine peaked in the mid-1980's and has started to decline, but remains above previous levels (NMFS 1998). Fogarty and Murawski (1998) suggested that overfishing of flounders and gadids resulted in an ecological replacement of these species by small elasmobranchs (including dogfish and skates).

In contrast to skates, yellowtail flounder appear to be less common than they were previously. Yellowtail flounder ranked second in abundance at the station in the Southeast Harbor in 1966-67, but did not occur at the comparable station in this study, or at any other station in Gloucester Harbor. Yellowtail flounder are considered "fully exploited," but there is evidence that spawning stock biomass, although low, is increasing (NMFS 1998). Decreases in stock abundance have resulted in a contraction of the range of yellowtail flounder in Canada (Brodie et al. 1997). The current low levels in Gloucester Harbor are probably a result of decreased abundance in the Gulf of Maine, rather than any localized effect.

4.4 LOBSTERS

CTH_3 of lobsters in Gloucester Harbor was higher in the Inner Harbor (2.9) compared with the Outer Harbor (0.5). CTH_3 of sublegal lobsters was the same in the Inner and Outer Harbor (1.1). Currently, lobstering is prohibited in the Inner Harbor, and this area may be serving as a refuge for legal-size lobster. Seasonally, CTH_3 was highest in September which is consistent with data collected by the Massachusetts Division of Marine Fisheries (Pava et al. 1998). CTH_3 of legal-size lobsters (0.9) in Gloucester Harbor was lower than the CTH_3 reported for Cape Ann in 1997 (1.1), but higher than for the entire coast (0.8; Estrella and Glenn 1998). However, the CTH_3 from Gloucester Harbor, and Cape Ann (Pava et al. 1997) may be closer than is apparent because CTH_3 from Cape Ann does not include ovigerous females. CTH_3 of sublegal lobsters (1.1) was less than the catch/haul (not standardized for soak time) of sublegal lobsters from Cape Ann (1.9) and the entire state (1.4).

Changes in water temperature can affect lobster catches, as water temperature modifies lobster activity. Increases in lobster catch have been correlated with increasing water temperature (Fogarty 1988; Campbell et al. 1991). Higher water temperature increases the activity levels of lobsters making them more likely to enter traps. The decreased CPUE during the fall and winter is likely a result of lower water temperatures decreasing lobster activity. Furthermore, there is evidence that lobsters will move to deeper, offshore water in the winter, to avoid cold inshore water (MacKenzie and Moring 1985).

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APPENDICES

Appendix Figure 1. Length-Frequency diagram for winter flounder captured in the trawl at Station GT1 in Gloucester Harbor, June 1998 through May 1999

Appendix Figure 2 Length-frequency diagram for winter flounder captured in the trawl at Station GT2 in Gloucester Harbor, June 1998 through May 1999

Appendix Figure 3. Length-frequency diagram for winter flounder captured in the trawl at Station GT3 in Gloucester Harbor, June 1998 through May 1999

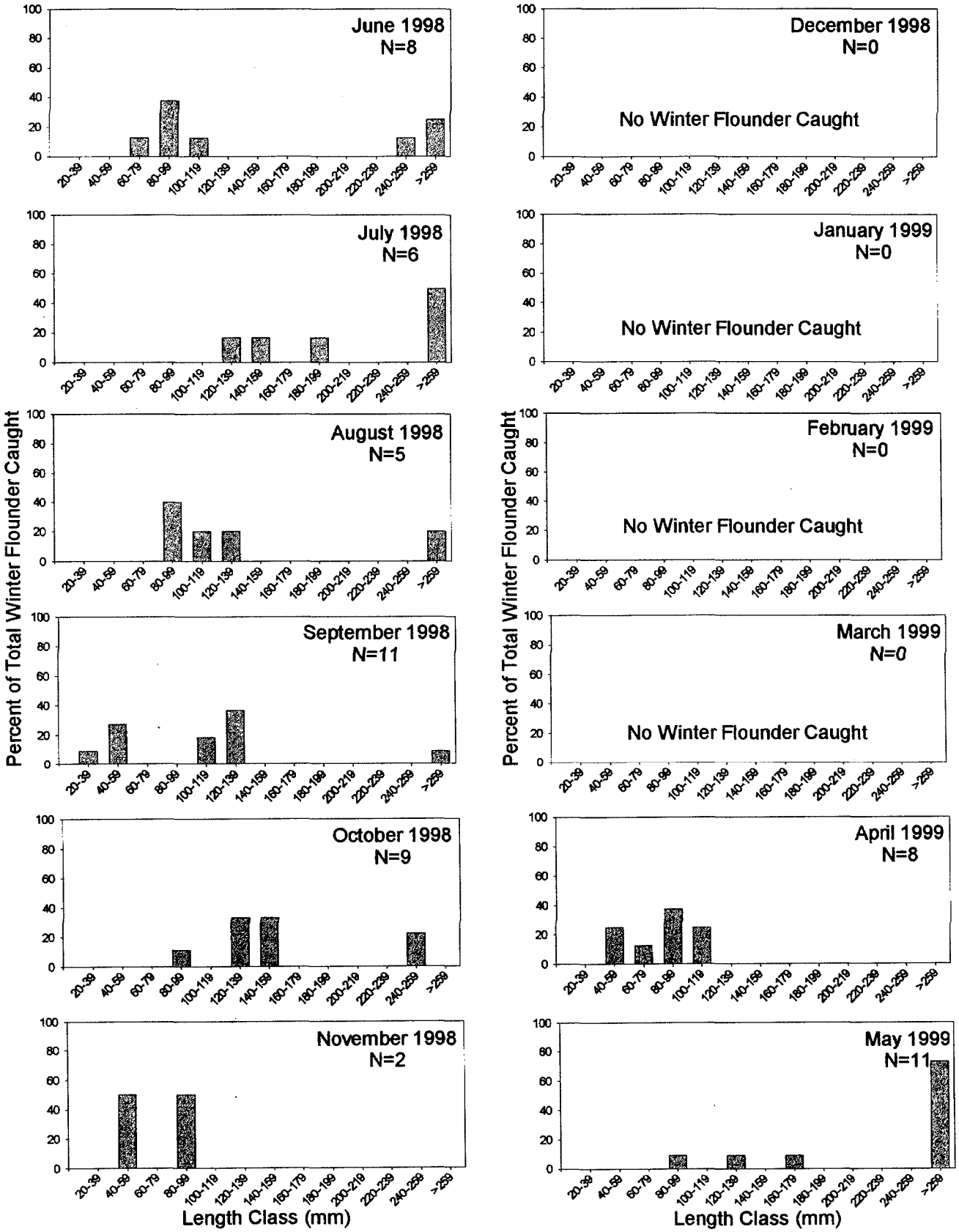
Appendix Figure 4. Length-frequency diagram for winter flounder captured in the trawl at Station GT4 in Gloucester Harbor, June 1998 through May 1999

Appendix Figure 5. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT1 in Gloucester Harbor, June 1998 through May 1999

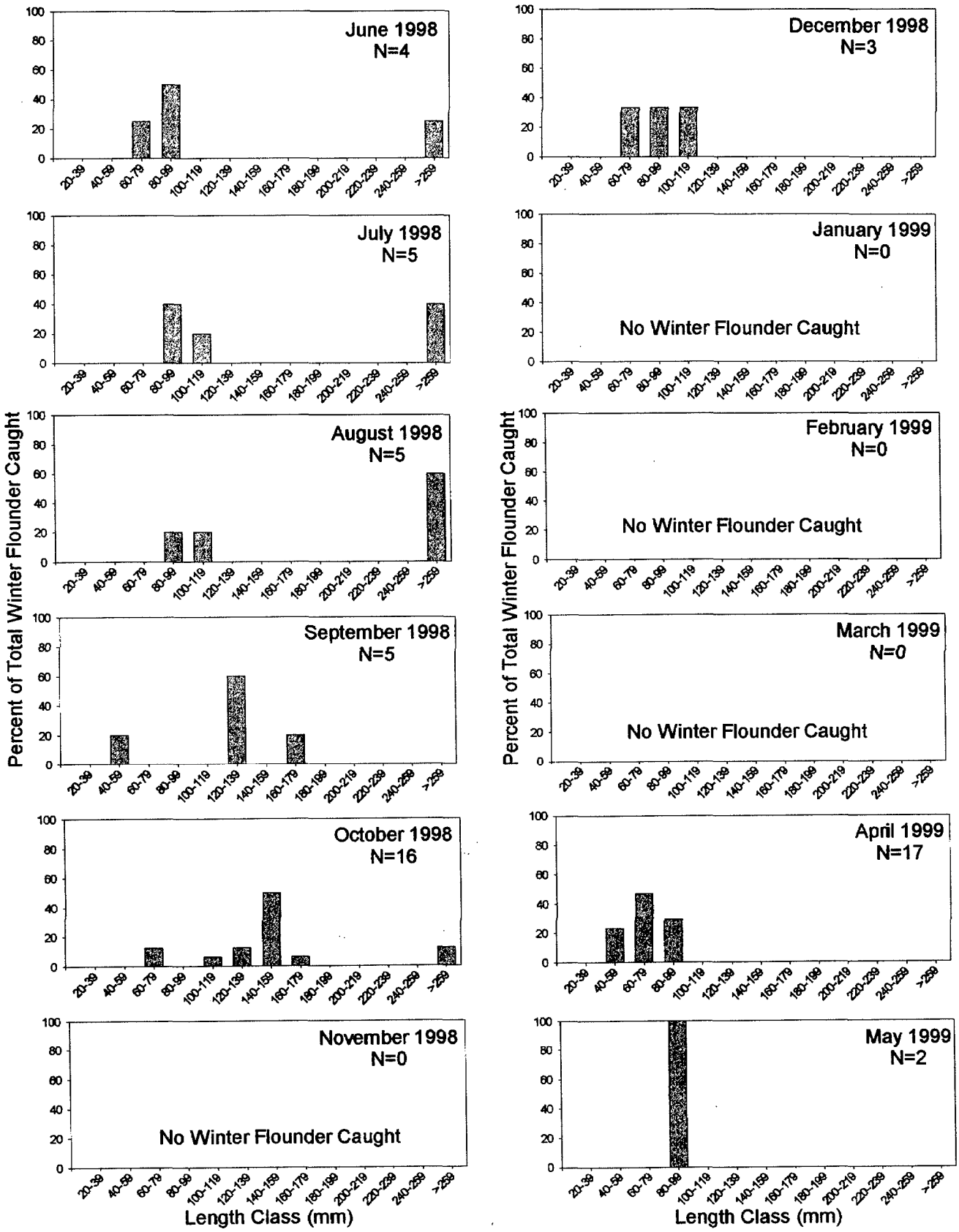
Appendix Figure 6. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT2 in Gloucester Harbor, June 1998 through May 1999

Appendix Figure 7. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT3 in Gloucester Harbor, June 1998 through May 1999

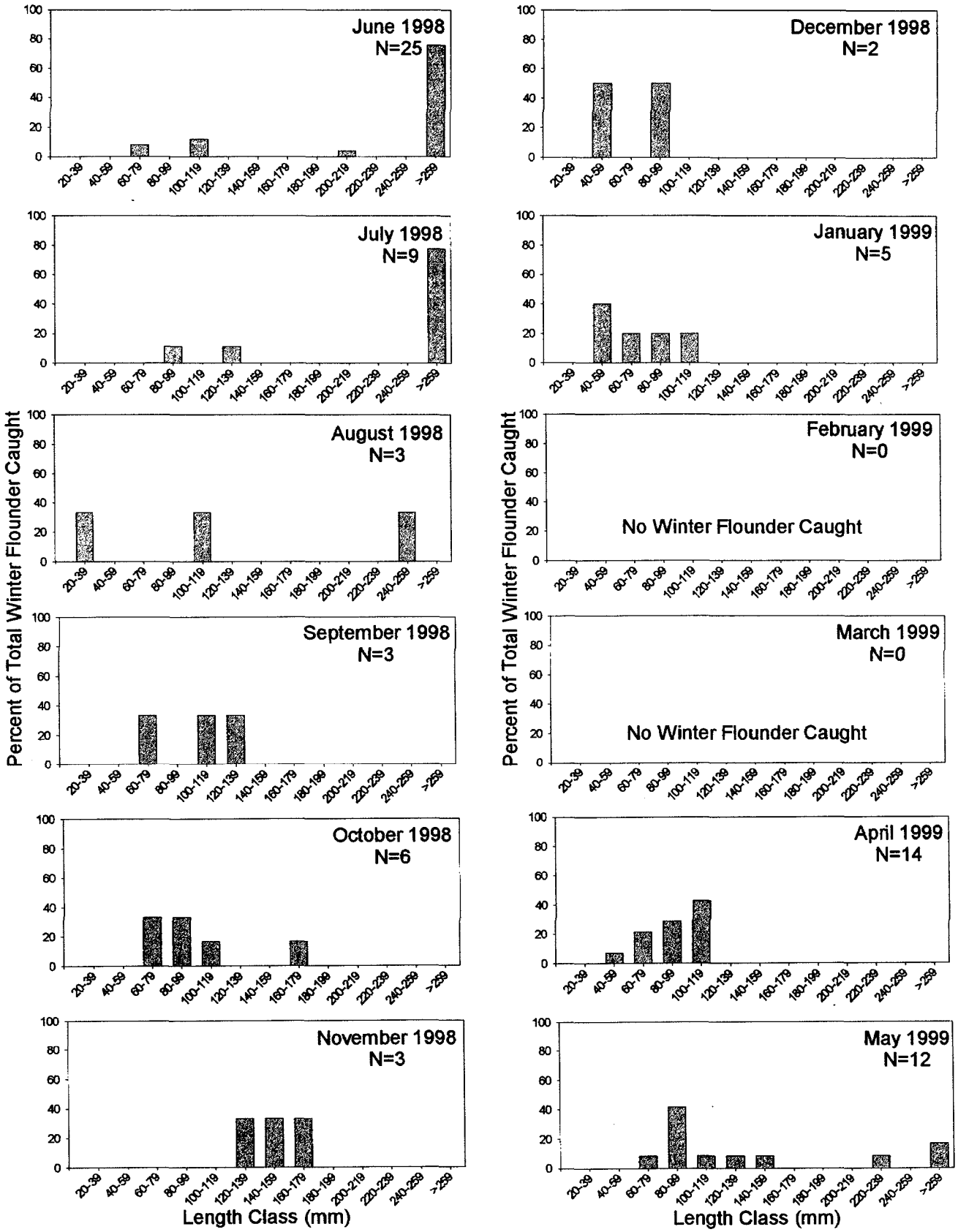
Appendix Figure 8. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT4 in Gloucester Harbor, June 1998 through May 1999



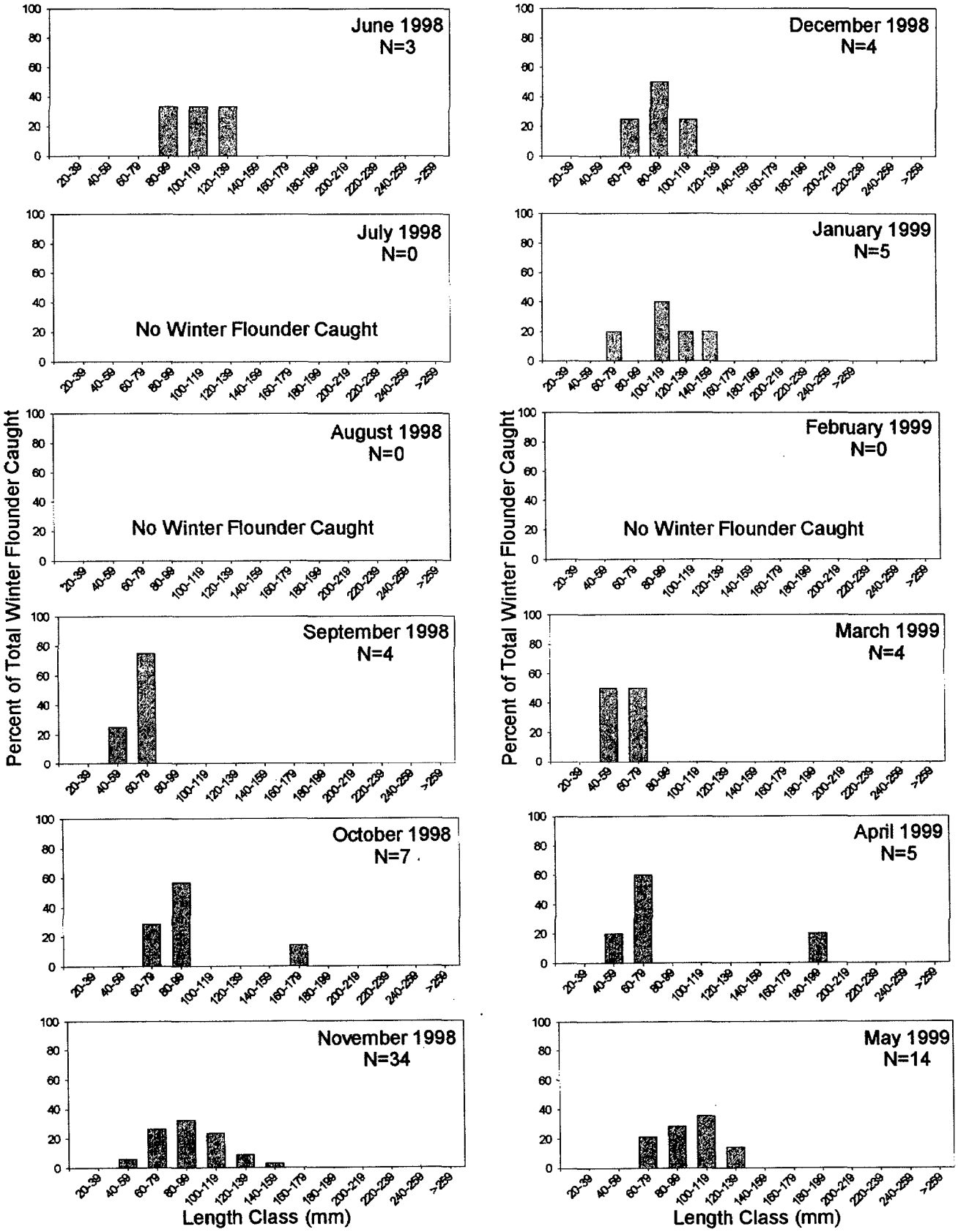
Appendix Figure 1. Length-frequency diagram for winter flounder captured in the trawl at Station GT1 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).



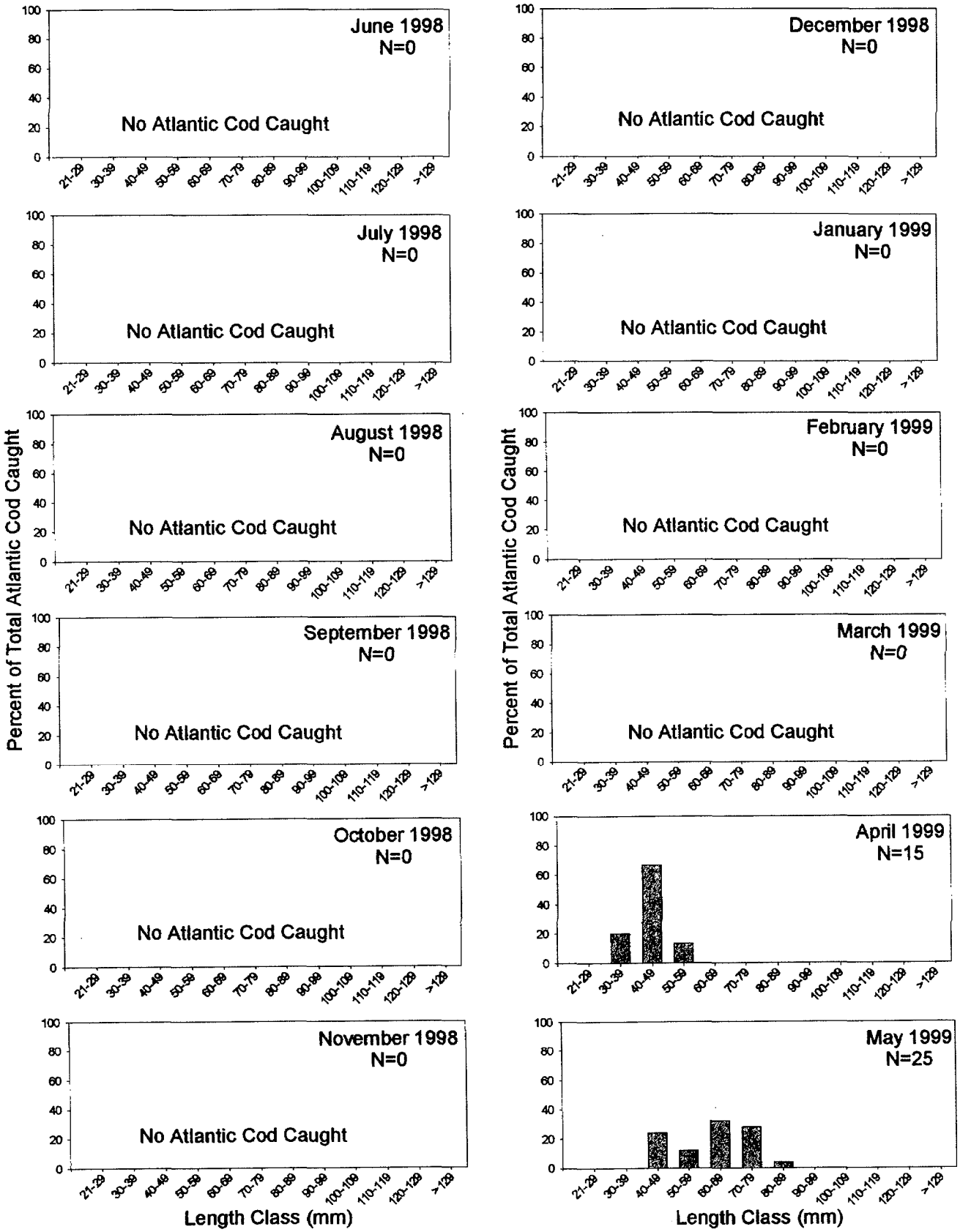
Appendix Figure 2. Length-frequency diagram for winter flounder captured in the trawl at Station GT2 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).



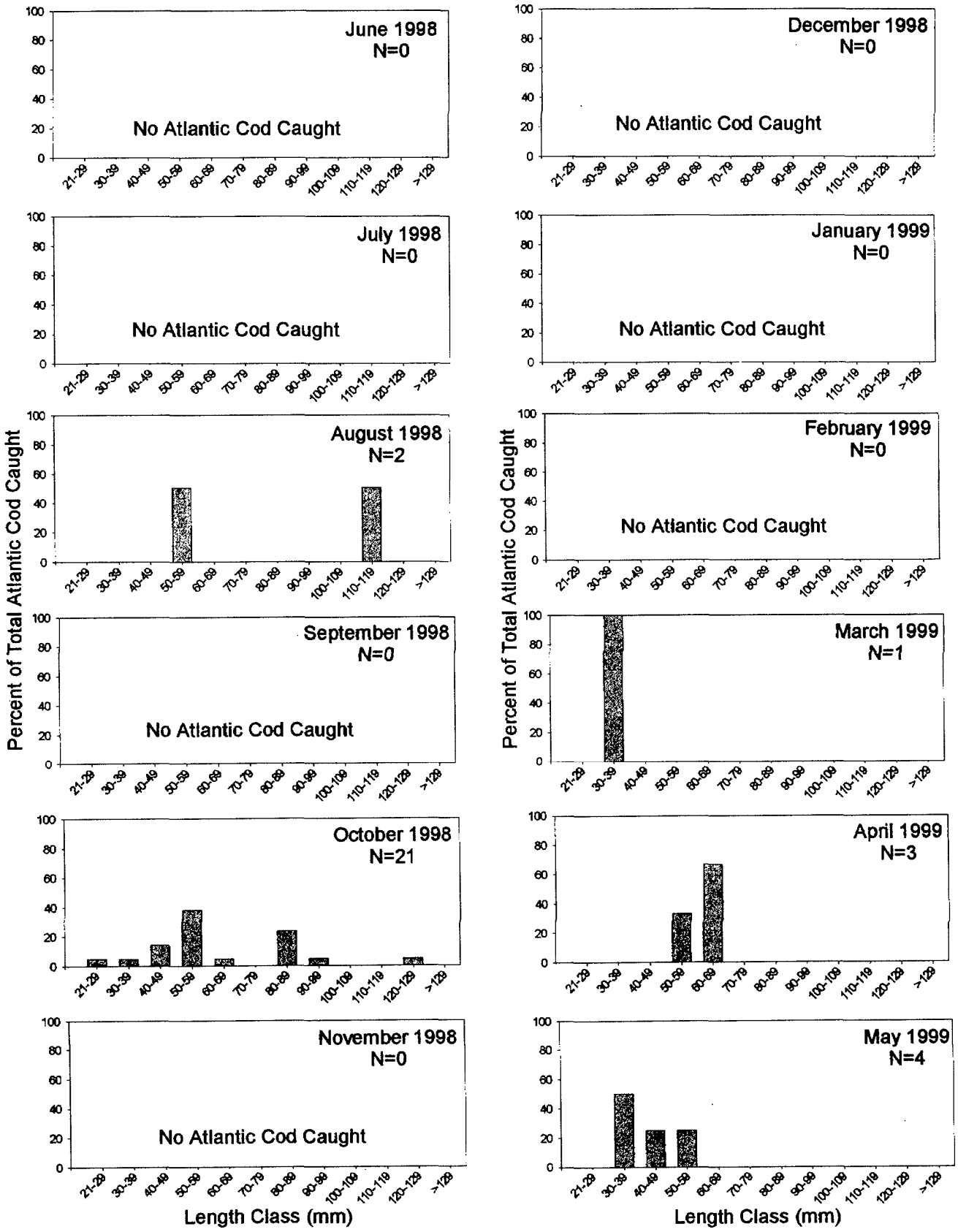
Appendix Figure 3. Length-frequency diagram for winter flounder captured in the trawl at Station GT3 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).



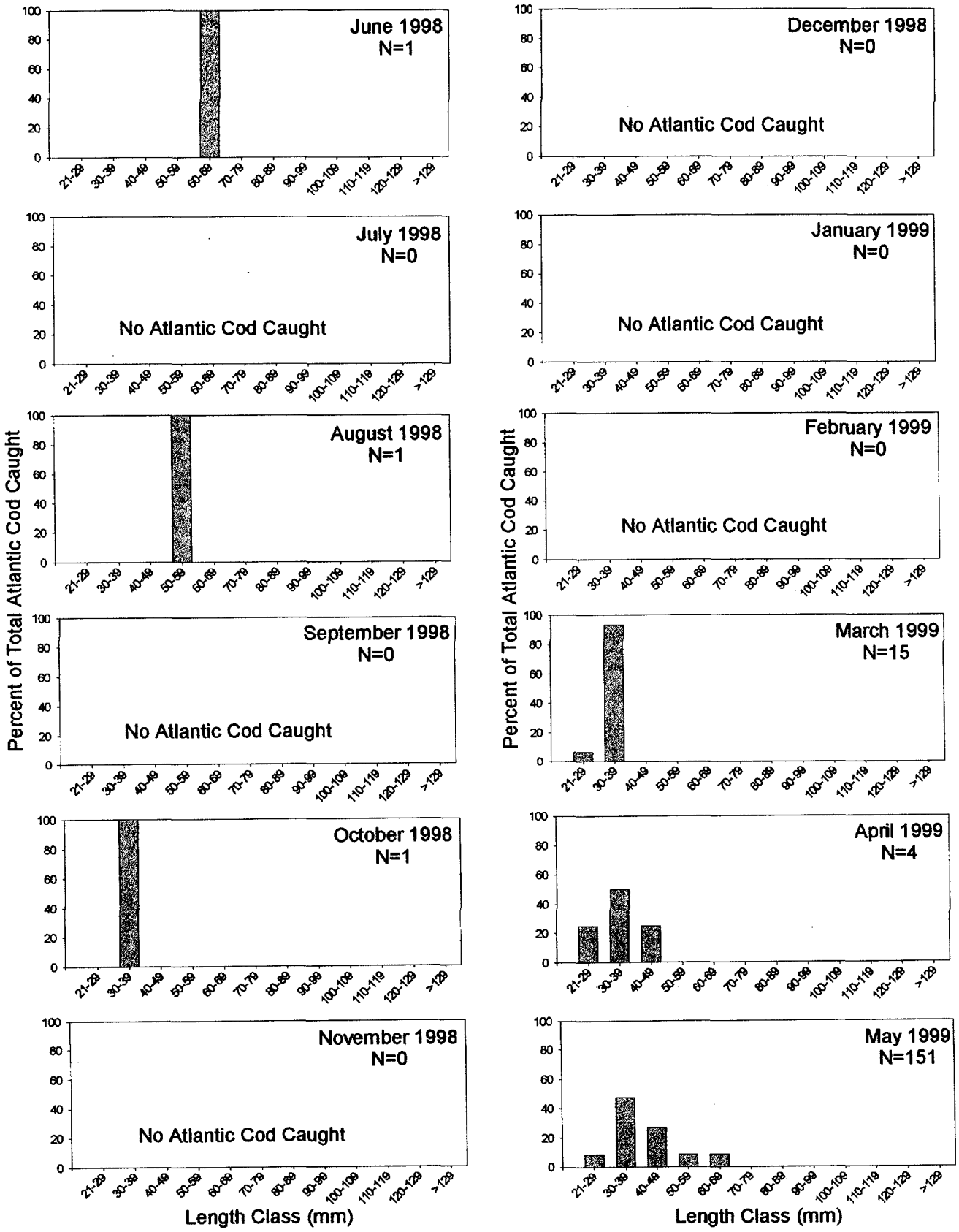
Appendix Figure 4. Length-frequency diagram for winter flounder captured in the trawl at Station GT4 in Gloucester Harbor, June 1998 through May 1999 (N = number of fish).



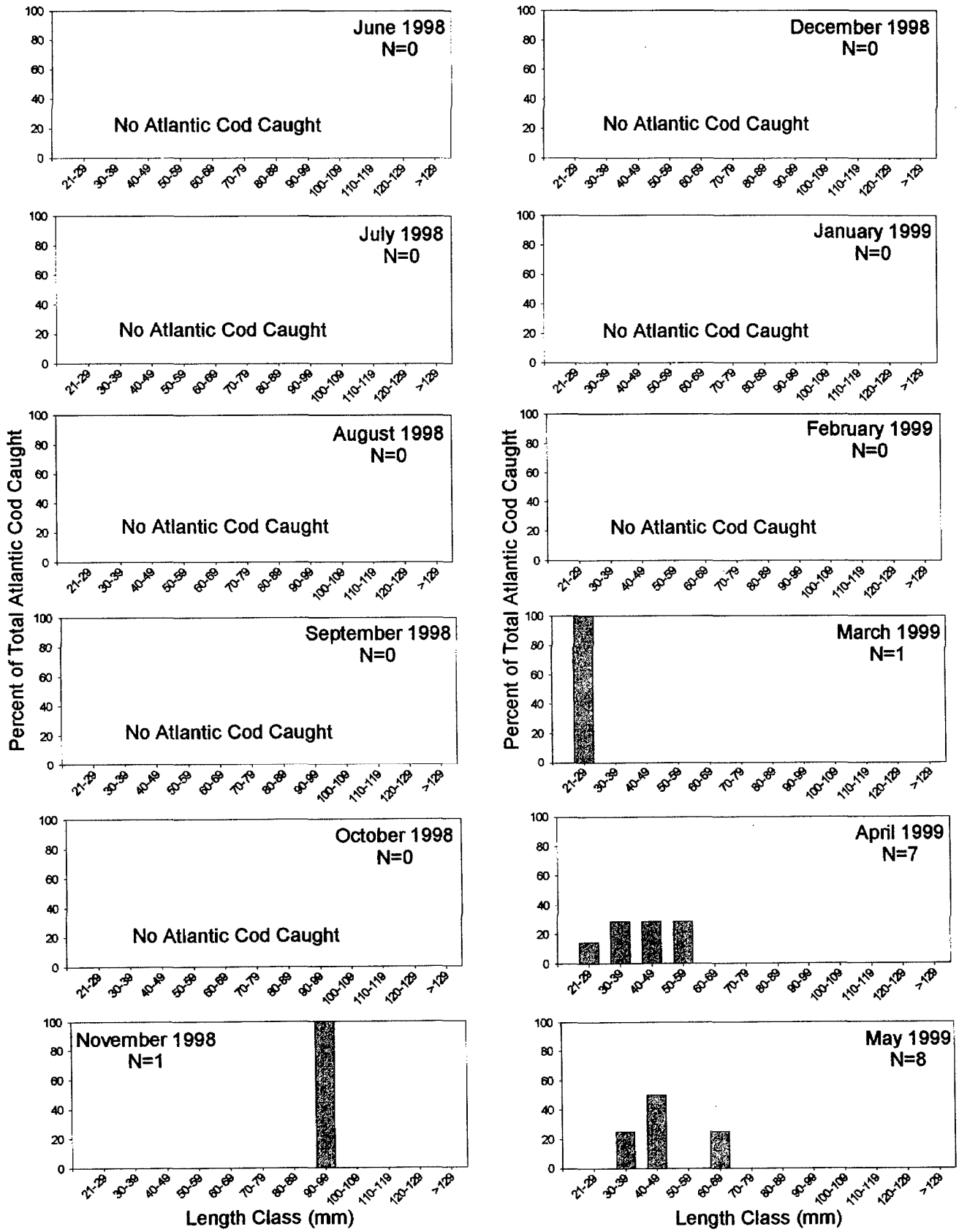
Appendix Figure 5. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT1 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).



Appendix Figure 6. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT2 in Gloucester Harbor, June 1998 through May 1999 (N = number of fish).



Appendix Figure 7. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT3 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).



Appendix Figure 8. Length-frequency diagram for Atlantic cod captured in the trawl at Station GT4 in Gloucester Harbor, June 1998 through May 1999 (N=number of fish).

APPENDIX TABLE A-1.

Common and scientific names of fishes captured in the seine in Gloucester Harbor.

Common Name	Scientific Name
American sand lance	*Ammodytes americanus*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic silverside	*Menidia menidia*
Bay anchovy	*Anchoa mitchilli*
Blueback herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Cunner	*Tautogolabrus adspersus*
Grubby	*Myoxocephalus aenaeus*
Hake sp.	*Urophycis* sp.
Lumpfish	*Cyclopterus lumpus*
Mummichog	*Fundulus heteroclitus*
Northern pipefish	*Syngnathus fuscus*
Northern puffer	*Sphoeroides maculatus*
Pollock	*Pollachius virens*
Rainbow smelt	*Osmerus mordax*
Red hake	*Urophycis chuss*
Rock gunnel	*Pholis gunnellus*
Shorthorn sculpin	*Myoxocephalus scorpius*
Threespine stickleback	*Gasterosteus aculeatus*
Windowpane	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*

APPENDIX TABLE A-2.

Common and scientific names of fishes captured in the trawl in Gloucester Harbor.

Common Name	Scientific Name
Atlantic cod	*Gadus morhua*
Atlantic silverside	*Menidia menidia*
Blueback herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Cunner	*Tautogolabrus adspersus*
Grubby	*Myoxocephalus aenaeus*
Hake sp.	*Urophycis* sp.
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Lumpfish	*Cyclopterus lumpus*
Northern pipefish	*Syngnathus fuscus*
Northern puffer	*Sphoeroides maculatus*
Ocean pout	*Macrozoarces americanus*
Pollock	*Pollachius virens*
Radiated shanny	*Ulvaria subbifurcata*
Rainbow smelt	*Osmerus mordax*
Red hake	*Urophycis chuss*
Rock gunnel	*Pholis gunnellus*
Sea raven	*Hemitripterus americanus*
Shorthorn sculpin	*Myoxocephalus scorpius*
Skate sp.	*Raja* sp.
Snailfish sp.	*Liparis* sp.
White hake	*Urophycis tenuis*
Windowpane	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*

Appendix Table 1. Arithmetic mean catch per unit effort (catch/haul) of all species captured in the seine at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.32
Atlantic menhaden	0.00	0.00	0.00	0.13	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.11	1.90
Atlantic silverside	0.00	0.00	0.88	20.25	37.63	0.00	0.25	0.00	0.25	0.25	1.00	0.25	5.06	3.39	76.90
Bay anchovy	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.32
Blueback herring	0.50	2.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.22	3.96
Bluefish	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.16
Cunner	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.32
Grubby	1.25	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	1.74
Hake sp.	0.00	0.00	0.00	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.47
Lumpfish	0.13	0.00	0.13	4.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.38	6.17
Mummichog	0.00	0.00	0.13	0.00	0.38	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.07	1.58
Northern pipefish	0.13	0.13	0.00	0.13	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.05	1.27
Northern puffer	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.16
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.01	0.16
Rainbow smelt	0.00	0.00	0.00	0.25	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.79
Red hake	0.38	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.63
Rock gunnel	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.16
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.01	0.16
Threespine stickleback	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.02	0.01	0.32
Windowpane	0.38	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0:03	0.63
Winter flounder	0.13	0.00	0.00	0.75	0.25	0.00	0.25	0.00	0.00	0.00	0.00	0.13	0.13	0.06	1.90
Total	3.38	3.00	1.25	26.75	41.13	0.75	0.50	0.00	0.25	0.25	1.00	0.75	6.58	3.81	100.00

Appendix Table 2. Arithmetic mean catch per unit effort (catch/haul) of all species captured in the seine at station GS1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	0.00	0.00	0.00	26.00	11.00	0.00	1.00	0.00	0.00	0.00	4.00	0.50	3.54	2.24	83.33
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hake sp.	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.98
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	2.94
Northern pipefish	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	1.96
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.98
Red hake	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	1.96
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.98
Windowpane	1.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.13	3.92
Winter flounder	0.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.13	0.09	2.94
Total	3.50	0.00	0.00	27.00	14.00	0.00	2.00	0.00	0.00	0.00	4.00	0.50	4.25	2.37	100.00

Appendix Table 3. Arithmetic mean catch per unit effort (catch/haul) of all species captured in the seine at station GS2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	5.88
Atlantic silverside	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	17.65
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	23.53
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	11.76
Grubby	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	11.76
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	11.76
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	5.88
Rock gunnel	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	5.88
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	5.88
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	5.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.71	0.43	100.00

Appendix Table 4. Arithmetic mean catch per unit effort (catch/haul) of all species captured in the seine at station GS3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.41
Atlantic menhaden	0.00	0.00	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.38	1.83
Atlantic silverside	0.00	0.00	2.50	53.00	138.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.13	11.91	78.66
Bay anchovy	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.41
Blueback herring	0.00	10.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.88	4.27
Bluefish	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.20
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	2.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.17	1.02
Hake sp.	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.41
Lumpfish	0.50	0.00	0.50	18.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.63	1.54	7.93
Mummichog	0.00	0.00	0.50	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.25	1.42
Northern pipefish	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.41
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.20
Rainbow smelt	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.11	0.81
Red hake	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.20
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.20
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	3.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.33	0.25	1.63
Total	3.00	12.00	4.00	77.00	145.50	3.00	0.00	0.00	0.00	0.00	0.00	1.50	20.50	12.98	100.00

Appendix Table 5. Arithmetic mean catch per unit effort (catch/haul) of all species captured in the seine at station GS4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	9.52
Atlantic silverside	0.00	0.00	1.00	0.50	1.50	0.00	0.00	0.00	1.00	1.00	0.00	0.50	0.46	0.16	52.38
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	19.05
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	9.52
Northern puffer	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	4.76
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	4.76
Total	2.00	0.00	1.00	1.00	4.00	0.00	0.00	0.00	1.00	1.00	0.00	0.50	0.88	0.34	100.00

Appendix Table 6. Arithmetic mean biomass per unit effort (g/haul) of all species captured in the seine at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.46
Atlantic menhaden	0.00	0.00	0.00	0.25	9.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.82	3.74
Atlantic silverside	0.00	0.00	3.13	82.88	125.75	0.00	0.50	0.00	0.75	0.50	3.75	0.50	18.15	11.92	80.35
Bay anchovy	0.00	0.50	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.23
Blueback herring	0.63	5.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.48	2.35
Bluefish	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.05
Cunner	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.14
Grubby	0.50	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.23
Hake sp.	0.00	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.09
Lumpfish	3.38	0.00	0.13	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.35	2.31
Mummichog	0.00	0.00	0.38	0.00	0.38	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.07	0.55
Northern pipefish	0.13	0.13	0.00	0.13	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.28
Northern puffer	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.05
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.01	0.05
Rainbow smelt	0.00	0.00	0.00	0.38	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.12	0.65
Red hake	0.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.28
Rock gunnel	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.14
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.01	0.01	0.05
Threespine stickleback	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.02	0.01	0.09
Windowpane	6.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.50	2.77
Winter flounder	1.13	0.00	0.00	7.25	0.63	0.00	4.00	0.00	0.00	0.00	0.00	1.00	1.17	0.64	5.17
Total	12.88	6.88	3.75	95.50	139.88	0.75	4.50	0.00	0.75	0.50	3.75	1.88	22.58	13.15	100.00

Appendix Table 7. Arithmetic mean biomass per unit effort (g/haul) of all species captured in the seine at station GS1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic silverside	0.00	0.00	0.00	86.00	25.00	0.00	2.00	0.00	0.00	0.00	15.00	0.50	10.71	7.22	68.53
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hake sp.	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.27
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.80
Northern pipefish	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.53
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.38	2.40
Red hake	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.27
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.27
Windowpane	24.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	2.02	16.00
Winter flounder	4.50	0.00	0.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	1.71	1.35	10.93
Total	29.50	0.00	0.00	92.50	32.00	0.00	18.00	0.00	0.00	0.00	15.00	0.50	15.63	7.82	100.00

Appendix Table 8. Arithmetic mean biomass per unit effort (g/haul) of all species captured in the seine at station GS2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	7.69
Atlantic silverside	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.33	30.77
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	19.23
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	11.54
Grubby	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	7.69
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.85
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.85
Rock gunnel	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	11.54
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	3.85
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	7.00	0.00	0.00	5.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.08	0.68	100.00

Appendix Table 9. Arithmetic mean biomass per unit effort (g/haul) of all species captured in the seine at station GS3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.42	0.57
Atlantic menhaden	0.00	0.00	0.00	0.00	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	3.25	4.48
Atlantic silverside	0.00	0.00	12.00	241.00	475.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.67	42.61	83.68
Bay anchovy	0.00	2.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.17	0.29
Blueback herring	0.00	23.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92	1.92	2.64
Bluefish	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.06
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.11
Hake sp.	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.06
Lumpfish	13.50	0.00	0.50	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	1.38	2.87
Mummichog	0.00	0.00	1.50	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.27	0.52
Northern pipefish	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.11
Northern puffer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.06
Rainbow smelt	0.00	0.00	0.00	1.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.14	0.29
Red hake	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.23
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.06
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	29.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.88	2.40	3.97
Total	14.50	27.50	14.50	283.50	522.00	3.00	0.00	0.00	0.00	0.00	0.00	5.00	72.50	46.95	100.00

Appendix Table 10. Arithmetic mean biomass per unit effort (g/haul) of all species captured in the seine at station GS4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.70
Atlantic silverside	0.00	0.00	0.50	0.50	3.00	0.00	0.00	0.00	3.00	2.00	0.00	1.50	0.88	0.34	77.78
Bay anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grubby	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.70
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mummichog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern pipefish	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.70
Northern puffer	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	3.70
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Threespine stickleback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter flounder	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	7.41
Total	0.50	0.00	0.50	1.00	5.00	0.00	0.00	0.00	3.00	2.00	0.00	1.50	1.13	0.45	100.00

Appendix Table 11. Arithmetic mean catch per unit effort (catch/400-m tow) of all species captured in the trawl at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.12	0.00	0.37	0.00	2.75	0.25	0.00	0.00	0.00	4.50	7.28	23.54	3.23	1.97	21.05
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.13	0.03	0.02	0.20
Blueback herring	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.18
Butterfish	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.15
Cunner	0.00	0.13	0.00	0.50	1.26	1.25	0.00	0.00	0.26	0.50	0.25	0.75	0.41	0.13	2.65
Grubby	0.26	0.23	0.22	0.65	0.63	0.00	1.33	0.75	0.00	0.00	0.26	0.00	0.36	0.12	2.35
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.38	0.16	0.13	1.02
Hake sp.	0.00	0.35	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.32
Longhorn sculpin	0.00	0.00	0.00	0.50	0.13	1.00	0.50	0.00	0.00	0.00	0.00	0.25	0.20	0.09	1.29
Lumpfish	0.00	0.00	0.00	0.38	0.63	0.75	1.04	0.00	0.00	0.00	0.00	0.00	0.23	0.11	1.52
Northern pipefish	0.00	0.00	0.00	0.13	0.37	1.00	0.00	0.00	0.00	0.00	0.26	0.00	0.15	0.09	0.95
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.13	0.07	0.06	0.46
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.27	1.88	0.60	0.45	3.88
Radiated shanny	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.09	0.08	0.61
Rainbow smelt	0.00	0.11	0.00	0.00	0.13	1.00	1.08	0.00	0.00	0.00	1.00	0.00	0.28	0.13	1.80
Red hake	0.75	0.70	0.25	0.38	0.62	2.00	0.00	0.00	0.00	0.00	0.50	0.63	0.49	0.16	3.16
Rock gunnel	0.12	0.23	0.00	0.64	0.38	1.25	0.27	0.00	0.50	1.75	0.26	1.50	0.58	0.17	3.75
Sea raven	0.12	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.07	0.05	0.47
Shorthorn sculpin	0.38	0.00	0.00	0.00	0.13	0.25	0.00	0.00	0.00	1.25	3.51	1.77	0.61	0.31	3.95
Skate sp.	6.05	2.87	4.87	5.06	7.17	1.50	0.25	0.00	0.00	0.00	1.01	8.87	3.14	0.91	20.42
Snailfish sp.	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.12	0.08	0.06	0.54
White hake	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.03	0.02	0.20
Windowpane	0.53	1.09	0.48	0.27	0.13	0.50	0.27	0.00	0.00	0.25	0.00	1.12	0.39	0.11	2.51
Winter flounder	4.98	2.38	1.55	2.90	4.75	9.75	2.33	2.50	0.00	2.00	10.93	4.87	4.08	0.95	26.56
Total	13.55	8.09	8.18	11.81	19.32	20.75	7.07	3.25	0.76	10.25	34.76	46.53	15.36	3.86	100.00

Appendix Table 12. Arithmetic mean catch per unit effort (catch/400-m tow) of all species captured in the trawl at station GT1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	12.50	2.29	1.55	16.33
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.77
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	2.00	1.00	0.00	0.38	0.19	2.67
Grubby	1.03	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.11	1.16
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.08	0.59
Hake sp.	0.00	1.40	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.12	1.42
Longhorn sculpin	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.89
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.59
Northern pipefish	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.59
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.30
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.00	4.00	1.75	1.43	12.47
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.25	0.25	1.78
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	1.49	0.49	0.49	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.41	0.16	2.95
Rock gunnel	0.49	0.47	0.00	0.50	0.50	5.00	0.00	0.00	0.95	4.00	0.00	6.00	1.49	0.63	10.63
Sea raven	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.08	0.06	0.59
Shorthorn sculpin	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	6.00	3.00	0.79	0.53	5.64
Skate sp.	5.90	2.44	3.36	3.50	7.50	1.00	0.00	0.00	0.00	0.00	0.00	5.00	2.39	0.77	17.04
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.25	0.25	1.78
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.08	0.59
Windowpane	0.51	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.59
Winter flounder	3.95	2.90	2.33	5.50	4.50	2.00	0.00	0.00	0.00	0.00	8.00	5.50	2.89	0.77	20.60
Total	13.86	8.62	7.97	12.00	14.50	10.00	1.00	0.00	0.95	6.00	55.00	38.50	14.03	4.74	100.00

Appendix Table 13. Arithmetic mean catch per unit effort (catch/400-m tow) of all species captured in the trawl at station GT2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	1.00	0.00	10.50	0.00	0.00	0.00	0.00	1.00	2.93	1.96	1.45	0.87	17.35
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	1.00	1.00	3.00	0.00	0.00	0.00	0.00	0.00	2.99	0.67	0.33	7.97
Grubby	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	0.00	0.00	0.00	0.00	0.25	0.18	2.99
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.13	0.13	1.50
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	0.00	0.50	0.00	2.00	0.00	0.00	0.00	0.00	1.00	0.29	0.18	3.49
Lumpfish	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.09	1.50
Northern pipefish	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	1.00
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.93	0.00	0.24	0.24	2.92
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.08	0.08	1.00
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.08	0.08	0.97
Red hake	0.00	0.48	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.50	0.21	0.10	2.47
Rock gunnel	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.13	0.09	1.50
Sea raven	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.12	0.09	1.47
Shorthorn sculpin	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.95	1.00	0.46	0.22	5.48
Skate sp.	0.50	0.48	0.50	2.50	3.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.71	0.33	8.46
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	0.54	0.95	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.09	1.99
Winter flounder	2.12	2.35	2.48	2.50	8.00	0.00	3.00	0.00	0.00	0.00	16.59	1.00	3.17	1.38	37.95
Total	3.70	4.25	3.98	7.00	27.00	4.00	7.00	2.00	0.00	4.00	25.37	11.93	8.35	2.55	100.00

Appendix Table 14. Arithmetic mean catch per unit effort (catch/400-m tow) of all species captured in the trawl at station GT3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.48	0.00	0.48	0.00	0.49	0.00	0.00	0.00	0.00	15.00	4.00	75.50	8.00	6.26	33.73
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.50	0.13	0.09	0.53
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	1.00	0.98	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.13	1.05
Grubby	0.00	0.00	0.89	0.50	0.49	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.24	0.11	1.01
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.25	0.25	1.05
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	0.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.09	0.53
Lumpfish	0.00	0.00	0.00	0.50	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.21	0.11	0.88
Northern pipefish	0.00	0.00	0.00	0.50	0.49	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.17	1.05
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.50	0.29	0.22	1.23
Radiated shanny	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.17
Rainbow smelt	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.20	0.17	0.86
Red hake	0.48	1.85	0.00	1.00	0.98	4.00	0.00	0.00	0.00	0.00	2.00	0.50	0.90	0.35	3.80
Rock gunnel	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.20	0.17	0.86
Sea raven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.00	1.00	0.46	0.26	1.93
Skate sp.	7.79	8.06	11.11	10.50	15.61	5.00	0.00	0.00	0.00	0.00	2.00	22.91	6.92	2.10	29.17
Snailfish sp.	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.08	0.05	0.34
White hake	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.18
Windowpane	0.00	2.34	0.92	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	3.96	0.77	0.36	3.24
Winter flounder	12.29	4.26	1.40	1.50	2.93	3.00	2.00	5.00	0.00	0.00	14.00	5.99	4.36	1.30	18.40
Total	22.48	17.42	15.27	16.00	21.95	19.00	3.00	6.00	0.00	19.00	31.00	113.35	23.71	8.53	100.00

Appendix Table 15. Arithmetic mean catch per unit effort (catch/400-m tow) of all species captured in the trawl at station GT4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.00	7.18	4.21	1.20	0.66	7.81
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.59
Cunner	0.00	0.50	0.00	0.00	2.55	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.34	0.22	2.23
Grubby	0.00	0.00	0.00	2.12	2.05	0.00	4.32	0.00	0.00	0.00	1.03	0.00	0.79	0.40	5.17
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.17	0.17	1.11
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	1.63
Lumpfish	0.00	0.00	0.00	0.53	1.54	2.00	2.16	0.00	0.00	0.00	0.00	0.00	0.52	0.25	3.38
Northern pipefish	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.03	0.00	0.17	0.11	1.10
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.08	0.00	0.26	0.26	1.67
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.09	0.09	0.56
Rainbow smelt	0.00	0.00	0.00	0.00	0.51	4.00	4.32	0.00	0.00	0.00	1.03	0.00	0.82	0.46	5.35
Red hake	1.03	0.00	0.50	0.00	0.51	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.25	2.74
Rock gunnel	0.00	0.00	0.00	1.58	1.03	0.00	1.08	0.00	1.05	0.00	1.03	0.00	0.48	0.18	3.13
Sea raven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.08	0.08	0.54
Shorthorn sculpin	0.50	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.00	3.08	2.07	0.72	0.31	4.69
Skate sp.	10.00	0.50	4.49	3.76	2.05	0.00	0.00	0.00	0.00	0.00	2.05	7.57	2.53	0.97	16.51
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	1.05	1.05	0.50	1.08	0.00	1.00	1.08	0.00	0.00	0.00	0.00	0.50	0.52	0.15	3.40
Winter flounder	1.58	0.00	0.00	2.11	3.59	34.00	4.32	5.00	0.00	8.00	5.13	7.00	5.89	2.67	38.39
Total	14.16	2.05	5.49	12.25	13.83	50.00	17.30	5.00	2.11	12.00	27.69	22.36	15.35	3.88	100.00

Appendix Table 16. Arithmetic mean biomass per unit effort (g/400-m tow) of all species captured in the trawl at all stations combined in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.12	0.00	0.61	0.00	7.00	1.50	0.00	0.00	0.00	1.50	3.48	18.15	2.70	1.53	0.11
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.25	0.06	0.04	0.00
Blueback herring	0.00	0.00	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00
Butterfish	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00
Cunner	0.00	0.13	0.00	3.75	30.60	1.25	0.00	0.00	0.26	0.50	0.25	1.62	3.20	2.51	0.13
Grubby	0.13	0.35	0.78	1.57	5.58	0.00	12.81	3.25	0.00	0.00	1.28	0.00	2.15	1.09	0.09
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.25	0.08	0.06	0.00
Hake sp.	0.00	3.72	0.00	5.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.53	0.03
Longhorn sculpin	0.00	0.00	0.00	2.75	0.38	3.50	2.50	0.00	0.00	0.00	0.00	18.75	2.32	1.54	0.09
Lumpfish	0.00	0.00	0.00	0.51	4.23	9.00	39.72	0.00	0.00	0.00	0.00	0.00	4.45	3.30	0.18
Northern pipefish	0.00	0.00	0.00	0.13	0.37	1.00	0.00	0.00	0.00	0.00	0.26	0.00	0.15	0.09	0.01
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.13	0.03	0.02	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.26	1.88	0.43	0.30	0.02
Radiated shanny	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.00	0.07	0.06	0.00
Rainbow smelt	0.00	0.34	0.00	0.00	5.13	22.50	3.24	0.00	0.00	0.00	3.00	0.00	2.85	1.86	0.12
Red hake	2.45	3.55	0.37	0.50	20.99	23.50	0.00	0.00	0.00	0.00	2.00	7.38	5.06	2.40	0.21
Rock gunnel	1.59	3.56	0.00	2.45	0.77	1.00	1.62	0.00	0.74	1.75	1.54	1.75	1.40	0.29	0.06
Sea raven	165.24	0.00	0.00	0.00	125.00	0.00	0.00	0.00	0.00	0.00	0.00	442.66	61.08	38.35	2.48
Shorthorn sculpin	101.78	0.00	0.00	0.00	50.00	0.50	0.00	0.00	0.00	5.00	406.50	31.02	49.57	33.67	2.01
Skate sp.	3859.7	1805.4	2271.9	2681.2	4992.1	292.50	187.50	0.00	0.00	0.00	1137.2	6259.8	1957.3	615.80	79.41
Snailfish sp.	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.12	0.06	0.04	0.00
White hake	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.00	0.32	0.22	0.01
Windowpane	118.65	230.98	100.79	66.22	31.25	2.25	3.78	0.00	0.00	0.50	0.00	123.89	56.53	21.32	2.29
Winter flounder	1439.0	714.44	225.19	79.20	238.35	148.50	21.27	22.25	0.00	6.00	83.07	791.64	314.08	128.15	12.74
Total	5690.9	2762.4	2600.8	2844.2	5511.9	507.50	272.45	25.50	1.00	15.25	1645.8	7699.2	2464.8	752.13	100.00

Appendix Table 17. Arithmetic mean biomass per unit effort (g/400-m tow) of all species captured in the trawl at station GT1 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	26.00	2.58	2.17	0.13
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	4.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.36	0.02
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	2.00	1.00	0.00	0.38	0.19	0.02
Grubby	0.51	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.12	0.01
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.08	0.00
Hake sp.	0.00	14.88	0.00	22.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.16	2.11	0.16
Longhorn sculpin	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.42	0.02
Lumpfish	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	6.67	6.67	0.33
Northern pipefish	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	6.00	1.33	0.93	0.07
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.08	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red hake	7.34	1.46	0.49	0.50	12.50	0.00	0.00	0.00	0.00	0.00	0.00	26.00	4.02	2.29	0.20
Rock gunnel	6.34	6.98	0.00	0.50	0.50	4.00	0.00	0.00	1.90	4.00	0.00	7.00	2.60	0.84	0.13
Sea raven	660.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.50	58.12	54.89	2.91
Shorthorn sculpin	0.00	0.00	0.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00	31.00	96.00	27.25	17.68	1.37
Skate sp.	3551.0	1512.2	2071.0	2075.0	5000.0	70.00	0.00	0.00	0.00	0.00	0.00	4000.0	1523.3	526.94	76.38
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.17	0.17	0.01
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.58	0.58	0.03
Windowpane	153.85	0.00	25.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.93	12.80	0.75
Winter flounder	545.82	642.31	200.77	225.00	255.00	4.00	0.00	0.00	0.00	0.00	55.00	2250.0	348.16	184.17	17.46
Total	4925.8	2179.2	2302.0	2328.0	5469.5	80.00	80.00	0.00	1.90	6.00	113.00	6448.0	1994.5	693.67	100.00

Appendix Table 18. Arithmetic mean biomass per unit effort (g/400-m tow) of all species captured in the trawl at station GT2 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	1.50	0.00	27.50	0.00	0.00	0.00	0.00	1.00	4.88	2.48	3.11	2.26	0.31
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	8.50	1.50	2.00	0.00	0.00	0.00	0.00	0.00	6.49	1.54	0.84	0.15
Grubby	0.00	0.00	0.00	0.00	0.00	0.00	8.00	12.00	0.00	0.00	0.00	0.00	1.67	1.15	0.17
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.08	0.08	0.01
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	0.00	1.50	0.00	10.00	0.00	0.00	0.00	0.00	75.00	7.21	6.22	0.72
Lumpfish	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.06	0.01
Northern pipefish	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.01
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.08	0.08	0.01
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.04	0.04	0.00
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.08	0.08	0.01
Red hake	0.00	1.90	0.00	0.00	1.00	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.58	0.26	0.06
Rock gunnel	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.33	0.26	0.03
Sea raven	0.00	0.00	0.00	0.00	500.00	0.00	0.00	0.00	0.00	0.00	0.00	634.15	94.51	64.25	9.41
Shorthorn sculpin	55.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	976.59	24.00	88.86	80.85	8.84
Skate sp.	650.00	571.43	425.00	1575.0	2800.0	0.00	750.00	0.00	0.00	0.00	0.00	0.00	564.29	246.06	56.15
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	189.19	214.29	0.00	0.00	125.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.04	23.69	4.38
Winter flounder	320.92	736.51	556.67	60.00	600.00	0.00	32.00	0.00	0.00	0.00	65.37	8.00	198.29	80.36	19.73
Total	1215.8	1524.1	983.17	1647.0	4058.0	4.00	800.00	12.00	0.00	12.00	1048.8	753.61	1004.9	327.28	100.00

Appendix Table 19. Arithmetic mean biomass per unit effort (g/400-m tow) of all species captured in the trawl at station GT3 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.48	0.00	0.95	0.00	0.49	0.00	0.00	0.00	0.00	3.00	2.00	41.00	3.99	3.38	0.08
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	1.00	0.25	0.18	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cunner	0.00	0.00	0.00	6.50	1.95	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.56	0.02
Grubby	0.00	0.00	3.11	1.50	4.88	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.87	0.46	0.02
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.08	0.08	0.00
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	6.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.51	0.01
Lumpfish	0.00	0.00	0.00	0.50	0.00	26.00	14.00	0.00	0.00	0.00	0.00	0.00	3.38	2.36	0.07
Northern pipefish	0.00	0.00	0.00	0.50	0.49	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.17	0.00
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.17	0.11	0.00
Radiated shanny	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.00
Rainbow smelt	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.95	0.83	0.02
Red hake	1.43	10.82	0.00	1.50	65.85	26.00	0.00	0.00	0.00	0.00	8.00	1.50	9.59	5.57	0.19
Rock gunnel	0.00	7.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.77	0.61	0.02
Sea raven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shorthorn sculpin	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00	0.50	0.49	0.24	0.01
Skate sp.	5343.1	4712.9	6152.4	5000.0	11220	1100.0	0.00	0.00	0.00	0.00	2600.0	15464	4299.3	1416.3	84.72
Snailfish sp.	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.08	0.05	0.00
White hake	8.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.71	0.01
Windowpane	0.00	638.58	177.78	0.00	0.00	6.00	0.00	0.00	0.00	2.00	0.00	495.07	109.95	63.93	2.17
Winter flounder	4856.2	1478.9	143.30	25.50	51.22	140.00	12.00	30.00	0.00	0.00	135.00	835.06	642.27	404.33	12.66
Total	10212	6849.8	6478.0	5042.0	11344	1306.0	26.00	31.00	0.00	9.00	2759.0	16840	5074.7	1583.9	100.00

Appendix Table 20. Arithmetic mean biomass per unit effort (g/400-m tow) of all species captured in the trawl at station GT4 in Gloucester Harbor, June 1998 through May 1999.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Annual Mean CPUE	S.E.	Percent
Atlantic cod	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	2.00	2.05	3.14	1.10	0.55	0.06
Atlantic silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blueback herring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Butterfish	0.00	0.00	0.00	1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.01
Cunner	0.00	0.50	0.00	0.00	118.46	0.00	0.00	0.00	1.05	0.00	0.00	0.00	10.00	9.86	0.56
Grubby	0.00	0.00	0.00	4.78	17.44	0.00	43.24	0.00	0.00	0.00	5.13	0.00	5.88	3.70	0.33
Gulf snailfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.09	0.09	0.00
Hake sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longhorn sculpin	0.00	0.00	0.00	0.00	0.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.06
Lumpfish	0.00	0.00	0.00	1.05	16.41	10.00	64.86	0.00	0.00	0.00	0.00	0.00	7.69	5.41	0.43
Northern pipefish	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.03	0.00	0.17	0.11	0.01
Ocean pout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pollock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.17	0.17	0.01
Radiated shanny	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.17	0.17	0.01
Rainbow smelt	0.00	0.00	0.00	0.00	20.51	90.00	12.97	0.00	0.00	0.00	1.03	0.00	10.38	7.49	0.58
Red hake	1.03	0.00	1.00	0.00	4.62	66.00	0.00	0.00	0.00	0.00	0.00	0.00	6.05	5.46	0.34
Rock gunnel	0.00	0.00	0.00	6.32	2.56	0.00	6.49	0.00	1.05	0.00	6.15	0.00	1.88	0.80	0.11
Sea raven	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1100.0	91.67	91.67	5.14
Shorthorn sculpin	350.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	8.00	616.41	3.57	81.67	56.58	4.58
Skate sp.	5894.7	425.00	439.02	2074.7	948.72	0.00	0.00	0.00	0.00	0.00	1948.7	5575.0	1442.2	616.97	80.79
Snailfish sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White hake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Windowpane	131.58	71.05	200.00	264.86	0.00	3.00	15.14	0.00	0.00	0.00	0.00	0.50	57.18	26.62	3.20
Winter flounder	33.16	0.00	0.00	6.32	47.18	450.00	41.08	59.00	0.00	24.00	76.92	73.50	67.60	35.69	3.79
Total	6410.5	496.55	640.02	2359.6	1175.9	640.00	183.78	59.00	2.11	34.00	2662.6	6755.7	1785.0	694.37	100.00