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Interjurisdictional Fisheries Resource Monitoring and Assessment**

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Lobster Resource and Fishery Monitoring



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American Lobster (*Homarus americanus*)

The Gulf of Maine lobster fishery has seen a doubling in landings in the last fifteen years. The increases in landings cannot be entirely explained by increase in effort (traps and fishermen), rather the abundance of individuals on the bottom has increased for unknown reasons. The lobster population increased first in western counties (York, Cumberland, Lincoln and Knox) and is currently continuing to increase in eastern counties (Hancock and Washington). These trends can be observed on the bottom through diver surveys, standardized landings per length of coastline and by offshore trawl surveys conducted by the National Marine Fisheries Service (Steneck and Wilson 2001, ASMFC 2000). For the Gulf of Maine, despite recent increases in landings and fishing effort, fishing mortality rates declined and abundance increased during the last ten years in the stock area as a whole, however a sub-area (Massachusetts Bay) showed very different conditions from the rest of the stock area. Total landings increased by 75% from 1982-1997, reaching a record high of 26,230 metric tons in 1997 (ASMFC 2000). In recent years Maine landings have represented approximately 90% of the Gulf of Maine catch. In 2002 the Maine lobster fishery landed a record 61.7 million pounds valued at \$204 million, a 28% increase in catch from 2001.

In 2002 DMR lobster programs strived to collect data on the Maine lobster fishery in order to assess the status of the resource, monitor trends in the fishery and population, and provide information for management of the fishery. Three jobs have been outlined that address continued fishery dependent sampling programs in 2002 (Job #1), spatial and temporal trends in the fishery (Job #2) and characterization of newly settled and juvenile lobsters along the coast (Job #3). Data generated by this project have already contributed to assessment and management requests in 2002 and will further add to the upcoming ASMFC lobster stock assessment in 2003.

Job #1

Job Title: Lobster Resource and Fishery Monitoring

Objectives:

Monitor the status of Maine's lobster fishery and the biological characteristics of the lobster population in 2002.

Results:

Commercial Port Sampling Program

The commercial port-sampling program began in 1967 as Maine's first comprehensive survey of the lobster fishery. It remains largely the same in our 35th consecutive year. To survey the commercial fishery through probability sampling a multistage sampling plan with stratification was developed. Lobster buyers that have five or more boats fishing are added to a continuously updated dealer database. The port samplers randomly draw ten dealers a month from this list. All lobstermen who deliver their catches on sample-days are interviewed for catch and effort information. In addition, we randomly select a cluster sample of 10 lobsters per catch for biological data.

Due to budget limitations in 1970 the dockside sampling was discontinued for the winter months (January through March), thus reducing our sampling to nine months each year (April through December) until 1999. In 1999 assessment needs for data in the winter months prompted a return to January-March sampling; however, in 2002, budget constraints again terminated the year round survey and we returned to a nine month sampling season (April-December). The winter catch (2000 and 2001) comprised 2% of the summarized yearly landings. This compares with the early years when the winter months (January-March) consisted of 5% of the yearly catch.

During the sampling year 2002, we have: (1) collected catch and effort data from lobstermen at ten randomly selected dealers each month, beginning April 1, and ending December 31; (2) compiled the survey data by sample day, then summarized these results by month and year (Table 1); (3) completed daily, monthly, and annual estimates of mean lengths and weights along with percentages of females, culls, and soft-shell lobsters from the cluster samples (Table 2); and (4) completed the expanded estimates by sample month and year for all dealer-days in the survey (Table 3).

Our survey team periodically adds/removes interview questions to address current management strategies, hoping to obtain information from the commercial fishermen themselves. Current ASMFC management plans call for mandatory V-notching in Area 1 (Maine waters). This prompted the port sampling team to introduce additional questions to the survey in 2002; one was the reintroduction of the v-notch question previously asked in the years 1986-1988: Do you

V-notch berried female lobsters? Also added was a new question: Do you re-notch (re-notch old V-notch lobsters if deemed necessary)?

In 2002, a total of 90 dealer locations buying from more than 5 lobstermen were randomly selected. We received information at 59 dealers or 66% of those drawn. At the height of the sampling season 136 dealers were buying from 5 or more lobstermen (133 in 2001). The randomized sampling schedule was drawn monthly from our continuously updated open dealer database. The data points represented in figure 1 were dealers drawn in 2002, some more than once. The port sampling crew collected lobster catch/effort data and biological information from 494 boats (61 more boats than sampled in 2000 as well as in 2001) landing lobster from Kittery to Eastport, Maine. No data was retrieved from 31 locations due to lack of transportation to an island (4 cases), dealer closure (2 cases), and inclement weather preventing lobstermen from fishing, or other reasons (25 cases). Sampling days when no lobstermen were fishing their gear were recorded as a "no boat day".

In 2002, the total catch sampled weighed approximately 71.5 tons and consisted of 111,035 lobsters with a landed value of \$465,971 (largest figures in history of survey). The cluster sample (actual measurements recorded) contained 2,509 males and 2,413 females. The mean weight of landed lobsters was 568.1 ± 4.0 gm; lower than 2001 (584.9 gm). The mean carapace length of $89.3 \text{ mm} \pm 0.2\text{mm}$ was also lower than 2001 (90.1 mm). It does not appear that the size increased as expected due to the escape vent increase in 1999.

Selected catch/effort findings, for 2002, show a catch rate of 1.47 lbs./trap-haul and 288.50 lbs./boat-day. These figures are higher than 2001 (1.36 lbs./trap-haul and 253.63 lbs./boat-day) but still less than the record landings year of 2000 (1.51 lbs./trap-haul and 298.92 lbs./boat-day). In 2001, the average price for lobsters was \$4.56 for hard, \$2.88 for soft, and \$4.26 for select. In 2002, the average price for lobsters was \$4.32 for hard, \$3.20 for soft, and \$4.58 for select. The price dropped sharply in 2001 but stayed strong in 2002 (Figure 2). The average soft-shell price raised \$0.32 from 2001 to 2002. During interviews the lobstermen were generally satisfied with the price in 2002. None of the dealers had a price for culled (lobsters missing or small regenerating claws) lobsters. We also noticed a wide range of interpretations of what a select lobster was. It seemed to vary depending on location. Many dealers measure carapace length with a special gauge (4in. carapace length) and others by varying weights (1.3/4 pounds and over, some 2 pounds and over). Needless to say, these differences caused conflict between dealers and lobstermen. In the coming year we plan to record these differences.

In the 2000 sampling season, two bait questions were added to the port sampling survey. Each boat captain was asked, "What type of bait was used for this catch?" and "How many bushels of each were used?" In 2002, we asked these questions again as a response to the industry members who voiced a concern about the reliance on herring. Herring comprised 81.1% of the total bait by bushel used in 2002. This is up from 79% in 2001. When measured as a percent of trap-hauls this figure drops to 70.7 % as the percent of pogies, redfish, flounder, and cowhide increase. Of concern is the added presence of artificial bait such as cow and pig hide. These may present an ecological change as reports indicate lobsters developing hairballs from using this bait. Only 0.2% of the bait by bushel used was classified as cowhide. When taken as a percent of trap-hauls the former figure raises to 1.5%. We received quite a few comments in the spring dealing with

shortage and expense of bait. The survey shows an overwhelming dependence on herring (Figure 3). We will continue to monitor the types and amount of bait used.

We added new questions to the survey this year: “Do you V-notch?”. We gathered information to gauge lobstermen’s participation in V-notching berried females, 95.7% of the sampled lobstermen in this annual period do V-notch. Previous data gathered from 1986-1988 revealed 90% of lobstermen V-notched. This shows a small rise in overall participation, but V-notching has always had a strong presence in Maine waters. We introduced the question: “Do you re-notch old V-notch lobsters if needed?”, to gain insight into the mindset of the lobsterman’s conservation approach to v- notching. Of the lobstermen questioned 90.1% re-notch. The most common response from the lobstermen to this question is “If I can’t keep it nobody else will either.” Figure 4 shows a county breakdown of the percentages of lobstermen who do v-notch and re-notch. Interestingly, Hancock County represented the highest number of interviews (as well as the highest landings) and the lowest number of lobstermen who v-notch and re-notch. Through response from interviews the vast majority of lobstermen deem this the prime conservation tool for the preservation of the fishery. From our conversations with lobstermen, we found a strong sentiment toward V-notching/re-notching and feel confident in removing this question from our survey, perhaps reintroducing it again in a later year.

Commercial Sea Sampling Program

The Department of Marine Resources sea sampling program began collecting at-sea catch/effort and biological information on legal and discarded lobsters from the near shore Maine lobster fishery in 1985. At that time three ports Cape Porpoise, Boothbay Harbor, Tenants Harbor/Spruce Head were sampled. In 1998, the program expanded to include all seven-lobster zones throughout the fishing season and 18 boats participated. Since 1999, each lobster management zone is visited three times monthly from May through November, weather and volunteer availability permitting.

New program initiatives in 2002 included the implementation of additional data collection for v-notch and bycatch categories, development of an all inclusive lobster database that brings together present and historical data, and efforts to increase new volunteer participation and to target different ports. To increase spatial representation of sampling trips, the DMR began a pilot program in cooperation with the Island Institute (Rockland, Maine) to collect sampling data from under sampled and remote islands. DMR samplers also contacted over 50 new fishermen and were able to go out on 98 different boats out of 40 different ports (Table 4) totaling 172 trips (Table 5). All months exceeded sampling trip expectations aside from May.

The sea sampling data is collected to look at spatial and temporal trends in the lobster fishery for catch per unit effort and length frequency information. Specific biological data including length, sex, egg condition, presence of a v-notch, molt status and spatial data by trap was captured for 116,652 lobsters in over 99% of traps hauled (Table 5). For 2002 the highest catch rate for legals was in October (2.24 lobsters trap haul⁻¹), this was 22% higher then the previous August (1.75 lobsters trap haul⁻¹), which had the highest catch rate in 2001. The lowest catch rate for legals was in June 0.59 trap haul⁻¹ similar to the lowest in June 2001 at 0.33 trap haul⁻¹.

In an effort to protect egg-bearing lobsters, lobstermen in Maine have practiced v-notching for nearly 100 years. V-notching provides protection from harvest for 1-3 molts after eggs have been released. In response to reaching the egg per recruit goal of $F_{10\%}$ by 2008, fishermen have adopted v-notching as the primary tool to rebuild the fishery.

In 2002 new v-notching categories, renotching old notches and notching on board, were added to the sampling protocol to better represent v-notching activity. In 2002, 30% of all legal size females observed were protected by a v-notch, Zones E and F had the highest percentages for the season at 36%. The greatest proportion of legal size berried females per trap haul were observed in Zones C and D respectively. However the greatest proportion of legal size berried with a v-notch was observed in zones F (83%) and C (81%) however the range for all zones was 63%-83%. Although most lobsters come from Penobscot Bay which encompasses zones C and D (over half of Maine lobster landings or more than 32 million pounds) v-notching activity varies from zone to zone. Seasonally the greatest proportion of berried (newly extruded eggs) as well as berried with a v-notch were observed in October and November of 2002 (Figure 5). Since the expansion of the program in 1998 data collected for all zones combined for legal size berried females with a v-notch has remained above 70% (Figure 6).

Fish caught incidentally as bycatch were recorded for the first time in 2002. DMR observers recorded twenty-one (21) species of bycatch. Non-regulated species accounted for greater than 75% of the bycatch, with sea ravens and sculpins the most prevalent. Cod and black sea bass were the most abundant regulated species caught in 2002 (Table 6). Overall, bycatch was found in 3.1% of trap hauls along the Maine coast.

Job #2

Job Title: Lobster Resource Assessment and Management

Objectives:

Evaluate the Maine port and sea sampling databases in order to characterize spatial and temporal trends in lobster catches. Develop a GIS-based spatial database which overlays sea sampling data with bottom topography to begin to define spatial differences in demography. Work with other state lobster scientists to develop a regional database for the Gulf of Maine lobster fishery. To determine management options for the coastal Maine lobster fishery, which are consistent with ASMFC lobster management plan and to advise Department administrators, legislators, and industry representatives of such options.

Results:

Commercial Port-Sampling Program

Size composition of the landed catch has been recorded since the programs inception in 1967. Length-frequencies for the ten-lobster cluster samples measured from each boat were grouped into 1 mm carapace lengths for males, females, and sexes combined (Table 7). From this, the percentages of lobsters within the 14% carapace length molt groupings of 83-94, 95-108, 109-124, 125-127 mm were calculated. The reason for choosing 14% increments is because they closely approximate the calculated percent increase in carapace length with ecdysis for legal-sized lobsters from premolt and postmolt section and from the study of Wilder (1953). These values were then used to estimate the number of lobsters harvested in each size category by dividing the total pounds harvested (Maine landings) by the mean weight of the commercially caught lobsters (Table 8). Over 84% of the lobsters were landed in the first molt grouping. This has varied from a low of 70% in 1973 to a high of 90.1% in 1989, with an average of 81.56% (Figure 7).

Probability sampling of the commercial lobster fishery enables the DMR to make unbiased estimates of the total catch and effort on a monthly and yearly basis for the collective total of 136 dealers (See Thomas, 1973 for calculations). The expanded port sampling estimates indicate a record lobster landing for 2002. This concurs with the preliminary Maine landings data reported by NMFS (Figure 6). The comparable estimates from NMFS must exceed the estimates from the survey because of the necessary constraints of the sampling period and the fact that we cannot efficiently sample individual lobstermen who retail their catch. Interestingly, the percent difference between the survey and NMFS landings has greatly decreased in the past 10 years. By dividing expanded estimates by NMFS landings we obtain a percent difference. The mean percent difference from 1967-2002 was 65%, 1992-2002 was 78%, and 1997-2002 is 93%. The port sampling program has remained consistent by design, whereas, the landings reporting has remained voluntary and has been previously assumed consistent. Of concern is the consistency of landings from NMFS data. Specifically, over the 35-year period, summer months have the highest ratio between expanded estimates and reported landings. The increased ratios in summer

months and in the past ten years are more likely due to a change in the reporting of landings in Maine (Table 9) rather than changes in port sampling methodology.

The fishing effort categories have shown an increase over 2001, but still not as strong as 2000 (Figure 9). In recent years, managers and industry members have focused on reducing fishing effort by limiting the number of allowable traps fished by each lobsterman. From 1999-2001, the mean number of traps fished declined while the percentage of two parlor traps increased. In 2002, both mean traps/boat and percentage of two parlor traps increased (Figure 10). The design of the double parlor trap results in a higher lobster retention rate when compared against a single parlor trap (See Gear Selectivity Study, Annual Report, 1989). It appears that both effort and efficiency have increased, so trap limits may not have reduced the potential fishing effort.

Commercial Sea Sampling Program

The distribution of catch rates of egg bearing lobsters was investigated each month (May-November) to determine what depth lobsters may release their eggs (Figure 11). The majority of traps were fished in water less than 40 fathoms for each month, however in November very few traps were recorded in less than 20 fathoms. In waters 10-30 fathoms the catch rates of egg bearing lobsters was consistently between 0.05 and 0.1 trap haul⁻¹. In May and November high catch rates of egg bearing lobsters were observed in water depths greater than 50 fathoms (0.5 to 0.9 trap haul⁻¹). It should be noted that the number of trap hauls at these depths are relatively few. Catch rates for legal lobsters do not relate to abundance on the bottom unless the number of traps in an area is incorporated, however catch rates may be related to abundance for non-targeted lobsters (Steneck and Wilson 2002).

The timing of egg release was explored in addition to the distribution of egg-bearing lobster. The timing of release could be impacted by the length and severity of the previous winter, and can impact the timing of subsequent settlement of post-larvae in the fall after release (Aiken and Waddy 1986, Wahle and Steneck 1991). In 2002, DMR samplers recorded the presence of "hatching eggs"; the majority was recorded between June 1 and August 15, with an inferred peak of hatching around July 15 (Figure 12).

Yearly means of catch per trap haul for legal size lobster have remained consistent since 1985, while landings have nearly tripled (Figure 13). May and June have the highest catch rates of sublegal lobsters each year. During June and July sublegal lobsters molt and become "recruited" into the legal size range for commercial harvest signifying the start of the "shedder" season. The monthly proportion of molt frequency (Figure 14) for 2000–2002 typifies the annual trend seen throughout the sampling season as most lobsters begin to shed their old shells. These newly recruited soft shell lobster; also known as "shedders", comprise approximately 80%-90% of the yearly landings for the Maine lobster fishery (Figure 7). By July the legal size catch per trap haul begins to increase (Figure 14) and on average peaks from August to October for all zones. Within the fishery the onset of the "shedder" season is observed at different times for each fishing zone. "Shedders" are observed first in the western zones.

Spatial variation in sublegal catch rates is apparent when comparing different lobster zones along the Maine coast. Zones D, E, G have been sampled regularly each year since the programs inception in 1985 (Figure 15). Throughout this time series several management tools were implemented by the state. These included two gauge size increases in 1988 and 1989 increasing the minimum legal size of 80 mm carapace length to the present minimum 82.5 mm and vent increases. Vent increases were implemented in 1992 and 1999 in an effort to make traps more selective for legal size lobster and to decrease the amount of sublegals caught and handled. In the last five years Zones E and F have recorded the greatest sublegal catch rates (Table 10). Following the implementation of each vent increase the catch per trap haul of sublegal lobsters decreased for each zone, but increased the next subsequent year.

A key component to the sea sampling program is to record the discarded and illegal lobsters not landed by the fishery. Illegals include berried and/or v-notched lobster at or between 82.5 and 127mm. The program documents several individual characteristics for each discarded lobster. In the time series from 1985, catch rates of illegals observed have stayed relatively consistent (Figure 16). Zones D and E have had the highest averages for all zones in the last five years 1998-2002 (Table 10).

The presence of large berried females that supply larvae for future years are an important component in determining the health of the lobster fishery. Studies have shown that the larger the female lobster, the greater numbers of eggs extruded. On the Maine coast since 1985 there has been a decrease in the mean carapace length of ovigerous females observed in zones sampled throughout all years (Figure 17). Zone D and E have shown the greatest decline ranging from 10.8% to 8.5 %. Broken down by molt groups I, II, and III representing 81-93mm, 94-108mm, 109-125mm respectively, the trend for both zones shows greater numbers of molt group I trap haul⁻¹ over all sampled years and an increase in the observed percentage of the smaller size range as well (Figure 18).

Job #3

Job Title: Lobster Resource Assessment and Management

Objectives:

To determine the regional distribution and abundance of newly settled and juvenile lobsters each year.

Results:

Monitoring of the 2002 juvenile lobster settlement was conducted as a collaborative effort between the University of Maine, Bigelow Laboratory for Ocean Sciences and the DMR. As in previous years the University of Maine and Bigelow sampled different sections of the coast with DMR staff assisting in the field and processing samples. Bigelow revisited 20 sites from the Maine-New Hampshire boarder through the Pemaquid region (Zones G, F and E) and the University of Maine revisited 20 sites from Penobscot Bay to Cutler (Zones D, C, B and A) for a total of 40 sites statewide.

Sites in eastern Maine (Zones A and B) were relocated in 2002 based upon additional sampling work conducted by DMR staff in October of 2001. The objective of the additional sampling in 2001 was to address the issue of why there was little to no evidence of lobster settlement in eastern Maine when commercial landings have traditionally been high. There seemed to be a limited number of explanations for this finding: 1) Young of the year lobster densities were in fact very low in eastern Maine, 2) Sampling effort was too low to detect the settlement signal or, 3) the site selection for eastern Maine was inappropriate. To test if sampling effort was adequate DMR staff increased the number of quadrats sampled from 48 to 101. Monte Carlo simulations were run on the aggregate data and it was determined that when densities of YOY lobsters dropped below 0.2 m^{-2} 20-25 quadrats needed to be sampled. Previously 12 quadrats were sampled per site. In addition to testing for minimum sufficient sample size DMR staff wanted to determine if water temperature at the traditional sites might be impacting settlement. Boudreau *et al.* (1992) suggest that water temperatures of at least 15°C are needed to promote larval settlement. Using monthly composite satellite images for sea surface temperature, provided by Dr. Andrew Thomas at the University of Maine, DMR staff chose sites that had maintained a minimum of 15°C during the settlement period. For eastern Maine this meant selecting sites that were at the inside sheltered bays. Suction sampling that was conducted at these sites showed average densities of 0.16 m^{-2} with some individual sites having densities as high as 1.45 m^{-2} . Sampling that was conducted at the traditional exposed sites, which had surface waters $2-4^{\circ}$ cooler than the 15°C threshold, had no detectable settlement for the same time period. Based on this evidence DMR chose to relocate sentinel sites in eastern Maine and selected new sites using substrate charts and composite sea surface temperature images. The number of quadrats sampled will be increased in future surveys.

Statewide settlement was down in 2002 from the record highs seen the previous year (Figure 19) but was still higher than the settlement in 2000 for all management areas with the exception of Zone C. Zone E continued to have the highest settlement in the state while Zone B again had lower settlement than the rest of the coast. The average settlement for the mid-coast (Zone E) was 1.35 m^{-2} for 2002, significantly higher than the 14-year mean of $0.95 \text{ individuals m}^{-2}$ (Figure 20)

Table 1. Survey catch and effort values category for each sample month, 2002.

	<u>APRIL</u>	<u>MAY</u>	<u>JUNE</u>	<u>JULY</u>	<u>AUGUST</u>	<u>SEPTEMBER</u>	<u>OCTOBER</u>	<u>NOVEMBER</u>	<u>DECEMBER</u>	<u>TOTAL</u>
1. TOTAL CATCH IN POUNDS (LBS.)	1,549	2,771	7,792	24,626	31,015	42,162	21,976	8,027	3,178	143,096
2. TOTAL CATCH IN NUMBERS (NO.)	1,234	2,132	6,007	18,883	24,415	32,328	17,232	6,268	2,536	111,035
3. TOTAL VALUE OF CATCH (\$)	5,659.80	10,906.30	32,952.90	77,773.40	96,178.45	133,479.50	70,996.80	24,649.30	13,374.30	465,971
4. TOTAL NO. OF FEMALES IN SAMPLE	71	143	349	254	490	660	237	131	79	2,414
5. TOTAL NO. OF MALES IN SAMPLE	72	147	267	456	610	574	173	119	91	2,509
6. TOTAL NO. OF TRAP-HAULS	3,007	5,609	12,163	14,471	20,959	25,397	8,287	5,231	2,447	97,571
7. TOTAL NO. OF TRAPS SET OUT	7,996	14,309	32,414	44,092	61,545	78,906	26,300	16,382	6,845	288,789
8. TOTAL NO. OF MAN-DAYS	30	50	122	127	194	214	74	49	32	892
9. TOTAL NO. OF MAN-HOURS	242.78	439.55	950.53	1,034.21	1,537.63	1,655.68	600.68	430.27	245.93	7,137
10. TOTAL NO. OF BOAT-DAYS	15	29	63	71	110	124	41	25	18	496
11. TOTAL NO. OF BOAT-HOURS	120.10	252.19	487.72	569.90	868.55	960.42	325.38	214.80	137.61	3,937
12. MEAN WEIGHT LOBSTERS (LBS.)	1.26	1.30	1.30	1.30	1.27	1.30	1.28	1.28	1.25	1.29
13. CATCH IN LBS. / TRAP-HAUL	0.52	0.49	0.64	1.70	1.48	1.66	2.65	1.53	1.30	1.47
14. CATCH IN NO. / TRAP-HAUL	0.41	0.38	0.49	1.30	1.16	1.27	2.08	1.20	1.04	1.14
15. CATCH IN LBS. / MAN-DAY	51.63	55.42	63.87	193.91	159.87	197.02	296.97	163.82	99.31	160.42
16. CATCH IN NO. / MAN-DAY	41.13	42.64	49.24	148.69	125.85	151.07	232.86	127.92	79.25	124.48
17. CATCH IN LBS. / MAN-HOUR	6.38	6.30	8.20	23.81	20.17	25.47	36.59	18.66	12.92	20.05
18. CATCH IN NO. / MAN-HOUR	5.08	4.85	6.32	18.26	15.88	19.53	28.69	14.57	10.31	15.56
19. CATCH IN LBS. / BOAT-DAY	103.27	95.55	123.68	346.85	281.95	340.02	536.00	321.08	176.56	288.50
20. CATCH IN NO. / BOAT-DAY	82.27	73.52	95.35	265.96	221.95	260.71	420.29	250.72	140.89	223.86
21. VALUE / TRAP-HAUL (\$)	1.88	1.94	2.71	5.37	4.59	5.26	8.57	4.71	5.47	4.78
22. VALUE / MAN-DAY (\$)	188.66	218.13	270.11	612.39	495.77	623.74	959.42	503.05	417.95	522.39
23. VALUE / MAN-HOUR (\$)	23.31	24.81	34.67	75.20	62.55	80.62	118.19	57.29	54.38	65.30
24. VALUE / BOAT-DAY (\$)	377.32	376.08	523.06	1,095.40	874.35	1,076.50	1,731.60	985.97	743.02	939.46
25. VALUE / BOAT-HOUR (\$)	47.13	43.25	67.57	136.47	110.73	138.98	218.20	114.75	97.19	118.39

Table 2. Mean carapace length (mm) and weight (gm) with percentages of female, soft-shell, and cull (missing or regenerating claw) lobsters in cluster samples by dealer code and sampled month, 2002.

JANUARY						FEBRUARY						MARCH						APRIL					
Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull
																		K-3	88.0	591.0	50.0%	0.0%	0.0%
																		K-22	87.4	541.1	62.7%	0.0%	4.8%
																		K-1	88.5	564.0	46.3%	0.0%	3.3%
																		K-37	85.1	484.0	40.0%	0.0%	20.0%
																		K-15	89.2	590.5	31.6%	0.0%	0.0%
X						X						X						X	87.6	554.1	0.5	0.0	0.1
SE	00	00	00	00	00	SE	00	00	00	00	00	SE	00	00	00	00	00	SE	07	198	0.1	0.0	0.0
MAY						JUNE						JULY						AUGUST					
Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull
H-39	86.3	524.5	52.8%	0.0%	11.0%	H-6	89.2	579.9	59.0%	21.1%	6.4%	K-25	90.7	595.4	34.4%	93.7%	2.7%	C-35	87.7	515.3	34.5%	98.4%	19.8%
L-2	89.9	575.5	65.4%	0.0%	0.0%	K-5	91.0	610.0	40.0%	90.0%	0.0%	W-24	90.9	605.0	50.0%	60.0%	0.0%	W-7	90.7	591.2	38.9%	99.2%	7.7%
H-5	88.5	557.9	56.4%	0.0%	10.9%	K-25	90.2	619.3	57.8%	12.8%	5.9%	W-5	90.7	594.4	41.8%	93.7%	7.0%	K-38	89.5	572.1	36.8%	100.0%	9.0%
L-12	89.3	610.7	37.9%	0.0%	4.1%	W-8	88.2	571.5	61.2%	0.0%	2.4%	H-34	89.4	583.6	57.9%	84.6%	3.0%	C-24	88.9	562.7	46.0%	95.3%	8.0%
K-16	88.7	544.9	51.5%	0.0%	20.0%	H-35	89.0	581.0	47.0%	0.0%	6.0%	H-22	90.5	588.4	29.7%	76.3%	9.1%	S-5	89.4	539.2	35.3%	97.4%	8.9%
L-4	87.6	543.6	16.6%	0.0%	6.6%	C-15	86.4	536.4	33.9%	0.0%	13.1%	Y-20	88.5	556.7	28.0%	79.8%	10.2%	Y-14	89.4	557.6	43.2%	100.0%	20.3%
K-4	88.3	547.5	44.8%	0.0%	10.0%	K-32	88.8	572.0	59.2%	0.0%	6.7%	C-6	88.8	543.3	25.1%	100.0%	11.4%	C-28	90.0	555.7	46.6%	100.0%	6.3%
												L-5	89.0	553.0	45.3%	85.2%	8.1%	W-3	89.9	577.7	47.4%	100.0%	2.7%
																		Y-4	88.3	532.8	56.0%	100.0%	17.2%
																		H-2	90.5	588.7	51.2%	100.0%	5.0%
X	88.4	557.8	46.5%	0.0%	8.9%	X	89.0	581.4	51.2%	17.7%	5.8%	X	89.8	577.5	39.0%	84.2%	6.4%	X	89.4	561.3	43.6%	99.0%	10.5%
SE	04	106	0.1%	0.0%	2.4%	SE	06	103	0.0%	12.5%	0.0%	SE	04	81	0.0%	0.0%	0.0%	SE	03	75	2.3%	0.5%	2.0%
SEPTEMBER						OCTOBER						NOVEMBER						DECEMBER					
Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull	Code	Length	Weight	Female	Soft	Cull
K-2	89.7	569.4	51.1%	100.0%	9.2%	W-24	94.1	669.3	51.3%	100.0%	4.9%	C-15	90.1	583.5	59.6%	100.0%	14.5%	K-38	89.1	548.3	30.7%	100.0%	21.4%
H-20	90.4	591.1	45.8%	100.0%	5.9%	H-34	90.3	586.7	63.2%	100.0%	20.7%	C-20	87.2	520.4	49.6%	100.0%	9.6%	Y-26	88.7	542.3	55.4%	100.0%	14.8%
C-10	89.1	540.5	38.8%	100.0%	17.5%	K-3	89.5	551.6	59.1%	100.0%	11.9%	C-17	89.5	572.1	62.2%	100.0%	7.7%	K-17	90.5	600.9	41.1%	100.0%	12.6%
S-5	90.6	582.2	45.9%	100.0%	9.2%	H-26	88.2	534.6	62.5%	100.0%	0.0%	H-5	91.7	621.9	57.6%	100.0%	5.7%						
C-15	88.6	543.9	71.3%	100.0%	9.6%	H-18	89.8	568.2	67.3%	100.0%	5.7%												
Y-3	89.6	538.3	56.9%	100.0%	12.5%	Y-25	89.2	535.2	63.9%	100.0%	25.9%												
H-28	91.1	593.9	53.0%	100.0%	10.5%																		
C-12	89.0	561.2	39.6%	100.0%	9.7%																		
H-28	90.7	583.3	60.3%	100.0%	4.9%																		
X	89.9	567.1	51.4%	100.0%	9.9%	X	90.2	574.3	61.2%	100.0%	11.5%	X	89.6	574.5	57.3%	100.0%	9.4%	X	89.4	563.8	42.4%	100.0%	16.3%
SE	03	74	3.5%	0.0%	1.2%	SE	08	20.7	2.3%	0.0%	4.1%	SE	09	20.9	2.7%	0.0%	1.9%	SE	06	18.6	7.2%	0.0%	2.6%
YEARLY TOTAL																							
Code	Length	Weight	Female	Soft	Cull																		
X	89.3	568.1	48.3%	67.6%	9.0%																		
SE	02	40	1.5%	5.8%	0.8%																		

Table 3. Expanded estimates of catch and effort with standard errors calculated for all dealer-days, 2002.

MONTH	Catch in Pounds	Catch in Numbers	Value in Dollars	Number of Traps	Number of Trap-Hauls	Number of T.H.S.Q.D.	Number of Min-Days	Number of Boat-Days	Pounds per Trap-Haul	Numbers per Trap-Haul	Numbers per T.H.S.Q.D.	Pounds per Boat-Day	Pounds per Min-Day
APR	515817 +- 249,523	410,922 +- 196,892	1,884,713 +- 951,624	177,511 +- 92,975	1,001,331 +- 476,015	8,082,576 +- 4,377,307	9,990 +- 4,603	4,995 +- 2,394	0.51513 +- 0.04642	0.41038 +- 0.03326	0.05094 +- 0.00693	103.26967 +- 7.19747	51.63333 +- 4.16190
MAY	1,073,763 +- 630,949	826,150 +- 461,370	4,226,191 +- 2,365,539	256,518 +- 163,833	2,173,488 +- 1,388,352	10,741,500 +- 6,434,371	19,375 +- 10,960	11,238 +- 6,180	0.49403 +- 0.03691	0.38010 +- 0.04004	0.07691 +- 0.00775	96.55172 +- 6.95476	55.42000 +- 3.67121
JUN	2,431,104 +- 1,165,756	1,874,184 +- 902,450	10,281,305 +- 4,988,524	601,974 +- 289,623	3,794,866 +- 1,633,194	22,776,936 +- 9,497,287	38,064 +- 16,377	19,666 +- 8,255	0.06406 +- 0.00941	0.49388 +- 0.08366	0.10574 +- 0.01700	123.69254 +- 20.53636	63.86885 +- 10.52808
JUL	8,643,726 +- 5,063,384	6,627,933 +- 3,853,873	27,298,463 +- 15,607,228	744,053 +- 336,347	5,079,321 +- 2,228,994	19,575,305 +- 8,920,090	44,577 +- 20,048	24,921 +- 9,962	1.70175 +- 0.30323	1.30489 +- 0.22354	0.33687 +- 0.04465	346.84507 +- 64.44127	193.90551 +- 25.94861
AUG	11,388,708 +- 2,817,848	8,965,188 +- 2,164,152	35,316,727 +- 8,412,197	837,012 +- 156,043	7,698,145 +- 1,655,455	30,266,460 +- 6,047,343	71,237 +- 13,185	40,392 +- 6,837	1.47979 +- 0.11500	1.16489 +- 0.08948	0.29621 +- 0.02547	281.95455 +- 26.05140	159.87113 +- 12.64912
SEPT	16,628,693 +- 5,441,735	12,750,163 +- 4,056,042	52,644,295 +- 17,442,035	1,192,357 +- 304,706	10,016,577 +- 2,707,733	39,266,464 +- 10,058,448	84,402 +- 19,466	48,906 +- 11,018	1.66012 +- 0.12661	1.27291 +- 0.08413	0.32471 +- 0.02485	340.01613 +- 38.74941	197.01889 +- 21.63621
OCT	9,962,453 +- 3,651,854	7,811,840 +- 2,819,218	32,185,216 +- 11,952,729	596,133 +- 237,096	3,756,773 +- 1,419,829	20,087,200 +- 7,866,512	33,547 +- 12,198	18,597 +- 6,804	2.65186 +- 0.59164	2.07940 +- 0.44739	0.38890 +- 0.09439	536.00000 +- 101.79836	296.97297 +- 60.90711
NOV	3,258,962 +- 1,681,371	2,544,808 +- 1,300,878	10,007,616 +- 5,173,045	516,033 +- 261,294	2,123,786 +- 1,020,533	11,646,110 +- 5,866,031	19,894 +- 9,358	10,150 +- 4,709	1.53451 +- 0.23640	1.19624 +- 0.14730	0.21651 +- 0.01021	321.08000 +- 36.07260	163.81633 +- 13.84228
DEC	1,039,206 +- 630,870	829,272 +- 503,240	4,373,396 +- 2,665,431	249,702 +- 184,674	800,169 +- 513,860	9,197,855 +- 5,147,559	10,464 +- 5,764	5,886 +- 3,335	1.29873 +- 0.21999	1.03637 +- 0.17861	0.08016 +- 0.01241	176.55556 +- 24.25658	99.31250 +- 15.22858
TOTAL	54,942,432 +- 9,031,666	42,640,460 +- 6,851,783	178,217,923 +- 28,751,880	5,169,293 +- 0	36,442,446 +- 4,814,364	171,740,407 +- 28,751,880	331,560 +- 40,420	184,731 +- 21,425	1.46658 +- 0.07821	1.13799 +- 0.05817	0.23922 +- 0.01233	288.50000 +- 16.82736	160.42153 +- 8.51836

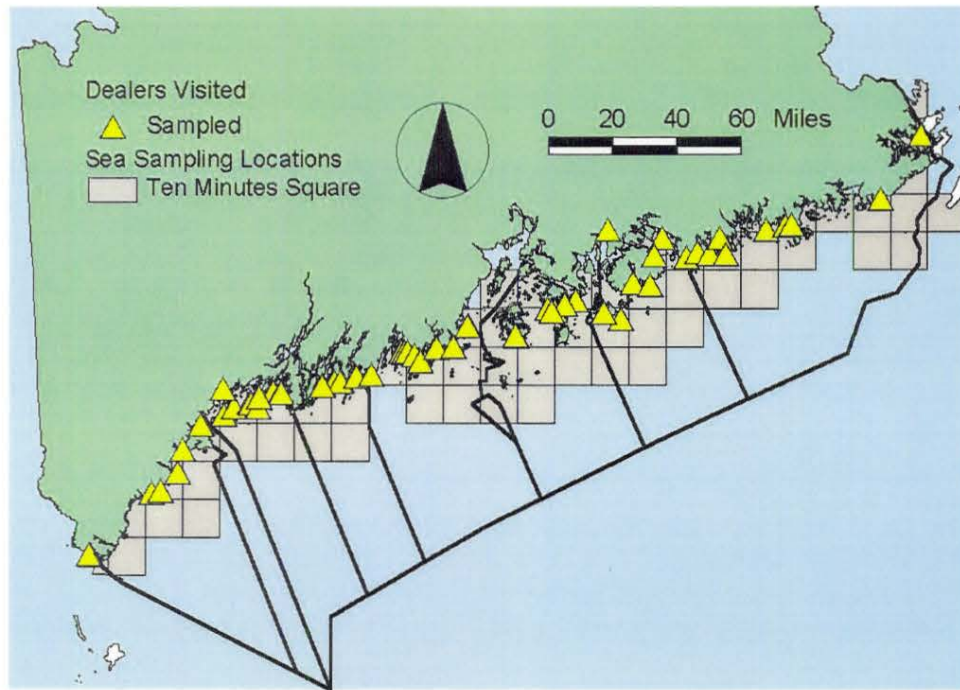


Figure 1. Location of dealers visited by the commercial port sampling program (yellow triangles) in 2002. Shaded grids represent location of sea sampling trips, by ten-minute square, in 2002. Lines indicated management zones along the coast.

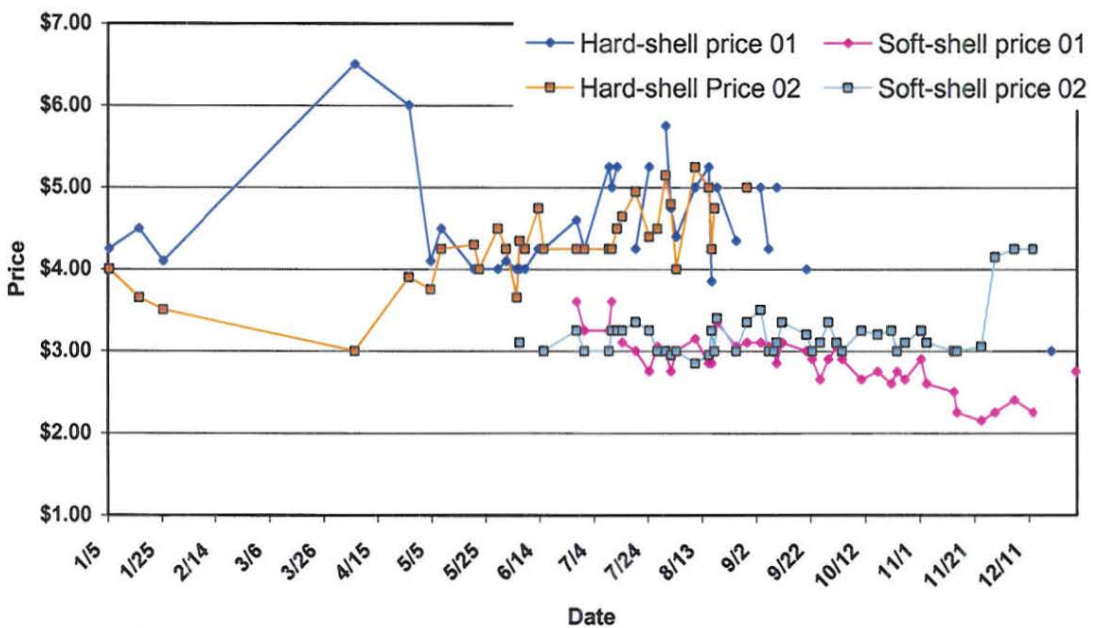


Figure 2. The daily price per pound of lobsters, 2001-2002 as recorded by the port-sampling program.

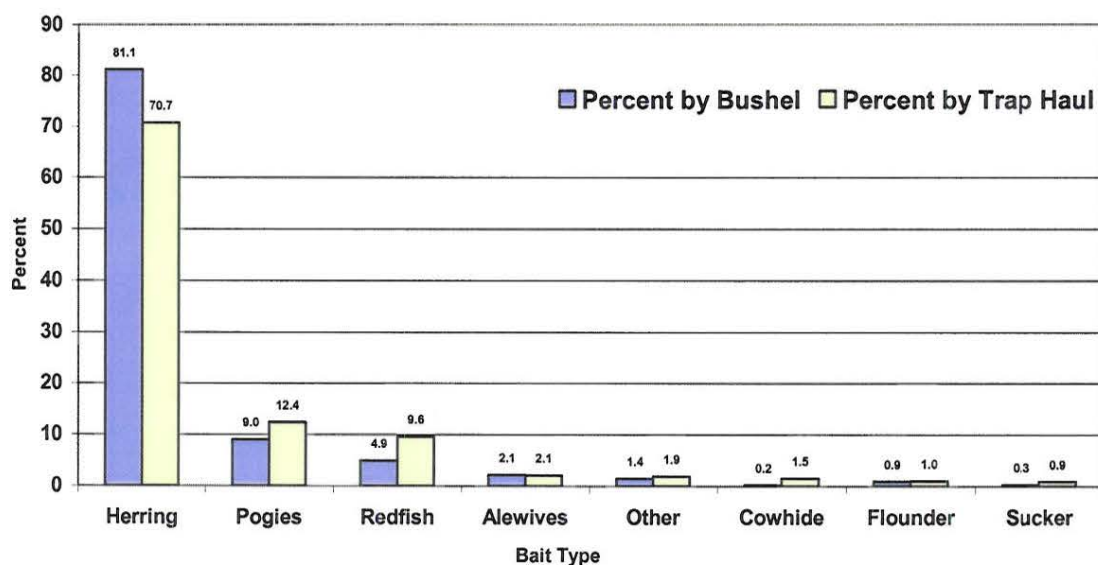


Figure 3. Proportional use of bait by amount (bushel) and as a percentage of traps hauled in 2002, based on interviews conducted by the port sampling team (n=494 boats).

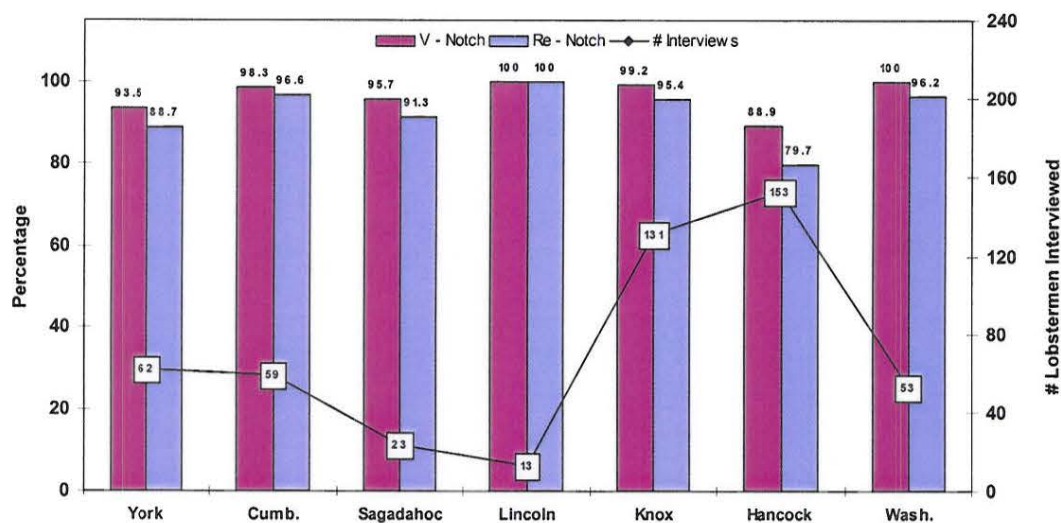


Figure 4. Percentage of interviewed fishermen who responded that they (1) V-notch egg bearing lobsters and (2) re-notch lobsters with old or marginal V-notches in 2002. This question will not be asked again in 2003.

Table 4. Ports visited during the 2002 sea sampling season.

	May	June	July	August	September	October	November
A	Jonesport Corea Cutler	Cutler Corea Jonesport	Cutler Perry Beals Island	Eastport Bucks harbor Machiasport	Jonesport Addison Corea	Corea Milbridge Eastport	Corea(2)
B	Northeast Harbor Bar Harbor	Bar Harbor(2) Southwest Harbor	Isleford Southwest Harbor Winter Harbor	Winter Harbor Bar Harbor(2)	Northeast Harbor Bar Harbor Southwest Harbor	Islesford(3) Southwest Harbor Bar Harbor(2)	Southwest Harbor Isleford Bar Harbor
C	Stonington(2) Vinalhaven	Vinalhaven(3) Stonington	Stonington(3) Vinalhaven	Stonington(2) Vinalhaven(2)	Stonington(2) Matinicus(3)	Stonington(3) Matinicus(3) Vinalhaven(3)	Stonington(1) Vinalhaven(3) Matinicus(3)
D	Sprucehead(2)	Sprucehead(2) Rockland	Sprucehead(2) Rockland Islesboro(3) Round Pond	Rockland Sprucehead(2) Islesboro(3)	Sprucehead Rockland Islesboro(3) Tenants Harbor	Sprucehead(3) Islesboro(2) Cushing	Round Pond Cushing(2) Tenants Harbor
E	Boothbay Harbor Boothbay Harbor	Pemaquid South Bristol Boothbay Harbor	Pemaquid South Bristol(2)	South Bristol Boothbay Harbor(2)	Boothbay (2) Boothbay Harbor(2)	Pemaquid Phippsburg Boothbay Harbor	South Bristol Boothbay Harbor(2)
F	Portland	Portland(2) Cousins Island	West Harpswell Harpswell Portland	Orrs Island(2) Yarmouth Cape Elizabeth Harpswell	Long Island Harpswell Portland	Cundy's Harbor South Harpswell Long Island	Portland South Harpswell Harpswell
G	York Harbor	Pine Point Kittery Point Cape Porpoise	Kittery Point Camp Ellis Cape Porpoise	Kittery Point Kittery Cape Porpoise	Pine Point Wells Cape Porpoise	Camp Ellis Cape Porpoise York Harbor	York Harbor Cape Porpoise

Table 5. The monthly sea sampling totals recorded for the 2002 season. The sampling design called for each lobster management zone (A through G) to be sampled three times monthly.

Totals by Trip	May	June	July	August	September	October	November	Total
Total Sampling Trips	14	22	25	27	27	33	24	172
Total Catch in Pounds	2132	2812	7141	10338	13474	20347	9955	66198
Total Catch in Numbers	8543	13036	13050	17457	22609	25830	16127	116652
Total Boat Hours	1139	182	198	224	235	291	221	2488
Total Number of Trap Hauls	2574	4400	5067	5529	5874	6477	4191	34112
Total Number of Legals	1719	2652	5941	8617	10611	14846	7554	51940
Total Number of Sublegals	6213	9462	6446	7851	10276	8125	6323	54696
Total Number of IllLegals	611	922	663	989	1722	2859	2250	10016
Total Number of Oversize	24	21	20	21	35	110	46	277
Total Number of Berried	184	436	283	349	336	993	496	3077
Total Number of Berried with Vnotch	63	161	106	95	115	457	273	1270
Total Number of Berried w/o Vnotch	5	23	10	6	5	0	9	58
Total Number of NonBerried with Vnotch	560	829	650	911	1808	2943	2511	10212

	May	Jun	Jul	Aug	Sep	Oct	Nov
Average Legals/TH	0.66	0.59	1.16	1.54	1.78	2.24	1.79
St Dev*	0.90	0.90	1.39	1.71	1.84	2.10	1.61
Average Sublegals/TH	2.38	2.12	1.26	1.40	1.73	1.23	1.50
Stdev*	2.57	2.38	1.67	1.87	2.02	1.57	1.75
Average Illegals/TH	0.23	0.21	0.13	0.18	0.29	0.43	0.53
Stdev*	0.47	0.48	0.36	0.42	0.48	0.61	0.63
Average Vnotch/TH	0.27	0.25	0.16	0.20	0.35	0.56	0.71
Stdev*	0.57	0.57	0.46	0.49	0.63	0.93	0.95

Totals CPUE by Trap with 99% of lobsters Measured

*Stdev based on averages by trap

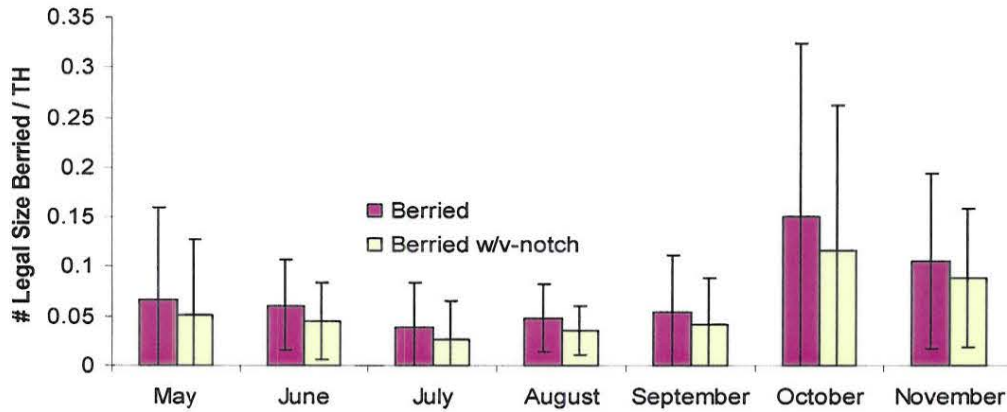


Figure 5. Monthly catch rates (per trap haul) of legal size egg bearing lobsters (with or without a v-notch) for 2002 (standard error derived from averages by trip).

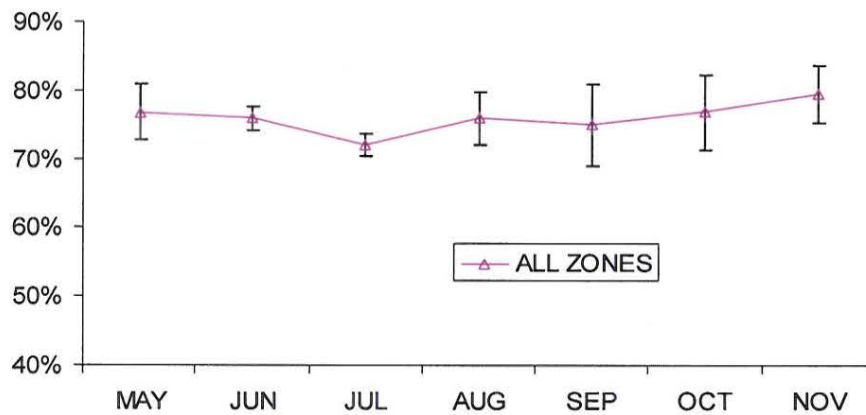


Figure 6. Observed percentage of legal sized (>83 mm CL) berried lobsters with a V-notch (1999-2002). Standard deviation is derived from averages by month.

Table 6. The species, size and number of bycatch encountered during the 2002 sea sampling season. Fish were caught in less than 4% of all traps sampled.

Species	Average (CM)	Standev	Number
Sea Raven	37	11.3	279
Sculpin Spp.	26	10.5	200
Longhorn Sculpin	29	10.3	182
Cod	37	14.1	153
Shorthorn Sculpin	28	6.8	113
Black Sea Bass	31	12.0	27
Cunner	19	5.6	23
Redfish	18	7.2	19
Flounder	26	12.0	17
Cusk	42	23.8	16
Alewife	34	15.7	7
Skate	37	12.0	7
Shad	53	31.8	6
Ocean Pout	40	10.8	5
Pollock	29	11.0	3
Dogfish	82	7.1	2
Lumpfish	9	2.1	2
Mackerel	31	4.2	2
Hake	65		1
Stripe Sea Bass	51		1
Wolfish	67		1

Table 7. Port sampling length frequencies from the survey cluster samples by sex and month, 2002.

CL	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER			TOTAL		
(mm)	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot
82	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
83	9	13	22	25	25	50	41	49	90	24	25	49	43	40	83	24	38	62	4	11	15	11	17	28	1	2	3	182	220	402
84	16	3	19	21	23	44	27	32	59	17	17	34	34	42	76	34	43	77	12	14	26	7	4	11	5	13	18	173	191	364
85	15	8	23	23	12	35	23	19	42	23	21	44	39	40	79	35	47	82	10	21	31	11	13	24	4	10	14	183	191	374
86	3	6	9	8	5	13	17	24	41	32	22	54	46	28	74	41	55	96	10	22	32	7	9	16	9	7	16	173	177	350
87	3	8	11	9	2	11	16	20	36	35	18	53	39	49	88	45	50	95	17	11	28	8	8	16	11	8	19	183	174	357
88	1	6	7	13	12	25	15	21	36	37	25	62	41	48	89	34	62	96	12	16	28	8	6	14	9	5	14	170	201	371
89	4	4	8	8	6	14	9	29	38	23	18	41	32	51	83	37	56	93	17	22	39	9	12	21	4	5	9	143	203	346
90	3	7	9	5	10	15	13	24	37	33	25	58	48	41	89	42	52	94	21	21	42	5	17	22	11	11	22	181	208	388
91	3	3	6	6	8	14	13	22	35	31	14	45	41	36	77	30	51	81	9	18	27	9	7	16	7	9	16	149	168	317
92	3	4	7	5	9	14	6	26	32	38	21	59	37	33	70	30	58	88	12	24	36	14	12	26	7	6	13	152	193	345
93	2	3	5	9	3	12	21	14	35	32	17	49	46	24	70	40	37	77	7	16	23	6	7	13	5	0	5	168	121	289
94	1	0	1	2	3	5	13	19	32	30	10	40	44	16	60	30	30	60	9	18	27	5	6	11	4	1	5	138	103	241
95	1	5	6	2	10	12	9	11	20	31	10	41	37	13	50	37	28	65	12	11	23	4	6	10	5	0	5	138	94	232
96	1	1	2	1	6	7	8	18	26	23	0	23	21	13	34	28	18	46	4	5	9	3	3	6	2	0	2	91	64	155
97	3	0	3	1	1	2	11	3	14	10	3	13	21	6	27	24	16	40	6	2	8	1	1	2	2	1	3	79	33	112
98	2	0	2	1	2	3	6	2	8	18	2	20	21	5	26	25	6	31	2	3	5	2	0	2	1	0	1	78	20	98
99	0	0	0	4	1	5	2	2	4	6	0	6	4	0	4	9	1	10	2	0	2	0	1	1	0	0	0	27	5	32
100	0	0	0	0	0	0	4	3	7	6	0	6	4	1	5	10	2	12	1	1	2	2	0	2	2	1	3	29	8	37
101	0	0	0	0	0	0	2	4	6	2	1	3	2	1	3	9	3	12	3	0	3	1	0	1	1	0	1	20	9	29
102	0	0	0	0	0	0	2	0	2	0	1	1	0	0	0	2	2	4	0	1	1	2	0	2	0	0	0	6	4	10
103	0	0	0	2	0	2	0	2	2	1	0	1	2	0	2	4	1	5	0	0	0	1	0	1	0	0	0	10	3	13
104	1	0	1	0	0	0	1	2	3	1	0	1	1	1	2	0	0	0	0	0	0	0	1	1	1	0	1	5	4	9
105	1	0	1	0	1	1	3	0	3	0	0	0	0	1	1	1	1	2	0	0	0	0	1	1	0	0	0	5	4	9
106	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	2	3
107	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
108	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	2	1	3
109	0	0	0	0	1	1	1	1	2	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	3	2	5
110	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	3	3	0	0	0	0	0	0	0	0	0	1	3	4
111	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
112	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2	1	3
113	0	0	0	0	0	0	1	0	1	0	1	1	1	0	1	2	0	2	0	0	0	0	0	0	0	0	0	4	1	5
114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1
115	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
116	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	0	3
117	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
120	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1
122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	72	71	143	147	142	289	267	349	616	456	254	710	610	490	1100	574	660	1234	173	237	410	119	131	250	91	79	170	2,509	2,414	4,923

Table 8. Port sampling expanded landings by numbers and 14% molt groupings (1967 – 2002).

Year	Total Commercial	(0.93-1.32 lbs.)		(1.36-1.98 lbs.)		(2.03-2.95 lbs.)		(3.02-3.31 lbs.)	
	Catch in Numbers	81-92 mm.		93-106 mm.		107-122 mm.		123-127 mm. (legal max.)	
1967	14,175,747	11,462,509	80.86%	2,435,393	17.18%	249,493	1.76%	28,352	0.20%
1968	17,550,287	14,338,584	81.70%	2,930,898	16.70%	261,499	1.49%	19,305	0.11%
1969	16,952,803	13,423,229	79.18%	3,254,938	19.20%	252,597	1.49%	22,039	0.13%
1970	15,400,228	11,442,369	74.30%	3,676,034	23.87%	264,884	1.72%	16,940	0.11%
1971	15,007,138	11,567,502	77.08%	3,270,055	21.79%	165,078	1.10%	4,502	0.03%
1972	13,894,416	10,184,607	73.30%	3,458,320	24.89%	220,921	1.59%	30,568	0.22%
1973	14,322,852	10,034,590	70.06%	3,968,862	27.71%	309,374	2.16%	10,026	0.07%
1974	13,829,971	10,041,942	72.61%	3,532,175	25.54%	233,726	1.69%	22,128	0.16%
1975	14,421,535	10,842,110	75.18%	3,252,056	22.55%	310,063	2.15%	17,306	0.12%
1976	16,102,587	12,010,920	74.59%	3,774,446	23.44%	275,354	1.71%	41,867	0.26%
1977	15,535,410	11,789,823	75.89%	3,441,093	22.15%	270,316	1.74%	34,178	0.22%
1978	16,212,253	12,893,605	79.53%	3,062,495	18.89%	238,320	1.47%	17,833	0.11%
1979	18,444,362	15,061,666	81.66%	3,181,652	17.25%	178,910	0.97%	22,133	0.12%
1980	18,165,860	14,089,441	77.56%	3,745,800	20.62%	330,619	1.82%	0	0.00%
1981	18,859,682	15,153,754	80.35%	3,381,541	17.93%	303,641	1.61%	20,746	0.11%
1982	19,077,739	14,209,100	74.48%	4,586,288	24.04%	257,549	1.35%	24,801	0.13%
1983	18,466,341	14,507,157	78.56%	3,792,986	20.54%	158,810	0.86%	7,386	0.04%
1984	16,419,066	13,399,600	81.61%	2,738,700	16.68%	262,705	1.60%	16,419	0.10%
1985	15,662,026	13,101,285	83.65%	2,216,177	14.15%	302,277	1.93%	42,287	0.27%
1986	16,284,560	13,346,825	81.96%	2,703,237	16.60%	226,355	1.39%	8,142	0.05%
1987	16,443,400	13,851,920	84.24%	2,385,937	14.51%	198,965	1.21%	6,577	0.04%
		(0.96-1.37 lbs.)		(1.41-2.04 lbs.)		(2.09-3.02 lbs.)		(3.09-3.31 lbs.)	
		82-93 mm.		94-107 mm.		108-123 mm.		124-127 mm. (legal max.)	
1988	17,612,735	15,481,594	87.90%	1,937,400	11.00%	188,456	1.07%	7,045	0.04%
		(0.99-1.41 lbs.)		(1.45-2.09 lbs.)		(2.15-3.09 lbs.)		(3.16-3.31 lbs.)	
		83-94 mm.		95-108 mm.		109-124 mm.		125-127 mm. (legal max.)	
1989	19,041,146	17,266,511	90.68%	1,620,402	8.51%	140,904	0.74%	11,425	0.06%
1990	22,642,627	19,893,812	87.86%	2,499,746	11.04%	242,276	1.07%	9,057	0.04%
1991	24,875,717	22,201,577	89.25%	2,509,960	10.09%	156,717	0.63%	7,463	0.03%
1992	21,509,906	18,814,715	87.47%	2,374,694	11.04%	286,082	1.33%	32,265	0.15%
1993	23,982,134	20,552,689	85.70%	3,093,695	12.90%	294,980	1.23%	38,371	0.16%
1994	30,656,826	26,622,388	86.84%	3,933,271	12.83%	101,168	0.33%	0	0.00%
1995	28,301,132	23,693,708	83.72%	4,332,903	15.31%	263,200	0.93%	8,490	0.03%
1996	28,978,102	25,161,686	86.83%	3,523,737	12.16%	283,985	0.98%	8,693	0.03%
1997	36,486,936	31,721,742	86.94%	4,473,298	12.26%	259,057	0.71%	32,838	0.09%
1998	37,928,024	32,967,038	86.92%	4,775,138	12.59%	178,262	0.47%	7,586	0.02%
1999	41,757,568	35,402,066	84.78%	6,113,308	14.64%	242,194	0.58%	0	0.00%
2000	44,353,028	37,411,779	84.35%	6,675,131	15.05%	243,942	0.55%	22,177	0.05%
2001	35,485,685	29,882,495	84.21%	4,985,739	14.05%	599,708	1.69%	17,743	0.05%
2002	44,304,184	37,321,844	84.24%	6,694,362	15.11%	287,977	0.65%	0	0.00%

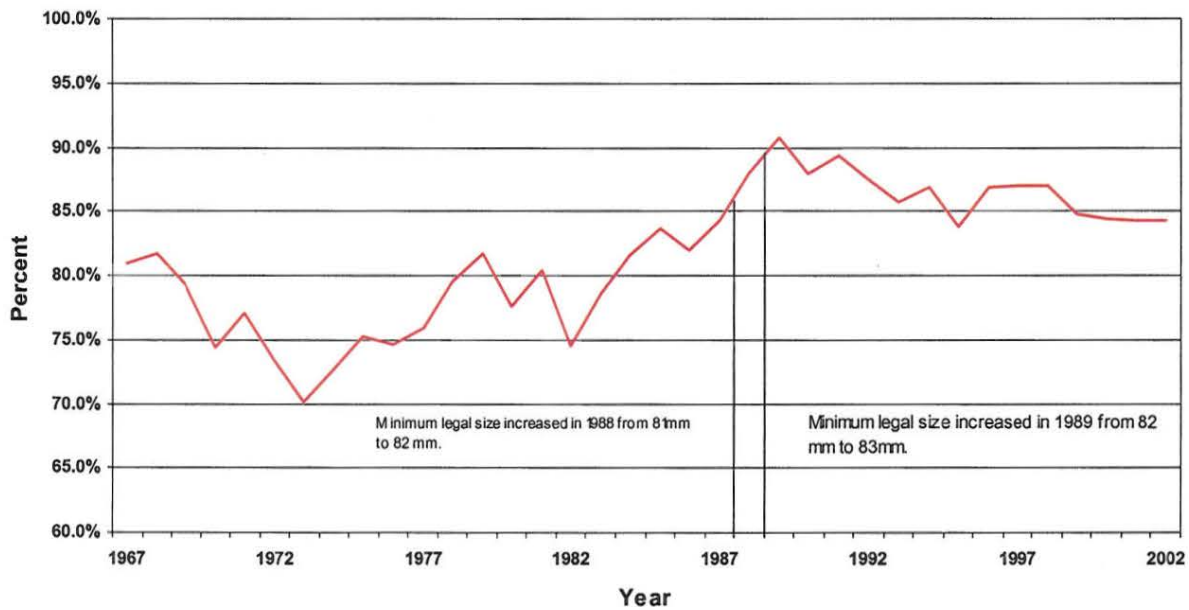


Figure 7. Percentage of lobsters harvested in the first 14% carapace length molt group, 1967-2002, as recorded in the port sampling program.

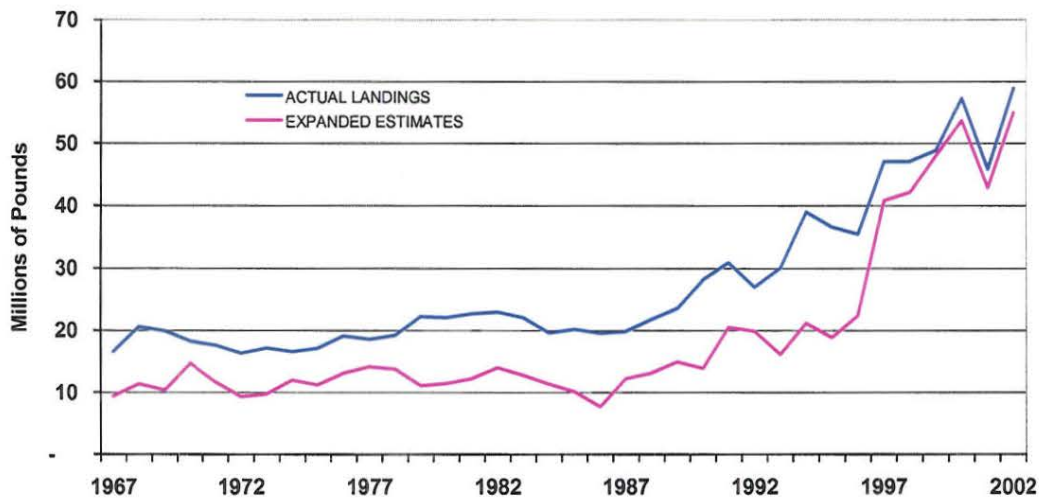


Figure 8. Comparison of port sampling expanded estimates with reported Maine landings, 1967-2002. The difference between the expanded estimates and the reported landings over time, there was a 65% difference 67-02, a 78% difference 92-02, and a 93% difference 97-02.

year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1967	0.23	0.91	0.85	0.43	0.42	0.43	0.34	0.72	0.06
1968	0.50	0.49	0.60	0.64	0.58	0.50	0.85	0.34	0.00
1969	0.72	0.47	0.56	0.49	0.77	0.52	0.52	0.32	0.26
1970	1.03	0.49	0.59	0.49	0.96	1.14	0.61	1.48	0.35
1971	0.28	0.90	0.32	0.50	1.00	0.94	0.66	0.33	0.39
1972	0.36	0.27	0.59	0.41	0.38	0.73	0.85	0.58	0.40
1973	0.26	0.27	0.91	0.70	0.73	0.98	0.62	0.26	0.12
1974	0.32	0.76	1.22	0.67	0.72	0.48	1.10	0.68	0.12
1975	1.81	0.25	0.99	0.26	0.75	0.80	0.78	0.78	0.31
1976	0.39	0.75	0.55	0.61	0.73	1.02	0.74	0.34	0.82
1977	0.77	0.66	0.92	1.06	1.23	0.64	0.45	0.94	0.07
1978	0.74	0.50	0.97	0.40	0.66	1.09	0.42	1.27	0.31
1979	0.28	0.24	0.55	0.38	0.64	0.45	0.52	0.73	0.30
1980	0.00	0.61	0.36	0.80	0.59	0.57	0.72	0.02	0.19
1981	0.04	0.54	0.83	0.64	0.76	0.67	0.34	0.36	0.39
1982	0.82	0.53	1.06	0.40	0.67	0.93	0.66	0.39	0.09
1983	0.65	0.43	0.53	0.47	0.90	0.39	0.53	0.99	0.09
1984	0.00	0.31	0.98	0.67	0.56	0.59	0.85	0.37	0.61
1985	0.30	0.35	0.61	0.32	0.57	0.55	0.75	0.48	0.00
1986	0.40	1.15	0.36	0.32	0.48	0.18	0.51	0.27	0.66
1987	0.39	0.50	0.42	0.75	0.80	0.79	0.27	0.72	0.36
1988	0.42	1.14	0.43	0.40	0.75	0.54	0.28	1.16	0.63
1989	0.82	0.47	0.38	0.50	0.63	0.53	1.10	0.76	0.25
1990	0.39	0.87	1.13	0.60	0.35	0.72	0.41	0.32	0.00
1991	0.96	0.11	0.18	1.02	0.66	1.10	0.57	0.21	0.64
1992	0.70	0.30	0.40	0.54	1.16	1.22	0.43	0.41	0.36
1993	1.76	0.50	1.62	0.71	0.34	0.37	0.76	0.66	0.03
1994	0.45	0.65	0.29	1.14	0.71	0.32	0.41	0.42	0.17
1995	0.00	0.27	0.56	0.46	0.74	0.50	0.63	0.19	0.00
1996	0.90	1.23	0.47	0.66	1.03	0.64	0.29	0.18	0.15
1997	1.45	1.07	0.40	0.49	1.11	1.21	0.73	0.26	1.32
1998	1.18	0.60	0.78	0.66	0.84	1.35	1.12	0.49	0.52
1999	0.35	0.83	0.63	1.27	0.99	0.94	0.87	0.80	0.31
2000	0.49	0.98	0.29	1.30	0.76	0.73	1.09	1.66	0.36
2001	0.34	0.07	1.19	0.92	0.64	0.98	1.37	1.11	0.67
median	0.42	0.50	0.59	0.60	0.73	0.67	0.63	0.48	0.31
avg	0.59	0.58	0.67	0.63	0.73	0.73	0.66	0.60	0.32

Table 9. Monthly ratios of expanded estimates to reported landings from 1967 to 2001. Ratios below 0.60 are shaded gray, between 0.61 and 1.0 are white and greater than 1.01 are black. The 35-year average is 0.65, but has increased in recent years.

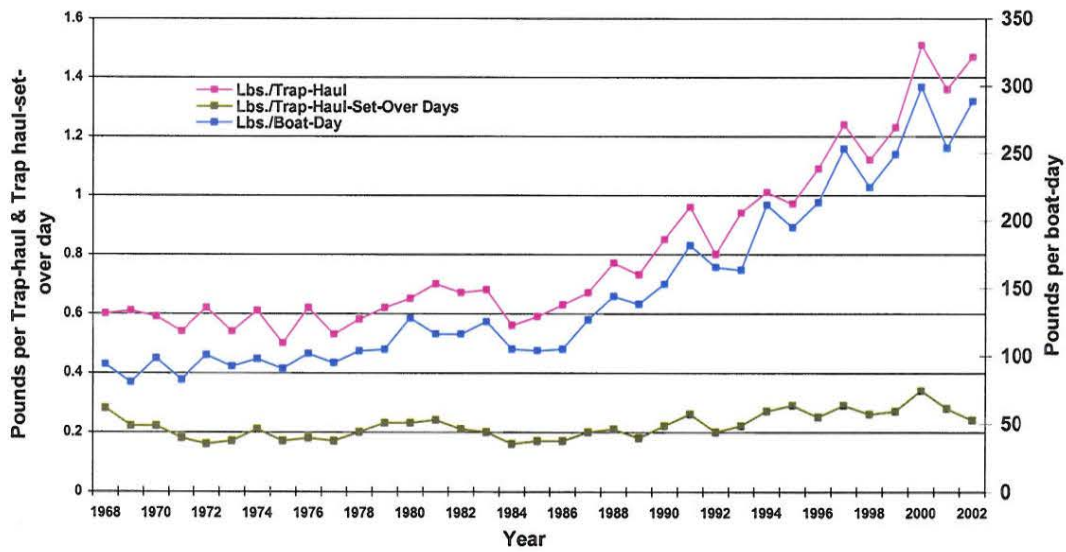


Figure 9. Catch-per-unit-effort categories from port sampling data, 1967-2002.

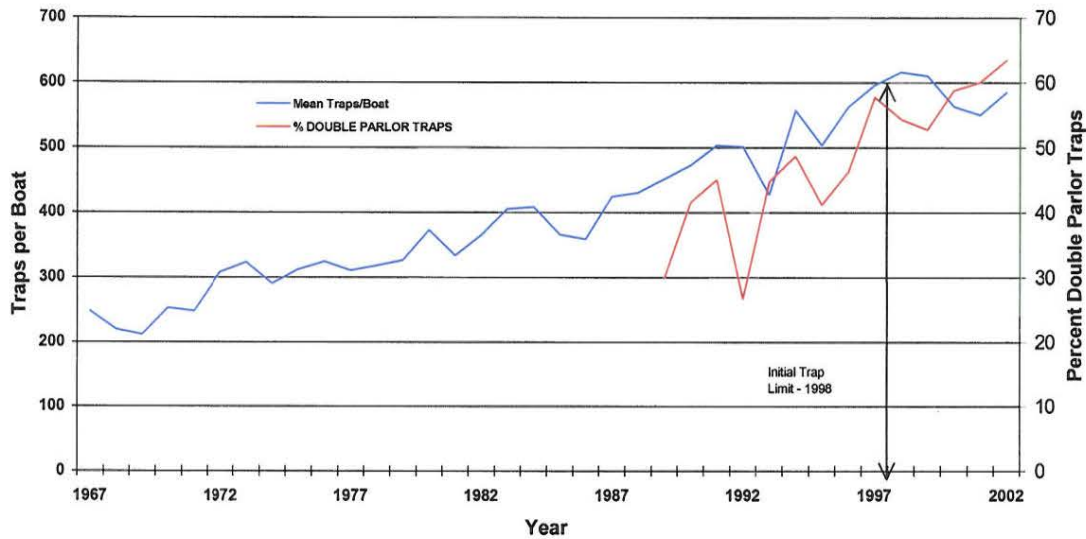


Figure 10. Comparison of mean number of traps per boat and percent double parlor traps fished, 1967-2002. Based on interviews collected by the port sampling team.

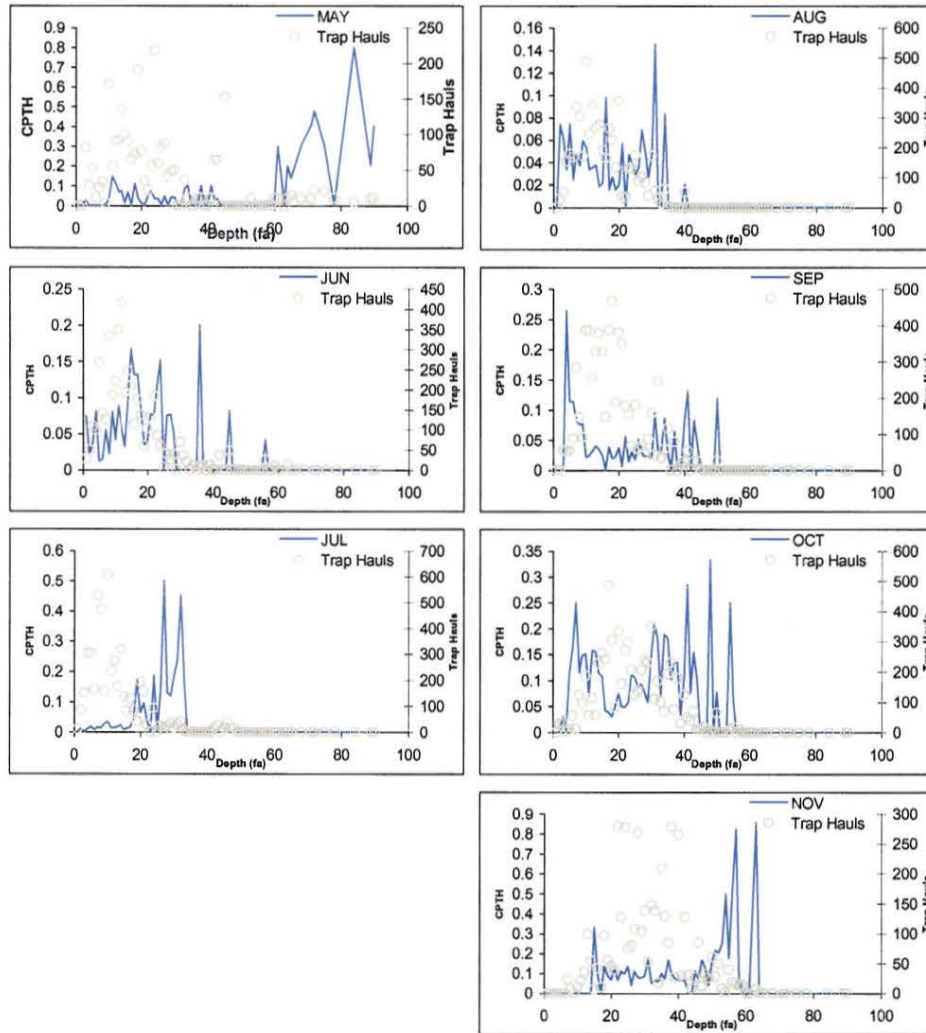


Figure 11. Average catch rate of berried lobsters in 2002 by depth and month. Open circles indicate trap hauls by depth.

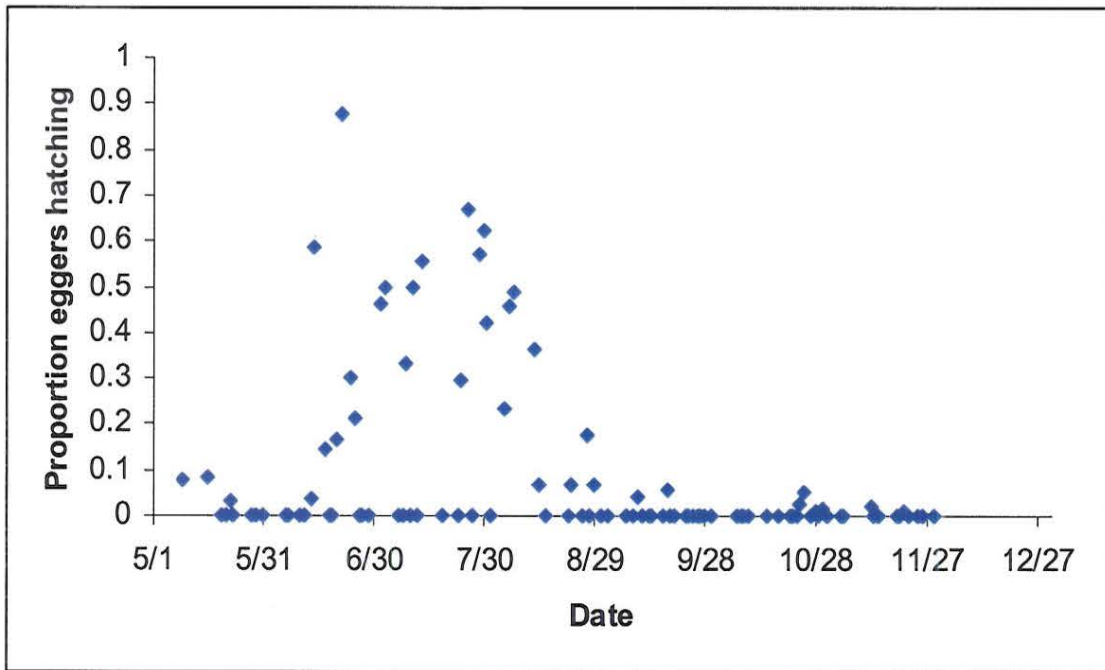


Figure 12. Proportion of observed berried lobsters with "hatching" eggs in 2002.

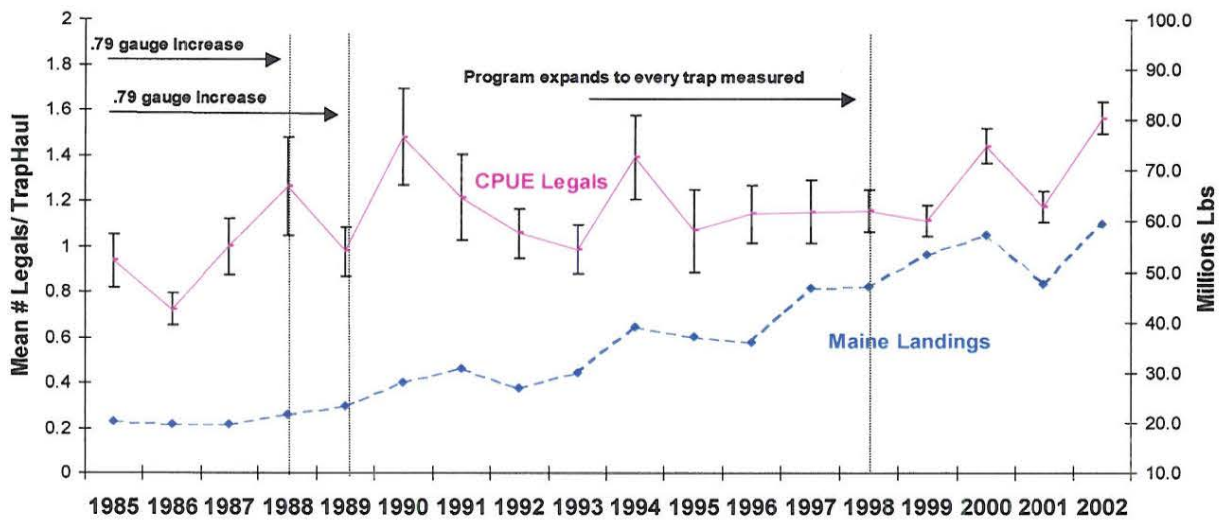


Figure 13. The catch per trap haul of legal lobsters from 1985-2002 (based on sea sampling surveys) and annual Maine landings. Error bars indicate the standard error of catch per trap for each sampling trip.

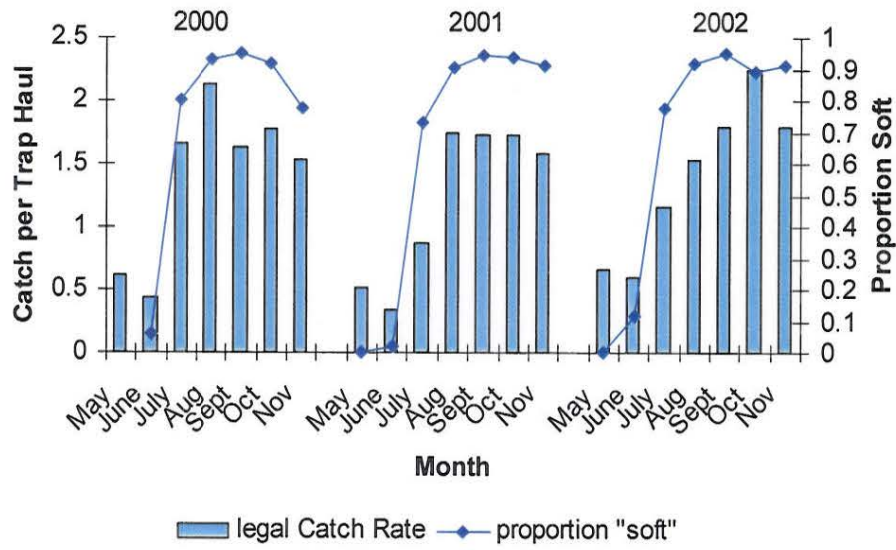


Figure 14. 2000-2002-molt frequency and observed catch per trap haul of legals by month. Error bars indicate standard deviation among trap hauls.

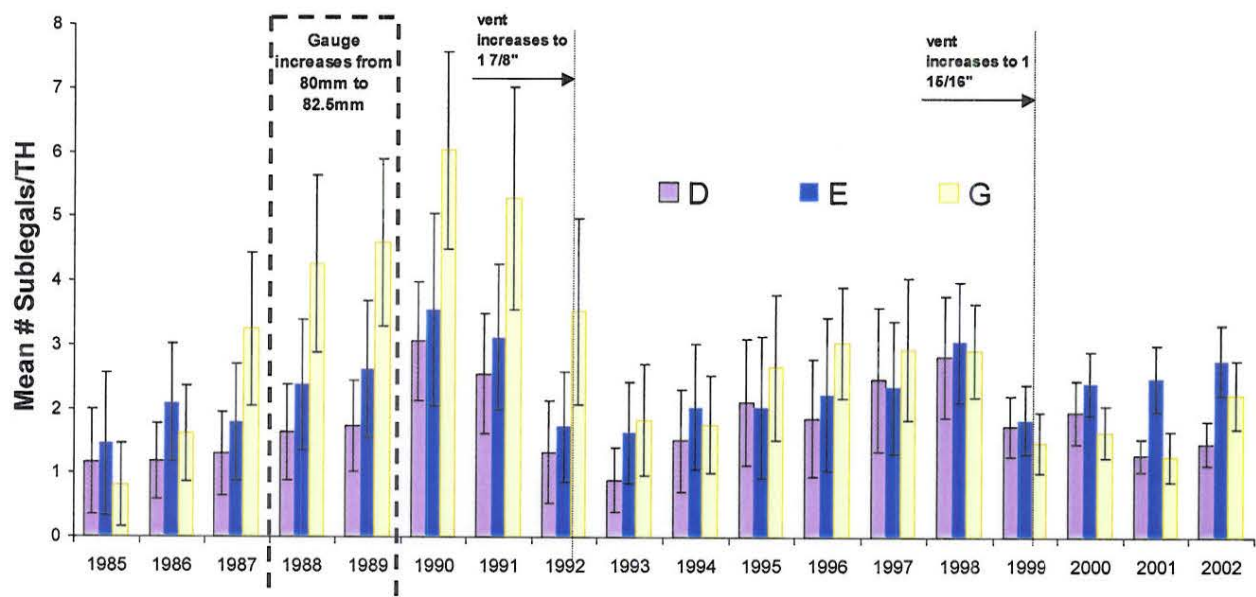


Figure 15. Catch Per Trap Haul of Sublegals 1985-2002. Error bars indicate the standard error of catch rates between individual sampling trips.

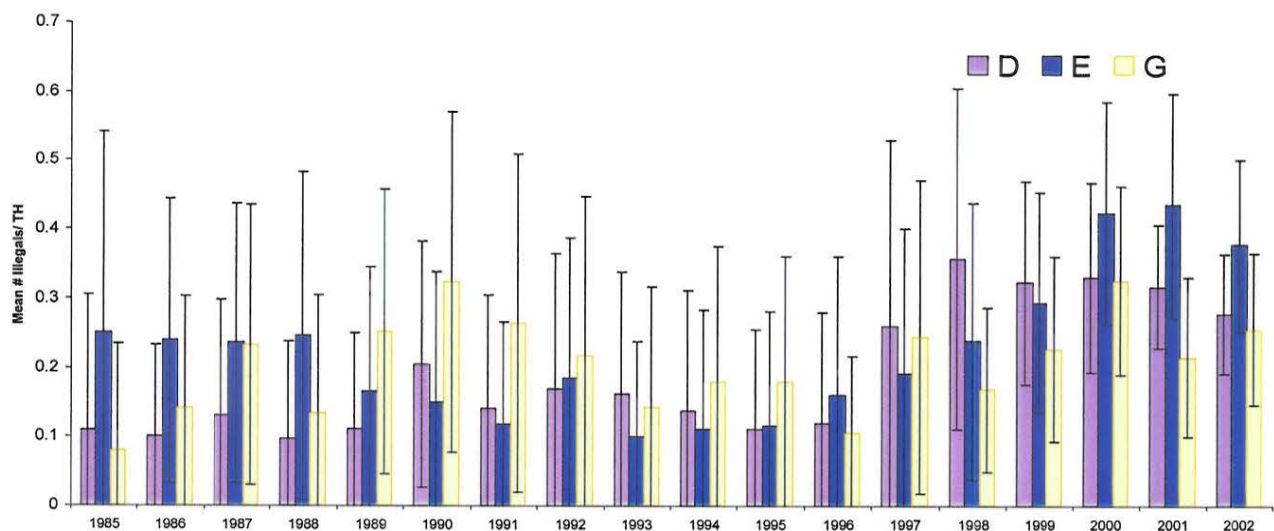


Figure 16. Catch Per Trap Haul of Illegals 1985-2002 for Zones D, E and G. Error bars indicate the standard error of catch rates between individual sampling trips.

Table 10. Catch rates per trap haul for legals, sublegals and illegals for all zones (A-G) from 1998-2002.

YEAR	Zone	Trips	TotalLegals	AveLegal	StDevLegal	SELegals	TotalSublegals	AveSublegals	StDevSublegals	SESublegals	TotalIllegals	Ave Illegals	StDev Illegals	SEIllegals
1998	A	27	6557	1.08	1.66	0.32	6198	1.00	1.33	0.26	842	0.14	0.40	0.08
1999	A	17	5344	1.41	1.88	0.46	2775	0.73	1.14	0.28	456	0.12	0.35	0.09
2000	A	20	6902	1.65	2.13	0.48	3483	0.83	1.18	0.26	1732	0.41	0.88	0.20
2001	A	19	7284	2.09	2.32	0.53	4562	1.31	1.54	0.35	1859	0.53	1.29	0.30
2002	A	20	5726	1.45	1.84	0.41	4855	1.23	1.94	0.43	612	0.15	0.41	0.09
1998	B	8	2659	1.08	1.40	0.49	3562	1.44	1.77	0.62	471	0.19	0.47	0.16
1999	B	19	4487	0.95	1.22	0.28	4083	0.87	1.21	0.28	1366	0.29	0.63	0.14
2000	B	19	5674	1.27	1.62	0.37	3695	0.83	1.16	0.27	1274	0.28	0.70	0.16
2000	B	1	309	1.22	1.23	1.23	190	0.75	0.94	0.94	96	0.38	0.57	0.57
2002	B	23	7259	1.44	1.82	0.38	5504	1.09	1.47	0.31	1457	0.29	0.54	0.11
1998	C	9	2614	1.07	1.17	0.39	2681	1.09	1.43	0.48	409	0.17	0.43	0.14
1999	C	19	4979	1.19	1.51	0.35	3342	0.80	1.25	0.29	1195	0.29	0.66	0.15
2000	C	27	10468	1.69	1.77	0.34	4794	0.77	1.12	0.22	3301	0.53	1.00	0.19
2001	C	18	4037	1.17	1.45	0.34	3303	0.96	1.38	0.32	1261	0.37	0.82	0.19
2002	C	40	12808	1.74	1.88	0.30	9564	1.30	1.66	0.26	2609	0.35	0.58	0.09
1998	D	7	2106	1.16	1.53	0.58	5127	2.81	2.50	0.95	654	0.36	0.65	0.25
1999	D	17	5945	1.59	1.77	0.43	6463	1.73	1.91	0.46	1207	0.32	0.60	0.15
2000	D	20	7062	1.65	1.81	0.40	8353	1.95	2.21	0.49	1416	0.33	0.61	0.14
2001	D	47	12062	1.33	1.67	0.24	11598	1.28	1.79	0.26	2885	0.32	0.61	0.09
2002	D	43	11170	1.62	1.76	0.30	10091	1.46	2.01	0.34	1921	0.28	0.50	0.09
1998	E	8	2594	1.18	1.51	0.53	6720	3.05	2.64	0.93	528	0.24	0.57	0.20
1999	E	15	3337	1.14	1.45	0.37	5401	1.84	2.12	0.55	868	0.30	0.62	0.16
2000	E	22	6072	1.57	1.66	0.35	9295	2.41	2.32	0.49	1644	0.43	0.75	0.16
2001	E	21	5621	1.49	1.50	0.33	9358	2.48	2.35	0.51	1647	0.44	0.75	0.16
2002	E	20	5786	1.58	1.57	0.35	10128	2.76	2.43	0.54	1387	0.38	0.55	0.12
1998	F	10	3001	0.98	1.55	0.49	8051	2.64	2.95	0.93	903	0.30	0.73	0.23
1999	F	20	5129	0.89	1.15	0.26	11808	2.05	2.52	0.56	1885	0.33	0.76	0.17
2000	F	18	5333	1.09	1.27	0.30	15965	3.26	2.62	0.62	2241	0.46	0.80	0.19
2001	F	27	5688	0.89	1.11	0.21	10402	1.62	1.93	0.37	1950	0.30	0.69	0.13
2002	F	20	5184	1.11	1.32	0.29	7876	1.69	1.79	0.40	1277	0.27	0.49	0.11
1998	G	12	1516	1.00	1.20	0.35	4442	2.92	2.55	0.74	257	0.17	0.41	0.12
1999	G	15	2251	0.79	1.01	0.26	4203	1.48	1.84	0.47	648	0.23	0.52	0.13
2000	G	22	4193	1.21	1.47	0.31	5704	1.65	1.90	0.40	1133	0.33	0.64	0.14
2001	G	19	2812	0.92	1.17	0.27	3836	1.25	1.71	0.39	660	0.22	0.51	0.12
2002	G	18	4064	1.35	1.54	0.36	6710	2.23	2.27	0.53	771	0.26	0.47	0.11

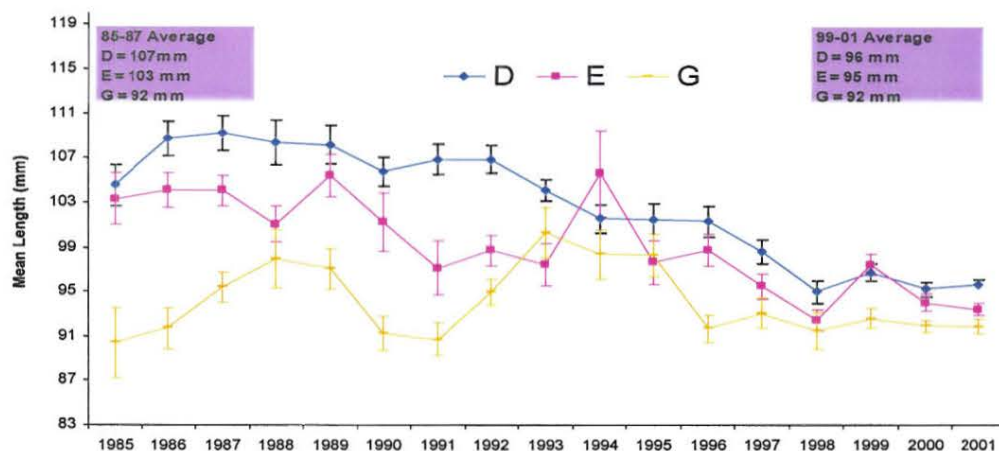


Figure 17. Mean carapace length of egg bearing lobsters 1985-2001 from measured and sub-sampled traps. Error bars indicate standard deviation among individuals for each year.

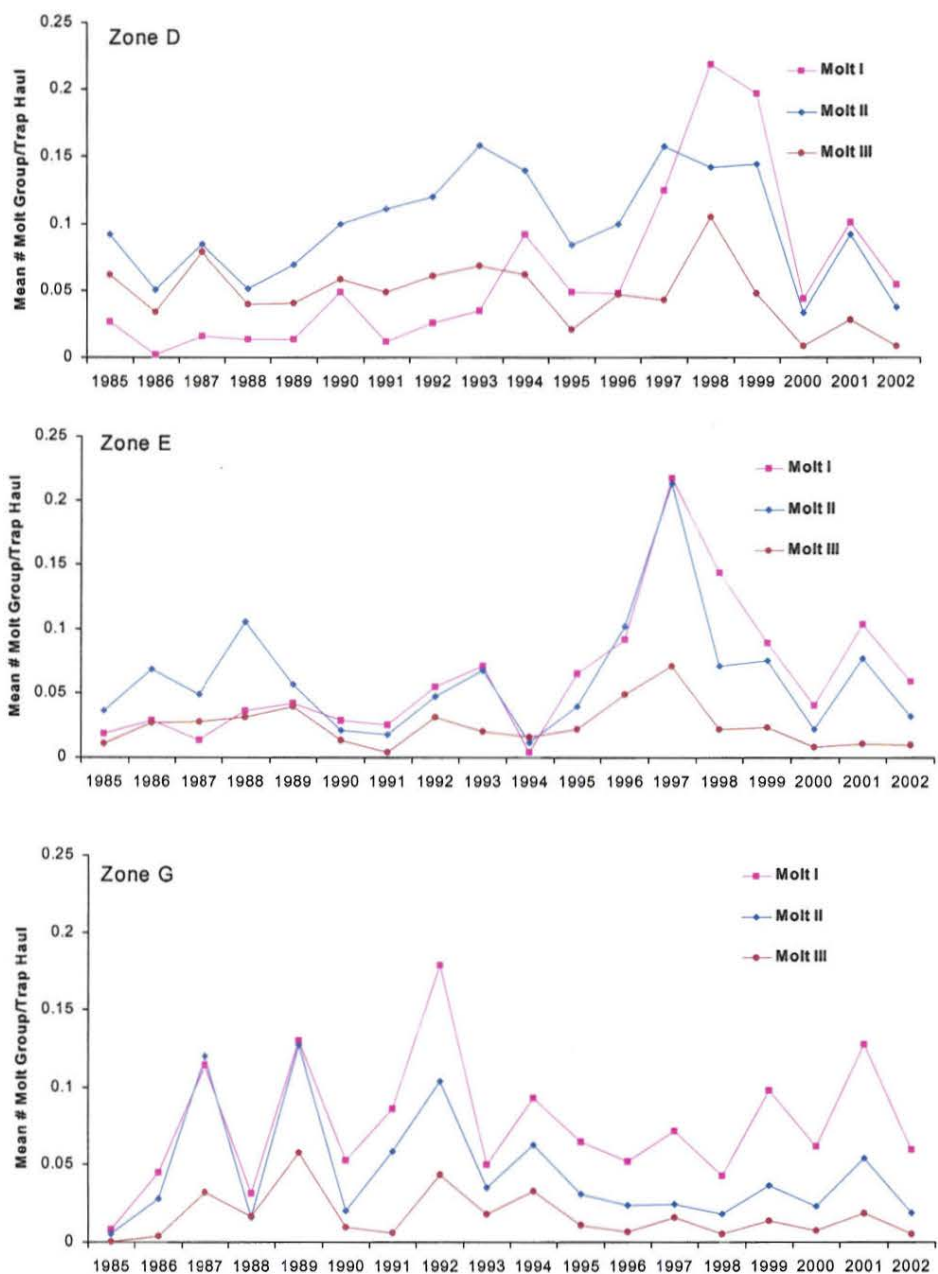


Figure 18. Average catch rates of three size classes of berried lobsters in three lobster management zones (1985-2002).

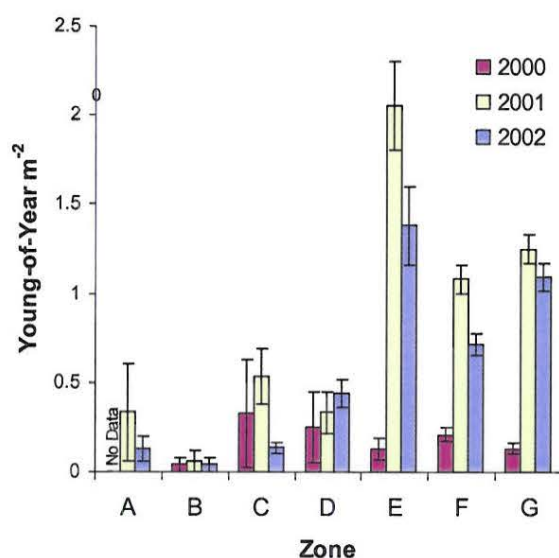


Figure 19. The average density (number m⁻²) of Young-Of-Year lobsters at the end of the settlement season, by lobster management zone (2000 to 2002). Zones run from east (Zone A) to west (Zone G). Zone A was not sampled in 2000. Error bars indicate standard error between quadrats. Source: Bigelow Laboratory for Ocean Sciences and the University of Maine.

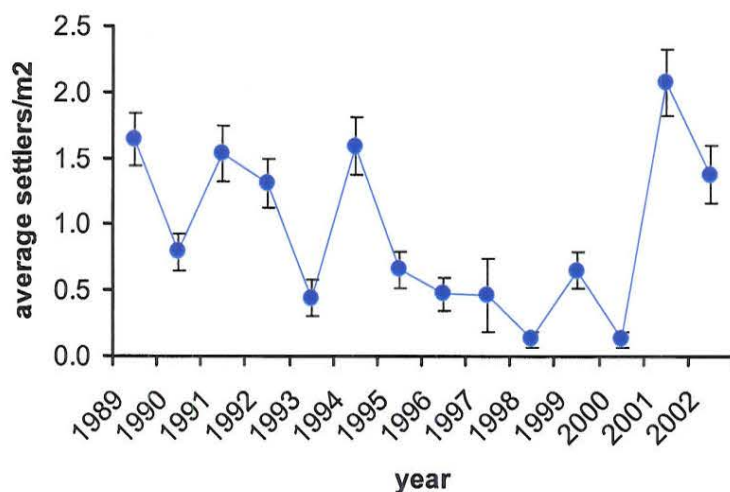


Figure 20. Time series, maintained by the Bigelow Laboratory for Ocean Sciences, of annual settlement of Young-Of-Year lobsters in the Mid-coast (Zone E) region. Error bars indicate standard error between quadrats.

NORTHERN SHRIMP

Lessie White and Marilyn Metcalfe

Job #1

Job Title: Port Sampling (The shrimp fishery was closed July 1, 2002 - December 31, 2002).

Objective:

Collect catch per unit effort data that represents the relative abundance of shrimp available to the Maine shrimp fishery and collect samples of the catch for laboratory analysis.

COMMERCIAL SHRIMP PORT SAMPLING PROJECT

The commercial shrimp port sampling project is conducted by the Maine Department of Marine Resources Biological Monitoring and Assessment Division headquartered at West Boothbay Harbor.

Purpose:

The purpose of this project is to furnish sufficient biological and catch/effort information about the commercial shrimp fishery to the Department's Assessment and Statistics people so they, in conjunction with the Atlantic States Marine Fisheries Commission's Northern Shrimp Technical Committee, will be able to offer the best scientific advice available to fishery managers. We do this by collecting samples from many individual fishing grounds, gathering catch and effort information through captain interviews at various fishing ports, and by completing laboratory analyses of the shrimp collected.

Sampling and Laboratory Procedures:

During our boat captain interviews the following information is recorded, depending on whether the boat is a dragger or trapper: Date, Dealer, Boat name, Catch Location, Depth fished, Total hours of drag time, Number of tows, Number of Traps, Number of days the traps have been set, Total pounds caught, Comments, Number in crew and Captain's name. Permission is asked of the captain to take a 2 lb sample from his catch back to Boothbay Harbor for laboratory analyses. Samples are purchased at \$4.00 for a 2 lb sample.

For each dragger sampled, information from the interview forms is used to determine the total catch of the vessels sampled at each dealer, the total drag time, the range of catches in pounds, the average catch in pounds per boat, the average catch per unit of effort (CPUE) expressed in lbs/hr drag time for each vessel, the range of CPUE's, and the average CPUE for the vessels sampled.

From the information gathered from trappers, the total catch of the trappers sampled at each dealer, the total number of traps fished, the total soak time, the range of catches in pounds, the average catch/vessel in lbs, the range of catches in lbs/trap, the average lbs/thsod (thsod = trap hauled set over day) and the average catch/trap is calculated. The boat price for the shrimp on that day for both draggers and trappers is recorded.

We also maintain/update discrete lists of fishing grounds from which the samples are harvested, vessels sampled, and dealer sites utilized so the lists can be reviewed and the sites/vessels readily selected to help lessen repeated sampling of the same body of shrimp, thus spatially broadening the sample base.

Shrimp are processed in the laboratory in order to generate sex - specific length frequency distributions, thus providing information on the size and age composition of the catch from different fishing grounds.

Results:

The shrimp season this year started on February 15, 2002 and ran through March 11, 2002 (last day of shrimping in the 2002 season). During the season 46 shrimp samples and corresponding captain interviews were obtained for 38 dragger trips (30 different draggers) and 8 trapper trips (7 different trappers) at 8 dealer locations from Portland, Maine to South Bristol, Maine (Appendix 1). Thirty-five samples were collected in February from 7 different dealer locations from Portland, ME to South Bristol, ME and 11 in March from 4 different dealer locations from Portland, ME to South Bristol, ME. The length of the boats sampled varied from 31' - 60'.

Draggers sampled in February had the highest average daily catch, 1,544.1 lbs/day, and highest average catch per unit of effort (CPUE), 209.5 lbs/hr drag time. The average daily catch and average CPUE per dragger in March was 660.4 lbs/day, 86.7 lbs/hr.

For the period February - March 2002, the average daily catch for the 38 draggers was 1,274.1 lbs with an average CPUE of 171.1 lbs/hr drag time. For the 8 trappers, the total catch was 6,400 lbs with an average catch of 5.9 lbs/trap and 2.18 lbs/trap/day.

Table 1 lists the 8 shrimp dealers where 46 shrimp samples were obtained from February 15 - March 11 with the total visits to each dealer, the number of samples obtained at each visit (the number of boats sampled) and the total number of samples obtained at each dealer.

Table 2 lists the following for each month from February, 2002 - March, 2002: 1) the number of dealers visited and their locations, 2) number of samples collected, 3) number of different draggers sampled, 4) number of different trappers sampled, 5) length range of the boats sampled, 6) number of fishing grounds that the samples came from 7) total catch in lbs for draggers, 8) total catch in lbs for trappers, 9) number of dragger boat days, 10) draggers average catch/day in lbs, 11) total hours drag time, 12) lbs/hr drag time, 13) total number of traps hauled, 14) total set over days, 15) average lbs/trap and 16) average lbs/trap/day. The table also includes totals for each of these indices.

Job #2

Job Title: Laboratory Analysis of Biological Samples

Objective:

Determine the size and age composition and other biological attributes of the commercial catch.

Annual Stock Assessment:

ASSESSMENT REPORT

FOR

GULF OF MAINE NORTHERN SHRIMP -- 2002

Prepared

October 30, 2002

by the

Atlantic States Marine Fisheries Commission's
Northern Shrimp Technical Committee

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INTRODUCTION

Biological Characteristics

Northern shrimp (*Pandalus borealis*) are hermaphroditic, maturing first as males at roughly 2½ years of age and then transforming to females at roughly 3½ years of age. In the Gulf of Maine, spawning takes place in offshore waters beginning in late July. By early fall, most adult females extrude their eggs onto the abdomen. Egg bearing females move inshore in late autumn and winter, where the eggs hatch. Juveniles remain in coastal waters for a year or more before migrating to deeper offshore waters, where they mature as males. The exact extent and location of these migrations is variable and unpredictable. The males pass through a series of transitional stages before maturing as females. Some females may survive to repeat the spawning process in succeeding years. The females are the individuals targeted in the Gulf of Maine fishery. Natural mortality seems to be most pronounced immediately following hatching, and it is believed that most shrimp do not live past age 5.

Fishery Management

The Gulf of Maine fishery for northern shrimp is managed through interstate agreement between the states of Maine, New Hampshire and Massachusetts. The management framework evolved between 1972-1979 under the auspices of the State/Federal Fisheries Management Program. In 1980, this program was restructured as the Interstate Fisheries Management Program (ISFMP) of the Atlantic States Marine Fisheries Commission (ASMFC). The Fishery Management Plan for Northern Shrimp was approved under the ISFMP in October 1986 (FMR No. 9., ASMFC) and northern shrimp continues to be managed under this plan today. Amendment #1 is currently under development to consider expanding the tools available to manage the fishery, anticipated for completion in late 2002 or early 2003. Within the ISFMP structure, the Northern Shrimp Technical Committee (NSTC) provides annual stock assessments and related information to the ASMFC Northern Shrimp Section. Annually, the Section decides on management regimes after thorough consideration of the NSTC stock assessment, the input from an industry advisory panel and comment from others within the shrimp fishing industry. Management under the 1986 FMP has been conducted primarily by seasonal closures and mesh size restrictions and is intended "to optimize yield, recognizing that natural fluctuations in abundance will occur" (FMP, p ii.).

Fishery Assessment

Stock assessments conducted in the 1980's and 1990's have keyed on strong year classes, (i.e. those hatched in 1982, 1987 and 1992). Each strong year class supports the shrimp fishery for about three years commencing about three years after hatching. The fishery was supported during the late 1980s and early and mid 1990s by the strong 1982, 1987 and 1992 year classes with other years depending on less robust year classes. The 1993 year class proved to be strong also, producing the first back-to-back strong year classes since the late 1960's. Based on the abundance of the 1992 and 1993 year classes, the NSTC recommended a full season for 1995-1996, but recommended reductions in fishing effort for December, April and May for the 1996-97 fishery to afford some protection for small shrimp in the offshore areas. The NSTC recommended limiting the fishery to February and March for the 1997-98 season and a 40-day season during the months of February and March in 1998-99 to protect the berried females and young shrimp in light of a rapidly declining resource. The NSTC recommended two options for the 1999-2000 fishing season: 1) closed season; 2) open February 14-March 18 or February 16-March 14 and May 7-31. Due to an increase in the exploitable biomass in the 2000-2001 season, the Committee recommended a modest increase in landings and a corresponding extension of the season to 61 days. In 2001, however, the low numbers of large shrimp, the lack of new recruits, and the presence of a single year class of medium sized shrimp led the committee to recommend that no fishing be conducted in the 2002 season.

At its fall 2001 meeting, the Northern Shrimp Section approved a 25 day season from February 15, 2002 to March 11, 2002, inclusive. In addition, the Section continued to require the use of a finfish excluder device known as the "Nordmore Grate" throughout the shrimp fishing season.

The following report presents the results of the Technical Committee's 2002 stock assessment. Analyses and recommendations are based on: 1) research vessel survey data collected by the Committee during summer and by the Northeast Fisheries Science Center (NEFSC) during spring and autumn, 2) commercial landings data collected by the National Marine Fisheries

Service (NMFS) port agents, 3) biological sampling of the commercial landings by personnel from the participating states and the NMFS, and 4) data from vessel trip reports filed by shrimp fishers. In addition to previously used traditional methods of assessing the stock (i.e. landings data, commercial effort and CPUE estimates, indices of abundance, etc.) more innovative, quantitative tools, such as the Collie-Sissenwine Analysis, ASPIC surplus production, yield per recruit, and eggs per recruit models were introduced in 1997 and continue to be used to provide guidance for management of the stock.

COMMERCIAL FISHERY TRENDS

Landings

Annual landings of Gulf of Maine northern shrimp declined from an average of 11,400 metric tons (mt) during 1969-1972 to about 400 mt in 1977, culminating in a closure of the fishery in 1978 (Table 1). The fishery reopened in 1979 and landings increased steadily to over 5,000 mt by 1987. Landings ranged from 2,300-4,400 mt between 1988-1994, and then rose dramatically to 9,200 mt in 1996, the highest since 1973. Landings declined between 1996 and 1999 to 1,816 mt. This was followed by a slight increase to 2,390 mt in the 2000 season. The 2001 fishing season landings dropped to 1,327 m, and dropped further in the 25-day 2002 season to 375 mt, the lowest northern shrimp landings since the fishery was closed in 1978.

Maine landed 86% (322 mt) of the 2002 season total while New Hampshire and Massachusetts landed 13% (47 mt) and 1.5% (6 mt), respectively. The proportional distribution of landings among the states was similar to 2001, but has shifted gradually since the 1980's when Massachusetts accounted for about 30% of the catch, (Table 1, Figure 1).

The relative proportion of landings by month remained similar to past years. The month of February yielded the highest proportion of the catch, while March exhibited the lowest (Table 2).

Most northern shrimp fishing in the Gulf of Maine is conducted by otter trawls, although traps are also employed off the central Maine coast. According to Vessel Trip Reports (VTRs), trappers accounted for about 8.2, 9.1, and 8.2% of the three states' landings in 2000, 2001, and 2002 respectively.

Size Composition of Landings

Size composition data (Figures 2-4), collected since the early 1980's, indicate that trends in landings have been determined primarily by recruitment of strong (dominant) year classes. Landings more than tripled with recruitment of a strong 1982 year class in 1985 and 1986. The 1987 season landings of 5,300 mt (Table 1) were supported in large part by mature females (assumed age 5) from this year class. Landings declined sharply in 1988 with the passage of this year class through the fishery. A strong 1987 year class began to recruit to the fishery in spring of 1989 and was a major contributor to the 1990-1992 fisheries (NSTC Assessment Reports, 1988-1993). The 1992 year class was the first year class of notable size since 1987 and began recruiting to the fishery in March and April 1995. The 1992 year class was supplemented by a moderate sized 1993 year class, which partially supported the relatively large annual landings in 1995, 1996 and 1997. The early months of the 1998 season showed high catches from the last of the 1993 year class coming ashore as second year females. Landings were low in the 1999

season due to very poor recruitment in 1994 and 1995, and moderate recruitment in 1996. The increase in landings observed in 2000 was dominated by first year berried females from the 1996 year class. The poor landings observed in 2001 were composed primarily of egg-bearing females landed early in the season, and males caught in January, March, and April, the males accounting for approximately 30% of the catch during these months and representing the 1999 year class. This catch profile is indicative of the low survival of the females from the 1996 year class and the poor recruitment of the 1997 and 1998 year classes, which entered the 2001 fishery as transitionals and first year berried females. In the 2002 fishery, the 1997 and 1998 yearclasses (4- and 5- year old females) continued to be weak, and the moderate 1999 yearclass (3-year old males, transitionals, and early-maturing females) dominated the catches. 2-year old shrimp (2000 yearclass) were generally absent, but a noticeable quantity of 1-year-old shrimp (2001 yearclass) were caught (Figures 2-4). The high incidence of the medium-sized, 3-year-old, 1999 year class in the 2002 catches resulted in relatively high counts per pound (45 to 64, see table below).

2002 commercial shrimp fishery counts per pound, from port samples

	<i>Pandalus borealis</i> only		All shrimp species	
	Feb.	Mar.	Feb.	Mar.
Maine	45	55	47	57
Massachusetts	54	64	54	63
New Hampshire	51	58	51	60

Effort and Distribution of Effort

Maine trapping operations accounted for 4% to 8% of the state's total number of trips from 1987 to 1994, and for 15.9, 16.9, and 18.0% in 2000, 2001, and 2002 respectively, according to 2000-2002 Vessel Trip Report (VTR) data.

Since the late 1970's, effort in the fishery (measured by numbers of trips in which shrimp gear is used) has increased and then declined on two occasions. The total number of trawl trips in the fishery peaked at 12,285 during the 1987 season (Table 3, Figure 5). Increases in season length, shrimp abundance and record ex-vessel prices coupled with reduced abundance of groundfish all contributed to this increase. Effort subsequently fell to an average of 9,500 trips for the 1988, 1989, and 1990 seasons, fell further to an average of 7,900 trips in the 1991 and 1992 seasons, and declined to 6,000 trips in the 1994 season. Effort nearly doubled between 1994 and 1996 and then declined again from the 1996 level of 11,791 to 3,811 trips in 1999, 3,335 in 2000, 3,527 in 2001, and 870 in 2002 (Table 3).

Approximately 310 vessels participated in the shrimp fishery in 1997, 260 in 1998, and about 238 in 1999. In 1999, the majority (181) were from Maine, while the number of vessels from New Hampshire ports remained at about 30, and the numbers from Massachusetts declined from 33 vessels in 1998 to 27 in 1999. In 2000 and 2001 there were 285 and 274 vessels participating, respectively. In 2002, there were 133 vessels from Maine, 6 from Massachusetts, and 21 from New Hampshire, for a total of 160 vessels that reported shrimp trips.

Prior to 1994, effort (numbers of trips by state and month) was estimated from landings data collected from dealers, and landings per trip information (LPUE) from dockside interviews of vessel captains:

$$Effort = \frac{Landings}{LPUE}$$

Beginning in the spring of 1994, a vessel trip reporting system (VTR) supplemented the collection of effort information from interviews. From 1995 to 2000, landings per trip (LPUE) from these logbooks were expanded to total landings from the dealer weighouts to estimate the

total trips:

$$Total.Trips = VTR.Trips \frac{Total.Landings}{VTR.Landings}$$

Since 2000, VTR landings have exceeded dealer weighout landings, and the above expansion is not necessary. However, VTRs for 2002 are still being received. The vessel logbook database is currently incomplete and has not been thoroughly audited (for an evaluation of vessel trip report data see NEFSC 1996). Therefore, landings and effort estimates reported here for recent years should be considered extremely preliminary. The 1996 assessment report (Schick et al. 1996) provides a comparison of 1995 shrimp catch and effort data from both the NEFSC interview and logbook systems and addresses the differences between the systems at that time. It showed a slightly larger estimate from the logbook system than from the interview system. Thus effort statistics reported through 1994 are not directly comparable to those collected after 1994. However, patterns in effort can be examined if the difference between the systems is taken into account. An additional complication of the logbook system is that one portion of the shrimp fishery may not be adequately represented by the logbook system during 1994-1999. Smaller vessels fishing exclusively in Maine coastal waters are not required to have federal groundfish permits and were not required to submit shrimp vessel trip reports until 2000. In the 1994-2000 assessments, effort from unpermitted vessels was characterized by catch per unit effort of permitted vessels.

Seasonal trends in distribution of effort can be evaluated from port interview data. The relative magnitude of offshore fishing effort (deeper than 55 fathoms) has varied, reflecting seasonal movements of mature females (inshore in early winter and offshore following larval hatching), but also reflecting harvesters' choices for fishing on concentrations of shrimp. As an example, the 1994 fishery stayed in deep water only through the beginning of January, shifted inshore through the middle of March and then moved into deeper water for the duration of the season. The 1995 fishing patterns revealed an early inshore migration in December and an early offshore migration with most fishing occurring offshore even during March. The 1999 season's effort was all offshore in December and almost all offshore in January. Effort moved inshore in February and remained primarily inshore throughout March. Effort in April and May was all offshore. This distribution of effort reflects the fact that the main body of shrimp available to the fleet was from the three-year-old 1996 year class, and they were split between transitionals that remained offshore and early maturing females that made some shoreward migration during the winter. During the 2000 season, effort was almost entirely inshore in January and February and increasingly offshore in March. In 2001, 17% of fishing was offshore in January, decreasing to 5% in February, increasingly offshore (78%) in March and entirely offshore in April, from Maine port interview data. In the 2002 season, 100% of fishing was inshore in February, and 20% was inshore in March, from Maine, New Hampshire, and Massachusetts port interview data.

Catch per Unit Effort

Catch per unit effort (CPUE) indices have been developed from NMFS interview data (1983-1994) and logbook data (1995-2002) and are measures of resource abundance and availability (Figure 5). They are typically measured in catch per hour or catch per trip. A trip is a less precise measure of effort, because trips from interviews and logbooks include both single day trips and multiple day trips (in the spring), and the proportion of such trips can vary from season to season.

Pounds landed per trip increased from 844 pounds in 1983 to over 1,300 pounds in 1985 when the strong 1982 year class entered the fishery. CPUE subsequently dropped to below 750 pounds/trip in 1988 but increased to 1,050 pounds in 1990 with entry of the strong 1987 year class. This index averaged 980 pounds between 1991-1992, declined to 767 pounds in 1993, and increased in 1994 to 1,073 pounds. The 1995, 1996 and 1997 CPUEs, from logbooks, rose sharply to 1,362 pounds in 1995, rose again to 1,714 in 1996 and declined to 1,454 in 1997. The CPUEs for 1996 and 1997 were the highest since the early 1970's. The 1998 CPUE was 1,317, showing a continued high level compared to earlier years and the 1999 CPUE dropped to 1,067 pounds per trip, which is still considerably higher than in previous years with poor recruitment. The 2000 CPUE increased to 1,444 pounds per trip. In 2001, the catch per trip dropped to 756 pounds per trip, the lowest since 1993. In 2002, the catch per trip was 872 pounds.

More precise CPUE indices (pounds landed per hour fished) have also been developed for both inshore (depth less than 55 fathoms) and offshore (depth more than 55 fathoms) areas using information collected by Maine's and New Hampshire's port sampling programs, and agree well with the (less precise) catch per trip data from logbooks (see text table below and Figure 5). Inshore CPUE for 2002 was 223 lbs/hr, offshore was 91, and the season average was 194 lbs/hr.

ME/NH CPUE in lbs./hour towed, from port sampling. Catch in lbs./trip is from NMFS weighout and logbook data.

<u>Year</u>	<u>Inshore (<55F)</u>	<u>Offshore (>55F)</u>	<u>Total</u>	<u>Catch/trip</u>
1991	94	152	140	988
1992	132	93	117	974
1993	82	129	92	767
1994	139	149	141	1,073
1995	172	205	193	1,362
1996	340	203	251	1,714
1997	206	192	194	1,454
1998	158	151	154	1,317
1999	159	146	152	1,067
2000	288	337	292	1,444
2001	100	135	109	756
2002	223	91	194	872

RESOURCE CONDITIONS

Trends in abundance have been monitored since the late 1960's from data collected in Northeast Fisheries Science Center (NEFSC) spring and autumn bottom trawl surveys and in summer surveys by the State of Maine (discontinued in 1983). The state-federal shrimp survey was initiated by the NSTC in 1984. The latter survey is conducted each summer aboard the R/V GLORIA MICHELLE employing a stratified random sampling design and gear specifically designed for Gulf of Maine conditions. Strata sampled, and catch per tow data for the 2002 summer survey cruise are plotted in Figure 6a. The NSTC has placed primary dependence on the summer survey for fishery-independent data used in stock assessments, although NEFSC spring and autumn survey data have been valuable as well.

There has generally been good agreement between the NEFSC autumn survey index (stratified mean catch per tow, kg) and fishery trends (Figure 7). The index declined precipitously as the fishery collapsed during the 1970s; this was followed by a substantial increase in the middle 1980's to early 1990's, with peaks in 1986, 1990 and 1994. This reflects recruitment and growth of the strong 1982, 1987 and 1992 year classes and the above average 1993 year class. After declining to 1.1 kg per tow in 1996, the index rose sharply in 1998 and 1999 to 2.30 and 2.54 kg per tow respectively, both well above the time series mean of 1.58 kg per tow. This is likely due to recruitment of the 1996 year class to the survey gear at age 2 in 1998 and age 3 in 1999. With the passage of the 1996 year class, and subsequent poor year classes, the 2000 fall survey index declined to 1.44 kg per tow. This trend continued in 2001, with the index dropping to 0.64 kg per tow, indicating very weak 1997 and 1998 year classes.

Abundance and biomass indices (stratified mean catch per tow in numbers and weight) for the state-federal summer survey from 1984-2002 are given in Table 4, and length-frequencies by cruise are provided in Figure 9. The $\log_e$ transformed mean weight per tow averaged 15.8 kg/tow between 1984 and 1990. Beginning in 1991 this index began to decline and averaged 10.2 kg/tow between 1991 and 1996. The index then declined further, averaging 6.1 kg/tow from 1997 to 2001, and reaching a time series low of 4.3 kg/tow in 2001. In 2002 the index increased markedly to 9.2 kg/tow, still below the time series average (11.1). The total mean number per tow demonstrated the same general trends over the time series.

The stratified mean catch per tow in numbers of 1.5-year old shrimp (Table 4, Figure 8, and graphically represented as the total number in the first size modes in Figure 9) represents a recruitment index. Although these shrimp are not fully recruited to the survey gear, this index appears sufficient as a preliminary estimate of year class strength. This survey index indicated strong year classes in 1987, 1992, and 2001, and moderately strong year classes in 1990, 1993, 1996, and 1999. The strong 1992 year class observed at (assumed) age 1.5 in the 1993 summer survey (Figure 9) was smaller than the dominant 1982 and 1987 year classes, but was followed by the above-average 1993 year class. These two year classes supported the fishery in 1996-1997. The 1996 year class appeared comparable to the moderately strong 1993 year class (Table 4, Figures 8 and 9). Recruitment between 1996 and 1999 was poor, with the 1997 and 1998 year classes being among the weakest in the time series (Figure 9). The above-average 1999 year class, is comparable to the 1996 year class. The age 1.5 recruitment index was at a time series low in 2001 (2000 year class), with a stratified mean of 36 individuals per tow on the

transformed scale. This reflects the poorest recruitment index observed in the 19-year history of the survey. The 2002 age 1.5 recruitment index was 1,059, which is a time series high and represents an extremely strong 2001 year class. It is also interesting to note that, in the 2002 summer survey, more small females (< 19 mm CL, assumed 1.5 years old) were caught than at any other time in the history of the survey (Figure 9).

The relative strengths of the 1998, 1999, and 2000 year classes described above as age 1.5 recruits have been confirmed by subsequent summer surveys, that is, the assumed 1998 year class has been weak in all four surveys in which it could have been detected (1999-2002), 1999 continued to appear as a moderate year class in 2001 and 2002 surveys, and the 2000 year class was again virtually absent in 2002.

Individuals >22 mm will be fully recruited to the upcoming winter fishery (primarily age 3 and older) and thus survey catches of shrimp in this size category provide indices of harvestable numbers and biomass for the coming season. (Table 4, Figure 8). The harvestable biomass index exhibited large peaks in 1985 and 1990, reflecting the very strong 1982 and 1987 year classes respectively. This index has varied from year to year but generally trended down since 1990, and has remained below the time series mean of 5.2 kg/tow (transformed) since 1995. The 2001 index of 1.5 kg/tow represented a time series low, indicative of poor 1997 and 1998 year classes. In 2002 the index increased slightly to 2.9 kg/tow, reflecting recruitment of the moderate 1999 year class to the index. Despite the increase in 2002, the index is still well below the time series mean and reflects an overall poor spawning stock biomass.

ANALYTICAL STOCK ASSESSMENT

Descriptive information for the Gulf of Maine shrimp fishery (total catch, port sampling, trawl selectivity, survey catches, and life history studies) were modeled to estimate fishing mortality, stock abundance, and candidate target fishing levels. The analytical stock assessment comprises three fishery models: the Collie-Sissenwine Analysis (CSA) (Collie and Sissenwine 1983; Collie and Kruse 1998) tracks the removals of shrimp using summer survey indices of recruits and fully-recruited shrimp scaled to total catch in numbers; surplus production analysis models the biomass dynamics of the stock with a longer time series of total landings and three survey indices of stock biomass; a yield-per-recruit and eggs-per-recruit model simulates the life history of shrimp (including growth rates, transition rates, natural mortality, and fecundity) and fishing mortality on recruited shrimp using estimates of trawl selectivity to estimate yield and egg production at various levels of fishing mortality, for guidance in determining the levels of fishing that are most productive and sustainable.

CSA (called "modified DeLury" in previous assessments) results are summarized in Table 5 and Figures 10 and 11. Abundance and catchability were relatively well-estimated, and the model fit the data well. Estimates of recruitment to the fishery averaged 0.8 billion individuals, peaked at 1.3 billion before the 1990 fishing season, but declined steadily to less than 0.4 billion before the 2002 fishing season. The current estimate indicates a sharp rise up to 1 billion prior to the next scheduled fishing year (2003). Fully-recruited abundance averaged 1.0 billion individuals and peaked at 1.5 billion before the 1991 season. Fully-recruited abundance decreased to a time series low of less than 0.4 billion in 1999 and increased to 0.6 billion in the current year. Total

stock biomass estimates averaged about 13,200 mt, with a peak at over 22,000 mt before the 1991 season, and a decrease to a time series low of 5,700 mt in 1999. Total stock biomass has increased over the last three years to its current value of 9,200 mt (Table 5, Figures 10, 11).

Annual estimates of fishing mortality (F) averaged 0.34 (26% exploitation) for the 1985 to 1995 fishing seasons, peaked at 0.87 (52% exploitation) in the 1997 season and decreased to 0.28 (22% exploitation) in the 2000 season (Table 5; Figures 10, 11). In 2001, F rose to 0.40 (29% exploitation). In the most recent fishing year (2002) the short season and poor stock condition (in terms of exploitable shrimp) along with an exceptional recruitment pulse resulted in F estimates of essentially 0.0. The three year (2000 - 2002) average is 0.22 (18% exploitation). The recent pattern in F reflects the pattern in nominal fishing effort (Figure 5). Precision of CSA estimates was assessed by "bootstrap" analysis, in which survey measurement errors were randomly shuffled 2000 times to provide simulated replications of the model. Bootstrap results suggest that estimates of abundance, biomass and mortality were relatively precise.

An alternative method of estimating stock size and F was used to corroborate results from CSA analysis. A surplus production model was fit to seasonal catch and survey biomass indices from 1968 to 2002 (summarized in Table 6). Estimates of F from the biomass dynamics model generally confirm the pattern of estimates from the CSA model (Figures 12 & 13). F in 2002 ($F = 0.03$) was the lowest observed since the fishery was completely closed in 1978 ($F = 0.00$). This is explained by the very limited 2002 fishery. The 2002 starting biomass was at its highest level since 1997, but still remains well below highs observed in the mid 1980's through early 1990's.

Yield per recruit and percent maximum spawning potential were estimated for the Gulf of Maine northern shrimp fishery (Figure 14). Yield per recruit was maximum at $F=0.77$ (F_{max}) (48% exploitation) (Table 7). The increase in yield per unit F decreased to one tenth the initial increase at $F=0.46$ ($F_{0.1}$) (33% exploitation). Maximum spawning potential (i.e., with no F) was 2,395 eggs per recruit. Spawning potential was reduced by half at $F=0.25$ ($F_{50\%}$, 20% exploitation).

As concluded by the Stock Assessment Review Committee (SARC) in 1997, the stock was not replacing itself when spawning potential was reduced to less than 20% of maximum, and the stock collapsed when egg production was reduced further. Reproductive success for Gulf of Maine northern shrimp may be a function of population fecundity and spring seawater temperature (Figure 15). Therefore, $F_{20\%}$ may be an appropriate overfishing threshold, which would result in target Fs well below 0.6. A sustainable target F may be the average F from 1985 to 1995, which was 0.34 (which allows 40% egg production per recruit) (Figure 13).

SUMMARY

Landings in the Gulf of Maine northern shrimp fishery have declined since the mid 1990's, from a high for the decade of 9,166 mt in 1996 to 375 mt in 2002, the result of low abundance of shrimp and reductions in fishing effort. The number of fishing vessels and trawl trips have dropped from about 310 and 10,734 respectively in 1997 to 160 and 870 in 2002, although vessel reporting, particularly from the Maine small boat fleet, has probably improved. Fishing

mortality rates, as calculated by CSA, have declined from 0.87 in 1997 to 0 in 2002. Although generally declining, in 5 of the past 7 fishing seasons F has been above the target of 0.34 recommended by the 1997 Stock Assessment Review Committee.

Current landings, vessels, and trips are calculated from vessel trip reports (VTRs). Note that 2001 landings were incomplete when calculated from VTRs in October of 2001 (Tables 1-2, 2001 assessment), and went up by 18% when recalculated in September 2002 (Tables 1-2 here). Thus it must be assumed that 2002 vessel trip reports are also incomplete at this time. However, it is safe to say that the 2002 fishery was short, mostly inshore, with limited participation, and with relatively good catches per trip and per hour, but with high occurrences of small shrimp (assumed 3-year-old, 1999 year class).

Exploitable biomass as estimated from CSA declined from 15,500 mt in 1995 to a time series low of 5,700 in 1999. Since then the biomass estimate has risen to 9,200 mt in 2002, as a result of the appearance of the moderate 1999 year class and the strong 2001 year class. This estimate is still well below the time-series average of 13,000 mt, and below the average of the relatively stable 1985-1995 period of 17,000 mt (Table 5). The estimate of spawning stock biomass (Figure 15, arrow labeled "03") is also still well below the time-series mean.

Size composition data from both the fishery and summer surveys indicate that good landings have followed the recruitment of strong (dominant) year classes. Poor landings since 1997, as well as low biomass estimates, can be attributed in part to the below-average recruitment of the 1994, 1995, 1997, and 1998 year classes.

In 2003, the 1997 year class will have passed out of the fishery, and the very weak 1998 year class (assumed 5-year old females), moderate 1999 year class (assumed 4-year-old females), virtually absent 2000 year class (assumed 3-year-old males, transitionals, and early-maturing females), very strong 2001 year class (assumed 2-year-old males, transitionals, and early-maturing females), and unknown 2002 year class (juveniles) will remain.

RECOMMENDATIONS

The Northern Shrimp Technical Committee recommends that the Section allow no 2003 fishing season which threatens the reproductive capacity of the 1999 yearclass or which allows significant catches of the 2001 year class. The Committee bases its recommendation to the Section on its assessment of current stock status, the biology of the species, and the opportunity for improving resource conditions.

Figure 13 suggests that several years of low fishing mortality will be required to rebuild the stock to time-series norms. The NSTC is encouraged by the advent of the very strong 2001 year class, but continues to be concerned about future recruitment, considering that there has been recruitment failure in 2 of the last 4 years. Because of the failure of the 1998 and 2000 year classes, the 1999 year class, as assumed 4-year-old females of moderate abundance this coming winter, represents the only significant source of egg production for the next two years (2003 and 2004). The possible lack of mature males during the 2003 summer spawning season (because of the missing 2000 year class) is also cause for concern. In 2005 the 5-year-old female year class

(2000) will again be absent. For these reasons, the protection of the 1999 year class is of vital importance.

The strong 2001 year class represents a welcome opportunity to rebuild the stock, and the NSTC emphasizes the importance of protecting these small shrimp. In the 1989 fishery, when the strong 1987 year class was also two years old, that year class dominated catches (Figure 4), especially in April and May (1989 assessment). Because of an unusually high number of early-maturing females in the 2001 year class, it is possible that some of these 2-year-old shrimp will also migrate inshore, making small shrimp even more difficult to avoid. A 2003 fishery can anticipate large catches but the sizes of individual shrimp is expected to be bimodal, that is, catches are likely to be comprised of both 4-year-old and 2-year-old shrimp, possibly even inshore.

Yield-per-recruit and egg-per-recruit analyses (Table 7) show that shrimp reach both their potential weight yield and maximum egg production at about ages 4-5. Therefore, protecting small shrimp is recommended for both economical and biological reasons. Although current shrimp trawl gear can be expected to retain only 23% of two-year-old shrimp encountered (Table 7), this year class is so much more numerous than any others present that catches of it will be significant if allowed. Catches of 2-year-old males can be expected to be above 100 count per pound (Table 7). Large catches of small shrimp will result in relatively high fishing mortality rates, which will threaten reproduction in 2003, 2004, and 2005.

If a fishery in 2003 must be conducted, the committee recommends another conservative season similar to the 2002 season (25 days), constructed to maximize the successful reproduction of the female 1999 yearclass, and to protect the immature 2001 year class until it reaches both economic and reproductive usefulness. Any fishing pressure on the 1999 year class, the only significant source of egg production for the next two years, should be extremely light and should occur only after their eggs have hatched. Notice that in 2002, over 50% of the shrimp landed in Maine in February were still carrying eggs (Figure 2). The NSTC also recommends that there be no offshore fishery (early or spring) in 2003 to protect the 2001 year class, and that other measures to protect small shrimp be considered.

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Table 1. Commercial landings (mt) of northern shrimp in the western Gulf of Maine, 1958-2002.

Year	Maine		Massachusetts		New Hampshire		Total		\$/Lb
1958	2.3		0.0		0.0		2.3		0.32
1959	5.4		2.3		0.0		7.7		0.29
1960	40.4		0.5		0.0		40.9		0.23
1961	30.4		0.5		0.0		30.9		0.20
1962	159.7		16.3		0.0		176.0		0.15
1963	244.0		10.4		0.0		254.4		0.12
1964	419.4		3.1		0.0		422.5		0.12
1965	947.0		8.0		0.0		955.0		0.12
1966	1,737.8		10.5		18.1		1,766.4		0.14
1967	3,141.1		10.0		20.0		3,171.1		0.12
1968	6,515.0		51.9		43.1		6,610.0		0.11
1969	10,992.9		1,772.9		58.1		12,823.9		0.12
1970	7,712.8		2,902.1		54.4		10,669.3		0.20
1971	8,354.7		2,723.8		50.8		11,129.3		0.19
1972	7,515.6		3,504.5		74.8		11,094.9		0.19
1973	5,476.7		3,868.2		59.9		9,404.8		0.27
1974	4,430.7		3,477.3		36.7		7,944.7		0.32
1975	3,177.0		2,080.2		29.5		5,286.7		0.26
1976	617.2		397.8		7.3		1,022.3		0.34
1977	148.0		236.9		2.3		387.2		0.55
1978	0.0		0.0		0.0		0.0		0.24
1979	32.9		451.3		2.3		486.5		0.33
1980	71.4		260.3		7.4		339.1		0.65
1981	528.6		538.1		4.5		1,071.2		0.64
1982	883.2	*(853.3)	658.5	*(655.3)	32.8	*(21.6)	1,574.5	*(1,530.2)	0.60
1983	1,022.0	(892.5)	508.0	(458.4)	36.5	(46.2)	1,566.5	(1,397.1)	0.67
1984	2,564.7	(2,394.9)	565.3	(525.1)	96.8	(30.7)	3,226.8	(2,950.7)	0.49
1985	2,956.9	(2,946.4)	1,030.6	(968.0)	207.4	(216.5)	4,194.9	(4,130.9)	0.44
1986	3,407.3	(3,268.2)	1,085.6	(1,136.3)	191.1	(230.5)	4,684.0	(4,635.0)	0.63
1987	3,534.2	(3,673.2)	1,338.7	(1,422.2)	152.5	(157.8)	5,025.4	(5,253.2)	1.10
1988	2,272.4	(2,257.2)	631.5	(619.6)	173.1	(154.5)	3,077.0	(3,031.3)	1.10
1989	2,542.6	(2,384.0)	749.6	(699.9)	314.3	(231.5)	3,606.5	(3,315.4)	0.98
1990	2,961.5	(3,236.1)	993.2	(974.3)	447.3	(451.2)	4,402.0	(4,661.6)	0.72
1991	2,431.1	(2,488.1)	727.6	(801.1)	208.2	(282.2)	3,366.9	(3,571.4)	0.93
1992	2,973.9	(3,054.1)	291.6	(289.1)	100.1	(100.0)	3,365.6	(3,443.6)	0.99
1993	1,562.8	(1,492.2)	300.3	(292.8)	441.1	(357.4)	2,304.7	(2,142.9)	1.03
1994	2,815.5	(2,239.3)	374.4	(247.5)	520.9	(428.0)	3,710.8	(2,914.8)	0.79
1995		(5,022.7)		(678.8)		(764.9)		(6,466.4)	0.88
1996		(7,737.0)		(658.0)		(771.0)		(9,166.1)	0.72
1997		(6,050.0)		(362.8)		(666.3)		(7,079.1)	0.82
1998		(3482.0)		(247.2)		(445.2)		(4,174.4)	0.94
1999		(1523.4)		(75.7)		(217.0)		(1,816.1)	0.93
2000		(2067.3)		(109.9)		(212.3)		(2,389.5)	0.79
2001		** (1071.8)		** (49.1)		** (205.8)		** (1326.7)	0.90
2002		** (322.1)		** (5.8)		** (47.2)		** (375.0)	

*Numbers in parentheses are computed on a seasonal basis.

**Preliminary.

Table 2. Distribution of landings (metric tons) in the Gulf of Maine northern shrimp fishery by state and month, 1986-2002.

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total		Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1986 Season, 203 days, Dec 1 - May 31, extended to June 21									1995 Season, 128 days, Dec 1 - Apr 30, 1 day per week off								
Maine	346.9	747.8	1,405.3	415.4	104.2	149.2	99.4	3,268.2	Maine	747.6	1,397.7	1,338.2	912.0	627.2			5,022.7
Mass.	154.3	213.4	221.2	200.7	111.2	84.8	150.7	1,136.3	Mass.	210.7	154.0	104.1	111.0	99.0			678.8
N.H.	57.7	75.9	70.8	14.2	1.3	0.0	10.6	230.5	N.H.	160.6	186.8	118.3	158.5	140.7			764.9
Total	558.9	1,037.1	1,697.3	630.3	216.7	234.0	260.7	4,635.0	Total	1,118.9	1,738.5	1,560.6	1,181.5	866.9			6,466.4
1987 Season, 182 days, Dec 1 - May 31									1996 Season, 152 days, Dec 1 - May 31, 1 day per week off								
Maine	485.9	906.2	1,192.7	672.9	287.6	127.9	7.0	3,680.2	Maine	1,124.1	1,678.3	3,004.6	785.2	350.4	794.5		7,737.1
Mass.	103.5	260.0	384.9	310.2	180.8	182.8	5.7	1,427.9	Mass.	167.9	106.7	188.7	67.8	66.5	60.3		657.9
N.H.	18.4	53.6	62.8	15.7	7.3	0.0	0.1	157.9	N.H.	189.8	169.5	234.0	81.9	78.8	17.1		771.1
Total	607.8	1,219.8	1,640.4	998.8	475.7	310.7	12.8	5,266.0	Total	1,481.8	1,954.5	3,427.3	934.9	495.7	871.9		9,166.1
1988 Season, 183 days, Dec 1 - May 31									1997 Season, 156 days, Dec 1 - May 27, two 5-day and four 4-day blocks off								
Maine	339.7	793.9	788.1	243.6	24.6	67.3	1.2	2,258.4	Maine	1,178.5	1,114.9	1,713.1	758.4	754.8	530.3		6,050.0
Mass.	14.4	225.8	255.0	104.9	8.6	10.9	0.0	619.6	Mass.	90.2	110.4	111.4	49.0	1.2	0.5		362.7
N.H.	13.0	72.6	53.7	14.9	0.3	0.0	3.1	157.6	N.H.	185.6	104.1	140.1	108.6	85.8	42.2		666.4
Total	367.1	1,092.3	1,096.8	363.4	33.5	78.2	4.3	3,035.6	Total	1,454.3	1,329.4	1,964.6	916.0	841.8	573.0		7,079.1
1989 Season, 182 days, Dec 1 - May 31									1998 Season, 105 days, Dec 8-May 22, weekends off except Mar 14-15, Dec 25-31 and Mar 16-31 off.								
Maine	353.6	770.5	700.6	246.4	218.7	94.2		2,384.0	Maine	511.1	926.8	1,211.1	401.7	228.7	202.6		3,482.0
Mass.	26.2	197.5	154.9	104.8	160.9	55.6		699.9	Mass.	49.1	78.0	90.5	14.3	15.3	0.0		247.2
N.H.	28.5	106.9	77.0	15.4	3.7	0.0		231.5	N.H.	89.4	106.9	143.5	54.3	49.0	2.1		445.2
Total	408.3	1,074.9	932.5	366.6	383.3	149.8		3,315.4	Total	649.6	1,111.7	1,445.1	470.3	293.0	204.7		4,174.4
1990 Season, 182 days, Dec 1 - May 31									1999 Season, 90 days, Dec 15 - May 25, weekends, Dec 24 - Jan 3, Jan 27-31, Feb 24-28, Mar 16-31, and Apr 29 - May 2 off.								
Maine	512.4	778.2	509.7	638.5	514.0	282.8	0.1	3,235.7	Maine	79.9	192.7	590.8	240.6	204.5	214.9		1,523.4
Mass.	75.6	344.4	184.8	100.2	158.9	110.0	4.3	978.2	Mass.	25.0	23.8	16.0	2.5	8.4			75.7
N.H.	111.3	191.7	116.1	30.7	1.4			451.2	N.H.	46.5	63.2	52.2	10.0	36.5	8.6		217.0
Total	699.3	1,314.3	810.6	769.4	674.3	392.8	4.4	4,665.1	Total	151.4	279.7	659.0	253.1	249.4	223.5		1,816.1
1991 Season, 182 days, Dec 1 - May 31									2000 Season, 51 days, Jan 17 - Mar 15, Sundays off								
Maine	238.2	509.1	884.0	454.9	251.7	148.2	2.0	2,488.1	Maine	607.4	1,271.4	188.5					2,067.3
Mass.	90.5	174.7	175.9	131.2	93.3	133.8	1.6	801.0	Mass.	17.4	78.7	13.8					109.9
N.H.	107.3	104.4	33.8	27.8	7.8	1.0		282.1	N.H.	39.6	131.1	41.6					212.3
Total	436.0	788.2	1,093.7	613.9	352.8	283.0	3.6	3,571.2	Total	664.4	1,481.2	243.9					2,389.5
1992 Season, 153 days, Dec 15 - May 15									*2001 Season, 83 days, Jan 9 - Apr 30, Mar 18 - Apr 16 off, experimental offshore fishery in May								
Maine	181.1	880.9	1,278.9	462.5	163.6	87.2		3,054.2	Maine	573.0	436.1	35.9	26.5	0.3			1,071.8
Mass.	17.1	148.2	73.3	47.5	2.9		0.1	289.1	Mass.	38.5	8.8	1.9	0.0	0			49.1
N.H.	33.4	47.0	11.9	6.8	1.0			100.1	N.H.	127.4	37.2	12.1	29.0	0			205.8
Total	231.6	1,076.1	1,364.1	516.8	167.5	87.2	0.4	3,443.7	Total	738.9	482.2	49.8	55.5	0.3			1,326.7
1993 Season, 138 days, Dec 14 - April 30									*2002 Season, 25 days, Feb 15 - Mar 11								
Maine	100.9	369.0	597.0	297.5	127.8			1,492.2	Maine			253.6	68.5				322.1
Mass.	19.6	82.0	81.9	62.3	42.0	5.0		292.8	Mass.			3.7	2.1				5.8
N.H.	33.5	85.4	101.7	77.0	59.8			357.4	N.H.			35.6	11.6				47.2
Total	154.0	536.4	780.6	436.8	229.6	5.0	0.4	2,142.8	Total			292.8	82.2				375.0
1994 Season, 122 days, Dec 15 - Apr 15									* Preliminary data								
Maine	171.5	647.7	971.9	399.5	48.7			2,239.3									
Mass.	27.1	68.0	100.8	38.8	12.8			247.5									
N.H.	117.2	124.3	128.7	49.6	8.2			428.0									
Total	315.8	840.0	1,201.4	487.9	69.7			2,914.8									

Table 3. Distribution of fishing effort (number of trawl trips) in the Gulf of Maine northern shrimp fishery by state and month, 1986-2002.

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total		Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1986 Season, 203 days, Dec 1 - May 31, extended to June 21									1995 Season, 128 days, Dec 1 - Apr 30, 1 day per week off								
Maine	590.0	1,309.0	2,798.0	831.0	224.0	133.0	68.0	5,953.0	Maine	879.0	2,341.0	2,641.0	1,337.0	694.0			7,892.0
Mass.	128.0	235.0	225.0	320.0	194.0	133.0	159.0	1,394.0	Mass.	145.0	385.0	275.0	157.0	109.0			1,071.0
N.H.	156.0	163.0	165.0	51.0	3.0		17.0	555.0	N.H.	189.0	331.0	279.0	359.0	344.0			1,502.0
Total	874.0	1,707.0	3,188.0	1,202.0	421.0	266.0	244.0	7,902.0	Total	1,213.0	3,057.0	3,195.0	1,853.0	1,147.0			10,465.0
1987 Season, 182 days, Dec 1 - May 31									1996 Season, 152 days, Dec 1 - May 31, 1 day per week off								
Maine	993.0	2,373.0	3,073.0	2,241.0	617.0	340.0	16.0	9,653.0	Maine	1,341.0	2,030.0	3,190.0	1,461.0	444.0	457.0		8,923.0
Mass.	325.0	354.0	414.0	426.0	283.0	317.0	164.0	2,283.0	Mass.	299.0	248.0	325.0	269.0	106.0	126.0		1,373.0
N.H.	67.0	164.0	175.0	95.0	28.0		32.0	561.0	N.H.	331.0	311.0	389.0	248.0	155.0	61.0		1,495.0
Total	1,385.0	2,891.0	3,662.0	2,762.0	928.0	657.0		12,285.0	Total	1,971.0	2,589.0	3,904.0	1,978.0	705.0	644.0		11,791.0
1988 Season, 183 days, Dec 1 - May 31									1997 Season, 156 days, Dec 1 - May 27, two 5-day and four 4-day blocks off								
Maine	972.0	2,183.0	2,720.0	1,231.0	193.0	122.0		7,421.0	Maine	1,674.0	1,753.0	2,737.0	1,178.0	793.0	530.0		8,665.0
Mass.	28.0	326.0	426.0	315.0	26.0	57.0		1,178.0	Mass.	184.0	226.0	245.0	114.0	7.0	1.0		777.0
N.H.	72.0	231.0	236.0	99.0	3.0			641.0	N.H.	277.0	245.0	301.0	218.0	189.0	62.0		1,292.0
Total	1,072.0	2,740.0	3,382.0	1,645.0	222.0	179.0		9,240.0	Total	2,135.0	2,224.0	3,283.0	1,510.0	989.0	593.0		10,734.0
1989 Season, 182 days, Dec 1 - May 31									1998 Season, 105 days, Dec 8-May 22, weekends off except Mar 14-15, Dec 25-31 and Mar 16-31 off.								
Maine	958.0	2,479.0	2,332.0	936.0	249.0	84.0		7,038.0	Maine	852.0	1,548.0	1,653.0	725.0	346.0	189.0		5,313.0
Mass.	103.0	479.0	402.0	254.0	297.0	102.0		1,637.0	Mass.	94.0	200.0	148.0	70.0	3.0	1.0		515.0
N.H.	120.0	369.0	312.0	69.0	16.0			886.0	N.H.	141.0	216.0	182.0	134.0	83.0	22.0		778.0
Total	1,181.0	3,327.0	3,046.0	1,259.0	562.0	186.0		9,561.0	Total	1,086.0	1,964.0	1,983.0	929.0	432.0	212.0		6,606.0
1990 Season, 182 days, Dec 1 - May 31									1999 Season, 90 days, Dec 15 - May 25, weekends, Dec 24 - Jan 3, Jan 27-31, Feb 24-28, Mar 16-31, and Apr 29 - May 2 off.								
Maine	1,036.0	1,710.0	1,529.0	1,986.0	897.0	238.0		7,396.0	Maine	190.0	556.0	1,125.0	553.0	324.0	172.0		2,920.0
Mass.	147.0	459.0	273.0	202.0	175.0	118.0		1,374.0	Mass.	39.0	57.0	71.0	9.0	40.0			216.0
N.H.	178.0	363.0	284.0	157.0	6.0			988.0	N.H.	82.0	192.0	213.0	44.0	123.0	21.0		675.0
Total	1,361.0	2,532.0	2,086.0	2,345.0	1,078.0	356.0		9,758.0	Total	311.0	805.0	1,409.0	606.0	487.0	193.0		3,811.0
1991 Season, 182 days, Dec 1 - May 31									2000 Season, 51 days, Jan 17 - Mar 15, Sundays off								
Maine	568.0	1,286.0	2,070.0	1,050.0	438.0	139.0		5,551.0	Maine		653.0	1,838.0	401.0				2,892.0
Mass.	264.0	416.0	401.0	231.0	154.0	147.0		1,613.0	Mass.		23.0	100.0	27.0				150.0
N.H.	279.0	285.0	135.0	82.0	22.0	1.0		804.0	N.H.		36.0	179.0	78.0				293.0
Total	1,111.0	1,987.0	2,606.0	1,363.0	614.0	287.0		7,968.0	Total		712.0	2,117.0	506.0				3,335.0
1992 Season, 153 days, Dec 15 - May 15									*2001 Season, 83 days, Jan 9 - Apr 30, Mar 18 - Apr 16 off, experimental offshore fishery in May								
Maine	411.0	1,966.0	2,700.0	1,222.0	318.0	141.0		6,758.0	Maine		1491.0	1209.0	112.0	39.0	6.0		2,857.0
Mass.	59.0	337.0	145.0	101.0	41.0			683.0	Mass.		111.0	46.0	10.0	1.0			168.0
N.H.	96.0	153.0	76.0	29.0	3.0			357.0	N.H.		302.0	142.0	27.0	31.0			502.0
Total	566.0	2,456.0	2,921.0	1,352.0	362.0	141.0		7,798.0	Total		1904.0	1397.0	149.0	71.0	6.0		3,527.0
1993 Season, 138 days, Dec 14 - April 30									*2002 Season, 25 days, Feb 15 - Mar 11								
Maine	249.0	1,102.0	1,777.0	1,032.0	227.0			4,387.0	Maine			502.0	195.0				697.0
Mass.	60.0	200.0	250.0	185.0	72.0			767.0	Mass.			13.0	8.0				21.0
N.H.	76.0	246.0	275.0	256.0	151.0			1,004.0	N.H.			108.0	44.0				152.0
Total	385.0	1,548.0	2,302.0	1,473.0	450.0			6,158.0	Total			623.0	247.0				870.0
1994 Season, 122 days, Dec 15 - Apr 15									* Preliminary data								
Maine	265.0	1,340.0	1,889.0	1,065.0	122.0			4,681.0									
Mass.	58.0	152.0	147.0	83.0	15.0			455.0									
N.H.	169.0	228.0	266.0	173.0	18.0			854.0									
Total	492.0	1,720.0	2,302.0	1,321.0	155.0			5,990.0									

Table 4. Stratified mean numbers and weights, per tow,* of northern shrimp collected during R/V Gloria Michelle summer surveys 1984-2002.

Untransformed					
	Total	Age-1.5	>22 mm**	Weight	Weight**
<u>Year</u>	<u>Number</u>	<u>Number</u>	<u>Number</u>	<u>(kg)</u>	<u>>22 mm (kg)</u>
1984	3,005	48	826	22.6	8.9
1985	3,531	643	2,262	29.4	22.3
1986	3,327	703	1,688	29.7	19.6
1987	2,441	545	1,360	21.0	15.2
1988	4,310	2,812	1,012	26.6	11.7
1989	3,580	525	1,072	27.3	11.5
1990	3,021	264	2,097	29.4	22.2
1991	1,992	765	1,042	18.2	12.6
1992	1,503	443	625	12.9	7.6
1993	3,569	2,334	772	17.9	8.5
1994	3,435	1,285	849	21.1	9.3
1995	2,856	576	1,238	21.1	13.8
1996	2,651	793	1,223	20.2	13.8
1997	3,161	1,551	1,017	19.8	11.6
1998	2,319	533	676	15.1	7.4
1999	1,648	471	719	11.9	7.8
2000	1,843	997	647	11.9	7.2
2001	870	69	281	6.5	2.9
2002	3,157	2,313	571	15.0	6.3

Log _e Transformed					
	Total	Age-1.5	>22 mm**	Weight	Weight**
<u>Year</u>	<u>Number</u>	<u>Number</u>	<u>Number</u>	<u>(kg)</u>	<u>>22 mm (kg)</u>
1984	1,152	18	316	10.5	3.4
1985	1,849	337	1,184	17.7	11.7
1986	1,695	358	860	19.6	10.0
1987	1,385	342	854	14.8	9.5
1988	1,269	828	298	12.8	3.4
1989	1,883	276	564	17.0	6.1
1990	1,624	142	1,127	18.1	12.0
1991	1,255	482	657	11.7	8.0
1992	955	282	397	9.4	4.8
1993	1,156	757	250	9.1	2.8
1994	984	368	243	8.7	2.7
1995	1,449	292	628	13.3	7.0
1996	776	232	358	8.8	4.0
1997	762	374	245	7.7	2.8
1998	583	134	170	6.3	1.9
1999	398	114	174	5.8	1.9
2000	807	437	283	6.4	3.2
2001	451	36	146	4.3	1.5
2002	1,446	1,059	261	9.2	2.9

*Based on strata 1, 3, 5, 6, 7 and 8.

**Will be fully recruited to the winter fishery.

Table 5. Summary of results from Collie-Sissenwine Analysis of Gulf of Maine shrimp.

<u>Fishing Season</u>	<u>New Recruits (millions)</u>	<u>Fully- Recruited (millions)</u>	<u>F (NR+FR)</u>	<u>Biomass (mt)</u>
1985	987	947	0.09	14,051
1986	1,179	1,370	0.28	21,719
1987	985	1,498	0.40	22,499
1988	757	1,299	0.48	18,799
1989	1,177	987	0.18	14,220
1990	1,313	1,403	0.33	20,637
1991	829	1,519	0.44	22,190
1992	608	1,177	0.46	16,962
1993	512	881	0.42	12,396
1994	711	713	0.32	9,199
1995	975	809	0.33	12,378
1996	883	1,003	0.65	15,516
1997	534	764	0.87	11,008
1998	510	425	0.62	6,728
1999	408	391	0.46	5,791
2000	303	393	0.28	5,658
2001	445	409	0.40	6,238
2002	358	448	-0.01	6,110
2003	1,001	634		9,244
1985-1995 average	912	1,146	0.34	16,823
2000-2003 average	527	471	0.22	6,812

Table 6. Summary of results from surplus production analysis of Gulf of Maine shrimp.

Fishing Season	Input			Catch (mt)	Results			
	Fall (kg/tow)	Maine (kg/tow)	Summer (kg/tow)		Biomass (mt)	F	B/Bmsy	F/Fmsy
1968	3.2	45.8		5,708	46,330	0.13	1.53	0.73
1969	2.7	31.2		12,140	44,520	0.30	1.47	1.75
1970	3.7	40.8		11,330	36,960	0.34	1.22	1.96
1971	3.0	9.4		10,590	30,750	0.38	1.02	2.22
1972	3.3	7.0		11,220	25,300	0.51	0.84	2.99
1973	1.9	7.8		9,691	18,860	0.61	0.62	3.57
1974	0.8	4.9		8,024	13,160	0.77	0.43	4.50
1975	0.9	6.7		6,142	8,075	1.10	0.27	6.43
1976	0.6	4.8		1,387	3,660	0.39	0.12	2.29
1977	0.2	1.6		372	3,416	0.10	0.11	0.57
1978	0.4	3.2		17	4,276	0.00	0.14	0.02
1979	0.5	4.4		487	5,838	0.07	0.19	0.43
1980	0.5	2.7		339	7,363	0.04	0.24	0.24
1981	1.5	3.0		1,071	9,505	0.10	0.31	0.60
1982	0.3			1,530	11,400	0.12	0.38	0.72
1983	1.0			1,397	13,230	0.10	0.44	0.57
1984	1.9		10.47	2,951	15,600	0.18	0.52	1.06
1985	1.6		17.69	4,131	16,710	0.25	0.55	1.44
1986	2.5		19.61	4,635	16,740	0.28	0.55	1.64
1987	1.7		15.40	5,253	16,220	0.34	0.54	1.97
1988	1.2		12.76	3,031	14,930	0.20	0.49	1.15
1989	1.8		16.95	3,315	15,840	0.20	0.52	1.19
1990	2.0		18.12	4,662	16,600	0.29	0.55	1.67
1991	0.9		11.68	3,571	16,030	0.22	0.53	1.28
1992	0.6		9.43	3,444	16,550	0.20	0.55	1.19
1993	1.6		9.14	2,143	17,290	0.12	0.57	0.68
1994	2.2		8.69	2,915	19,540	0.14	0.65	0.83
1995	1.8		13.29	6,466	21,270	0.32	0.70	1.85
1996	1.1		8.77	9,166	19,440	0.55	0.64	3.19
1997	1.3		7.73	7,154	14,420	0.58	0.48	3.36
1998	2.3		6.33	4,174	10,650	0.42	0.35	2.44
1999	2.5		5.78	1,816	9,334	0.19	0.31	1.08
2000	1.4		6.39	2,389	10,350	0.22	0.34	1.31
2001	0.6		4.33	1,327	10,970	0.11	0.36	0.65
2002			9.20	375	12,930	0.03	0.43	0.15
2003					16,360		0.54	
1971-74 average					22,018	0.57		
1985-95 average					17,065	0.23		
2000-03 average					11,417	0.12		

Table 7. Yield and egg production per recruit of Gulf of Maine northern shrimp.

For an example fishing mortality $F = 0.20$, natural mortality $M = 0.25$, and 1,000 age 0 recruits.

Input Data							Results							
	Length	Transition	Fishery	Male	Female	Fecundity	Total	Male	Female	Male	Female	Yield	Egg	
<u>Age</u>	<u>(mm)</u>	<u>Rate (% Fem)</u>	<u>Selectivity</u>	<u>wt (g)</u>	<u>wt (g)</u>	<u>at length</u>	<u>N</u>	<u>N</u>	<u>N</u>	<u>Catch</u>	<u>Catch</u>	<u>(g)</u>	<u>Production</u>	
1	11.17	0	0.033	0.84	1.24	0	774	774	0	4	0	4	0	
2	18.43	0	0.230	3.79	4.82	0	575	575	0	31	0	117	0	
3	23.50	0.081	0.579	7.87	9.30	1,286	399	367	32	56	0	439	41,581	
4	27.04	0.922	0.799	12.00	13.58	1,876	265	21	244	48	4	635	458,156	
5	29.51	0.997	0.893	15.60	17.19	2,287	173	0	172	3	35	657	393,661	
6	31.23	1.000	0.933	18.50	20.04	2,574	112	0	111	0	26	523	287,027	
7	32.43	1.000	1.000	20.72	22.19	2,775	71	0	71	0	18	399	197,299	
												total	2,773	1,377,725
												total/recruit	2.773	1,378
												% of max		57.52

Ref. Point	F	YPR	%EPR
F_{max}	0.77	4.25	14.77
$F_{0.1}$	0.46	3.99	29.83
$F_{example}$	0.20	2.77	57.52
$F_{50\%}$	0.25	3.14	50
$F_{40\%}$	0.34	3.62	40
$F_{30\%}$	0.45	3.97	30
$F_{20\%}$	0.63	4.21	20
$F_{10\%}$	0.95	4.21	10

Count per pound		
Age	Male	Female
1	540	366
2	120	94
3	58	49
4	38	33
5	29	26
6	25	23
7	22	20

Figure 1. Gulf of Maine northern shrimp landings by fishing season.

Landings in Metric Tons

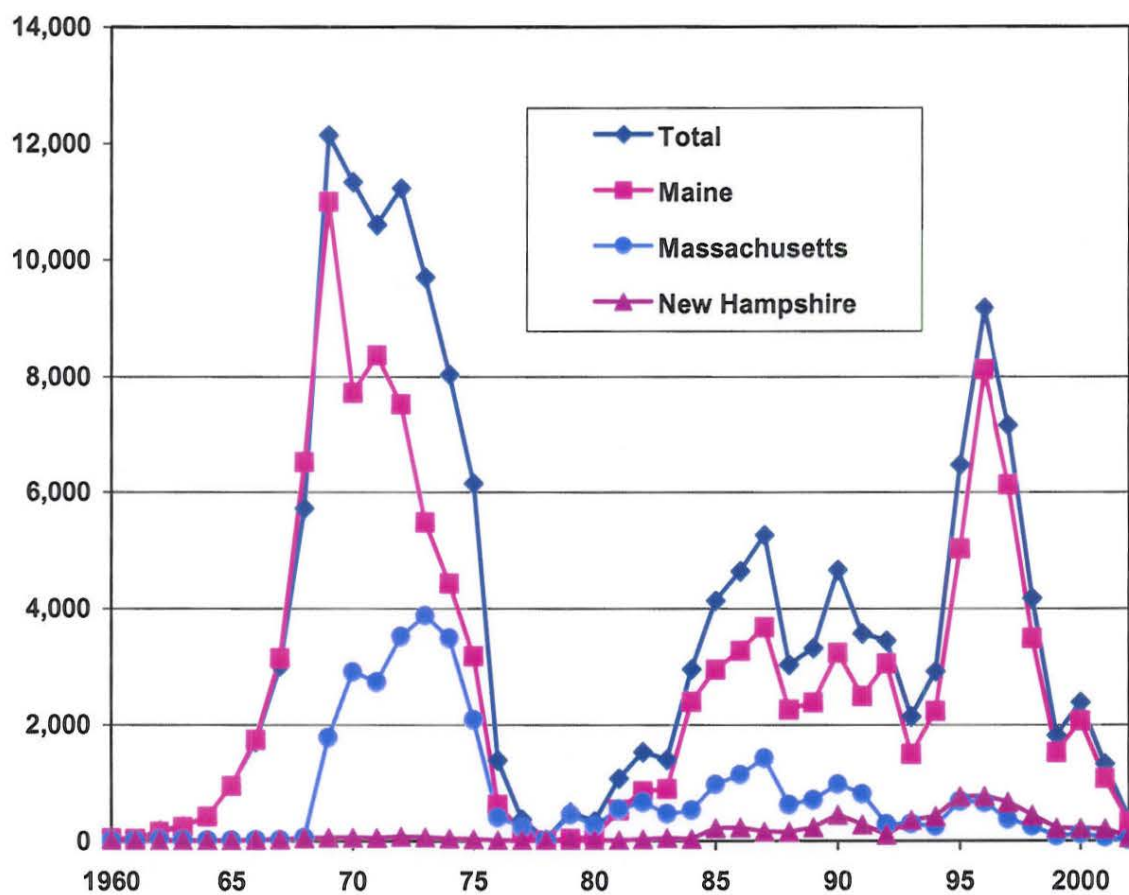


Figure 2. Length frequency distribution from samples of the Maine shrimp catch during the 2002 season.

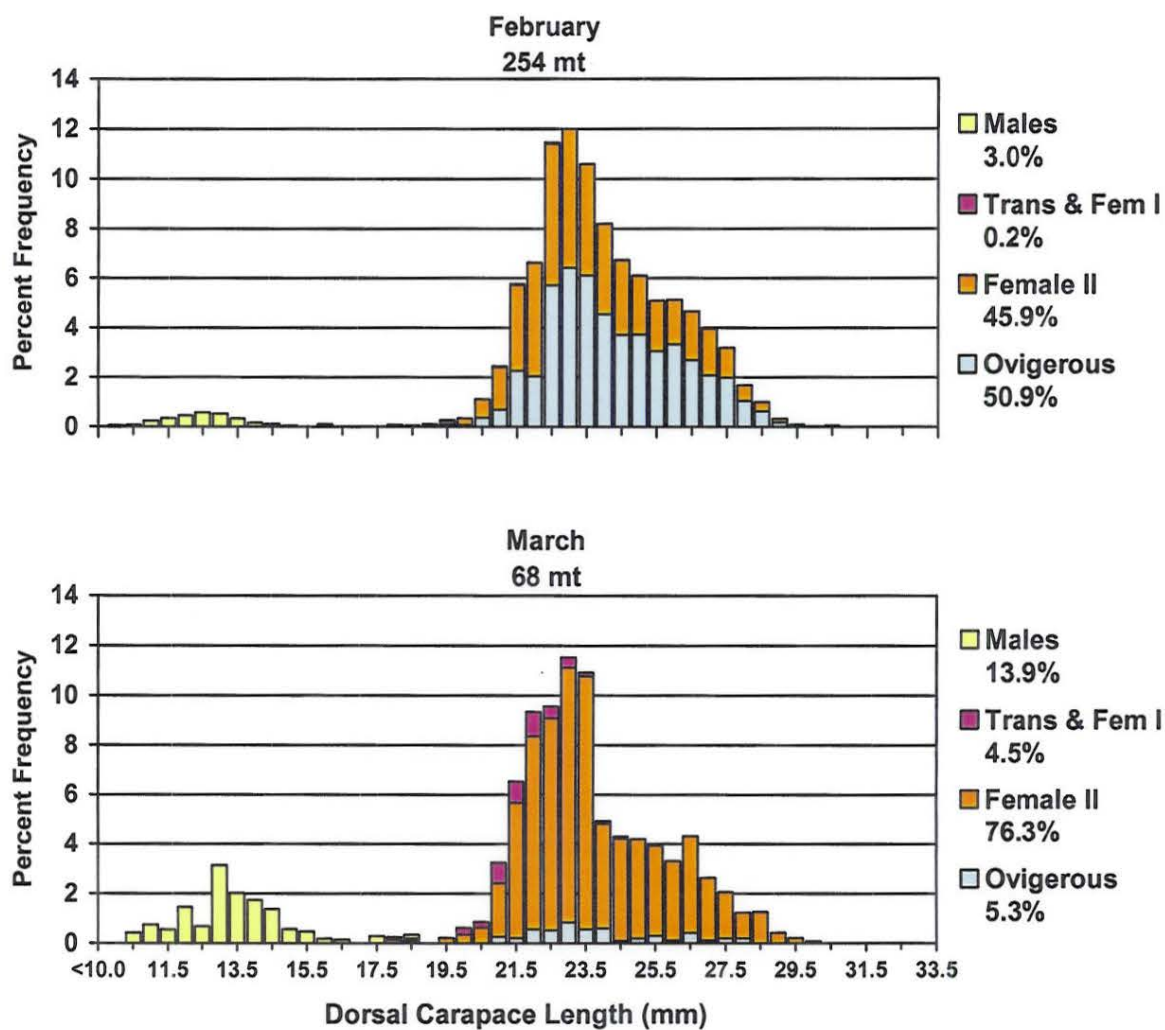


Figure 3. Length frequency distribution from samples of Massachusetts and New Hampshire shrimp catches during the 2002 season.

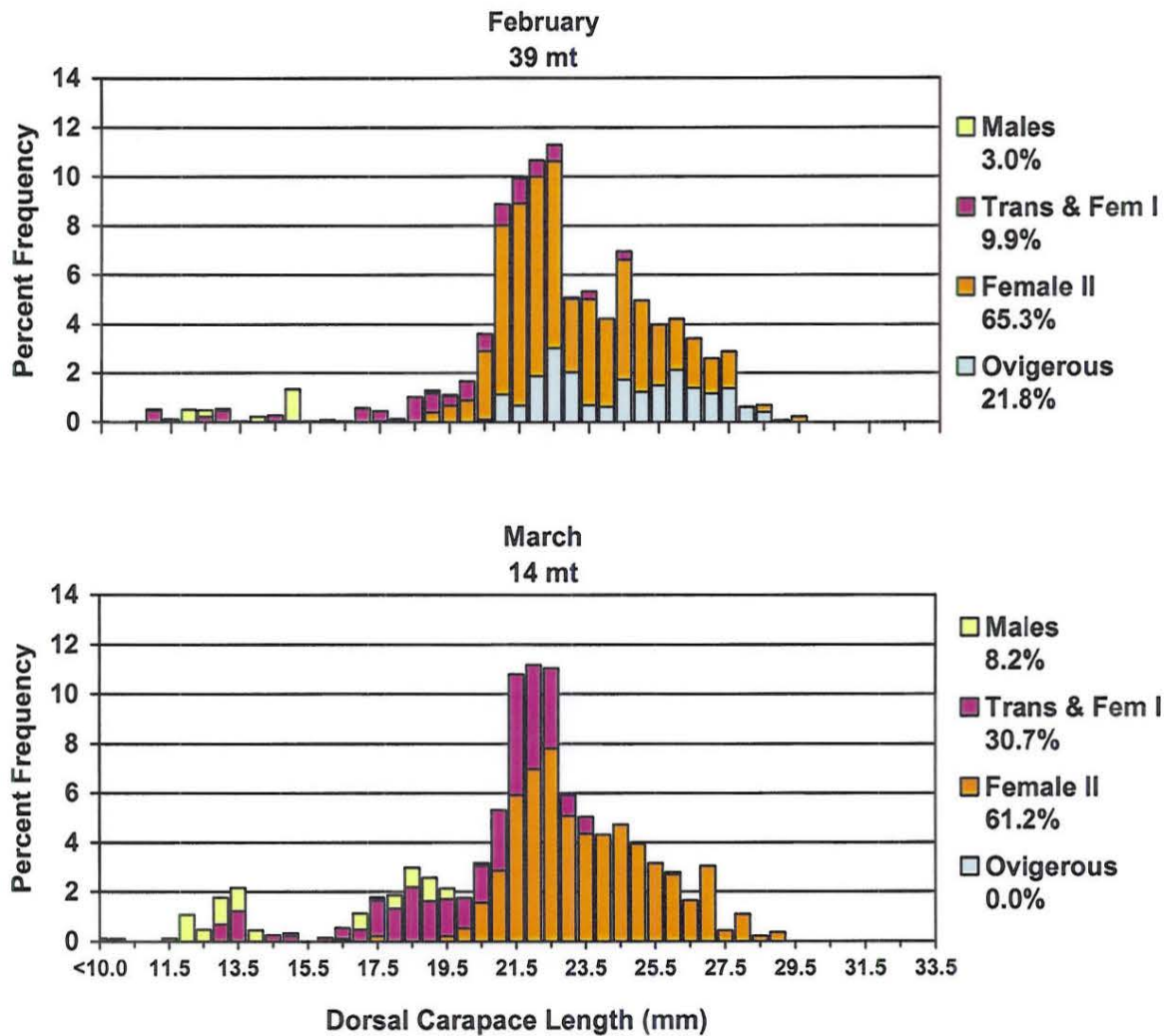


Figure 4. Gulf of Maine northern shrimp landings by length, developmental stage, and fishing season.

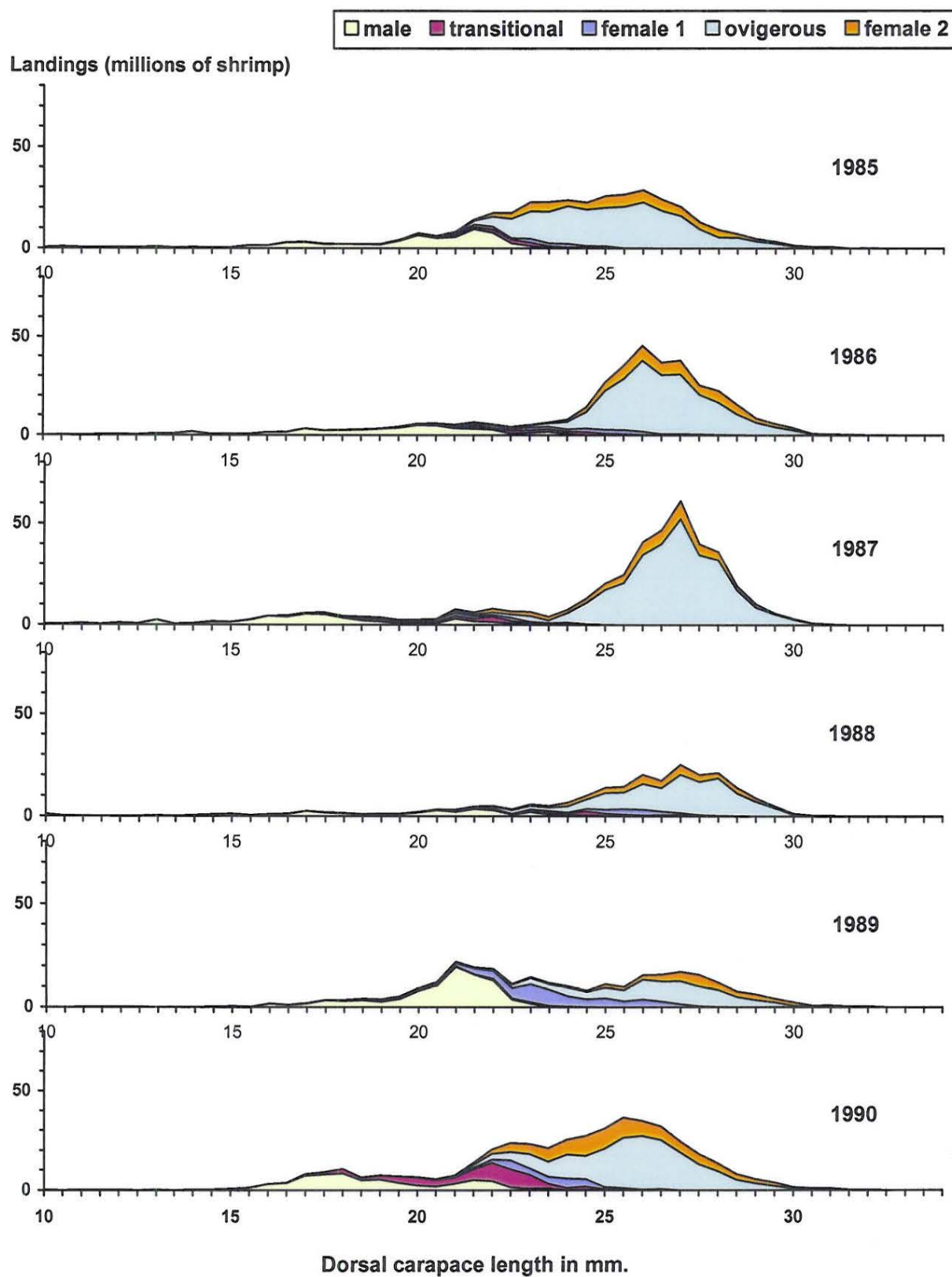


Figure 4. continued.

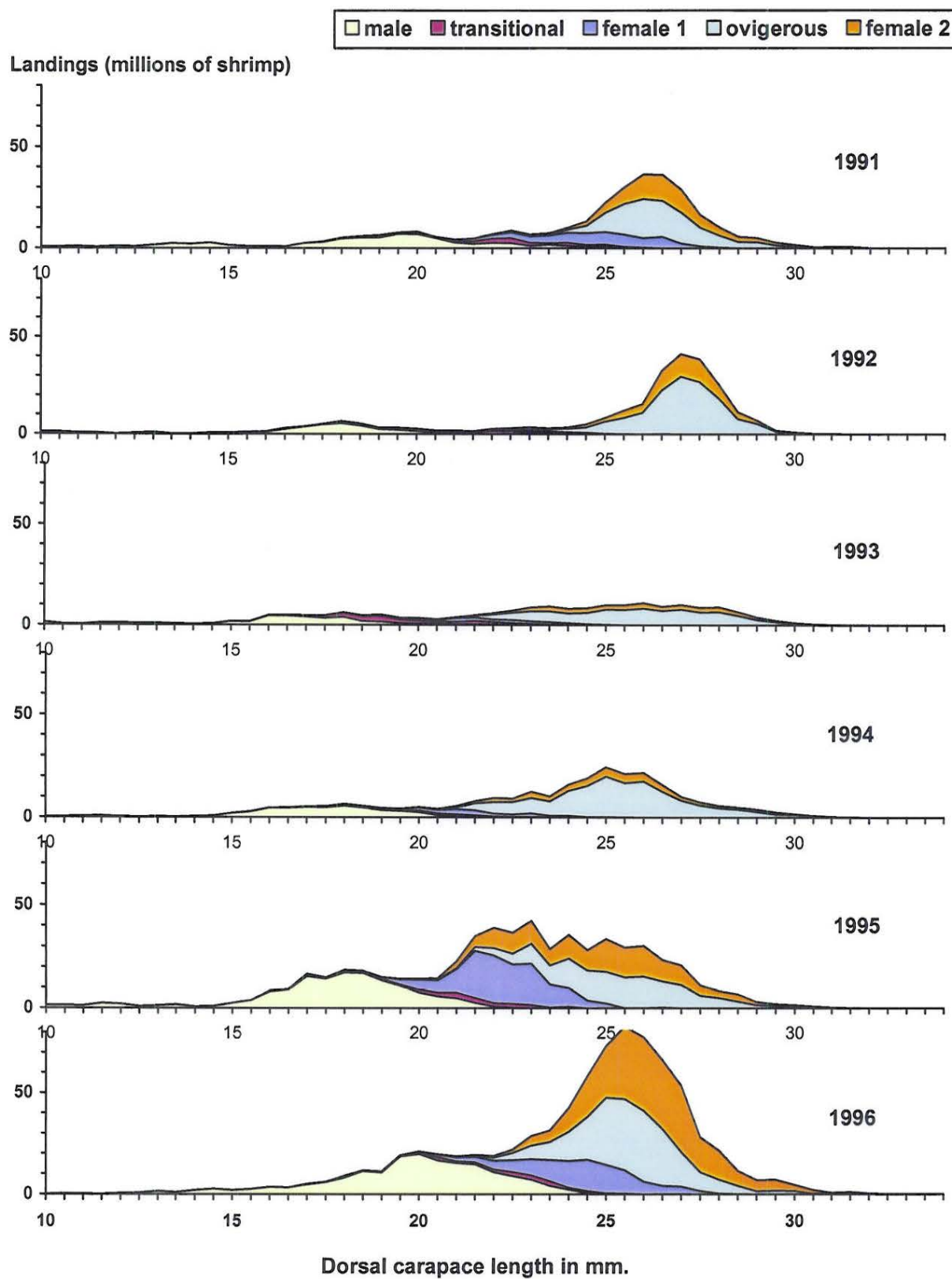


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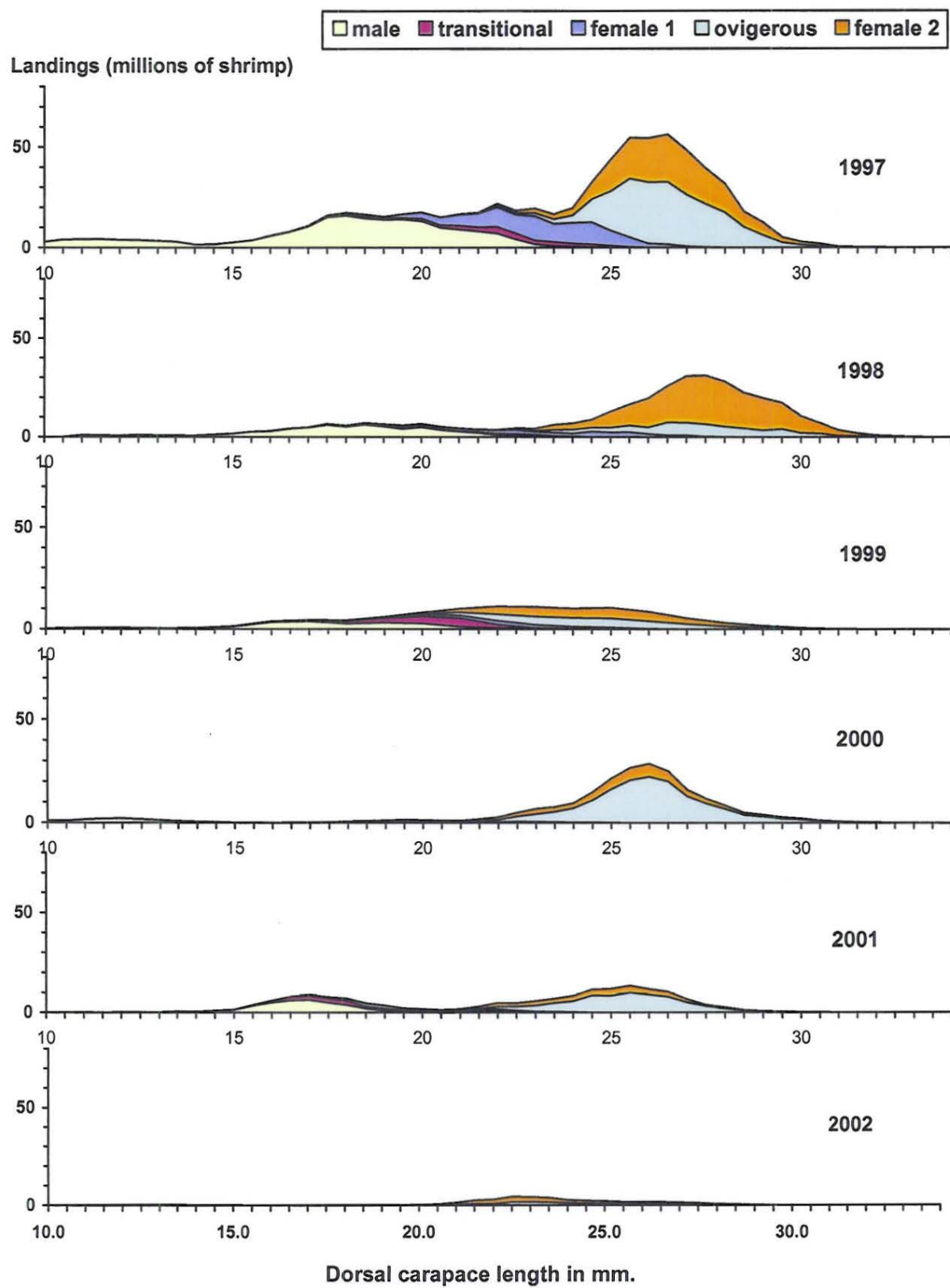
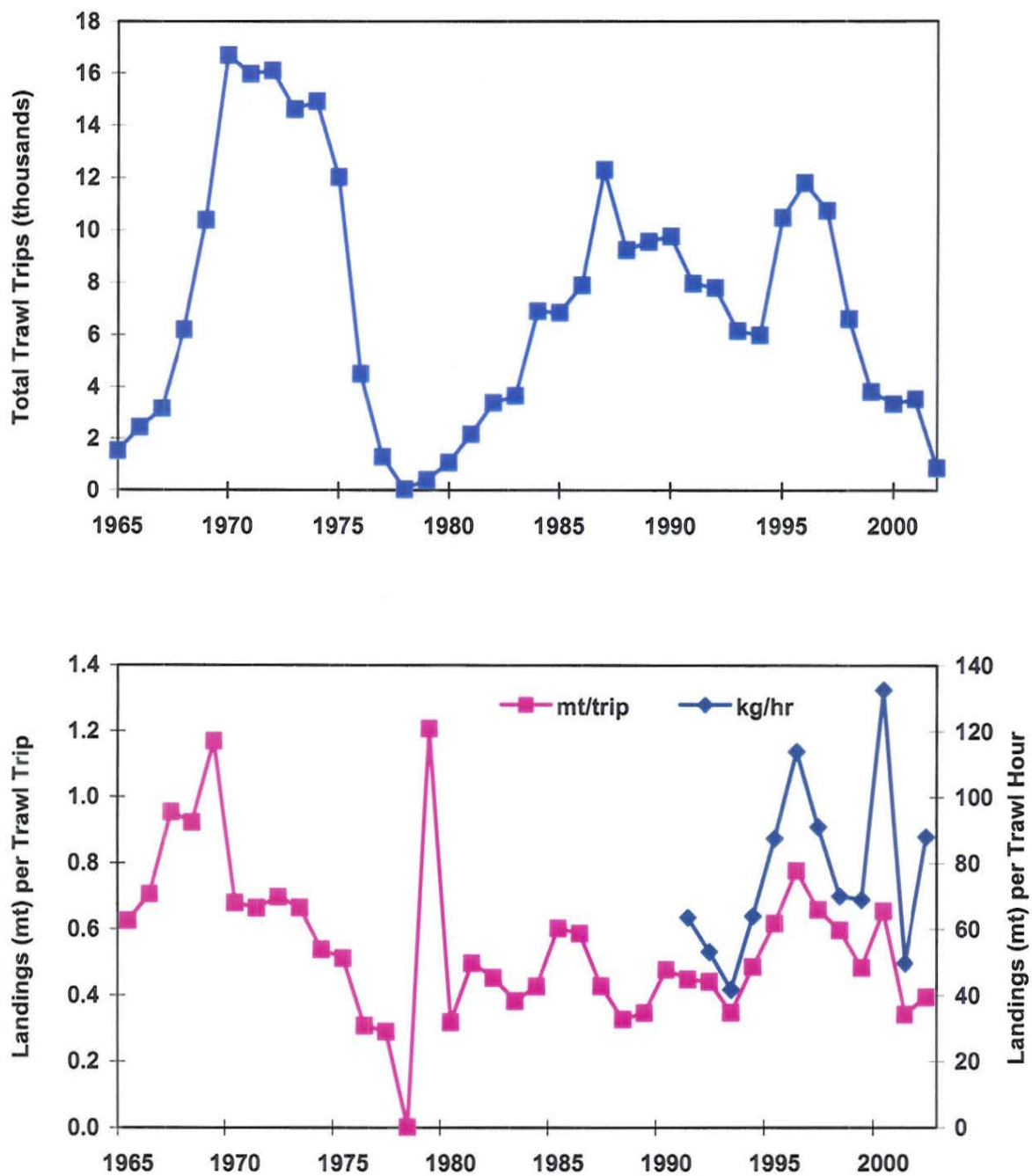
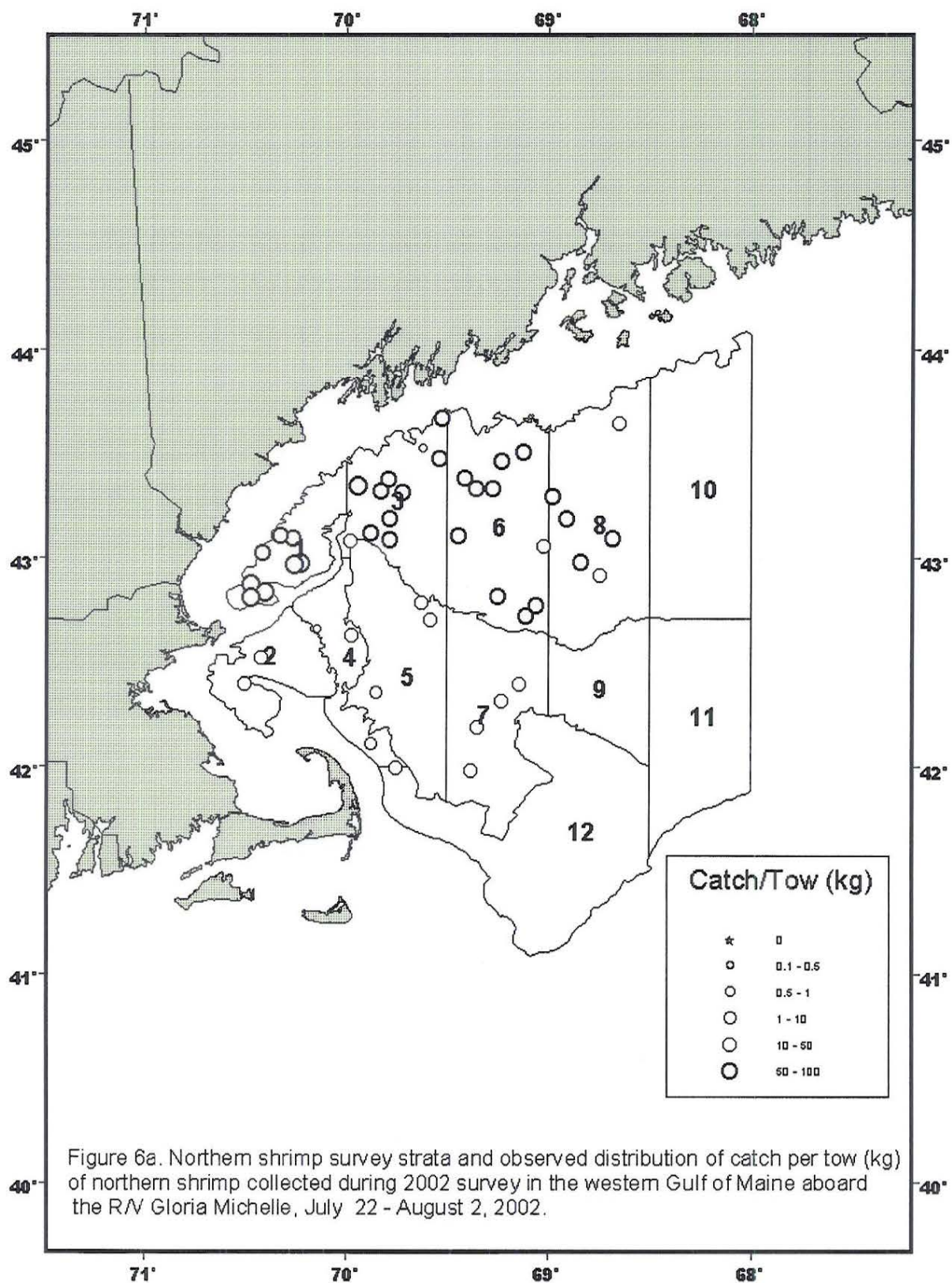


Figure 5. Nominal fishing effort (above) and catch per unit effort (below) in the Gulf of Maine northern shrimp trawl fishery.





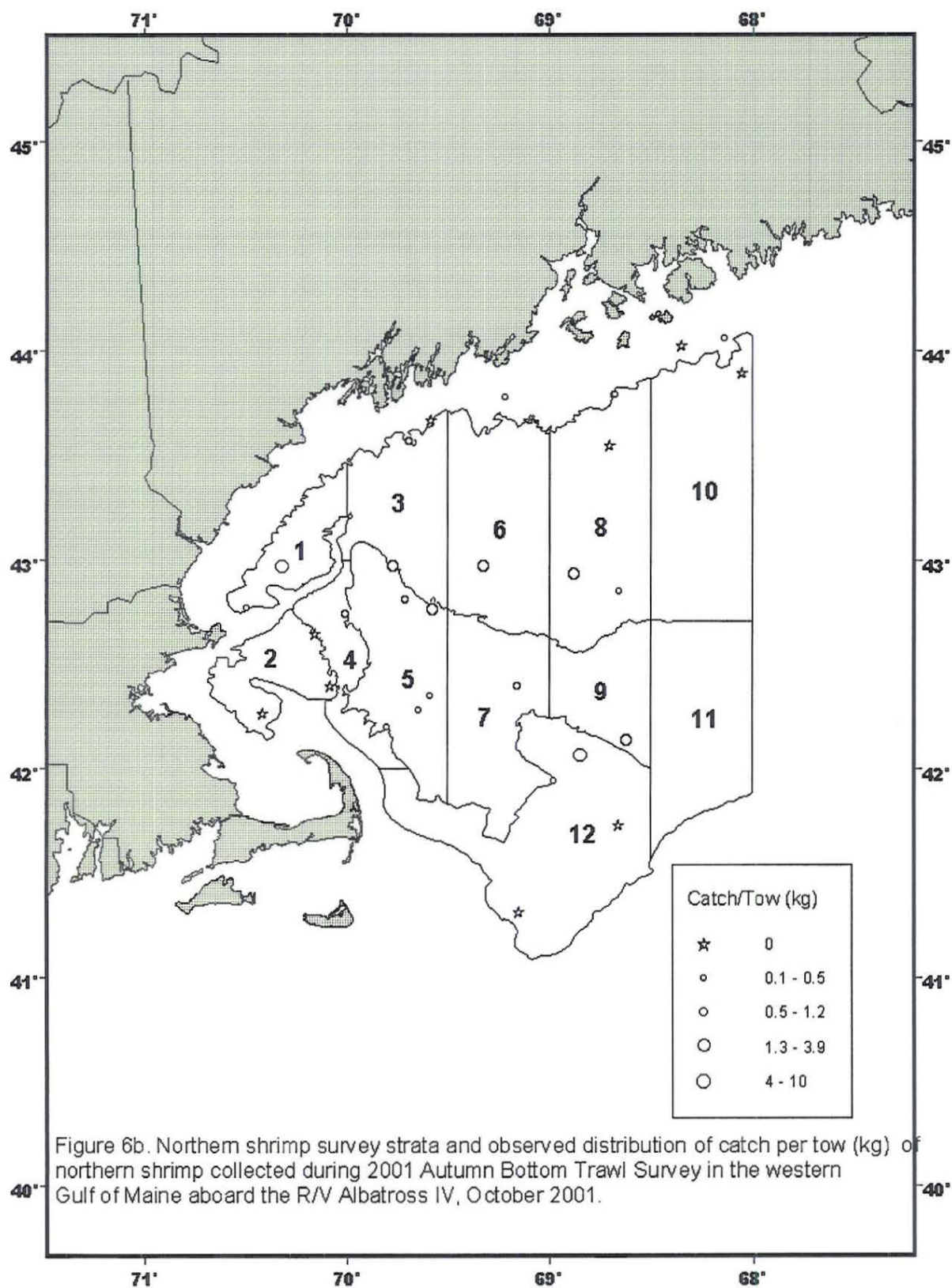


Figure 7. Fall survey index and landings of Gulf of Maine northern shrimp the following season.

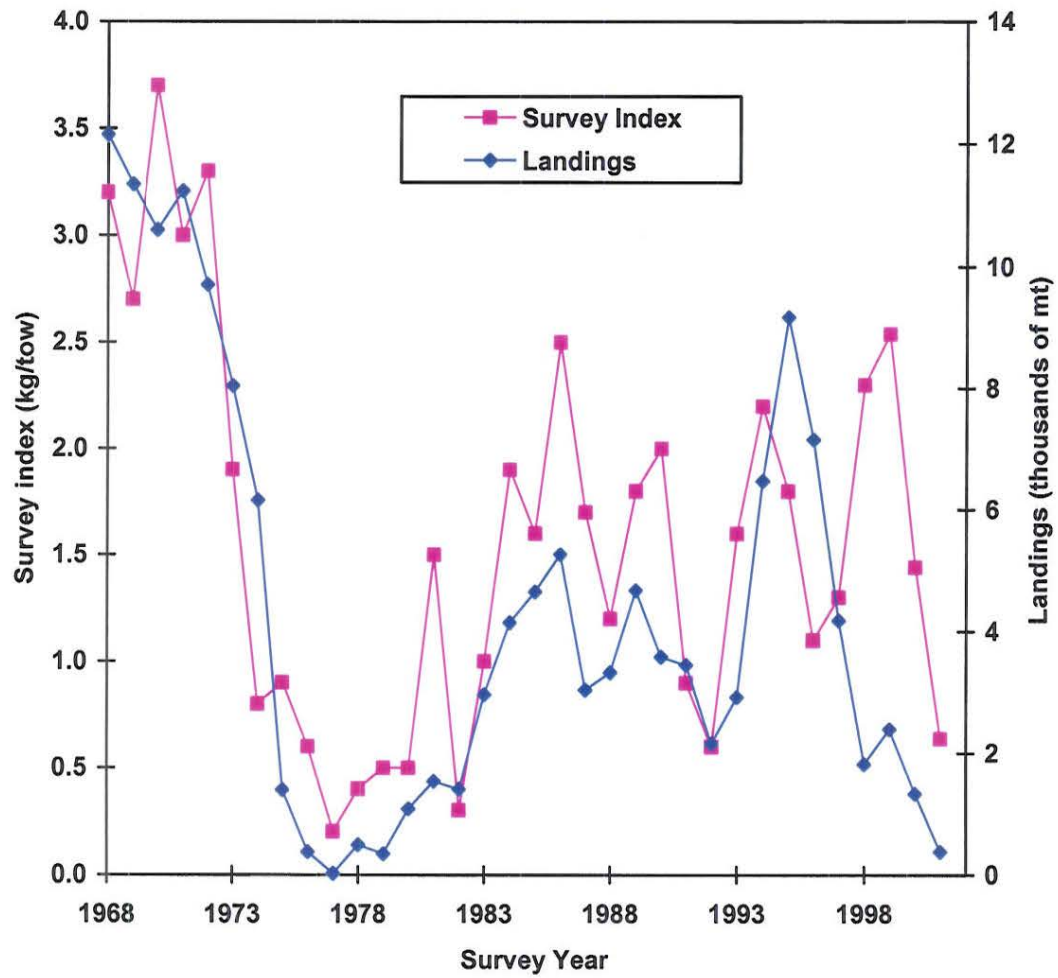


Figure 8. Gulf of Maine northern shrimp summer survey indices of abundance and biomass.

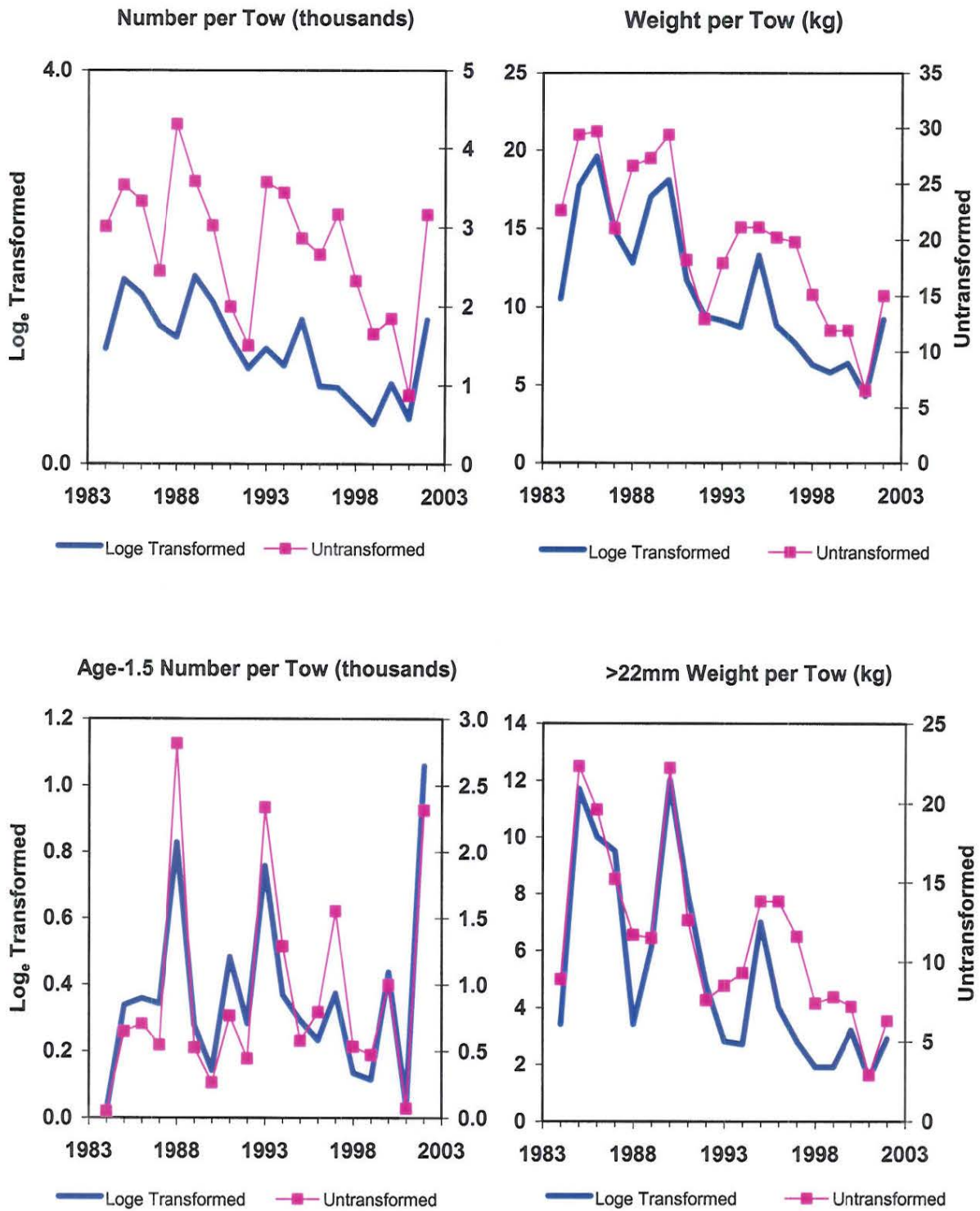


Figure 9. Gulf of Maine northern shrimp summer survey mean catch per tow by length and development stage. 2-digit numbers are assumed 1.5 age year class.

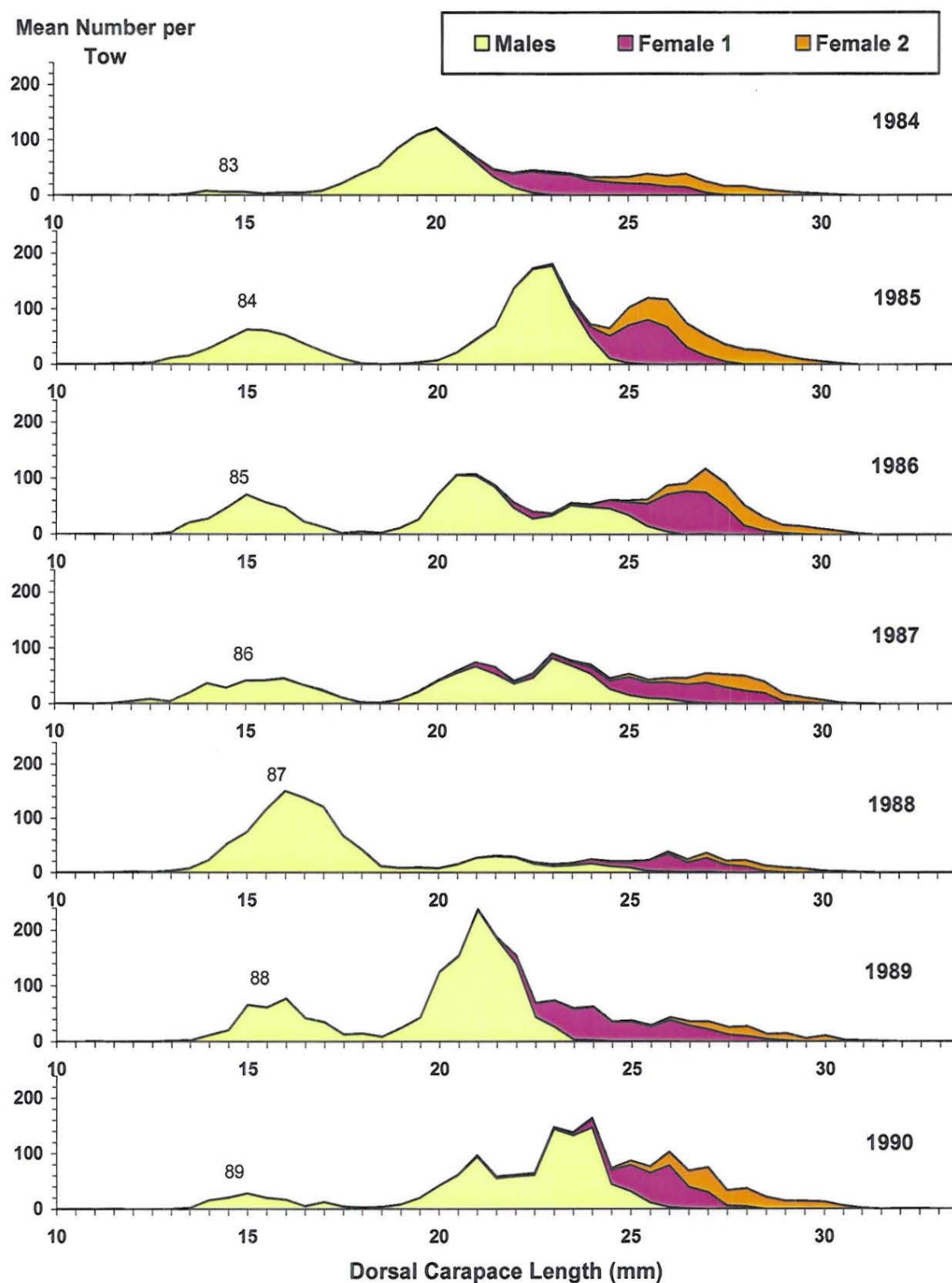


Figure 9. continued

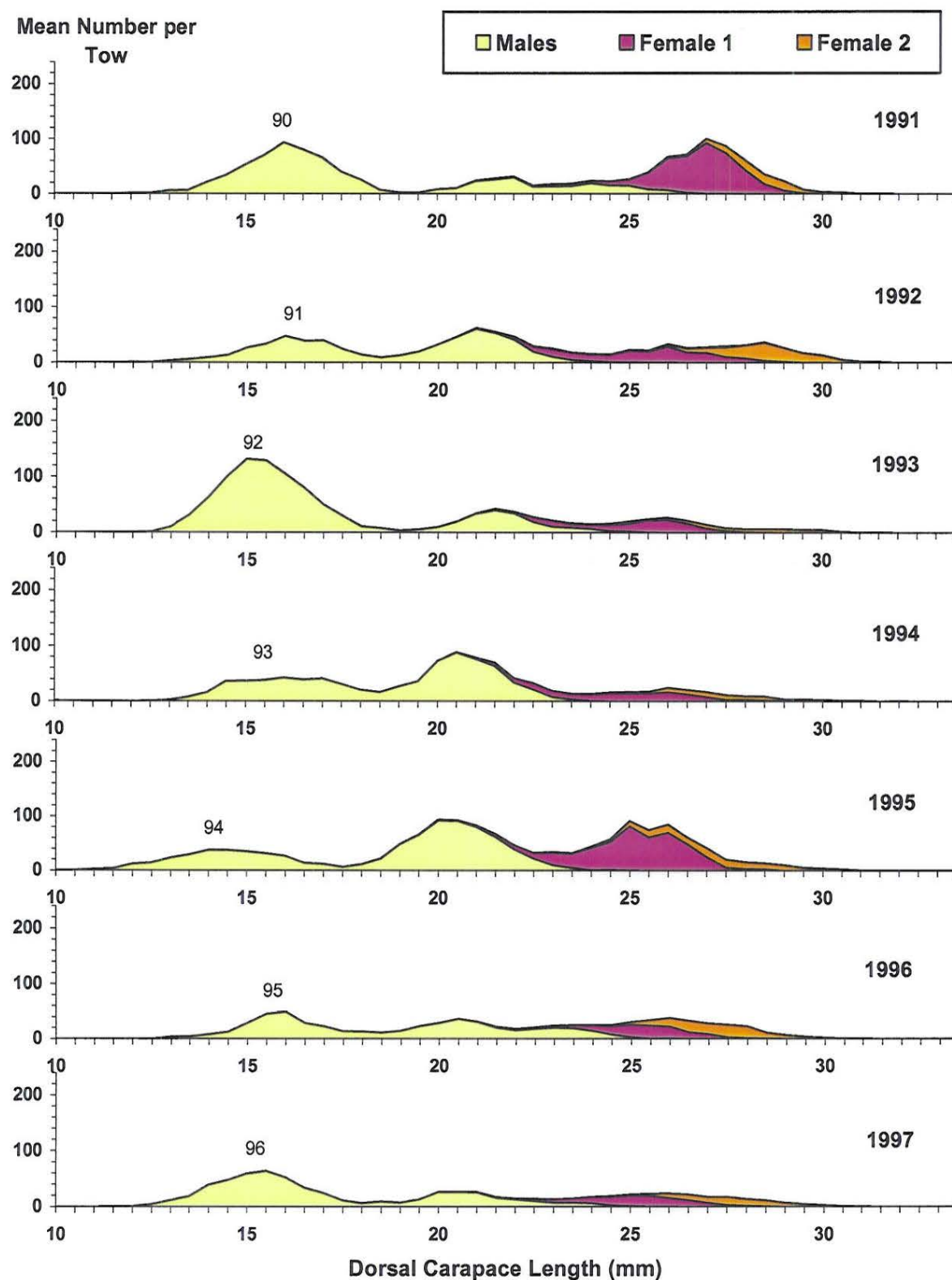


Figure 9. continued

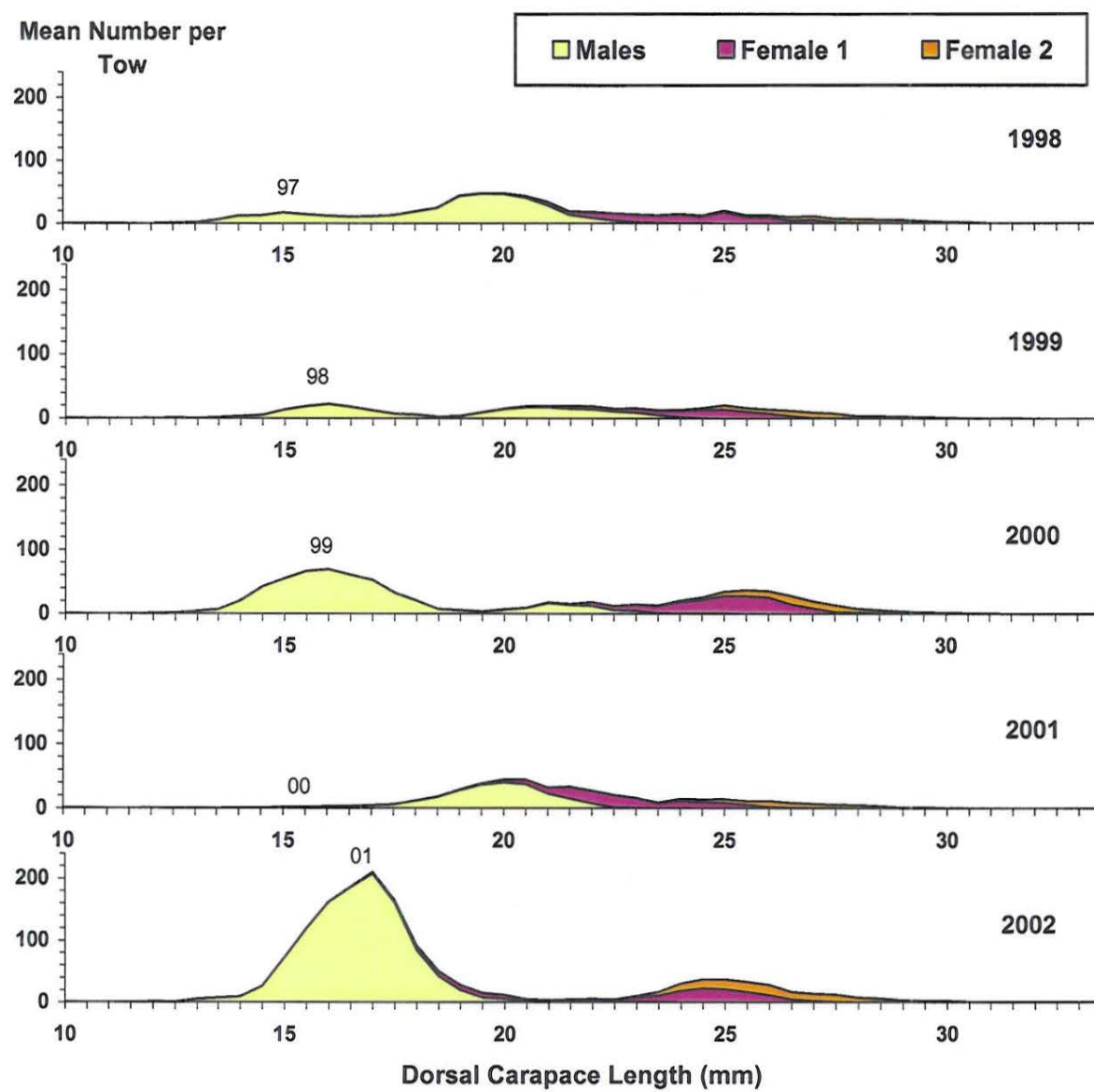


Figure 10. Fishing mortality, abundance, and biomass of Gulf of Maine northern shrimp, least squares estimates, bootstrapped means, and 80% confidence intervals.

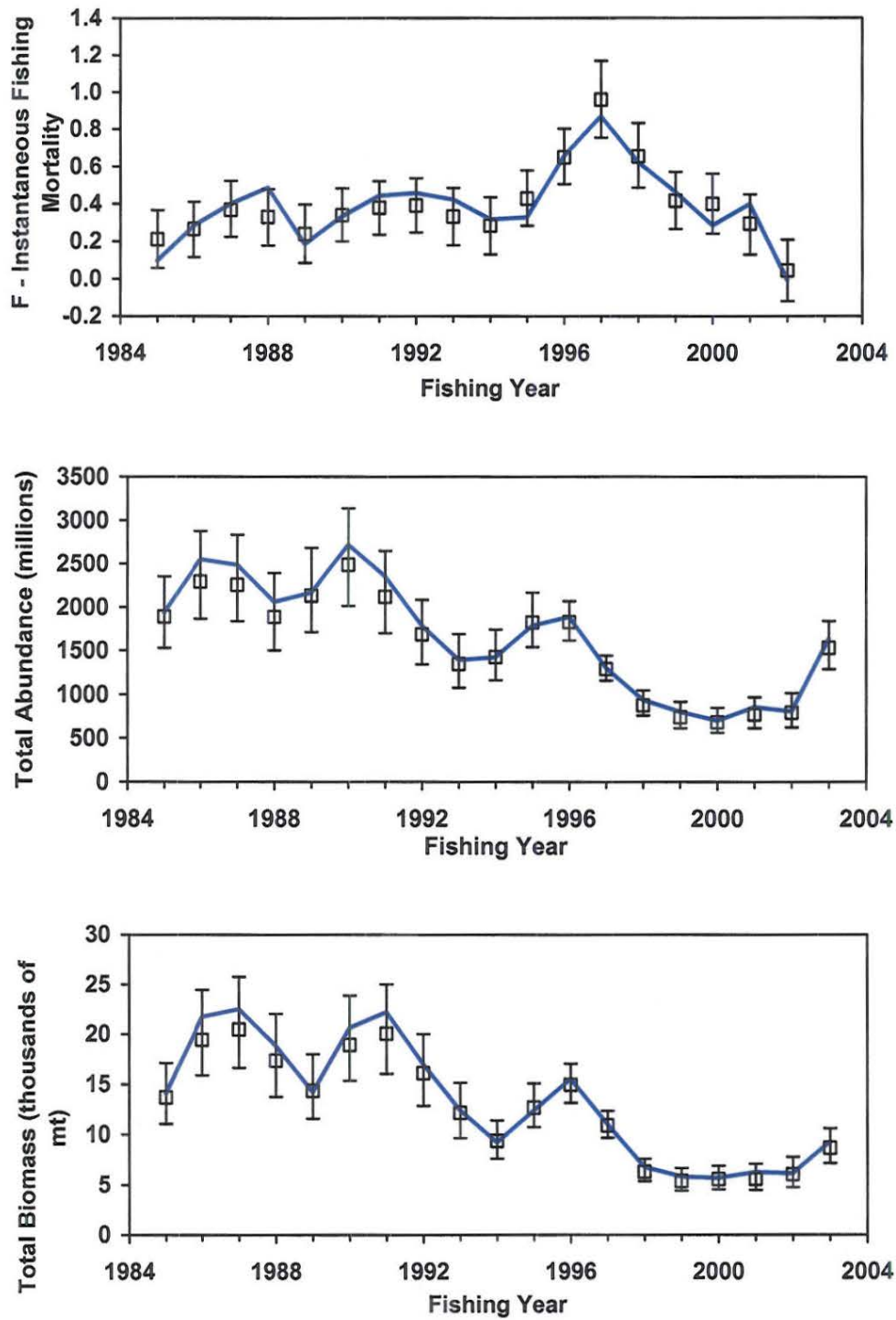


Figure 10. continued

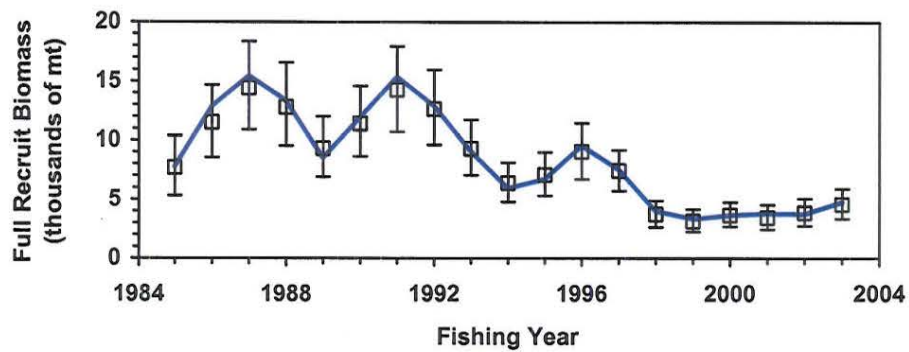
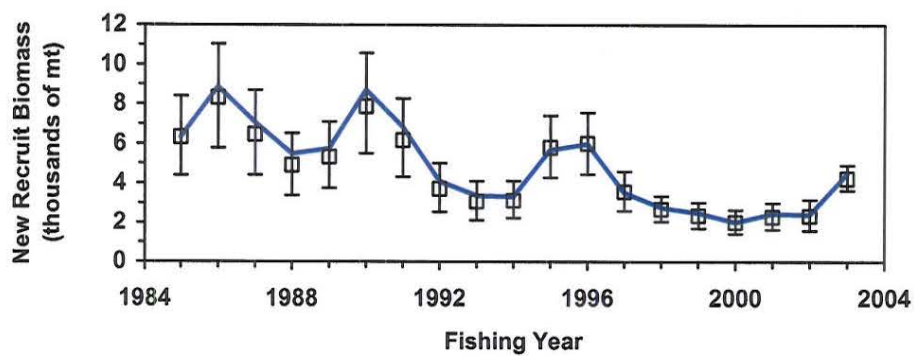
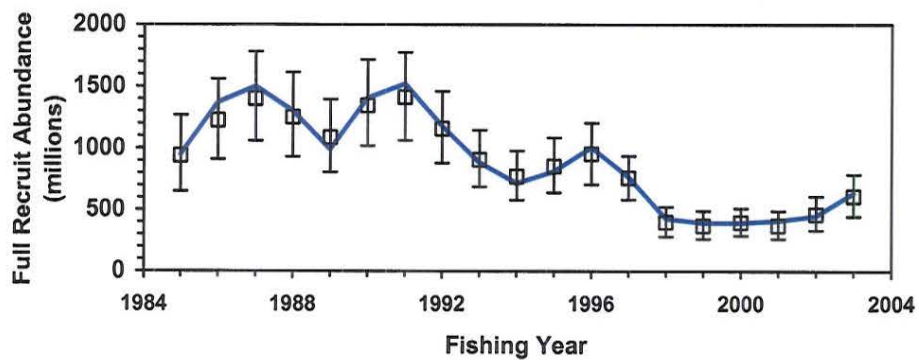
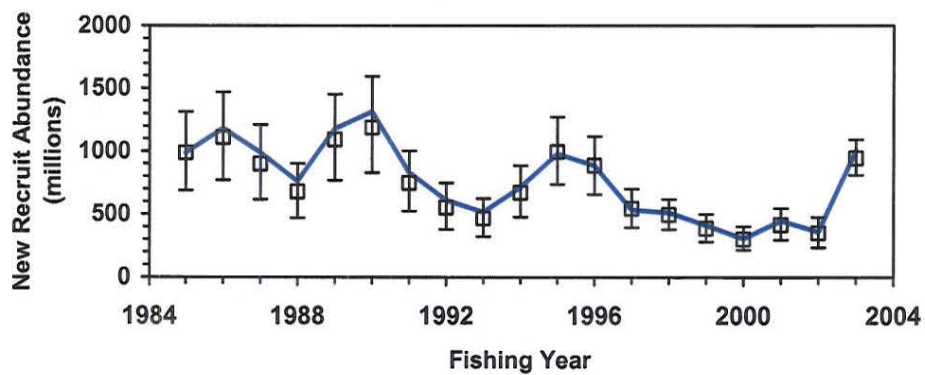


Figure 11. Collie-Sissenwine Analysis Input Data and Results

Northern Shrimp using Summer Survey		Indices of Abundance		Total Catch Millions
Survey Year*		Recruits	Full Recruits	
1984		447.5580	479.0570	352.7928
1985		619.4560	925.4300	361.1710
1986		533.2920	848.5440	425.2945
1987		482.8980	766.9030	228.4345
1988		459.7550	387.7140	283.6468
1989		701.0930	817.9000	442.4292
1990		511.5210	907.5220	320.2898
1991		374.2770	612.0870	262.4338
1992		313.5950	444.3580	194.7883
1993		410.1960	320.7500	270.4058
1994		368.5900	364.3020	615.3185
1995		485.7860	653.3320	799.3678
1996		257.6520	348.6160	718.4332
1997		257.2980	267.1010	373.6801
1998		217.1340	226.6420	215.1221
1999		137.3900	174.6070	209.2793
2000		276.2810	288.1930	141.4937
2001		171.8090	196.3560	38.6779
2002		550.6000	372.9300	

* Survey Year Data are applied to the following Fishing Year

Input File Name	R2002.dat
Tuning Dataset	Survey
Time of Survey (yr)	0
Time of Catch (yr)	0.5
Natural Mortality Rate	0.25
Relative Catchability: Recruits to Full Recruits s_r	0.7 - 1.0
Catchability Estimate and CV	0.550 0.16
Average Partial Recruitment Rate to Fishery	0.63
Average $Z_{all\ sizes}$ (1999-2001)	0.59
Average $Z_{all\ sizes}$ (2000-2001)	0.44

Survey Year*	Stock Size Estimates millions at time of Survey		Total Mortality $Z_{all\ sizes}$	Fishing Mortality All Sizes
	Recruits	Full Recruits		
1984	986.8	947.3	0.34	0.09
1985	1179.3	1369.9	0.53	0.28
1986	984.7	1497.6	0.65	0.40
1987	757.5	1298.8	0.73	0.48
1988	1176.6	987.2	0.43	0.18
1989	1313.2	1402.9	0.58	0.33
1990	829.4	1519.4	0.69	0.44
1991	608.2	1177.1	0.71	0.46
1992	511.5	881.3	0.67	0.42
1993	711.4	712.6	0.57	0.32
1994	975.1	808.6	0.58	0.33
1995	883.4	1002.7	0.90	0.65
1996	534.0	764.1	1.12	0.87
1997	510.5	424.6	0.87	0.62
1998	408.2	391.5	0.71	0.46
1999	303.4	392.8	0.53	0.28
2000	445.1	409.4	0.65	0.40
2001	357.9	447.9	0.24	-0.01
2002	1000.6	634.2		

Note that the recruit abundance index for the last year is NOT used in the least squares estimation. It is, however, used in conjunction with the least squares estimate of q_n and the selectivity of the recruits to calculate recruit population size in 2001

* Survey Year Data are applied to the following Fishing Year

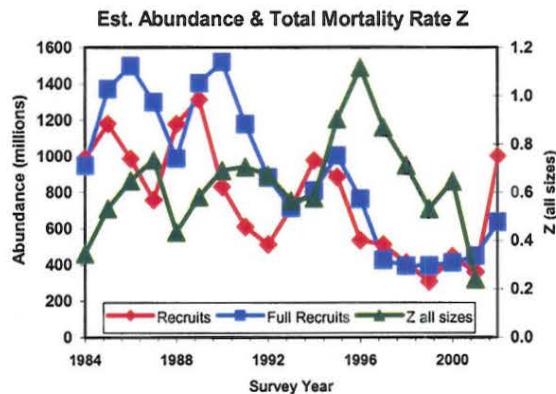
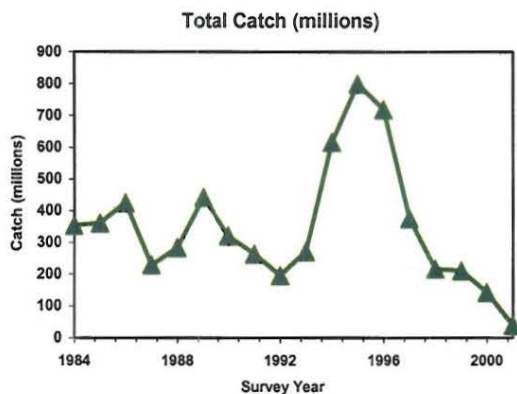


Figure 12. Estimates of fishing mortality (above) and stock biomass (below) for northern shrimp from Collie-Sissenwine analysis and surplus production modeling.

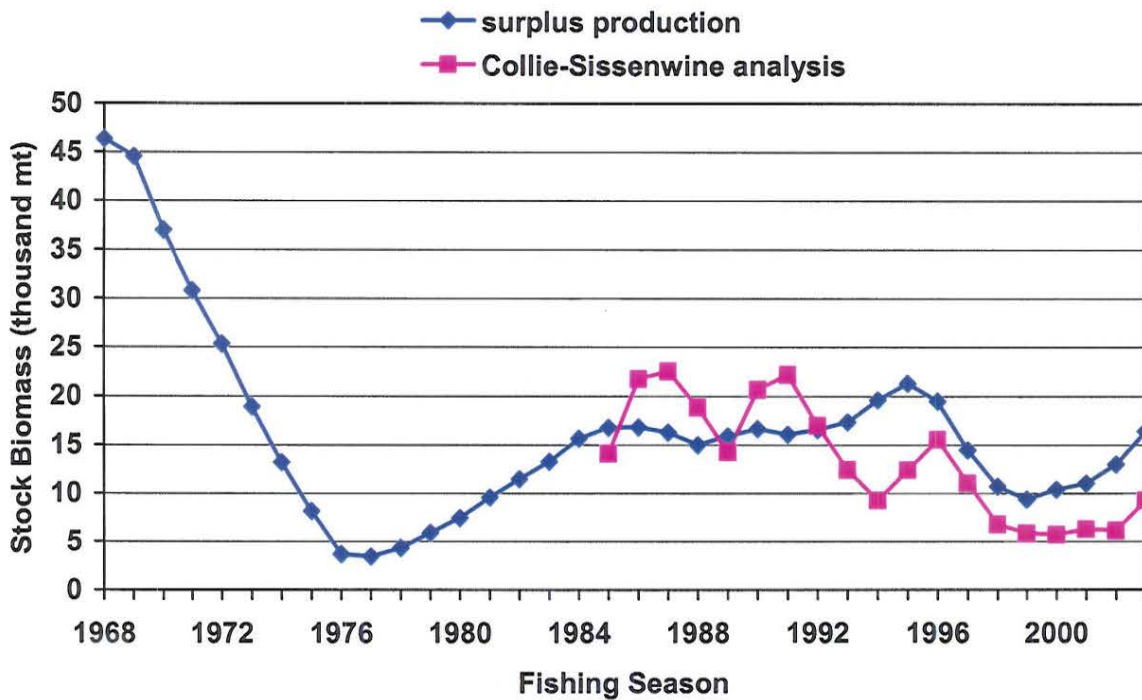
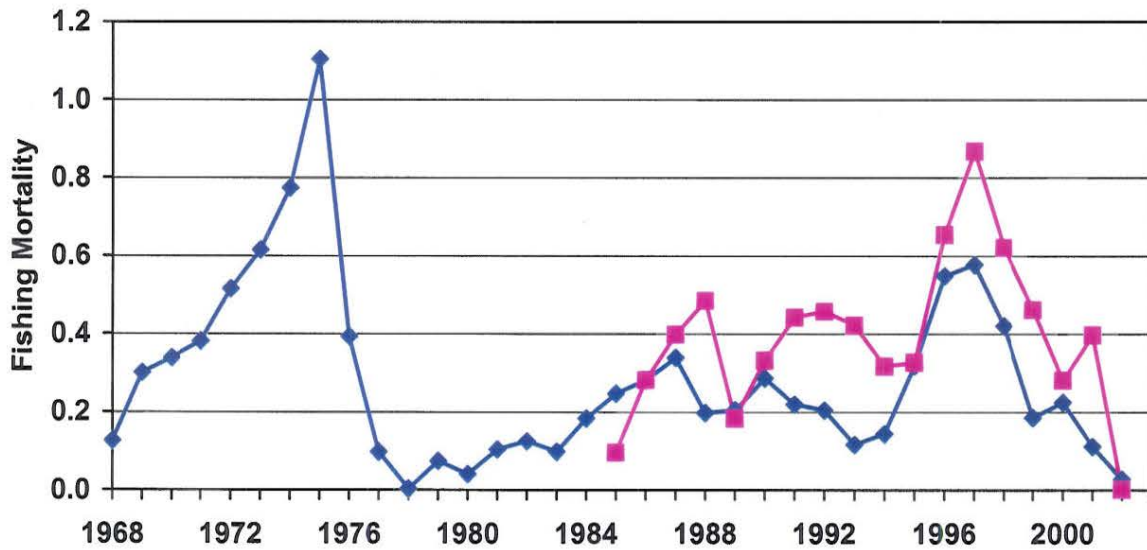


Figure 13. Biomass dynamics of the Gulf of Maine northern shrimp fishery, from surplus production (above) and Collie-Sissenwine (below) analyses, with possible fishing mortality and biomass reference points.

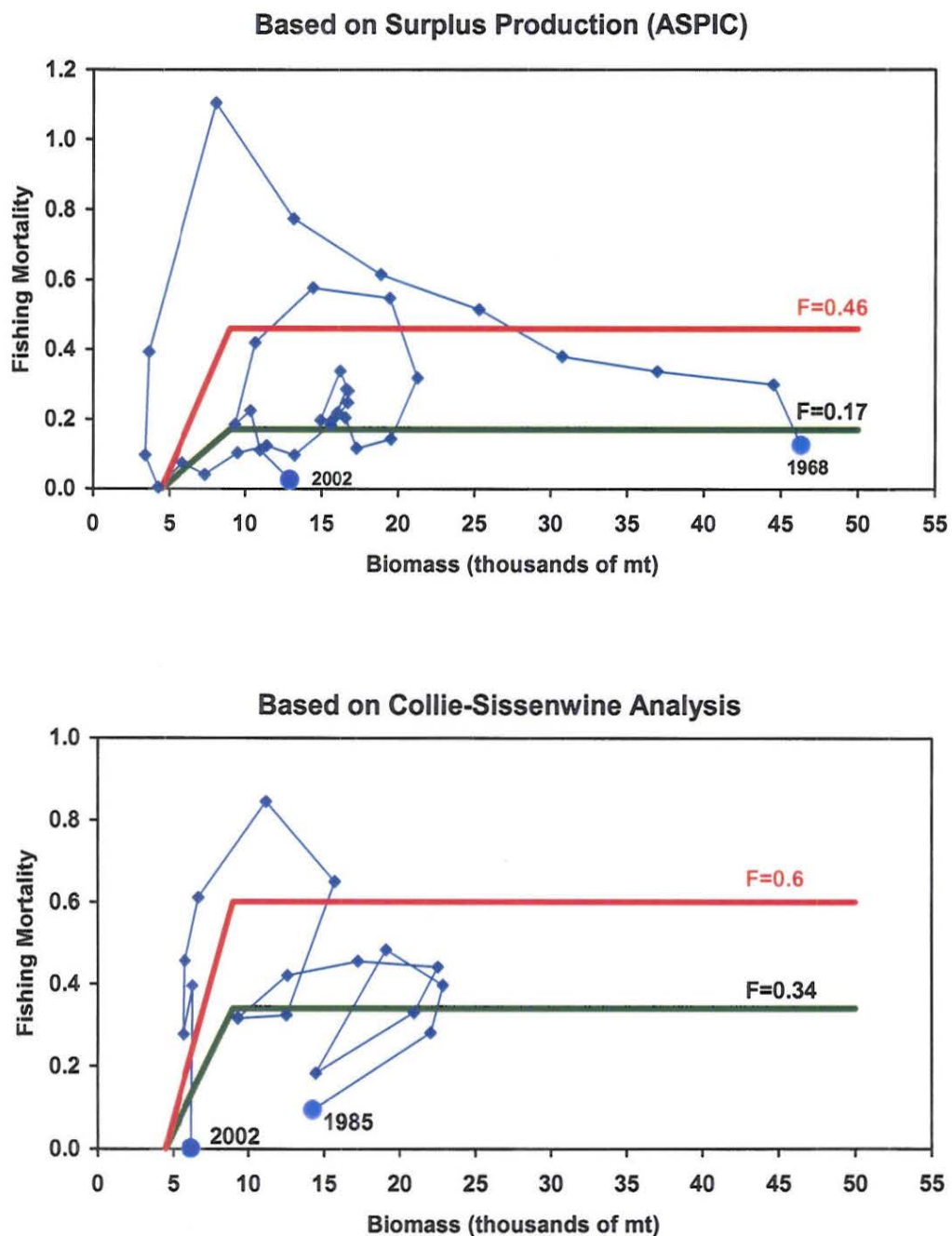


Figure 14. Yield and egg production per recruit.

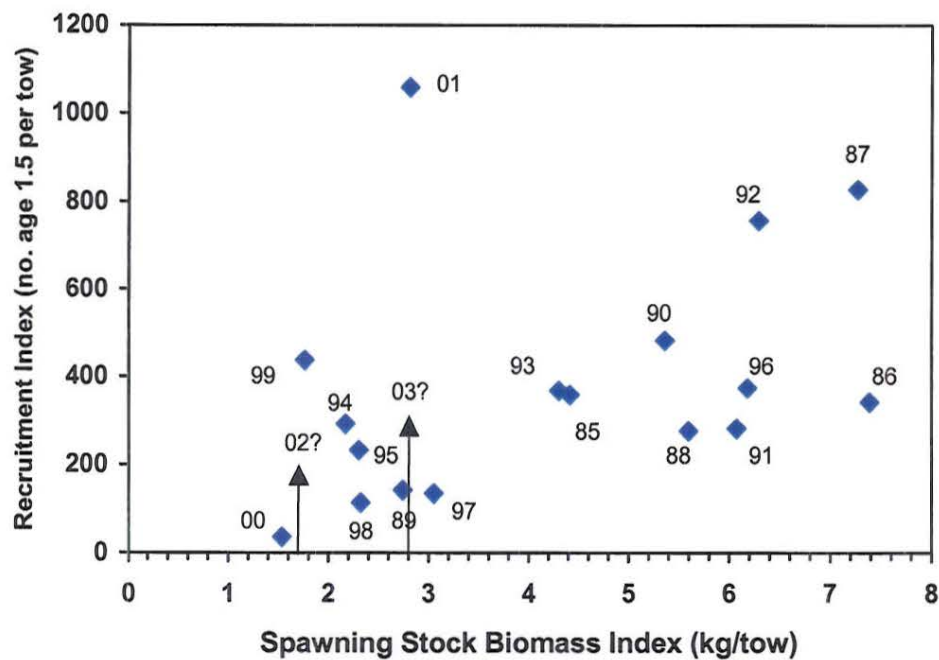
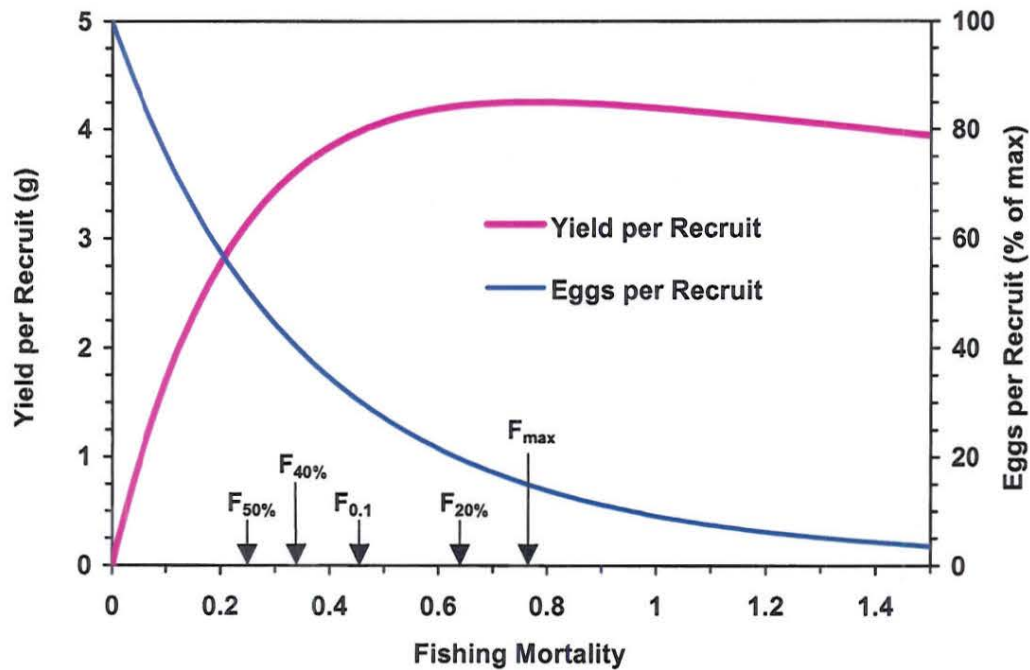


Figure 15. Relationship between summer survey index of Gulf of Maine female shrimp biomass the summer before spawning to age 1.5 abundance two years later. Two-digit numbers indicate the assumed age 1.5 year class.

Data from Maine's commercial port sampling program are combined with data from similar programs in New Hampshire and Massachusetts, and used by the Technical Committee of the ASMFC Northern Shrimp Section in their annual assessment of the Gulf of Maine shrimp stock. A copy of the 2002 assessment report is attached (Appendix 2). The table on page 9 of that report shows that CPUE in 2002 was the second poorest in the eleven-year series. Size frequency data by sex and stage (figures 2-4) are expanded to catch data for the three-state region, and used to identify the relative strength of year classes in the catch, and the timing of egg drop. The data are also used in analytical modeling of the stock, which requires an estimate of the total catch in numbers, found by expanding numbers in samples to numbers in the sampled catches to numbers in the total catch.

Table 1

Number of Shrimp Port Samples Collected by Dealer:

Dealer	No. Visits	Samples collected/visit	Total Samples
1. Atlantic Edge Lobster, Boothbay Harbor	2	2,2	4
2. Shaw's Wharf, New Harbor	1	7	7
3. South Bristol Co-op, South Bristol	2	5,2	7
4. Cundys Harbor Wharf, Cundys Harbor	1	7	7
5. Portland Fish Exchange, Portland	1	3	3
6. Pemaquid Fishermen's Co-op, Pemaquid	2	2,1	3
7. River Catch Inc., Portland	3	3,6,4	13
8. Nancy's Seafood, Portland	1	2	2
Totals	13		46

Table 2**Commercial Shrimp Port Sampling February 15 - March 11, 2002**

	# Dealers Visited & Locations *1	# Samples Collected	Boats		Length Range (ft)	# Fishing Grounds	Total catch in (lbs)		Dragger Boat Days	Draggers Av. Catch Per Day (lbs)	Total Hrs. Drag Time	lbs./Hr Drag Time	Total # Traps Hauled	Total Set Over Days	Average	
			# Different Draggers Sampled *2	# Trappers Sampled			Draggers	Trappers							Average lbs./trap	Average lbs/trap haul set over day
Feb. 2002	7 Portland, ME to South Bristol, ME	35	24	7	31' - 60'	12	38,603	6,400	27	1,544.1	184.25	209.5	1,083	22	5.9	2.18
Mar. 2002	4 Portland, ME to South Bristol, ME	11	11	0	40' - 60'	12	7,264	0	11	660.4	83.75	86.7	0	0	0	0
Season	8	46	30	7	31' - 60'	22	45,867	6,400	38	1,274.1	268	171.15	1,083	22	5.9	2.18
Totals:	Portland, ME to South Bristol, ME different dealers		different draggers	different trappers		different fishing grounds										

*1 Dealers visited more than one time in any given month are only counted once.

Sampling is also conducted at the Portsmouth, N.H. Fishermen's Co-op due to the fact that some Maine shrimp boats land their catches at that facility.

*2 Some vessels may be sampled more than once in a given month. Hence the number of samples collected may exceed the number of different vessels sampled.

Appendix 1

Commercial Shrimp Port Sampling. Monthly Report for February, 2002 (days 1 – 14 of the 25 day season):

This year's DMR port sampling team consists of Lessie White and Marilyn Metcalfe.

The opening of the 2002 shrimp season on Friday, February 15 was marked by bad weather, and while a few boats netted catches of considerable size, the remainder of the fleet did not fare as well. Following opening day, catches began a continuous decline, which prompted nearly all of the boats east of the South Bristol/New Harbor area to quit by the end of the first week. While boats received \$1.00/lb for their opening-day catches, prices quickly dropped to \$.60/lb over the long President's Day weekend as the market became flooded with product and buyers went on holiday. However prices rebounded to \$1.00/lb once the holiday had passed, and by the end of February the price/lb had risen to \$1.30.

Overall, the quality of the shrimp caught in February was much better than shrimp caught during the same month last year. A majority of dragger catches consisted of 3-year-old shrimp, with some 4 year olds and fewer 5 year olds mixed-in. Trappers catches appeared to be primarily made-up of 4 and 5 year old shrimp.

Port sampling began on February 15, and during the 14 days allowed for shrimping between February 15 – 28 shrimp samples and corresponding captain interviews for catch information were obtained from 27 draggers and 8 trappers at 7 dealers from Portland, ME to New Harbor, ME. The lengths of the sampled vessels ranged from 31' to 60'. The price ranged from \$.60/lb to a high of \$1.30/lb by the end of the month.

Boats were sampled at the following 7 dealers: Shaw's Wharf, New Harbor; Pemaquid Fishermens Co-op, Pemaquid; South Bristol Co-op, South Bristol; Atlantic Edge Lobster, Boothbay Harbor; Cundys Harbor Wharf, Cundys Harbor; Portland Fish Exchange, Portland; and River Catch Inc., Portland.

Catches were much higher than in February 2001. Daily catches for the 27 draggers sampled ranged from 288 to 3,835 lbs, the average daily catch was 1,544.1 lbs. The range of catches in lbs/hr drag time (CPUE) was 39.0 – 838.7 lbs/hr, while the average CPUE was 209.5 lbs/hr. (This compares with an average daily catch of 757.1 lbs and an average CPUE of 102.3 lbs/hr for 36 draggers sampled in February 2001.) The 8 trappers sampled hauled 1,083 traps for a total of 6,400 lbs for an average catch of 5.9 lbs/trap and 2.18 lbs/trap/day. (Trappers sampled in February 2001 had an average catch of 4.4 lbs/trap and 1.12 lbs/trap/day).

Many fishermen interviewed expressed concern that, due to the shortness of this years shrimp season, they were being forced to fish on days when weather conditions were unsafe. A couple of captains even reported that sea state conditions were so poor on opening day that they had water in their wheelhouses. It was suggested by 2 fishermen that, if the season is ever shortened again, it should begin at sunrise of opening day rather than midnight. On opening day several boats went out before the sun was up only adding to the already dangerous conditions created by poor weather. "No one was paying any attention to anyone else or could not see

anyone else until the sun came up,” one fisherman commented. Trappers told of losing traps overboard as they tried to set them, and one trapper lost half a load of traps when, due to weather, the load shifted and he was forced to cut them loose. Although he was able to grapple most of them back once the weather let-up, the point remains that conditions posed by a short season and inclement weather were dangerous.

In the port of Cundys Harbor, most shrimpers felt that fishing should take place only on weekdays in order to allow the shrimp markets time to “catch-up” on the weekends. Fishermen from Boothbay Harbor and South Bristol expressed their opinion that the season should have opened a week or 2 earlier.

None of the trappers interviewed felt that regulators had taken their fishery into account this season. They expressed their belief that they would only be able to get-in 1 week of real fishing out of the 3 week season due to the time it takes them to set-out all their traps as well as the time it takes them to get them all in again by the end of closing day. Almost this entire group feels that a separate season for trappers and draggers is needed. One trapper stated “We don’t catch the shrimp unless they have started to drop their eggs and we don’t catch small shrimp so we are not hurting the spawning process.” Most of the captains interviewed, regardless of the type of gear they fish, believe that the shrimp will have moved offshore by the time another 2 weeks has passed.

Commercial Shrimp Port Sampling. Monthly Report for March, 2002 (days 15 – 25 of the 25 day season):

This year’s DMR port sampling team consists of Lessie White and Marilyn Metcalfe.

The catches for the month of March were lower than those of the previous month. Female shrimp began their migration offshore and the areas being fished reflected this point. The count per pound was higher in March than it had been in February due to a larger number of males showing-up in the catch as the boats followed the shrimp offshore. The weather for the first week of March was less than optimal and the last four days of the season were lost completely due to high winds. Boat prices that began the month at \$1.30/lb went as high as \$1.80/lb by the close of the season. The decreasing trend in catches that had begun by the season’s second week continued through the end of the season.

During the 11 days allowed for shrimping between March 1 – 11 shrimp samples and corresponding captain interviews for catch information were obtained from 11 draggers at 4 dealers from Portland, ME to South Bristol, ME. The lengths of the sampled vessels ranged from 40’ to 60’. The price ranged from \$1.30/lb to \$1.80/lb, with the price around \$1.50/lb at the end of the season.

Boats were sampled at the following 4 dealers: South Bristol Co-op, South Bristol; Atlantic Edge Lobster, Boothbay Harbor; Portland Fish Exchange, Portland; and River Catch Inc., Portland.

Catches were a little lower than in March 2001. Daily catches for the 11 draggers sampled ranged from 515 to 1,050 lbs, the average daily catch was 660.4 lbs. The range of catches in lbs/hr drag time (CPUE) was 58.9 – 116.7 lbs/hr, while the average CPUE was 86.7 lbs/hr. (This compares with an average daily catch of 771.6 lbs and an average CPUE of 93.3 lbs/hr for 9 draggers sampled in March 2001.)

Most of the fishermen this month reiterated the feeling that they were being forced to fish in bad weather due to the short length of the season. They also felt that if the season had opened sooner, their catches would have shown that there was plenty of shrimp out there.

SEA URCHINS

Margaret Hunter, Kerry Lyons, and Robert Russell

Introduction

The objective of this program is to collect information about the Maine sea urchin fishery and resource in order to assess the status of the resource, monitor trends in the fishery, and provide information for the management of the fishery.

Maine DMR's sea urchin program has five components: 1) a port sampling project; 2) a dealer logbook project; 3) a fishery-independent summer survey; 4) a computer model to identify possible biological reference points (Chen and Hunter 2003); and 5) other contracted and in-house research projects which, during 2002, investigated large-mesh catch bags for divers, monitored small experimental closed areas to evaluate the usefulness of closed rotational areas, monitored larval settlement, made further refinements to the computer model, and used the summer survey data to develop a spatial model to estimate total urchin biomass for the state.

Regulations and Statutes:

Management of Maine's green sea urchin resource (*Strongylocentrotus droebachiensis*) was initiated in 1992 and new regulations and statutes have been added on an annual basis since that time (Table 1). Management occurs either through the Maine state legislative process, or using the DMR commissioner's regulatory authority and public process. Both DMR and the legislature are advised by the Maine Sea Urchin Zone Council (SUZC), which consists of 6 divers, 6 draggers, 4 buyers, 1 tender, and 2 independent scientists.

The most important management measures include the creation of two exclusive fishing zones (Figure 1), a limited entry licensing system (Table 2), minimum and maximum size limits (2¹/₁₆ and 3 inches respectively), and limits on the fishing season, currently 94 days/yr (Tables 3-4).

Landings:

It is well known from evidence found in "kitchen middens" that Maine's aboriginal inhabitants consumed sea urchins. In more recent times, the first actual records of sea urchin landings date from 1929. Between 1937-1986, sea urchin landings varied between 3,008 and 180,085 lb. valued between \$306.00 and \$9,078.00. These urchins were shipped whole to Chicago, Boston, and New York City (Fulton Fish Market) where they were purchased by ethnic groups of Italian, Spanish, Portuguese, German, Greek, and French descent. In about 1980, a market for Maine sea urchins opened in France. Beginning in the mid 70s, the Japanese were expressing considerable interest in North American urchins and by 1986, because of an improved yen/dollar exchange rate and a decline in the California fishery, the value of Maine sea urchins increased. During 1987, the sea urchin fishery in Maine expanded rapidly, and continued to as processing plants opened on the east coast and a market in Japan developed for processed roe (Amory, 1994). Table 5 shows that landings peaked in 1993 at 42 million lb. Value peaked in 1995 at \$36 million. The fishery has steadily declined since then as a result of over fishing, as well as size

restrictions, harvester attrition, die-offs, and shortened seasons. Improvements in the price allowed the fishery to continue to maintain a value of about \$20 million annually until 2001, when it dropped to \$12 million. Preliminary landings for 2002 are about 6.2 million lb. (2.8 mt) valued at \$7.6 million.

Landings data were compiled by NMFS port agents until the beginning of the 1996-97 fishing season. During August 1996 the state of Maine implemented a mandatory dealer reporting system ("logbook"), from which landings are now derived.

Figure 2 presents recent landings data and illustrates the shift of the fishery from Zone 1 to Zone 2 over the years.

Fishing Methods:

Approximately 80% of the sea urchins landed in Maine are hand-harvested by divers; the rest are caught by small (30-45 ft) draggers, most using light "Green" drags. Dragging occurs mostly in Washington County, where extreme tides causing strong currents and poor visibility make diving difficult. Almost all fishing occurs in shallow (5-60ft) water (Tables 6-7).

Season:

The sea urchin harvesting season was 365 days long between 1987-1992 (Table 3). Beginning in 1993, the season length was gradually reduced to the 2002-2003 season of 94 days. The selection of these 94 days is the joint responsibility of the Department of Marine Resources and the SUZC. Factors such as harvest method, fishing zone, market conditions, holidays, demand and spawning conditions are considered in the selection of fishing days. Calendars for the 2001-2002 season are shown in Table 4a and 4b.

Commercial Port Sampling Program

Job #1

Job Title: Sea Urchin Port Sampling

Objective:

Determine spatial/temporal patterns in catch, effort, catch per unit effort, gonad condition, size composition, percent roe, and test (shell) condition of dive and drag harvested urchins, that could be useful for resource monitoring, assessment, and management.

Methods:

The commercial sea urchin port sampling program was initiated during the 1994-1995 season. During that season, interviews were collected coast wide by telephone surveys. Since the 1995-1996 season, we have collected interview and size information from a commercial port sampling program conducted at buying stations along the entire coast. We attempt to sample twice a week

(once in each zone) at randomly selected buying stations, during weather conditions when harvesters are active. Sampling activities are usually confined to locations where at least 5 harvesters are expected to unload their catches.

We try to proportionally allocate the sampling trips to each county (York, Cumberland, Sagadahoc, Lincoln, Knox, Hancock, and Washington) by the importance of the county to overall landings. More interviews and samples are obtained in counties with more buying stations and more landings. The sampling of urchin landings by proportional allocation is complicated by a constant change in the numbers and locations of buying stations during the course of the season.

The coast of Maine has been divided into two management zones in order to control urchin-harvesting effort and establish harvesting seasons that are based upon the urchin reproductive cycle. Spawning occurs earlier in western Maine (Zone 1) and Zone 1 opens and closes sooner than Zone 2 (eastern Maine) because the product (uni) is not desirable during spawning. The division line between Zone 1 and Zone 2 occurs in Penobscot Bay (Figure 1) with York, Cumberland, Sagadahoc, Lincoln, and part of Knox counties in Zone 1, and Hancock, Washington, and part of Knox counties in Zone 2.

Results and Discussion:

During the 2001-2002 season, port samplers interviewed 266 divers and 48 draggers. The breakdown of diver interviews by county fished was York (1), Cumberland (6), Sagadahoc/Lincoln (32), Knox (108), Hancock (85), and Washington (34). Dragger interviews were in Knox (2), Hancock (10), and Washington (36). Port samplers also measured and weighed 4,560 urchins from 228 catches in both zones.

The fishing locations of all the harvesters interviewed are plotted in Figure 3 by 10-minute square, with a dot in the middle of the 10-minute square.

The total weight of the catches that were sampled was 142,200 lbs. The total landings for the state for the season was 7,850,572 lbs. Therefore, the percentage of landings that were sampled, or sampling intensity, was 2.14% (Table 8c).

A summary of information recorded from diver and dragger interviews during the 2001-2002 season is shown in Tables 6 and 7 respectively. Table 6 shows that the mean (average) diver age was 36.7, the mean minimum and mean maximum diver harvest depths were 11.7 and 26.2 ft. respectively, the mean catch per diver day was 529.6 lbs., the mean percent roe was 13.4%, and the mean number of bottom hours was 3.7. Table 7 shows that the mean dragger boat length was 35.2 ft., the mean minimum and mean maximum dragger harvest depths were 21.7 and 38.2 ft. respectively, the mean catch per dragger-day was 532.5 lbs., the mean percent roe was 13.8%, the mean numbers of hours fished was 5.8, the mean number of minutes per tow was 7.8, and the mean number of tows per dragger-day was 36.7. Other important parameters are also listed in Tables 6 and 7. Selected information mentioned above for the 2001-2002 season is compared with previous seasons in Table 9.

CPUE for both divers and draggers is presented in Table 8a-b and Figures 4-6. A comparison of the pounds per bottom hour summarized from diver interviews conducted during 8 consecutive harvesting seasons (Figure 6), shows that CPUE has been consistently higher in Zone 2 than in Zone 1, but that it has been declining steadily in Zone 2. A drop in both zones between 2000-01 and 2001-02 could be attributed to an increase in the minimum size for 2001-02 (from 2 inches with a 5% tolerance by number to $2\frac{1}{16}$ inches with a 5% tolerance by number).

It is likely that CPUE is not a good index of stock abundance for this fishery. Anecdotal information from harvesters, as well as our analytical analyses, suggest that the resource is in better condition in Zone 2 than in Zone 1, and that it has been increasingly stressed in both zones since the port sampling began. If that is so, why has CPUE not declined steadily in Zone 1? We suspect that divers who cannot maintain catch levels of at least 135-150 pounds per bottom hour leave the fishery, and that attrition in Zone 1 has removed those harvesters who were the least successful. In other words, CPUE in Zone 1 has "bottomed out", and will not be a useful indicator of stock status in the future unless it is combined with an attrition rate factor, or until it increases. This theory is supported by the licensing data in Table 2, which show that the Zone 1 diver attrition rate has been 60% between 1995 and 2002, while Zone 2 diver attrition has been 41% for the same period.

No attempt will be made to draw conclusions from dragger CPUE information (Figure 5 and Table 8b) because of small sample sizes. The overall CPUE for draggers, expressed as lbs./foot drag width/ hour towed, has remained fairly constant during the first seven seasons, with a drop in 2001-02 that could be accounted for in part by the increased minimum size limit.

Expanded size (diameter) frequency information summarized from commercial samplings, and expressed as a percentage of the weight (not numbers) of the commercial catch is shown in Figures 7-9. Expressing these data by weight instead of numbers is useful for analyzing the effect on catches of possible changes in legal size limits. Figure 10 shows the size frequency as a percentage of the catch in numbers (not weight). Figures 9 and 10 show that 6.6% of the landed catch in weight, which was 9.5% by number, are undersized (less than $2\frac{1}{16}$ inches or 52.4 mm in diameter). This suggests that the industry had difficulty complying with the new minimum size limit. There does not appear to be a compliance problem with the 3-inch maximum size limit.

The percentage (by number) of the catch less than $2\frac{1}{4}$ inches and less than 2 inches is plotted over time in Figure 11. This suggests that the proportion of smaller urchins in the catches has been steadily increasing, and that the increase in the minimum size in 2001-02 was successful in reducing the proportion of small urchins.

Sea Urchin Fishery-Independent Survey

Job #2

Job Title: Sea Urchin Survey, lead diver.

Objective:

Conduct a survey of Maine's sea urchin resource using SCUBA diving and underwater camera techniques, to develop a time series of abundance indices and biomass estimates for the state by region.

Introduction:

Although our port sampling and logbook programs provide important information about the fishery, they cannot tell us the quantity, size, or health of the urchins that remain in the water when the season is over.

Other researchers have been monitoring larval abundances, which may or may not reflect adult stock abundance. Several research projects have evaluated urchin stocks at several Maine locations, and although useful, these were short-term studies with different purposes.

In 2001 a formal stock assessment model was developed, but because it uses mostly fishery-dependent data, its results are likely to be biased. An unbiased estimate of sea urchin abundance is required. An annual fishery-independent survey can provide this information. The survey will also allow us to identify areas that may have been impacted by a die-off, and also allow us to quantify young urchins coming along.

Methods:

We worked with several scientists and harvesters to design a survey that used both divers (shallow) and a remotely-deployed video camera (deep) to count and measure urchins at 292 sites from Kittery to Eastport in 2001. The survey took nine weeks using three urchin industry vessels and four urchin industry divers.

The state's coastline was divided into 9 regions, each of roughly equal economic importance, that is, with roughly equal sea urchin landings in 2000 (Figure 12). 20 sites were chosen randomly for the dive portion of the survey in each of the 9 regions, and another 20 for the video camera portion. The dive sites were chosen from areas with hard bottom and a complete depth profile from 15m (49 ft.) to 0m. Camera sites were chosen from hard bottom in the 15-40m (49-131ft.) depth range. A few sites in each region turned out to be unsuitable, but a goal was made and achieved to sample at least 16 dive sites and 16 camera sites in each of the 9 regions.

The survey was divided into three legs, and three industry vessels, each supplying a captain and an experienced urchin diver, were hired, one for each leg. Another commercial urchin diver was hired for the entire survey period. A fifth diver from DMR was the lead diver and scientist for the project.

At each of the dive sites, 90 quadrats were evaluated. Three divers began their dives at the deepest end of the site and swam toward shore (see picture on cover). They each carried a 1 square meter frame made of PVC pipe. They each dropped this frame haphazardly ten times each in the 10-15m (33-49 ft.) depth range (stratum), again in the 5-10m (16-33 ft.) depth range, and again in the 0-5m (0-16 ft.) depth range. All urchins 10mm and larger within the frame (quadrat) were counted, and the algal cover was evaluated. At one randomly selected quadrat from each depth range, each diver collected all the urchins in the quadrat, brought them to the surface, measured their diameters to the nearest mm., and released them.

At the deeper sites, a video camera mounted on a ½ square meter frame was lowered from the boat until it rested on the bottom. About 10 seconds of video footage was filmed, then the frame was raised for a few seconds while the boat drifted and the frame was lowered again. This was repeated for 10 filmings, or quadrats, at each site. The film was later viewed and evaluated for sea urchin abundance, size, and algal cover.

Design changes from 2001 for the 2002 survey:

Results from a computer simulation that resampled the urchin abundance data for each site and depth stratum 10,000 times, varying the number of quadrats sampled, showed that improvements in relative error became minor when more than about 20 quadrats per depth stratum per site were sampled (Figure 13) (Robert Grabowski, U. Maine School of Marine Science, unpublished). The sites chosen for this analysis and shown in Figure 13 were the “worst case” sites, that is, the sites with the greatest variance in urchin abundance among the quadrats sampled. Based on this analysis, only 2 divers were utilized to evaluate 20 quadrats per depth stratum per site in 2002, instead of 3 divers evaluating 30 quadrats. This significantly reduced the cost of the survey without significantly increasing the variability of the results.

Other reductions in cost were achieved by reducing the number of dive sites sampled in each region from 16 to 15 and the number of camera sites from 16 to 10. This resulted in a total of 226 sites visited in 2002.

Another change was the assignment of 5 dive sites and 3 camera sites in each region as “sentinel sites”, that is, sites from the 2001 survey that were chosen to be visited again in 2002. We asked harvesters to recommend sites to us, from those sampled in 2001 that were of historical importance as urchin producing sites, and will continue to monitor these 72 sites each year. The other 154 sites visited in 2002 were chosen randomly from suitable substrate within each region, the same way all the sites were chosen in 2001.

One further addition to the 2002 survey was the counting and measuring of subsamples of the crabs *Cancer borealis* and *Cancer irroratus*, which have been reported as increasingly important predators of Maine’s sea urchins.

Results and Discussion:

The 2002 survey was conducted between May 15 and July 10, 2002. 226 sites were evaluated: 72 sentinel sites and 154 randomly selected sites.

Sea urchin abundances (counts) and average abundance (counts per square meter for the dive sites, per ½ square meter for the camera sites) have been calculated for each site and for each depth stratum (Table 10), for each of the nine regions. A total of 81,698 urchins were counted in 8,510 quadrats, for an average of 9.9 urchins per quadrat statewide, compared with 8.8 urchins per quadrat in 2001.

It should be noted that the abundances are calculated regardless of the urchin's size or quality. Some of the highest densities (such as in Cobscook Bay and one site in Casco Bay) were almost entirely below the legal minimum size.

Although there were, on average, more urchins per quadrat in 2002 than in 2001, this increase was due to a relatively small number of sites that showed a remarkable increase in the number of small (<30mm) urchins.

A spatial analysis was conducted to estimate total biomass (Robert Grabowski and Kate Jones, U. Maine School of Marine Science, unpublished and Grabowski MS thesis, 2003). This analysis used spatial analysis tools to develop a density model for each of the 4 depth strata for 5 size categories of urchins for each of the two management zones. Each of these 40 density models was then applied to the coastal areas that had suitable substrates (rock or gravel) in that depth range. Applying a length-weight relationship developed from our port samples provided a biomass estimate for each of these models. By adding model estimates together, total urchin biomass was estimated for each management zone:

	2001	2002
Zone 1	50,000 mt	28,000 mt
Zone 2	200,000 mt	164,000 mt
Total	250,000 mt	192,000 mt

Certainly further work is required to evaluate the uncertainty of these estimates. They suggest that although there was an increase in the overall average number of urchins per quadrat, there was a decline in biomass in both zones from 2001 to 2002.

Urchin abundances at the 72 sentinel sites are plotted in Figure 14. Seventeen sites showed an increase in abundance, 33 sites declined, and 22 sites had no change because there were no urchins in either year. There was no obvious spatial pattern in these trends. Further work is required to determine whether these differences are statistically significant.

Much of our effort in the first two years of this survey has been spent in perfecting the survey design and efficiency, the database design and data entry screens, and working with industry to reduce survey costs. Further analysis on design efficiency, in particular the determination of the optimum number of sites and strata, is underway. Much more analysis must be conducted to

estimate total and exploitable biomass, develop an appropriate abundance index, evaluate algal cover and crab abundance, and evaluate temporal and spatial variance in the abundance data.

Literature Cited:

Chen, Y. and M. Hunter. 2003. Assessing the green sea urchin (*Strongylocentrotus drobachensis*) stock in Maine, USA. *Fisheries Research* 60: 527-537.

Table 1. History of the Management Laws and DMR Regulations (reg) for the Maine Green Sea Urchin Fishery. (Laws and regulations usually go into effect during the late summer.)

Before 1992

- Commercial fishing license (\$33) required annually (law)

1992

- \$89 sea urchin licenses required for hand harvesting and dragging annually (law)

1993

- Minimum size limit of 2 in. (law) (probably not enforced until 1994)
- Authority to adopt rules on drag size, nighttime dragging, and tolerance on under-sized urchins granted to DMR (law)
- Nighttime harvesting of urchins prohibited (reg, effective Dec. 22, 1993)
- 10% tolerance on sea urchins less than 2 in. (reg, effective Dec. 22, 1993)
- Urchin drag width restricted to 5½ ft. (reg, effective Dec. 22, 1993)

1994

- Research surcharge on licenses: \$160/harvester, \$500/buyer, \$2500/processor annually (law)
- Sea urchin research fund established (law)
- Moratorium on new licenses (law)
- Two fishing zones established with seasons (did not take effect until 1995) (law):
Zone 1: Closed Apr. 1 - Aug. 15, Zone 2: Closed May 15 - Oct. 1
- Authority to adopt rules for processor/buyer logbooks granted to DMR (law)
- Permits for buyers and processors required (law)
- Safety training required for divers, effective 1995 (law)

1995

- Modified season closures (law):
Zone 1: Apr. 1 - Aug. 31 (not enacted in time for Zone 1 opening on Aug. 16, 1995)
Zone 2: May 1 - Oct.
- Hand-raking and trapping license added (\$89 plus \$160 surcharge annually) (law)
- Exception to license moratorium due to medical conditions and deceased license transfer to family members (law)
- Authority to extend closing dates for entire zones or portions thereof, to conserve spawning urchins, granted to DMR (has never been exercised) (law)
- License (\$89) and surcharge (\$35) annually and safety training required for tenders (law)

1996

- Sea Urchin Zone Council established (to advise on selection of fishing days), consisting of: 3 draggers, 3 divers, 1 buyer, and 1 processor from each zone plus 2 scientists (law)
- Fishing days limited to 150 per year in Zone 1 and 170 in Zone 2 (law)
- Limitations on switching zones - cap at the zone's previous year's total (law)
- Logbooks required from buyers/processors (reg)

Table 1 continued

- Modified zone season closure: May 1 – July 31, for both zones (law)
- Draggers not allowed to fish during August or Sept. (law)
- Violations of sea urchin laws result in mandatory \$500 fine (law)

1997

- Fishing days limited to 120 per year in each Zone (reg)
- Role of Sea Urchin Zone Council expanded: recommend fishing days, the spending of the research fund, and other matters of interest to the urchin industry (law)
- Harvesters cannot switch zones during the open season (law)

1998

- Role of Sea Urchin Zone Council expanded: recommend limited entry ratio (law)
- Lottery for issuing a limited number of new licenses (law and reg)
- Up to 30% of license surcharge may be used for enforcement overtime (law)
- Two seasons in Zone 2 (harvester chooses one) (law)
Early: Oct.-Mar. or Late: Nov.-Apr.
- Tender added to Zone Council (law)

1999

- Surcharge may be used for Council support, 30% for law enforcement (law)
- Failure to submit logbook reports may prevent license renewal (law)
- No possession of urchins on boat during no-fishing day (law)
- Mandatory suspension of license for violation of season or zone restrictions (law)
- Condition for switching zones: 1 in for 1 out (law)
- Sea Urchin Zone Council membership changed to 2 buyer/processors per zone (law)
- Six small areas closed for research (reg)

2000

- No exceptions to the license moratorium for medical conditions; no transfer of deceased harvester's license to family members (law)
- Minimum size tolerance reduced from 10% to 5% (reg)
- Season reduced to 110 days per year (reg)
- Maximum size of 3½" established, with a 5% tolerance, to be reduce to 3 3/8" in 2001 and reduced again to 3¼" in 2002 (reg) (but see 2001)
- Casco Bay research area closed for reseeding (reg)

2001

- Season reduced to 94 days per year (reg)
- Minimum size increased to 2 1/16", 5% tolerance (reg)
- Maximum size reduced to 3.0", 5% tolerance (reg)
- DMR given authority to implement limited entry system (law, see 2002 for reg)
- Drag license holder must be on boat, exceptions for multiple license holders, one-time transfer of license allowed (law)

Table 1 continued

- Surcharge may be used for Council travel expenses (law)
- Mandatory suspension of license for violation of closed areas (law)
- Diving from a vessel with urchins aboard illegal without license etc. (law)
- Processor's surcharge reduced from \$2500 to \$1000. (law)

2002

- One-time expansion of drag license eligibility. (law)
- Limited entry license lottery system as defined in law in 1998 repromulgated in regulation with minor changes. (reg)

Table 2. Maine Sea Urchin Licenses (issued annually)

2002	Zone 1	Zone 2	Totals
Divers	246	343	589
Draggers	53	242	295
Raker/Trappers	2	1	3
Tenders			355
Buyers			23
Processors			12
Harvester Total	301	586	887

2001	Zone 1	Zone 2	Totals
Divers	281	383	664
Draggers	65	240	305
Raker/Trappers	2	2	4
Tenders			453
Buyers			30
Processors			11
Harvester Total	348	625	973

2000	Zone 1	Zone 2	Totals
Divers	313	407	720
Draggers	74	242	316
Raker/Trappers	2	2	4
Tenders			530
Buyers			31
Processors			18
Harvester Total	389	651	1,040

1999	Zone 1	Zone 2	Totals
Divers	332	437	769
Draggers	87	252	339
Raker/Trappers	2	2	4
Tenders			538
Buyers			42
Processors			15
Harvester Total	421	691	1,112

1998	Zone 1	Zone 2	Totals
Divers	348	460	808
Draggers	95	260	355
Raker/Trappers	1	1	2
Tenders			544
Buyers			51
Processors			18
Harvester Total	444	721	1,165

1997	Zone 1	Zone 2	Totals
Divers	405	514	919
Draggers	133	287	420
Raker/Trappers	1	2	3
Tenders			648
Buyers			65
Processors			20
Harvester Total	539	803	1,342

1996	Zone 1	Zone 2	Totals
Divers	501	562	1,063
Draggers	167	327	494
Raker/Trappers	2	4	6
Tenders			730
Buyers			70
Processors			19
Harvester Total	670	893	1,563

1995	Zone 1	Zone 2	Totals
Divers	611	580	1,191
Draggers	237	404	641
Raker/Trappers	3	5	8
Tenders			736
Buyers			96
Processors			18
Harvester Total	851	989	1,840

(No Zones, No Buyer/Processor Permits)	1994	1993	1992
Divers	1,725	1,437	829
Draggers	1,000	567	246
Tenders	843	-	-
Harvester Total	2,725	2,004	1,075

Table 3. The Annual (top) or Seasonal (bottom) Number of Open Fishing Days

Year or Season	Total Days		
1986	365		
1987	365		
1988	365		
1989	365		
1990	365		
1991	365		
1992	365		
1993	335		
		Zone 1 Days	Zone 2 Days
1994-1995		228	225
1995-1996		228	211
1996-1997		150	170
1997-1998		120	120
1998-1999		120	120
1999-2000		120	120
2000-2001		110	110
2001-2002		94	94
2002-2003		94	94

Table 4a. 2001-02 Sea Urchin Season Calendar for Zone 1

☒ = Closed

☐ = Open

Divers, Rakers, and Trappers

September 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X						

October 2001						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8 X	9 X	10 X	11 X	12 X	13 X
14 X	15 X	16 X	17 X	18 X	19 X	20 X
21 X	22 X	23 X	24 X	25 X	26 X	27 X
28 X	29 X	30 X	31 X			

November 2001						
S	M	Tu	W	Th	F	S
				1 X	2 X	3 X
4 X	5 X	6 X	7 X	8 X	9 X	10 X
11 X	12 X	13 X	14 X	15 X	16 X	17 X
18 X	19 X	20 X	21 X	22 X	23 X	24 X
25 X	26 X	27 X	28 X	29 X	30 X	

December 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X	31 X					

January 2002						
S	M	Tu	W	Th	F	S
		1 X	2 X	3 X	4 X	5 X
6 X	7 X	8 X	9 X	10 X	11 X	12 X
13 X	14 X	15 X	16 X	17 X	18 X	19 X
20 X	21 X	22 X	23 X	24 X	25 X	26 X
27 X	28 X	29 X	30 X	31 X		

February 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4 X	5 X	6 X	7 X	8 X	9 X
10 X	11 X	12 X	13 X	14 X	15 X	16 X
17 X	18 X	19 X	20 X	21 X	22 X	23 X
24 X	25 X	26 X	27 X	28 X		

March 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4 X	5 X	6 X	7 X	8 X	9 X
10 X	11 X	12 X	13 X	14 X	15 X	16 X
17 X	18 X	19 X	20 X	21 X	22 X	23 X
24 X	25 X	26 X	27 X	28 X	29 X	30 X
31 X						

April 2002						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8 X	9 X	10 X	11 X	12 X	13 X
14 X	15 X	16 X	17 X	18 X	19 X	20 X
21 X	22 X	23 X	24 X	25 X	26 X	27 X
28 X	29 X	30 X				

☒ = Closed

☐ = Open

Draggers

September 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X						

October 2001						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8 X	9 X	10 X	11 X	12 X	13 X
14 X	15 X	16 X	17 X	18 X	19 X	20 X
21 X	22 X	23 X	24 X	25 X	26 X	27 X
28 X	29 X	30 X	31 X			

November 2001						
S	M	Tu	W	Th	F	S
				1 X	2 X	3 X
4 X	5 X	6 X	7 X	8 X	9 X	10 X
11 X	12 X	13 X	14 X	15 X	16 X	17 X
18 X	19 X	20 X	21 X	22 X	23 X	24 X
25 X	26 X	27 X	28 X	29 X	30 X	

December 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X	31 X					

January 2002						
S	M	Tu	W	Th	F	S
		1 X	2 X	3 X	4 X	5 X
6 X	7 X	8 X	9 X	10 X	11 X	12 X
13 X	14 X	15 X	16 X	17 X	18 X	19 X
20 X	21 X	22 X	23 X	24 X	25 X	26 X
27 X	28 X	29 X	30 X	31 X		

February 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4 X	5 X	6 X	7 X	8 X	9 X
10 X	11 X	12 X	13 X	14 X	15 X	16 X
17 X	18 X	19 X	20 X	21 X	22 X	23 X
24 X	25 X	26 X	27 X	28 X		

March 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4 X	5 X	6 X	7 X	8 X	9 X
10 X	11 X	12 X	13 X	14 X	15 X	16 X
17 X	18 X	19 X	20 X	21 X	22 X	23 X
24 X	25 X	26 X	27 X	28 X	29 X	30 X
31 X						

April 2002						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8 X	9 X	10 X	11 X	12 X	13 X
14 X	15 X	16 X	17 X	18 X	19 X	20 X
21 X	22 X	23 X	24 X	25 X	26 X	27 X
28 X	29 X	30 X				

Table 4b. 2001-02 Sea Urchin Season Calendar for Zone 2

X = Closed

□ = Open

Early Season for Divers, Draggers, Rakers, and Trappers

September 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X						

October 2001						
S	M	Tu	W	Th	F	S
	1	2	3	4	5 X	6 X
7 X	8	9	10	11 X	12 X	13 X
14 X	15	16	17	18 X	19 X	20 X
21 X	22	23	24	25 X	26 X	27 X
28 X	29	30	31			

November 2001						
S	M	Tu	W	Th	F	S
				1 X	2 X	3 X
4 X	5	6	7	8 X	9 X	10 X
11 X	12	13	14	15 X	16 X	17 X
18 X	19	20	21	22 X	23 X	24 X
25 X	26	27	28	29	30 X	

December 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3	4	5	6	7 X	8 X
9 X	10	11	12	13	14 X	15 X
16 X	17	18	19	20	21 X	22 X
23 X	24	25 X	26	27	28	29 X
30 X	31 X					

January 2002						
S	M	Tu	W	Th	F	S
		1 X	2	3	4	5 X
6 X	7	8	9	10	11 X	12 X
13 X	14	15	16	17	18 X	19 X
20 X	21	22	23	24	25 X	26 X
27 X	28	29	30	31		

February 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4	5	6	7	8 X	9 X
10 X	11	12	13	14	15 X	16 X
17 X	18	19	20	21	22 X	23 X
24 X	25	26	27	28		

March 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4	5	6	7	8 X	9 X
10 X	11	12	13	14	15 X	16 X
17 X	18	19	20	21 X	22 X	23 X
24 X	25	26	27	28	29 X	30 X
31 X						

April 2002						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8	9	10	11 X	12 X	13 X
14 X	15	16	17	18 X	19 X	20 X
21 X	22	23	24	25 X	26 X	27 X
28 X	29	30				

X = Closed

□ = Open

Late Season for Divers, Draggers, Rakers, and Trappers

September 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3 X	4 X	5 X	6 X	7 X	8 X
9 X	10 X	11 X	12 X	13 X	14 X	15 X
16 X	17 X	18 X	19 X	20 X	21 X	22 X
23 X	24 X	25 X	26 X	27 X	28 X	29 X
30 X						

October 2001						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8	9	10	11 X	12 X	13 X
14 X	15	16	17	18 X	19 X	20 X
21 X	22	23	24	25 X	26 X	27 X
28 X	29	30	31			

November 2001						
S	M	Tu	W	Th	F	S
				1 X	2 X	3 X
4 X	5	6	7	8 X	9 X	10 X
11 X	12	13	14	15 X	16 X	17 X
18 X	19	20	21	22 X	23 X	24 X
25 X	26	27	28	29	30 X	

December 2001						
S	M	Tu	W	Th	F	S
						1 X
2 X	3	4	5	6	7 X	8 X
9 X	10	11	12	13	14 X	15 X
16 X	17	18	19	20	21 X	22 X
23 X	24	25 X	26	27	28	29 X
30 X	31 X					

January 2002						
S	M	Tu	W	Th	F	S
		1 X	2	3	4	5 X
6 X	7	8	9	10	11 X	12 X
13 X	14	15	16	17	18 X	19 X
20 X	21	22	23	24	25 X	26 X
27 X	28	29	30	31		

February 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4	5	6	7	8 X	9 X
10 X	11	12	13	14	15 X	16 X
17 X	18	19	20	21	22 X	23 X
24 X	25	26	27	28		

March 2002						
S	M	Tu	W	Th	F	S
					1 X	2 X
3 X	4	5	6	7	8 X	9 X
10 X	11	12	13	14	15 X	16 X
17 X	18	19	20	21 X	22 X	23 X
24 X	25	26	27	28	29 X	30 X
31 X						

April 2002						
S	M	Tu	W	Th	F	S
	1 X	2 X	3 X	4 X	5 X	6 X
7 X	8	9	10	11 X	12 X	13 X
14 X	15	16	17	18 X	19 X	20 X
21 X	22	23	24	25 X	26 X	27 X
28 X	29	30				

**Table 5. Maine Sea Urchin Landings and Value.
Annually (top), and by Fishing Season and Method (bottom).**

<u>Year</u>	<u>Zone 1 Lbs</u>	<u>Zone 2 Lbs</u>	<u>Unknown</u>	<u>Total Lbs</u>	<u>mt</u>	<u>Value \$</u>	<u>Price/Lb</u>
1987	703,117	737,044	0	1,440,161	653	236,391	0.16
1988	4,785,426	1,436,178	0	6,221,604	2,822	1,758,805	0.28
1989	8,197,758	1,459,300	0	9,657,058	4,380	3,698,118	0.38
1990	10,839,402	1,663,010	956,250	13,458,662	6,105	6,045,618	0.45
1991	15,982,088	4,553,323	0	20,535,411	9,315	11,158,425	0.54
1992	16,843,094	9,896,348	0	26,739,442	12,129	15,322,447	0.57
1993	24,318,751	17,822,387	0	42,141,138	19,115	27,103,054	0.64
1994	18,486,945	19,805,992	2,675	38,295,612	17,371	33,081,336	0.86
1995	17,326,155	17,260,255	103,900	34,690,310	15,735	36,154,579	1.04
1996	13,384,298	12,455,302	0	25,839,600	11,721	28,983,365	1.12
1997	7,202,556	12,177,700	0	19,380,256	8,791	21,103,986	1.09
1998	6,170,825	10,056,001	0	16,226,826	7,360	18,466,554	1.14
1999	5,532,139	9,746,586	0	15,278,725	6,930	19,780,181	1.29
2000	4,738,053	8,029,889	0	12,767,942	5,792	17,689,186	1.39
2001	4,057,174	5,991,024	0	10,048,198	4,558	12,969,300	1.29
*2002	2,401,260	3,859,956	0	6,261,216	2,840	7,571,984	1.21

<u>Season</u>	<u>Diver Lbs</u>	<u>Dragger Lbs</u>	<u>Raker Lbs</u>	<u>Unknown</u>	<u>Total Lbs</u>	<u>Value \$</u>	<u>Price/Lb</u>
1996-97	18,448,266	3,987,435	30,674	1,388,234	23,854,609	26,580,434	1.11
1997-98	13,859,985	3,028,436	28,595	31,684	16,948,700	18,339,532	1.08
1998-99	13,365,737	3,228,624	32,766	75,811	16,702,938	20,102,119	1.20
1999-00	10,960,385	2,900,783	22,445	171,502	14,055,115	18,858,460	1.34
2000-01	9,110,119	2,657,862	17,279	32,700	11,817,960	16,119,624	1.36
*2001-02	6,017,163	1,820,012	13,397	0	7,850,572	9,717,479	1.24

* Preliminary

Table 6. Maine Sea Urchin Diver Catch/Effort Summary for 2001-2002

Catch Location		Age	Exper	Depth				Weather	Catch (per Diver-Day)				Effort (per Diver-Day)		Catch/Effort Statistics			
		(Yrs)	(Yrs)	Ft(Min)	Ft(Max)	M(Min)	M(Max)	*Code	Pounds	Price/Lb	Value(\$)	Net Roe %	BottomHrs	AwayHrs	Lbs/AwayHr	\$/AwayHr	Lbs/BotmHr	\$/BotmHr
York County	Mean	49.0	12.0	5.0	20.0	1.5	6.1	2.0	360.0	2.00	720.00	12.0	4.0	6.5	55.4	110.77	90.0	180.00
	Std Dev																	
	Std Err																	
	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cumberland County	Mean	38.3	7.8	10.8	23.3	3.3	7.1	1.3	586.0	1.7	1003.33	11.7	3.2	7.0	80.6	139.25	187.9	317.31
	Std Dev	4.59	3.19	12.01	9.31	3.66	2.84	0.52	237.02	0.31	420.48	1.86	1.03	1.82	16.16	41.11	64.97	111.23
	Std Err	1.87	1.30	4.90	3.80	1.49	1.16	0.21	96.76	0.12	171.66	0.76	0.42	0.74	6.60	16.78	26.53	45.41
	N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Sagadahoc - Lincoln	Mean	36.9	9.4	14.4	32.4	4.4	9.9	1.6	425.3	1.10	478.39	13.8	3.3	6.2	67.3	75.28	130.5	143.37
	Std Dev	7.32	3.43	10.77	11.73	3.28	3.57	0.61	223.13	0.21	281.56	3.29	1.29	1.44	31.31	40.72	50.22	59.31
	Std Err	1.29	0.61	1.90	2.07	0.58	0.63	0.11	39.44	0.04	49.77	0.58	0.23	0.25	5.53	7.20	8.88	10.48
	N	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Knox-Waldo Counties	Mean	36.7	9.9	8.1	22.9	2.5	7.0	2.1	551.4	1.13	633.46	12.9	3.9	7.6	74.4	84.62	145.2	163.90
	Std Dev	5.38	2.55	7.52	7.95	2.29	2.42	0.76	228.20	0.21	332.77	1.99	1.07	1.73	30.23	42.20	48.84	66.36
	Std Err	0.52	0.25	0.72	0.76	0.22	0.23	0.07	22.06	0.02	32.17	0.19	0.10	0.17	2.92	4.08	4.72	6.42
	N	106	108	108	108	108	108	108	107	107	107	107	108	108	107	107	107	107
Hancock County	Mean	37.0	10.0	12.2	26.8	3.7	8.2	1.8	518.8	1.11	556.70	14.0	3.8	7.4	71.1	75.16	136.9	149.05
	Std Dev	6.60	2.69	11.16	11.89	3.40	3.62	0.75	248.66	0.36	275.83	1.61	1.08	1.33	32.90	34.13	59.08	73.14
	Std Err	0.72	0.29	1.21	1.29	0.37	0.39	0.08	26.97	0.04	29.92	0.17	0.12	0.14	3.57	3.70	6.41	7.93
	N	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Washington County	Mean	35.1	10.6	19.6	30.0	6.0	9.1	1.8	580.9	0.82	487.01	13.8	3.4	5.6	107.4	90.12	172.5	143.54
	Std Dev	4.85	3.86	8.07	9.44	2.46	2.88	0.76	255.50	0.20	278.68	2.36	0.84	1.64	44.96	47.50	73.64	72.68
	Std Err	0.84	0.67	1.38	1.62	0.42	0.49	0.13	43.82	0.03	47.79	0.41	0.14	0.28	7.71	8.15	12.63	12.46
	N	33	33	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
All Combined	Mean	36.7	9.9	11.7	26.2	3.6	8.0	1.9	529.6	1.09	580.02	13.4	3.7	7.1	76.8	82.50	145.0	157.58
	Std Dev	6.02	2.92	10.07	10.51	3.07	3.20	0.75	240.26	0.31	314.45	2.18	1.09	1.71	35.08	41.27	57.62	73.82
	Std Err	0.37	0.18	0.62	0.64	0.19	0.20	0.05	14.76	0.02	19.32	0.13	0.07	0.10	2.16	2.54	3.54	4.53
	N	263	265	266	266	266	266	266	265	265	265	265	266	266	265	265	265	265

* Weather code: 1 = Worse than average, 2 = Average, 3 = Better than average, for this time of year.

Table 7. Maine Sea Urchin Dragger Catch/Effort Summary for 2001-2002

Catch Location		Boat (Ft)	No. of Crew	Depth				Weather *Code	Catch (per Dragger-Day)			
				Ft(Min)	Ft(Max)	M(Min)	M(Max)		Pounds	Price/Lb	Value(\$)	Net Roe %
Knox-Waldo Counties	Mean	40.0	2.5	10.0	27.5	3.0	8.4	2.0	411.0	1.00	411.00	12.5
	Std Dev	0.00	0.71	0.00	3.54	0.00	1.08	0.00	21.21	0.00	21.21	0.71
	Std Err	0.00	0.50	0.00	2.50	0.00	0.76	0.00	15.00	0.00	15.00	0.50
	N	2	2	2	2	2	2	2	2	2	2	2
Hancock County	Mean	33.7	2.9	11.5	26.5	3.5	8.1	2.6	486.9	0.98	499.11	12.8
	Std Dev	4.60	0.32	7.47	9.14	2.28	2.79	0.52	194.19	0.33	325.44	0.98
	Std Err	1.45	0.10	2.36	2.89	0.72	0.88	0.16	61.41	0.10	102.91	0.31
	N	10	10	10	10	10	10	10	10	10	10	10
Washington County	Mean	35.4	2.2	25.2	42.0	7.7	12.8	1.4	551.9	0.96	528.70	14.1
	Std Dev	3.33	0.52	20.91	24.45	6.37	7.45	0.60	318.19	0.28	326.95	3.68
	Std Err	0.56	0.09	3.49	4.08	1.06	1.24	0.10	53.03	0.05	54.49	0.61
	N	36	36	36	36	36	36	36	36	36	36	36
All Combined	Mean	35.2	2.4	21.7	38.2	6.6	11.6	1.7	532.5	0.97	517.63	13.8
	Std Dev	3.71	0.56	19.34	22.51	5.89	6.86	0.75	289.80	0.28	317.08	3.27
	Std Err	0.54	0.08	2.79	3.25	0.85	0.99	0.11	41.83	0.04	45.77	0.47
	N	48	48	48	48	48	48	48	48	48	48	48

* Weather code is 1 = Worse than average, 2 = Average,
3 = Better than average, for this time of year.

Catch Location		Effort (per Dragger-Day)										Catch/Effort Statistics									
		Width(ft)	Width(M)	Away Hrs	Fish Hrs	Mins/Tow	Tows/Hr	Total Tows	Tow Hrs	Man-Hrs	Ft-TowHrs	Lbs/TowHr	Kg/TowHr	Lb/ManHr	Lb/Ft-TowHr	Kg/M-TowHr	\$/TowHr	\$/ManHr	\$/Ft-TowHr	\$/M-TowHr	
Knox-Waldo Counties	Mean	5.5	1.7	7.6	5.7	9.5	5.5	32.8	4.9	19.4	26.7	93.0	42.2	23.2	16.9	25.2	92.97	23.21	16.90	55.46	
	Std Dev	0.00	0.00	0.88	1.36	2.12	2.12	19.56	1.94	7.60	10.65	41.47	18.81	10.20	7.54	11.22	41.47	10.20	7.54	24.74	
	Std Err	0.00	0.00	0.51	0.96	1.50	1.50	13.83	1.37	5.38	7.53	29.33	13.30	7.21	5.33	7.94	29.33	7.21	5.33	17.49	
	N	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Hancock County	Mean	5.5	1.7	8.1	6.6	7.4	7.4	48.3	5.8	23.6	31.8	88.5	40.1	20.9	16.1	23.9	94.02	20.77	17.09	56.09	
	Std Dev	0.00	0.00	0.97	0.77	1.35	1.78	11.61	0.94	4.14	5.19	44.05	19.98	7.95	8.01	11.92	81.44	11.63	14.81	48.58	
	Std Err	0.00	0.00	0.31	0.24	0.43	0.56	3.67	0.30	1.31	1.64	13.93	6.32	2.52	2.53	3.77	25.75	3.68	4.68	15.36	
	N	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Washington County	Mean	5.5	1.7	7.1	5.6	7.8	5.9	33.6	4.0	15.8	22.1	151.9	68.9	36.2	27.6	41.1	142.54	33.55	25.93	85.09	
	Std Dev	0.03	0.01	1.87	1.63	3.38	2.20	16.32	1.75	5.97	9.63	89.64	40.66	17.06	16.29	24.24	93.69	17.42	17.02	55.86	
	Std Err	0.01	0.00	0.31	0.27	0.56	0.37	2.72	0.29	0.99	1.61	14.94	6.78	2.84	2.71	4.04	15.61	2.90	2.84	9.31	
	N	36	36	37	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	
All Combined	Mean	5.5	1.7	7.4	5.8	7.8	6.2	36.7	4.4	17.6	24.3	136.2	61.8	32.5	24.8	36.9	130.37	30.45	23.72	77.81	
	Std Dev	0.03	0.01	1.72	1.51	3.02	2.17	16.39	1.75	6.43	9.62	84.52	38.34	16.55	15.36	22.86	91.09	16.84	16.56	54.32	
	Std Err	0.00	0.00	0.25	0.22	0.44	0.31	2.37	0.25	0.93	1.39	12.20	5.53	2.39	2.22	3.30	13.15	2.43	2.39	7.84	
	N	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	

Tables 8a-b. Maine Sea Urchin Catch/Effort Summary, 1994/1995 - 2001/2002 Seasons

Diver Lbs per Bottom Hour

<u>County of Catch</u>	<u>Oct 1994 - Mar 1995</u>		<u>Dec 1995 - Apr 1996</u>		<u>Aug 1996 - Apr 1997</u>		<u>Sep 1997 - Apr 1998</u>		<u>Sep 1998 - Apr 1999</u>		<u>Sep 1999 - Apr 2000</u>		<u>Sep 2000 - Apr 2001</u>		<u>Sep 2001 - Apr 2002</u>	
	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>
York	141.2	19	130.2	8	122.0	18	203.9	14	223.7	17	138.7	12	172.1	9	90.0	1
Cumberland	163.6	42	130.8	28	130.4	27	111.3	16	117.2	23	113.2	23	250.3	5	187.9	6
Sagadahoc-Lincoln	184.7	76	150.9	38	141.7	47	124.6	57	161.5	85	163.5	49	152.1	41	130.5	32
Knox-Waldo	183.8	89	170.0	27	167.2	101	145.9	110	173.9	117	156.3	86	181.9	108	145.2	107
Hancock	226.4	71	211.2	29	208.9	110	204.3	78	200.5	73	177.1	74	152.1	84	136.9	85
Washington	232.7	42	242.7	80	220.0	122	205.8	102	209.8	106	202.5	82	202.3	23	172.5	34
All Combined	195.4	341	192.4	213	186.1	425	171.9	381	183.7	422	170.0	326	172.1	270	145.0	265

Dragger Lbs per Foot Width - Tow Hour

<u>County of Catch</u>	<u>Oct 1994 - Mar 1995</u>		<u>Dec 1995 - Apr 1996</u>		<u>Aug 1996 - Apr 1997</u>		<u>Sep 1997 - Apr 1998</u>		<u>Sep 1998 - Apr 1999</u>		<u>Sep 1999 - Apr 2000</u>		<u>Sep 2000 - Apr 2001</u>		<u>Sep 2001 - Apr 2002</u>	
	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>
York	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0
Cumberland	-	0	43.1	3	-	0	-	0	27.2	1	-	0	-	0	-	0
Sagadahoc-Lincoln	-	0	-	0	22.1	1	-	0	-	0	6.9	1	-	0	-	0
Knox-Waldo	32.5	17	20.6	9	23.9	10	28.9	12	29.8	9	37.9	9	19.2	6	16.9	2
Hancock	43.6	24	22.1	3	32.1	12	45.9	4	55.1	3	59.0	9	35.2	15	16.1	10
Washington	40.3	20	36.7	41	32.9	62	32.3	50	35.5	58	30.5	58	34.5	45	27.6	36
All Combined	39.1	63	33.7	56	31.6	85	32.5	66	35.5	71	34.4	77	33.3	66	24.8	48

Table 8c. Commercial Port Sampling Intensity for 2001-02 by Month and County (lbs sampled/lbs landed).

<u>2001-02</u>	<u>Cumb</u>	<u>Han</u>	<u>Kno/Wal</u>	<u>Lin</u>	<u>Wash</u>	<u>Total</u>
Sep	0.1280		0.0209	0.0378		0.0307
Oct	0.0000	0.0155	0.0340	0.0787	0.0178	0.0249
Nov	0.0000	0.0274	0.0271	0.0000	0.0034	0.0175
Dec	0.0487	0.0000	0.0138	0.0049	0.0232	0.0108
Jan	0.0000	0.0089	0.0330	0.0408	0.0183	0.0210
Feb	0.0064	0.0656	0.0059	0.0000	0.0000	0.0200
Mar	0.0000	0.1293	0.0000	0.0000	0.0287	0.0419
Apr		0.0621			0.0371	0.0448
Total	0.0185	0.0219	0.0227	0.0243	0.0184	0.0214

Table 9. Summary of Selected Diver and Dragger Interview Data, 1994/1995 - 2001/2002 Maine Sea Urchin Seasons

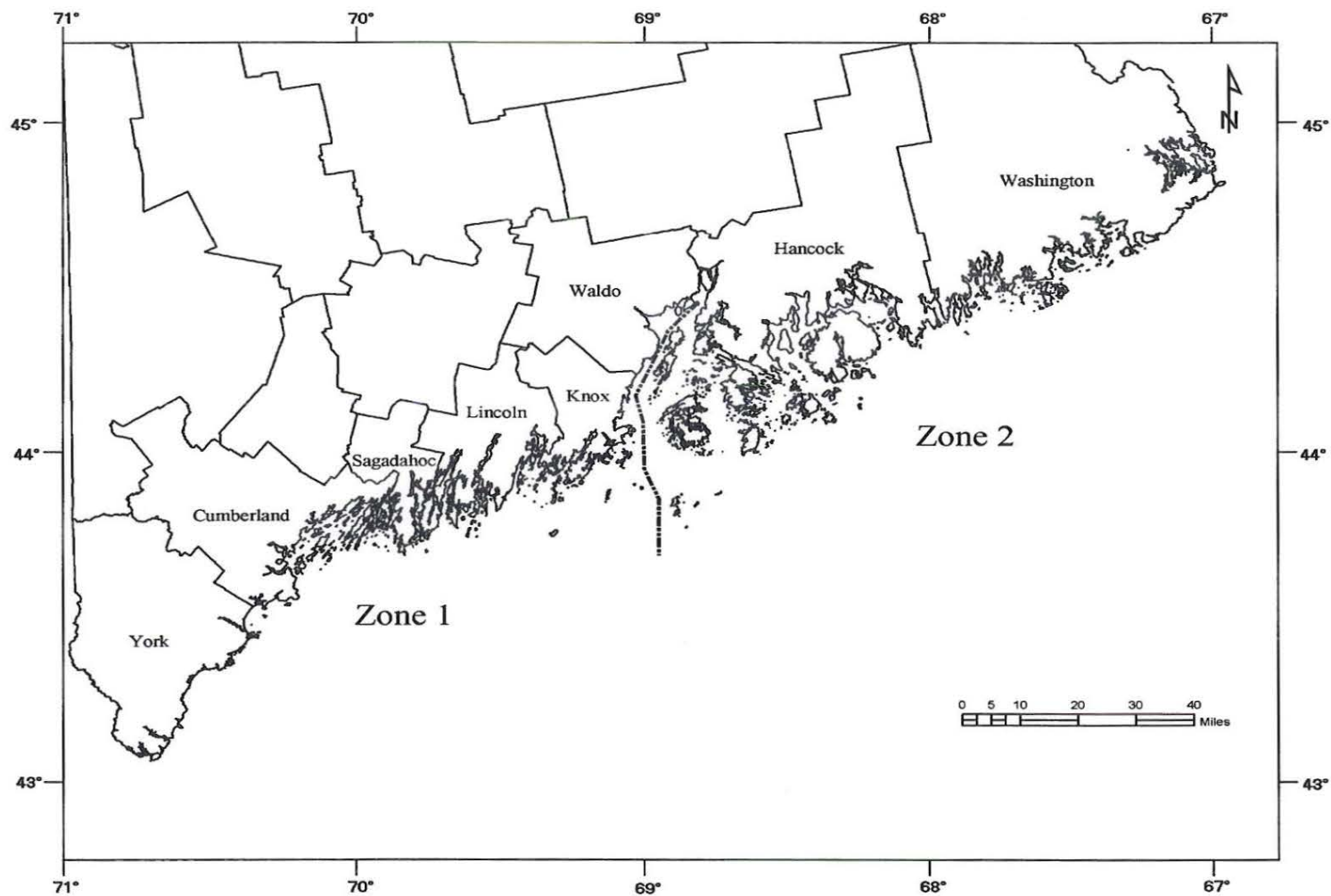
	<u>Oct 1994 - Mar 1995</u>		<u>Dec 1995 - Apr 1996</u>		<u>Aug 1996 - Apr 1997</u>		<u>Sep 1997 - Apr 1998</u>		<u>Sep 1998 - Apr 1999</u>		<u>Sep 1999 - Apr 2000</u>		<u>Sep 2000 - Apr 2001</u>		<u>Sep 2001 - Apr 2002</u>	
	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>	<u>Mean</u>	<u>N</u>
<u>Divers</u>																
Age	33.6	254	32.3	216	32.8	437	33.5	385	34.9	423	35.2	334	36.7	272	36.7	263
Min. Depth (ft)	10.9	341	14.5	213	8.4	425	9.3	381	9.0	422	8.6	327	9.8	272	11.7	266
Max. Depth (ft)	21.9	341	31.7	213	24.5	425	27.3	381	24.9	422	25.0	327	27.0	272	26.2	266
Daily Catch (lbs)	628.0	341	558.7	219	606.7	441	587.8	388	584.1	425	563.3	334	571.4	273	529.6	265
Price (\$/Lb)	1.07	341	1.04	219	1.05	441	1.18	388	1.19	425	1.39	336	1.30	272	1.09	265
Roe %	12.5	340	13.3	213	12.2	436	13.9	388	14.4	406	13.5	336	13.4	272	13.4	265
Bottom Hours	3.4	341	3.0	213	3.4	425	3.6	381	3.3	422	3.4	328	3.5	270	3.7	266
Away Hours	6.7	162	6.3	213	6.8	427	6.8	383	6.8	421	6.7	330	6.9	271	7.1	266
<u>Draggers</u>																
Boat Length (ft)	33.2	64	34.3	59	35.1	86	35.1	67	36.2	72	36.5	78	35.2	66	35.2	48
Min. Depth (ft)	16.6	64	18.1	58	22.6	85	15.9	67	20.8	72	15.0	78	19.6	66	21.7	48
Max. Depth (ft)	39.4	64	43.6	58	54.8	85	57.0	67	57.4	72	50.6	78	51.0	62	38.2	48
Daily Catch (lbs)	564.3	64	444.3	60	526.6	86	607.9	68	665.2	72	602.4	79	575.3	66	532.5	48
Price (\$/Lb)	0.87	64	1.01	60	1.01	86	0.91	68	1.02	72	1.35	79	1.13	66	0.97	48
Roe %	11.1	64	15.2	60	13.4	86	12.7	68	12.9	70	14.0	78	13.0	66	13.8	48
Hours Fished	5.6	64	5.0	59	5.4	85	6.0	66	5.9	72	5.3	78	5.4	66	5.8	48
Minutes per Tow	7.4	64	8.3	59	7.4	85	9.0	67	7.8	72	7.6	78	7.5	66	7.8	48
Tows per Day	34.3	64	30.9	57	34.5	85	35.5	66	35.5	71	34.6	78	35.5	66	36.7	48

Table 10. Total number of urchins, average urchins per quadrat*, and number of quadrats evaluated, by region and depth, 2001 and 2002 summer surveys.

Region Name	Region Number	Depth Stratum	2001			2002		
			Total Urchins	Average Urchins	No. of Quadrats	Total Urchins	Average Urchins	No. of Quadrats
Kittery to Phippsburg	1	1 (1-16ft)	139	0.28	515	1,001	3.34	300
	1	2 (16-33ft)	82	0.15	540	17	0.06	300
	1	3 (33-49ft)	60	0.13	471	27	0.10	270
	1	4 (49-140ft)	0	0.00	180	0	0.00	100
Phippsburg - Boothbay - - Bristol - Bremen	2	1	671	1.33	504	1,647	5.49	300
	2	2	2,013	4.08	493	2,277	7.59	300
	2	3	1,433	3.32	431	414	1.80	230
	2	4	0	0.00	150	0	0.00	100
Friendship - Port Clyde - - Tenants - Rockland (Zone boundary)	3	1	2,516	5.25	480	758	2.53	300
	3	2	1,485	3.09	480	2,485	8.28	300
	3	3	1,054	2.30	460	1,599	5.71	280
	3	4	0	0.00	160	0	0.00	110
Isleboro - Vinalhaven - - Stonington	4	1	4,315	9.38	460	1,071	3.57	300
	4	2	1,215	2.70	450	407	1.36	300
	4	3	726	1.73	420	52	0.22	240
	4	4	0	0.00	160	0	0.00	100
Blue Hill - Swans Is - - Mount Desert Is	5	1	2,994	6.24	480	517	1.72	300
	5	2	1,957	4.08	480	512	1.71	300
	5	3	1,739	3.78	460	1,026	5.40	190
	5	4	3	0.02	160	0	0.00	100
Frenchman Bay - Winter Harbor - Corea - Steuben	6	1	4,763	9.92	480	2,922	9.74	300
	6	2	5,737	11.95	480	5,415	18.11	300
	6	3	4,869	11.88	410	3,195	13.89	230
	6	4	21	0.13	160	32	0.32	100
Milbridge - Addison - - Jonesport	7	1	2,855	5.97	478	1,264	4.21	300
	7	2	4,289	9.13	470	2,257	7.52	300
	7	3	4,694	12.04	390	1,758	8.79	200
	7	4	3	0.02	160	9	0.09	100
Roque Is - Machiasport - - Cutler - W. Quoddy Hd	8	1	3,509	7.48	470	2,671	8.90	300
	8	2	8,555	17.82	480	4,962	16.54	300
	8	3	9,065	19.71	460	4,326	16.64	260
	8	4	45	0.28	160	48	0.48	100
Cobscook Bay	9	1	19,278	40.16	480	14,779	49.26	300
	9	2	18,116	37.74	480	13,216	44.05	300
	9	3	15,265	36.35	420	10,764	35.88	300
	9	4	389	2.43	160	270	2.76	100
Totals			123,855	8.80	14,072	81,698	9.60	8,510

* Dive sites used 1 sq. m. quadrats; video camera sites (Depth Stratum = 4) used ½ sq. m. quadrats.

Figure 1. Maine Coastal Counties and Sea Urchin Management Zones



Maine Sea Urchin Landings by Fishing Season and Zone, 1987 - 2001

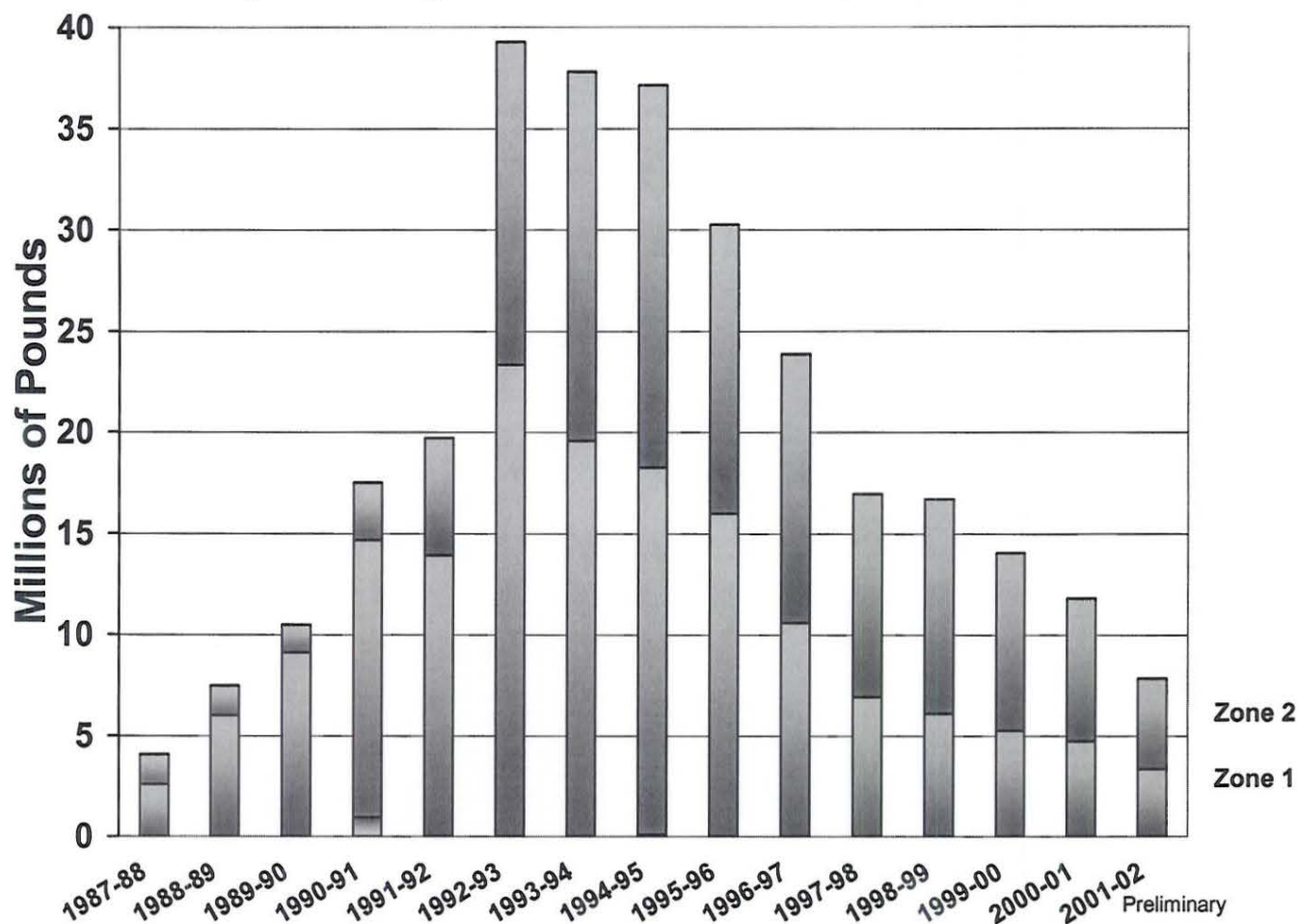


Figure 2. Maine Sea Urchin Landings by Fishing Season and Zone, 1987-2001

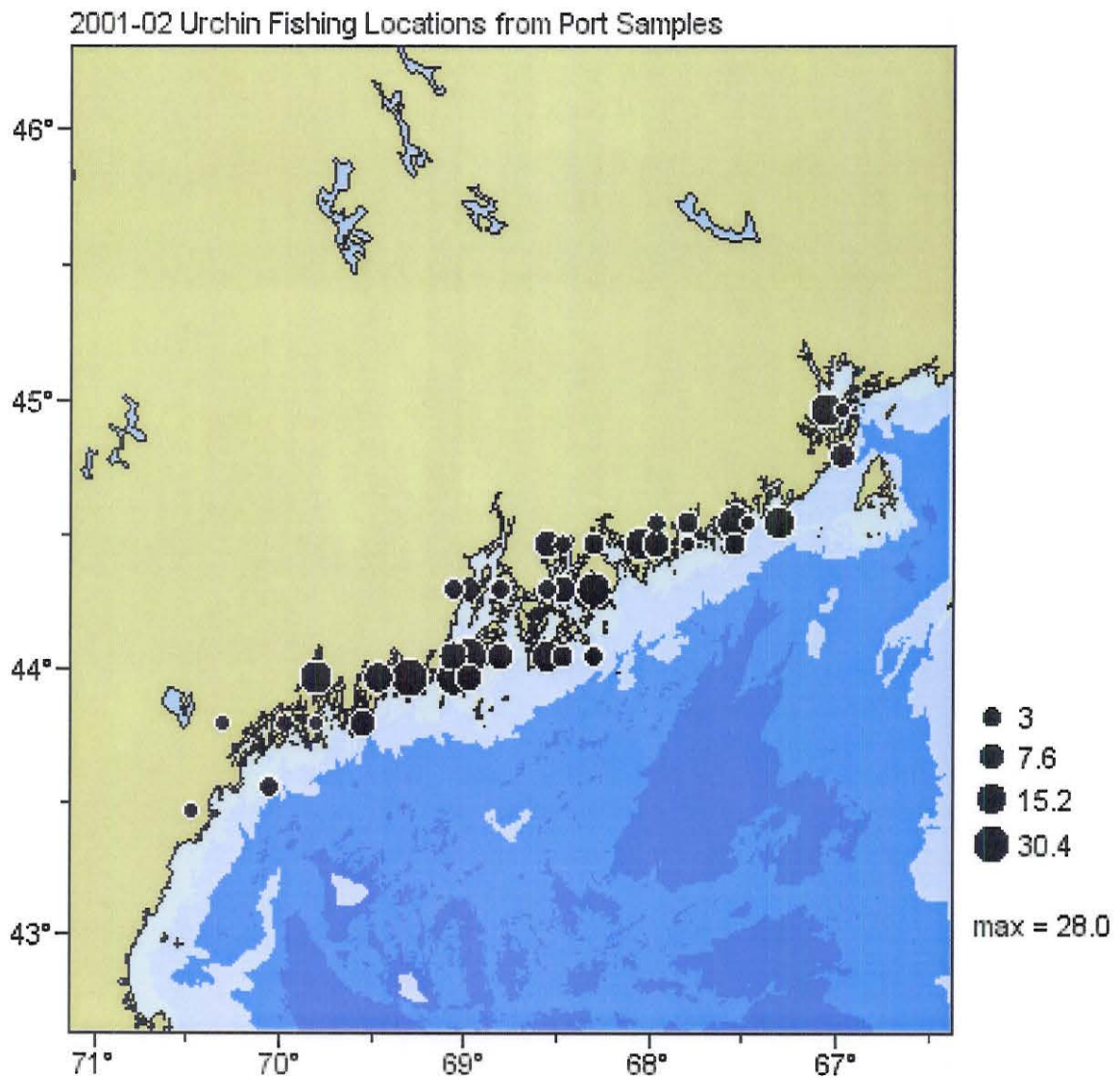


Figure 3. Fishing Locations from Port Sampling Interviews by 10-Minute Square. Size of dot indicates the number of interviewed harvesters fishing in that square.

Maine Sea Urchin Diver Catch/Effort by Year and County

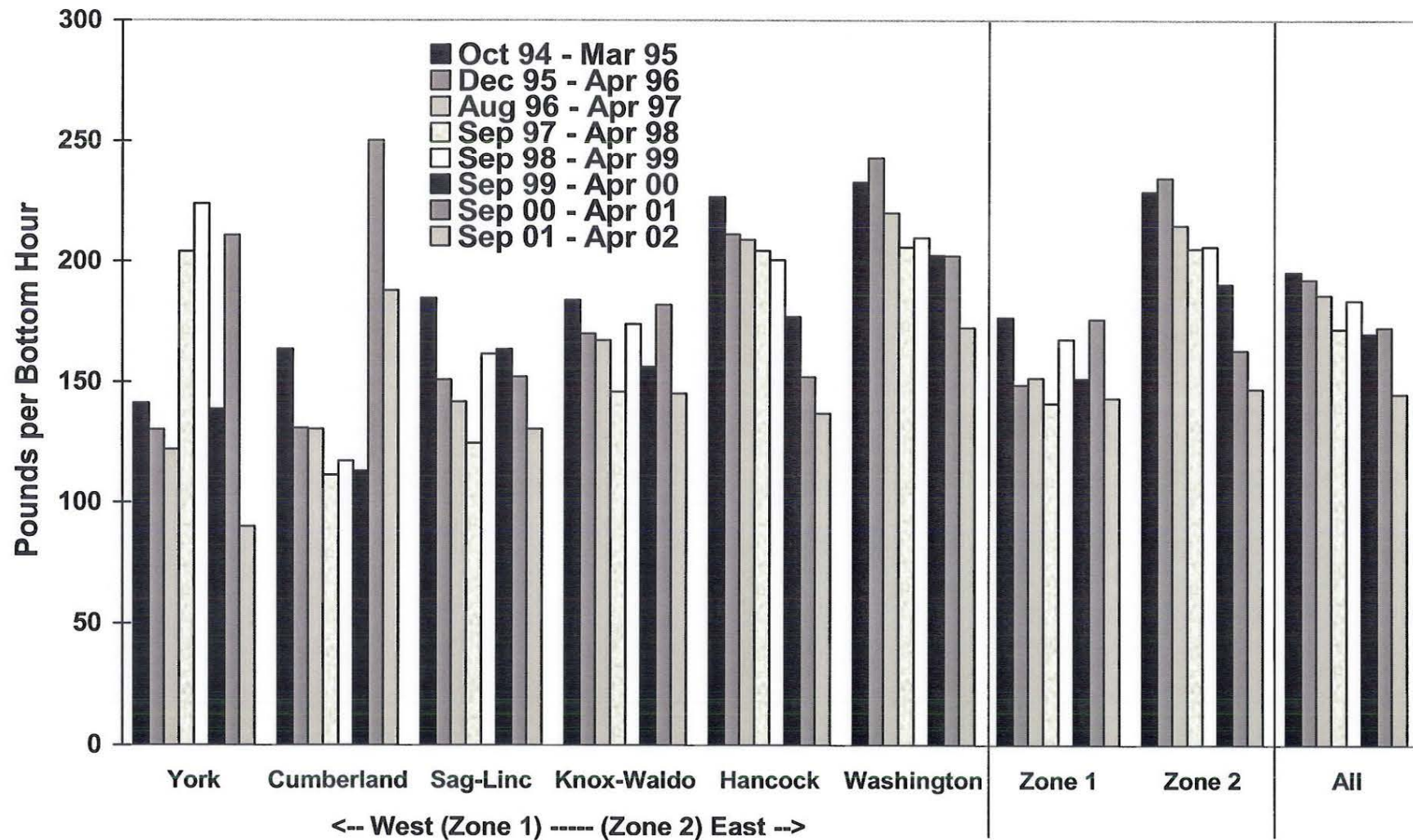


Figure 4. Maine Sea Urchin Diver Mean Catch/Effort by Year (Season) and County

Maine Sea Urchin Dragger Catch/Effort by Year and County

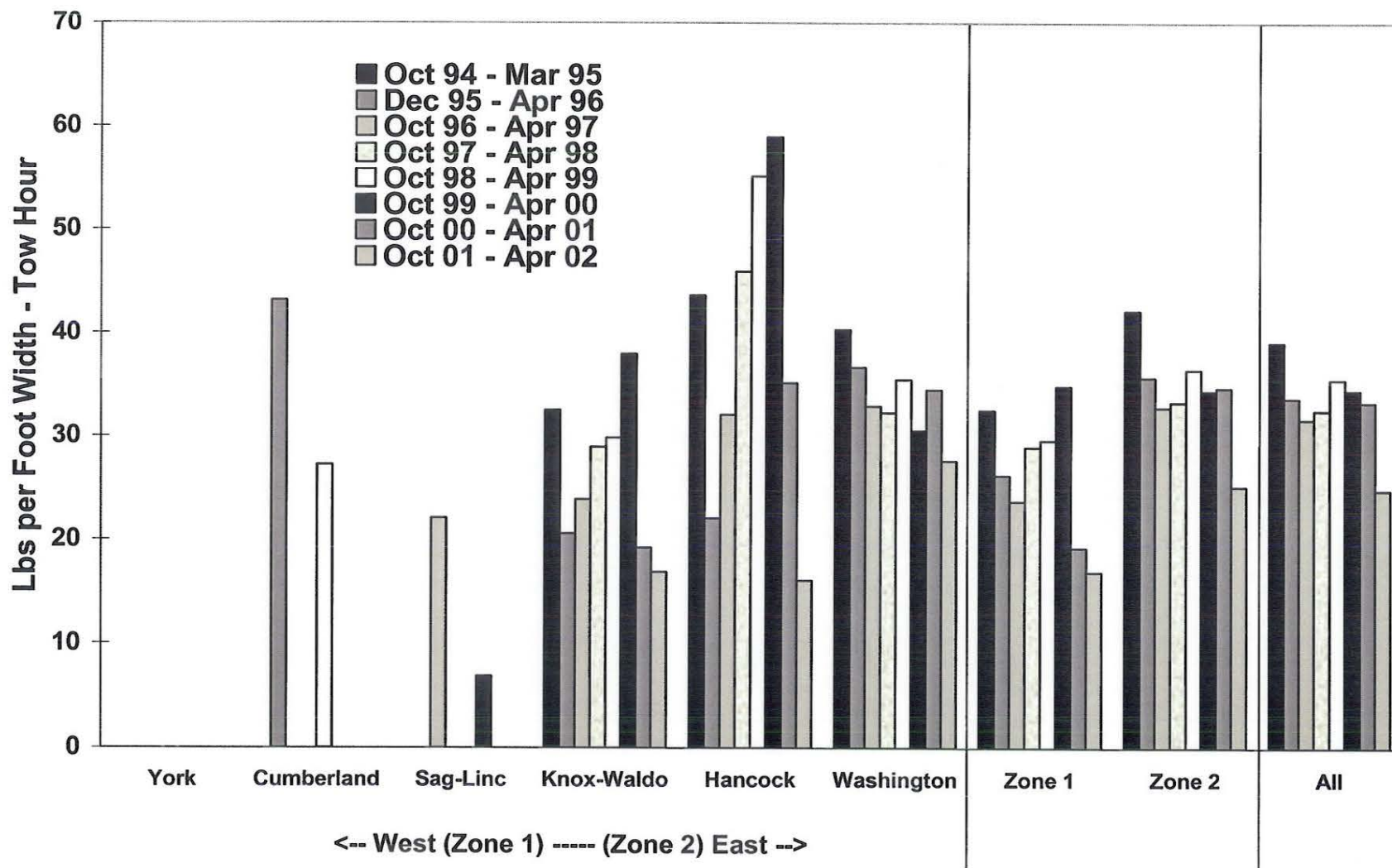


Figure 5. Maine Sea Urchin Dragger Mean Catch/Effort by Year (Season) and County

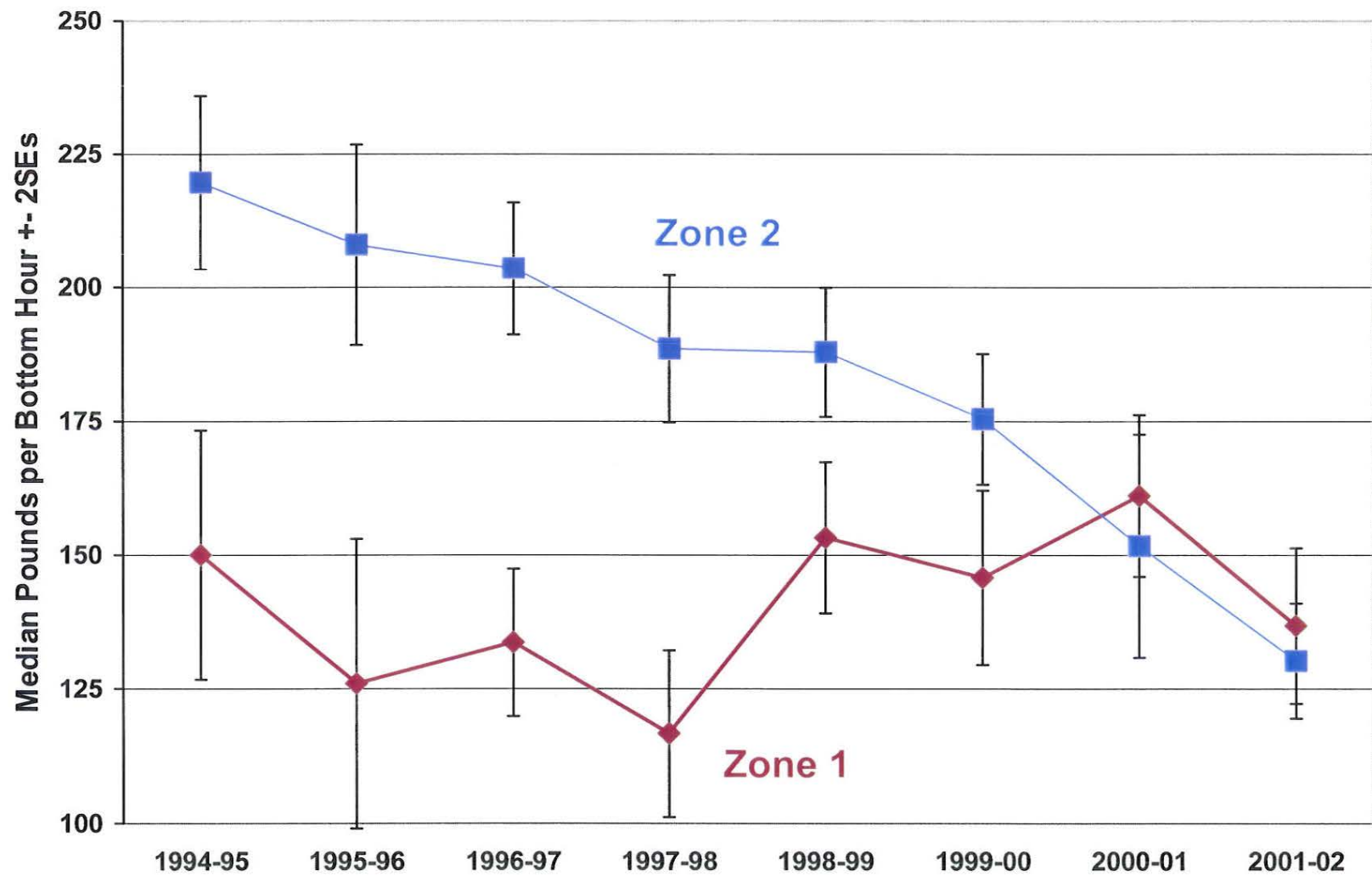


Figure 6. Maine Sea Urchin Diver Median Catch/Effort by Year (Season) and Zone

Maine Sea Urchin Diameters - Zone 1 2001-2002

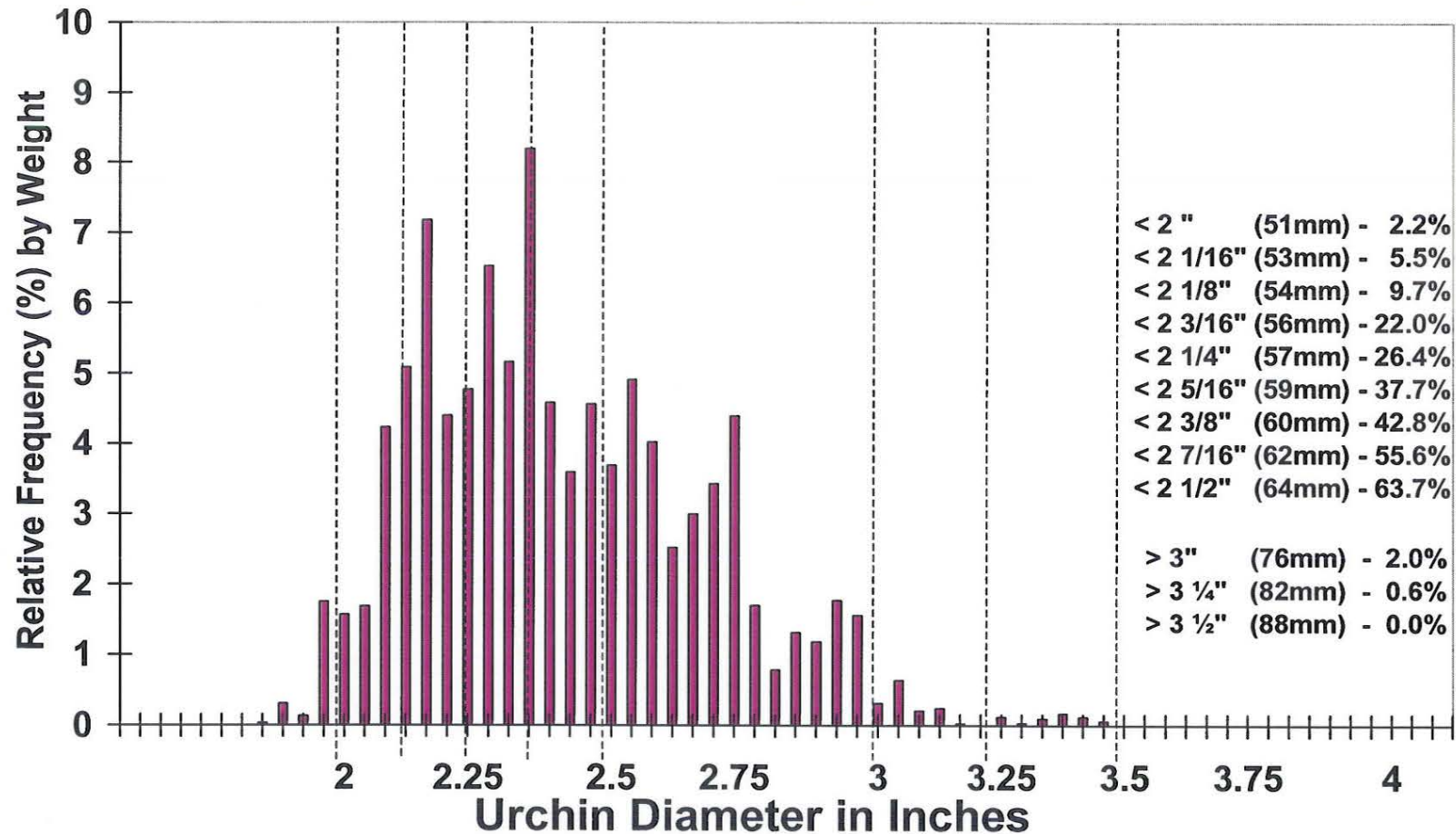


Figure 7. Size Frequency by Weight from the Commercial Catch for 2001-02, Zone 1. The small X-axis tic marks are in millimeters, beginning with 40mm. The legal size range in 2001-02 was $2\frac{1}{16}$ to 3 inches, with a 5% tolerance for undersized and a 5% tolerance for oversized urchins, by number.

Maine Sea Urchin Diameters - Zone 2 2001-2002

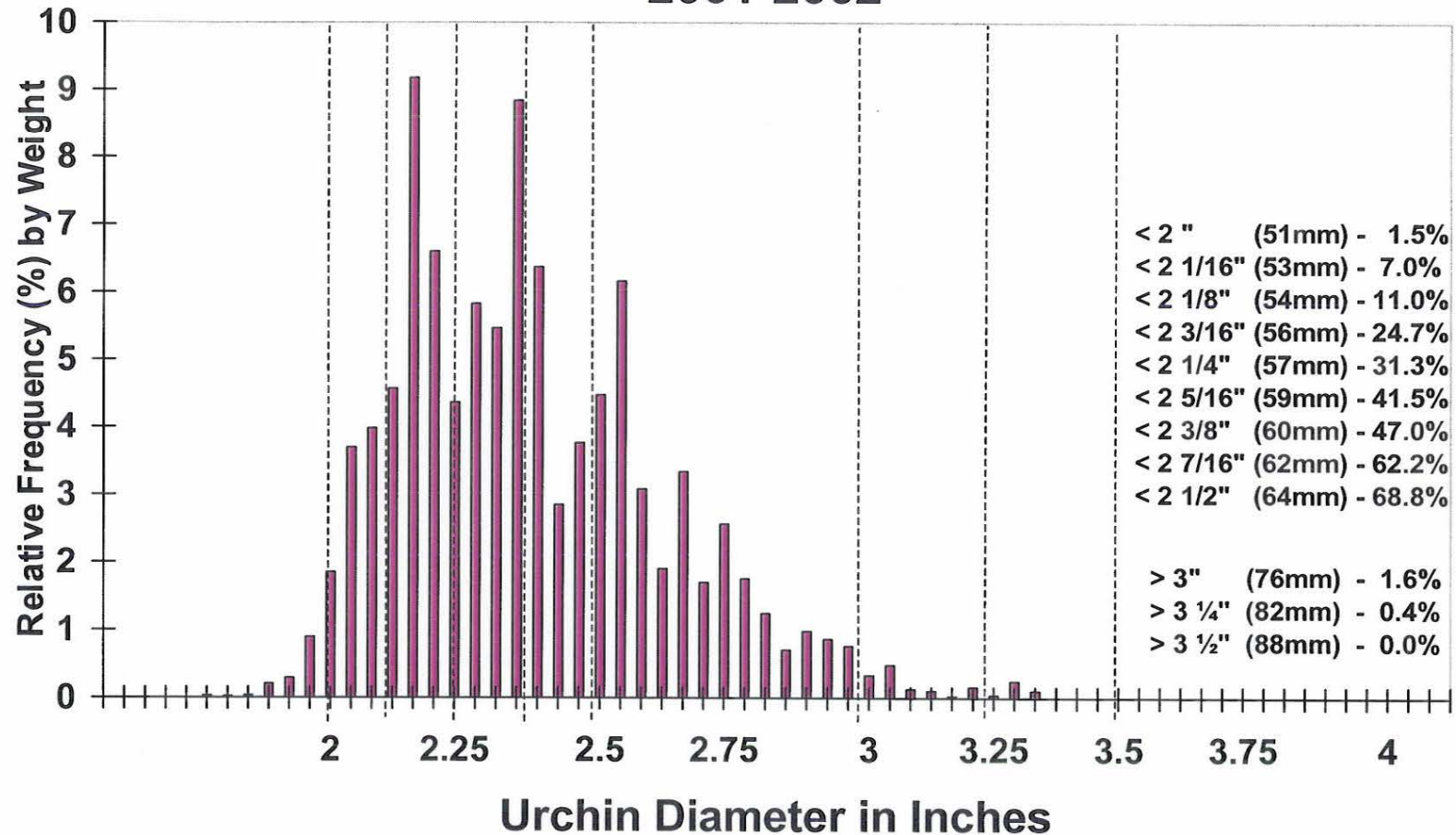


Figure 8. Size Frequency by Weight from the Commercial Catch for 2001-02, Zone 2. The small X-axis tic marks are in millimeters, beginning with 40mm. The legal size range in 2001-02 was $2\frac{1}{16}$ to 3 inches, with a 5% tolerance for undersized and 5% tolerance for oversized urchins, by number.

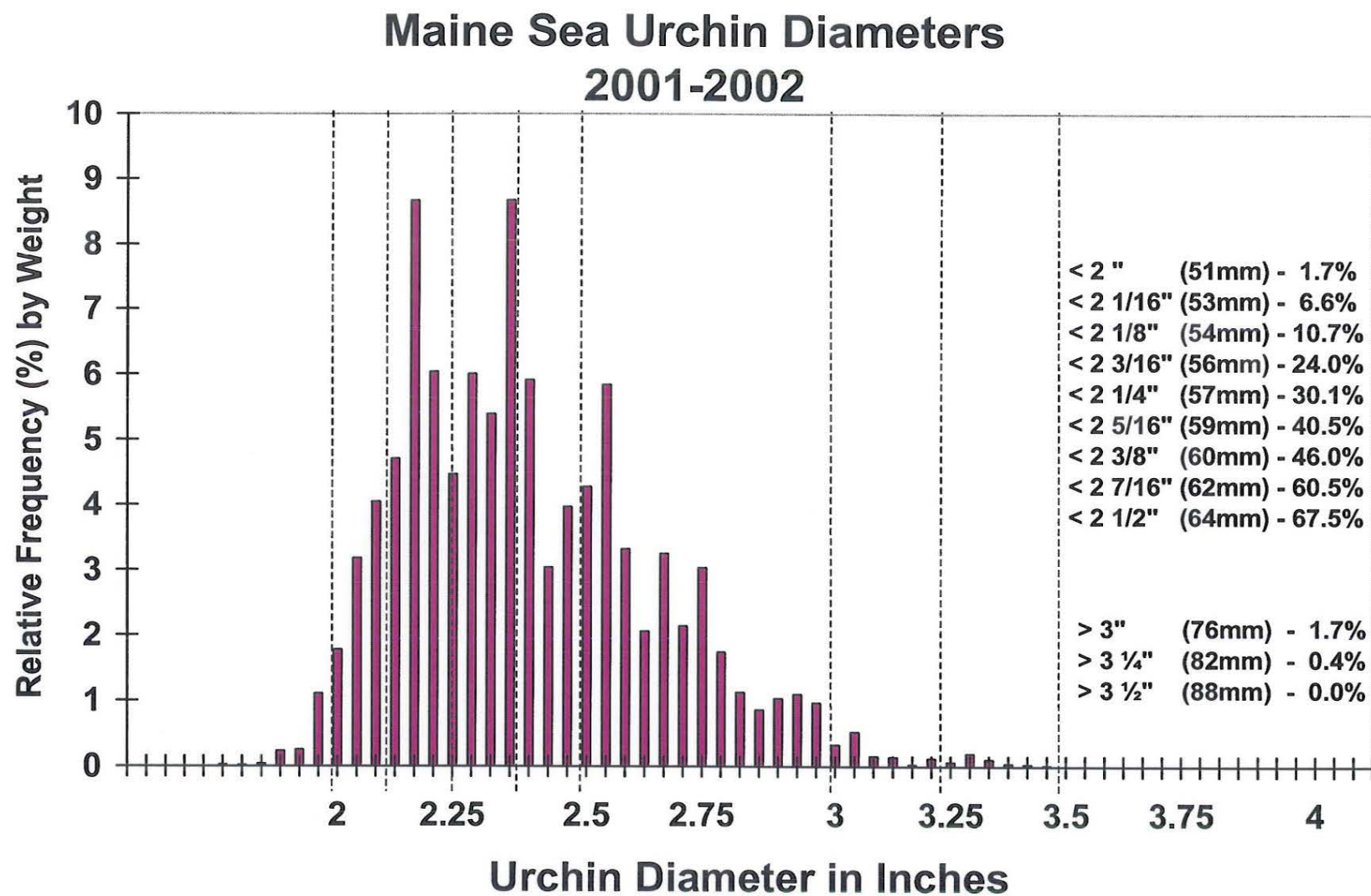


Figure 9. Size Frequency by Weight from the Commercial Catch for 2001-02, Both Zones. The small X-axis tic marks are in millimeters, beginning with 40mm. The legal size range in 2001-02 was $2\frac{1}{16}$ to 3 inches, with a 5% tolerance for undersized and a 5% tolerance for oversized urchins, by number.

Maine Sea Urchin Diameters 2001-2002

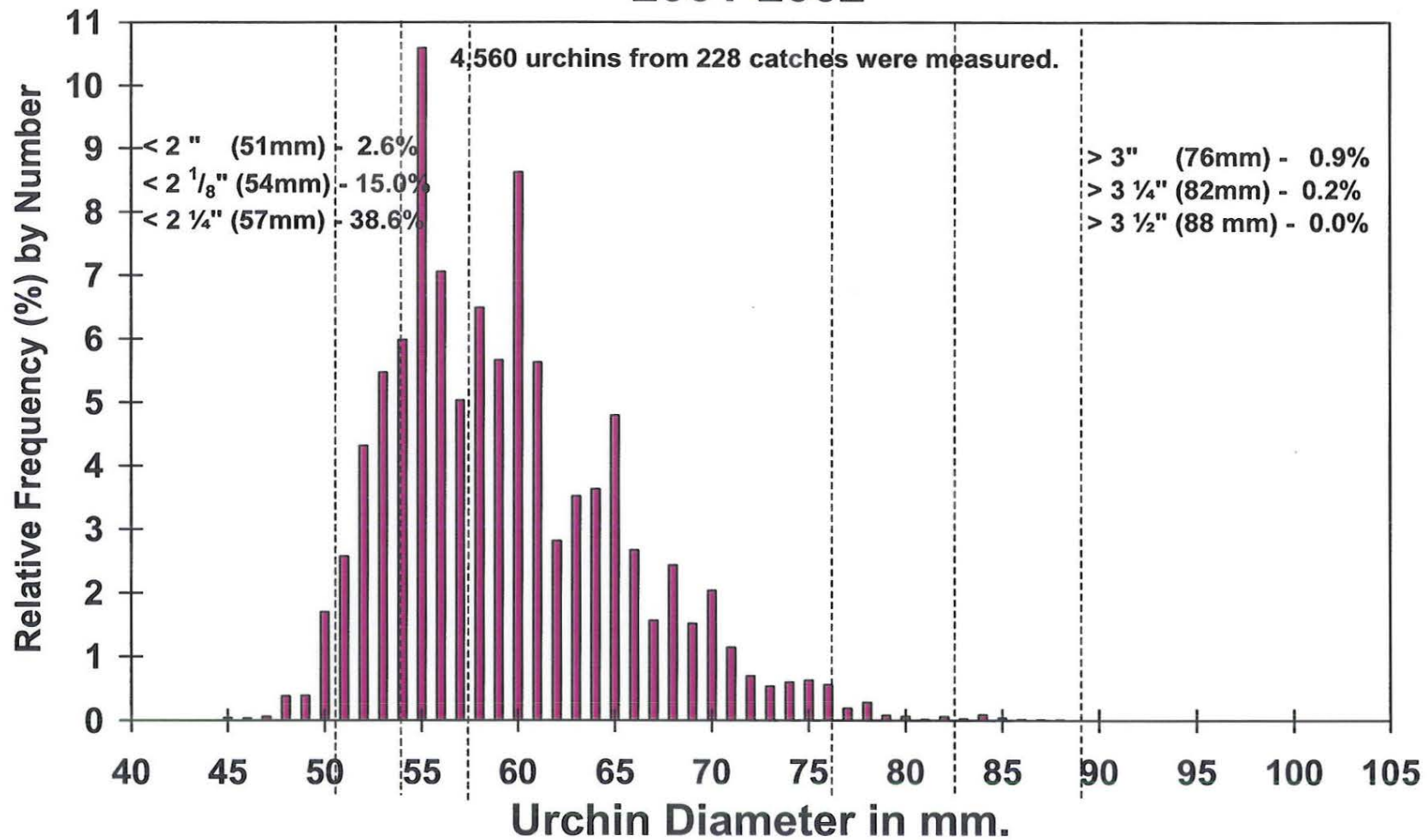


Figure 10. Size Frequency by Numbers from the Commercial Catch for 2001-02, Both Zones. The legal size range in 2001-02 was 2¹/₁₆ to 3 inches, with a 5% tolerance for undersized and a 5% tolerance for oversized urchins, by number.

Percentage of Small Sea Urchins in Commercial Catches All Areas Combined

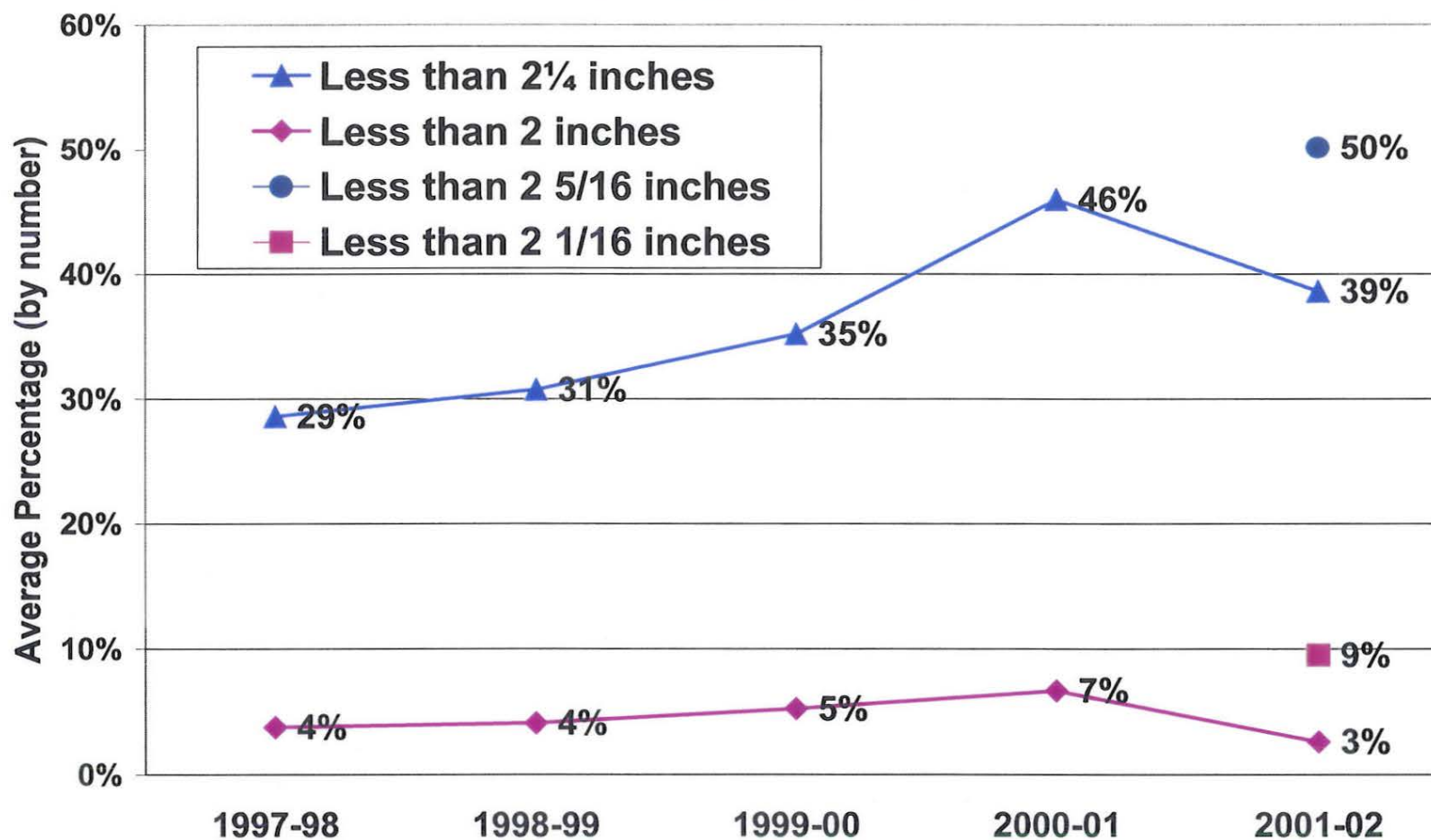


Figure 11. Percentage (by number) of Small Urchins in Sampled Catches, Both Zones. The legal size range in 2000-01 was 2 to 3½ inches, with a 5% tolerance for undersized and a 5% tolerance for oversized urchins, by number. The legal size range in 2001-02 was 2¹/₁₆ to 3 inches, with the same tolerances.

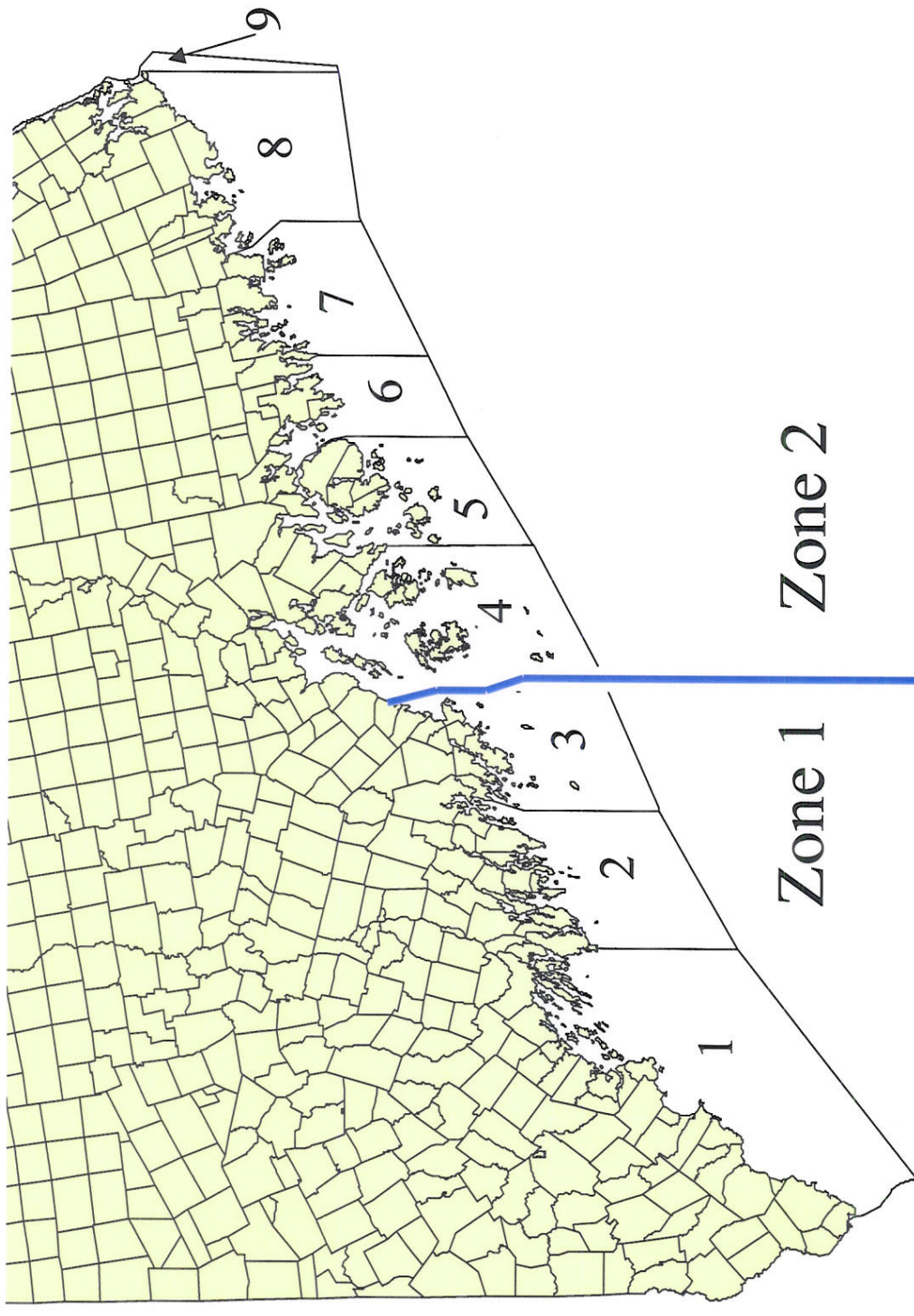


Figure 12. Maine Sea Urchin Survey Regions

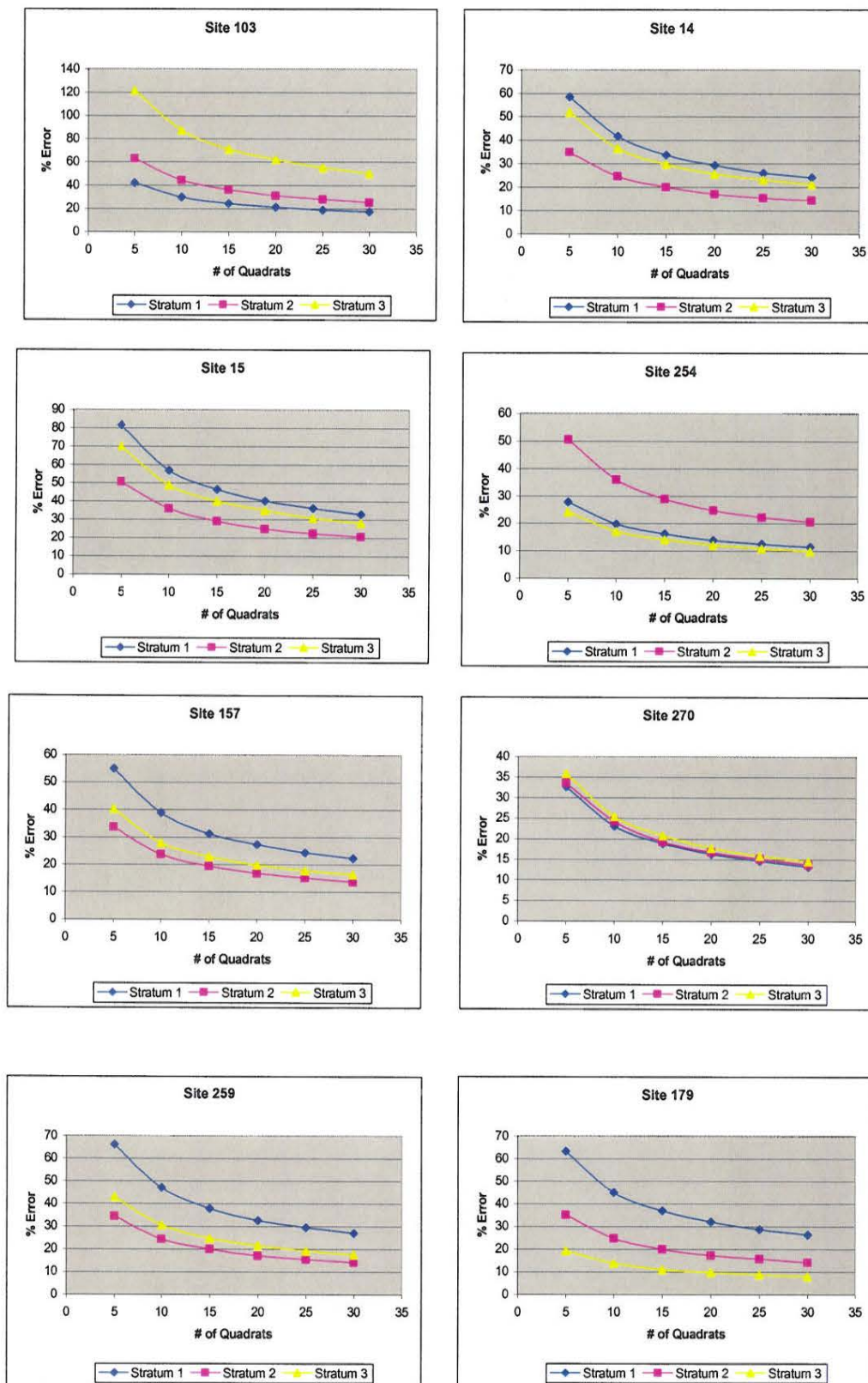
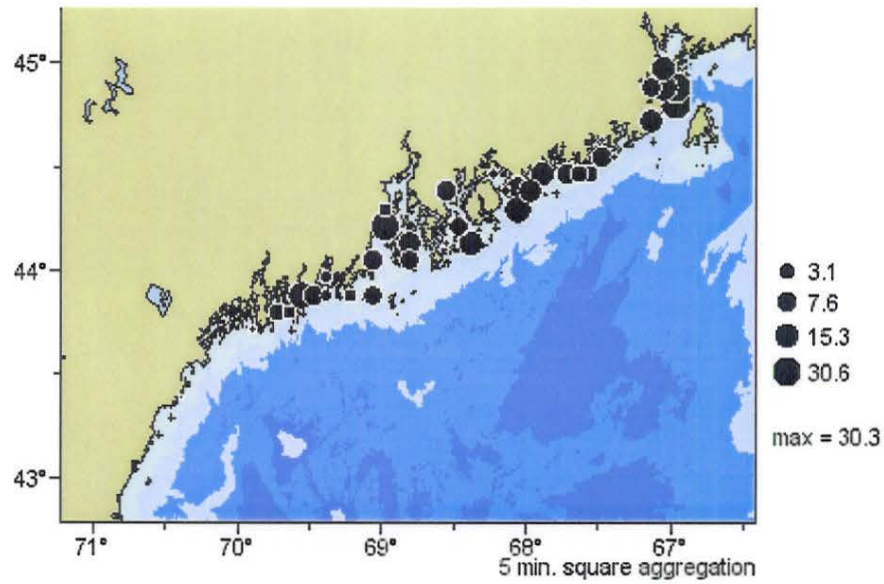


Figure 13. Results of Survey Resampling Simulation. Strata are depth strata.

2001



2002

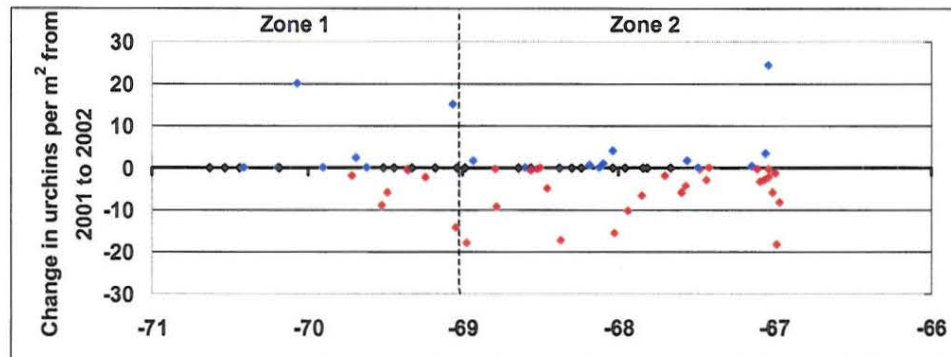
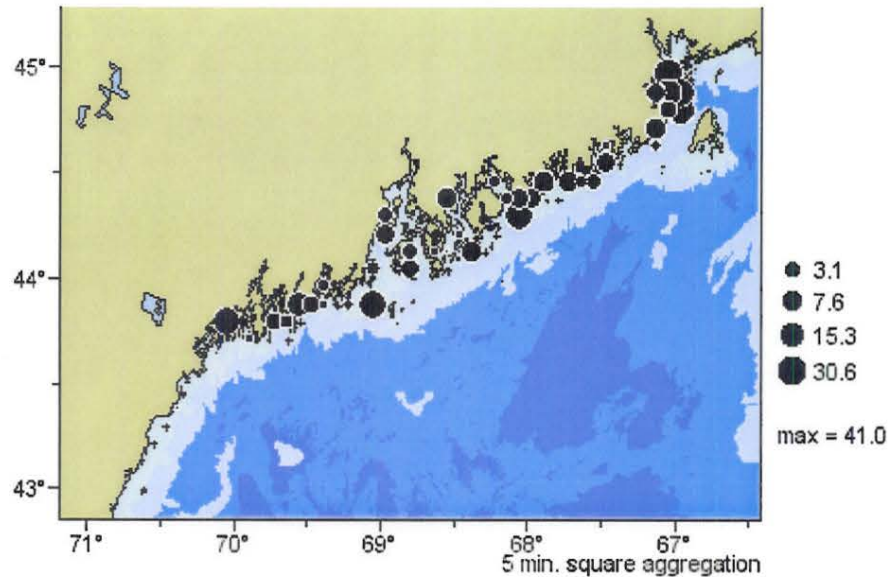


Figure 14. Comparison of 2001 and 2002 average abundances (number of urchins per quadrat) at the 72 survey sentinel sites. 17 sites (blue, above the Y-axis) increased, 33 sites (red, below the Y-axis) declined, 22 sites had no change because there were no urchins in either year (black, on Y-axis). X-axis on graph is site location in degrees longitude.

GROUNDFISH

Kevin Kelly

Job#1

JOB TITLE: Gulf of Maine Groundfish Assessment and Management

OBJECTIVE:

Represent the State of Maine in meetings of the NEFMC's Multi-species Monitoring Committee (MMC) and Groundfish Plan Development Team (GPDT) and participate in resource assessment and management activities of these two groups. Also participate in development of resource monitoring activities such as study fleets and industry based-surveys.

Multispecies (groundfish) assessment and management:

During 2002, we participated in the activities of the Groundfish Plan Development Team (GPDT) of the New England Fishery Management Council (NEFMC). As a result of court proceedings stemming from a lawsuit over Amendment 9 of the Multispecies (Groundfish) Management Plan brought on by several environmental groups against the National Marine Fisheries Service, there was considerable well-publicized activity regarding New England groundfish during 2002. The court threatened to impose its own restrictions on the multispecies fishery unless industry stakeholders could develop their own measures in time for the beginning (May 1) of the 2002 fishing year that would meet Amendment 9 biological goals. Some compromise measures were ultimately put in place for 2002 but sweeping new measures were to be implemented in 2003 under the court mandate. These developments hastened the need for NEFMC to develop and implement Amendment 13 to the groundfish Plan.

NEFMC adopted on an interim basis new biological reference points developed by a working group convened by NMFS earlier in the year. Some of these new reference points affected biological goals for Amendment 13 considerably. We attended several GPDT meetings during 2002 (Table 1) and reviewed and commented on management proposals. We also met with and provided input to the ME DMR Commissioner and staff regarding groundfish during early 2002.

Later in 2002 it was announced by NMFS that there was an issue that may have affected the performance of the sampling gear used on its spring and fall groundfish surveys. This prompted NMFS to conduct tests on the gear and to evaluate any effects that errant performance of the trawl would have on data used in stock assessment. The court order that required Amendment 13 to be put into place by May 2003 was modified based on the possibility of problems with stock assessments based on trawl survey data. Amendment 13 was delayed for implementation until January 2004. The GPDT continued analyses of management alternatives for Amendment 13.

We were successful in 2002 in securing a contract from NMFS to undertake a cod tagging project in the Gulf of Maine. The project is entitled *A Tagging Study of Atlantic Cod in the Gulf of Maine: Cashes Ledge and Fippennies Ledge and Mt. Desert Is. Out to Browns Bank*. We submitted a proposal to do this project in response to federal Broad Agency Announcement (BAA EASC 02-0002) Cooperative Research Partners Initiative “Atlantic Cod (*Gadus morhua*) Tagging Program.”

Collaborators on this project include Canada Department of Fisheries and Oceans, Gulf of Maine Aquarium and Manomet Center for Conservation Sciences. Cod will be tagged in both U.S. and Canadian waters including Cashes Ledge and Fippennies Ledge, Mt. Desert Island out to Browns Bank and the outer Bay of Fundy. The project goal is to determine patterns of movement of Atlantic cod by tagging fish throughout the year in these areas over a two-year period. Our goal is to tag 20,000 fish per year over this time.

Tagging will be conducted using commercial fishing vessels as tagging platforms. A total of eight (8) vessels will be contracted to conduct seven (7) directed tagging trips each year. Scientific personnel will be present on tagging trips to tag fish and record pertinent information. A broad scale cod tagging effort has not been conducted in U.S. waters since at least 1959. Our study is part of a comprehensive tagging effort that will take place in both inshore and offshore waters of the Gulf of Maine, Georges Bank and southern New England.

Table 1. Groundfish meetings attended during 2002

<u>Date</u>	<u>Agency or group</u>	<u>Place</u>
7-Mar	Groundfish PDT	Newburyport, MA
8-Mar	ME DMR Commissioner	Hallowell, ME
4-Apr	ME DMR Commissioner	Hallowell, ME
25-Apr	Groundfish PDT	conference call
7-May	NEFMC Groundfish Comm.	Portland, ME
8-May	NEFMC Groundfish Comm.	Portland, ME
29-May	Groundfish PDT	Woods Hole, MA
18-Jun	Groundfish PDT	Newburyport, MA
10-Jul	Groundfish PDT	Woods Hole, MA
26-Jul	Whiting Mon. Committee	Mansfield, MA
18-Sep	Groundfish PDT	Newburyport, MA
13-Nov	Groundfish PDT	conference call

ATLANTIC HERRING
(Clupea harengus)

David Libby
Matthew Cieri
Kohl Kanwit
Eileen McNair
Lisa Pinkham

Job # 1

Job Title: Collection of Atlantic Herring Catch and Landings Data

Objective:

Collect catch and landings data and monitor the status of the commercial Atlantic herring fishery throughout the range of the species along the U.S. Atlantic coast.

Results:

Landings and Catch Data:

Landings reports received from canneries and bait dealers during 2001 were processed as described in the 1999 IJF annual report (Project No. 3-IJ-154). In 2002 any herring dealer/processor (any person(s) purchasing herring from a harvester with the purpose of retail or wholesale) fell under the Federal mandatory dealer reporting requirement. Dealers sent in monthly reports of herring purchases from harvesters to the DMR where the information was entered into the NMFS "CODES" reporting system. The summarized data was then sent to the NMFS office in Portland, Maine to become part of the NMFS commercial fisheries database. A partial herring dealer reporting for 2002 is shown in Table 1. The totals in Table 1 for herring utilization show about 27,568 mt going to food (canned as sardines and stakes) while about 45,042 mt was sold as bait mostly for the lobster fishery. Domestic dealer reports accounted for about 80% of harvester reported landings. It is not known at this time whether this discrepancy is caused by permitted dealers not reporting fully (underreporting or missing months) or dealers that are not permitted and therefore not known.

Landings and catch data were also made available to the ASMFC and NEFMC Atlantic Herring Plan Development Team to be included in the "2001 Atlantic Herring Stock Assessment and Fishery Evaluation Report" (SAFE) and fishery regulation plans that were developed by both organizations during 2002. Catch and Sampling data collected by project staff were used in the Trans-boundary Assessment in February 2003. A working paper from that assessment is attached (Appendix 1).

IVR Reporting:

A mandatory call-in system is included in the New England Fishery Management Council's Herring Fishery Management Plan. Using this system the catch and quota for Area 1A was closely monitored during this past year. Also, the call-in design and protocol, fishermen notification and implementation were further fine-tuned this past year. The IVR system for the timely reporting of herring catches was a success because of industry involvement. See Appendix 2 for the complete IVR annual report.

VTR Reporting:

Herring catch data was also compiled from NMFS vessel trip reports (VTR) (see Appendix 3). Harvesters report VTR data on a monthly basis. Because harvesters give precise location (coordinates or Loran) on a per trip basis, this reporting system allows for detailed catch information from specific areas. VTR data are useful for stock assessment and effort information. Because they are reported on a monthly basis, and the lag between catches and reports, this system is not useful for quota monitoring.

Table 1: dealer data for the 2002 Atlantic herring fishery**Utilization by MT / Value in U.S. Currency of Herring Dealer Data Reported by Month**

	FOOD	VALUE	BAIT	VALUE	OTHER*	VALUE	Total Monthly MT	VALUE
Jan	4,574	\$514,629	779	\$101,555	0.0	\$0	5,353	\$616,184
Feb	3,484	\$389,836	396	\$52,253	0.0	\$0	3,879	\$442,089
Mar	615	\$70,719	696	\$91,708	0.0	\$0	1,311	\$162,427
Apr	617	\$70,964	2,025	\$274,494	0.0	\$0	2,642	\$345,458
May	130	\$16,121	1,625	\$257,798	18.0	\$0	1,773	\$273,919
Jun	3,614	\$443,534	4,442	\$620,577	0.0	\$0	8,057	\$1,064,111
Jul	3,639	\$484,448	9,909	\$1,338,435	0.0	\$0	13,548	\$1,822,883
Aug	1,853	\$238,727	7,987	\$1,244,510	0.0	\$0	9,839	\$1,483,237
Sep	1,340	\$168,712	7,303	\$1,311,301	0.0	\$0	8,643	\$1,480,013
Oct	1,671	\$200,339	5,940	\$962,120	0.0	\$0	7,610	\$1,162,459

Job # 2

Job Title: Herring Sample Collection and Processing

Objective:

Collect samples of herring from the Atlantic Coast commercial catches and process the samples for biological characteristics.

Results:

Approximately 11,200 sampled herring were processed in 2002, 23% from fishing trips made in 2001 and 77% from 2002 trips. Otoliths were removed from approximately 3,000 fish for ageing purposes. Processing and ageing of the 2001 samples was completed in April 2002 and made available to the annual SAFE report. Fewer samples were collected in 2002 (235) compared to 2001 (240) but better reflected the geographic range of the fishery. Refer to Appendix 4 for the commercial catch sampling completion report.

Job # 3

Job Title: Herring Catch and Sample Analysis

Objective:

Analyze catch and sample data to produce catch-at-age attributes for the past year.

Results:

Estimates of catch-at-age for herring caught in the U.S. commercial fishery in 2001 were derived from catch statistics and sample data generated by DMR using age-length keys and mean weights-at-age for individual months, gear types, and fishing areas using a BIOSTAT program. Additional catch-at-age estimates are provided for New Brunswick each year by the Canadian Department of Fisheries and Oceans in St. Andrews. The 2001 estimates were added to the existing time series (1967-2000) of catch-at-age and trawl survey data for stock assessment purposes. Stock assessments for the coastal stock complex and the Gulf of Maine stock component were performed in collaboration with fishery scientists from the other New England states, NMFS, and the Canadian Department of Fisheries and Oceans using virtual population analysis techniques and a surplus production model.

Additionally, a preliminary catch at age matrix was derived for the 2002 fishing year. These data, and data from previous years were instrumental as input data for both age structured and biomass models used during the Trans-Boundary Resource Assessment this past February (Table 2).

Table 2. Catch at Age for the Atlantic Herring Fishery 1998-2002 (note 2002 data are preliminary)

Weight (mt) Harvested at age

	1	2	3	4	5	6	7	8	9	10	11 +	Total
1998	0	10,589	9,016	38,530	8,090	4,790	5,776	3,141	1,197	397	76	81,601
1999	20	6,065	25,751	9,651	29,594	12,698	6,203	3,832	886	103	0	94,803
2000	0	14,093	4,688	15,947	24,270	30,445	8,762	3,278	638	250	87	102,459
2001	5	4,544	38,144	6,775	15,035	21,531	25,152	5,604	1,081	131	24	118,028
2002	232	4,618	9,838	31,974	12,310	11,713	13,033	6,744	745	84	33	91,324

Numbers (X 1000) Harvested at age

	1	2	3	4	5	6	7	8	9	10	11 +	Total
1998	0	240,609	109,839	321,663	56,069	29,267	31,640	16,064	5,764	1,618	281	812,814
1999	667	103,606	285,314	82,967	216,579	79,553	35,158	19,554	4,527	357	0	828,282
2000	0	195,108	41,892	121,107	155,341	175,833	44,078	15,388	2,832	1,037	319	752,937
2001	117	74,760	379,858	51,299	98,063	127,478	135,847	26,771	5,153	484	91	899,921
2002	9,478	78,818	98,907	248,045	82,732	69,480	71,488	33,697	3,416	354	47	696,462

Job # 4

Job Title: Herring Assessment and Advice

Objective:

Conduct herring stock assessments and provide biological advice relevant to the management of the U.S. Atlantic herring coastal stock complex and the Gulf of Maine herring stock, and contribute to the implementation and improvement of regional fishery management and research plans.

Results:

Updated catch-at-age estimates were provided for assessments of the coastal stock complex and the Gulf of Maine for the TRAC (See Job 3 above). Personnel also participated in that assessment during the peer review process (see Appendix 5).

Other data analysis activities were also performed in the production of the Stock Assessment and Fishery Evaluation Report (SAFE). Catch and sample data are used to monitor the status of the fishery and the resource and to estimate the age composition of the catch. Additionally, catch and sample data were used to indicate spawning tolerance closures (ASMFC), to predict area closures after the Total Allowable Catch (TAC) had been achieved, and to indicate the best possible effort control scenarios to extend the TAC as late in the season as possible.

Also during this period, staff assisted the New England Fishery management Council staff in the preparation for an upcoming amendment scheduled to be completed this year.

Job # 5

JOB TITLE: Historical Data Analysis

OBJECTIVE:

Conduct a review and modification of historical catch and sample data from 1960 to the present.
PROGRESS:

Staff is in the process of updating and verifying catch and landings from 1960 to the present. This involves comparisons and additions to Maine's database from NMFS and NAFO sources. Total catches for US east coast by year are available (Figure 1) Also, Sample data is also being updated, verified, and corrected. Once completed a new catch at age matrix will be developed using BIOSSTAT. These results will serve as important input into the age structured population model for Atlantic Herring, and give a clearer picture as to the productivity and proper management of this complex.

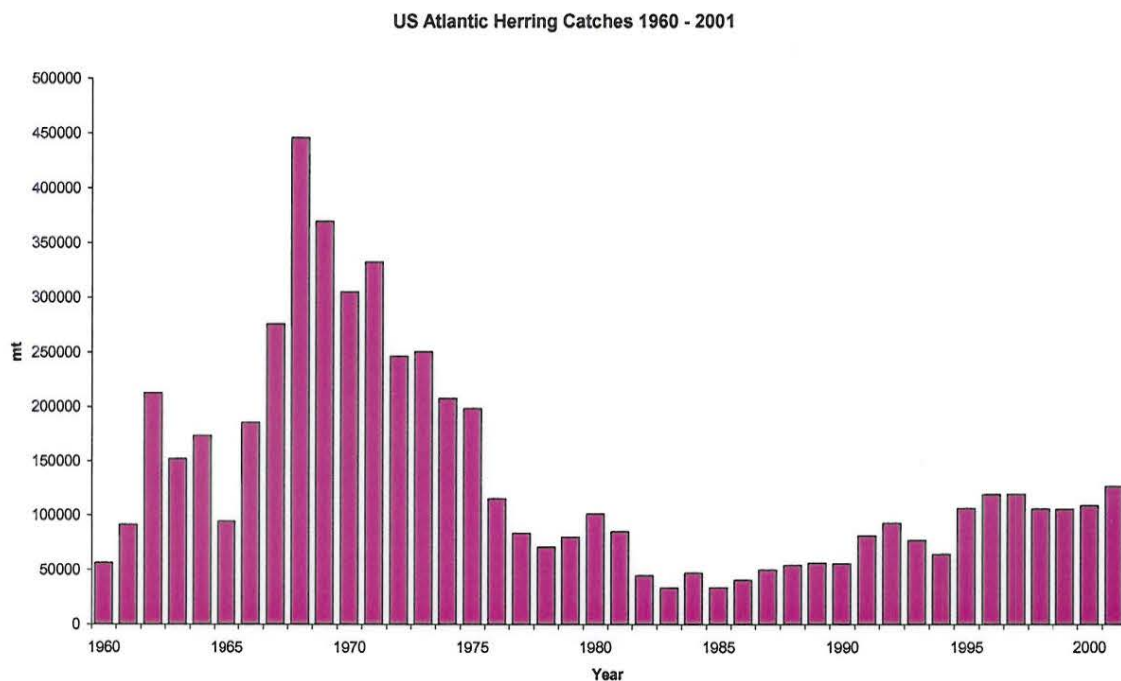


Figure 1. US east coast catches of Atlantic Herring by year.

Job # 6

Job Title: Herring tagging using micro-wire tags

Objective:

Conduct micro-wire tagging on Gulf of Maine Atlantic herring

Results:

DMR staff members are currently in the process of reevaluating the Atlantic herring micro-wire tagging project. Over the course of the last year significant problems have arisen related to the tag recovery process. Regrettably one of the detection units was damaged in the fall of 2002 and could not be repaired. This event represented a significant setback for the project. Subsequent meetings held with the industry resulted in DMR staff beginning the process of investigating the use of conventional spaghetti tags rather than coded micro-wire tags. A trial tagging program using spaghetti tags will run from April 1st to the 15th using an aquarium codend on a mid-water trawl vessel in near shore waters off Rhode Island. This fieldwork will target herring on winter-feeding grounds and should provide

information on mixing rates from the three management areas. See Appendix 6 for a tagging project completion report.

APPENDIX 1:

Landings, Samples, and the Catch at Age matrix for the Atlantic Herring Fishery: 2002

Matthew Cieri
David Libby
Kohl Kanwit
Eileen McNair
& Lisa Pinkham

Introduction:

The Maine Department of Marine Resources (MDMR) is the primary state agency in the New England region for Atlantic herring research, resource monitoring, and management. The two primary types of information that are collected and processed at the Department's Fisheries Research Laboratory in Boothbay Harbor are: 1) catch and landings information for the herring commercial fishery; and 2) age, size, and other biological characteristics of the commercial catch throughout the range of the fishery. The Boothbay Harbor Laboratory has played an important role in monitoring the status of the Gulf of Maine herring resource and the US fishery for over 30 years. When the U.S. Bureau of Commercial Fisheries closed its laboratory in Boothbay Harbor in 1973, the responsibility for maintaining the herring landings and sample databases passed to the MDMR. Except for a brief hiatus between 1985 and 1990, when the NMFS again was in charge, the Department has worked closely with industry to compile the annual landings statistics for the state.

Landings:

Landings data are available since the 1950's (Anthony and Waring, 1980). But for the purposes of this assessment, data are presented from 1960 (Table 1). Prior to 1994, US landings were collected by a combination of canning industry reports and reports by NMFS port agents. After 1994, harvesters using Vessel Trip Reports (VTR) directly reported US landings data. With implementation of the US Federal Fishery Management Plan (FMP) in 1999, harvesters were required to use both VTR and Interactive Voice Reports (IVR). Federally licensed dealers were also required to submit monthly reports (NEFMC, 1999).

Harvesters report VTR data on a monthly basis. Because harvesters give precise location (coordinates or Loran) on a per trip basis, this reporting system allows for detailed catch information from specific areas. VTR data are useful for stock assessment and effort information. Because they are reported on a monthly basis, and the lag between catches and reports, this system is not useful for quota monitoring (NEFMC, 2001).

The IVR call in system is also a harvester report. Harvesters report combined catches by Management Area on weekly schedule. While both trip level information and precise location are not reported, this system is useful for near real time quota monitoring. IVR data is not generally useful for stock assessment, or management questions that require information by sub-area or gear.

Dealer Reporting is a monthly reporting system for all federally licensed dealers of Atlantic Herring. While this system does not give specific catch by area information, detailed information on amount landed, price paid, and utilization of landings is gathered.

Both IVR and VTR data incorporates landing to foreign vessels by domestic harvesters. Dealer data accounts for only landings made to domestic dealers. NMFS and state observers collect data on landings to foreign processing or fishing vessels. At the end of a fishing year, all reporting systems are analyzed to uncover discrepancies.

Total removals in the 1970's were much higher than they are currently (Figure 1), due in part to fishing by foreign fleets. Since 1990, total removals of Atlantic Herring from the stock complex have ranged from 77,000 to 150,000 mt (average; 107,000 mt).

Landings data, analyzed by gear type, shows that the fishery has changed substantially since the 1960's. While there was purse seine activity in the 70's, fixed gear was the predominate method of catching herring in the US until the early 80's. After about 1981, the fishery was dominated first by purse seine, then by single mid-water trawling. Currently, the fishery is dominated by single and pair mid-water trawls (Figure 2).

US domestic landings have recently changed in the area of harvest. Previously herring were predominately taken from Management Area 1A (Figure 3). But in recent years, there has been a notable increase in harvest from Georges Bank and the winter fishery off of Rhode Island. Thus is in part due to the change from purse seine to mid-water gear. Purse seines tend to be less effective in deeper water.

Samples:

Samples of herring collected from the commercial catch are processed at the Maine Department of Marine Resources (DMR) laboratory in Boothbay Harbor. Historically samples were obtained from canning plants, some of which transported fish from other states. NMFS port agents; fishery biologists in other states; and the Canadian Department of Fisheries and Oceans would also provide samples or data to the State of Maine. Recently, Maine has been given a grant from the Atlantic Coastal Cooperative Statistic Program (ACCSP) for a dedicated herring sampler. Normally 4-8 samples are collected each month by statistical area harvested. However, more extensive sampling has occurred during foreign fishing or processing operations. Current sampling ratio is approximately one 50 fish sample per 500 mt.

Usually, between 150 and 200 samples (7,500- 10,000 fish) are processed each year (Figure 4). Samples of 50 fish are processed for length (mm total length), weight (grams), sex, and, where applicable, sexual maturity and gonad stage, using standard procedures and criteria. From each sample the sagittal otoliths are removed from two fish per centimeter group and embedded in plastic blocks for ageing. Periodic calibration of ageing procedures is done with NMFS scientists.

Resulting data for the stock complex suggest a large reduction in weight at age (for non-spawners), since the early 1980's (Table 2 & Figure 5). A similar reduction in total length is also noticeable (Figure 6). Such reduction in both weight and length at age may have implications to the partial recruitment vector for this complex.

BIOSTAT and the Catch at Age Matrix:

Biostat is a software program which uses catch and sample files to produce catch at age data in both numbers of fish at age and total weight of fish at age by Unit. A Unit is defined as a month, geographical area (composed of one or more statistical areas) and gear type (fixed or mobile). Currently geographical areas are defined as Eastern Gulf of Maine (statistical areas;) Western Gulf of Maine (statistical areas;) Southern New England/ Mid-Atlantic (statistical areas;) and Georges Bank (statistical areas;). Gear type is defined as fixed (stop seine and weir) or mobile (purse seine, pair midwater trawl, single mid-water trawl and bottom trawl). The sample parameters for a given Unit are weighted by the total catch from that Unit. In the event that sample data is unavailable for a particular Unit, sample data is borrowed from the next adjacent Unit, with preference given to borrowing between months as opposed to geographically. The catches at age matrix for each Unit are summed across all Units for total catch at age for the year for all US landings from the complex.

More specifically, BIOSTAT first sums the catch (in metric tons) by a Unit. A length frequency grouped by centimeters is then developed from the sample data in that Unit. An age length key is then developed from the frequency of age by centimeter length group (mm as total length) from all samples in that Unit. The age frequencies are proportioned across ages for each length group. The mean weights (grams) at age are calculated from all individual weights within an age class from all samples in a particular Unit. The mean weights at age are then multiplied by the sum of numbers at age, which gives an expanded weight at age in that Unit. Catches in weight (mt) at age are derived from total weight of the catch multiplied by the weight at age proportion. Catch in numbers at age is calculated from catch in weight at age divided by the mean weight at age times 1,000,000 (convert grams to metric tons) for each Unit.

Examination of the catch at age matrix reveals interesting trends within the data. Strong year classes are noticeable particularly for 1994, 1996, and 1998 (Tables 3& 4). The 1994 and 1998 year classes seem particularly strong complex wide. Overall, the age structure of this complex has shifted to older individuals since the 1980's (Figure 7). This trend may be attributable to many factors including; the abundance of older age classes, industry trends towards landing larger fish, demise of the inshore fixed gear fishery (which tended to catch smaller fish), and the above noted reduction in size at age.

References:

Anthony V.C. and G. Waring 1980. Assessment and management of the Georges Bank herring fishery. *Rapp. P.-v. Reun. Cons. Int. Explor. Mer* 177:72-111.

New England Fishery Management Council (NEFMC). 1999 Atlantic Herring Fishery Management Plan And Environmental impact Statement 64 pp + appendices

New England Fishery Management Council (NEFMC). 2001 Stock Assessment and Fishery Evaluation Report for 2001.

Table 1. GEORGES BANK (GB), GULF OF MAINE (GOM), SOUTHERN NEW ENGLAND (SNE), MIDDLE ATLANTIC (MAT) AND NEW BRUNSWICK, CANADA (NB) HERRING CATCH, 1960-2002. (INCLUDES FOREIGN FISHING, INTERNAL WATERS PROCESSING OPERATIONS AND AT-SEA TRANSFERS TO CANADIAN CARRIERS IN THE GOM).

YEAR	FOR GB ¹	U.S. GB ²	CAN GB	FOR GOM	US GOM ³	SNE ⁴	MAT ⁵	TOT US	NB ⁶	TOTAL FOR	TOTAL
1960					60,237	261	152	60,650	34,304	34,304	94,954
1961	67,550	105			25,548	197	101	25,951	8,054	75,604	101,555
1962	152,141	101			69,980	131	98	70,310	20,698	172,839	243,149
1963	97,646	322			67,736	195	78	68,331	29,366	127,012	195,343
1964	130,949	489			27,226	200	148	28,063	29,432	160,381	188,444
1965	41,691	1,191			34,104	303	208	35,806	33,460	75,151	110,957
1966	138,396	4,308			29,167	3,185	176	36,836	35,805	174,201	211,037
1967	217,532	1,211		5,226	30,191	247	524	32,173	30,032	247,564	279,737
1968	372,840	758		21,497	40,928	245	122	42,053	33,145	405,985	448,038
1969	307,080	3,678		25,084	28,336	2,104	193	34,311	26,539	333,619	367,930
1970	245,283	2,011		13,716	28,070	1,037	189	31,307	15,840	261,123	292,430
1971	263,525	3,822		19,498	32,631	1,318	1,151	38,922	12,660	276,185	315,107
1972	171,408	2,782		24,220	37,444	2,310	409	42,945	32,699	204,107	247,052
1973	197,708	4,627		10,725	21,767	4,249	233	30,876	19,935	217,643	248,519
1974	146,155	3,370		7,865	29,491	2,918	200	35,979	20,602	166,757	202,736
1975	141,513	4,583		5,249	31,938	4,119	117	40,757	30,819	172,332	213,089
1976	42,758	744		921	49,887	191	57	50,879	29,206	71,964	122,843
1977	1,776	381		382	50,348	301	33	51,063	23,487	25,263	76,326
1978		2,059			48,734	1,730	46	52,569	38,842	38,842	91,411
1979		1,270			63,492	1,341	31	66,134	37,828	37,828	103,962
1980		1,700			82,244	1,200	21	85,165	13,525	13,525	98,690
1981		672			64,324	749	16	65,761	19,080	19,080	84,841
1982		1,378			32,157	1,394	20	34,949	25,963	25,963	60,912
1983		58			24,824	72	21	24,975	11,383	11,383	36,358
1984		53			33,958	79	10	34,100	8,698	8,698	42,798
1985		316			27,157	196	13	27,682	27,863	27,863	55,545
1986		586			27,942	632	20	29,180	27,883	27,883	57,063
1987		11			39,970	376	87	40,444	27,320	27,320	67,764
1988					39,568	1,307	365	41,240	33,421	33,421	74,661
1989					52,774	269	39	53,082	44,112	44,112	97,194
1990			91		54,192	761	48	55,001	38,778	38,869	93,870
1991			64		50,984	3,947	402	55,333	24,576	24,640	79,973
1992					55,948	716	4,564	61,228	31,968	31,968	93,196
1993					53,929	1,829	1,347	57,105	31,572	31,572	88,677
1994		474	266		51,413	1,935	502	54,324	22,241	22,507	76,831
1995		64			69,989	14,630	856	85,539	18,248	18,248	103,787
1996		1,758	2,491		78,885	26,876	1,079	108,598	15,913	18,404	127,002
1997		6,262	79		71,395	20,914	527	99,098	20,552	20,631	119,729
1998		31,067			52,683	20,084	1,903	105,737	20,092	20,092	125,829
1999		6,243			76,861	21,528	1,028	105,659	18,592	18,592	124,251
2000		16,171	275		64,839	27,275	568	108,853	16,830	17,105	125,958
2001	1,241	34,510	3,317		55,815	17,691	420	108,436	20,210	24,768	133,204
2002*		15,217	1,605		68,543	7,486	29	91,275	11,800	13,405	104,680

¹1961-1987: foreign catch from areas 5Z and 6, including some U.S. landings (<5,000 mt/yr)

²1994-2002: catch from NMFS statistical areas 521, 522, 525, 526, 561 and 562

³ ME, MA & NH landings; ⁴RI, CT, NY landings; ⁵NJ, DE, MD, VA landings; ⁶ fixed gear catch only. *Note 2002 landings are preliminary

Table 2. Mean weight at age (kg), U.S. Atlantic herring stock complex, 1967-2002. Note 2002 data are preliminary

Year	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10	AGE 11+
1967	0.005	0.029	0.078	0.118	0.162	0.257	0.275	0.342	0.288	0.292	0.313
1968	0.007	0.025	0.059	0.142	0.194	0.215	0.245	0.26	0.273	0.292	0.313
1969	0.01	0.039	0.079	0.051	0.252	0.27	0.32	0.296	0.273	0.292	0.313
1970	0.021	0.063	0.106	0.167	0.21	0.24	0.304	0.309	0.311	0.292	0.313
1971	0.019	0.049	0.115	0.18	0.234	0.327	0.294	0.291	0.329	0.331	0.313
1972	0.035	0.051	0.12	0.187	0.234	0.273	0.314	0.357	0.273	0.292	0.313
1973	0.016	0.054	0.108	0.17	0.233	0.257	0.293	0.325	0.338	0.263	0.324
1974	0.017	0.053	0.108	0.169	0.204	0.232	0.247	0.272	0.286	0.293	0.305
1975	0.023	0.051	0.096	0.169	0.192	0.23	0.274	0.274	0.302	0.293	0.314
1976	0.018	0.042	0.114	0.179	0.206	0.211	0.26	0.282	0.319	0.334	0.399
1977	0.016	0.042	0.103	0.161	0.189	0.219	0.228	0.26	0.304	0.294	0.281
1978	0.013	0.04	0.12	0.186	0.226	0.256	0.273	0.285	0.317	0.349	0.345
1979	0.008	0.032	0.089	0.198	0.255	0.281	0.182	0.325	0.332	0.313	0.313
1980	0.015	0.041	0.103	0.169	0.268	0.319	0.344	0.241	0.306	0.391	0.372
1981	0.012	0.045	0.114	0.19	0.232	0.293	0.316	0.342	0.47	0.304	0.373
1982	0.02	0.049	0.13	0.194	0.25	0.267	0.3	0.322	0.342	0.423	0.313
1983	0.022	0.055	0.138	0.216	0.223	0.31	0.348	0.368	0.39	0.397	0.313
1984	0.019	0.051	0.133	0.182	0.227	0.26	0.305	0.343	0.314	0.402	0.528
1985	0.013	0.049	0.139	0.181	0.203	0.229	0.281	0.273	0.289	0.292	0.313
1986	0.021	0.053	0.116	0.166	0.215	0.23	0.251	0.26	0.299	0.292	0.313
1987	0.018	0.044	0.093	0.141	0.178	0.218	0.233	0.227	0.251	0.265	0.32
1988	0.009	0.034	0.09	0.129	0.164	0.187	0.228	0.238	0.254	0.292	0.247
1989	0.005	0.046	0.101	0.136	0.168	0.196	0.235	0.248	0.244	0.313	0.3
1990	0.005	0.044	0.099	0.148	0.183	0.194	0.207	0.229	0.24	0.258	0.3
1991	0.005	0.053	0.087	0.133	0.166	0.193	0.214	0.225	0.229	0.243	0.3
1992	0.005	0.046	0.09	0.128	0.153	0.175	0.201	0.219	0.229	0.256	0.3
1993	0.005	0.044	0.096	0.132	0.158	0.182	0.211	0.238	0.258	0.282	0.3
1994	0.005	0.049	0.086	0.119	0.139	0.159	0.184	0.214	0.243	0.261	0.3
1995	0.026	0.056	0.097	0.123	0.14	0.155	0.17	0.192	0.224	0.256	0.272
1996	0.025	0.054	0.091	0.125	0.152	0.171	0.191	0.206	0.235	0.249	0.332
1997	0.016	0.057	0.09	0.122	0.145	0.17	0.187	0.216	0.264	0.332	0.345
1998	0.000	0.050	0.082	0.119	0.144	0.165	0.184	0.198	0.213	0.247	0.267
1999	0.030	0.058	0.088	0.116	0.139	0.158	0.178	0.196	0.201	0.290	0.000
2000	0.000	0.071	0.107	0.128	0.154	0.173	0.198	0.212	0.229	0.243	0.267
2001	0.039	0.057	0.100	0.132	0.153	0.171	0.189	0.213	0.218	0.282	0.262
2002	0.025	0.059	0.094	0.125	0.147	0.165	0.181	0.198	0.217	0.208	0.208

Table 3. Catch at age (millions) for coastal US Atlantic herring fishery. Note 2002 data are preliminary

Year	1	2	3	4	5	6	7	8	9	10	11+
1967	6.83	261.94	166.4	42.6	10.64	15.53	9.05	0.67	0.45	0.39	0.17
1968	13.29	695.48	177.37	24.09	32	29.87	28.93	19.01	3.24	2.49	0.65
1969	10.02	231.06	229.66	18.8	14.41	24.28	22.29	22.85	20.03	5.73	1.03
1970	2.02	168.93	55.35	30.74	20.29	25.96	33	26.75	21.09	14.7	2.88
1971	73.72	55.51	44.23	45.07	44.84	44.01	29.17	17.86	12.18	8.55	3.53
1972	0.68	357.84	23.73	45.07	43.79	49.6	25.2	9.49	2.89	2.68	1.65
1973	11.36	143.56	96.75	7.64	11.85	13.75	13.09	7.47	1.8	0.55	0.34
1974	31.36	181.33	63.52	110.36	8.82	5.46	2.96	2.05	0.94	0.44	0.35
1975	28.26	181.47	49.2	25.75	90.98	9.54	3.81	2.27	1.09	0.45	0.27
1976	23.59	331.48	137.18	20.55	15.88	57.96	3.7	0.68	0.89	0.18	0.09
1977	82.21	454.92	72.68	42.87	12.48	10.79	42.9	2.3	0.56	0.39	0.32
1978	56.02	328.01	80.67	20.1	37.8	4.62	7.68	30.85	1.1	0.65	0.22
1979	4.16	750.35	170.08	43.4	14.86	15.84	5.67	3.42	6.9	0.34	0
1980	67.15	224.72	301.08	163.46	20.85	6.03	8.09	0.78	0.62	4.43	0.12
1981	8.37	874.47	15.58	57.9	41.52	4.55	1.31	1.17	0.04	0.14	0.81
1982	22.49	274.05	36.94	3.52	28.47	17.7	1.98	0.38	0.75	0.12	0.15
1983	30.28	132.19	37.42	21.37	0.81	6.22	7.17	0.33	0.19	0.13	0
1984	4.53	98.45	113.11	32.12	22	1	3.13	1.35	0.37	0.04	0
1985	9.9	177.3	36.89	31.6	17.81	8.92	0.25	1.51	0.49	0	0
1986	37.47	111.15	103.49	24.21	27.3	11.52	5.38	0	0.34	0	0.33
1987	15.28	92.12	85.28	124.43	20.67	11	3.12	1.71	0.02	0.21	0.01
1988	3.23	153.08	64.73	38.69	85.45	18.8	6.58	1.53	0.69	0	0.03
1989	0.21	129.19	84.62	86.7	58.62	87.67	17.74	5.29	1.39	0.03	0
1990	0.01	116.25	151.56	58.67	31.64	35.94	67.45	25.11	12.19	3.64	1.09
1991	0.01	123.52	135.99	78.08	55.77	30.12	20.67	18.01	8.29	3.08	1.2
1992	0	171.06	121.89	57.78	77.73	52.05	25.13	15.28	13.25	3.54	0
1993	0	139.82	137.4	64.29	65.33	38.47	29.75	16.34	4.48	1.62	0.33
1994	0	131.53	112.22	62.74	69.02	62.08	33.44	17.84	5.12	1.39	0.05
1995	1.38	205.59	93.44	38.53	36.12	82	89.96	56.16	17.32	3.39	0.88
1996	0.44	344.5	135.92	60.78	73.16	166.97	96.98	27.66	6.25	2.2	0.15
1997	1.91	75.7	422.38	69.52	49.8	76.8	82.09	18.44	2.76	0.04	0.1
1998	0.00	236.62	80.71	210.01	45.23	22.83	26.06	14.92	5.47	1.49	0.28
1999	0.67	103.61	277.84	77.51	196.55	71.26	32.12	17.89	4.49	0.36	0.00
2000	0.00	190.11	37.28	95.16	134.31	147.58	35.15	12.83	2.43	1.02	0.31
2001	0.12	72.93	245.86	36.63	67.99	96.37	108.74	22.38	4.89	0.48	0.09
2002	9.48	78.82	96.37	198.71	66.52	58.96	60.60	26.68	3.12	0.35	0.05

Table 4. Catch at age (millions) for Georges Bank Atlantic herring fishery. Note 2002 data are preliminary

Year	1	2	3	4	5	6	7	8	9	10	11+
1967	0	1.8	6.9	60.6	108	250.7	379.2	49.4	11.1	10	0
1968	0	2.5	52.1	133.3	336	233.4	432.9	336.4	21.8	6.6	0
1969	0	0	73.4	210.8	277.1	278.1	188.5	190.5	109.7	23.6	0
1970	0	12.6	125.4	450.5	270.3	122.3	92.9	51.6	29.6	17.7	0
1971	0	12.9	332.5	275.5	284.6	175.8	103.9	50.4	13.9	21.8	0
1972	0	28	35	110	214	158	100	45	29	21	0
1973	0	10	1026	266	64	33	23	12	3	5	0
1974	0	1.9	39.9	608.9	68.6	12.9	6.1	3.5	2.1	0	0
1975	0	1.4	11.3	76.8	503	34.6	12.5	6.2	4.2	0.1	0
1976	0	0.5	7.5	6.8	18.6	140.8	5.1	2.3	1.2	0.3	0
1977	0	0.1	0.3	6.7	1.2	0.2	1.9	0.1	0.1	0	0
1978	0	0.1	5.6	2.3	4.3	0.5	0.3	1.2	0	0	0
1979	0	0.1	5.1	2.1	0.4	0.4	0	0.1	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0
1996	0	5.79	2.29	1.02	1.23	2.81	1.63	0.46	0.1	0.04	0
1997	0	2	49	5.29	1.18	1.5	1.16	0.51	0.09	0	0
1998	0.00	240.61	109.84	321.66	56.07	29.27	31.64	16.06	5.76	1.62	0.28
1999	0.67	103.61	285.31	82.97	216.58	79.55	35.16	19.55	4.53	0.36	0.00
2000	0.00	195.11	41.89	121.11	155.34	175.83	44.08	15.39	2.83	1.04	0.32
2001	0.12	74.76	379.86	51.30	98.06	127.48	135.85	26.77	5.15	0.48	0.09
2002	9.48	78.82	98.91	248.05	82.73	69.48	71.49	33.70	3.42	0.35	0.05

Figure 1 Landings from the Atlantic Herring Complex. Note 2002 data are preliminary

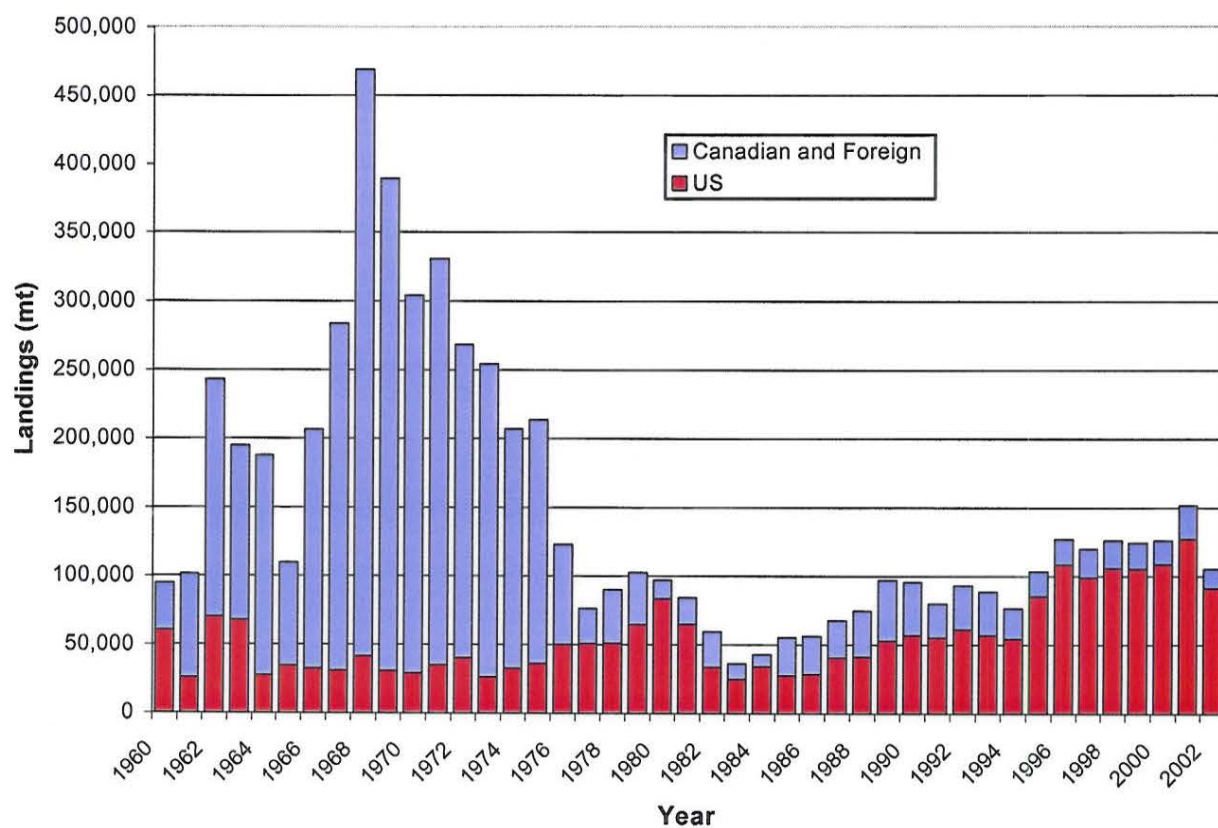


Figure 2. Percentage of landings by gear type for the US Atlantic Herring fishery

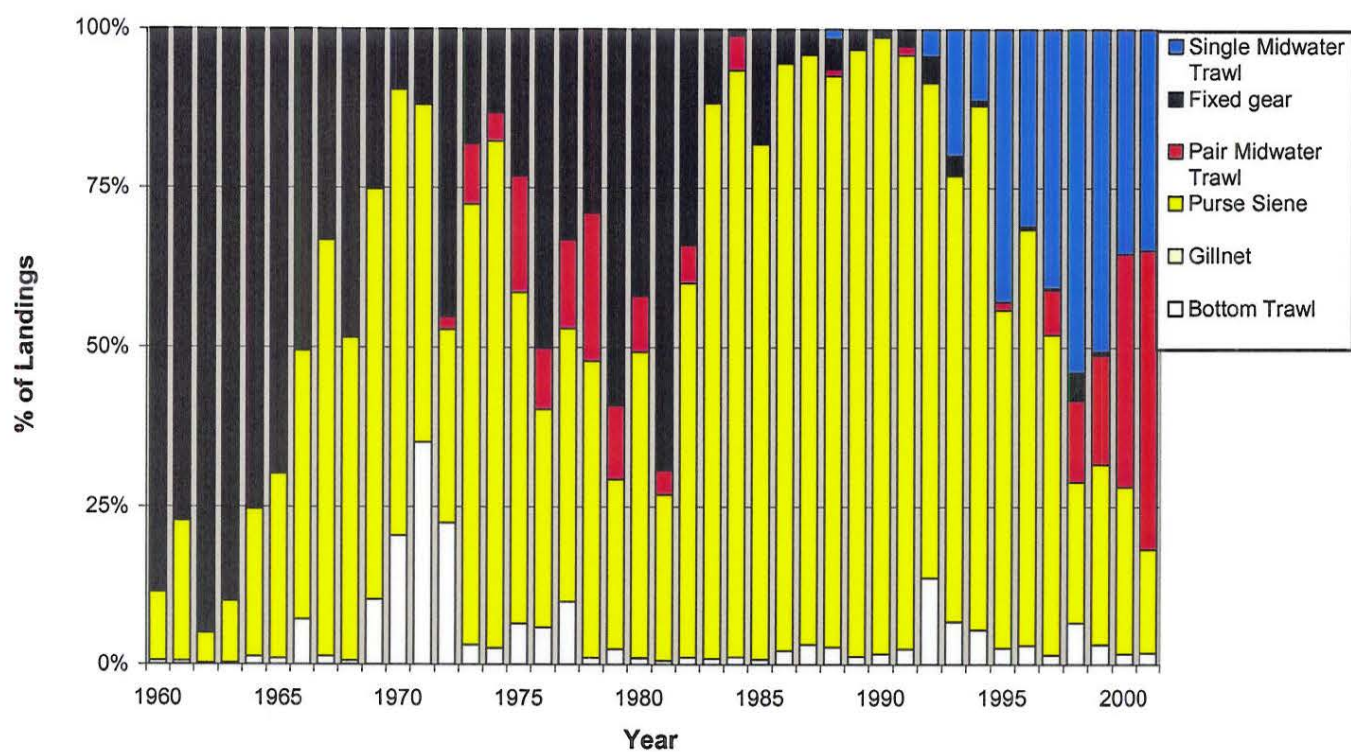


Figure 3. Percentage of landings by management area for the US Atlantic Herring fishery

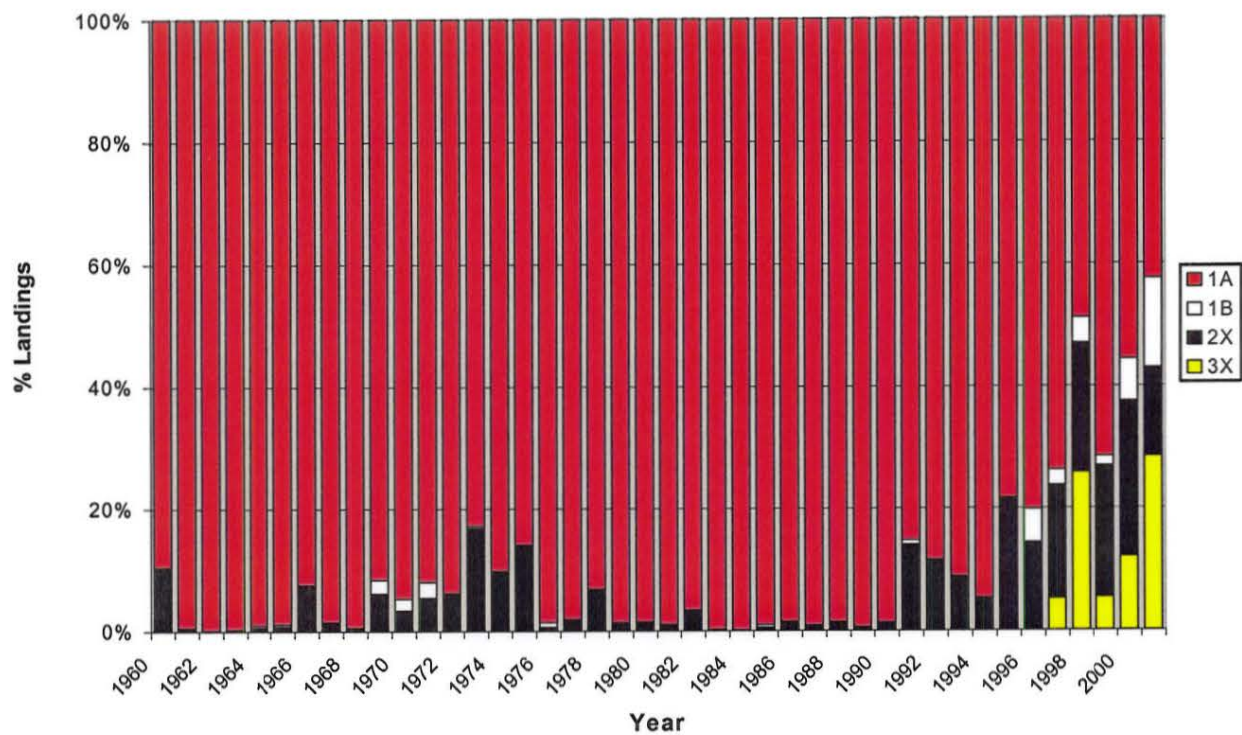


Figure 4. Number of samples processed for the US Atlantic herring Fishery

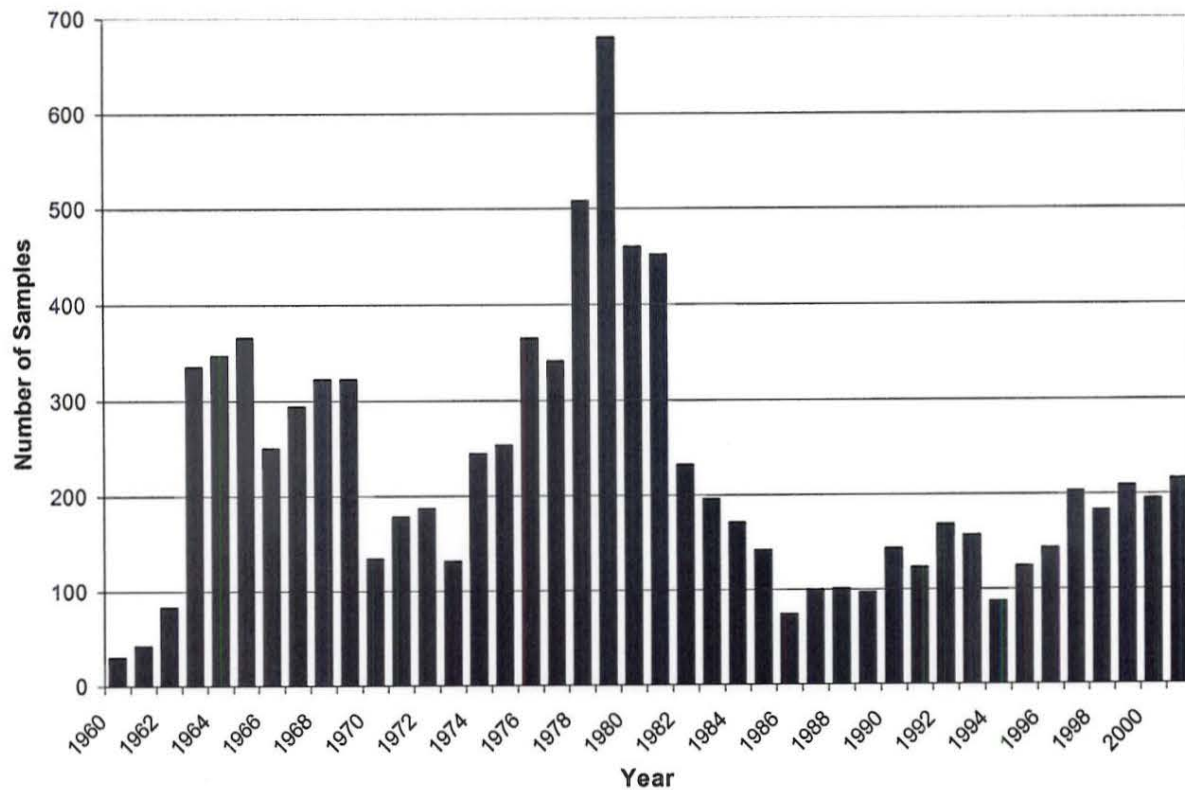
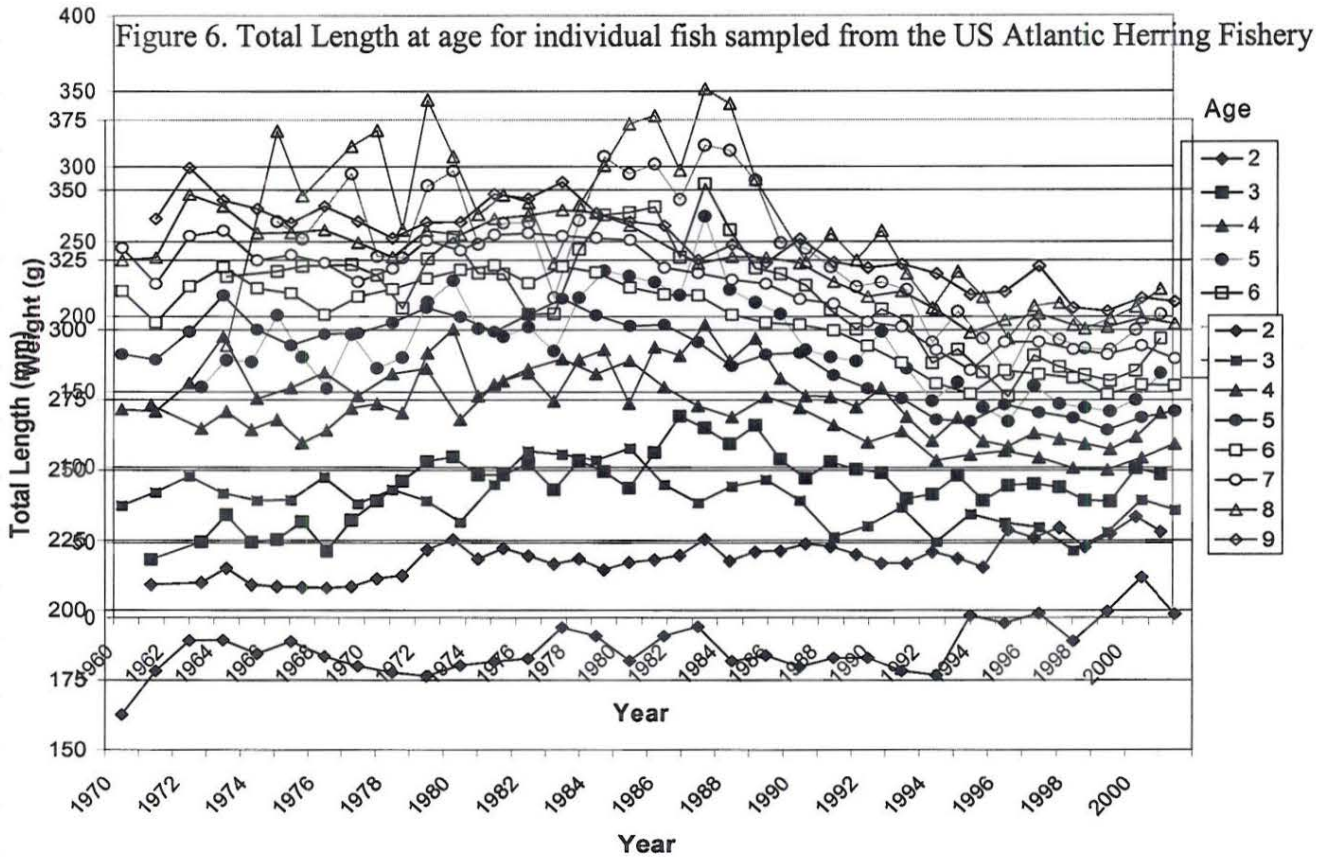


Figure 5. Weight at age for individuals fish sampled from the US Atlantic Herring Fishery



APPENDIX 2:

The Atlantic Herring Fishery and the Interactive Voice Response System (IVR) Annual Report - 2002

Background:

The New England Fisheries Management Council implemented the Atlantic Sea Herring Fisheries Management Plan (FMP) in 2000. Regulations included in the FMP mandate that harvesters report daily fishing activities using the federal Vessel Trip Report (VTR) forms and submit weekly catch reports using the Interactive Voice Response (IVR) system. The IVR system is an automated, phone-based reporting method initially created for multi-species dealer reporting. It was later modified to include Atlantic herring catch reports in response to the need for real-time quota monitoring. Every "Category 1" federally licensed vessel is required to compile their daily herring catches (in pounds) by week and report them for each federal management area fished (see attached map). Commercial fishermen in state waters who hold a herring permit and catch more than 2000 lbs. in a week are also required to report their landings using the IVR system.

The main reason for utilizing the IVR system in the Atlantic herring fishery is the Total Allowable Catch (TAC) limits set for the four federal management areas. As part of the herring FMP, each management area is assigned a TAC (in metric tons). Although harvesters are required to report catches with VTR forms, near real-time data is obtained through the IVR system allowing the TACs to be accurately monitored. When a management area is projected to reach 95% of the TAC, the Regional Administrator enacts a closure for all directed fishing.

Total Allowable Catches for 2002

Management Area	TAC (mt)	95% of TAC (mt)
Area 1A (Jan 1 st – May 31 st)	6,000	5,700
Area 1A (June 1 st – Dec 31 st)	54,000	51,300
Area 1B	10,000	9,500
Area 2	50,000	47,500
Area 3*	50,000	47,500

* = The Area 3 quota was increased to 60,000 mt for 2003

Annual Summary:

The 2002 season was the third year of mandatory IVR reporting for the Atlantic herring fleet. A total of 96 vessels had a Category 1 permit in 2002, of those vessels, 42 reported using the IVR system. Although IVR reporting compliance among herring permit holders was less than 50%, dedicated herring vessels (about 26 in number) had a compliance level approaching 100%. The total catch in 2002 reached 91,831 mt, a 24% decrease from 2001. The Area 1A harvest accounted for approximately 65% of the total catch followed by Area 3 with 16% and Area 2 with 12% of the total. The most notable decrease in catch was in Area 3 that went from 37,174 mt in 2001 to 14,540 mt, a 61% reduction. Based on IVR data, discards accounted for 234 lbs (.11 mt) of the yearly harvest.

Total Catch by Area for 2002 (mt)

Area 1A	Area 1B	Area 2	Area 3
59,263	7,355	10,673	14,540
99% of TAC	74% of TAC	21% of TAC	29% of TAC

The following tables show Atlantic herring catches by week for 2000-2002 based on IVR reporting. These tables are accompanied by two graphs depicting the annual total harvest and the Area 1A catch for this three-year period.

IVR Updates:

IVR catch updates are sent out on a weekly basis by email to individuals from the herring industry and management communities. Inaccurate or delayed reporting occasionally leads to slight adjustments in the data. Therefore, please use this annual summary to replace any weekly catch numbers you have received throughout the year. If you would like to be added to the IVR update list please contact Kohl Kanwit at Maine DMR (by phone: 207-633-9535 or by email: kohl.kanwit@state.me.us).

Important Note:

The catch numbers in this report reflect only those obtained through the IVR system. All Atlantic herring catch assessments and analyses are based on VTR data due to their higher degree of detail. A 2002 catch report based on the VTR data will be available by March 1st, 2002.

IVR Reported Catch in Metric Tons - 2000

Week #	Area 1A	Area 1B	Area 2	Area 3	Total
01 (1/2/00)	0		1954	60	2014
02	0		823		823
03	0		961		961
04	0		1909		1909
05	27		1457		1484
06	0		1735		1735
07	0		1635		1635
08	0		2052		2052
09	16		1260		1276
10	0		1467		1467
11	32		416	140	588
12	0		33		33
13	0		104		104
14	0				
15	578		156		734
16	356		32		388
17	381		64	91	536
18	2030		64		2095
19	1739	38			1777
20	1742				1742
21	1945	84			2030
22	2073				2073
23	1588				1588
24	2354				2354
25	3011				3011
26	3157				3157
27	3250				3250
28	3960				3960
29	3305			259	3564
30	3934	209		159	4301
31	2450*			1033	3483* = 2 days out of the fishery
32	2525			414	2939
33	2606			429	3035
34	3529		357	657	4543
35	2350			1646	3996
36	1257*			1471	2728* = 3 days out of the fishery
37	798			2878	3676
38	1121			1117	2239
39	1644*			2385	4029* = 4 days out of the fishery
40	1764			1759	3523
41	1455			1135	2590
42	2539			220	2759
43	3123			135	3258
44		581			581
45		2105		298	2402
46		1750			1750
47		1135	332		1467
48		811	536		1347
49		236	1639		1875
50		181	750	129	1061
51		54	308		363
52			228		228
Total	57287	7185	20274	16415	106513

IVR Reported Catch in Metric Tons -
2001

Week #	Area 1A	Area 1B	Area 2	Area 3	Total
01			1080		1080
02			1125		1125
03			2343		2343
04			2537		2537
05			2148		2148
06			1652		1652
07			1068		1068
08	1104		579		1683
09	1062		129		1191
10	304		25		329
11	641		79		721
12	36		86		122
13	357		136		493
14	434				434
15	637				637
16	483		272		755
17	504		197		701
18	931		152		1083
19	1434				1434
20	1524			5	1530
21	1945				1945
22	1715				1715
23	1930				1930
24	1847				1847
25	2608				2608
26	2296			625	2921
27	1640*		19	1001	2660*
28	2251			1501	3753
29	1374			2109	3483
30	1226			2452	3678
31	2213	40		1415	3668
32	1890			1536	3425
33	2293			1677	3970
34	1524			1523	3047
35	2323			2235	4559
36	1423			3074	4497
37	1328			3731	5059
38	1598			3462	5060
39	1237			2448	3685
40	1665			1921	3586
41	942		190	3687	4819
42	2476		248	1353	4076
43	3285		234	953	4473
44	3384		20	14	3418
45	2505	159	34	221	2919
46		1168	221	230	1619
47		673			673
48		1791	747		2538
49		1643	994		2636
50		1957	369		2327
51		1166	218		1383
52		270	256		525
Total	58370	8866	17160	37174	121569

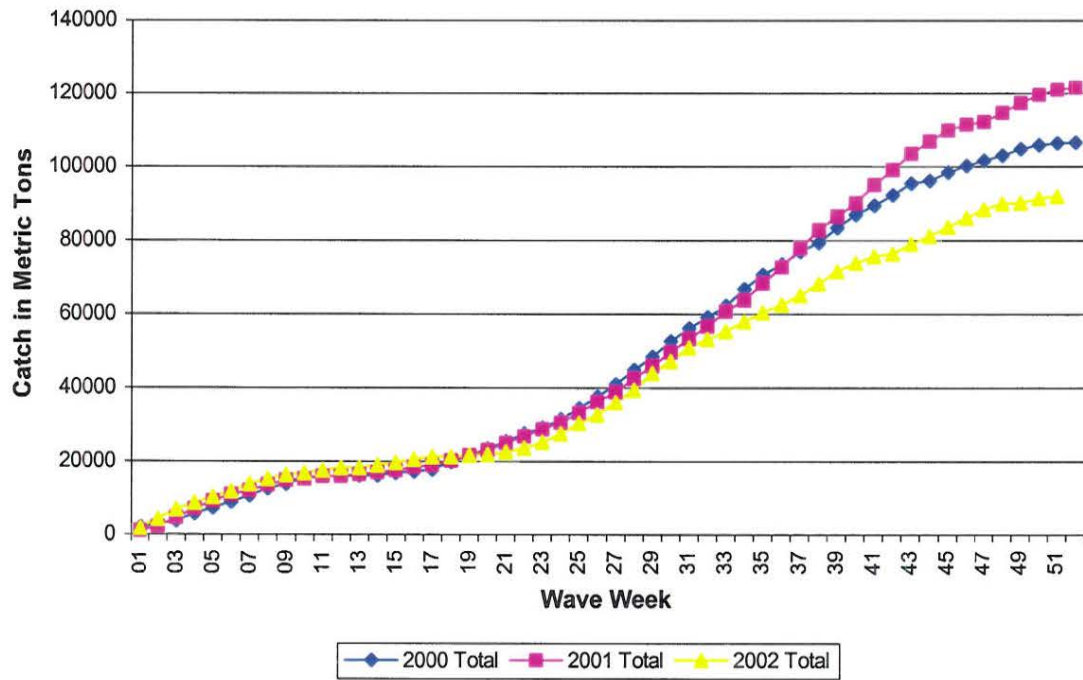
* = 3 days out of the fishery

IVR Reported Catch in Metric Tons - 2002

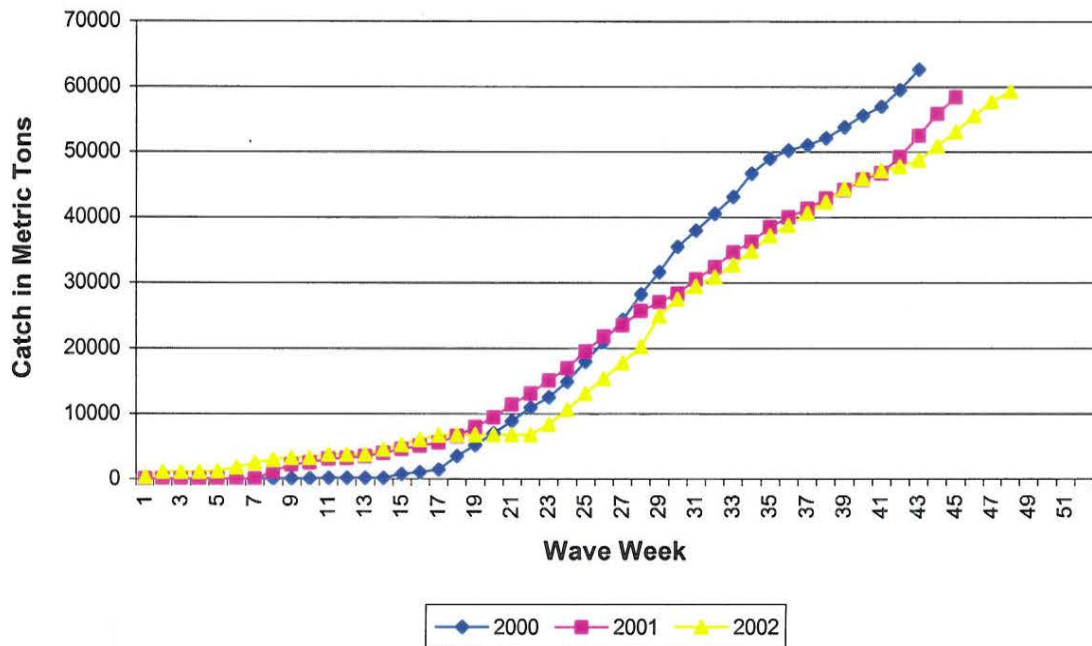
Week #	Area 1A	Area 1B	Area 2	Area 3	Total
01	254	1022	566		1842
02	794		1371	289	2454
03		537	1871	157	2565
04		394	1317	97	1808
05	141	522	909		1571
06	624	197	766		1587
07	635		1412		2047
08	508		805		1313
09	318		792		1111
10			485		485
11	461	242	82		784
12		586			586
13					0
14	785		23		808
15	718				718
16	796				796
17	693	14			707
18			50		50
19			163	142	305
20			23	203	226
21		205		493	698
22		999		153	1152
23	1542*				0*
24	2355				2355
25	2469	299			2768
26	2254			116	2370
27	2390	201		614	3205
28	2438	195		725	3358
29	4662			102	4764
30	2585			541	3125
31	2016			1719	3735
32	1357			916	2273
33	1851			292	2142
34	2128			478	2606
35	2383			198	2581
36	1510			512	2022
37	1882			695	2577
38	1704			1379	3082
39	2089			1224	3314
40	1553			862	2415
41	1194			584	1779
42	593				593
43	1079			1660	2740
44	2120				2120
45	2178			320	2498
46	2478			33	2511
47	2209			37	2246
48	1517				1517
49		287			287
50		1108			1108
51		548	38		586
52					
Total	57720	7355	10673	14540	90288

0* = 2 days out of the fishery

Cumulative Total Catch



Cumulative Catches for Area 1A



APPENDIX 3:



Atlantic herring catch report - 2002 *Maine Department of Marine Resources*

Introduction

Atlantic herring is one of the most biologically and economically important species in the Gulf of Maine. Herring are oceanic plankton-feeding fish that occur in large schools, and inhabit coastal and continental shelf waters from Labrador to Cape Hatteras. Adults (age 3+) migrate south from summer/fall spawning grounds in the Gulf of Maine to over-winter off southern New England and the Mid-Atlantic states. Important commercial fisheries for juvenile herring (ages 1 to 2) existed since the last century through the 1980's along the coasts of Maine and New Brunswick. Development of large-scale fisheries for adult herring is comparatively recent, primarily occurring in the Gulf of Maine, on Georges Bank, and in southern New England waters. Herring are an important food source for many species of fish, mammals, and seabirds.



The Maine Department of Marine Resources (DMR) has collected Atlantic herring catch and landings data from 1947 to the present, with a brief hiatus between 1985 and 1990 when the National Marine Fisheries Service (NMFS) assumed this responsibility. The Atlantic herring fisheries data collection program has broadened in scope and improved accuracy during the past number of years. In 2000, NMFS approved a Fisheries Management Plan (FMP) for Atlantic herring, making it a federally regulated species and requiring mandatory reporting from both the harvest and market sectors. In accordance with the Atlantic States Marine Fisheries Commission (regulatory body for state waters on the east coast), Maine also initiated a program of mandatory reporting using the federal guidelines.



The mandatory Vessel Trip Reporting (VTR) program began in 1994 under the auspices of NMFS' multispecies regulations. The reports are filled out by the vessel operator on a trip-by-trip basis and submitted monthly to NMFS in Gloucester, MA. They include information on the vessel, fishing gear, date, species caught, location

of catch, pounds caught, port landed, and dealers supplied. In addition to VTR reporting, the Interactive Voice Response (IVR) system has been integrated into herring management to monitor Total Allowable Catch (TAC) quotas in the four federal areas. Utilization of the IVR system allows near real-time data to be obtained through weekly vessel call-ins. DMR also collects information from the dealers and processors involved in the herring industry. Prior to

2000, landings data was obtained on a voluntary basis from individual dealers and processors of Atlantic herring. However, beginning in 2000, all dealers who buy herring from federally permitted vessels in Maine ports are also required to obtain a federal permit and report their transactions.

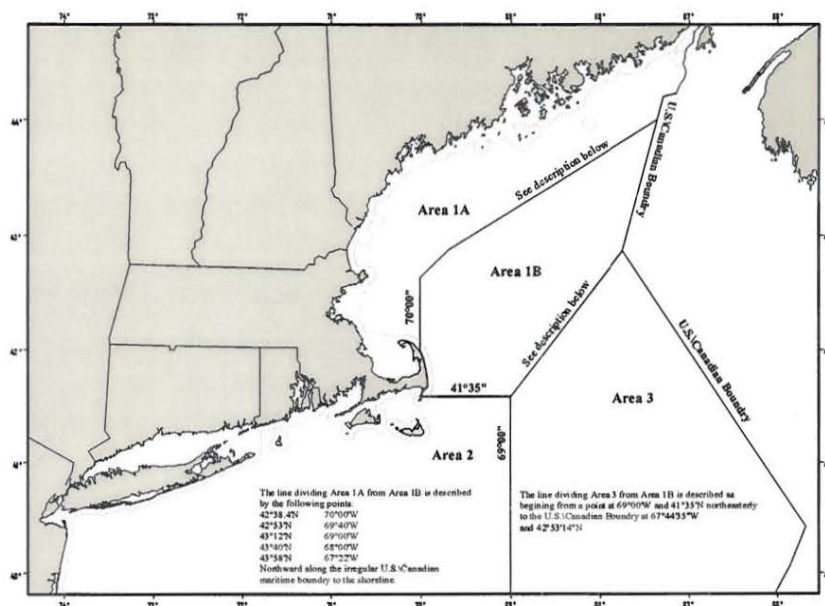
An intensive port-sampling program is also managed by DMR. Commercial catch samples are collected directly from vessels throughout the range of the fishery. The samples are then transported to the DMR laboratory in Boothbay Harbor and processed for length, weight, sex, maturity and age data. Information gathered through this program is used to generate a catch-at-age matrix for stock assessment purposes.



Preliminary Catch Data - 2002

According to preliminary VTR data, the total Atlantic herring catch in 2002 was 83,104 metric tons (mt)*. However, IVR data indicate that 91,831 mt were caught in 2002 fishery, representing an 8,727 mt difference between the two data sources. There are two likely explanations for this discrepancy; first, VTR data is only an estimated 80% complete and second, the IVR data is generally reported as a hail weight not actual weight based on sales. For the purposes of this report, only VTR catch data will be discussed.

The herring fishery is divided into four federal management areas. Each area has a specified TAC set by the New England Fisheries Management Council (NEFMC) on an annual basis.



The TACs (mt) in 2002 were:

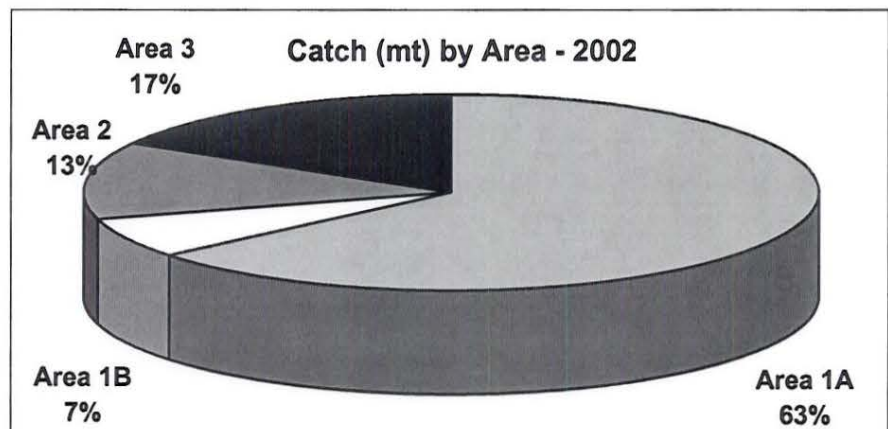
Area 1A	60,000
Area 1B	10,000
Area 2	50,000
Area 3	50,000

The catch by area in 2002 was:

Area 1A	53,182
Area 1B	5,551
Area 2	10,576
Area 3	13,795
Total	83,104

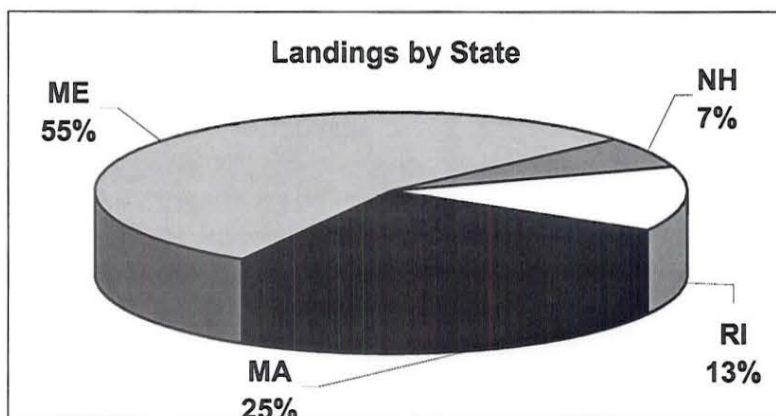
*- 1 metric ton = 2205 lbs.

Ports



The herring fishery moves along the Atlantic coast with the migrating fish, occurring primarily in the Gulf of Maine during the summer and off Rhode Island in the winter. Although there are only a handful of major ports for herring landings, there are many smaller ports associated with canneries, specialized markets and business locations. Landings and commercial catch sampling efforts are focused in the following ports: Portland, Rockland, Stonington, Prospect Harbor, and Bath, Maine; Newington and Portsmouth, New Hampshire; Gloucester and New Bedford,

Massachusetts; North Kingstown and Point Judith, Rhode Island and occasionally Cape May, New Jersey.



Maine	45,184
Massachusetts	20,385
Rhode Island	10,840
New Hampshire	5,388
New Jersey	685
Connecticut	504
New York	117

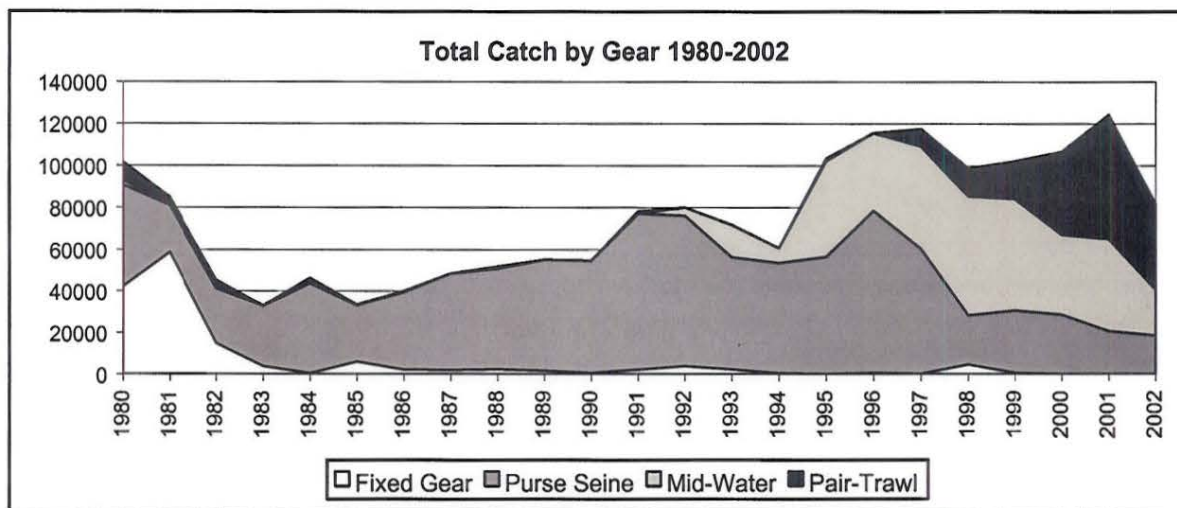
Gear Types

Atlantic herring can be caught by a variety of gear types, however two; purse seine and mid-water trawl dominate the current fishery in US territorial waters. Fixed gear, including weirs and stop-seines, were the traditional means of capturing herring when they schooled in near-shore



waters during late summer and fall. However, beginning in the 1980's purse seine vessels began catching the bulk of the annual herring landings. Another transition began in the early 1990's with the entry of mid-water trawlers into the herring fishery. Because of seasonal fish availability in the current fishery

some vessels use both mid-water trawl and purse seine gear to catch herring. In 2002, purse seine vessels caught 22% (18,639) of the total catch while mid-water trawlers caught 26% (21,982) and pair-trawl vessels caught 50% (41,281). Two percent of the total annual landings were caught by other gear types.



Historic Landings

DMR has recently compiled and edited all the historic Atlantic herring catches and port landings beginning in 1960. Attempts were made to reconcile the various databases (DMR cannery and dealer reports, NMFS Commercial Fisheries Database, NMFS public website) and published

tables (NMFS Stock Assessment Workshop [SAW] and Review [SARC], foreign catches from Georges Bank and Gulf of Maine) of catches into a single comprehensive database. Data was compiled by year, month, state/port, area caught, gear, and metric tons.

YEAR	Total	% Change
1960	55873	-9%
1961	91067	-3%
1962	212197	-5%
1963	152195	-9%
1964	173140	8%
1965	94810	18%
1966	188195	7%
1967	276262	8%
1968	445754	2%
1969	371550	1%
1970	306606	5%
1971	334775	4%
1972	248842	4%
1973	254676	6%
1974	210776	10%
1975	202645	7%
1976	115338	18%
1977	83631	36%
1978	72688	27%
1979	81082	18%
1980	102728	17%

YEAR	Total	% Change
1981	85422	23%
1982	45826	24%
1983	33284	25%
1984	46718	27%
1985	33668	18%
1986	40805	28%
1987	49967	19%
1988	53617	23%
1989	55857	5%
1990	55573	1%
1991	80165	31%
1992	92748	34%
1993	77056	26%
1994	64256	15%
1995	106305	20%
1996	119119	9%
1997	119427	17%
1998	105737	0%
1999	105647	0%
2000	108568	0%
2001	126584	0%

For more information regarding this catch report contact Kohl Kanwit at (207) 633-9535 or by email at kohl.kanwit@maine.gov

APPENDIX 4:

Completion Report for “Commercial catch sampling of Atlantic herring (*Clupea harengus*)”

J. Kohl Kanwit
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Maine Dept. of Marine Resources

David A. Libby
Marine Resources Scientist
Maine Dept. of Marine Resources

Project Background:

The Atlantic herring is one of the most biologically and economically important species in the Gulf of Maine. Herring are oceanic plankton-feeding fish that occur in large schools, and inhabit coastal and continental shelf waters and are widely distributed from Labrador to Cape Hatteras. Adults (age 3+) migrate south from summer/fall spawning grounds in the Gulf of Maine to overwinter off southern New England and the Mid-Atlantic states. Important commercial fisheries for juvenile herring (ages 1 to 2) existed along the coasts of Maine and New Brunswick up until the mid 1980's. Development of large-scale fisheries for adult herring is comparatively recent, primarily occurring in the Gulf of Maine, on Georges Bank, and in southern New England and Mid-Atlantic waters. Commercial landings are currently around 260 million pounds with 60 percent going to the lobster bait market and 40 percent to processing facilities.

Since 1960 the Maine Department of Marine Resources (DMR) has collected and processed Atlantic herring commercial catch samples. Sampling was historically carried out with the cooperation of private companies (canneries) and the National Marine Fisheries Service (NMFS). This system of sampling the commercial catch resulted in incomplete coverage of the fishery and insufficient collection of population data. In an effort to improve the commercial catch sampling program, DMR wrote a grant proposal to the Atlantic States Coastal Cooperative Statistics Program in 2000 and was awarded funding to hire a dedicated sampler. This position began on May 1st, 2001 and continued through April 30th, 2002.

Objectives:

The objectives of this project were:

1. Improve the consistency of sampling by hiring a dedicated, impartial port sampler that follows specific scientific protocols.
2. Maintain sampling in ports formally covered by NMFS port agents and increase sampling in new ports with significant herring landings.
3. Contribute to the collection of population data required for the implementation of the Atlantic States Marine Fisheries Commission (ASMFC) and New England Fisheries Management Council (NEFMC) Fisheries Management Plan (FMP).
4. Effect accurate timing of spawning closures by closely monitoring catch locations and the maturity of landed herring.

Results:

1. The consistency of herring sampling was greatly improved through implementation of this grant. The dedicated sampler and DMR biologists developed a sampling protocol for the collection of herring by port, gear type and catch location (see Appendix A).
2. In the past few years NMFS port offices have experienced a reduction in personnel accompanied by an increase and reprioritization of responsibilities. The addition of a dedicated herring sampler allowed NMFS to focus their efforts on other species. Additionally, ports where NMFS offices were permanently closed were still sampled for herring despite the absence of port agents (i.e. Rockland, ME where an estimated 22 millions pounds of herring were landed in 2001).

The dedicated sampler was also able to incorporate ports that suddenly experienced a significant increase in herring landings. Two such ports were Stonington, ME where a full-time herring vessel offloads and Gloucester, MA where a new herring processing plant opened.

3. Atlantic herring are regulated jointly by ASMFC and NEFMC through separate but complimentary Fishery Management Plans (FMP). Both FMPs rely on the BIOSTAT program that generates catch at age matrices based on commercial catch sampling. These data are critical in the determination of population structure and for the effective implementation of the FMPs. Prior to 2001, large landings would occur over the course of the fishing season in ports that were never sampled. Additionally, some gear types were over represented (i.e. only seiners landed in Rockland where a NMFS port office was located) while others were missing from the data set entirely (i.e. weirs). The dedicated herring sampler has increased the number of samples (from 196 in 2000 to 270 in 2001) and, more importantly, the coverage of various ports and gear types. This thorough sampling of the commercial catch allows for a more accurate determination of population structure and therefore affords the opportunity for better management of the species.
4. Spawning closures are an integral part of the ASMFC Atlantic herring FMP. These area closures are determined based on samples collected from the commercial fleet prior to the fish reaching advanced stages of maturity. In 2001 the dedicated herring sampler was able to intensively sample catches from the spawning areas and transport them fresh to the lab for processing. This allowed managers to accurately predict when the herring in each spawning area were mature and the regions were closed with minimal impact on the fishery and maximum protection for the fish.

Approach:

The dedicated port sampler monitored the Atlantic herring fishery in all east coast ports where significant landings were made (>500 mt). Based on an established protocol, samples (50

fish/vessel) were collected from vessels when they came into port to offload their catch. The dedicated herring sampling position began in May of 2001 and continued through April of 2002. During the first 6 months of the project (May-Oct.) the sampler focused on collecting fish in northern New England ports. Subsequently, the sampler followed the fishery to southern New England and mid-Atlantic ports between November and April. The sampler remained in Portland, Maine for the duration of the program since it was a geographically central base of operation for most of the fishing season. Office space was provided for the sampler at the DMR lab in W. Boothbay Harbor and in the NMFS office on the Portland waterfront.

Project Objective 1: Sampling Maine and New Hampshire:

The sampler began this project by collecting herring at ports throughout Maine and New Hampshire until the federal management area "1A" closed in November. When 1A reopened in January, samples were again collected in the northern New England ports. The ports included in the regular rotation were: Portland, Bath, Sebasco, New Harbor, Rockland, Stonington, Prospect Harbor and Lubec, ME and Newington, NH.

Project Objective 2: Sampling Massachusetts, Rhode Island, New York and New Jersey
The sampler routinely collected herring at ports throughout Massachusetts, Rhode Island and occasionally New Jersey. No significant herring catches were landed in New York so sampling was not conducted in that state. The ports included in the regular rotation were: Point Judith and Kingston, RI; Gloucester, MA and Cape May, NJ. The sampler transported fish to the DMR lab on a weekly basis allowing the samples to be processed in a timely manner.

Conclusion:

The DMR feels that the "Commercial catch sampling of Atlantic herring (*Clupea harengus*)" program was extremely successful during its 12-month term. More than 250 herring samples were collected and processed providing the most complete sampling in years. The sampler was able to meet all expectations outlined in the proposal as well as incorporate port sampling of other commercially important species. During the months of March and April, the port sampler assisted with sea urchin fieldwork that included dockside interviews and collection of biological samples. The majority of the sampling took place in Cumberland, Washington, Hancock and Lincoln counties in Maine. In addition to assisting with sea urchin work, the port sampler was able to collect Atlantic mackerel samples throughout the east coast for NMFS. This work was accomplished by maintaining contact with the pelagic fishing fleet after their switch from herring to mackerel in the early spring. Samples were collected following a National Marine Fisheries Service protocol and subsequently transported to the science center in Woods Hole, MA.

We are currently in our second year of this project, which was continued through another grant award from ACCSP. The second year is progressing successfully with the sampler actively collecting fish from the herring fleet in northern New England. Additionally, the sampler is committing one day a week to assisting the state landings coordinator with catch statistics.

Atlantic herring samples by gear type and month - 2001

Month	Purse Seine	Pair Trawl	Weir	Mid-Water	Total
1	1	10		5	16
2		6		9	15
3				1	1
4		1		5	6
5	3	6		15	24
6	15	3		12	30
7	11	12	2	15	40
8	14	5		9	28
9	19	15		10	44
10	9	13		14	36
11	1	8		7	16
12		13		1	14
Total	73	92	2	103	270

Atlantic herring samples by state and month - 2001*

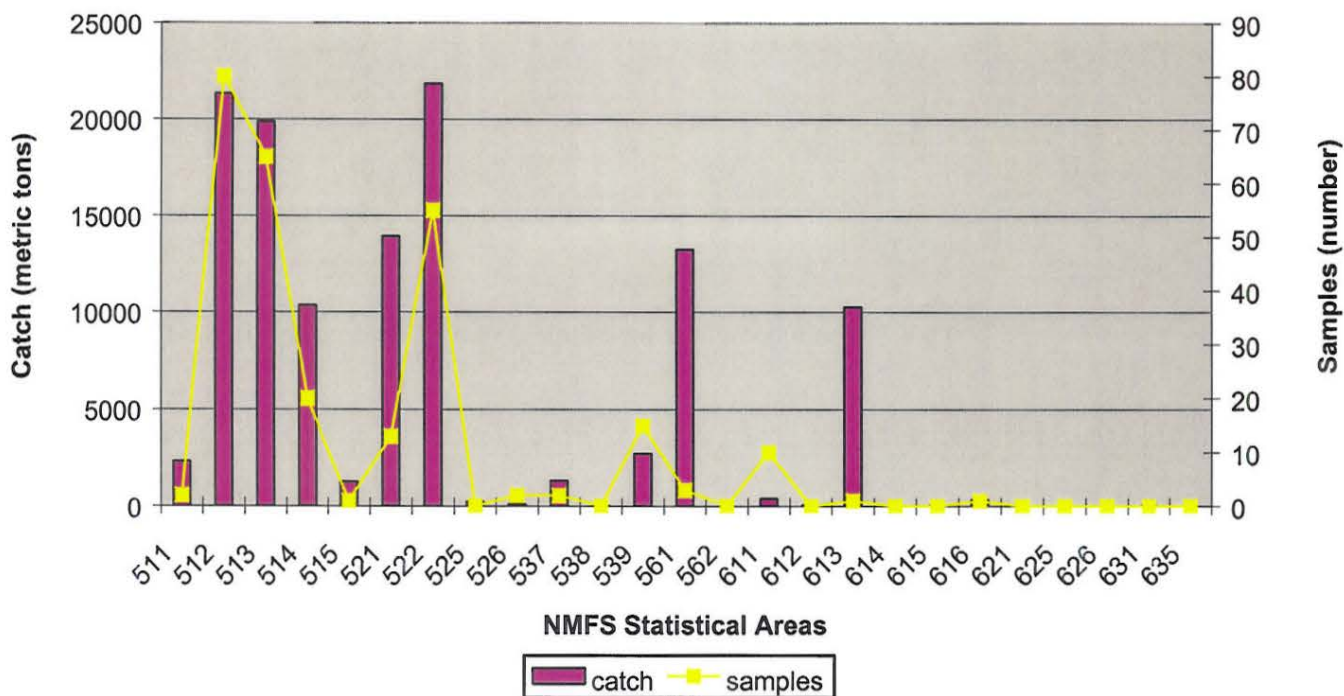
Month	MA	ME	NH	RI	Total
1				16	16
2	4			11	15
3	1				1
4	2	1		3	6
5		22	2		24
6		26	4		30
7	4	30	6		40
8	2	21	5		28
9	9	30	5		44
10	9	21	6		36
11	9	4	3		16
12	14				14
Total	54	155	31	30	270
%Samp/St	20	57	11	11	
%Catch/St	22	55	7	14	

* - The grant period was for May 2001-April 2002. Sampling occurred in NJ in the spring of 2002 and is therefore absent from the 2001 sample log.

Atlantic herring samples by NMFS statistical areas and month - 2001

Month	511	512	513	514	515	521	522	526	537	539	561	611	613	616	Total
1									2	12		2			16
2			2	2						3		8			15
3				1											1
4		1	2	1									1	1	6
5			24												24
6		25	4				1								30
7	2	16	5				16				1				40
8		16	2			2	8								28
9		19	1			5	17				2				44
10		3	19	1			13								36
11			6	6		2		2							16
12				9	1	4									14
Total	2	80	65	20	1	13	55	2	2	15	3	10	1	1	270

Catch and Samples



APPENDIX 5A:

Transboundary Resource Assessment Committee Report of Meeting of 10-14 February 2003

The Transboundary Resource Assessment Committee (TRAC) met during 10-14 February 2003 in the Conference Center, Biological Station, St. Andrews, NB, Canada, to address the Remit in Annex 1 following the Agenda in Annex 2. Participants are listed in Annex 3. The list of working papers is given in Annex 4. The consensus report on the status of the stock complex is attached as Annex 5.

Introduction:

The TRAC was established in 1998 to peer review assessments of transboundary resources in the Georges Bank area and thus to ensure that the management efforts of both Canada and USA, pursued either independently or cooperatively, are founded on a common understanding of resource status.

While scientists from both countries have participated in each other's peer review of the Gulf of Maine/Georges Bank herring assessments, there has not been a joint peer review meeting, as there has been since 1998 for Georges Bank cod, haddock and yellowtail. On 26 June 2000, P. Kurkul (Northeast Regional Administrator, NMFS) and N. Bellefontaine (Regional Director General, DFO Maritimes Region) received a joint request from the US and Canadian herring fishing industries to undertake a Canada / US peer review of Gulf of Maine herring under the auspices of TRAC. Due to data availability and workload, this meeting could not be undertaken earlier. This meeting responds to that request.

TRAC conducts appraisals of "benchmark reviews" and of "assessment reviews". Benchmark reviews examine the methodologies that may be most suited for assessment of a particular stock and establish an approach to be followed. Assessment reviews examine the results and interpretation of conclusions arising from application of a "benchmark" approach. The aim is to conduct benchmark reviews periodically, say every few years, at meetings dedicated to this task alone. The schedule of assessment reviews is tailored to the fisheries management planning process. The schedule for herring did not permit such a separation. This meeting addresses both a benchmark review and an assessment review.

Definition of Management Unit:

TRAC WP2003/01 Melvin, G.D. et al Review of geographical range, seasonal composition, and management units for the Gulf of Maine/Georges Bank stock complex
A synthesis review of herring stock structure indicated that three major spawning components have been identified in the Gulf of Maine/Georges Bank area. These are coastal Gulf of Maine, Georges Bank and Nantucket Shoals. While these components are considered relatively distinct during spawning, intermixing during other seasons, including when fisheries or surveys are prosecuted, is presumed to occur. Due to the impracticality of separating spawning components

for the catch and survey indices, the resource must be assessed as a complex of the three components.

TRAC WP2003/02 Melvin, G.D. et al Management of the stock complex

An objective of fisheries management for herring is to prevent overfishing of the resource. This implies that fishing effort should be distributed over the components of the complex roughly proportionate to their biomass by defining a suitable partitioning of the complex into management areas. Two pieces of information are needed to implement such a strategy, the relative biomass of each component and the contribution that each component makes to the various fisheries conducted in each management area.

Rapporteur: L. Jacobson

TRAC did not review all the data and observations on which the prevailing view of stock structure has been based, though some larval and adult herring survey distributions were examined. Spawning groups appear to mix seasonally and are taken in the same fisheries. One of the primary difficulties was in separating U.S. catches of the Georges Bank taken in the Gulf of Maine. There was consensus to combine the three major spawning groups into a single stock complex for assessment purposes. The decision was pragmatic and based on biological interactions, the location and seasonality of fisheries, and difficulties in obtaining separate catch and survey data for each spawning group.

In lieu of spawning group-specific assessments, the group agreed that spawning groups should be considered carefully in crafting management advice. Potential differences in productivity are important. Some components may be very productive, and capable of sustaining high fishing mortality rates, while other components may be relatively unproductive. The average F_{msy} value for the whole stock may, for example, be high enough to deplete unproductive components.

Management should endeavor to maintain spawning on all grounds in order to maintain significant production from all spawning groups. Production in different seasons and areas would be the basis for advice regarding potential harvest levels in different areas. There is little or no new information in this assessment about the seasonal distribution of herring catches by area, beyond what was used in previous assessments. There is, however, new hydroacoustic survey information that could be used to refine estimates of relative abundance in the inshore and offshore areas of the Gulf of Maine. The latter may be important because the proportion of the stock offshore in the Georges Bank has likely increased as biomass has increased offshore.

It was **recommended** that the boundaries between management areas in the US Fishery Management Plan be reviewed for possible realignment in order to correspond better with the defined spawning components, the fishery patterns and the resolution of the data. Three changes should be considered; (1) moving the boundary between Area 1B and area 2; (2) moving the area 2/3 boundary from its current position (69:00) further west to about 70:00, and (3) including the Canadian portion of Georges Bank in area 2. It was further **recommended** that the results of the tagging initiative in the coastal New Brunswick weir fishery be examined to refine the understanding of stock structure and the affinity of those juvenile catches with this stock complex. Finally, it was **recommended** that a large scale morphometrics study be initiated to

study mixing rates and distributions of herring from 4X, 5Y, and 5Z components in seasonal fisheries in the region.

Estimation of Contemporary State Overview and Fishery Data:

TRAC WP2003/03 Melvin, G.D. et al A general overview of the fishery and past assessments

Principle fisheries on the stock complex over the years have included US coastal fisheries in Div. 5Y, Canadian weir fisheries off the coast of New Brunswick in Div. 4X, foreign fisheries mostly in Div. 5Z prior to 1977 and, more recently, US coastal and offshore fisheries in Div. 5Z and Subarea 6. Since 1991, herring in the Gulf of Maine/Georges Bank area have been assessed as a stock complex, in recognition of the impracticality of partitioning the catch by spawning component.

TRAC WP2003/04 Cieri, M. et al Landings, samples, and the catch at age matrix for the Atlantic herring fishery: 2002

Landings and samples data, length frequency and age length key, are processed by unit, defined as month/geographical area/gear, to derive catch at age in both weight and number. The results reveal strong 1994, 1998 year-classes and moderate recruitment for other years. The catch shows a higher prevalence of older herring after the 1980s, roughly coinciding with a change from fixed gear to purse seine and subsequently midwater trawl gears in US fisheries. There has been a reduction in length and weight at age for herring ages 3 and older since the mid 1980s.

Rapporteur: R. Mohn

The magnitude of landings data for the late 1960s and early 1970s are probably an underestimate, perhaps by about a factor of two in some years. Landings data since then are considered more reliable and from 1994 to the present, data were audited by cross-referencing three distinct reporting systems. Nonetheless, some industry representatives commented that the recent landings did not represent all the herring that suffered mortality due to fishing operations. The magnitude of any additional mortality could not be quantified. Weir fishermen observed that although their catches were low in 2002, this was partly due to low effort. Furthermore, herring were seen outside the weirs and perhaps the relative absence of predators altered their behavior, making them less vulnerable to the weirs.

Sampling of the fishery for length and age composition was extensive and representative of the spatial and temporal patterns in the fishery. Unsourced units were few and were readily accommodated by borrowing from adjacent units.

The average weight at age in the fishery declined since the mid 1980s. There was concern that the change might have been due to a shift in markets or gear and seasonal changes in the fishery. Calibration of age determinations is done routinely and there is no indication that the reduction in size at age in the late 1980s is an artifact caused by drift in interpretation. Subsequent checking using consistent area/season strata confirmed a decline in weight at age. This was corroborated by NMFS and DFO survey observations. The pattern also displays an apparent change in growth as a function of age. In recent years age two herring are getting larger while older fish are getting smaller. The pattern was noted in both fishery and survey results. There

was speculation that this could be an age specific density dependent effect coincident with stock recovery in the early 1980s.

Comparisons of age determinations by readers with DMR, NMFS and DFO indicated poor agreement for ages greater than about five. It has been observed that otoliths are harder to interpret recently with compression of outer zones. It was **recommended** to conduct a workshop on age determination involving staff from the three laboratories.

Survey Indices:

TRAC WP2003/05 Melvin, G.D. et al Overview of assessment surveys

Surveys of early stage larvae are taken as an indicator of the spawning stock biomass that gave rise to them but are not considered reflective of year-class strength. The larval surveys were terminated in the mid 1990s but they indicated an increase in spawning stock biomass after the mid 1980s. Bottom trawl surveys also indicate an increase in biomass after the mid 1980s. Bottom trawl survey indices are substantially higher in recent years than at any other time since the inception of the surveys. This same pattern is evident for bottom trawl surveys in Div. 4WX and in Div. 4T. Mean length at age, calculated from survey observations, is lower for 1987-91 year-classes compared to 1983-85 year-classes. Agreement, between US and Canadian readers, in age interpretation is not very good beyond about age 5.

TRAC WP2003/06 Overholtz, W. et al Acoustic surveys and results

Acoustic surveys in 1998 were focused on locating spawning and pre-spawning concentrations in the Gulf of Maine and on Georges Bank. During 1999-2002, the objectives of acoustic surveys included estimation of herring abundance. Zigzag and parallel systematic as well as stratified random transect designs have been used over these years. Kriging was used to estimate mean herring backscatter. Intercepts from eleven target strength equations were applied to each survey and the results were averaged. A weighted average of the various designs used in each year indicated a gradual increase in biomass from 1999 to 2001 and a substantial decline in 2002.

Rapporteur: C. LeBlanc

The larval herring surveys have not been used as indices of abundance in the most recent assessment. This was because the series were terminated in the mid 1990s and high annual variability had been observed. It was noted though that the trends appeared to reflect some aspects of recent population developments and that they may be useful for bridging a period in the mid to late 1980s when the catchability of trawl surveys appeared to change. The group decided to incorporate these indices into the assessment.

The bottom-trawl surveys were designed for groundfish, but indices of abundance for herring have been developed based on them. There were concerns that a bottom trawl may not sample herring effectively if they were distributed in the water column above the headline. Reports of commercial mid-water operations suggested that herring were often fairly close to bottom. There were also doubts raised about the reliability and comparability of these indices during the early part of the 1970's when large amounts of herring were removed off George's Bank but the indices indicated very low abundance. It was noted that adjustments to NMFS surveys (spring and autumn) have previously been made for vessel changes but not for the door replacement in

1985. Remedial steps will be taken to introduce corrections for survey timing and for gear change in the assessment. It was noted that there appears to be a change in survey catchability coincident with the door replacement in 1985. Year-class tracking was best in the NMFS spring survey. Surveys do not track year-classes well after about age 6. The abundance of herring of ages 6 and older declines rapidly and may be indicative of a catchability problem or may be confounded by the difficulty in interpreting the age of older herring. A similar increase in bottom trawl survey abundance during the mid 1980s was observed for herring on the Scotian Shelf and in the Gulf of St. Lawrence. It could not be established if those changes were due to increased abundance, alteration in behavior or vessel changes.

The use of stratified arithmetic means for calculating the bottom trawl survey indices was discussed. It was suggested that the calculation of the index be done on log scale or assuming a Poisson distribution in order to account for the nature of the variability. It was noted that log-transform of the data does not adequately address year effects and raises concerns about proper treatment of the large number of zero tows where no herring are caught. Transformations of data may be worth pursuing in specific cases but past experience suggests that they can not be considered an automatic improvement for routine application. It was noted that the design based estimates of variance were not used in weighting observations for the assessment. Further, the design based estimates would not be appropriate because they are not reflective of the variation in the catchability process.

Acoustic surveys have been conducted in the inshore Gulf of Maine since 1998. Surveys are conducted at night to minimize target strength variability. The decline in biomass estimates from 2001 to 2002 was thought to be due to timing of surveys. Spawning is very punctual and could easily be missed if the survey is conducted at the wrong time.

Acoustic surveys have also been conducted on Georges Bank since 1998. Each offshore survey was completed in 5 to 6 days prior to 2002 and in 9 to 10 days in 2002, due to increase in sampling intensity. The duration is short enough to ensure that double counting and movement of migrating herring should be minimal. Herring were distributed from the Great South Channel to the Northern Edge of Georges Bank along the 100 meter contour. They were close to bottom in mostly continuous schools with some patchiness. Vessel avoidance is not thought to be a problem since the distribution was in deep water near the bottom. Herring did not show any diel movement and did not appear to be feeding at the time of the surveys. Aggregations seem to disperse in early October soon after spawning. Survey timing in 2002 was similar to the previous years, but indications, confirmed by fishery sampling data, were that spawning occurred earlier and part of the spawning aggregation might have been missed, resulting in the low biomass estimate.

Biological sampling was done during the acoustic survey using a mid-water trawl, generally towed near the bottom. The predominant species was herring with a bycatch of mostly silver hake and redfish. Post-survey processing was done to account for acoustic backscatter of non-target species. The length and age composition data from mid-water trawl samples for herring have not been analyzed. Age 2 immature herring are mixed with adults.

Stock specific target strength values are not available. Eleven target strength equations from herring stocks in the North Atlantic were used in the analysis. The range of target strength relationship intercepts that were used in the calculations implied a range in biomass that varied by a factor of five. The biomass calculation is done for the area of aggregation only and does not include the peripheral area surveyed but where herring were consistently absent. This practice should not bias the estimate of biomass but its effect on the variance calculation was unknown. Means and variance of herring backscatter were estimated with geostatistical methods and a correction for geometric anisotropy was done from east to west. It was noted that the Kriging variance was not representative of the repeatability of surveys and is not comparable to design based estimates of variance. Design based variance calculations are based on between transect variability. Neither the kriging nor design based variances are the appropriate variance for observations used in assessment model.

Attempts to compare results from the inshore (GOMAQ_DMR) and offshore (NMFS) acoustic surveys in 2002 failed due to equipment problems on the contracted vessel. It is **recommended** that experiments aimed at calibrating the inshore and offshore acoustic surveys should be pursued.

Assessment:

*TRAC WP2003/07 Overholtz, W. et al VPA/FPA analysis and results +Appendix:
KLAMZ model*

An updated (adding additional catch at age and survey data for 1998-2001) US VPA calibration continued to show a severe retrospective pattern and the same problems that were recognized in the previous assessment. Because of the severe retrospective pattern, problems with aging, and recognition of major problems in the previous assessment, an age aggregated assessment was pursued. A biomass dynamic delay-difference model using only two age classes, age 2 recruits and ages 3+ aggregated, was investigated. The fishing mortality rate is assumed to be the same for both age groups but otherwise the mortality dynamics are similar to VPA. A von-Bertalanfy relationship is used to model annual changes in the growth of herring. A recruitment parameter is estimated for each year-class. NMFS winter, spring and autumn bottom trawl surveys, and DFO bottom trawl surveys were used as indices of biomass for age 2 and for ages 3+. NMFS and DFO larval surveys were used as indices of spawning biomass. NMFS acoustic surveys were used as indices of total biomass. Survey covariates were used to account for catchability changes associated with change in timing (via temperature anomaly) of the autumn survey and with change of the trawl doors in 1985 for both the spring and autumn surveys.

The acoustic surveys were also used to scale the absolute biomass, after adjusting for the proportion on Georges Bank, as the acoustic surveys did not cover the Gulf of Maine. The results indicated that fishing mortality was very high from the late 1960s to the mid 1980s, exceeding 1.0 in several years, followed by an abrupt decline over about a two year period to about 0.2 and a subsequent decline during the 1990s to a low of 0.06 in 2002. Biomass declined to a low in the early 1980s and has since progressively increased to about 1.8 million mt.

TRAC WP2003/08 Power, M.J. et al Gulf of Maine herring complex VPA analysis

Examination of an updated VPA calibration continued to display a severe retrospective pattern and had troublesome patterns in residuals. Most of the concerns related to an apparent change in catchability at about the mid 1980s. A truncated VPA calibration, using only ages showing acceptably low variation for the ln index residuals, resulted in improved diagnostics but only a moderate amelioration of the retrospective pattern. Concern remains also about the catchability pattern by age for the surveys and about the fishery partial recruitment pattern by age, particularly in the most recent years. The results indicate that the fishing mortality was very high at about 0.8 between the early 1970s and the early 1980s, declined to about 0.2 by the mid 1980s, fluctuated between 0.2 and 0.4 until the late 1990s when it declined again to about 0.2. Biomass decreased progressively between 1967 and 1977, remained low until the mid 1980s when it increased with the recruitment of the 1983 year-class, remained at that level until the late 1990s when it increases progressively, due to improved recruitment, to about 0.8 million mt, about two thirds of the high biomass in 1967.

Rapporteurs: R. Conser & G. Stefansson

KLAMZ is a forward projecting delay-difference model, which estimates initial stock size (in 1960), recruitment and fishing mortality for each year in the model (1960-2002), and the parameters for a Beverton-Holt stock recruitment curve. Approximately 100 parameters were estimated in this model application of KLAMZ. AD Model Builder libraries were used for optimization and parameter estimation. A full suit of 11 surveys were used in the model and a set of dummy variables and temperature covariates were incorporated to adjust nominal survey observations when needed, e.g. to adjust for trawl door changes. As the model is new to this assessment, additional documentation was requested, e.g. a full list of model parameters along with their point estimates and standard errors, the correlation matrix for estimated parameters, etc.

Surplus production calculations were carried out using stock biomass estimates from the KLAMZ model:

$$S_y = B_{y+1} - B_y + C_y$$

where

S_y is the surplus production during year y

B_y is the stock biomass at the beginning of year y

B_{y+1} is the stock biomass at the beginning of year $y+1$

C_y is the catch in weight during year y

S_y and B_y were then used to estimate MSY reference points using the Fox model. Although this was done within the KLAMZ model, the weight given to this likelihood component was near zero and as such, had no effect on other parameters estimated in the model. Estimates of reference points using the Schaefer model were completed after the fact. Although this approach is reasonable, some internal inconsistency may be result from using the Beverton-Holt stock recruitment relationship to model herring compensation within the estimation model, while using the Schaefer production functions to model compensation for the reference point calculations.

In several cases, the combination of dummy variables and temperature covariates resulted in pronounced adjustments to nominal survey time series. While it was agreed in principal that adjustments were necessary, the magnitude of the adjustment was questioned in some cases, e.g.

a 70-fold increase in efficiency of the NMFS fall survey due to door changes and environmental effects. It was suggested that plots of each survey time series be provided illustrating the original and adjusted time series.

A table of likelihood components from the fitted model was presented. With many surveys, an estimated stock recruitment relationship, priors, weights, and penalty functions, KLAMZ has many likelihood components that sometimes “pull” the optimal solution in differing directions, e.g. toward low survey catchability/high biomass or toward high survey catchability/low biomass. While the table of likelihood components at the solution was quite helpful in illustrating this model tension, additional runs were requested that explicitly weight a key component very high (e.g. $\lambda=1000$) while all other weights were low (e.g. $\lambda=1$). In this way, the effect of each component on the fishery management results would become more clearly evident.

With many estimated parameters, the possibility of parameter confounding was raised. In particular, model estimates of important management state variables (e.g. abundance and fishing mortality in recent years) may be confounded with estimates of survey catchability. Additional diagnostics should be examined, e.g. from the Hessian matrix and bootstrap results.

Although KLAMZ is not as highly parameterized as some assessment models used in other fora, the estimation of 100+ parameters via a highly nonlinear objective function does raise the possibility of a relatively flat response surface with multiple local minima. This is of practical importance if several different local minima have similar likelihoods but different fisheries management implications. KLAMZ runs should be made using a variety of initial value vectors for the estimated parameters and these results should be reported with the final model run.

KLAMZ results are somewhat difficult to compare to the results of a fully age-structure model (e.g. ADAPT). It would be useful to forward project KLAMZ recruitment estimates into an age structure using the model’s assumptions of fixed F and M to compare the resulting age structure with other results. Further, it would be helpful if this could be done in a numbers-based mode as well as the weight-based mode that is inherent to KLAMZ

After extended discussion of the model and results, it was agreed to:

- test fixed growth parameters
- change maturity parameters
- look at dropping covariates in some submodels in accordance with significance level
- test effect of not including temperature
- revise the prior on recruitment variance
- carry out bias-correction using the bootstrap results

Final analyses with the KLAMZ model also used a revised prior for the variance of log recruitment. Reducing the emphasis on the likelihood components for the stock recruitment and its variance resulted in substantially higher estimates of recent recruitment.

ADAPT is an age structured VPA calibration model that typically estimates terminal year abundance and index catchabilities. The ADAPT model formulation used in the previous stock

assessment (SAW27, 1998) was updated with the new catch-at-age and survey data that have become available post-1998. Retrospective patterns continued to be pronounced. Subsequent exploration with ADAPT included index selection and weighting, truncation of time series to exclude pre-1983 indices and aggregation to an age 6 plus-group.

A mean-squared-error (MSE) criterion of $MSE < 3$ was initially used to include survey series. These MSE values were based on an initial VPA with all surveys included. Truncating survey series to include only post-1983 data resulted in much lower MSE but still high at around and over 1.0. Subsequently, survey series were weighted proportional to the inverse of MSE, internally updated. It was decided that the exclusion criterion, $MSE \geq 3$, was not sufficiently well founded since the internal weighting scheme should provide the appropriate relative variability between series. On the other hand it is possible that the inclusion of very noisy series could give undue high weighting to one series leading to inappropriate down-weighting of better series. Since the initial MSE values and selection scheme were derived from a VPA fitted to all series it is also possible that the MSE values for one series are overestimates due to the inclusion of other series. It is therefore desirable to fit to each series separately first and investigate the results. The exclusion of series should ideally be either done a priori using independent criteria, such as stock area coverage. A posteriori the series can be selected based on residual patterns or other consistency checks rather than only based on raw MSE values.

Initially, fishing mortality on the oldest age (10) was initially set equal to that on the next to oldest age (9), i.e. not as an average of several younger ages. Subsequently it was set to the average of ages 5-9. Recent recruitment estimates from KLAMZ were very high and imply a high abundance of old fish. ADAPT results suggested increasing fishing mortality with age, resulting in reduced abundance of old fish. This inconsistency gives cause for loosening up the ADAPT assumptions on fishing mortality for the oldest age, yet without resorting to setting it based on a single age group. Fishermen indicated that they do not avoid large fish so the reason for large fish to exist but not appear in the catch would be due to location of the fishery. It is presumed that older fish tends to be more prevalent on Georges Bank rather than in-shore in the Gulf of Maine where much of the fishery is located. It was concluded that for final ADAPT results the fishing mortality on age 10 would be set to the average of ages 7-9 and the resulting fishery partial recruitment patterns will be examined. Estimation of abundance at all ages over age 2 could be attempted in the terminal year.

The utility of and criteria for exclusion of various survey series were discussed at length. The aim was to specify a common set of indices to be used in both KLAMZ and ADAPT in final analyses. It was determined to exclude DFO survey results for 1993 and 1994 because the western portion of the survey area was not covered due to operational difficulties. Larval surveys were included since they might help bridge across the year 1985 and hence link together the periods before and after the door change on the NMFS bottom trawl surveys. A break for the NMFS larval survey in 1988 was introduced to account for a marked change in the magnitude of the index that may be associated with differences in processing. NMFS and DFO bottom trawl surveys were included as were NMFS offshore acoustic surveys. The entire time series for the NMFS spring and fall surveys would be included but with a break in 1985 that allows estimation of distinct catchability coefficients. The reference run will thus include all available surveys, unweighted. In addition, analyses with internally weighted time series would also be presented.

Other options, e.g. analyses including survey series one-at-a-time, will be considered for diagnostics.

The ADAPT and KLAMZ models differed in population dynamics, complicating comparisons. However, both models assumed that the natural mortality rate was equal to 0.2 and constant over time for all ages and that the total catch was assumed known without error. Comparability of assessment results was enhanced by ensuring that the same survey indices were used and that they were treated in a similar manner. For example the door effect was included in ADAPT runs and the temperature covariate can be eliminated from a KLAMZ run.

One of the principle differences between the population dynamics in the KLAMZ and ADAPT models pertained to aggregation of ages. In recognition of possible age mis-specification for older ages, an ADAPT formulation using an age 6 plus-group may be a practical intermediate approach that can shed some insight. Since the delay-difference model aggregates all ages except the youngest, this will be a move towards making these models somewhat more similar, possibly illustrating the cause of some differences. It may also be worth while to move the plus-group to younger ages so as to move closer to the delay-difference model. Initial exploration with an ADAPT formulation using an age 6 plus-group indicated that the choice of weighting schemes seriously affected the biomass estimates. Analyses using internal weighting of survey series were not stable, suggesting that one or more survey series was attracting undue weighting. There was not sufficient time to explore this further during the meeting. This remains a potential avenue for exploration.

It was noted that assessment results should be broadly consistent with the acoustic estimates of total biomass, after adjusting for the fraction in the stock complex covered by the offshore acoustic survey.

Subsequent diagnostic evaluations of KLAMZ model results indicated that the change in catchability in 1985 was very large, particularly for the fall survey. The effect of this change for the age 3 plus-group in the spring was marginal. Many of the survey likelihood components tended to pull the biomass estimates towards higher values, but particularly the NMFS spring survey at age 2. Changes in the weighting given to the NMFS spring age 3 plus-group index had a considerable effect on the perceived accuracy of this series. The temperature/timing effect, which accounts for a drift in about one month in survey timing, was significant for the NMFS fall age 3 plus group index but, surprisingly was not significant for the same survey at age 2. The increasing trend in residuals for the DFO survey might be due to an increasing portion of the herring stock complex occurring on Georges Bank, as the DFO survey does not cover the remainder of the geographic range. A few of the correlations were surprisingly surprising and cause for concern, notably the correlations between recruitment estimates in early years and important management parameters, e.g. biomass in the terminal year, were around and over 0.6. Bootstrap results indicated that biomass estimates had a large bias in the early years but in recent years the bias was negative and on the order of about 10%.

Subsequent diagnostic evaluations of ADAPT indicated that biomass values ranged from 624,000t to 1,183,000t when the NMFS bottom trawl surveys were used one-at-a-time (analysis using DFO survey did not converge, larval surveys terminated in 1995 and could not be used on

their own, acoustic survey series too short). Partial recruitment to the fishery for recent years in these runs appears to be strictly increasing with age from age 5. Biomass estimates resulting from runs with weighting are quite similar to the converged runs. When including all fleets, with weighting (or ML estimation of variances), there are no indications that individual indices may pull estimates influentially and hence it was agreed that final results would include all fleets in a weighted manner. Differences in catchability between the early and latter time series for the NMFS spring and fall surveys was greatest at younger ages and was particularly large for the NMFS fall survey. The retrospective pattern for the final three years was not as pronounced, but there was a marked shift in the results for years prior to that, suggesting an abrupt change in survey catchability between 1999 and 2000.

Even when KLAMZ and ADAPT were based on as similar assumptions as possible and used the same sources for indices of abundance, the resulting biomass estimates differed by a factor greater than two.

Characterization of Productivity:

TRAC WP2003/09 Clark, K.J. et al Biological reference points for Gulf of Maine herring
One of the objectives of fisheries management is to keep fishing mortality rate moderate. FMSY proxies were investigated using per recruit analyses and productivity analyses. The productivity analyses explored various parametric and nonparametric stock recruit relationships. The range of F reference points was between 0.15 and 0.35 with the majority being in the vicinity of 0.2.

TRAC WP2003/10 Overholtz, W. et al Biological reference points
Yield per recruit and SSB per recruit reference points were updated and gave results of $F_{0.1}=0.18$, $F_{40\%}=0.15$ and $F_{max}=0.40$. Updated surplus production reference points were $FMSY=0.25$, $BMSY=896,000$ mt, and $MSY=222,000$ mt.

Rapporteur: J. Gibson
Selection of a functional relationship is a principle consideration. Other analyses suggest the Beverton-Holt model provides a better fit to herring data than the Ricker and debatably could be given preference. The Ricker analysis should be included for comparison. The non-parametric model doesn't require a functional form and also provides a useful comparison. Some thought that it should be constrained to pass through the origin (recruitment >0 at $SSB=0$ is an impossibility) while others argued that an unconstrained fit provides an empirical description over the observed range without making extrapolation assumptions about where the bend to the origin begins.

Selection of an appropriate error distribution can influence results. In principle, a symmetric additive error structure, e.g. Gaussian, is not justifiable either statistically (does not constrain recruitment to be positive), or biologically (multiplicative error arising from survival probabilities between ages/life stages) and could therefore be dismissed. The use of lognormal or gamma distributions is more appropriate. Some argued that log recruits should be used for any fit, whether it is a functional parametric form or a non-parametric smooth, with transformation bias correction applied.

Further diagnostic analyses could be useful. Sensitivity analysis of assumed constants in the yield/spawner per recruit components could be explored, as well as for the slope at the origin of the stock recruitment relationship. Meta-analyses can be used to examine the plausibility of the stock recruitment parameter estimates. Some assessment of the goodness of fit of the stock recruitment model would also be beneficial. Non-stationarity in the stock recruitment relationship should be examined.

Other reference points follow directly from these types of analyses and could be examined, e.g. F_{crash} , F_{ssbmsy} , $\text{SSB}_{F=0}$, etc. This led to a discussion about whether the slope at the origin of the stock recruitment relationship could be estimated reliably. Some observed that many herring datasets have observations near the origin. Bayesian methods could be used to include information from other populations. The view was expressed that F_{crash} is an important reference point and uncertainty in its estimate can be assessed.

Reference points are often derived from a yield/spawner per recruit model with a reproductive component. A surplus production model could be fit to production results from assessments for comparison, as was done with the KLAMZ approach.

Projection:

Only short term projections to 2004 were provided, therefore assumptions about future recruitment have no impact. Projections were conducted from the results of both the KLAMZ and ADAPT models assuming that the catch in 2003 would be 100,000t, approximately equal to that in 2002. Natural mortality was assumed to be 0.2 as in the assessment. Two F scenarios were considered, $F = 0.2$, approximating the F estimated by the VPA in recent years and corresponding roughly to an F_{MSY} proxy reference points, as well as $F = 0.1$.

KLAMZ projections are dependent on the internally estimated dynamics and the externally estimated growth relationship. The results from the KLAMZ projections indicated that a catch of about 323,000t in 2004 corresponds to an $F = 0.2$ and results in a decrease in 2+ biomass from about 1,800,000t in 2004 to about 1,640,000t in 2005. With an $F = 0.1$, the resulting catch is about 170,000t and the 2+ biomass decreases from about 1,800,000t to about 1,790,000t.

The ADAPT projections were done from the bias adjusted VPA results and assumed that the fishery partial recruitment to be fully recruited for ages 2 and older and 0.01 at age 1. The fishery and population weights at age were taken as the average from 1992 to 2002. The results indicated that a catch of about 100,000t in 2004 corresponds to an $F = 0.2$ and results in a decrease in 3+ biomass from about 550,000t in 2004 to about 500,000t in 2005. With an $F = 0.1$, the resulting catch is about 60,000t and the 3+ biomass stays constant at about 550,000t.

Guidance for Subsequent Assessments:

It will be some years before sufficient new and revised data can be assembled to attempt again to discriminate between the results of these and other competing models. In the ensuing period, it is considered prudent to report the results of both the delay-difference and the fully age structured

VPA models. If progress is made with intermediate models which aggregate data to, say a 6 plus group, these results could also be considered.

**Transboundary Resources Assessment Committee
Biological Station
St. Andrew's, NB, Canada
10 - 14 February 2003**

Background:

The TRAC was established in 1998 to peer review assessments of transboundary resources in the Georges Bank area and thus to ensure that the management efforts of both Canada and USA, pursued either independently or cooperatively, are founded on a common understanding of resource status.

While scientists from both countries have participated in each other's peer review of the Gulf of Maine herring assessments, there has not been a joint peer review meeting, as there has been since 1998 for Georges Bank cod, haddock and yellowtail. On 26 June 2000, P. Kurkul (Northeast Regional Administrator, NMFS) and N. Bellefontaine (Regional Director General, DFO Maritimes Region) received a joint request from the US and Canadian herring fishing industries to undertake a Canada / US peer review of Gulf of Maine herring under the auspices of TRAC. Due to data availability and workload, this meeting could not be undertaken before at least spring 2002. This meeting is to address this request.

Objectives:

Definition of the Management Unit

- Review the geographical range and seasonal composition of the coastal stock complex.
- Develop consensus on management units for provision of advice

Estimation of Contemporary State

- Review the assessment framework (s) for the Gulf of Maine herring management units. The agreed approach would be used to provide the management agencies of each country with stock status information.
 - The landings and catch at age will be accepted as presented i.e. will not include evaluation of methods of analysis for catch at age
 - The methods and results of developing indices from surveys and for conducting population analyses of herring will be reviewed and evaluated
 - Information regarding the relative status of the various components within the stock complex, including basic input data will be provided to the extent possible
- Using the agreed assessment framework, update the status of the coastal stock complex of Atlantic herring through 2002 and characterize the variability of estimates of stock size and fishing mortality rates.

Characterization of Productivity to Determine Harvest Strategy

- Review biological reference points for Atlantic herring to meet management requirements of both countries.

Procedure for Projection to Evaluate Tactics

- Review framework for the provision of projections to meet the requirements of both countries
- For Canadian management purposes, for a range of yield quotas in 2003, evaluate the consequences on exploitation rate in 2003 and on spawning stock biomass (or its proxy) in 2004
- For US management purposes, provide projected estimates of catch for 2003- 2004 and spawning stock biomass for 2004 - 2005 at various levels of Fishing Mortality for the coastal complex.

Guidance on Activities

- Develop consensus on an approach to be applied for routine assessment of stock evaluation until the next "benchmark" is conducted
- Suggest schedule for next benchmark and identify factors that would trigger a benchmark ahead of schedule

Products:

- Meeting Proceedings, which will document the details of the assessment framework and summarize the results of the production dynamics analyses.
- Canadian Stock Status Report for Georges Bank herring stock
- US Advisory Report for Gulf of Maine herring complex

APPENDIX 5C: DRAFT AGENDA

Transboundary Resources Assessment Committee Biological Station St. Andrew's, NB, Canada 10 - 14 February 2003

Definition of Management Unit

- Overview & context (Gary Melvin)

Estimation of Contemporary State

- Overview, history & context (Gary Melvin)
- Fishery data (Matthew Cieri)
- Bottom trawl surveys (Gary Melvin)
- Acoustic Surveys (Bill Overholtz)
- Assessment
 - Coastal Complex
 - ADAPT (Bill Overholtz, Mike Power, Gary Melvin, Stratis Gavaris)
 - Likelihood (Larry Jacobson, Bill Overholtz)
 - Georges Bank
 - ADAPT (Mike Power, Gary Melvin, Stratis Gavaris)

Characterization of Productivity

- Context for biological reference points in herring (Kirsten Clark)
- Biological reference points (Bill Overholtz, Gary Melvin, Larry Jacobson)

Projection

- Framework for conducting projections (Bill Overholtz, Gary Melvin)
- Projected estimates of catch for 2003-2004 and SSB for 2004-2005 (Bill Overholtz)
- Overview of partitioning of coastal complex catch (Bill Overholtz)
- For a range of catch in 2003, evaluate consequences for F in 2003 and SSB in 2004 (Gary Melvin)

Review Stock Status Report/Advisory Report

APPENDIX 5D: LIST OF ATTENDANTS

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APPENDIX 5E: LIST OF WORKING PAPERS

TRAC WP2003/01 Melvin, G.D. et al Review of geographical range, seasonal composition, and management units for the Gulf of Maine/Georges Bank stock complex

TRAC WP2003/02 Melvin, G.D. et al Management of the stock complex

TRAC WP2003/03 Melvin, G.D. et al A general overview of the fishery and past assessments

TRAC WP2003/04 Cieri, M. et al Landings, samples, and the catch at age matrix for the Atlantic herring fishery: 2002

TRAC WP2003/05 Melvin, G.D. et al Overview of assessment surveys

TRAC WP2003/06 Overholtz, W. et al Acoustic surveys and results

TRAC WP2003/07 Overholtz, W. et al VPA/FPA analysis and results +Appendix: KLAMZ model

TRAC WP2003/08 Power, M.J. et al Gulf of Maine herring complex VPA analysis

TRAC WP2003/09 Clark, K.J. et al Biological reference points for Gulf of Maine herring

TRAC WP2003/10 Overholtz, W. et al Biological reference points

APPENDIX 5F: CONSENSUS REPORT

Atlantic Herring: Georges Bank, Nantucket Shoals, Gulf of Maine Stock Complex

Stock Complex and Management Units:

Atlantic herring spawn in discrete locations to which they are presumed to return. In the Gulf of Maine and Georges Bank there are major herring spawning grounds on the northern edge of Georges Bank, on Nantucket shoals and in the coastal waters of Cape Cod through Maine. Herring from these spawning areas migrate and mix outside of the spawning season, and are mixed in most fisheries and in research surveys. As a result, the herring of the Gulf of Maine and Georges Bank are considered to be a complex made up of three major distinct but seasonally intermixing components (Georges Bank, Nantucket Shoals and the coastal Gulf of Maine).

While it would normally be considered desirable to treat components separately in assessment and management, intermixing of components in the fishery and in surveys preclude separate assessment and management. It was therefore deemed necessary (as has been done in recent years) to undertake an evaluation of the entire complex with subsequent consideration of the individual components.

Management boundaries in the US Federal-Atlantic States Marine Fisheries Commission (ASMFC) fisheries management plan for herring were based on the current distribution of seasonal fisheries during the summer in the Gulf of Maine (GOM), on Georges Bank and in southern New England (SNE) during the winter. These boundary lines correspond to a rough demarcation between the coastal and Georges Bank/Nantucket Shoals components and to the spatial/seasonal components of the fisheries on the stock complex. The GOM, Georges Bank and the area south of Cape Cod were divided into three major management areas (areas 1-3) for the purpose of allocation of catch from the various seasonal components of the fishery.

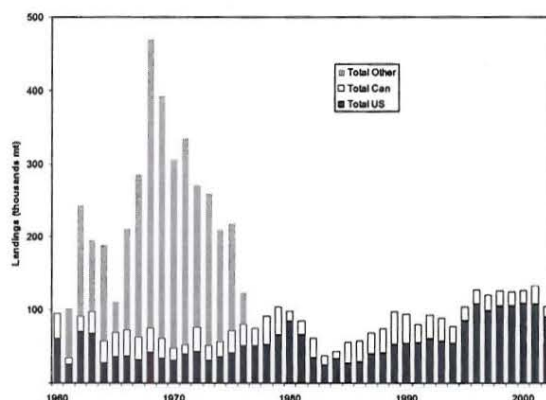
In previous assessments the relative proportions between the inshore GOM and Georges Bank were determined from an analysis of the National Marine Fisheries Service (NMFS) autumn bottom trawl survey indices allocated to inshore and offshore strata. Since 1996 these relative proportions from the autumn survey became more variable and gave results that were contrary to other information suggesting that the Georges Bank component is currently much larger than the inshore component. An analysis of comparisons between the relative size of the two components using hydroacoustics results from both the inshore and offshore areas and previous assessments (Stevenson 1998) suggest that the current proportion in the GOM is much smaller. A summary of these results suggested that the percentage of the total stock in the inshore GOM is currently somewhere near 10-15% in contrast to the 25% that was used in recent years. These reflect available results at the present time, but require confirmation from subsequent calibrations of NMFS and inshore surveys.

Fisheries and Landings:

The coastal herring fisheries of Division 5Y are among the oldest in the western Atlantic, dating back over a century. These fisheries have evolved from traps (weirs and shutoffs) through gillnet to purse seine and midwater trawl. Landings in these fisheries peaked at 94,200t in 1950 and

have averaged about 50,000t since 1951. Landings in the contiguous New Brunswick weir fishery, which has historically been considered to take fish from this stock complex, have averaged 26,000t over the same period.

Herring landings increased dramatically in the early 1960's with the development of a predominantly foreign fleet fishery, first using gillnets then trawls and purse seines, in the (then) international waters of Georges Bank and southern New England. Landings in this fishery increased from 68,000t in 1961 to at least 373,000t in 1968, but then decreased rapidly as the stock collapsed and as management measures were introduced in the early 1970's. Limited directed fishing for herring occurred on Georges Bank between 1979 and 1995. Since 1996 landings have increased to almost 40,000t in 2001 and were about 17,000 in 2002.

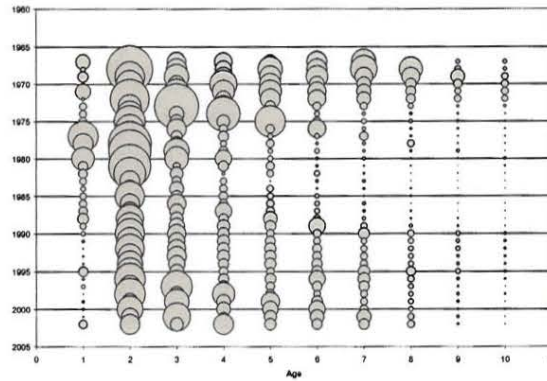


State of the Stock

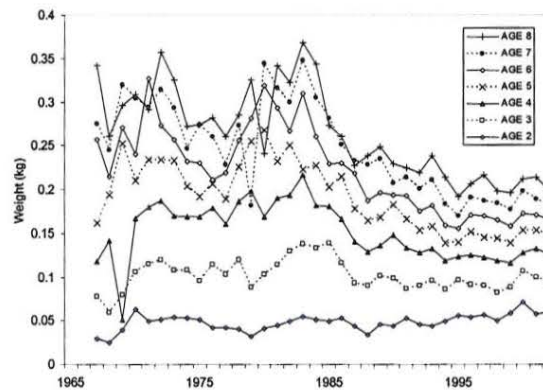
Commercial fishery information

Commercial landings compiled for the period since 1959 from Maine Department of Marine Resources (DMR), Fisheries and Oceans Canada (DFO) and the International Commission for Northwest Atlantic Fisheries (ICNAF) sources (1961-1978), are considered to be reliable in recent years but may represent a minimum catch in the early period.

Age composition of the commercial catch is available since 1967. A comparison of age determinations by NMFS and DFO readers showed consistency in age determination to age 5, but reduced agreement on older ages. Examination of the catch at age indicated some misallocation to adjacent ages. The size of the bubbles in the accompanying graph corresponds to the magnitude of the catch at age.

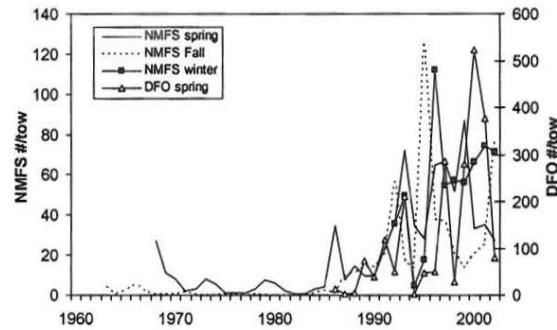


The growth rate of herring in the Georges Bank/Gulf of Maine complex has changed. Size at age of mature herring has decreased coincident with expansion of the population since about 1982.

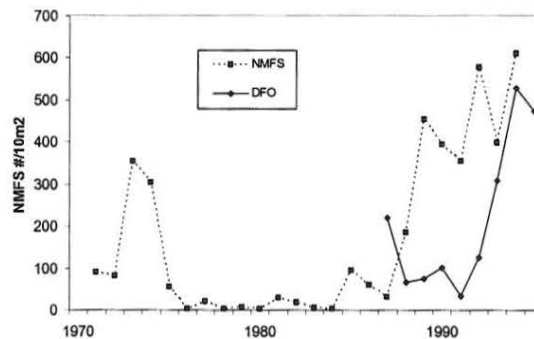


Research Surveys

Several bottom trawl surveys have been undertaken by both NMFS and DFO in this area. While designed primarily for groundfish, these surveys also take herring, and provide some of the longest time series of survey information. These differ in season and length of time series and there is uncertainty regarding the consistency of herring catchability. The NMFS spring (1968-2002) and NMFS autumn (1963-2002) surveys cover the complete distribution of herring, while the NMFS winter includes mostly the over-wintering area in Southern New England. The DFO spring survey covers only Georges Bank and represents a small portion of the northern distribution during that time of year. Timing of the surveys is relatively constant for each of the time series, except for the fall survey where the mean survey date has changed by about one month becoming progressively earlier. Indices of abundance were developed using the strata defined in the 27th NMFS Stock Assessment Workshop. Both the NMFS spring and autumn surveys imply that a change in catchability occurred around 1985, coincident with a bottom trawl door change. The surveys indices were subsequently divided into two time periods pre-1985 and 1985- present.



Larval surveys undertaken by both the NMFS (1971-1994) and by DFO (1987-1995) which covered Georges Bank and Nantucket, were terminated in the mid 1990's. Statistical analysis of the NMFS survey suggested a difference in catchability between two time periods, 1971-1988 and 1989-1994.



The NMFS hydroacoustic program began in 1998 with a series of surveys on inshore locations and a broad scale survey of the entirety of the GOM. Surveys on Georges Bank in 1998 were of a pilot nature and were useful in pinpointing the location of spawning fish. During subsequent years (1999-2002) larger scale surveys were conducted on Georges Bank with the intent of covering the entire spawning distribution of herring. Three surveys in each year (1999-2001) were completed on Georges Bank, utilizing systematic zigzag, parallel and stratified random designs. One parallel design survey was completed in 2002. An analysis of acoustic information was completed using 11 available TS equations for herring stocks in the North Atlantic. Results suggest that the average 2+ biomass increased from about 1.2 million mt in 1999 to about 1.8 million mt in 2001 on Georges Bank. The survey during 2002 suggested a 2+ biomass of 0.8 million mt, but other information suggests that the peak spawning time on Georges Bank may have occurred prior to the survey.

The hydroacoustic program in the inshore area of the GOM has been conducted by the DMR-Gulf of Maine Aquarium during 1999-2002. Surveys from this program were conducted at frequent intervals during September-November, utilizing a systematic zigzag design. Results suggest that the spawning biomass during this period increased from 200,000t in 1999 to 350,000t in 2001, and decreased to 200,000t in 2002.

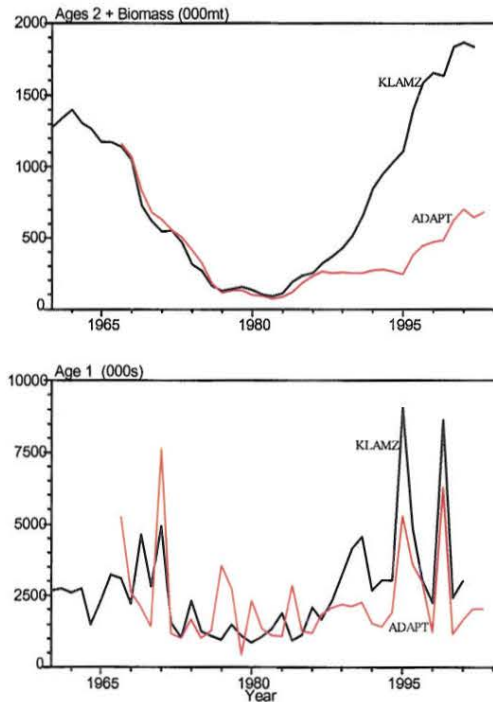
Assessments

Two approaches, a delay-difference model (KLAMZ) and a calibrated VPA model (ADAPT) were used to evaluate stock status. Both models assumed that the natural mortality rate was equal to 0.2 and constant over time for all ages. The total catch was assumed known without error in both models and all available indices were used, though given different weightings according to their variability.

KLAMZ partitions the herring stock into two age groups (age 2 and age 3+). All delay-difference calculations for herring were in units of biomass assuming von Bertalanffy growth. The delay-difference model is “foreward-casting” and simulates the herring stock starting with the first year in the analysis. Model parameters, biomass, recruitment biomass and fishing mortality rates are estimated from survey data and other information including hydroacoustic biomass estimates and a spawner-recruit constraint.

For ADAPT, the survey indices were used to calibrate a VPA with the following further assumptions; error in the catch at age is negligible and the fishing mortality on age 10 is equal to the weighted average for ages 7-9. This approach places greater emphasis on the catch at age observations, particularly in earlier years. Inconsistencies between the catch at age information and trends in the survey indices can give rise to retrospective patterns (systematic positive or negative differences in estimates as additional years of data are used) and this assessment displays a marked retrospective pattern.

Results from the primary methods used for the assessment differ considerably in some regards, reflecting uncertainties in input data sets, but several important agreements are also seen. Historical biomass trends until 1985 are very similar. Differences between model estimates appear in the mid-1980s, when the biomass and recruitment estimates diverge. This is due to the combined effects of divergent mortality and recruitment estimates.



Estimates of the current stock biomass are quite dependent on model assumptions and weightings given to data sets. This application of ADAPT, tends to give estimates of mortality rates which correspond to catch at age data (indicating higher mortality rates and lower biomasses). KLAMZ leans towards the scaling implied by the acoustic survey biomass estimates and the stock recruit constraint (indicating higher biomass and lower fishing mortality). The KLAMZ results seemed to track trends in recent survey data more closely than did the ADAPT results, implying more older fish in the population during recent years and a different recent recruitment pattern. Evidence for higher proportions of older fish in the catch at age or surveys is not strong.

To verify and compare models, new and revised data need to be considered. Thus a continuation of the hydroacoustic survey is likely to elucidate trends in biomass when they appear and improved age determinations for older fish should give a better indication of the total mortality in the stock. While results are substantially different, the estimation error internal to each model is considerable, blurring the statistical significance of those differences. This is a reflection of the great variation in the observed survey indices. An additional complicating factor that contributes to this statistical uncertainty is the apparent change in survey catchability before and after 1985, particularly for the NMFS autumn survey. The KLAMZ model estimated the magnitude of this effect to be a factor of 68 times for age 2 and 10 times for ages 3+ while the ADAPT model estimated it to be a factor of about 60 times at age 2 and decrease to about a factor of 10 at age 8.

A possible way to resolve the discrepancy between model results, is to use hydroacoustics to directly estimate abundance (with accompanying target strength verification).

Productivity and Biological Reference Points:

Biological reference points (BRP's) based on the KLAMZ assessment were updated from the last assessment and are based on a yield per recruit model (Thompson-Bell) for $F_{40\%}$, $F_{0.1}$ and $F_{\max}$, and a surplus production model for F_{msy} , MSY and B_{msy} . The yield per recruit model results gave an $F_{\max}=0.40$, an $F_{0.1}=0.18$ and an $F_{40\%}=0.15$. The new $F_{\max}$ is the same and the $F_{0.1}$ is slightly lower than values from the last assessment. Reference points from the production model were also re-estimated, using a formulation that is consistent with the KLAMZ model. The new biological reference points for the herring complex were estimated as $F_{\text{msy}}=0.25$, MSY =222,000 mt and $B_{\text{msy}}=896,000$ mt. These reference points are all less than those from the previous assessment, which used a conditioned ASPIC model to estimate the BRP's.

BRP's were also estimated using a yield/spawner per recruit model with a reproductive component fitted to ADAPT model output. $F_{0.1}$ and $F_{40\%}$ estimates were similar to those estimated in the KLAMZ assessment. $F_{95\% \text{MSY}}$, was estimated to be in the range of 0.20 - 0.22 using a parametric and nonparametric stock recruitment relationship.

Although the ADAPT and KLAMZ assessments suggest different levels of production and biomass at MSY, the reference fishing mortality rates produced by the two approaches were similar. There is greater uncertainty about biomass reference points than the fishing mortality reference points.

Projections/Forecast:

Projections were conducted from the results of both the KLAMZ and ADAPT models assuming that the catch in 2003 would be 100,000t, approximately equal to that in 2002. Natural mortality was assumed to be 0.2 as in the assessment. Two F scenarios were considered, $F = 0.2$, approximating the F estimated by the VPA in recent years and corresponding roughly to an F_{MSY} proxy reference points, as well as $F = 0.1$.

The results from the KLAMZ projections indicated that a catch of about 323,000t in 2004 corresponds to an $F = 0.2$ and results in a decrease in 2+ biomass from about 1,800,000t in 2004 to about 1,640,000t in 2005. With an $F = 0.1$, the resulting catch is about 170,000t and the 2+ biomass decreases from about 1,800,000t to about 1,790,000t.

The ADAPT projections were done from the bias adjusted VPA results and assumed that the fishery partial recruitment to be fully recruited for ages 2 and older and 0.01 at age 1. The fishery and population weights at age were taken as the average from 1992 to 2002. The results indicated that a catch of about 100,000t in 2004 corresponds to an $F = 0.2$ and results in a decrease in 3+ biomass from about 550,000t in 2004 to about 500,000t in 2005. With an $F = 0.1$, the resulting catch is about 60,000t and the 3+ biomass stays constant at about 550,000t.

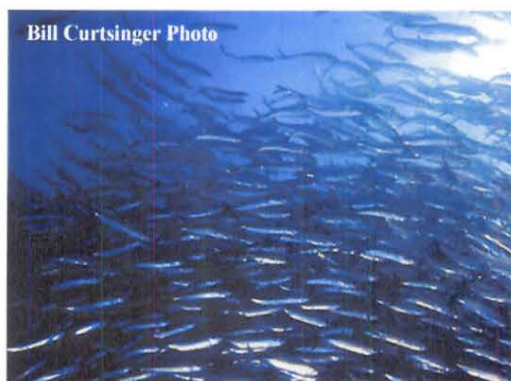
APPENDIX 6:

Completion Report for “Atlantic herring stock discreteness and migration”

J. Kohl Kanwit
Marine Resources Scientist
Maine Dept. of Marine Resources

Overview:

The Maine Department of Marine Resources (DMR), in conjunction with Alton West (Stinson 2001 Inc.), was awarded a grant by the Maine Outdoor Heritage Fund (MOHF) for the purchase of an automated microwire tag detection unit. This unit was required in order to successfully implement a coded wire tagging pilot project for Atlantic herring.



The Atlantic herring is one of the most biologically and economically important species in the Gulf of Maine. Herring are oceanic plankton-feeding fish that occur in large schools, and inhabit coastal and continental shelf waters and are widely distributed from Labrador to Cape Hatteras. Adults (age 3+) migrate south from summer/fall spawning grounds in the Gulf of Maine to over-winter off southern New England and the Mid-Atlantic states. Important commercial fisheries for juvenile herring (ages 1 to 2) existed since the last century through the 1980's along the coasts of Maine and New Brunswick. Development of large-scale fisheries for adult herring is comparatively recent, primarily occurring in the Gulf of Maine, on Georges Bank, and in southern New England and Mid-Atlantic waters. Herring are an important food source for many species of fish, mammals, and seabirds. Commercial landings are currently around 200 million pounds with 60 percent going to the lobster bait market and 40 percent to canneries.

Project Need:

Atlantic herring may have the most complex stock structure of any marine fish (Iles and Sinclair 1982). Traditionally three stocks of herring have been recognized from the Gulf of Maine region, and within in each of these are a number of discrete spawning units. For management purposes, the U.S. stocks are assessed as one unit and the most recent Stock Assessment Workshop (27th SAW 1998) concluded that the US Atlantic coastal herring stock complex is large and underutilized. The current fishing mortality of the coastal stock complex is estimated at less than .10, well below the target fishing mortality of .25. However, a recent analysis indicated that the Gulf of Maine stock component is fully exploited. Additional indications from the most recent Gulf of Maine herring assessment show an unsustainable fishing mortality of .35 for the inshore stock complex (Stevenson 2000).



Based on this evidence, it became increasingly apparent that a tagging project designed to assess stock discreteness, exploitation rates and reevaluate catch allocations was needed. Microwire tags were selected as the best option for marking herring, because they are less invasive, result in high retention rates and automated tag detection is capable of being integrated into bulk processing facilities.



Project Description and Objectives:

Sequential microwire tags

This project helped to address research objectives proposed by the New England Fishery Management Council and the Atlantic States Marine Fisheries Commission. The generous support of the herring industry (fishermen, dealers and processors) and equipment loans from the National Marine Fisheries Service enabled the DMR to initiate a coded wire tagging pilot project in 2001. The MOHF grant provided the necessary funds to purchase the automatic tag detection unit that was integrated into the Stinson 2000 Inc. processing facility in Bath, ME.

The objectives of the pilot project were:

1. develop and evaluate catch methods for obtaining live, high quality herring from a commercial fishing vessel platform

Result: Efficient and effective methods for obtaining live herring were developed for purse seine and mid-water trawl vessels.



Tagging on a purse seine vessel



Tagging on a mid-water trawl vessel

2. become versed in microwire tagging methods, technology and equipment

Result: Through extensive fieldwork DMR staff became proficient at operating and modifying microwire tagging equipment. Tagging rates of 500 fish per hour were attained by the end of the 2002 field season.

3. conduct lab studies to determine tag retention and handling mortality rates

Result: Although several attempts were made to transport live fish to the DMR Boothbay lab this objective was not achieved. Other possibilities are being evaluated for obtaining tag retention and handling mortality data.

4. install and evaluate a recovery system at the Stinson's 2001 Inc. processing plant in Bath

Result:

An automated detection unit was purchased in 2001 with MOHF funds and transported to the Connor's Brothers Ltd. (parent company of Stinson's 2001 Inc.) processing facility in Black's Harbour, New Brunswick. The engineers at Connor's designed and constructed a conveyor system that incorporated the detection unit into the processing line at a point where tags could be retrieved. After the modified conveyor line was installed at the Bath plant, testing ensued and showed the detection unit to be operating correctly. Unfortunately, the project experienced a setback when plant personnel accidentally damaged the conveyor line. After repairs were made the unit was reinstalled but test trials revealed a problem caused by moisture in the detector. The unit is currently awaiting shipment back to Northwest Marine

Technologies (NMT) for repair and will be accompanied by a trained technician when it is returned to the Bath plant.

Project Plan, Methodology and Expected Outcomes:

The Outdoor Heritage Fund grant proposal outlined the following project plan and expected outcomes:

1. The automated tunnel detection unit will be purchased and installed.

Result: The detection unit was purchased and installed into the processing line at the Bath packing plant. An extensive conveyor system was created by the plant engineers for the detection unit that included diverter gates, collection areas and bypass mechanisms.



Detection unit conveyor line

2. Testing of the recovery system will occur before or after plant operation hours. Initial testing will involve staged recovery events using freshly tagged fish and untagged fish from a recent catch. When the recovery system is operating at maximum efficiency, tagged fish will be planted in actual catches entering the plant.

Result: After the installation of the detection unit in the Bath plant, its efficiency was assessed through several trials. Please refer to Table 1.

3. All tagged fish detected in the Bath plant will be automatically diverted with a number of untagged herring. These fish will be frozen and processed at the DMR lab for age, length, weight, sex and maturity. The individual recaptured fish will be isolated with a portable magnetic detector, identified and documented. The exact location of recapture will be plotted and analyzed geographically using ArcView GIS software.



Diverting gates on conveyor

Result: The detection system only recovered 2 samples during the time of operation in 2002. Both samples were the result of debris from the vessels setting off the detector. These findings were not surprising since there were a very limited number of tagged herring released in the Gulf of Maine at that point (about 1,000 individuals).

4. Results of all tests and experiments will be analyzed and a full review by DMR staff and industry members will determine if a full-scale tagging project is warranted.

Result: The coded wire tagging project has experienced some set backs during the 2002 field season that have required review and evaluation. Although the detection units (one in Bath and one in Prospect Harbor) have operated for periods of time over the season their reliability needs to be improved. In an effort to accomplish this, the decision has been made to send both units back to NMT for repairs. After the units are returned they will be reinstalled and assessed by a trained NMT technician. Problems that still exist with the conveyor system will be fixed and the detection units will be retested for efficiency.

Continuation of the Project:

DMR has pursued many funding opportunities to support the continuation and expansion of the herring tagging project. In addition to the MOHF award, grants from the Northeast Consortium and the University of Maine were secured. The herring industry has also continued to support this project through contributions in kind and direct funding.

It is the intention of DMR to expand this program and involve a wider range of participants. Efforts are underway to tag herring off the Rhode Island coast this winter using commercial fishing vessels as research platforms. The Rhode Island Department of Natural Resources has expressed an interest in participating in the program on a long-term basis including providing some funding. DMR is also making plans to incorporate more processing facilities in the tag recovery effort. One existing plant and several that are in the process of building have expressed interest in having detection units installed. Opportunities for funding these additional detection units are being investigated. Despite the temporary problems the project is experiencing with the installation of the detection units, DMR feels strongly that these issues can be resolved. Once the recovery process is perfected the Atlantic herring tagging project will provide important data for the responsible and sustainable management of the fishery.

Table 1 : Detector Tests

Test No.	Description	Trial No.	No. Fish	No. Tag Fish	Time to Recovery	% Recovery	Comments
1 8/30/02	test of detection unit by seeding tagged fish directly in front of detector	1	20	0	N/A	N/A	untagged fish were run through the detector to check for false positive results
		2	20	1	immediate	100	tagged fish was recovered with 4 additional fish
2 8/30/02	test of detection unit by seeding tagged fish in a hopper 20' in front of detector	1	50	0	N/A	N/A	untagged fish were run through the detector to check for false positive results
		2	50	1	immediate	100	tagged fish was recovered with 6 additional fish
3 8/30/02	test of detection unit by seeding tagged fish in a hopper 20' in front of detector	1	70	0	N/A	N/A	untagged fish were run through the detector to check for false positive results
		2	70	2	immediate	100	tagged fish were recovered
		3	70	4	immediate	50	diverter gates got stuck
		4	70	4	immediate	100	gates operated properly all 4 fish were recovered
4 9/9/02	retest detector at point of recovery	1	5	5	immediate	100	all recoveries verified
5 9/9/02	tagged fish seeded at the exit of cutting machines	1	processing volume	5	2 mins.	100	all recoveries verified
		2	processing volume	5	2 mins.	100	all recoveries verified
		3	processing volume	5	2 mins.	100	all recoveries verified
6 9/9/02	tagged fish seeded in the flume before the cutters	1	processing volume	5	11 mins.	80	4 recoveries verified
		2	processing volume	5	unk.	80	4 recoveries verified
		3	processing volume	5	14 mins.	100	5 recoveries verified

FISHERY MONITORING AND ASSESSMENT

Job #1

Kohl Kanwit

Job Title: Atlantic Halibut (*Hippoglossus hippoglossus*) Monitoring

Objectives:

To collect biological data and assess movement patterns of Atlantic halibut through a federal experimental fishery and a voluntary state effort.

Results:

Assessment of the experimental and state waters fisheries for 2002 was conducted and presented to management and industry members (see Appendix 1-3). Biological samples were processed at the DMR lab and NMFS Science Center. The 2003 experimental fishery application was submitted and is pending approval by NMFS with a scheduled start date of April 1, 2003. Training sessions for state waters fishermen were held in Portland, Rockland, Ellsworth and Machias. Approximately 130 fishermen attended, qualifying them for a 2003 state halibut endorsement.

APPENDIX 1

2002 Experimental Halibut Fishery

Data Summary Compiled by:

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Submitted to:

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Project Overview:

The Maine Department of Marine Resources (DMR), in conjunction with the National Marine Fisheries Service (NMFS) and Maine Sea Grant, administered the third year of the Gulf of Maine Experimental Halibut Fishery from April 1-May 31, 2002. This fishery was conducted under the auspices of a federally issued exempted fishery permit in an area defined by the US/Canadian maritime boundary to the north, the 25600 LORAN line to the east and a line extending 180 degrees true south from 69 degrees west. In 2002, there were 6 participating vessels permitted to fish for halibut in federal waters with longline gear and sell their catch while complying with biological sampling protocols and tagging. During the 61 days of this fishery 234 halibut were kept and 235 were tagged and released for a total of 469 fish caught. It is important to note that during the 2002 season NMFS limited the experimental fishery to a total take of 234 halibut.

The experimental fishery in 2002 successfully complied with the guidelines of the federally issued permit and collected valuable data on Atlantic halibut. The participating fishermen were required to keep logbooks of their activities and submit them weekly to DMR. Biological samples (otoliths and gonads) were collected for 91% of the commercially sold fish. The otolith samples were subsequently sent to the NMFS Science Center in Woods Hole, MA for processing. DMR personnel collected the frozen gonad samples from the fishermen and processed them following the International Pacific Halibut Commission protocol. Unfortunately, 49 of the gonad samples could not be processed due to decomposition that occurred as a result of accidental thawing and re-freezing. Finally, DMR observers covered seven trips during the experiment to record bycatch and assist with sampling techniques.

In compliance with the federal permit, DMR is providing the following data summary for the 2002 experimental halibut fishery.

Experimental Fishery:

Six fishermen were issued a federal experimental fishery permit for the period between April 1 and May 31, 2002 (Table 1). The permit allowed them to fish for Atlantic halibut in federal waters with longline gear, limited to 700, size 14 oo circle hooks per vessel. Mandatory logbooks were maintained by each participant and included information on the date, location, number of sets, depth of sets, hooks per set, and bycatch. Data recorded for all halibut caught included: set number, fish length, weight, samples taken (otolith and gonad), and tag number if the fish was released.

In 2002, the 6 permitted vessels fished 127 days collectively (Table 2). The days fished by vessel ranged from 15 to 31 (Figure 1), during which a total of 838 sets were made, with a minimum of 70 and a maximum of 216 (Table 3). The number of hooks used by vessel also varied considerably from 3,260 to 18,100 with a total of 61,040 fished over the course of the experiment (Table 4). Gear was set in a wide range of depths, averaging 58 fathoms in April and 67 fathoms in May. Two hundred thirty four halibut were caught with 63% of the fish landed during the month of May (Tables 5 and 10). Thirty of the halibut kept were sold to the University of Maine for use as brood stock at their aquaculture facility in Franklin, ME (Table 6). Two hundred thirty five halibut were tagged and released, an 80% increase from the 2001

fishery (Table 7). Ten tagged halibut were recaptured in 2002, seven from the 2000 season, two from the 2001 season and one from the 2002 season (Table 11).

Biological Data:

Biological data and samples were collected for every halibut caught during the experimental fishery. Undersized halibut were measured, tagged and released as quickly as possible. Legal size halibut (>36 inches) were measured, weighed and sampled for otoliths and gonads.

The average length of kept halibut was 46 in. while the average length for released fish was 31 in.. The maximum length for the season was 75 in. and the minimum length was 23 in.. Dressed weights were taken for the halibut sold commercially and ranged from 105 lbs. to 15 lbs., averaging 38 lbs. (Figure 3). The fish sold live to the University were weighed whole and ranged from 88 lbs. to 29 lbs., averaging 52 lbs. (Figure 2). Released halibut were not weighed in an effort to limit stress on the fish.

Otoliths and gonads were sampled for every kept fish with the exception of those sold live to the University (Table 8). One hundred eighty six gonad samples were collected and 152 were processed at the DMR lab for sex and maturity. Of the 152 halibut gonad samples, 109 were female and 43 were male. The maturity stages were determined using the Pacific Halibut Commission's guidelines:

Females: Stage 1 = Immature
Stage 2 = Developing
Stage 3 = Ripe
Stage 4 = Resting

Males: Stage 1 = Immature
Stage 2 = Mature

The male gonads were comprised of 36 immature and seven mature samples for a total of 43. The remaining samples (109) were female with 75 immature, 27 developing, one ripe and six resting (Figure 4).

Recaptures:

Ten tagged halibut were recaptured during 2002. Four of the returned tags came from Canadian waters; three off Cape Sable, Nova Scotia and one off Port Au Basque, Newfoundland (Figures 5 and 6).

Observer Coverage:

DMR personnel observed seven halibut trips, with at least one trip on each of the participating vessels. There were no organisms noted as bycatch on the observed trips (for bycatch information from the entire fishery see Table 9). There were no marine mammal interactions

observed during the experimental halibut fishery. NMFS was unable to provide any observer coverage for this experimental fishery.

Table 1: Participants

Name	Vessel	Port
Bruce Jones	Nampy's Pride	Stonington
George Ingrish	Brooke Hali	Bucks Harbor
Jeff Alley	Nawthin' To It	Jonesport
Paul Dorr	Brandi Lee II	Stonington
Steve Rosen	Star Fisher	Vinalhaven
Todd Pinkham	Fish Hook	Steuben

Table 2: Days Fished by Vessel

Vessel	April	May	Total
Brandi Lee II	11	16	27
Brooke Hali	8	8	16
Fish Hook	5	10	15
Nampy's Pride	11	10	21
Nawthin' To It	19	12	31
Star Fisher	6	11	17
Total	60	67	127

Table 3: Sets by Vessel

Vessel	April	May	Total
Brandi Lee II	86	136	222
Brooke Hali	22	48	70
Fish Hook	21	51	72
Nampy's Pride	97	90	187
Nawthin' To It	126	90	216
Star Fisher	30	41	71
Total	382	456	838

Table 4: Hooks by Vessel

Vessel	April	May	Total
Brandi Lee II	7700	10400	18100
Brooke Hali	1440	1820	3260
Fish Hook	1580	3750	5330
Nampy's Pride	7700	7000	14700
Nawthin' To It	6300	4200	10500
Star Fisher	3550	5600	9150
Total	28270	32770	61040

Table 5: Halibut by Vessel

Vessel	April	May	Total
Brandi Lee II	43	87	130
Brooke Hali	13	39	52
Fish Hook	12	36	48
Nampy's Pride	47	61	108
Nawthin' To It	29	45	74
Star Fisher	29	28	57
Total	173	296	469

Table 6: Kept and Released Halibut by Vessel

Vessel	Kept ¹			Released			Grand Total
	April	May	Total	April	May	Total	
Brandi Lee II	11	30	41	32	57	89	130
Brooke Hali	12	26	38	1	13	14	52
Fish Hook	10	23	33	2	13	15	48
Nampy's Pride	24	9	33	23	52	75	108
Nawthin' To It	24	27	51	5	18	23	74
Star Fisher	16	22	38	13	6	19	57
Total	97	137	234	76	159	235	469

¹ = 30 of the kept fish were sold live to the University of Maine

Table 7: Tagged Halibut

Vessel	May	April	Total
Brandi Lee II	32	57	89
Brooke Hali	1	13	14
Fish Hook	2	13	15
Nampy's Pride	23	52	75
Nawthin' To It	5	18	23
Star Fisher	13	6	19
Total	76	159	235

Table 8: Biological Samples

Vessel	Gonads	Otoliths	Total
Brandi Lee II	40	40	80
Brooke Hali	36	38	74
Fish Hook	21	26	47
Nampy's Pride	33	33	66
Nawthin' To It	20	30	50
Star Fisher	36	36	72
Total	186	203	389

Table 9: Bycatch

Species	April	May	Total
Cod	1	3	4
Crab	1	3	4
Cusk	1	3	4
Dogfish	49	27	76
Haddock	1		1
Lobster	2	1	3
Scallop	6		6
Sculpin	4	3	7
Skate	2	8	10
Wolfish		1	1
Total	67	49	116

Table 10: Halibut by Vessel

Date	Brandi Lee II	Brooke Hali	Fish Hook	Nampy's Pride	Nawthin' To It	Star Fisher	Total
4/5/02				1			1
4/6/02	5	3	2			3	13
4/7/02	3	1	4				8
4/8/02					1		1
4/10/02					2		2
4/11/02	4				4		8
4/12/02	1	3		1	3		8
4/13/02					3		3
4/15/02					1		1
4/16/02					1	7	8
4/17/02	2	1	4	1	1	2	11
4/18/02		1			1		2
4/19/02	8	1			1		10
4/20/02	2			7	1		10
4/21/02	3	3	1				7
4/22/02				6	3	3	12
4/23/02	3		1	6	3		13
4/24/02	7			6	1	3	17
4/25/02				10		11	21
4/28/02	5						5
4/30/02				9	3		12
5/1/02	5	1			6		12
5/2/02	9				1	2	12
5/5/02	5					2	7
5/6/02	3	1			2		6
5/7/02	6				3		9
5/8/02					3		3
5/9/02		4			5	4	13
5/10/02		6		6			12
5/11/02			2				2
5/12/02	5	5		4			14
5/13/02	3	5	2	3			13
5/16/02		8				7	15
5/17/02			5			2	7
5/18/02	8			7		3	18
5/19/02	6	9	3				18
5/20/02				14			14
5/21/02	7					1	8
5/22/02	2		7	8			17
5/23/02	2		4		2		8
5/24/02					4		4
5/25/02			2		5	2	9
5/26/02				5	5		10
5/27/02	6			3	5	1	15
5/28/02	6		1	5	4	3	19
5/29/02			6	6		1	13
5/30/02	7		4				11
5/31/02	7						7
Total	130	52	48	108	74	57	469

Table 11: Recapture Data

Recap No	Tag No	Captain	Capture No	Days	LATDD	LONDD	Depth	Length (in)	Growth (in)
1	255	Paul Dorr	4/18/00		43.9723	-68.3187	60	28.5	
1	255	Paul Dorr	4/17/01	364	43.9672	-68.3216	60	33	4.5
2	351	Bruce Jones	5/25/00		44.0179	-68.3204	51	32	
2	351	Paul Dorr	5/11/01	351	44.0448	-68.2249	50	42	10
3	263	Paul R. Dorr	5/3/00		43.9796	-68.3053	55	31.5	
3	263	Gilbert Donaldson	1/30/02	637	42.8667	-65.3333	75	41.5	10
4	629	Trawl Survey	10/8/01		43.8563	-69.0827	33	20	
4	629	Stephen Jordan	1/30/02	114	43.0167	-69.4167	106	20.5	0.5
5	373	Bruce Jones	6/15/00		44.0165	-68.3423	50	30	
5	373	John Smith	6/19/02	734	43.3504	-66.1378	25	40	10
6	388	Paul R. Dorr	5/25/00		44.0059	-68.3096	45	30.5	
6	388	Bruce Jones	4/22/02	697	44.0626	-68.1918	54	43	12.5
7	389	Paul R. Dorr	5/21/00		44.0076	-68.3326	45	32	
7	389	Bruce Jones	5/19/02	728	44.0584	-68.1244	50	42	10
8	368	Bruce Jones	5/30/00		44.0831	-68.1878	48	23	
8	368	Bruce Jones	4/2/02	672	44.0714	-68.1482	48	41	18
9	258	Paul Dorr	4/18/00		43.9723	-68.3188	60	32	
9	258	Jim Stagg	5/22/02	764	49.6003	-59.7289	150	38	6
10	446	Paul Dorr	4/3/01		43.9650	-68.3321	55	31	
10	446	Paul Dorr	5/19/02	411	44.0104	-68.4421	45	42	11
11	377	Paul Dorr	5/23/00		43.9774	-68.4316	45	32	
11	377	Paul Dorr	5/21/02	728	43.9817	-68.4614	45	41	9
12	21	Steve Rosen	4/25/02		43.7059	-68.4475	60	31	
12	21	Paul Harris	10/2/02	160	43.1667	-65.5000		39	8

**Figure 1: CPUE
Halibut/Trips**

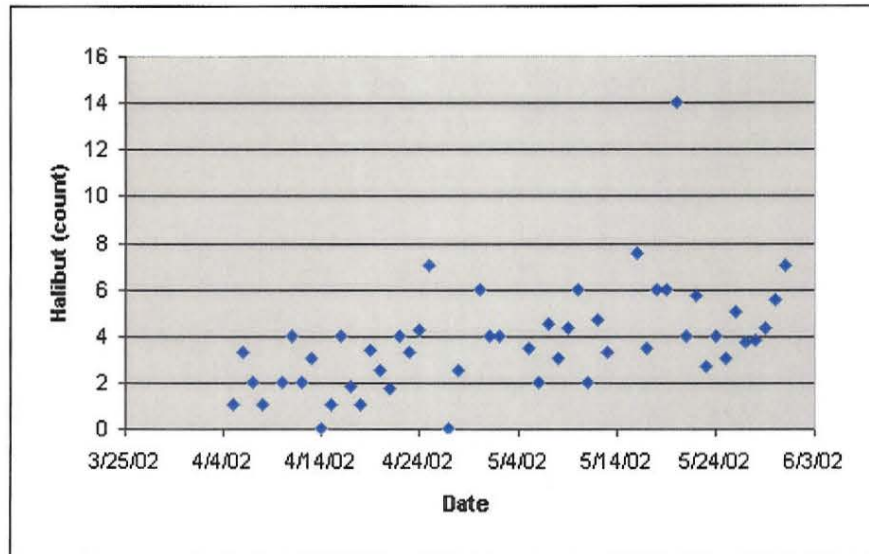


Figure 2: Length/Whole Weight

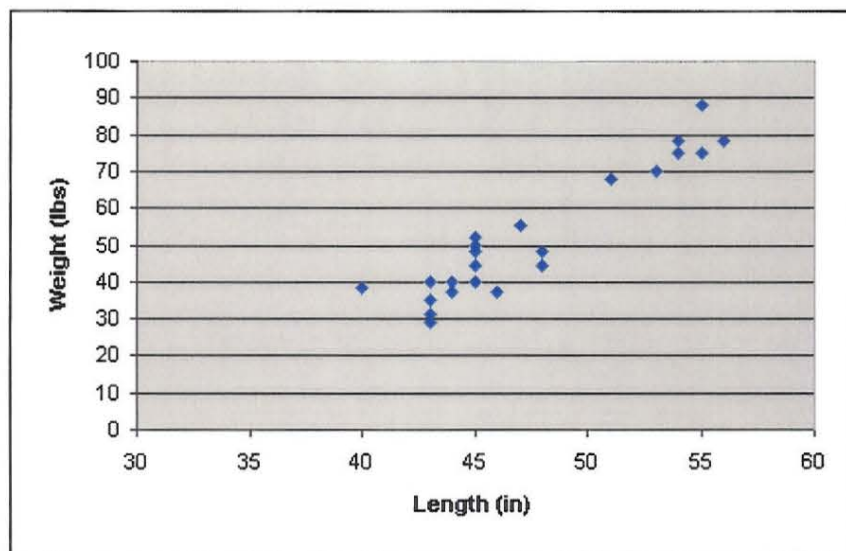


Figure 3: Length/Dressed Weight

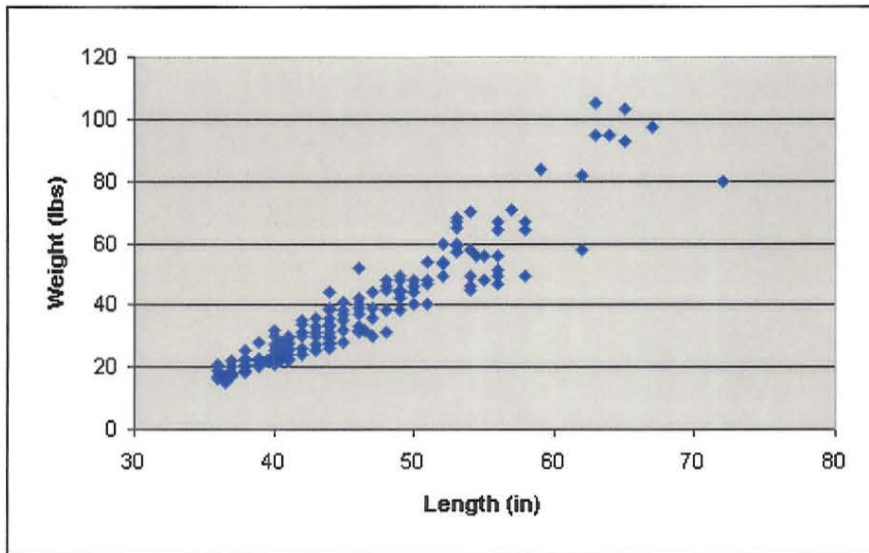
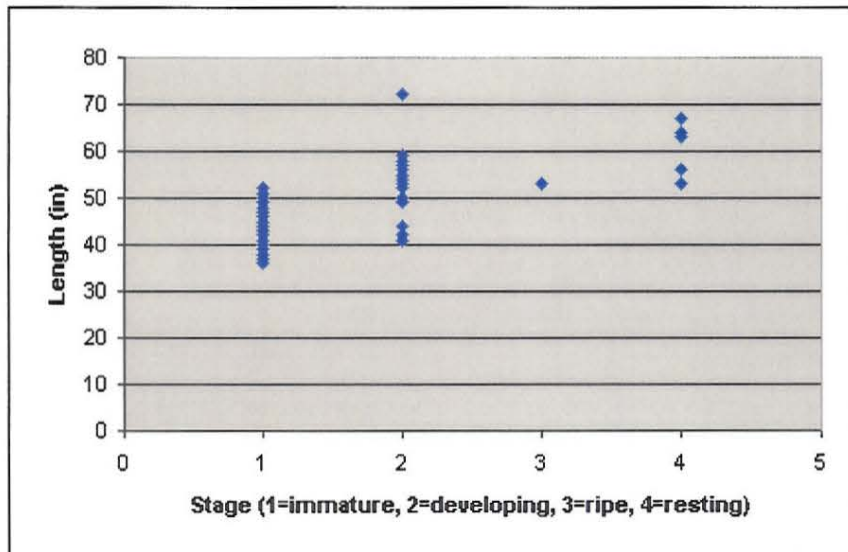


Figure 4: Length/Stage of Maturity for Females



APPENDIX 2

Proposed agency actions: **Approval of an experimental Atlantic halibut fishery in the Gulf of Maine.**

Type of statement: **Environmental Assessment**

Lead agency: **State of Maine Department of Marine Resources**

Cooperating agencies: **National Marine Fisheries Service**

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1.0 Purpose and Need for Action:

1.1 Exempted Fishing Permit Request:

The Maine Department of Environmental Resources (Maine DMR) has submitted a request to conduct an exempted experimental fishery for Atlantic halibut (*Hippoglossus hippoglossus*) in the eastern Gulf of Maine. In conjunction with this request, Maine DMR has requested that the National Marine Fisheries Service (NMFS) issue Exempted Fishing Permits (EFPs) to six traditional longline and tub trawl vessels for purposes of conducting this experimental fishery. The EFPs would authorize six vessels to fish for and possess Atlantic halibut in excess of the allowable landing and possession limit specified at 50 CFR 648.86(c), and to possess temporarily Atlantic halibut less than the minimum size requirement of 36 inches total length (TL) specified at § 648.83(a)(1) for purposes of scientific data collection.

1.2 Purpose and Goals:

The purpose of this action is to collect biological and ecological data on Atlantic halibut to be used in the long-term management of this fishery resource. The goal of the experiment is to collect data on the distribution, relative abundance, migration, stock definition, mortality rates, stock size, yield, and other significant biological reference points for Atlantic halibut. The proposed experiment would also collect data on age and growth, size and sex composition, and rate of onset of sexual maturity.

1.3 Background:

The Atlantic halibut (*Hippoglossus hippoglossus*) is the largest of flatfishes and is found along the continental shelf of the sub-Arctic on both sides of the North Atlantic Ocean and in parts of the Arctic Ocean. A fishery for halibut in U.S. waters began in the early 19th century and peaked from 1845 to 1900. The fishery had collapsed by the 1940s and for many years there was no directed fishery for Atlantic halibut in U.S. waters. Although the halibut resource was recognized as depleted in comparison to historic levels, this species was not federally managed until it was identified by NMFS as overfished (NMFS 1997). As a result of this overfished determination, NMFS was required by the Sustainable Fisheries Act to prepare a stock rebuilding plan for this fishery resource. As a result, NMFS included Atlantic halibut in the management unit of the Multispecies Fishery Management Plan (FMP) through Amendment 9 to the FMP, which was implemented on November 15, 1999 (64 FR 55821; October 15, 1999). Amendment 9 established a one fish per day possession limit for Atlantic halibut and a minimum size limit of 36-in. total length (TL). The Federal minimum size limit was adopted for Maine state waters in 2000 and more comprehensive regulations are in the approval process (new state regulations include a 3-month season, annual catch limit, daily fish limit, and mandatory tagging).

Amendment 9 recognized that there is very little scientific information on the Atlantic halibut resource. In light of this lack of information, Maine DMR made a request to NMFS in the spring

of 2000 to conduct an experimental fishery for Atlantic halibut in the eastern Gulf of Maine in order to collect biological information on this resource. This request was approved, and has resulted in annual requests from Maine DMR to continue this experimental fishery for purposes of collection additional biological information on Atlantic halibut. The results of the 2000 and 2001 experimental fisheries are presented below.

1.3.1 2000 Experimental Halibut Fishery:

The Maine DMR in collaboration with the NMFS, Maine Sea Grant and industry members conducted a survey of Atlantic halibut in the eastern Gulf of Maine. This fishery was conducted under the auspices of a federally issued exempted fishery permit (EFP) in an area defined by the US/Canadian maritime boundary to the north, the 25600 LORAN line to the east and a line extending 180 degrees true south from 69 degrees west. Three EFPs were issued by NMFS to Paul Dorr, Bruce Jones, and Steve Rosen for the period between April 15 and June 15, 2000. The EFPs allowed participating vessels to fish for Atlantic halibut in Federal waters with longline gear, limited to 700, size 14 oo circle hooks per vessel. Participants were required to maintain mandatory logbooks which collected information on the date, location, number of sets, depth of sets, hooks per set, and bycatch. Data recorded for all halibut caught included: set number, fish length, weight, samples taken (otolith and gonad), and tag number if the fish was released. The following is a summary of the data collected during the cooperative 2000 Atlantic halibut survey.

The experimental Atlantic halibut fishery took place over the course of 3 months (April 15th to June 15th) for a total of 62 available fishing days. In this time, the three permitted harvesters collectively fished a total of 77 days, 17 in April, 47 in May and 13 in June. The permit limited the longlines or tub trawls to 100 hooks each with no more than 700 hooks per vessel. The harvesters made a total of 500 sets that comprised 38,275 hooks fished during the season. A minimum of 200 hooks and a maximum of 1925 hooks were fished on a given day. A total of 98 sets were made in April, 304 in May, and 98 in June at depths ranging from 37-65 fathoms. In April, 60 halibut were caught at a mean depth of 61 fm in May 143 halibut were caught at a mean depth of 53 fm, and in June 31 halibut were caught at a mean depth of 43 fm.

A total of 234 halibut were captured during the course of the survey and of these fish, 162 were kept and 72 were released. Of the 162 kept halibut, 31 were sold to the University of Maine for aquaculture brood stock purposes. The experimental permit stipulated that biological data be collected on all captured fish. Halibut less than 36 inches were tagged and released, while halibut 36 in. and greater could be retained by the harvester, not exceeding 6 fish in a given day. Any halibut captured after the 6-fish/day limit was reached were tagged and released. The mean length of released fish was 31 in. with a minimum of 23 in. and a maximum of 35 in. The mean length of kept fish was 47 in. with a minimum of 36 in. and a maximum of 70 in. Weights were recorded on most kept fish, however, some were whole weights and some were dressed weights. A total of 141 halibut were weighed after they were dressed with a minimum of 17 lbs., a maximum of 109 lbs. and a mean of 43 lbs. Of the 141 halibut weighed, 31 were weighed whole (25 of which were sold to the University of Maine) with a minimum of 20 lbs., a maximum of 104 lbs. and a mean of 38 lbs. Released fish were not weighed.

In addition to tagging, scale samples were taken from 63 of the 72 released halibut. Biological samples were also taken from the kept fish, including otolith and gonad samples. Out of the total 162 kept fish, 47 sets of otoliths were taken, 21 gonads were collected and 84 scale samples were taken. The University of Maine will analyze the biological samples and the data will be made available at a later time.

Bycatch in the Atlantic halibut experimental fishery was recorded by number for each set the vessels made. Overall the bycatch seemed to be insignificant with the exception of one day when a vessel caught 400 dogfish. A total of 494 individual fish of non-target species were taken, with the greatest take being dogfish (447 individuals). Catfish, cusk, skate and cod made up the remaining bycatch take of 47 individual fish.

1.3.2 2001 Experimental Fishery:

The Maine Department of Marine Resources (DMR), in conjunction with the National Marine Fisheries Service (NMFS) and Maine Sea Grant, administered the second year of the Gulf of Maine Experimental Halibut Fishery from April 12-May 31, 2001. This experimental fishery was conducted in the same region as the 2000 experimental fishery, and under similar permit conditions. The only deviation from the protocol for the 2000 experimental fishery was the establishment of a 50 fish total allowable catch (TAC) for each vessel. Once each vessel achieved this TAC, they were restricted to a trip limit of 6 halibut. Six vessels were permitted to fish in the 2001 experimental fishery, however only 4 actively participated. During the 50 days of this fishery, 152 halibut were caught of which 126 were kept and 26 tagged and released.

The experimental fishery in 2001 successfully followed the guidelines of the federally issued permit and collected valuable data on Atlantic halibut. The compliance rate for biological sampling was almost 100%. Two recaptures were made from the previous year, providing initial indications of halibut movement patterns. Finally, DMR observers covered 22% of the available days during the experiment. The following is a summary of the 2001 experimental halibut fishery.

In 2001, 5 of the 6 permitted vessels fished 83 days collectively. One of the participants did not fish for halibut during the experimental period and therefore submitted no data. The days fished by vessel ranged from 4 to 26, during which a total of 485 sets were made, with a minimum of 8 and a maximum of 150. The number of hooks used by vessel also varied considerably from 6,150 to 14,700 with a total of 44,025 fished over the course of the experiment. Gear was set in a wide range of depths, averaging 67 fathoms in April and 45 fathoms in May. One hundred fifty two halibut were caught with almost 80% of these landed during the month of May. The majority of the halibut were kept (126), either sold for consumption or live to the University of Maine for use as brood stock (45 of the 126). Twenty-six undersized halibut were tagged and released during the experimental fishery and 2 were recaptured from the previous year. In regards to bycatch species taken during the 2001 experiment, a total of 214 individual fish of non-target species were taken consisting of 156 dogfish, 35 skate, 13 cusk, 3 sculpin, and 1 each of cod, hagfish, ocean catfish, crab, lobster, scallop, and wolffish.

The participating fishermen were required to keep logbooks of their activities and submit them weekly to DMR. All otolith samples were sent in weekly along with the logs and carefully documented at the DMR lab. The otoliths were subsequently sent to National Marine Fisheries Service (NMFS) Science Center in Woods Hole, MA for processing. At the end of the season, DMR personnel collected the frozen gonad samples from the fishermen and transported them to the lab for processing. All data were entered into a Microsoft Excel spreadsheet on a regular basis and forwarded to Jon Brodziak at the NMFS Science Center.

Biological data and samples were collected for every halibut caught during the experimental fishery. Undersized halibut were measured, tagged and released as quickly as possible. DMR staff, in conjunction with Steve Murawski (NMFS), determined that the benefit of scale sampling did not outweigh the stress it caused and was therefore discontinued. Legal size halibut (>36 inches) were measured, weighed and sampled for otoliths and gonads.

The average length of all halibut caught was 43 in., with an average of 45 in. for kept fish and 31 in. for released fish. The maximum length for the season was 68 in. and the minimum length was 15.5 in.. Dressed weights were taken for the halibut sold commercially and ranged from 97 lbs. to 15 lbs., averaging 41 lbs.. The fish sold live to the University were weighed whole and ranged from 83 lbs. to 16 lbs., averaging 39 lbs. Released halibut were not weighed in an effort to limit stress on the fish.

Otoliths and gonads were sampled for every kept fish with the exception of those sold live to the University. Seventy-eight otoliths could be sectioned and read by Doug Sigourney of UMass Amherst at the NMFS Wood's Hole lab. Legal sized halibut ranged in age from 15 to 5 years old and averaged 8 years. Gonad samples were processed at the DMR lab for sex and maturity, and showed a sex ratio of 17 to 61, males to females. The maturity stages were determined using the Pacific Halibut Commission's guidelines:

Females:

- Stage 1 = Immature
- Stage 2 = Ripening
- Stage 3 = Spawning
- Stage 4 = Resting

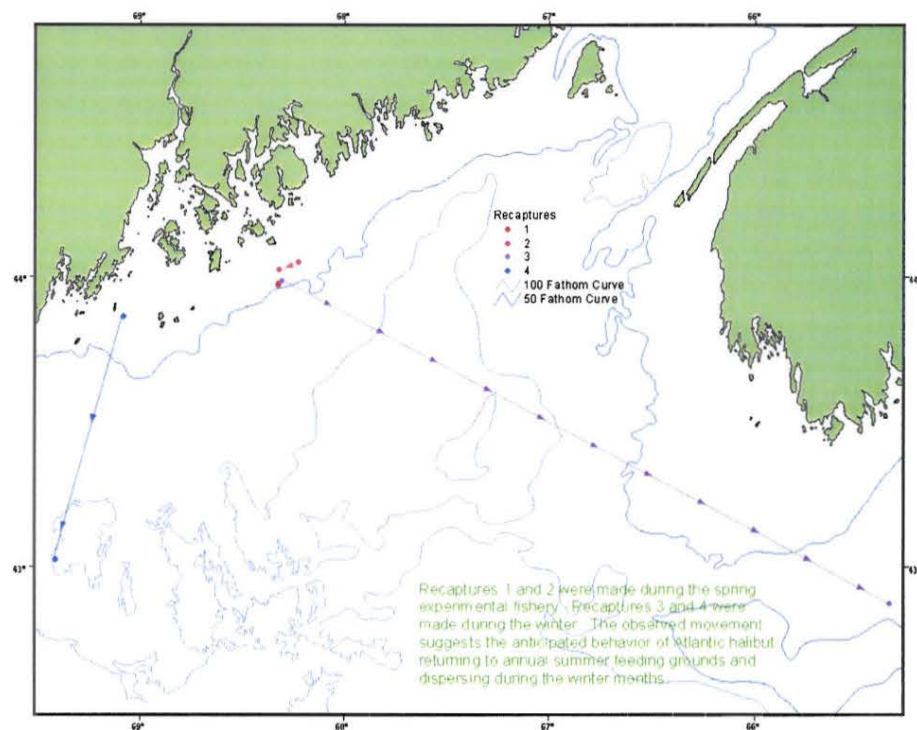
Males: Stage 1 = Immature
Stage 2 = Mature

The male gonads (17) were comprised of 9 immature and 8 mature samples with an average weight of 2.6 oz.. The remainder of the samples were female with 35 immature, 17 ripening and 9 resting, averaging 8.8 oz., and ranging from 2.0 to 28.2 oz.

DMR staff covered thirteen percent of the total trips fished (11 trips on 4 participating vessels), amounting to 22% of the available days. NMFS was unable to provide any observer coverage for this fishery. There were 15 individual organisms noted as bycatch on the observed trips including; cusk, lobster, skate, dogfish, scallop and crab. There were no marine mammal interactions observed during the experimental halibut fishery.

Four tagged halibut were recaptured during 2001. Halibut number 255 was tagged on April 18, 2000, in the vicinity of Mt. Dessert Rock. It was recaptured in virtually the exact same location on April 17, 2001. This halibut grew from 28.5 to 33 inches in one year. Halibut number 351 was tagged on May 25, 2000, also in the vicinity of Mt. Dessert Rock. This halibut was recaptured just to the west of its initial location on May 11, 2001, and sold live to the University. Halibut number 351 grew from 32 to 42 inches in almost one year. Halibut number 263 was tagged on May 30, 2000, in the vicinity of Stonington. It was recaptured on January 30, 2002 off Cape Sable, Nova Scotia. This fish was at large for 637 days and grew from 31.5 to 41.5 inches. Halibut number 629 was tagged on October 8, 2001, by the state trawl survey crew off Matinic Island. It was recaptured on January 30, 2002, off Three Dory Ridge 114 days after its original release. This fish grew from 20 to 20.5 inches. A depiction of this recapture information is presented in Figure 1.

Figure 1. Halibut recapture information.



2.0 Alternatives Including the Proposed Action:

There are three alternatives to consider; the preferred alternative that allows for an experimental Atlantic halibut fishery with 6 participants. This alternative would include a seasonal TAC of 50 fish per vessel and a total seasonal TAC of 1,080 halibut. Alternative 2 would follow the same scientific protocol as the preferred option, but include a daily limit of 6 fish/day and no vessel TAC. The total number of fish would be limited to 1,080 halibut. The NMFS Science Center in Woods Hole has determined that both alternative 1 and 2 represent a reasonable level of mortality. The final option is a no action alternative. This course of action

will fail to meet the current need for data collection and potentially lead to ineffective management of the Atlantic halibut resource.

2.1 Alternative 1 (Preferred Alternative):

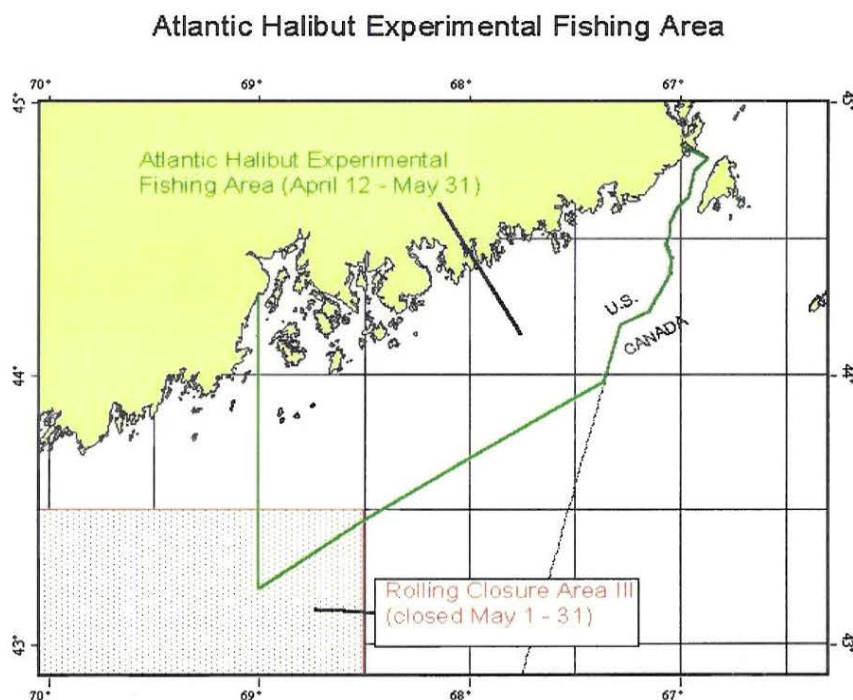
The preferred alternative is an experimental fishery designed to collect data on Atlantic halibut in the Gulf of Maine. The program is designed to compensate the participating fishermen for their data collection efforts by allowing them to sell legal sized halibut.

Scientific protocols:

1. The time period of the proposed experiment is for two months, April 1 through May 31, 2002, 60 days concurrent from the date of permit issuance. The experiment will be reviewed and adjusted annually.
2. The boundaries of the proposed experiment would be the US-Canadian maritime boundary to the north, the 25600 LORAN line to the east, and a line extending 180 degrees true south from 69 degrees West longitude to the west. In the State of Maine territorial waters, halibut fishing will be permitted only east of a line drawn 180 degrees true south from 69 degree West longitude to the EEZ, east to the seaward extension of the EEZ of the US-Canadian maritime boundary. A map of this area is presented in Figure 2.
3. The maximum number of boats participating at any one time in the experiment will be six.
4. Boats engaged in the experiment shall be limited to landing a total allowable catch (TAC) of 50 halibut, under which there will be no possession landing limit. Once the TAC has been reached, each vessel will be restricted to possessing 6 legal size halibut per day.
5. All halibut less than 36" in length must be measured for total length, tagged, returned immediately to the water, and the time, location, tag number, length recorded in the logbook.
6. Halibut must be caught only with hooks no smaller than 14 00 in size and restricted to circle hooks only in design. This type of hook design allows fish to be lip hooked rather than gut hooked. All released fish will therefore be in good shape and have a high survival rate. The selection of the 14 00 size is to reduce the catch of undersized fish.
7. The maximum total number of hooks per boat will be limited to 700. The purpose of this hook limit is to restrict effort and allow the seasonal TAC of 1,080 halibut to last over the entire season.
8. Mandatory logbooks will be maintained by all participants containing data on length of all halibut caught whether retained or released, time and place (latitude and longitude, dd/mm/ss, or appropriate LORAN bearings) of all halibut caught, and identification and measurement on any other species caught as bycatch.
9. Mandatory onboard observers may be required as requested by NMFS and Maine DMR

10. All experimental permit holders must complete a training program in the tagging and release of halibut.
11. All participants in the experimental fishery will be required to preserve the stomachs, gonads, record total length, extract otoliths, and any other biological samples requested for further analyses by Maine DMR and NMFS scientists. Maine DMR and/or NMFS scientific personal will provide training.
12. When participating in the experimental fishery, no species other than halibut may be retained.

Figure 2. Proposed study area for the 2002 Experimental Halibut Fishery



Collection of biological and environmental information:

1. Mandatory logbooks containing data on length of all fish caught whether retained or released, amount of gear set, bait type, time and place of all halibut caught, and identification and length on any other species (including marine mammals) caught as bycatch.
2. All halibut caught less than the 36" legal size must be tagged prior to their release and the time, place, tag number, and length recorded in the logbook.

3. All participants in the experimental fishery will be required to preserve the stomachs, gonads and any other biological samples requested for further analyses by DMR and NMFS scientists.
4. For all retained (kept) fish, measurements of total length, collection of otolith samples, and preservation of gonad tissue and stomach content must be a required condition of participation in the experimental fishery.
5. Training and use of forms provided will be a required condition of participation in the experimental fishery.

Data Handling and Analysis:

All data collected as a result of the experiment will be the property of the Maine DMR and NMFS, with an open exchange between investigators as a condition of the experiment. Following the weekly completion of the field sampling phase of the project (within 24 hours of docking), all logbooks and any other data specified by NMFS will be delivered to Kohl Kanwit or the Science and Research Director, NEFSC.

Maine DMR will make available, on a timely basis, a summary of the field data. This summary will include a summary of the number and positions of Atlantic halibut landed, a summary of the number and positions of Atlantic halibut tagged, a directory of the vessel's personnel, and a general description of the data collected. Maine DMR will also make an annual report to NMFS no later than six months following the close of the fishery. Final results of the experiment, including numbers of Atlantic halibut caught, size composition, distribution, bycatch rates, and environmental descriptions, will be produced as quickly as possible, but must undergo scientific peer review before any results are released to the media, and the general public. It is imperative that credible peer review of the scientific results is conducted and that the final report of the experiment be based upon the most appropriate scientific approaches and methods. Maine DMR will prepare an initial report of the findings. Result of the Department's work will be peer reviewed by appropriate personnel from the Northeast Fisheries Science Center or other appropriate forum. As a condition for participating in this experiment, participating vessels, researchers, and institutions agree that the release of information prior to the completion of the above peer review and publication of the peer review report to any of the entities noted above will not occur.

Survey Operations:

General procedure; each vessel will have 1 captain and at least 1 crewmember aboard.

Vessel Operations:

Vessel trips will commence for the appropriate time period after selections are made and the NMFS Northeast Regional Administrator has issued standard permits. Consultations with appropriate industry members and participating fishermen will occur before vessel operations begin.

Selection of commercial vessels and operating requirements:

Selection of the participating vessels will be a cooperative decision between Maine DMR and industry participants of the 2001 experimental fishery. Four vessels from the 2001 experiment intend to participate in the 2002 experimental fishery. Maine DMR intends to broaden the geographic range of the 2001 experiment to include two additional participants between Stonington and Jonesport. Qualifications for the new vessels will include significant past halibut fishery landings, knowledge of the fishing grounds, and commitment to the full terms and time limit of the experiment. A vessel contract agreement must be signed for all participants. Violation of the terms of the contract will result in the termination of the vessel's experimental permit. Logbooks, onboard observers and the tagging and release of halibut will be required as a condition of participation in the experimental fishery.

Permit Conditions:

1. Boats engaged in the experiment shall be limited to landing a total allowable catch (TAC) of 50 halibut, under which there will be no possession or landing limit. Once the TAC has been reached, each vessel will be restricted to possessing 6 legal size halibut per day
2. All halibut less than 36" in length must be tagged and returned immediately to the water.
3. All experimental permit holders must complete a training program in the tagging and release of halibut.
4. When participating in the EEZ experimental fishery, no species other than halibut may be retained.
5. Onboard observers as requested from NMFS and DMR.

2.2 Alternative 2:

This alternative is the same as the preferred alternative (described above) in all aspects except for the landing limit authorized to the six participating vessels. Under this alternative, each of the six participating vessels would only be authorized to land up to 6 Atlantic halibut per day. There would be no initial TAC allocated to each vessel. This is the same landing limit as authorized under the 2000 experimental halibut fishery. Based on the results of the 2000 experimental fishery, this landing limit is not preferred because it does not encourage the fishermen to travel far from shore, which is necessary to obtain reliable information on the distribution and migration patterns of Atlantic halibut. In addition, some participants in the 2000 experimental fishery expressed their desire to make 2-day trips to more distant fishing grounds, but said it was not economically feasible given the 6-fish/day limit.

2.3 Alternative 3 (No Action):

This alternative would maintain the status quo by not authorizing the exempted experimental fishery. This alternative does not address the issue of the need for scientific data on Atlantic halibut that is essential for the long-term management of this resource.

3.0 Affected Environment:

This section contains information on the various environments impacted by the proposed action, alternative 2 and the no action alternative. It contains information on the biological, social and economical factors influencing these management measures.

3.1 Biological Environment:

The proposed experimental fishery would be conducted in the Gulf of Maine/Georges Bank Regulated Mesh Area (GOM/GB RMA). This region consists of the Federal waters extending from the Maine, New Hampshire, and Massachusetts shorelines, out to the Exclusive Economic Zone (EEZ), and encompasses the two regions known as Georges Bank and the Gulf of Maine. The specific region of the GB/GOM RMA that would be affected by this action is located in the northernmost portion of the Gulf of Maine, as shown in Figure 2.

The Atlantic halibut resource is the biological resource that would be affected by this action. Very little information is available on life history, stock structure, and migratory habits of Atlantic halibut in the Gulf of Maine due to the collapse of this resource in the 1940s. During the height of the halibut fishery in the 19th century, the average size of females was 100-150 lb. and males rarely exceeded 50 lb.. The average size of halibut caught in the 2000 experimental fishery was 43 lbs dressed weight (no head or viscera) and 38 lbs. whole weight. Studies in Canadian waters report that Atlantic halibut are demersal, living on or near the bottom at temperatures within a few degrees of 5°C. Halibut are most abundant at depths of 200-500 m., but have been caught within a depth range of less than 100-700 m. (Bowering 1986). Atlantic halibut spawn from February to April but spawning areas are not well known. Halibut are broadcast spawners that mature first as 4 year olds for males and 6 year olds for females. The age at 50% maturity is estimated at age 8 for males and age 12 for females. Spawning in the western Atlantic is believed to occur on the slopes of the continental shelf and on the offshore banks, at depths of at least 183 m., over rough or rocky bottom.

The stock structure of Atlantic halibut in U.S. waters is not known. Two Canadian stocks are thought to exist (Neilson et al. 1987): a comparatively small one in the Gulf of St. Lawrence and a larger stock encompassing the Scotian Shelf and the southern Grand Banks of Newfoundland. Juveniles start to emigrate from nursery areas when the fish are 3-4 years old (Haug and Sundby 1987) and undergo a period of active movement. Recaptures in most tagging studies have been made in the vicinity of tagging; however, some long distance migrations have been documented from Labrador to the western coast of Greenland (Godo and Haug 1988), the Gulf of St. Lawrence to Iceland (McCracken and Martin 1955), the Scotian Shelf to the Grand Bank (Jensen and Wise 1961), and the western coast of Greenland to the Grand Bank (Godo and Haug 1988).

Results of the NMFS Northeast Fisheries Science Center bottom trawl survey, 1963-1997, provide information on the distribution of halibut in the Gulf of Maine. Halibut were caught in low numbers from the Gulf of Maine, with one individual caught as far south as Nantucket Shoals. The highest concentrations were found in Canadian waters, on Browns Bank and off southwestern Nova Scotia. In U.S. waters, lower concentrations were found on the northern slope of Georges Bank, Stellwagen Bank and off the coast of Maine.

3.2 Social Environment:

There is currently no directed fishery for Atlantic halibut in Federal waters. Landings are comprised mostly of bycatch from bottom trawlers prosecuting groundfish. Unfortunately many halibut are thrown into the "mixed flats" category for market and are never separated from other flat fish species. Additionally, since the landing limit is one fish per trip from Federal waters, many halibut are sold directly to restaurants or kept for personal consumption.

In Maine territorial waters a remnant halibut fishery has persisted. Many lobstermen traditionally set out tub trawls or snap gear in the spring to catch Atlantic halibut. In 2000, the state put forward regulations to establish a size limit on halibut that matched the Federal rule of 36 inches. In 2002, the state proposed regulations to limit the take of halibut in state waters to 50 fish per season per vessel. A season was also implemented, April-June for the western half of the state and May-July for the eastern half of the state. To prosecute halibut in state waters fishermen must obtain an endorsement and complete a training session on how to keep logbooks and tag undersized fish.

Information on the total halibut landed in New England, by state, is presented in Table 1. This information shows, that halibut landings have declined steadily since 1950, with landings in recent years averaging approximately 11 mt annually. The information presented Table 2 shows that landings in the state of Maine have historically comprised most of the halibut catch in New England. However, since the implementation of Amendment 9 in November 1999, Maine halibut landings have comprised only 25 percent of total halibut landings for New England. However, landings occurring in Maine state waters have historically been not well reported since many fishermen sell directly to restaurants. In addition, there is currently no reporting requirement for halibut fishermen in Maine.

Table 1. Historic reported landings in metric tons (2205 lbs.).

Atlantic halibut landings for New England

Year	Connecticut	Maine	Massachusetts	New Hampshire	Rhode Island	Grand Total
1950		39.1	203.6		0	242.7
1951		51.7	144.3			196
1952		40.4	139.1		0	179.5
1953		35.6	123			158.6
1954		47.8	153.8		0.2	201.8
1955		69.8	86			155.8
1956		48.7	89.8		0	138.5
1957		56.4	94.3			150.7

Table 1. Continued

1958		61.8	70.5			132.3
1959		44.2	91.4		0	135.6
1960		40.8	81.6			122.4
1961		31.3	97.1	1.1		129.5
1962		41.8	72.3	1.1		115.2
1963		41.9	80.7	1		123.6
1964		34.8	103.6	1.1		139.5
1965		42	105.2	1.3	0.1	148.6
1966		46.3	91.8	1.6	0.2	139.9
1967		45.3	86.6	1	0.2	133.1
1968		29.3	84.2	0.2	0.1	113.8
1969		23.8	71.8	0.2	0.6	96.4
1970		23.5	65.2	0.2	1	89.9
1971		34.9	75.6	0.4	0.4	111.3
1972		33.8	66.1	0.5	0.7	101.1
1973		27.4	59.4	0.7	0.1	87.6
1974		21.4	56.7	0.7	0	78.8
1975		20.6	55.4	1	0.3	77.3
1976		22	40.4	0.2	0.5	63.1
1977		21.1	34.6	1.4	0.6	57.7
1978		33.8	55.1	3.9	0.8	93.6
1979		40.1	49	2.9	0.8	92.8
1980	0	32.2	47.9	1.5	0.8	82.4
1981		28.1	52.2	0.8	0.6	81.7
1982		39.9	50.6	1.2	0.9	92.6
1983		40.2	32.7	2.4	0.8	76.1
1984		55.6	18.9	1	0.9	76.4
1985		42.6	46.1	0.3	1.4	90.4
1986		37.6	6.6	0.3	1.2	45.7
1987		24.9	5.7	0.4	0.3	31.3
1988		56.7	17	4.4	0.5	78.6
1989		18.1	2.6	0.4	0.1	21.2
1990	0.2	9.3	5.6	0.4	0.8	16.3
1991		19.7	9.9	0.5	2	32.1
1992		15.9	4.7	0.4	1.7	22.7
1993		13.7	4.7	0.2	0.6	19.2
1994		13.4	3.5	0.1	4.7	21.7
1995		5.2	4.9	0.4	0.1	10.6
1996		8.2	4.5	0.4	0.1	13.2
1997		10.3	2.5	1.1	0.1	14
1998	0	3.5	4	0.7	0.1	8.3
1999		5.3	4.8	1.1	0.2	11.4
2000		2.8	3	4.3	1	11.1
Grand Total	0.2	1634.6	2960.6	42.8	25.5	4663.7

Table 2. Percent of Total Halibut Landings in New England Landed in Maine

Year	Maine	% of Total	Total Landings
1990	9.3	57.1	16.3
1991	19.7	61.4	32.1
1992	15.9	70.0	22.7
1993	13.7	71.4	19.2
1994	13.4	61.8	21.7
1995	5.2	49.1	10.6
1996	8.2	62.1	13.2
1997	10.3	73.6	14
1998	3.5	42.2	8.3
1999	5.3	46.5	11.4
2000	2.8	25.2	11.1

3.3 Economic Environment:

As of February 15, 2001, there were a total of 3,394 federally permitted vessels authorized to land 1 Atlantic halibut per trip. Of these vessels, 1,599 held limited access multispecies permits and 1,795 held open access handgear (Category H) and/or open access multispecies (Category K) permits. A total of 274 of the limited access vessels were from Maine, while 307 of the open access permit holders were from Maine.

The value of the halibut fishery is difficult to measure since most fish are sold directly to restaurants and are never recorded on dealer logs or harvest reports. In addition, fishermen in Maine state waters were not required to report halibut landings until 2002 and dealers are still not required to report purchases. An estimated 50-75 fishermen pursue Atlantic halibut in state waters on an annual basis. Anecdotally, at least half of these individuals are fishing for personal consumption. Last year an informal survey of state waters fishermen indicated that around 1,000 Atlantic halibut were caught within the 3-mile limit. Fishermen who sold their catch reported a \$5-7 range per pound. Therefore, assuming about 1,500 lbs were for personal consumption and about 28,000 lbs were sold, the 2001 halibut catch represents a worth of \$168,000. It is important to remember that these numbers are based on an informal survey and do not account for the actual catch. A summary of the historic value of halibut landed in New England by state is presented in Table 3.

Table 3. Historic reported values in dollars.

Year	Connecticut	Maine	Massachusetts	New Hampshire	Rhode Island	Grand Total
1950		20470	91634		32	112136
1951		26784	71744			98528
1952		24913	78506			103454
1953		23937	67725			91662
1954		29077	77081		117	106275
1955		36862	43039			79901

Table 3. Continued

1956	29221	44924		27	74172
1957	28507	46182			74689
1958	35034	37154			72188
1959	24591	50020		14	74625
1960	24029	46410			70439
1961	21221	58051	875		80147
1962	30329	47751	1125		79205
1963	31034	57383	805		89222
1964	24922	72594	1000		98516
1965	31662	82251	1400	58	115371
1966	37351	79568	1400	187	118506
1967	39986	83172	880	90	124128
1968	26043	88696	225	108	115072
1969	21450	86791	240	601	109082
1970	25004	93369	375	1039	119787
1971	36721	121232	640	317	158910
1972	51175	132188	2310	805	186478
1973	54084	133509	1500	82	189175
1974	53626	141719	1600	40	196985
1975	47911	156273	2368	515	207067
1976	60006	112352	424	1047	173829
1977	67564	96718	4615	1190	170087
1978	106879	171518	12399	1382	292178
1979	145954	156067	13280	1505	316806
1980	26110606	141741	4646	1161	258180
1981	96960	153884	2512	1444	254800
1982	142228	150138	5468	2170	300004
1983	168179	109852	11678	2332	292041
1984	234277	62836	4343	3017	304473
1985	194616	174073	1244	4993	374926
1986	194168	28601	1537	3985	228291
1987	156844	31469	2314	955	191582
1988	278325	28257	24611	1981	333174
1989	104918	11877	1293	745	118833
1990	325 49830	23052	1154	2419	76780
1991	111013	43176	1789	6204	162182
1992	85160	23641	2484	3494	114779
1993	97825	17669	1331	2858	119683
1994	104042	18140	674	4151	127007
1995	43172	27717	2969	404	74262

Table 3. Continued						
1996	65452	24931	2846	505	93734	
1997	78806	14144	6112	379	99441	
1998	80 26867	21385	3361	489	52182	
1999	49143	23957	4532	1035	78667	
2000	24723	19190	14867	2412	61192	
Grand	363350					
Total	431	1	3775351	149258	56292	7614833

4.0 Environmental Consequences:

4.1 Biological Impacts of Alternatives:

4.1.1 Alternative 1 (Preferred Alternative):

Alternative 1 (preferred option) allows for the take of 1,080 Atlantic halibut. This represents about 54,000 lbs. if the seasonal limit is reached (assuming a 50 lb. mean weight) or approximately twice the reported annual landings for New England. However, during the past 2 seasons of the experimental fishery, the number of halibut taken has not exceeded approximately 11,700 lbs. (2000 catch of 234 individuals), which is less than half of the reported landings for Atlantic halibut caught in US waters in 2000. Thus, there is no indication that the 2002 season will result in higher landings than previously recorded in the experimental fishery. Furthermore, the amount of Atlantic halibut landed in Maine in 2000 was approximately 2.5 mt less than in 1999 when no experimental fishery was in effect. Therefore, the impact of the proposed 2002 experimental halibut fishery on the Atlantic halibut resources is expected to be minimal.

The amount of halibut landed during the 2001 experimental fishery is approximately 35-percent less than the amount of halibut landed during the 2000 experimental fishery. Because this information represents only two data points, it cannot be stated with any certainty that catch rates are declining, indicating a significant impact on the resource resulting from the experimental fishery. However, this information supports the need to collect additional information on the Atlantic halibut resource. As a means of minimizing any potential biological impacts, the Center intends to closely monitor the catch rates of vessels participating in this experimental fishery. If the Center determines that catch rates are declining, indicating a significant impact to the resource, NMFS would have the authority to terminate the experimental fishery. Furthermore, all sub-legal halibut are to be tagged and released with a method that has shown high rates of survival.

The proposed action would authorize up to six vessels to fish for Atlantic halibut using a maximum of 700 hooks per vessel. This would add up to 4,200 additional hooks to the water that would otherwise not be fished. Despite this increase in effort, the results of the 2000 and 2001 experimental fisheries demonstrate that bycatch of non-target species in this experimental fishery is minimal. This is likely due to the minimum hook size of 14/0 required for all experimental fishery participants. A total of 494 individual fish of non-target species were taken during the 2000 experimental fishery with the greatest take being dogfish (447 individuals). Of

the 447 dogfish captured during the 2000 experimental fishery, 400 were caught in a single day by one vessel. Catfish, cusk, skate and cod made up the remaining bycatch of 47 individual fish. During the 2001 experimental fishery, a total of 214 individual fish of non-target species were taken.; 156 dogfish, 35 skate, 13 cusk, 3 sculpin, and 1 each of cod, hagfish, ocean catfish, crab, lobster, scallop, and wolffish.

4.1.2 Alternative 2:

As stated in Section 2.2, Alternative 2 is similar to the preferred alternative in all aspects except the possession limit authorized for the participating vessels. Because the possession limit of 6 fish per vessel per day is more restrictive than allowing an initial TAC of 50 fish per vessel, it is possible that fewer Atlantic halibut would be harvested during the experimental fishery under this alternative. As a result, the impacts to the Atlantic halibut resource resulting from this alternative may be slightly less than under the preferred alternative.

Because participating vessels will be fishing in generally the same manner as under the preferred alternative, the expected bycatch of non-target species under this alternative is expected to be similar to that under the preferred alternative, which is minimal.

4.1.3 Alternative 3 (No action):

The no action alternative does not allow for data collection on Atlantic halibut and is therefore indirectly detrimental to the resource. Otherwise, no biological impacts are expected to result from this alternative beyond what was analyzed in Section (7.1.1.1.3) of the Environmental Assessment for Amendment 9 to the Multispecies FMP, and other actions involving the multispecies fishery of the northeastern United States.

This alternative would not result in any additional bycatch of non-target species since no additional fishing effort would be authorized under an experimental fishery.

4.2 Social Impacts of Alternatives:

4.2.1 Alternative 1 (Preferred Alternative):

As stated in Section 3.2, there continues to be a small directed Atlantic halibut fishery within the territorial waters of Maine. The information being obtained from the proposed experimental fishery can be used in the long-term sustainable management of the Atlantic halibut resource. Therefore, there may be some social benefit to the preferred alternative since the collection of biological and environmental information on this fishery resource could lead to the establishment of a sustainable, but perhaps limited, Atlantic halibut fishery in the eastern Gulf of Maine.

4.2.2 Alternative 2:

The possession limit that is proposed under Alternative 2 would not encourage the participating fishermen to travel far from their respective ports. This lack of incentive would limit the scope of the experimental fishery, and the value of the biological and ecological

information obtained on the Atlantic halibut resource. The less valuable the information, the less likely the information can be utilized in the long-term sustainable management of Atlantic halibut, impacting the ability of traditional halibut fishermen from Maine to target this resource in the future.

4.2.3 Alternative 3 (No action):

The “no action” alternative is not expected to result in any social impacts beyond what was analyzed in Section (7.3.2) of the Environmental Assessment for Amendment 9 to the Multispecies FMP, and other actions involving the multispecies fishery of the northeastern United States. However, there could be a negative social impact similar to the impact described in Section 4.2.2.

4.3 Economic Impacts:

4.3.1 Alternative 1 (Preferred Alternative):

At an average price of approximately \$4 per pound based on 1999 and 2000 landings and value data for the state of Maine, or \$5-7 per pound based on anecdotal information, the Atlantic halibut resource is a relatively valuable fishery for the few traditional fishermen that target this resource in Maine waters. The proposed experimental fishery would enable those fishermen from Maine that have an interest in the resource to participate in the collection of biological information that can be used in the long-term sustainable management of the Atlantic halibut fishery.

The proposed experimental fishery would authorize up to 6 vessels to be temporarily exempt from the established possession limit of 1 halibut per vessel per day. These vessels would benefit economically from the sale of these fish, but the intent is to offset the costs to the vessel of participating in the experiment, whose goal is to collect biological information on Atlantic halibut.

4.3.2 Alternative 2:

As stated in Section 4.2.2, a possession limit of 6 fish per vessel per day would not encourage participants in the experimental fishery to fish far from their respective ports. As a result, the biological data collected would be misrepresentative, and therefore not provide a reliable depiction of the distribution, migration patterns, and other biological reference points for the Atlantic halibut resource in the eastern Gulf of Maine. If the data collected is unreliable, then it can not be used to appropriately manage the Atlantic halibut resource, thus impacting the ability of traditional halibut fishermen from Maine to prosecute this fishery in the future.

4.3.3 Alternative 3 (No action):

The “no action” alternative could result in a negative economic impact since this alternative is not enabling the collection of valuable information that would lead to the long-term sustainable management of the Atlantic halibut resource.

4.4 Cumulative Impacts:

The cumulative impacts of this action and the non-preferred alternatives are difficult to determine due to the significant lack of information on the Atlantic halibut resource. Federal regulations currently restrict the commercial and recreational harvest of Atlantic halibut to 1 halibut per vessel per trip, and there are no additional Federal measures planned in the foreseeable future. However, the State of Maine recently (March 2002) approved measures to establish a fishing season for Atlantic halibut in state waters; April through June for the western half of the state and May through July for the eastern half of the state. The State also approved measures establishing a recreational harvest limit of one fish per vessel per day; a commercial harvest limit of 4 fish per vessel per day; a total allowable catch of 50 fish per season for both recreational and commercial vessels; gear requirements of 14 00 or greater circle hooks and no more than 450 hooks per vessel; and licensing, tagging, and reporting requirements. In 2000, Maine passed measures establishing a minimum size requirement of 36 inches to be consistent with Federal regulations. The restrictions on the proposed experimental fishing activity are similar to the regulations recently implemented in Maine. The major difference is that the possession limit and the amount of hooks authorized per vessel are slightly higher for the experimental fishery.

The proposed action would constitute the third year of an experimental Atlantic halibut fishery. As a result, there may be some adverse cumulative biological impact on the Atlantic halibut resource resulting from the proposed action. However, due to increased restrictions on halibut fishing in Maine waters, fishing effort on the halibut resource as a whole may likely decrease, thus reducing any cumulative biological impacts resulting from the proposed action. Thus, any cumulative biological impacts are expected to be minimal.

The information to be gathered from the proposed action is considered to be essential in the long-term sustainable management of this fishery resource. Thus, substantial long-term cumulative benefits (biological, social, and economic) could be realized from authorizing this experimental fishery for a third consecutive year.

4.4 Essential Fish Habitat (EFH) Assessment:

The area affected by this action has been identified as EFH for species managed by the Northeast Multispecies; Monkfish; Summer Flounder, Scup, and Black Sea Bass; Spiny Dogfish; Atlantic Mackerel, Squid, and Butterfish; Atlantic Herring; Atlantic Billfish; and Atlantic Tunas, Swordfish and Sharks Fishery Management Plans. The gear type being used to conduct this experimental fishery, longline gear, is not associated with adverse impacts to benthic habitat. Therefore, the proposed action in the context of the fishery as a whole is not expected to have an adverse impact on EFH.

4.6 Impacts to Marine Mammals, Endangered and Threatened Species, and Other Protected Resources:

The effects of the proposed action on protected marine mammals and sea turtles has been previously considered through informal section 7 consultations. Those consultations concluded that the experimental Atlantic halibut fishery was not expected to result in the addition of adverse impacts to protected species that had not been considered during consultation on the Multispecies FMP. Most ESA-listed species under NMFS jurisdiction are not expected to either occur in the study area or interact with the gear type used in experimental Atlantic halibut fishery. Of the ESA-listed cetaceans common to the western Atlantic, only sperm whales are known to interact with longline gear. However, sperm whales generally occur in waters greater than 180 meters in depth. Similarly, leatherback turtles may occur within the study area but are predominantly a pelagic species and feed on jellyfish (i.e., *Stomolophus*, *Chrysaora*, and *Aurelia*, and tunicates (salps, pyrosomas). In addition, the proposed experimental fishing activities would be conducted in Federal waters, beyond where concentrations of ESA-listed Atlantic salmon are most likely to be found. Therefore, it is highly unlikely that the proposed action will affect Atlantic salmon.

A formal section 7 consultation under the Endangered Species Act (ESA) was reinitiated for the Multispecies Fishery Management Plan (FMP) on May 4, 2000, and concluded on June 14, 2001. The conclusion of that consultation found jeopardy for right whales, but a Reasonable and Prudent Alternative (RPA) was provided to avoid jeopardy. This RPA is being implemented under the Atlantic Large Whale Take Reduction Plan with new gear modifications, Dynamic Area Management, and Seasonal Area Management, among other actions. This consultation also provided a new Incidental Take Statement for sea turtles consisting of 1 loggerhead (lethal or non-lethal take), and 1 green, leatherback or Kemp's ridley sea turtle annually (lethal or non-lethal take).

Based on the information provided, a recent section 7 consultation on the proposed action concluded that the action is not expected to result in additional adverse impacts that would change the basis for the determinations in previous consultations on the Multispecies FMP.

5.0 List of Preparers:

This document was prepared through the cooperative efforts of members of the staffs of Maine DMR and NMFS. Contributors include:

- J. Kohl Kanwit, Maine DMR, Marine Resources Scientist
- Allison Ferreira, NMFS, Policy Analyst

6.0 List of Agencies and Persons Consulted:

The Northeast Fisheries Science Center of NMFS was consulted in preparing this EA.

7.0 Finding of No Significant Impact (FONSI):

National Oceanic and Atmospheric Administration Order (NAO) 216-6 (revised May 20, 1999) provides nine criteria for determining the significance of the impacts of a proposed action. These criteria are discussed below:

1. *Can the proposed action be reasonably expected to jeopardize the sustainability of any target species that may be affected by the action?*

The proposed action is not expected to jeopardize the sustainability of any target species that may be affected by the action because the experimental fishery is of limited scope (only involving 6 vessels) and duration (lasting only 2 months). Although the Atlantic halibut resource is considered to be overfished, the biological information to be collected from this experimental fishery is essential for the long-term sustainable management of this fishery resource.

2. *Can the proposed action be reasonably expected to allow substantial damage to the ocean and coastal habitats and/or EFH as defined under the Magnuson-Stevens Act and identified in FMPs?*

The proposed action is not expected to allow substantial damage to the ocean and coastal habitats and/or EFH as defined under the Magnuson-Stevens Act and identified in the FMP. The area affected by this action has been identified as EFH for species managed by the Northeast Multispecies; Monkfish; Summer Flounder, Scup, and Black Sea Bass; Spiny Dogfish; Atlantic Mackerel, Squid, and Butterfish; Atlantic Herring; Atlantic Billfish; and Atlantic Tunas, Swordfish and Sharks Fishery Management Plans. This experimental fishery will be using longline and tub trawl gear exclusively. This gear type is not associated with adverse impacts to benthic habitat. Therefore, this experimental fishery is not expected to have an adverse impact on EFH.

3. *Can the proposed action be reasonably expected to have a substantial adverse impact on public health or safety?*

The proposed action is not expected to have a substantial adverse impact on public health or safety. The proposed experimental fishery is of limited scope and duration and involves only the collection of biological information on Atlantic halibut to be used in the long term management of this fishery resource.

4. *Can the proposed action be reasonably expected to have an adverse impact on endangered or threatened species, marine mammals, or critical habitat of these species?*

The proposed action can be reasonably expected to not have an adverse impact on endangered or threatened species, marine mammals, or critical habitat for these species. As stated in Section 4.6 of the EA, the activities to be conducted under the experimental fishery are within the scope of the Multispecies FMP and do not change the basis for the determinations made in previous consultations.

5. *Can the proposed action be reasonably expected to result in cumulative adverse effects that could have a substantial effect on the target species or non-target species?*

The proposed action is not expected to result in cumulative adverse effects that could have a substantial effect on target or non-target species. As stated in Section 4.1, bycatch of non-target species in this experimental fishery is expected to be minimal. However as discussed in Section 4.4, there may be some cumulative impacts on Atlantic halibut, the target species, but these impacts are not expected to be substantial.

6. *Can the proposed action be reasonably expected to jeopardize the sustainability of any non-target species?*

The proposed action is not expected to jeopardize the sustainability of any non-target species. As discussed in Section 4.0, the bycatch of non-target species in this experimental fishery is expected to be minimal, based on the results of the 2000 and 2001 experimental fisheries. Furthermore, this experimental fishery is targeting Atlantic halibut with highly selective fishing gear.

7. *Can the proposed action be expected to have a substantial impact on biodiversity and ecosystem function within the affected area (e.g., benthic productivity, predator-prey relationships, etc.)?*

The proposed action is not expected to have a substantial impact on biodiversity and ecosystem function within the affected area because the experimental fishery is targeting Atlantic halibut with highly selective fishing gear, thus minimizing bycatch of non-target species, and because the experiment is of limited scope and duration.

8. *Are significant social or economic impacts interrelated with significant natural or physical environmental effects?*

As discussed in Section 4.3 of this EA, the proposed action is not expected to result in significant social or economic impacts, or significant natural or physical environmental effects. Therefore, there are no significant social or economic impacts interrelated with significant natural or physical environmental impacts.

9. *To what degree are the effects on the quality of the human environment expected to be highly controversial?*

The measures contained in this action are not expected to be highly controversial. This experimental fishery proposes to collect much needed biological information on an overfished species to be used in the long-term sustainable management of this fishery resource. However, in light of recent a Federal court decision involving the multispecies fishery (Conservation Law Foundation et al. v. Evans), this action may be somewhat controversial since it temporarily increases effort on a groundfish stock that is considered to be overfished.

FONSI Statement:

In view of the analysis presented in this document and in the EIS for the FMP, the proposed experimental fishery to collect biological and ecological information on Atlantic halibut will not significantly affect the quality of the human environment, with specific reference to the criteria contained in Section 6.02 of NOAA Administrative Order NAO 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act (NEPA). Accordingly, the preparation of a Supplemental Environmental Impact Statement for the proposed action is not necessary.

Assistant Administrator for
Fisheries, NOAA

Date

8.0 References:

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APPENDIX 3

**Supplement to the Environmental Assessment
Prepared for the 2002 Experimental Halibut Fishery
in Groundfish Closed Areas in the Eastern Gulf of Maine**

Prepared by the Maine Department of Marine Resources

December 2002

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1.0 Introduction:

On November 1, 2002, the Maine Department of Marine Resources submitted an application requesting Exempted Fishing Permits (EFPs) for 6 fishermen, authorizing them to fish for Atlantic halibut in the Eastern Gulf of Maine. This experimental fishery is a continuation of the permit issued in 2000 and 2001.

An Environmental Assessment (EA) was prepared for the 2002 experimental fishery that analyzed the impacts of the halibut longline fishery on the human environment. This EA concluded that the activities conducted under the EFP are consistent with the goals and objectives of the Multispecies Fishery Management Plan (FMP), and will have no negative environmental impacts. The EA also considered the impacts of the EFP activities on Essential Fish Habitat (EFH), marine mammals, and protected species and found that the experimental halibut fishery will have no significant impact to EFH, marine mammals, or protected species. Because an EA was prepared for the previous experimental fishery and for the reasons listed below, an EA has not been prepared for the 2003 experimental fishery. Instead, the results of the 2002 experimental fishery and the cumulative impacts of the proposed 2003 experimental fishery are being addressed through a supplement to the EA.

Rational for not preparing a full EA for the 2003 experimental Atlantic halibut fishery:

- There are no significant changes in experimental design from the previous two experiments;
- This experiment is limited in scope;
- The results of the 2000, 2001 and 2002 experimental fisheries indicate that the proposed experiment will have no adverse impacts to the environment.

2.0 Purpose and Need:

The purpose of the 2003 experimental Atlantic halibut fishery is to continue to contribute to the protection and rebuilding of Atlantic halibut stocks by collecting and analyzing basic biological and ecological data. The goal of this experimental fishery is to expand the current data set for the purposes of assessment and analysis. The information obtained from the 2003 experimental fishery, as well as the previous experimental fisheries, will provide information to the National Marine Fisheries Service (NMFS) and the New England Fishery Management Council (Council) so that they can evaluate the status of the Atlantic halibut population in US waters.

3.0 Results of the 2002 Experimental Fishery:

The following paragraphs summarize the results of the 2002 experimental Atlantic halibut fishery (refer to complete EA for results from the 2000 and 2001 fisheries).

The Maine Department of Marine Resources (DMR), in conjunction with the National Marine Fisheries Service (NMFS) and Maine Sea Grant, administered the third year of the Gulf of Maine Experimental Halibut Fishery from April 1-May 31, 2002. This fishery was conducted under the auspices of a federally issued exempted fishery permit in an area defined by the US/Canadian

maritime boundary to the north, the 25600 LORAN line to the east and a line extending 180 degrees true south from 69 degrees west. In 2002, there were 6 participating vessels permitted to fish for halibut in federal waters with longline gear and sell their catch while complying with biological sampling protocols and tagging. During the 61 days of this fishery 234 halibut were kept and 235 were tagged and released for a total of 469 fish caught. It is important to note that during the 2002 season NMFS limited the experimental fishery to a total take of 234 halibut.

Six fishermen were issued a federal experimental fishery permit for the period between April 1 and May 31, 2002. The permit allowed them to fish for Atlantic halibut in federal waters with longline gear, limited to 700, size 14 oo circle hooks per vessel. Mandatory logbooks were maintained by each participant and included information on the date, location, number of sets, depth of sets, hooks per set, and bycatch. Data recorded for all halibut caught included: set number, fish length, weight, samples taken (otolith and gonad), and tag number if the fish was released.

In 2002, the 6 permitted vessels fished 127 days collectively. The days fished by vessel ranged from 15 to 31, during which a total of 838 sets were made, with a minimum of 70 and a maximum of 216. The number of hooks used by vessel also varied considerably from 3,260 to 18,100 with a total of 61,040 fished over the course of the experiment. Gear was set in a wide range of depths, averaging 58 fathoms in April and 67 fathoms in May. Two hundred thirty four halibut were caught with 63% of the fish landed during the month of May. Thirty of the halibut kept were sold to the University of Maine for use as brood stock at their aquaculture facility in Franklin, ME. Two hundred thirty five halibut were tagged and released, an 80% increase from the 2001 fishery. Ten tagged halibut were recaptured in 2002, seven from the 2000 season, two from the 2001 season and one from the 2002 season.

Biological data and samples were collected for every halibut caught during the experimental fishery. Undersized halibut were measured, tagged and released as quickly as possible. Legal size halibut (>36 inches) were measured, weighed and sampled for otoliths and gonads.

The average length of kept halibut was 46 in. while the average length for released fish was 31 in.. The maximum length for the season was 75 in. and the minimum length was 23 in.. Dressed weights were taken for the halibut sold commercially and ranged from 105 lbs. to 15 lbs., averaging 38 lbs.. The fish sold live to the University were weighed whole and ranged from 88 lbs. to 29 lbs., averaging 52 lbs.. Released halibut were not weighed in an effort to limit stress on the fish.

Otoliths and gonads were sampled for every kept fish with the exception of those sold live to the University of Maine. One hundred eighty six gonad samples were collected and 152 were processed at the DMR lab for sex and maturity. Of the 152 halibut gonad samples, 109 were female and 43 were male. The maturity stages were determined using the Pacific Halibut Commission's guidelines. The male gonads were comprised of 36 immature and seven mature samples for a total of 43. The remaining samples (109) were female with 75 immature, 27 developing, one ripe and six resting.

Ten tagged halibut were recaptured during 2002. Four of the returned tags came from Canadian waters: three off Cape Sable, Nova Scotia and one off Port Au Basque, Newfoundland.

DMR personnel observed seven halibut trips, with at least one trip on each of the participating vessels. There were no organisms noted as bycatch on the observed trips. There were no marine mammal or seabird interactions observed during the experimental halibut fishery. NMFS was unable to provide any observer coverage for this experimental fishery.

4.0 Changes to 2003 Experimental Fishery:

The only requested change from the previous Atlantic halibut experimental fishery is an increase in the quota. The 2002 experimental fishery was limited to a total take of 234 fish, based on the catch in 2000. However, in 2000 there were only 3 participants instead of the 6 fishermen permitted in 2001 and 2002. Given the current assessed status of the Atlantic halibut stock DMR understands the need for a conservative quota, but feels that the 234 fish limit is far too restrictive and negatively impacts the achievement of the project's stated goals. We recommend that the total allowable catch be set at 500 fish, with each vessel limited to 50 fish after which they can only land 4 fish per day (complementary to state regulations).

5.0 Cumulative Impacts:

The experimental Atlantic halibut fishery is a limited experiment since halibut only come inshore in early spring and the fishery is not intended to interact with the NMFS rolling closures. The results of the previous experimental fisheries indicate that there is no significant bycatch, adverse impacts on EFH or interactions with marine mammals. Therefore, no cumulative impacts to other species of groundfish, EFH or marine mammals are expected to result from authorizing the Atlantic halibut fishery in 2003.

6.0 Finding of No Significant Environmental Impact:

National Oceanic and Atmospheric Administration Order (NAO) 216-6 (revised May 20, 1999) provides nine criteria for determining the significance of the impacts of a proposed action. These criteria are discussed below:

1. *Can the proposed action be reasonably expected to jeopardize the sustainability of any target species that may be affected by the action?*

The proposed action is not expected to jeopardize the sustainability of any target species that may be affected by the action because the experimental fishery is of limited scope (only involving 6 vessels) and duration (lasting only 2 months). Although the Atlantic halibut resource is considered to be overfished, the biological information to be collected from this experimental fishery is essential for the long-term sustainable management of this fishery resource.

2. *Can the proposed action be reasonably expected to allow substantial damage to the ocean and coastal habitats and/or EFH as defined under the Magnuson-Stevens Act and identified in FMPs?*

The proposed action is not expected to allow substantial damage to the ocean and coastal habitats and/or EFH as defined under the Magnuson-Stevens Act and identified in the FMP. The area affected by this action has been identified as EFH for species managed by the Northeast Multispecies; Monkfish; Summer Flounder, Scup, and Black Sea Bass; Spiny Dogfish; Atlantic Mackerel, Squid, and Butterfish; Atlantic Herring; Atlantic Billfish; and Atlantic Tunas, Swordfish and Sharks Fishery Management Plans. This experimental fishery will be using longline and tub trawl gear exclusively. This gear type is not associated with adverse impacts to benthic habitat. Therefore, this experimental fishery is not expected to have an adverse impact on EFH.

3. Can the proposed action be reasonably expected to have a substantial adverse impact on public health or safety?

The proposed action is not expected to have a substantial adverse impact on public health or safety. The proposed experimental fishery is of limited scope and duration and involves only the collection of biological information on Atlantic halibut to be used in the long-term management of this fishery resource.

4. Can the proposed action be reasonably expected to have an adverse impact on endangered or threatened species, marine mammals, or critical habitat of these species?

The proposed action can be reasonably expected to not have an adverse impact on endangered or threatened species, marine mammals, or critical habitat for these species. As stated in Section 4.6 of the complete EA, the activities to be conducted under the experimental fishery are within the scope of the Multispecies FMP and do not change the basis for the determinations made in previous consultations.

5. Can the proposed action be reasonably expected to result in cumulative adverse effects that could have a substantial effect on the target species or non-target species?

The proposed action is not expected to result in cumulative adverse effects that could have a substantial effect on target or non-target species. Bycatch of non-target species in this experimental fishery is expected to be minimal based on results from the 2000-2002 experimental fisheries.

6. Can the proposed action be reasonably expected to jeopardize the sustainability of any non-target species?

The proposed action is not expected to jeopardize the sustainability of any non-target species. This experimental fishery is targeting Atlantic halibut with highly selective fishing gear including large circle hooks.

7. Can the proposed action be expected to have a substantial impact on biodiversity and ecosystem function within the affected area (e.g., benthic productivity, predator-prey relationships, etc.)?

The proposed action is not expected to have a substantial impact on biodiversity and ecosystem function within the affected area because the experimental fishery is targeting Atlantic halibut with highly selective fishing gear, thus minimizing bycatch of non-target species, and the experiment is of limited scope and duration.

8. Are significant social or economic impacts interrelated with significant natural or physical environmental effects?

As discussed in Section 4.3 of the EA, the proposed action is not expected to result in significant social or economic impacts, or significant natural or physical environmental effects. Therefore, there are no significant social or economic impacts interrelated with significant natural or physical environmental impacts.

9. To what degree are the effects on the quality of the human environment expected to be highly controversial?

The measures contained in this action are not expected to be highly controversial. This experimental fishery proposes to collect much needed biological information on an overfished species to be used in the long-term sustainable management of this fishery resource.

FONSI Statement:

In view of the analysis presented in this document, the complete EA and in the EIS for the FMP, the proposed experimental fishery to collect biological and ecological information on Atlantic halibut will not significantly affect the quality of the human environment, with specific reference to the criteria contained in Section 6.02 of NOAA Administrative Order NAO 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act (NEPA). Accordingly, the preparation of a Supplemental Environmental Impact Statement for the proposed action is not necessary.

Job #2

Scott Feindel, Glenn Nutting, Dan Schick

Job Title: Sea Scallop Monitoring and Assessment

Objective:

Monitor the status of the Maine sea scallop fishery, conduct a fishery independent survey of the resource, map scallop beds, and provide assistance to a community-based enhancement program.

Methods/Procedure:

With aid from outside funding sources, a five-fold approach has been initiated for sea scallop monitoring efforts including: At-sea sampling, dockside sampling, fishery-independent surveys using industry vessels, enhancement research and collaboration, and sea-floor mapping with a ROXANN bottom profiler. The table below depicts the timetable for work accomplished in 2002. The survey and sampling took place immediately prior and during the scallop season, which runs from December 1 to April 15, and setting/retrieval of spat collection gear and seed planting revolved around the scallop's life cycle.

2002 Work Schedule for Sea Scallop Programs

Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Sea Sampling												
Port Sampling												
Prepare survey												
Conduct survey												
Enhancement												
Data analysis & Reports (ongoing)												

Key to the survey and sampling programs was an Allegro™ handheld computer - which in conjunction with calipers, scales, and handheld GPS units equipped with RS232 ports - allowed for the rapid entry of shell measurements, meat weights, and location information in the field. Data entry screens for each program were configured using Data Plus Professional™ software, which aided in standardizing data entry, providing error checks, and minimizing subsequent data auditing and keying. Participation in all of the sampling programs was voluntary.

Sea Sampling - The sea sampling program was designed to obtain area-specific biological data and detailed information on catch rates and bycatch. It also provided an opportunity to record anecdotal local/ historical knowledge of various grounds and document fishing practices. Data recorded (see table below) mirrors the federal scallop observer program with some modifications. Sampling frequency (number of tows per trip sampled) depended on catch rates. With two observers on board nearly every tow could be worked up – or usually every other tow for trips with only one observer present. For sampled hauls, when the bag was dumped a digital

picture was taken, the catch sorted, and both legal and sublegal sized scallops retained. Bycatch and trash (seaweed, shell, rock and cobble etc.) were evaluated using a categorical scale (1-5 corresponding to present, some, common, abundant, very abundant). Scallop shell height was measured and the total pounds and volume of legal and sub-legal shellstock recorded. Legal sized scallops from selected hauls were shucked into separate containers and individual meats weighed back at the dock. Additionally, a sample of shells from the area was usually retained for later growth analyses. Catch rates were standardized by tow length (recorded on a GPS unit) and drag width. Additional shell length frequency and catch rate information was obtained from logbook information from captains involved in gear research with the department.

Data field outline for sea sampling program

<u>Vessel</u>	<u>Trip</u>	<u>Haul</u>	<u>Bycatch</u>	<u>Catch</u>	<u>Length Frequency</u>	<u>Meat weight frequency</u>
-Name -Length -Horsepower -Crew size -Gear Desc.	-Date -Port -Time sail -Time return -Weather -Sea state -Total catch	-Tow speed -Wire out -Location & time dredge in/haulback -Depth	-Species & abundance -Trash -Bottom type	-Lbs/ volume kept or discarded	-Shell height -clappers	-Individual meat weight frequency

Port Sampling - The commercial port sampling program collects catch, effort, meat weight frequency, and price information and provides a characterization of active vessels and gear types. The program designed, initiated, and tested during the 2001-2002 scallop season and expanded for the 2002-2003 season was modeled after an earlier DMR scallop port sampling program developed in the 1980s. Data collection consisted of a standardized boat interview and random sample of scallop meats from each boat's catch. Because larger scallop meats fetch a higher price, meats will often be size-sorted on board. In this case a separate 1 L sample is obtained from each size class of meats. Otherwise, three replicate 1 L samples are taken from the mixed catch. Subsequent phone interviews were necessary to collect catch weights and price information if a boat/ diver did not sell the catch at the dock. Port sampling was also used to obtain contact information for captains willing to take on at-sea observers.

Fishery Independent Survey - The purpose of the survey was to characterize the scallop population along the coast and to assess spatial variability in growth (from growth lines on shell samples), size structure, meat yield, seed occurrence, and relative abundance at several different scales. We also used the first year of the survey to develop protocols and tune future methodology based on the preliminary results. The survey relied on industry vessels using a standardized survey drag. Two seven-foot survey drags with 2 ½ inch ring bags (3 ½ inch rings are the legal standard) were purchased from a New Bedford welding company. Site selection was based on coastal wildlife inventory maps in conjunction with fisherman information and sediment-type maps. This year's effort was purposely focused on scallop grounds known to be currently or historically productive. Outreach and planning for the survey took place during the

summer of 2002 at several industry meetings along the coast. Because of potential interference with fixed gear from spring to late summer, the survey took place during the last half of October up to the opening day of scallop season (December 1, 2002). Data collected were similar to that described for sea sampling though more detailed. Tow times varied from two to ten minutes depending on the amount of trash and scallops in the area in order to obtain an adequate scallop sample size without saturating the survey gear. Speed average 3.5 knots. Catches were standardized by tow length (500 M) which was recorded on a GPS unit. Meat weight to shell dimension relationships were determined by measuring shell height, width, and depth and then shucking meats into designated individual compartments for weighing back on shore. Shells from these samples were bagged and labeled for later growth ring analyses. A Seabird SBE19plus CTD was deployed at stations within each sampling region. Additional samples for the water quality division were taken to look for the occurrence of Amnesiac Shellfish Poisoning (ASP) in scallops, and for a separate study on possible genetic differences of coastal Gulf of Maine scallops being conducted by Erin Fisher, a University of Maine Graduate student in the School of Marine Sciences. Scallop samples to be tested for ASP were packed whole in plastic bags, labeled, and frozen. Scallops for Erin Fisher's project were measured, shucked, and the weighed. A muscle sample was obtained using a tissue corer and then immediately placed in a microcentrifuge tube and covered with 90% ethanol.

Enhancement - The DMR continued collaborative efforts with an industry initiated enhancement program throughout 2002. Through outside funding, spat collection materials (1.5 mm bags and Netron) were, for a second year, provided free of charge to any interested fishermen. Outreach activities, scallop counts from retrieved bags, seed tagging, and pre- and post-seeding dive monitoring were carried out in coordination with Sea Grant extension agent Dana Morse. Locations and counts from sampled bags have been entered into a GIS database. We again endeavored to recruit fishermen from outside established pockets of long-standing participants to expand interest in the program and to obtain spat counts from bags deployed in a wider range along the coast. Bags are set by project participants in mid to late September. A portion of these need to be moved in winter (prior to shrimp season) and are brought to protected waters away from places where they might be towed up. In spring and early summer a sample of bags are retrieved and the spat counted, measured, and concurrently setting species evaluated. Information of this type collected over the past three years has been entered into a GIS database. Small scallops measuring from ½ to 1 inch are bottom seeded directly from the spat bags around July (when they have grown to a reasonable size but before they become constrained by their spat bag environment). Approximately 10% of the seed collected is placed in areas that are periodically monitored by members of the DMR dive team. The rest is seeded in areas thought to be appropriate by project participants. Activity is currently taken place under four special licenses headed by the Northwest Marine Alliance (NAMA), Sea Grant extension agent Dana Morse, Marsden Brewer, and the Stonington Fishery Alliance (SFA).

Results/Discussion:

The sea scallop monitoring initiatives described are part of a two year program to develop methodologies, establish needed industry relationships, and gather base-line data on the inshore scallop resource. Results from this start-up phase will enable future sampling efforts to be more cost effective. Data analysis is ongoing but expected to be completed in January of 2004.

Sea Sampling - Fourteen sampling trips were completed. Ports sailed from included Eastport, Cutler, Corea, Stonington, Harborside, Spruce Head, Chebeague Island, and Orr's Island. All sampling trips in 2002 were made from vessels engaged in dragging although we plan to also sample from dive vessels during the 2002-2003 season. Catch rates were highest in Cobscook Bay with up to 2 bushels of shellstock landed per 10 minute tow (Drag width is limited to 5.5 feet in this area). Gouldsboro Bay also had higher catch rates compared to other areas sampled. Tow times varied between 7 to over 25 minutes. Bycatch occurrence was highly variable as might be expected in an inshore fishery occurring over an area of widely varying habitats. Common animals encountered include: sea stars, green, rock, and jonah crabs, lobster, the ten-ridged whelk, sea urchins, sea cucumbers, and flounder. Detailed analyses of the two-year sea sampling program will be presented in a future report.

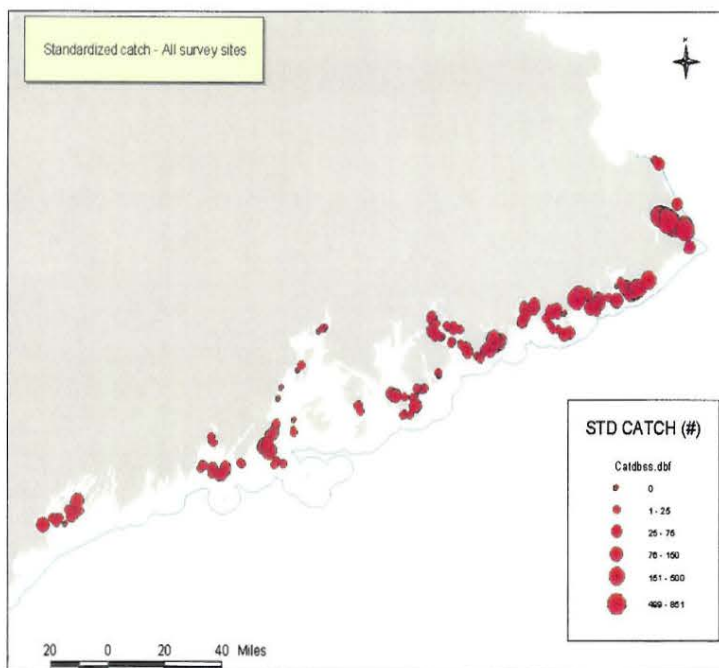
Industry response to the start-up program has been largely positive and many vessel captains have expressed an interest in taking observers on board. The number of trips and range of scallop grounds sampled however has been impacted by limited staff time and weather constraints – especially severe during the current 2002-2003 season. Scalping is a secondary fishery for many Maine fishermen. Although over 1200 licenses (dragger and diver combined) were sold in 2002 – only a fraction of those licensed actively scallop in any given season, depending on product price, the state of the resource, and other fishing opportunities. Work in 2002 focused on highly productive scallop areas where much of the activity of the inshore fleet is focused. We are evaluating ways to expand survey coverage and evaluating sampling schemes that would be more statistically relevant and representational of 'average' fishing activity and tracking trends.

Port Sampling - Commercial sampling sites were selected based on historical abundance centers in Eastport, Jonesport, Mount Desert Island, and Stonington. Landings have declined since 1995 and fishing activity has been only sporadic in some areas compared to previous years. There is currently no database of dealers specifically retailing scallops (just wholesale seafood dealers). Many of the dealers contacted in 2002 indicated that they would allow sampling at their facilities but were not currently buying – or were supplied by only 1-2 boats. Thus the program's focus was to repeat sample the most active ports instead of developing a random sampling design. A number of additional ports were also visited irregularly in attempts to gather more information and expand the program including Cutler, Bucks Harbor, Wiscasset, and Portland. Only 1-2 trips per month could be made when the program was first started during the 2001-2002 season (16 draggers, no divers, 48 samples). Additional staff had part of their time assigned to this project during the 2002-2003 season and an average of 4 trips were made per month. Phone interviews with dealers also provided additional information. From December 18, 2002 to March 19, 2003 we collected catch/ effort information and meat weights from 25 draggers (95 samples) and 11 divers (33 samples). Landings statistics were calculated for several catch/effort and economic parameters including lbs/foot-dredge width/tow-hour, dollars/foot-dredge width/ tow-hour, dollars/ tow-hour, and dollars/ man-hour fished. Detailed analyses of the two-year port sampling program will be finished following the 2002-2003 season.

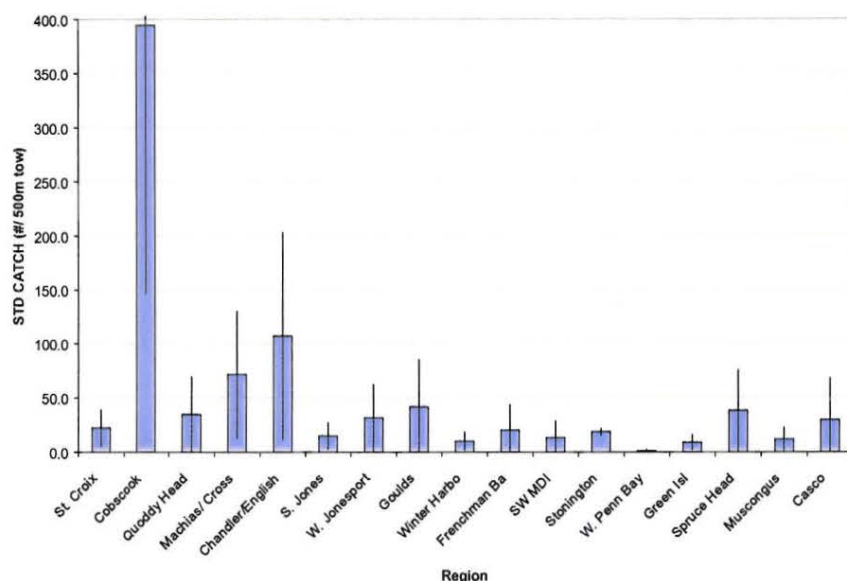
Survey - Three industry vessels were used in different sections of the coast to cover 236 total sites from Casco Bay to the St. Croix River over 23 days from October 26 to November 30, 2002. The majority of the survey from the St. Croix River to Stonington was conducted from the F/V Foxy Lady (Stonington, ME) owned by Wally Gray. The F/V Shearwater out of Owl's Head and owned by Gary Hatch covered sites in western Penobscot Bay to Casco Bay, and the F/V Sea Ryder (Spruce Head, owned by Erik Waterman) was used for more detailed sampling in western Penobscot Bay in preparation for additional studies on gear efficiency and bottom mapping.

Data is being examined at three different spatial scales (large scale, regionally, and patch scale or tow by tow) to look at relative abundance (total number of scallops, scallops greater than 3 ½" – the current minimum shell size standard, 2 ½" to 3 ½", and < 2 ½" shell height) size structure, recruitment, and meat yield trends. Faunal associations and trends occurring with depth, bottom type and temperature and productivity data from CTD drops and auxillary sources (GOMOOS buoys and previous studies) will also be explored. Data from the Gulf of Maine trawl survey, which covered many additional sites further from shore, was also added to the database.

Regionally, the highest relative abundance was in Cobscook Bay (see figures below). This area also contained consistently high abundances of seed, which partly accounts for the overall high density of scallops in the area. Other historically productive areas such as Penobscot Bay and areas around Mount Desert Island and Stonington were characterized by a generally low relative scallop density.

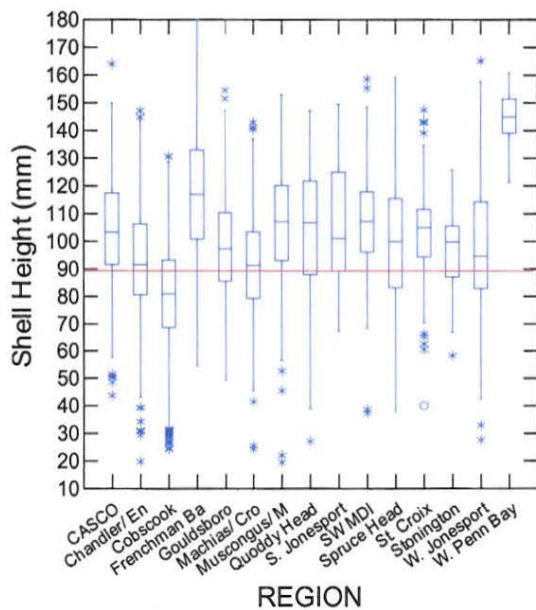


Standardized catch ranges (all scallop sizes; per 500 M tow) at all 2002 survey sites.

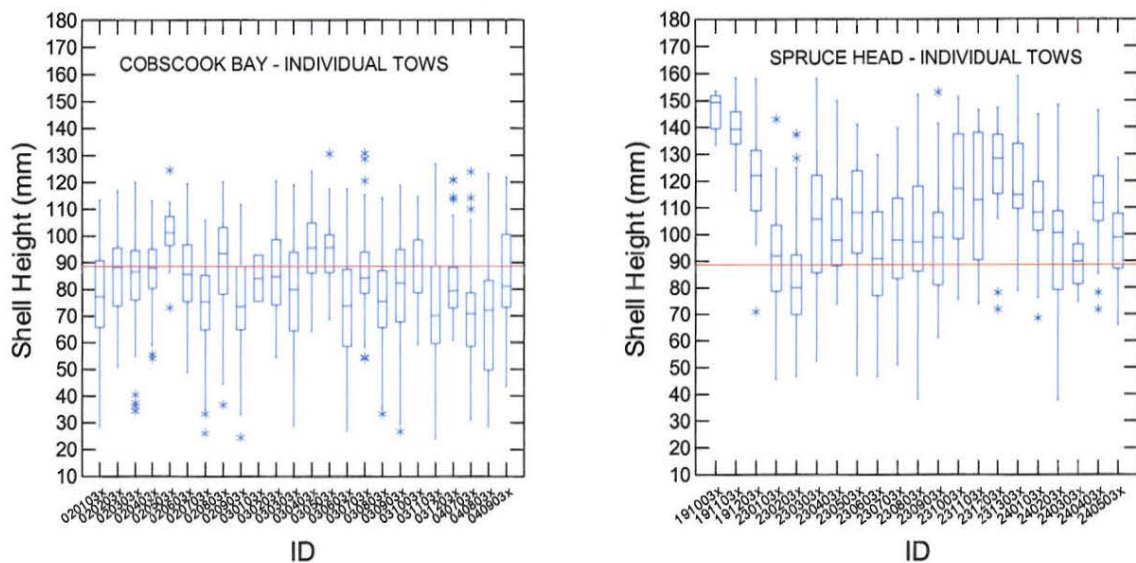


Mean standardized catches (per 500 M tow) by region.

Differences in the stock size structure were also apparent at both regional and patch scales (below).

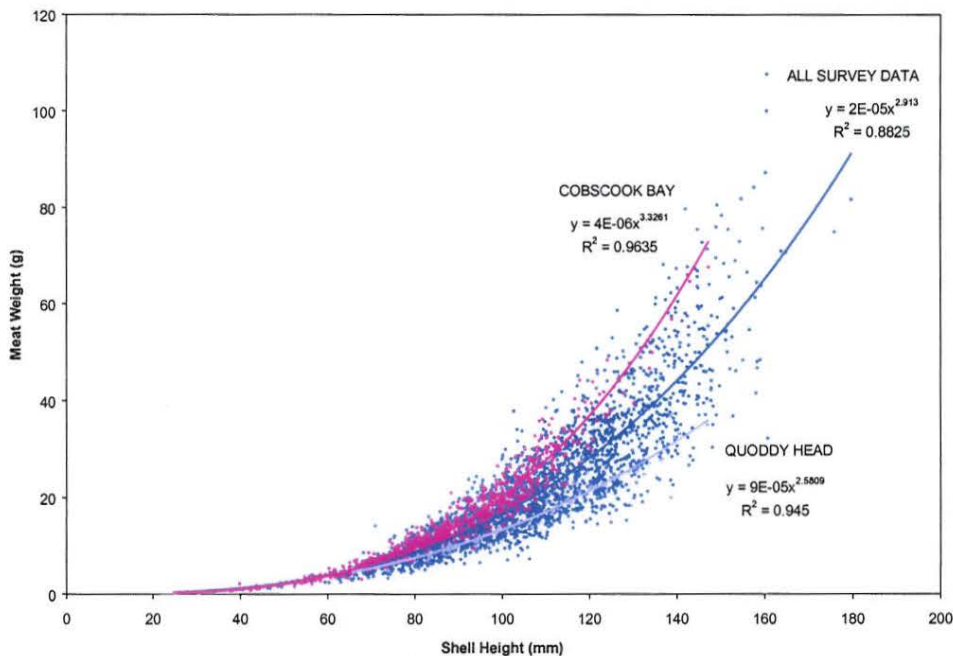


(left) Boxplot of combined regional shell size data showing differences in stock size structure. The middle horizontal line represents the size at which scallops are recruited into the fishery (3 ½ inch minimum shell size).



(above) Tow by tow box plot of shell size data for two different survey regions (Cobscook Bay and off Spruce Head in Penobscot Bay) showing patch scale differences in size structure of varying degrees. The middle horizontal line represents the size at which scallops are recruited into the fishery.

Differences in the meat weight to shell height relationship were also documented for surveyed regions. For example, meat yield as a function of size was significantly higher for Cobscook Bay scallops compared to the survey average. Scallops captured outside Quoddy Head had comparatively smaller meats at a given size (see figure below). Further data analysis will shed light on the primary factors related to these differences.



*Meat weight as a function of shell height – regional differences:
Cobscook Bay and Quoddy Head compared to survey average.*

Growth lines from collected shell samples will be measured or analyzed during the summer of 2003. Results from the Amnesiac Shellfish Toxin sampling and University of Maine genetics project are also pending.

A second survey is planned prior to the 2003-2004 season. Results from the first survey will be used to optimize this design. We also hope to extend the survey south to waters off Kittery.

Enhancement - A summary of enhancement activities carried out by DMR staff is presented below.

2001 Enhancement Activities

<u>Date</u>	<u>Activity</u>	<u>Location</u>	<u>Industry Group</u>	<u>Notes/ Observations</u>
03/01/02	ME Fish Forum Enhancement session	Rockland	All	<i>Outreach and results to date presented at special scallop enhancement session</i>
04/22/02	Enhancement presentation	Mystic, Ct	Outreach	<i>Presented Maine enhancement initiative at National Shellfisheries Association meeting</i>
05/05/02	Counts done on sampled spat bags	Stonington	M. Brewer	<i>Help provided by several community groups</i>
06/25/02	Pre-seed dive survey	Saco	NAMA	<i>UW video of selected 'control' site</i>
07/07/02	Seed release	Isle au Haut	M. Brewer	<i>Approx. 200,000 seed released from 3 boats</i>
07/12/02	Pre-seed dive survey	Saco	NAMA	<i>UW video of 2 additional sites – each with unique bottom type</i>
07/15/02	Sample bags counted	Milbridge		<i>More sample bags counted</i>
07/21/02	Seed release	Saco	NAMA	<i>Some animals caged; mussel set</i>
07/22/02	Seed release	Stonington	NAMA	<i>Seeded Deer Isle Thorofare, with approx. 150,000 animals including a limited amount of tagged year-two animals</i>
June-August	Spat collection materials distributed	Saco – Milbridge	NAMA/ SFA/ M. Brewer/ Sea Grant	<i>Approx. 80 rolls of netron and 6500 spat bags distributed</i>
08/27/02	Post seeding dive	Penobscot Bay	Sea Grant	<i>Monitoring dive at Cape Jellison – site seeded 14 months prior; scallops dispersed beyond site</i>
08/28/02	Post seeding dive	Isle au Haut/ Deer Isle	Sea Grant	<i>Seeded scallops still present at both sites; fourteen tag returns</i>

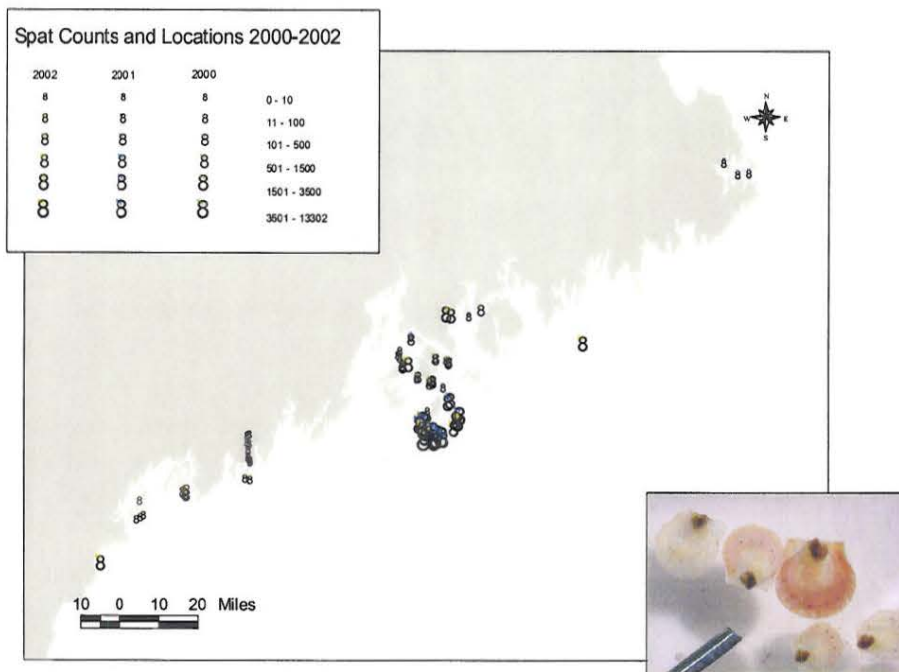
DMR staff participated in a number of outreach events. These events and other publicity are important to the project since it is a “new” activity on the water. In addition to garnering interest from fishermen willing to participate in the program it is important that other fishermen also understand the effort. Loss of spat collection gear set out in September of 2001 became a problem in certain locations – most likely due to bags being cut loose by a few individuals. It

remains undetermined whether this was malicious, due to interference with lobster gear set out in the area, or because buoys were perceived as 'new' lobster gear placed in areas traditionally fished by others. All of the groups involved in the effort are working to further educate local fishermen about the project with the hopes of preventing future losses. Despite these incidents, the majority of the bags were retrieved and an estimated 3 million seed were 'planted'.

Sample bags representing over 50 sites and water depths were retrieved and counted (figure below). Over time and with continued expansion of collection sites, this database may be an aid in the study of recruitment dynamics in coastal Maine waters.

Each year, three sites are chosen to seed and monitor. In 2002, seeded sites included Saco Bay, an area east of Isle Au Haut, and in the Deer Isle Thorofare. Although monitoring was sporadic, seeded scallops were still present in all of these areas 4 – 8 weeks after seeding. More follow-up dives will be conducted in these areas in the Spring of 2003. Dispersal was evident at these sites – but little mortality. On a follow-up dive conducted at a site seeded over 1 year ago (Cape Jellison) - no scallops were able to be recovered. DMR staff also helped document three potential seeding sites in Saco Bay prior to seed dispersal.

The Wild Scallop Stock Enhancement Project Coast-wide Spat Settlement Data



Spat counts by location, coastwide 2000-2002.

Eighty rolls of netron and 6000 spat bags were given out in Saco, South Bristol, Tenant's Harbor, Stonington, Southwest Harbor, and Milbridge. Bags were further distributed from these areas. Fishermen contribute their own lines, buoys, and anchors. A spat collection methods brochure was also written for distribution to interested industry members.

Deviations: No time was available to conduct bottom-type mapping with the ROXANN unit in 2002. This work will be planned for the summer and fall of 2003.

Job #3

Job Title: Ocean Quahog Assessment

Objective:

Develop an optimal cost-effective sampling strategy to determine the abundance, distribution, and size composition of the ocean quahog resource in the open fishing areas of eastern Maine.

Methods/Procedure:

An ocean quahog survey was designed and conducted to collect base-line information to begin to establish a biological basis for quota allocation set by the Mid-Atlantic Management Council (MAFMC). Objectives were to map the species' distribution to the 50-fathom depth contour and to obtain population structure, length-weight, relative abundance data and bycatch information. The main part of this effort was a stratified random survey within the area where fishing activity is currently allowed. This area consists of three PSP (Paralytic Shellfish Poisoning) monitoring zones (see figure 2 below). Ocean quahog beds extend beyond this range and exploratory surveys outside of the harvest zones may be carried out in the future, but funding constraints limited the survey work to 12 days at sea. Strata consisted of three depth ranges (10-40 m, 40-70 m, and 70-100 m) divided north and south by the three PSP management area boundaries for 9 total strata. A second systematic survey of a smaller area consisting of the most intensively fished beds between Cross Island and Petit Manan Island (46 stations) was also conducted. Lastly, a descriptive survey of an historically fished area in the St. Croix River and around Treat Island (23 stations) was also conducted, and six additional permanent stations established to track temporal trends.

The sampling gear was a standard Maine dry dredge lined with lobster wire with an effective $\frac{3}{4}$ " square mesh size. The Maine dry dredge resembles an iron cage on skis. The cutter bar measured 0.91 m. Teeth spacing was $1\frac{1}{4}$ " and they were set to a depth of $4\frac{1}{2}$ ". All work was completed from the *F/V Whitney and Ashley*, a 36 foot dragger owned by Kristan Porter, Cutler, ME. The bottom was surveyed at each station using the boat's sounder to determine if it was fishable. If the site was not fishable an area of approximately 0.3 nm was searched for suitable bottom. If fishable bottom was not found in this area, a notation was made and the boat continued on to the next site. Tow duration was 2 minutes at approximately 2.5 knots. Average tow length was approximately 150 meters. The tow wire was marked off incrementally and wire out to depth was kept at a constant 3:1 ratio. After towing, dredge contents were washed out by steaming with the dredge at the surface until water ran clear. The dredge was dumped into a shallow plywood box on deck. For areas with extremely high catches or trash amounts, the catch was split by mixing and leveling the contents of the plywood dumping platform and then dividing the pile in half once or twice using 2x4 guides which could be inserted into the middle of each side of the platform. A digital picture was taken of the dredge contents. Live quahogs and bycatch were separated out. Bycatch species were noted and either enumerated or assigned a categorical abundance (1-3) corresponding to 'present', 'common', or 'abundant'. The amount of quahog shell present was also noted. Volume and weight of the entire catch of live quahogs was recorded. The entire catch or a 5-L subsample was measured for shell length (the maximum

size of the shell), height (the dimension from the umbo to the maximum distance to the outer edge), and depth (the maximum distance from the outer surfaces of the left and right valves). Another subsample consisting of a haphazard selection of clams representative of the entire size range of the catch was bagged and kept cool. Quahogs were shucked on shore and whole, meat, and shell weight determined. The bottom type was recorded based on the dredge contents in combination with sounder information. Shells of shucked clams were washed, labeled with the station number and date, and archived for later growth and age analyses using an acetate peel method.

Additional animals occurring in areas outside the survey areas were measured over the course of the scallop survey (see job 2 above) and shell samples retained for aging and growth measurements.

Catch numbers (standardized to a 150 m tow length) were plotted in a GIS database. Relative abundance estimates, uncorrected for dredge efficiency, were computed. Optimal allocation of sampling effort for future surveys was determined assuming fixed sampling costs for all stations.

Results/Discussion:

A complete report for the survey was written in August of 2002 and submitted to the Mid-Atlantic Fisheries Management Council. Following is a summary of size composition, distribution, and abundance data. Acetate peel methodology for aging individuals has been tested and this work will commence in earnest during the summer of 2003.

Size Composition - Shell length frequency distributions for each individual survey are presented below. Market size ranges from 1 ½ to 2 ½ inches (38.1 mm – 63.5 mm) although smaller animals are generally preferred (40-50 mm). Mean shell length for the main survey was 47.1 mm (+/- 9.5 SD) and ranged from 15.9 mm to 70.6 mm. This mean size and range is significantly smaller than that of stocks occurring off the mid-Atlantic and Southern New England coasts. Mean size for the systematic survey was 50.3mm (+/- 12.7SD) with a range from 10.17 to 77.8 mm. St. Croix area quahogs measured 48.3 mm (+/- 12.2 SD) and ranged from 11.06 to 75.26 mm. This size distribution was bimodal with a secondary peak at approximately 30 mm and main peak at 52 mm. The percentage of smaller quahogs encountered at this site indicates relatively recent recruitment. Since the mesh size of the dredge was 19 mm square, there are likely many more quahogs in the 10 – 20 mm range here than appeared in the catch. Mean size for Treat Island quahogs was the largest of all the areas at 55.8 mm (+/- 7.5SD) with a minimum size of 36.0 mm and maximum of 64.7 mm.

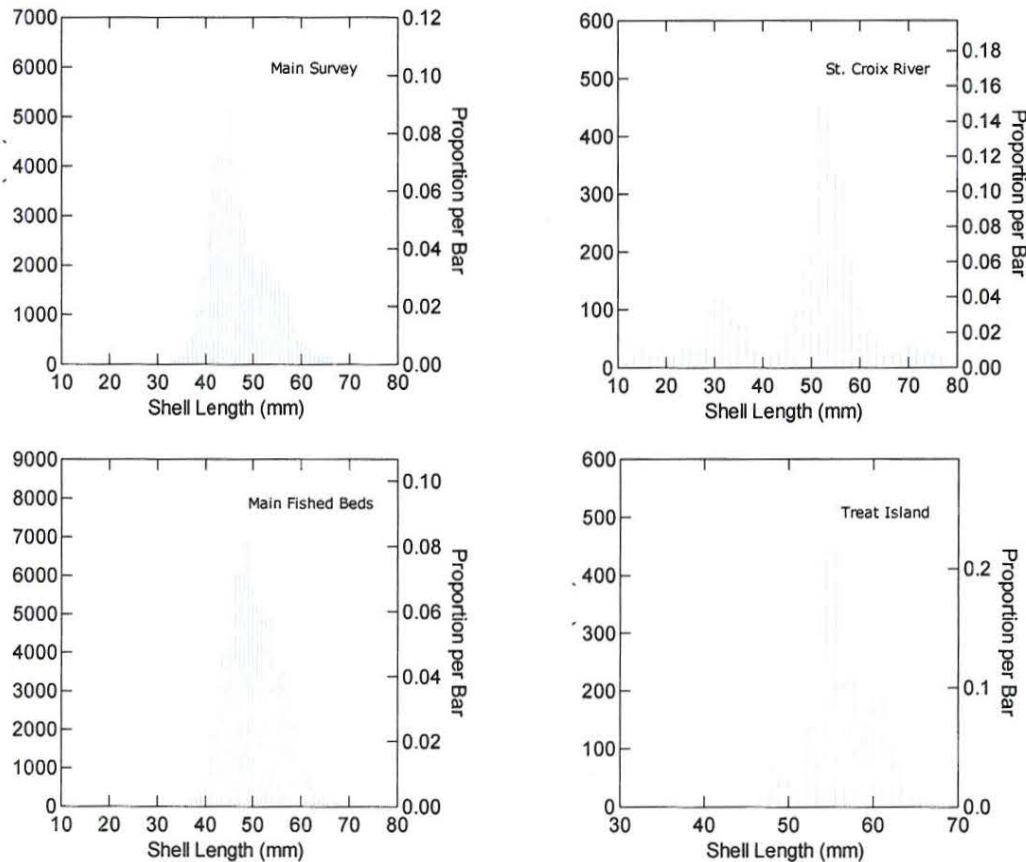


Fig. 1. Length frequency histograms for the main stratified random survey (top left), systematic survey of high recent fishing activity (bottom left), and samples from St. Croix River (top right), and Treat Island (bottom right) areas.

The overall meat weight to shell length relationship for clams over this size range was: $MW = 4.97 \times 10^{-6} \times SL^{3.5696}$. Average meat yield was 17.5%.

Distribution and Abundance - Of the 226 remaining stations, 68% or 154 were fishable overall. Of these, 30.5% (47 stations) contained quahogs. Few small patches of quahogs were discovered at random stations beyond known historically fished areas. Standardized catches from all survey areas are depicted below. Data from a 1994 NMFS qualitative survey is also plotted for comparative purposes. Distribution of quahogs and catches showed patchiness. The largest catches were in the main fished beds in zones 2 and 3 between Cross Island and Petit Manan Island. Most large catches were between 41 and 100+ meters and this 'swath' in quahog distribution seemed to continue at these depths southwest to the border between zones 1 and 2. However, abundances tapered off here and catches in this area southwest of Petit Manan were relatively small. Survey catches in the shallowest depth zone were restricted to Machias Bay and areas around Libby Island. Quahogs were caught at only two stations in zone 1. While areas around Isle au Haut were fished in the past, beds are known to be small and patchily distributed in this area.

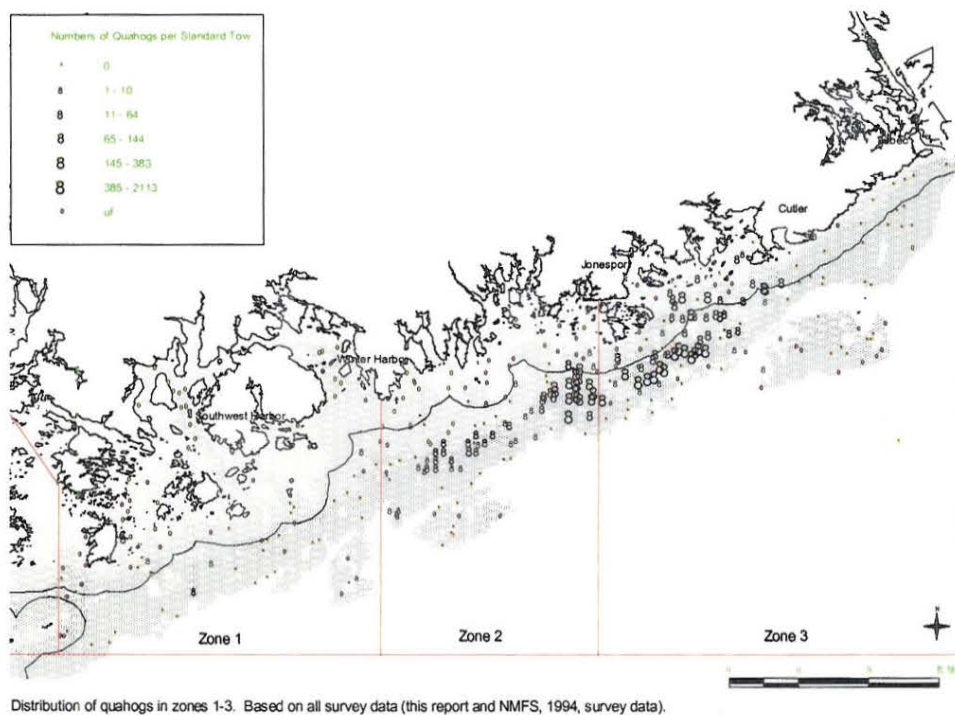


Fig. 2. Quahog distribution and abundance over all surveyed areas.

Abundance Indices - Relative abundance estimates obtained from the random stratified a systematic surveys are presented in the table below. A total of $7.13\text{E}+08$ ($\pm 1.78\text{E}+08$ SE) individuals or 776,442 ($\pm 214,495$ SE) “Maine” bushels were estimated for the entire harvestable area. As described above, most of the population was contained in strata 5, 6 and 9 (zones 2 and 3 at depths 41-100+ m). For the systematic survey of the smaller area where most fishing activity occurs, standardized catches ranged from 0 to 2113 animals per tow with a mean of 226.3. Relative quahog abundance was estimated at $1.13\text{E}+09$ ($\pm 3.4\text{E}+08$ SE) or 1288533 ($\pm 389,971$ SE) “Maine” bushels. These standard error estimates assume a random assignment of stations, and this assumption may not be valid given the systematic design of the survey. These numbers are not corrected for dredge efficiency, which is believed to be low for the dry dredge used in these surveys. The discrepancy between the relative abundance estimates calculated for the stratified random survey of all three management zones compared to the systematic survey of the main fished beds between Petit Manan Island and Cross Island could be due to either the large scope of the stratified random survey combined with a patchy resource distribution or due to biases in the systematic design of the smaller scale survey.

Relative biomass estimates for the random stratified survey

Strata	Area (NM)	Stations assigned (#)	Stations fishable (#)	Fishable Bottom (%)	Mean (#/tow)	SE	Total (# animals)	SE (# animals)	Bushel Conv. ** (#/ bushel)	Total (bushels)	SE (bushels)
1*	208	30	1	3%	0*						
2	123	18	6	33%	0.00						
3	254	37	26	70%	2.58	2.45	1.15E+07	1.09E+07	891	12907	12263
Zone 1	586	85	33	39%			1.15E+07			12907	12263
4	82	21	4	19%	0.74	0.25	2.88E+05	9.61E+04	1000	288	96
5	98	26	20	76%	117.35	42.71	2.19E+08	7.96E+07	1301	168217	61220
6	148	38	35	92%	23.74	11.76	8.10E+07	4.01E+07	1382	58630	29054
Zone 2	328	85	59	69%			3.00E+08			227135	
7	54	11	6	55%	8.66	4.23	6.39E+06	3.12E+06	578	6388	5399
8	71	15	11	73%	9.18	4.19	1.20E+07	5.46E+06	474	25250	11510
9	286	59	46	77%	69.69	27.99	3.83E+08	1.54E+08	758	504762	202741
Zone 3	411	85	63	74%			4.01E+08			536400	
Total	1117.2	225	154	68%			7.13E+08	1.78E+08		776442	214495

Relative biomass estimates for the systematic survey of the main fished beds

	Area (NM)	Stations assigned (#)	Stations fishable (#)	Fishable Bottom (%)	Mean no. per std tow	SE ***	Total (# animals)	SE (# animals)	Bushel Conv. ** (#/ bushel)	Total (bushels)	SE (bushels)
Systematic fished area	225	46	41	89%	226.30	68.49	1.14E+09	3.44E+08	882	1288533	389971

* strata dropped

** - Maine bushel (35.25 L)

*** bootstrap SE

Std. Tow area = 137.16 m²

Due to resource and habitat patchiness, standard errors for survey relative abundance estimates are high. A second survey with more intensive sampling will likely be necessary to obtain more precise relative abundance estimates. The mean and variance parameters obtained provide a basis to calculate the sampling effort needed to obtain a more precise abundance estimate. The table below shows the required number of sampling stations needed for 95% and 90% confidence intervals at precision levels of 10, 15, 20, and 25% of the population mean. Data from the systematic survey were used in these calculations since it was the area with the highest variance and highest population. An intensive survey of this area of about the same duration (12-15 days at sea assuming 40 stations per day or 400-500 stations) would be necessary to achieve an estimate within 20% of the population mean with 95% confidence or within 15% of the mean with 90% certainty. Although the sampling intensity in the present survey was not as high as desired, it provides a basis with which to better define the overall sampling frame in future surveys and with which to refine strata designations based on relative abundance. It is important to sample beyond known fishing grounds early on in a survey series so as not to miss potentially important resource concentrations. A dredge-efficiency study will also be needed before absolute biomass can be calculated. Results of this survey and a literature review of key biological parameters associated with *A. islandica* demonstrate a substantial degree of variability depending on locality and environment. This points to the need for continued research on the Gulf of Maine population.

*Required number of sample stations needed for various levels of precision at 95% and 90% confidence intervals.
Based on parameters estimated from the survey of main fished beds.*

Precision (% of mean)	95% Conf. Int.	90% Conf. Int.
10%	1739	1180
15%	775	524
20%	434	294
25%	278	188

In conclusion, a second optimized survey based on this work in combination with needed gear efficiency studies should produce a scientifically sound biomass estimate for the Gulf of Maine stock.

Job#4

Job Title: Sea Cucumber Survey and Population Dynamics

Objective:

Document catch, effort, and biological characteristics of the sea cucumber resource along the Maine coast.

Procedures/Methods:

Little field work was accomplished for this objective in 2002. Ancillary data on sea cucumber relative abundance and size structure was collected during the sea scallop survey described above (see job #2), but data have yet to be analyzed.

Results/Discussion:

A report was produced in February based on earlier preliminary surveys, logbook analyses, and an industry meeting. Staff worked with researchers at the University of Maine and College of the Atlantic to develop research proposals to submit to funding agencies to support needed work for this fishery – including collection of data and development of size-based (rather than age-based) fishery models. A small grant was awarded to investigate sea cucumber tagging methods. This work will be conducted in the Spring of 2003 in conjunction with Yong Chen and Sheril Kirshenbaum from the University of Maine. Staff also met with Roy Hart, a fisheries development officer visiting from Carbonear, Newfoundland in October 2002 to discuss regional developments in the sea cucumber industry including monitoring and research efforts.