SFC
APPROVED
BY
DATE 7/24/02

UNITED STATES
DEPARTMENT OF COMMERCE

National Ocean and Atmospheric Administration
National Marine Fisheries Service
State, Federal and Constituent Program Division

COMPLETION REPORT
Interjurisdictional Fisheries Resource Monitoring and Assessment

State: Maine
Project No. 3-IJ-180
Grant No. NA16FI1089

January 1, 2001 – December 31, 2001

Maine Department of Marine Resources
21 State House Station
Augusta, ME 04333

April 18, 2002

The Lobster Resource:
Monitoring, Assessment and Management

Award #NA16FL1089
FI

Completion Report

January 1, 2001 through December 31, 2001

Carl Wilson, Project Leader
Jason Bartlett
Alison Sirois
Gary Robinson

Summary:

The lobster port and sea sampling project receive significant funding from interjurisdictional projects. This money allows fulltime DMR staff to plan, implement and complete needed fishery dependent monitoring of the Maine lobster fishery. Parallel awards from other agencies that allow hiring of temporary personnel and cover costs associated with sampling enhance these projects. In 2001 the lobster project successfully completed two large-scale monitoring projects and contributed to a critical review of the existing programs with the University of Maine. The port-sampling project completed the second consecutive 12-month sampling season in recent years. Ten dealers were selected at random each month. Over the course of the season 433 interviews were conducted at 61 dealers on the coast. The at-sea sampling program visits each lobster management zone three times each month from May through November. In 2001, the sea sampling team completed 173 sampling trips out of 80 different ports, exceeding expectations for the season. Combined, these two programs provide a comprehensive look at the commercial lobster fishery in Maine.

Lobster Resource and Fishery Monitoring

Commercial Port Sampling Survey 2001

Jason Bartlett and Gary Robinson

The 2001 Commercial Port Sampling survey began January 1 and ended December 31. This marked the second consecutive year since 1969 to include sampling during the winter months (January through March). These data can be compared with the years 1967 through 1969, which constitute the last time data was collected on a year round basis. Assessment needs for data from the winter months prompted this recent increase in sampling but budget constraints terminated it both times (1969 and 2001). The winter catch represented approximately 2 % of the total landings in 2000 and 2001. The tables and summaries in this report will reflect the additional sampling in 2001.

During the 2001 sampling year we: (1) collected catch and effort data from lobstermen at ten randomly selected dealers each month; (2) compiled the daily survey data and summarized these results by month and year (Table 1); (3) completed daily, monthly, and annual tabulations of mean lengths and weights in addition to percentages of female, cull, 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).

The port sampling crew collected lobster biological information and catch/effort data from 433 boats (same number as the previous year) that landed catches at dealers from Kittery to Eastport, Maine. A total of 120 dealer locations (10 per month) buying from five or more fishermen were randomly selected in 2001. Of these, statistical information was collected at 61 locations or 51% of those drawn. No data were collected from the remaining 59 dealers due to travel logistics (2 instances), inclement weather that prevented the lobstermen from hauling their traps, or other reasons. During the months of February and March, no fishermen were out hauling their traps on the selected sampling days. Sampling days where no fishermen were out

are recorded as "no boat days." Comments from either the dealers or fishermen were recorded in Table 4.

The use of a cellular phone has proven to be an asset to the survey. It has allowed the port sampling crew to call dealers while in route on the sampling day. If no boats were out time and money was saved by preventing needless travel. We were able to call ahead 27 times on days when the weather was questionable (fog, wind, high seas) to determine if the dealer had any boats out fishing.

There were 133 lobster dealers that bought from five or more fishermen open during the 2001 sampling year. The randomized sampling schedule was representative of the distribution of dealers along the Maine coast and off shore islands. Many of the data points in Figure 1 refer to more than one dealer location, while some dealers were sampled more than once. The port sampling crew traveled 18,315 miles by land in addition to distance traveled by boat to off shore islands.

Length-frequencies for the ten-lobster cluster samples measured from each boat were grouped by 1 mm carapace length for males, females, and sexes combined (Table 5). From this, the percentages of lobsters within the 14% carapace length molt groupings of 83-94, 95-108, 109-124, and 125-127 mm were calculated. These values were then used to estimate the number of lobsters harvested in each size category by dividing the total pounds harvested (preliminary Maine landings data) by the mean weight of commercially caught lobsters (Table 6). Over 84% of the lobsters landed fell 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 81.5% (Figure 2).

The total catch sampled weighed approximately 55.2 tons and consisted of 85,751 lobsters with an ex-vessel value of $333,162. The ten-lobster cluster samples (actual measurements recorded) contained 2,182 females and 2,131 males. The mean weight of landed lobsters was 584.9 gm ± 7.7 and the mean carapace length was 90.1mm ± 0.3, slightly higher than the previous year (578.7gm and 89.8 mm). Since the increase in size of the escape vent on a lobster trap was initiated in 1999, it was expected that the mean sizes of legal lobsters would increase.

Some selected catch/effort findings for 2001 show a catch rate of 1.36 lbs./trap-haul and 253.63 lbs./boat day. These values are down from 2000 (1.51 lbs./trap-haul and 298.92 lbs./boat day), which was a record year for lobster landings. Average prices per pound were $4.56 for hard-shell, $2.88 for soft-shell, and $4.26 for select lobsters. None of the sampled dealers were paying a cull (lobsters missing one or both claws, or those with regenerated claws) price.

The year 2001 was the second consecutive year in recent times to incorporate winter sampling. In spite of this, data were collected from 433 lobster boats. This was the same number of boats sampled as in 2000 but fewer than years which did not include sampling in the winter. In the month of January, data were collected from 9 boats. No boats were sampled during February or March, due mainly to unfavorable weather conditions. Prior to the next sampling season, it will be determined if winter port sampling should be continued.

The expanded port sampling estimates indicated a decrease in lobster landings for 2001. This concurs with the preliminary Maine landings data reported by NMFS (Figure 3). The fishing effort categories have shown a decrease since 1999. The catch-per-unit-effort categories increased in 1999 and 2000, but decreased in 2001 (Figure 4). This change was reflected in the lower landings value. It should be noted that the spring lobster fishing was extremely slow, due in part to colder than normal water temperatures. The tragic events in September affected the fishery to a degree. The shipping capabilities of, and demand for, lobster dropped at a time when the catch was high. The price trend was decreasing throughout the year but was not greatly impacted by September 11th. Canadian processing plants still managed to buy a large percentage of Maine lobster to help stabilize the price until the Canadian fishery opened in November. At that time, the ex-vessel price of lobsters in Maine dropped because the Canadian market was flooded (Figure 5). During October, the price per pound of soft-shell lobsters averaged $2.76 while November's average dropped to $2.44. These factors may have played a role in the decreased landings for 2001.

In April 2000, two bait categories were added to the port sampling survey. Each boat captain was asked, "What types of bait were used for this catch?" and "How many bushels of each bait were used?" The bait questions were asked again in 2001 in response to industry members concerned about the availability of herring. Of the 433 lobster boats sampled, 275 (64%) used herring as the exclusive bait. One hundred and twenty boats (28%) used herring supplemented with an additional bait type, while 38 boats (9%) used bait species other than herring. In comparison with the previous year, the percent of boats fishing only herring is down while the percent fishing herring plus another type of bait is up. Herring constituted almost 79% of the total amount in bushels of bait used (Figure 6). The survey shows a great dependence of the lobster fishery on herring as the primary bait source. The types and amounts of lobster baits used will continue to be monitored.

In recent years, managers and industry members have focused on reducing fishing effort by limiting the allowable number of traps fished by each lobsterman. Since 1999, the first year after the initial trap reduction, the mean number of traps fished per boat has decreased while the percentage of double parlor traps has increased (Figure 7). 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 the more efficient trap is being fished to compensate for the reduction in effort.

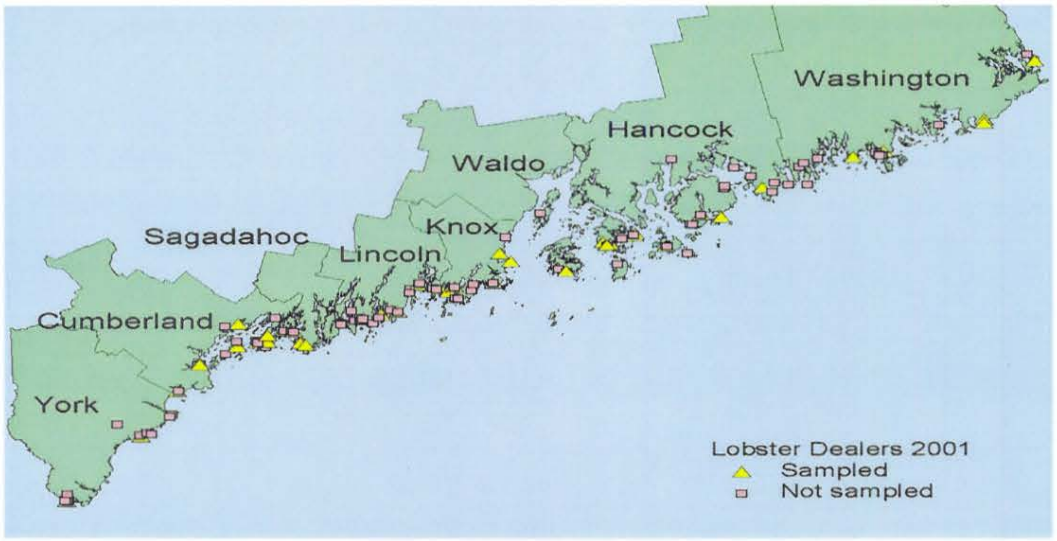


Figure 1. Location of dealers buying from 5 or more fishermen, 2001.

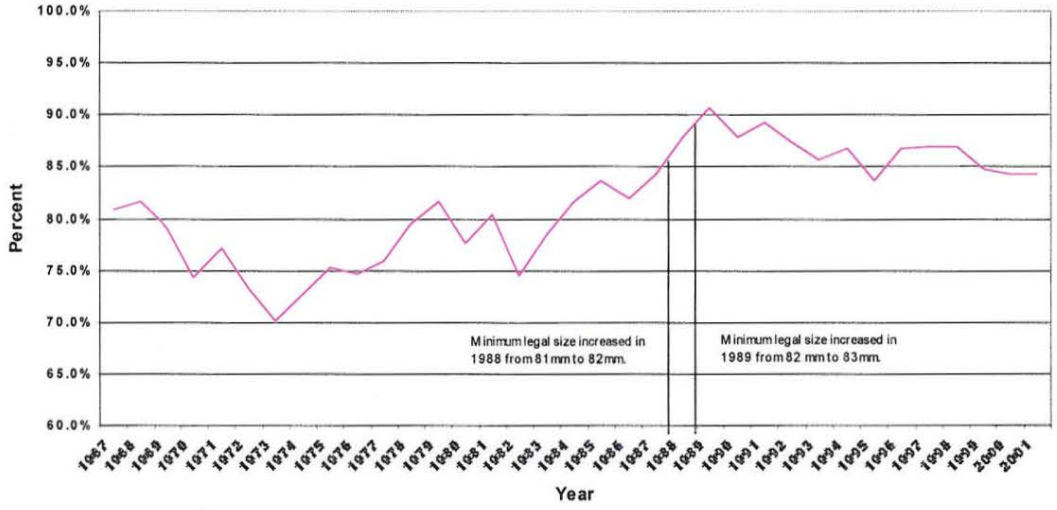


Figure 2. Percentage of lobsters harvested in the first 14% carapace length molt group.

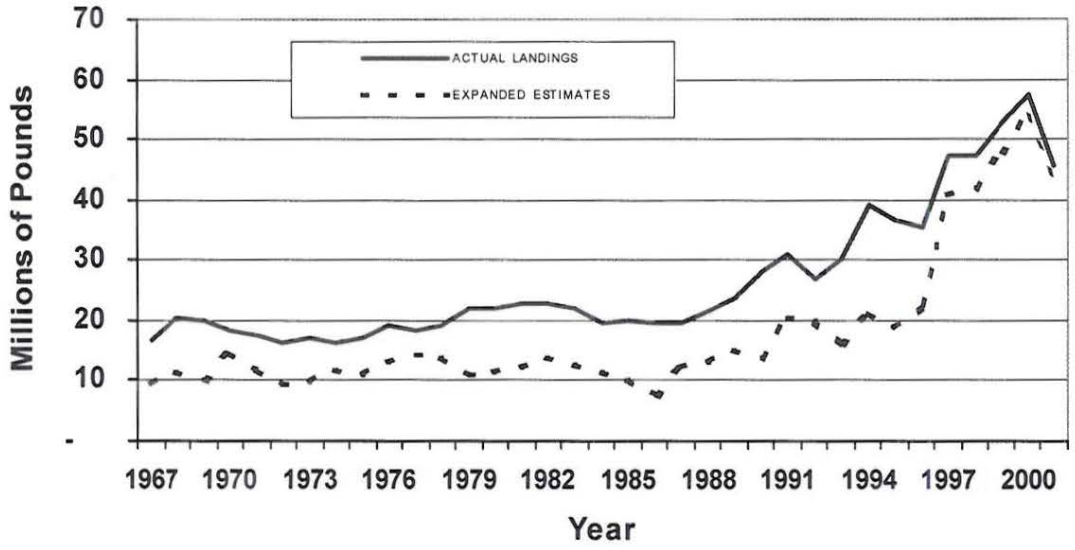


Figure 3. Comparison of port sampling expanded estimates with Maine total landings.

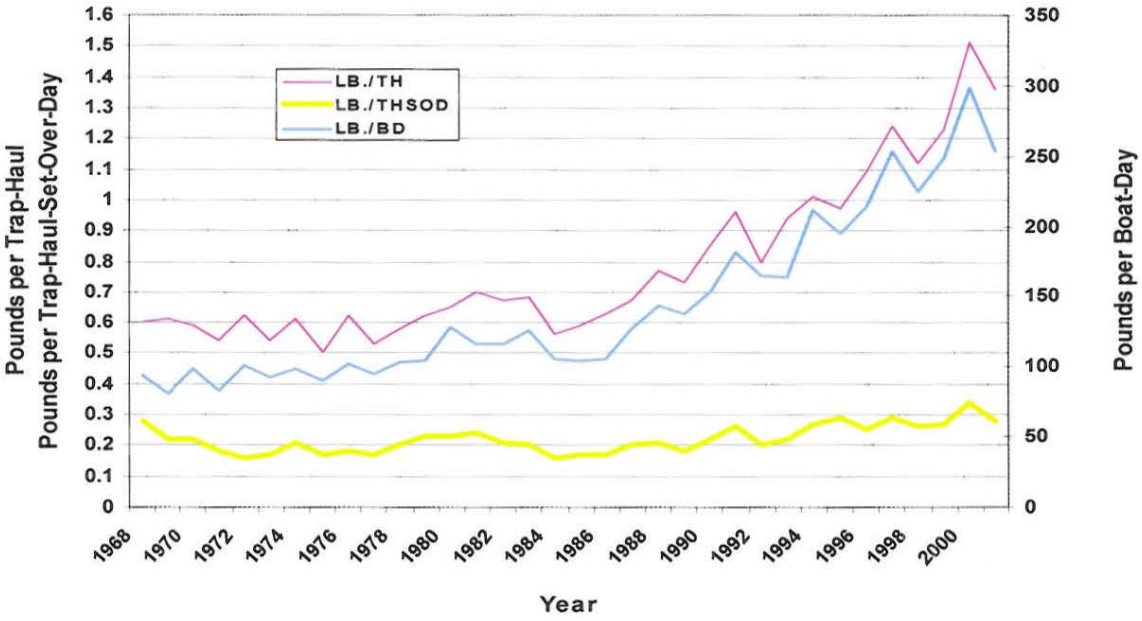


Figure 4. Catch-per-unit-effort categories from Port Sampling data, 1967-2001.

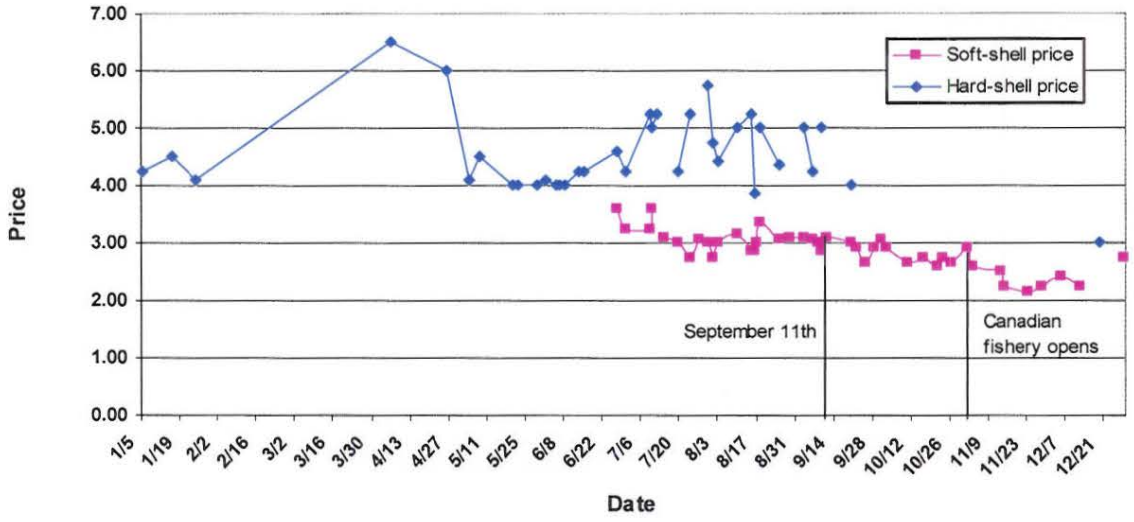


Figure 5. Price per pound of lobsters, 2001.

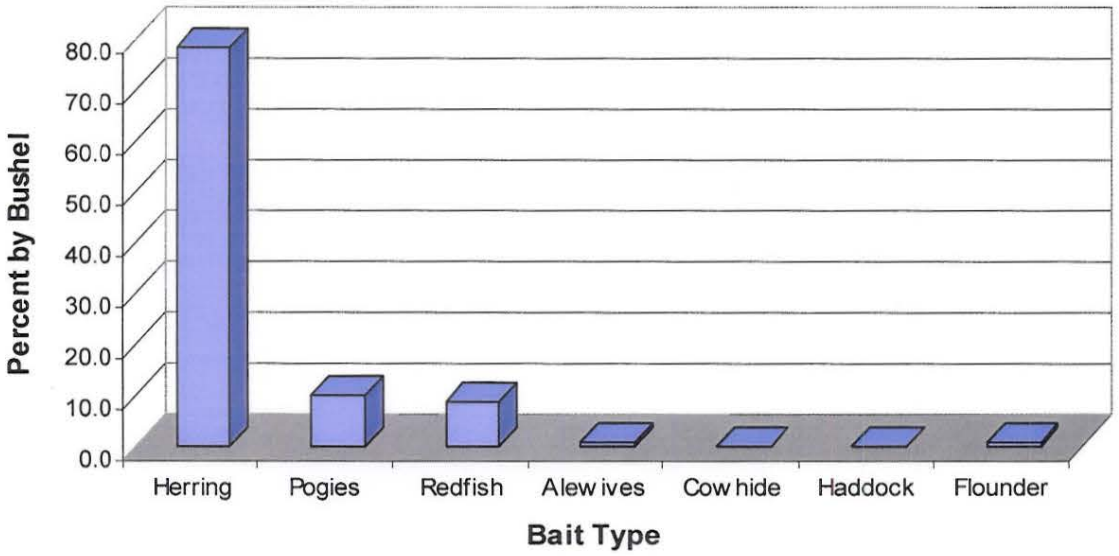


Figure 6. Percent of bait used by type, 2001.

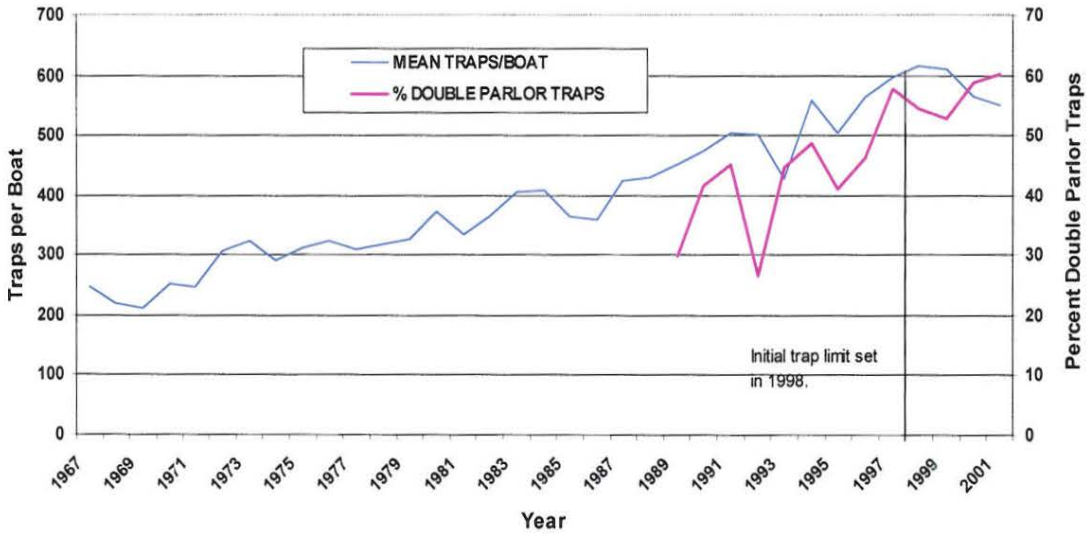


Figure 7. Comparison of mean number of traps per boat with percent of double parlor traps fished.

	JAN	FEB*	MAR*	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Totals
1. TOTAL CATCH IN POUNDS (LBS.)	1666			494	2260	4452	15625	22681	24057	25614	10172	3308	110329
2. TOTAL CATCH IN NUMBERS (NO.)	1061			399	1693	3178	12347	17901	18976	19871	7545	2780	85751
3. TOTAL VALUE OF CATCH ($)	7445.35			3012.00	9234.55	19153.25	47876.85	68420.90	72365.55	73348.75	22805.60	9499.00	333161.80
4. TOTAL NO. OF FEMALES IN SAMPLE	64			34	132	289	197	357	432	405	174	98	2182
5. TOTAL NO. OF MALES IN SAMPLE	26			36	97	229	359	463	398	325	126	72	2131
6. TOTAL NO. OF TRAP-HAULS	1308			1293	3956	10162	12425	16521	15894	12942	4308	2199	81008
7. TOTAL NO. OF TRAPS SET OUT	2845			2855	12775	31467	30746	47582	47203	40479	14747	7537	238236
8. TOTAL NO. OF MAN-DAYS	20			10	41	97	97	151	145	133	55	32	781
9. TOTAL NO. OF MAN-HOURS	149.73			88.74	295.82	773.61	788.57	1199.41	1129.91	1031.86	414.73	216.29	6088.67
10. TOTAL NO. OF BOAT-DAYS	9			7	23	53	56	83	83	73	30	18	435
11. TOTAL NO. OF BOAT-HOURS	67.38			59.91	164.04	419.64	455.83	653.97	632.96	550.68	215.55	120.09	3340.05
12. MEAN WEIGHT LOBSTERS (LBS.)	1.57			1.24	1.33	1.40	1.27	1.27	1.27	1.29	1.35	1.19	1.29
13. CATCH IN LBS. / TRAP-HAUL	1.27			0.38	0.57	0.44	1.26	1.37	1.51	1.98	2.36	1.50	1.36
14. CATCH IN NO. / TRAP-HAUL	0.81			0.31	0.43	0.31	0.99	1.08	1.19	1.54	1.75	1.26	1.06
15. CATCH IN LBS. / MAN-DAY	83.30			49.40	55.12	45.90	161.08	150.21	165.91	192.59	184.95	103.38	141.27
16. CATCH IN NO. / MAN-DAY	53.05			39.90	41.29	32.76	127.29	118.55	130.87	149.41	137.18	86.88	109.80
17. CATCH IN LBS. / MAN-HOUR	11.13			5.57	7.64	5.75	19.81	18.91	21.29	24.82	24.53	15.29	18.12
18. CATCH IN NO. / MAN-HOUR	7.09			4.50	5.72	4.11	15.66	14.92	16.79	19.26	18.19	12.85	14.08
19. CATCH IN LBS. / BOAT-DAY	185.11			70.57	98.26	84.00	279.02	273.27	289.84	350.88	339.07	183.78	253.63
20. CATCH IN NO. / BOAT-DAY	117.89			57.00	73.61	59.96	220.48	215.67	228.63	272.21	251.50	154.44	197.13
21. VALUE / TRAP-HAUL ($)	5.69			2.33	2.33	1.88	3.85	4.14	4.55	5.67	5.29	4.32	4.11
22. VALUE / MAN-DAY ($)	372.27			301.20	225.23	197.46	493.58	453.12	499.07	551.49	414.65	296.84	426.58
23. VALUE / MAN-HOUR ($)	49.73			33.94	31.22	24.76	60.71	57.05	64.05	71.08	54.99	43.92	54.73
24. VALUE / BOAT-DAY ($)	827.26			430.29	401.50	361.38	854.94	824.35	871.87	1004.80	760.19	527.72	765.89
25. VALUE / BOAT-HOUR ($)	110.50			50.28	56.29	45.64	105.03	104.62	114.33	133.20	105.80	79.10	99.77

*No boats fishing on selected sampling days.

Table 1. Survey catch and effort values summarized by category for each sample month, 2001.

JANUARY

Code	Length	Weight	Female	Soft	Cull
W-9	98.6	791.4	73.7%	0.0%	5.5%
L-4	86.4	503.0	49.1%	0.0%	10.9%
K-14	91.8	627.0	90.0%	0.0%	20.0%
X	92.3	640.5	71.0%	0.0%	12.1%
SE	3.5	83.5	0.1	0.0	0.0

FEBRUARY*

Code	Length	Weight	Female	Soft	Cull
X					
SE	0.0	0.0	0.0	0.0	0.0

MARCH*

Code	Length	Weight	Female	Soft	Cull
X					
SE	0.0	0.0	0.0	0.0	0.0

APRIL

Code	Length	Weight	Female	Soft	Cull
Y-24	88.0	545.3	42.2%	0.0%	10.0%
S-3	87.1	528.6	51.1%	0.0%	10.4%
X	87.5	536.9	46.6%	0.0%	10.2%
SE	0.4	8.3	0.0	0.0	0.0

MAY

Code	Length	Weight	Female	Soft	Cull
K-32	89.1	590.9	62.6%	0.0%	7.6%
S-4	92.1	637.6	82.6%	0.0%	11.0%
H-17	90.2	629.9	50.6%	0.0%	1.8%
K-6	88.5	570.8	48.6%	0.0%	2.1%
K-17	89.5	585.3	57.2%	0.0%	15.8%
X	89.9	602.9	60.3%	0.0%	8.6%
SE	0.6	13.1	6.1%	0.0%	2.3%

JUNE

Code	Length	Weight	Female	Soft	Cull
H-8	87.8	565.5	20.0%	0.0%	7.0%
K-38	90.5	602.6	61.6%	0.0%	6.5%
K-16	92.2	649.5	59.9%	0.0%	10.3%
W-7	87.5	558.8	54.8%	0.0%	5.9%
K-22	93.7	692.5	58.7%	0.0%	6.4%
K-5	93.6	705.9	48.4%	0.0%	10.0%
H-5	90.9	643.4	54.9%	6.4%	5.1%
H-1	89.7	602.2	73.2%	0.2	16.6%
X	90.7	627.5	53.9%	3.3%	8.5%
SE	0.8	19.3	5.5%	2.5%	1.3%

JULY

Code	Length	Weight	Female	Soft	Cull
H-15	89.3	590.0	60.0%	30.0%	0.0%
L-3	91.4	596.8	33.2%	74.8%	5.9%
W-23	93.1	681.5	50.0%	0.0%	8.6%
C-17	88.6	534.4	29.1%	100.0%	10.9%
C-25	89.0	551.1	39.8%	92.1%	15.8%
K-38	90.2	551.7	18.5%	100.0%	7.9%
C-23	89.0	544.4	29.2%	100.0%	4.4%
H-17	90.3	576.7	39.5%	100.0%	9.3%
X	90.1	578.3	37.4%	74.6%	7.8%
SE	0.5	16.7	4.6%	13.7%	1.6%

AUGUST

Code	Length	Weight	Female	Soft	Cull
H-1	91.1	614.3	47.2%	100.0%	4.6%
C-32	89.0	565.7	44.6%	100.0%	4.7%
L-3	89.4	549.1	33.9%	100.0%	7.5%
K-7	89.4	564.2	41.9%	100.0%	7.9%
C-35	88.5	544.7	39.0%	100.0%	12.2%
C-11	88.7	545.0	28.9%	100.0%	11.6%
H-7	90.2	576.9	34.6%	100.0%	4.6%
C-18	88.6	545.9	53.7%	100.0%	6.1%
C-1	88.0	520.2	42.0%	100.0%	12.4%
X	89.2	558.4	40.7%	100.0%	7.9%
SE	0.3	8.8	2.5%	0.0%	1.1%

SEPTEMBER

Code	Length	Weight	Female	Soft	Cull
L-4	90.2	603.6	39.0%	94.6%	8.1%
C-18	87.8	532.6	64.0%	100.0%	9.7%
C-15	89.0	549.2	53.9%	100.0%	8.4%
L-15	88.6	541.0	44.2%	100.0%	11.1%
Y-24	88.3	531.3	55.6%	100.0%	16.4%
H-20	88.9	561.1	50.6%	100.0%	2.0%
K-37	90.0	574.7	55.9%	100.0%	6.2%
H-6	91.8	615.6	42.2%	100.0%	6.7%
K-40	90.1	580.4	63.6%	100.0%	5.4%
X	89.4	565.5	52.1%	99.4%	8.2%
SE	0.4	10.1	3.0%	0.6%	1.4%

OCTOBER

Code	Length	Weight	Female	Soft	Cull
K-43	90.9	592.4	54.4%	100.0%	9.2%
K-25	90.1	574.1	47.8%	100.0%	8.2%
L-9	89.6	555.5	59.2%	100.0%	8.5%
W-11	89.3	547.7	62.6%	100.0%	17.2%
C-21	91.0	584.5	48.5%	100.0%	8.5%
C-25	90.3	573.2	55.0%	100.0%	10.5%
K-5	88.6	555.1	39.0%	100.0%	9.8%
X	90.0	568.9	52.4%	100.0%	10.3%
SE	0.3	6.3	0.0%	0.0%	1.2%

NOVEMBER

Code	Length	Weight	Female	Soft	Cull
L-20	89.7	555.4	30.0%	100.0%	16.6%
H-38	87.4	506.0	40.0%	100.0%	20.0%
W-24	97.5	758.0	52.4%	100.0%	8.8%
W-17	97.7	769.6	77.0%	100.0%	7.6%
K-14	91.4	605.5	59.2%	100.0%	6.9%
C-28	89.8	555.9	67.2%	100.0%	25.1%
X	92.2	625.1	54.3%	100.0%	14.2%
SE	1.8	45.7	7.1%	0.0%	3.1%

DECEMBER

Code	Length	Weight	Female	Soft	Cull
Y-9	88.3	511.4	60.0%	100.0%	12.8%
H-24	90.0	556.0	50.0%	100.0%	30.0%
L-11	89.1	563.7	50.8%	0.0%	4.2%
K-14	88.2	541.0	60.0%	100.0%	10.0%
X	88.9	543.0	55.2%	75.0%	14.2%
SE	0.4	11.6	2.8%	25.0%	5.6%

* No boats fishing on selected sampling days.

Yearly Totals

Code	Length	Weight	Female	Soft	Cull
X	90.1	584.9	50.6%	65.9%	9.7%

Table 2. Mean carapace length (mm) and weight (gm) with percentages of female, soft-shell, and cull (missing and/or regenerated claws[s]) lobsters in cluster samples by dealer code and sampled month, 2001.

MONTH	Catch in Pounds	Catch in Numbers	Value in Dollars	Number of Traps	Number of Trap-Hauls	Number of T.H.S.O.D.	Number of Man-Days	Number of Boat-Days	Pounds per Trap-Haul	Numbers per Trap-Haul	Numbers per T.H.S.O.D.	Pounds per Boat-Day	Pounds per Man-Day
JAN	433,826	276,284	1,938,769	79,660	340,603	4,869,220	5,208	2,344	1.27370	0.81116	0.05674	185.11111	83.30000
	+/- 286,797	+/- 170,878	+/- 1,290,038	+/- 63,882	+/- 265,813	+/- 3,895,098	+/- 3,901	+/- 1,574	+/- 0.31677	+/- 0.29794	+/- 0.02194	+/- 20.10847	+/- 15.00941
FEB*													
	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
MAR*													
	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
APR	155610	125,685	948,780	149,888	407,295	2,680,650	3,150	2,205	0.38206	0.30859	0.04689	70.57143	49.40000
	+/- 125,657	+/- 100,325	+/- 756,051	+/- 165,088	+/- 324,014	+/- 1,908,266	+/- 2,300	+/- 1,630	+/- 0.01069	+/- 0.00197	+/- 0.01151	+/- 12.46061	+/- 10.08600
MAY	840,720	629,796	3,435,253	306,600	1,471,632	7,933,644	15,252	8,556	0.57128	0.42796	0.07938	98.26087	55.12195
	+/- 307,568	+/- 231,375	+/- 1,247,468	+/- 117,656	+/- 530,278	+/- 3,064,511	+/- 5,613	+/- 3,139	+/- 0.09307	+/- 0.07305	+/- 0.01588	+/- 15.86023	+/- 7.82208
JUN	1,458,475	1,041,113	6,274,605	495,605	3,329,071	20,262,715	31,777	17,363	0.43810	0.31273	0.05138	84.00000	45.89691
	+/- 539,620	+/- 368,774	+/- 2,360,912	+/- 207,799	+/- 1,327,787	+/- 8,402,472	+/- 12,012	+/- 6,480	+/- 0.09585	+/- 0.06555	+/- 0.01135	+/- 20.46888	+/- 10.14272
JUL	6,093,750	4,815,330	18,671,972	499,623	4,845,750	17,130,360	37,830	21,840	1.25755	0.99372	0.28110	279.01786	161.08247
	+/- 2,198,136	+/- 1,693,519	+/- 6,643,653	+/- 132,696	+/- 1,510,699	+/- 4,234,233	+/- 10,169	+/- 6,013	+/- 0.14731	+/- 0.11770	+/- 0.03518	+/- 43.52169	+/- 22.66016
AUG	8,583,498	6,774,534	25,893,509	692,582	6,252,281	23,212,268	57,145	31,411	1.37286	1.08353	0.29185	273.26506	150.20530
	+/- 2,047,372	+/- 1,596,013	+/- 6,027,627	+/- 135,483	+/- 1,128,301	+/- 5,695,309	+/- 10,262	+/- 5,670	+/- 0.12218	+/- 0.09516	+/- 0.01520	+/- 23.12231	+/- 12.98217
SEPT	9,454,401	7,457,568	28,439,661	687,066	6,246,342	26,632,431	56,985	32,619	1.51359	1.19391	0.28002	289.84337	165.91035
	+/- 2,231,912	+/- 1,704,008	+/- 6,848,406	+/- 128,511	+/- 1,254,738	+/- 4,626,520	+/- 10,791	+/- 6,365	+/- 0.16891	+/- 0.12407	+/- 0.02427	+/- 37.67662	+/- 21.58616
OCT	10,798,862	8,377,614	30,923,833	786,449	5,456,347	27,318,415	56,073	30,777	1.97914	1.53539	0.30667	350.87671	192.58647
	+/- 4,311,459	+/- 3,271,895	+/- 12,649,003	+/- 232,889	+/- 1,613,970	+/- 8,461,537	+/- 16,605	+/- 8,889	+/- 0.33895	+/- 0.24425	+/- 0.04692	+/- 80.27231	+/- 37.97766
NOV	3,845,016	2,852,010	8,620,517	309,687	1,628,424	11,534,670	20,790	11,340	2.36119	1.75139	0.24726	339.06667	184.94546
	+/- 2,527,542	+/- 1,947,416	+/- 5,419,091	+/- 163,618	+/- 969,607	+/- 8,299,751	+/- 11,160	+/- 5,774	+/- 0.27909	+/- 0.22077	+/- 0.01050	+/- 59.01034	+/- 26.93234
DEC	1,117,773	939,362	3,209,712	205,383	743,042	4,817,102	10,813	6,082	1.50432	1.26421	0.19501	183.77778	103.37500
	+/- 871,932	+/- 723,892	+/- 2,600,401	+/- 168,556	+/- 541,080	+/- 3,454,765	+/- 7,652	+/- 4,327	+/- 0.10777	+/- 0.08181	+/- 0.01831	+/- 18.56919	+/- 12.59342
TOTAL	42,781,931	33,289,296	128,356,611	4,212,543	30,720,787	146,391,475	295,023	164,537	1.36195	1.05855	0.21821	253.62989	141.26633
	+/- 6,342,413	+/- 4,854,837	+/- 18,244,530	+/-	+/- 3,344,743	+/- 17,972,058	+/- 31,310	+/- 17,230	+/- 0.07287	+/- 0.05406	+/- 0.00994	+/- 17.01551	+/- 8.59066

Table 3. Expanded estimates of catch and effort with standard errors calculated for all dealer-days, 2001.

CL	Jan*			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec			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	M	F	Tot
82													5	3	8		1	1	4	3	7		2	2				1		1	10	9	19
83	1	2	3	5	10	15	8	15	23	20	32	52	15	19	34	29	28	57	20	39	59	14	18	32	9	8	17	6	10	16	127	181	308
84	2	2	4	5	4	9	13	11	24	31	26	57	19	17	36	30	40	70	38	21	59	22	26	48	5	6	11	5	13	18	170	166	336
85	3	2	5	5	3	8	9	13	22	21	19	40	17	21	38	27	39	66	36	47	83	24	38	62	9	7	16	5	7	12	156	196	352
86	2	2	4	6	2	8	6	9	15	16	14	30	31	24	55	33	27	60	34	32	66	17	23	40	5	10	15	6	12	18	156	155	311
87	1	5	6	1	2	3	5	6	11	21	24	45	30	23	53	30	39	69	27	45	72	16	28	44	8	12	20	5	8	13	144	192	336
88	3	2	5	1	3	4	5	10	15	16	13	29	18	5	23	27	33	60	27	39	66	21	40	61	7	11	18	4	13	17	129	169	298
89	3	3	6	3	2	5	6	6	12	12	15	27	25	15	40	33	32	65	19	38	57	27	43	70	10	13	23	5	3	8	143	170	313
90	1	7	8	3	2	5	6	11	17	8	11	19	19	11	30	31	32	63	30	34	64	16	31	47	4	15	19	8	8	16	126	162	288
91	1	5	6	2	1	3	8	10	18	6	17	23	30	19	49	37	21	58	18	31	49	22	33	55	13	14	27	5	8	13	142	159	301
92	1	2	3				7	6	13	8	19	27	32	10	42	45	18	63	23	38	61	25	44	69	7	10	17	6	5	11	154	152	306
93	2	2	4	2	2	4	2	8	10	4	7	11	26	6	32	30	16	46	21	20	41	29	32	61	6	16	22	5	4	9	127	113	240
94	1	1	2		1	1	2	9	11	9	23	32	17	6	23	36	13	49	23	12	35	30	16	46	8	8	16	3	6	9	129	95	224
95		3	3	1	1	2	1	4	5	2	9	11	22	7	29	18	8	26	24	14	38	20	13	33	3	8	11	2	1	3	93	68	161
96		1	1				3	3	6	7	12	19	11	3	14	20	5	25	20	11	31	14	9	23	6	5	11	2		2	83	49	132
97							2	5	7	8	4	12	19	2	21	14	3	17	9	6	15	9	7	16	6	3	9	2		2	69	30	99
98				1		1	1	1	2	5	7	12	10	2	12	8	1	9	8		8	8	1	9	4	4	8				45	16	61
99		1	1				3	1	4	5	5	10	5	1	6	5	1	6	7		7	4		4	6	1	7				35	10	45
100				1		1	1	1	2	3	3	6	2	1	3	4		4	3	1	4	5		5	5	1	6				24	7	31
101		1	1				2	1	3	2	1	3	4		4	3		3										1		1	12	3	15
102		1	1		1	1	1		1	2	3	5				1		1	1		1				1		1				6	5	11
103		1	1							1	4	5		1	1										1	2	3	1		1	3	8	11
104	1		1							1	5	6														1	1				2	6	8
105	2	1	3					1	1	1	1	2	1		1											1	1				4	4	8
106										1	2	3										1		1		2	2				2	4	6
107		3	3								2	2				1		1	2		2					1	1				3	6	9
108		3	3				1		1	1	2	3											1	1		1	1				2	7	9
109		2	2								2	2							1		1					1	1				1	5	6
110		2	2							2		2														2	2				2	4	6
111	1	2	3				1		1	1		1							1		1	1		1		1	1				5	3	8
112		2	2							1	1	2														1	1				1	4	5
113							1		1	4		4							2		2				1	1	2				8	1	9
114		1	1					1	1	1	1	2				1		1								2	2				2	5	7
115		1	1								1	1																				2	2
116		1	1				1		1	1		1														2	2				2	3	5
117										2	2	4														1	1				2	3	5
118										1		1		1	1					1	1				1		1				2	2	4
119											1	1	1		1																1	1	2
120	1	2	3				2		2	1		1														2	2				4	4	8
121		1	1								1	1														1	1					3	3
122										1		1																			1		1
123																																	
124										1		1													1		1				2		2
125										1		1																			1		1
126										1		1																			1		1
127																																	
Total	26	64	90	36	34	70	97	132	229	229	289	518	359	197	556	463	357	820	398	432	830	325	405	730	126	174	300	72	98	170	2,131	2,182	4,313

* No boats fishing on selected sampling days in February and March.

Table 5. Carapace length (CL) frequencies from the survey cluster samples by sex and month, 2001.

Year	Total Commercial Catch in Numbers	(0.93-1.32 lbs.) 81-92 mm.	(1.36-1.98 lbs.) 93-106 mm.	(2.03-2.95 lbs.) 107-122 mm.	(3.02-3.31 lbs 123-127 mm.(lega
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.) 82-93 mm.	(1.41-2.04 lbs.) 94-107 mm.	(2.09-3.02 lbs.) 108-123 mm.	(3.09-3.31 124-127 mm.(le
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.) 83-94 mm.	(1.45-2.09 lbs.) 95-108 mm.	(2.15-3.09 lbs.) 109-124 mm.	(3.16-3.31 125-127 mm.(le
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%

Table 6. Size composition by catch in numbers and 14 percent molt groupings of total Maine landings, 1967-2001.

Commercial Sea Sampling
Alison Sirois and Carl Wilson

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 resource from three ports (Cape Porpoise, Boothbay Harbor, Tenants Harbor/Spruce Head) in 1985. Since 1999 we have visited each of seven lobster management zones three times each month from May through November. From 1985 through 1999, specific biological data were collected from every third to sixth trap. In 2000, DMR began using voice recorders to collect data from nearly 97% of all traps hauled. Other additions included spatial positions, depth, and molt status.

The 2001 lobster season had a year influenced not only by biological factors but also by the events of September 11th. Prices were dropping before September 11th but a dramatic decline was observed in December (Figure 5, Port sampling). This may have contributed to a drop off in harvest rate and a lower catch for 2001. Biologically, 2001 started slowly, colder than normal temperatures may have caused delayed inshore movement and low catches. May and June averaged 0.52 and 0.33 legals per trap haul, however the catch rates quickly increased to normal (1.73 legals per trap haul) as the season moved along. This year specific length, sex, egg condition, presence of V-notch, and recent additions of shell condition and spatial data were recorded for 101,942 lobsters in over 95% of all traps (Table 1). The sea sampling program successfully collected information for 173 trips out of 80 different ports for the entire sampling season (Figure 1).

Legal and Sublegal Lobster

The catch per unit effort (CPUE) of legal and sublegal lobsters varied by management zone in 2001. From 1998-2001 the CPUE of legal lobster averaged 1.25 per trap haul with a low of 0.95 for Zone F and a high of 1.59 in Zone A (Figure 2). When compared to 2000, 2001 data showed decreases in legal CPUE for all zones with the exception of Zone A. Zone A continued to increase from 1.64 in 2000 to 2.04 per trap haul in 2001.

Due to the increase in vent size implemented in 1999, an assumption of a higher mean weight of legal lobsters for 2001 was expected. The average size increased from 1.26 lbs. per legal lobster in 1998 and 1999 to 1.30 lbs. per lobster in 2001, a 4% increase in yield per lobster (Table 1).

The average catch rate of sublegal lobsters was 1.64 per trap haul from 1998-2001 but varied by zone (Figure 3). Over the four year time period Zones E (2.47) and F (2.36) averaged the greatest catch per trap haul. In general over the four year period of expanded sampling, eastern zones (A, B and C) generally have lower catch rates than western zones (D, E, F and G). This pattern is consistent with published reports of juvenile lobster densities along the coast of Maine (Wilson and Steneck 2002). In 2001 four out of the seven zones showed an increase of sublegals per trap haul from 2000, with the greatest increase of 0.45 per trap haul was observed in Zone A. Zone F showed the largest decrease from 3.22 in 2000 to 1.67 per trap haul in 2001.

Oversize Lobster

The catch per trap haul of oversize lobsters (>127mm) decrease as you move from east to west along the coast of Maine (Figure 4). From 1998-2001 the greatest catch rates of oversize lobsters recorded was recorded east of Zone D. Following this trend the mean catch per trap haul of oversize lobster for the last four years shows Zone A at 0.023, Zone C at 0.015 and all other zones less then 0.01 per trap haul. In 2001, the average catch rate of oversize lobsters decreased in Zones A and C.

V-Notched and Berried Lobsters

In the 2001 sampling season 33% of all legal size females recorded were protected by a V-notch. The percent of legal size V-notches that are seen from one month to the next differs by geographic area. In 2001, 6% of the 11,781 v-notched lobsters recorded were sublegal. Generally we see the highest catch rate of V-notched sublegals is in the western part of the coast. Zone E had the highest rate of sublegal V-notched lobsters at 0.42 per trap haul and Zone B was the lowest at 0.02 per trap haul (Figure 5).

In 2001 22% of the 11,781 V-notch lobsters observed were berried and 68% of the berried lobsters were V-notched (Figure 6a.). The percentage of legal sized (>83 mm CL) berried lobsters with a v-notch was 76.5%. Zone B showed the highest percent overall of berried legal V-notch lobster at 83%. For 2001 the percent of V-notched legal size berried females by month stayed relatively constant throughout the season (Figure 7). Comparing multiple years (1999-2001) of data by month trends are relatively consistent with 2001 (Figure 8). Higher percentages of v-notches are observed later in the season and may be a result of multiple recaptures and opportunities to receive a V-notch. Berried females are less likely to trap in colder water, may limit data collected in May and June. The Downeast Lobstermans Association will initiate a voluntary V-notch count in the spring of 2002. This survey will provide a useful compliment to the sea sampling program, as the combined number of trap hauls will most likely be greater than we are able to achieve by sea sampling. Overall the mean number of berried females per trap haul was greater in 2001 for most zones, Zone A showed the greatest increase of 0.05 per trap haul from 2000 (Figure 9).

V-notching has been the primary conservation tool put forth by Maine lobstermen. The sea sampling program records different conditions of V-notched flippers (man-made, mutilation or uropod partially regenerated). Each category is also noted as old or new. In 2001 the greatest percentage of V-notches seen were man-made (47% old and 37% new) (Figure 10). When looking at all categories comparing old to new V-notches, Zone B showed an inverse relationship as was observed in the other zones (Figure 11). Zone D had the greatest difference of old to new, with 74% old and 26% new V-notches.

New regulations for mandatory V-notching, put in place by Atlantic States Marine Fisheries Commission, will be going into affect in July 2002. Past and future V-notch data collected by the sea sampling program will be a tool used to track the success of V-notching practiced by

lobstermen. Because it is difficult to determine how many newly notched lobsters for 2001 were previously V-notched new V-notch condition codes will added for 2002.

Egg Extrusion

The sea sampling program collects information on the catch rates of berried females. In addition the program assesses the developmental stage of eggs for each lobster (newly extruded, eye spots and hatching). Extrusion and release cycles can be inferred from egg stage. In 2001 hatching primarily occurred in June and July with extrusion beginning in July and continuing through November.

Spatial variation in the size of egg bearing lobsters increases from west to east and may be an indication of local size of maturation (Figure 13a). Size distribution of berried lobster is significant due to the fact fecundity increases with size.

Collaborations with Industry

Results for the 2001 season have been distributed to the industry in several ways. Individual trip reports for over 85 lobstermen were sent in January along with annual data summaries. DMR staff scientists have also presented and are scheduled to present the data results of the 2001 season to all zone councils by the end of March. Included in these presentations will be zone specific analysis looking at biological issues and observations within each zone. Data summaries were published in the DMR lobster newsletter and will be represented at the Fishermen's Forum.

2001 Sea Sampling Monthly Totals

	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	TOTAL
TOTAL CATCH IN POUNDS	1,729	2,449	7,590	15,774	9,159	11,312	7,607	**55,620**
TOTAL CATCH IN NUMBERS	5,295	10,503	13,359	21,493	15,154	20,519	15,619	**101,942**
TOTAL NUMBER OF SAMPLING TRIPS	15	30	32	30	20	27	19	**173**
TOTAL NUMBER OF BOAT-HOURS	111	217	262	263	179	207	172	**1,411**
TOTAL NUMBER OF TRAP-HAULS	2,506	5,763	6,813	6,843	4,080	4,890	3,849	**34,744**
TOTAL NUMBER OF LEGAL LOBSTERS	1,309	1,880	5,848	11,826	7,092	8,256	6,364	**42,575**
TOTAL NUMBER OF SUBLEGAL LOBSTERS	3,385	7,037	6,794	8,108	6,768	9,100	6,283	**47,475**
TOTAL NUMBER OF OVERSIZE LOBSTERS	9	53	21	33	31	70	114	**331**
MEAN WEIGHT IN POUNDS OF LEGAL LOBSTERS	1.32	1.30	1.30	1.33	1.29	1.37	1.20	**1.31**
TOTAL NUMBER OF LEGALS PER TRAP-HAUL	0.52	0.33	0.86	1.73	1.74	1.69	1.65	**1.23**
TOTAL NUMBER OF POUNDS PER TRAP-HAUL	0.69	0.42	1.11	2.31	2.24	2.31	1.98	**1.60**
TOTAL NUMBER OF BERRIED LOBSTERS	242	719	306	406	229	1,002	999	**3,903**
TOTAL NUMBER OF BERRIED LOBSTERS w/ V-NOTCH	152	456	163	270	141	704	755	**2,641**
TOTAL NUMBER OF BERRIED LOBSTERS w/o V-NOTCH	90	263	143	136	88	298	244	**1,262**
TOTAL NUMBER OF NON-BERRIED LOBSTERS w/ V-NOTCH	440	1,142	763	1,212	1,152	2,371	2,061	**9,141**

2001 Sea Sampling Zone Totals

	A	B	C	D	E	F	G	TOTAL
TOTAL CATCH IN POUNDS	10,317	6,666	5,495	15,628	6,193	7,544	3,778	**55,621**
TOTAL CATCH IN NUMBERS	13,696	10,869	8,598	26,543	16,627	18,014	7,595	**101,942**
TOTAL NUMBER OF SAMPLING TRIPS	19	22	18	47	21	28	18	**173**
TOTAL NUMBER OF BOAT-HOURS	156	191	161	351	178	215	159	**1,411**
TOTAL NUMBER OF TRAP-HAULS	3,572	5,211	3,442	9,156	3,779	6,708	2,876	**34,744**
TOTAL NUMBER OF LEGAL LOBSTERS	7,284	5,071	4,037	12,062	5,621	5,680	2,820	**42,575**
TOTAL NUMBER OF SUBLEGAL LOBSTERS	4,562	4,416	3,303	11,598	9,358	10,395	3,843	**47,475**
TOTAL NUMBER OF OVERSIZE LOBSTERS	109	58	49	78	22	6	9	**331**
MEAN WEIGHT IN POUNDS OF LEGAL LOBSTERS	1.42	1.31	1.36	1.30	1.10	1.33	1.34	**1.31**
TOTAL NUMBER OF LEGALS PER TRAP-HAUL	2.04	0.97	1.17	1.32	1.49	0.85	0.98	**1.23**
TOTAL NUMBER OF POUNDS PER TRAP-HAUL	2.89	1.28	1.60	1.71	1.64	1.12	1.31	**1.60**
TOTAL NUMBER OF BERRIED LOBSTERS	790	337	382	1,018	381	689	306	**3,903**
TOTAL NUMBER OF BERRIED LOBSTERS w/ V-NOTCH	569	280	256	748	259	339	190	**2,641**
TOTAL NUMBER OF BERRIED LOBSTERS w/o V-NOTCH	221	57	126	270	122	350	116	**1,262**

Table1. Summary Statistics for 2001 Sampling Season by Zone and Month

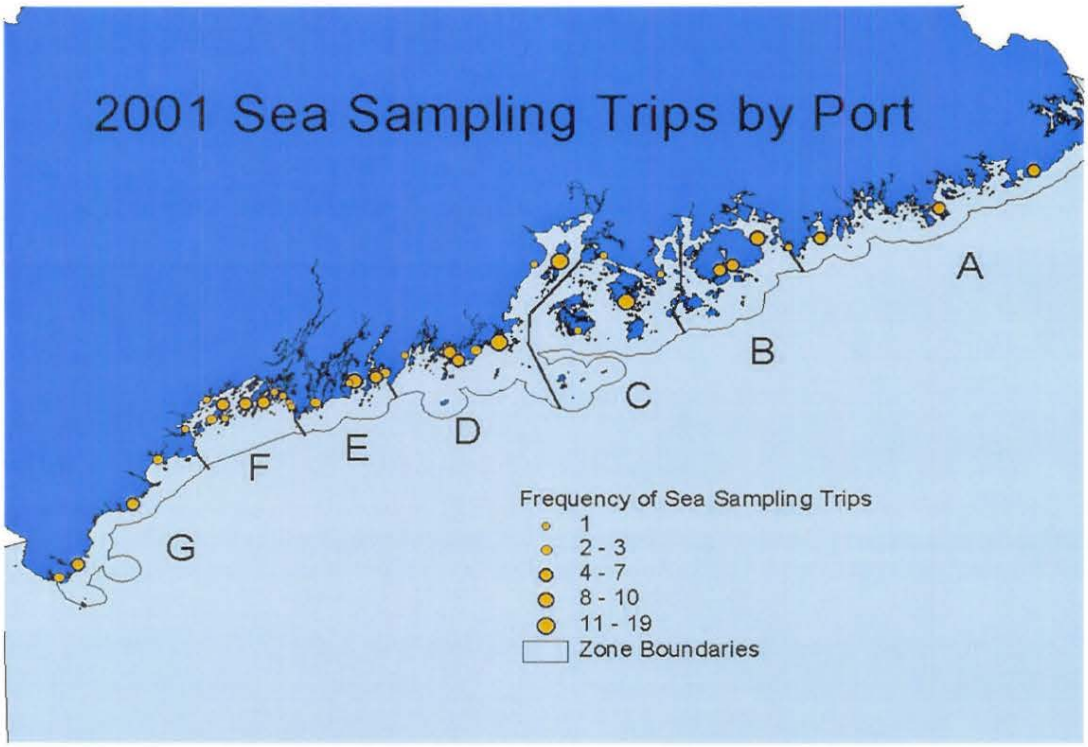
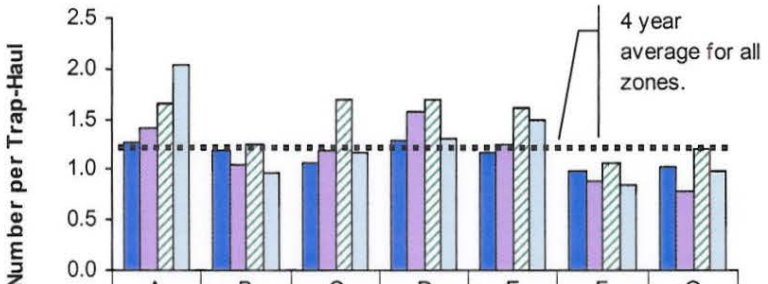
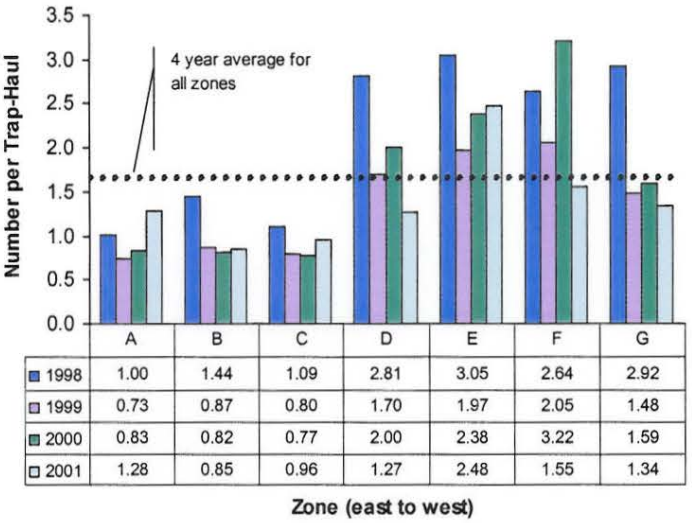


Figure 1. Sea Sampling Trips by Port in 2001



	A	B	C	D	E	F	G
1998	1.27	1.18	1.07	1.28	1.18	0.98	1.02
1999	1.41	1.05	1.19	1.57	1.25	0.89	0.79
2000	1.64	1.26	1.69	1.69	1.61	1.07	1.20
2001	2.04	0.97	1.17	1.32	1.49	0.85	0.98

Figure 2. Catch per trap haul of legal lobster 1998-2001 in the seven lobster management zones.



	A	B	C	D	E	F	G
1998	1.00	1.44	1.09	2.81	3.05	2.64	2.92
1999	0.73	0.87	0.80	1.70	1.97	2.05	1.48
2000	0.83	0.82	0.77	2.00	2.38	3.22	1.59
2001	1.28	0.85	0.96	1.27	2.48	1.55	1.34

Figure 3. Catch per trap haul of sublegal lobster 1998-2001 in the seven lobster management zones.

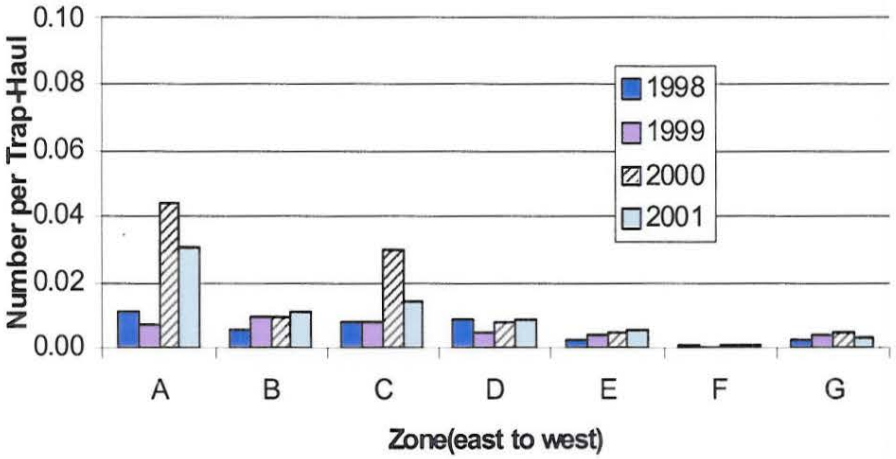


Figure 4. Catch per trap haul of oversize lobster 1998-2001 in the seven lobster management zones

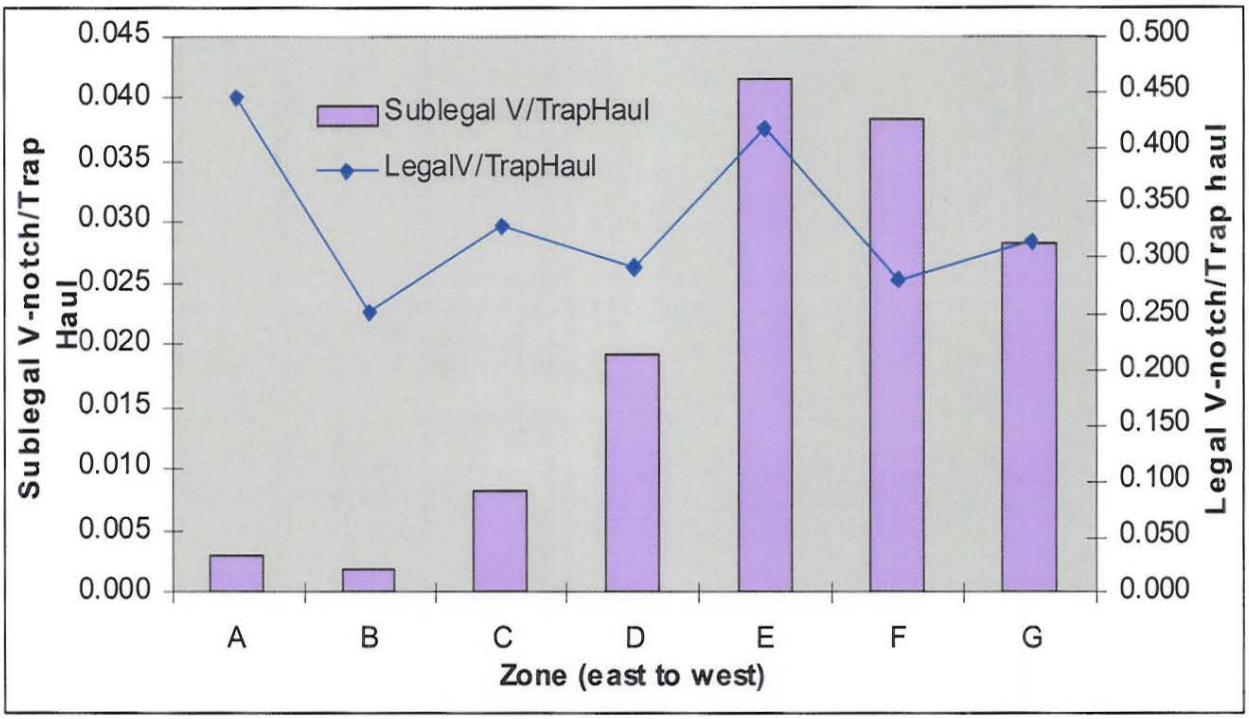


Figure 5. The observed percent of sublegal V-Notches showed a shift from west to east in the number of undersized(<83mm) lobster. Legal size V-notches varied by zone.

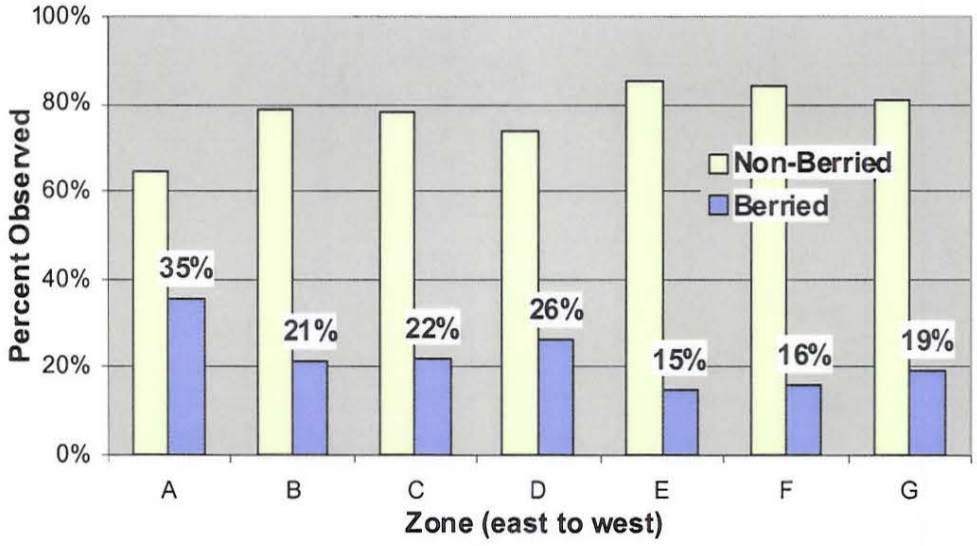


Figure 6a. 2001 V-Notch Lobster berried and non berried.

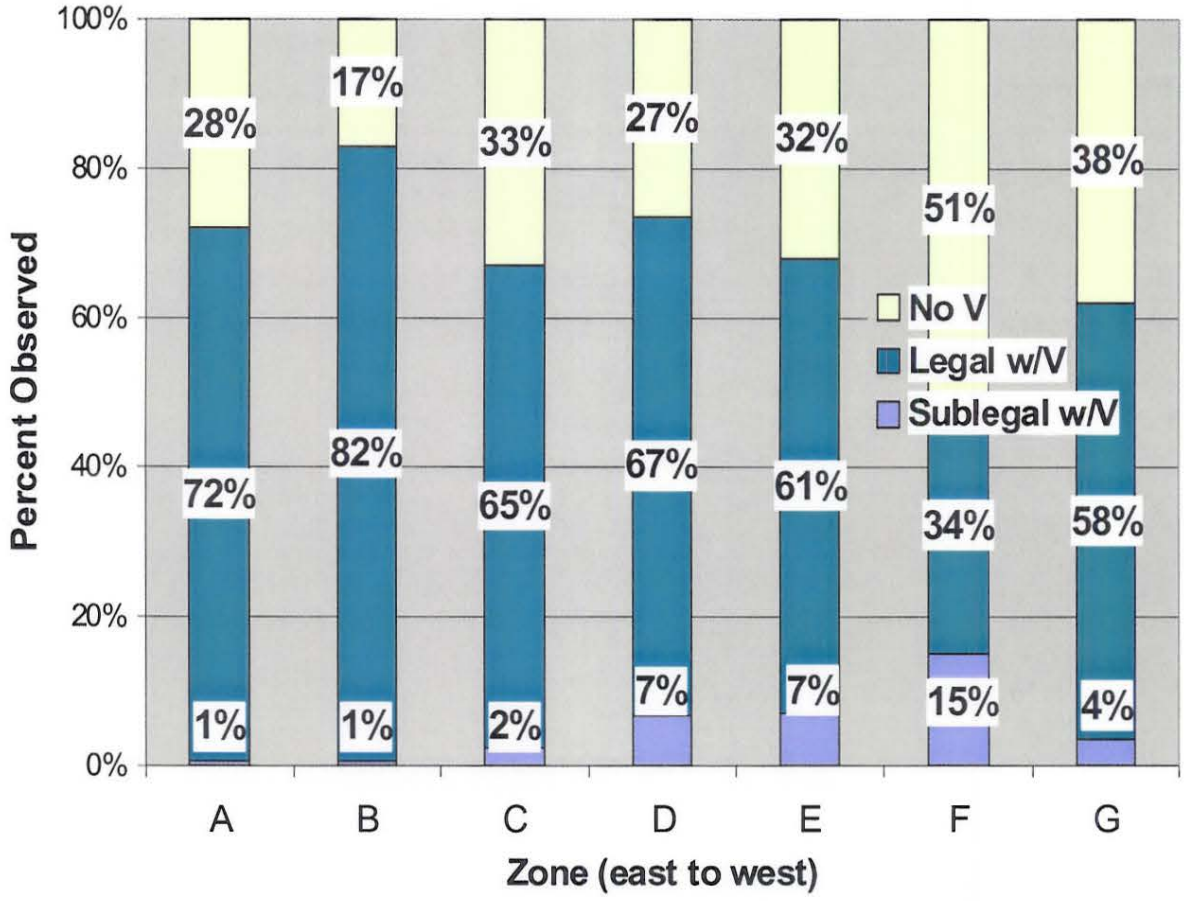


Figure 6b. 2001 Observed Percent Berried Lobster; Legal size with V-notch, Sublegal Size with V-notch, Lobster with No V-Notch.

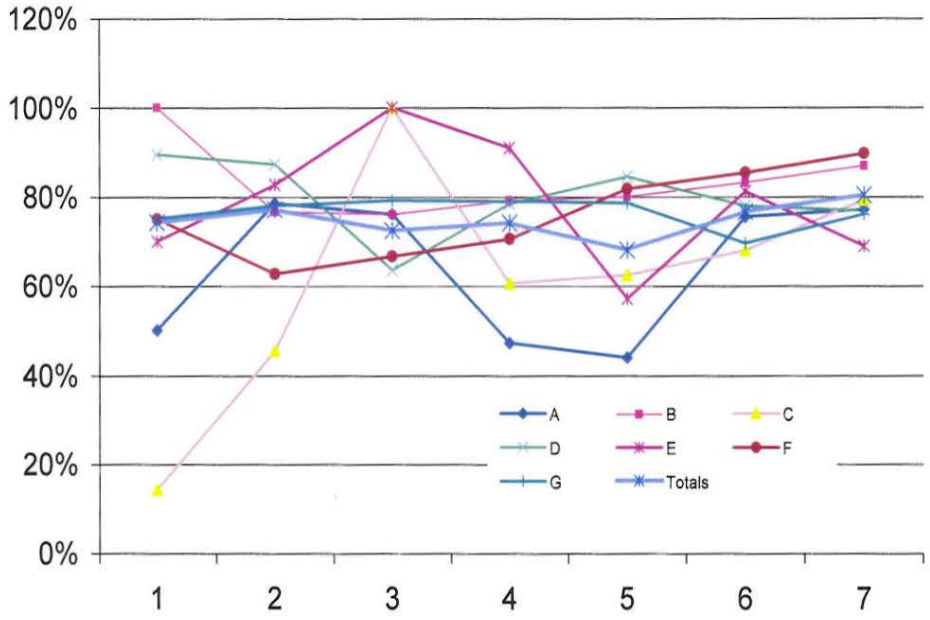


Figure 7. 2001 Egg Bearing Lobsters (>83 mm CL) with V-notch by month starting in May.

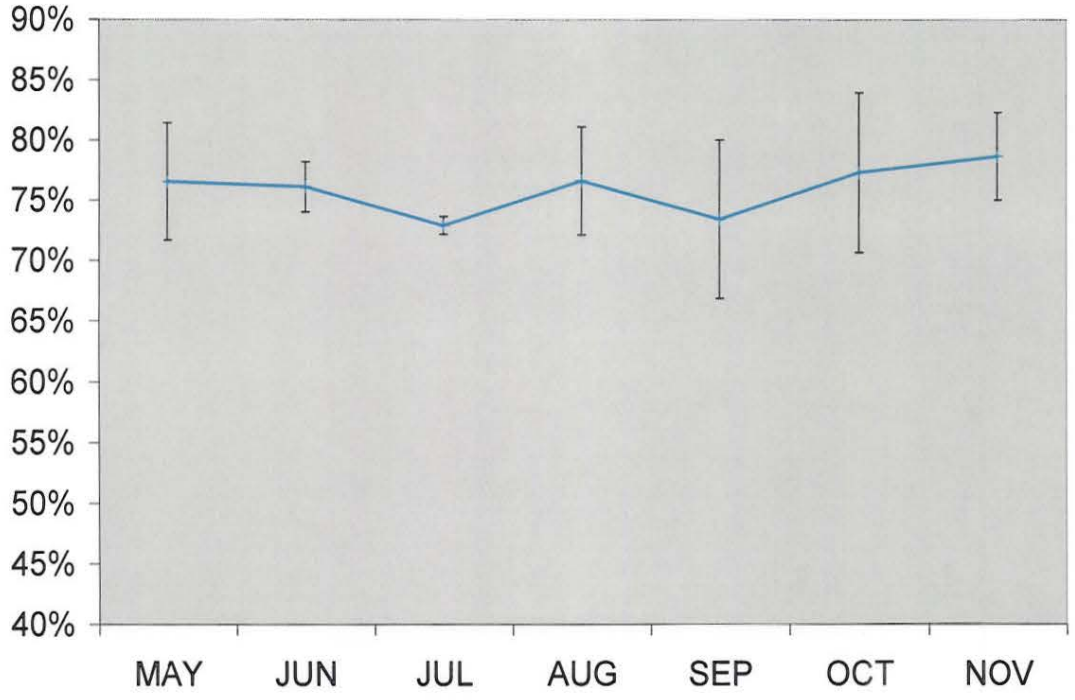


Figure 8. Egg Bearing Lobsters (>83 mm CL) with V-notch by month. (1999-2001). Error bars indicated standard deviation between years.

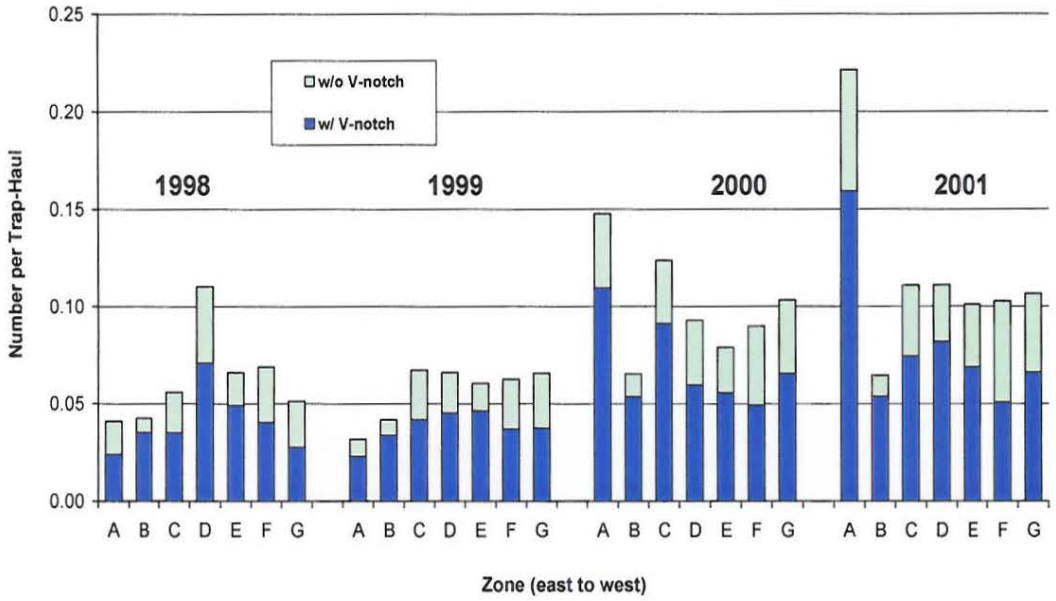


Figure 9. 2001 Catch per trap haul of berried female lobster from 1998 to 2001. Approximately 68% of all berried female are protected by a V-notch.

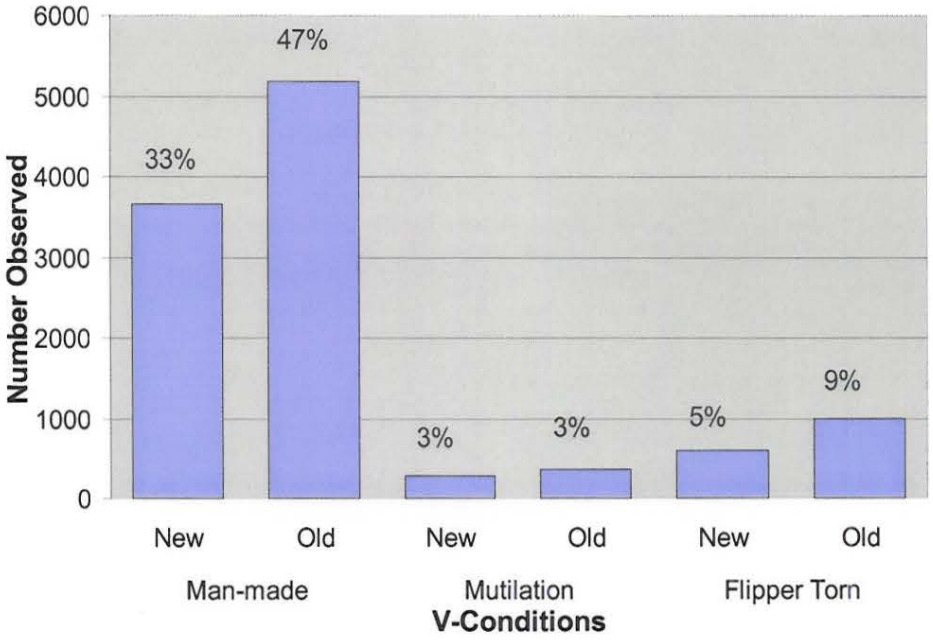


Figure 10. The observed percentages of V-notch categories for all berried and non-berried legal size V-notch lobsters in 2001 (all zones).

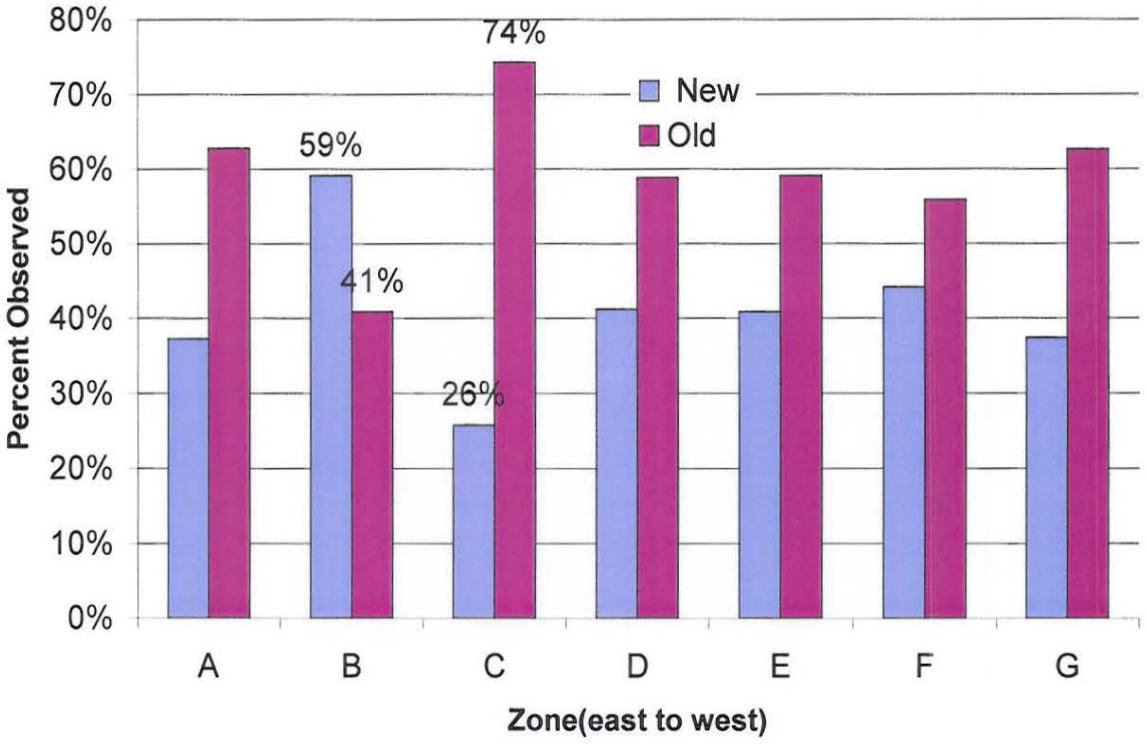


Figure 11. The percentage of New and Old V-Notch Categories for Legal Size (>83 mm CL) lobsters by zone in 2001.

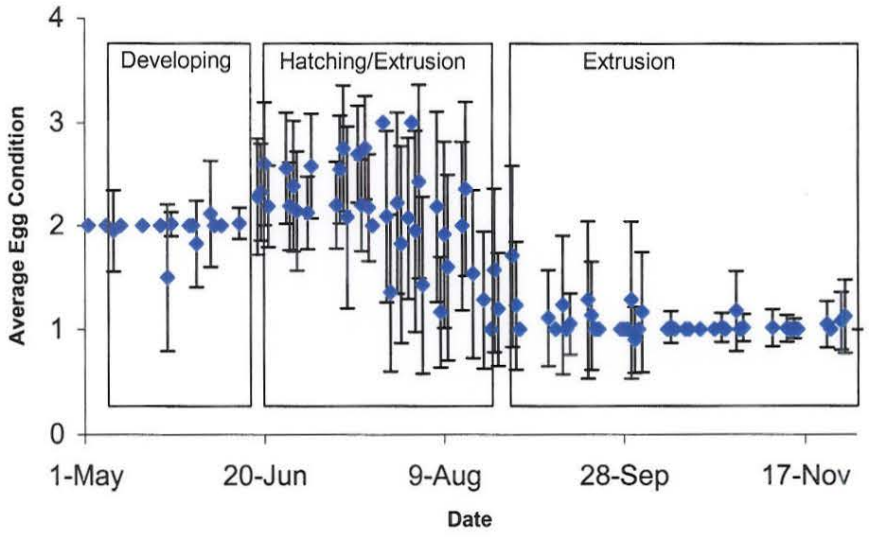


Figure 12. Egg development, hatching, and release as determined by daily sea sampling trips in 2001.

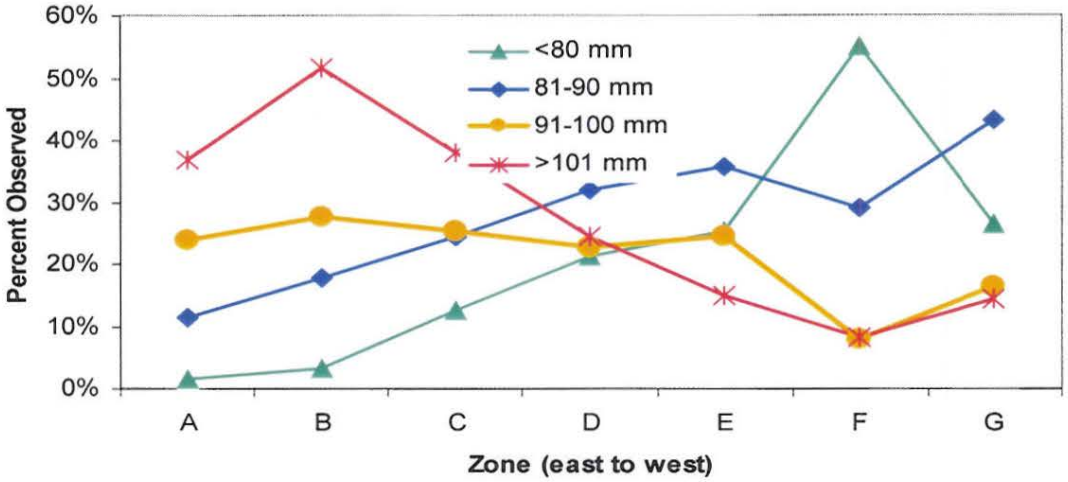


Figure 13a. Percent observed berried lobster by length group by zone for the 2001 sampling season.

Lobster Resource Assessment and Monitoring

The lobster program has been an active participant in ASFMC technical committee meetings and in an advisory role for LCMT and Management boards. Data collected in the lobster port and sea-sampling programs was used in the evaluation of the Area 1 plan submitted to ASMFC in June 2001. Specifically the percentages of V-notched lobsters were used as a proxy for V-notching compliance. Based on the field observations the LCMT proposed to increase V-notching to 100% mandatory compliance and strict "zero-tolerance" definition of V-notching.

The ASMFC has initiated the formation of a Lobster Database. The DMR has actively participated in the development and design of this database. Our programs will fully comply with the standards and will be readily available when needed.

As a way to further update existing and past data, periodic geographic positions are recorded during sea sampling trips. These positions were for the first time recorded in the lobster database in 2000. In 2001 we have returned to the original paper records of sea sampling trips, since 1985, to recover spatial information that was collected, but never inputted into a database.

A Comparative Analysis of Sea and Port Sampling Programs In Maine 1998-2000.
Kevin Scheirer, Dr. Yong Chen and Carl Wilson,

In the summer of 2001 a quantitative study was initiated to investigate the differences and similarities between the sea and port sampling programs. The two programs were established and designed to accomplish different goals. The port-sampling project was initiated in the summer of 1966; the purpose was to establish a coast-wide survey of the commercial lobster fishery. At that time the port-sampling project did not try to distinguish differences between regions of Maine, rather estimates were made on a monthly and annual basis for the coast. This is a randomized survey that factors in non-sampling days as part of the expanded estimates generated from the study. Only after the sampling design had been developed did spatial differences in catch and effort begin to be apparent. On the other hand the sea sampling program was explicitly designed to record the discarded catch in the lobster fishery. Started in 1985, the sea sampling program focused on three ports for the first 13 years. In 1998, the program was expanded to include all seven-lobster management zones, with the goal to document spatial variation along the coast of Maine. The sea sampling program draws on volunteers willing to take samplers out, this list was developed by the lobster zone councils. Understanding these differences in the two programs, DMR personnel initiated a collaborative project with the University of Maine to investigate these two programs.

Dr. Yong Chen (partially funded by DMR and the University of Maine) and his student, Kevin Scheirer, investigated differences in size composition and various measures of catch per unit of effort (cpue) of the port and sea sampling programs from 1998 to 2000. Correlations between different measures of cpue estimated by months within a sampling program tended to be strong and significant for each year, implying that all of these cpue measures would be sufficient in describing temporal variations in cpue. The strength of the statistical relationships between the two sampling programs varied depending on the measure of cpue, the year, and whether time or

area was the classification variable. The overall pattern that emerged was a stronger relationship between sea and port sampling data over time from 1998-2000, implying smaller differences between the two sampling programs in describing temporal variations in cpue. However mean yearly county cpue estimates showed significant differences between the two programs in all three years. Sea sampling tended to have a higher CPUE for each year and month, and could result from the non-random selection of volunteers. Size composition reported by the two programs was very similar with significant differences in only three months out of the twenty-one tested. An important finding of this study was to document the differences in magnitude of CPUE between the two programs. For all three years CPUE observed in the sea sampling program was significantly higher than that observed by the port sampling program. This difference may be attributed to the randomized nature of the port sampling program and the non-random nature of the sea sampling program. The sea sampling program may be selecting for "high-line" fishermen who are actively involved in the Zone council process and have volunteered to participate in the sea sampling program. Please refer to Appendix I for the full report, this document will be included in Kevin Scheirer's Master Thesis and is currently being prepared for submittal to a refereed journal.

APPENDIX I:

A Comparative Analysis of Sea and Port Sampling Programs In Maine: 1998 - 2000

Prepared by

Kevin Scheirer and Yong Chen
School of Marine Sciences
University of Maine
Orono, ME 04469

For
Maine Department of Marine Resources

Executive Summary

Lobster fishery data from 1998 –2000 collected by the Maine Department of Marine Resources' port and sea sampling programs was analyzed for differences in size composition and various measures of catch per unit of effort (cpue). Correlations between different measures of cpue estimated by months within a sampling program tended to be strong and significant for each year, implying that all of these cpue measures would be sufficient in describing temporal variations in cpue. The strength of the statistical relationships between the two sampling programs varied depending on the measure of cpue, the year, and whether time or area was the classification variable. The overall pattern that emerged was a stronger relationship between sea and port sampling data over time from 1998-2000, implying smaller differences between the two sampling programs in describing temporal variations in cpue. However mean yearly county cpue estimates showed significant differences between the two programs in all three years. Size composition reported by the two programs was very similar with significant differences in only three months out of the twenty-one tested.

Introduction

The increase in effort in the sea sampling program since 1998 has provided a more comprehensive and detailed picture of the Maine lobster fishery. In comparison, the port sampling program has been in place since 1967, and has remained largely unchanged until 2000, when sampling time for port sampling was expanded to the entire year. As a result of the expansion of effort, a comparative analysis was needed for evaluating differences in the data collected from the two sampling programs. Of key interest were cpue and size composition estimates as well as the overall scale of sampling and data collected, which are essential in assessing and monitoring the lobster stock and developing management plans for the lobster fishery in the state of Maine.

Methods

The port and sea sampling programs were compared using data from 1998 to 2000, because the sea sampling effort was initially expanded in 1998 and continued through 2000. Port sampling data was compiled from the database file "daysum" for each year. *Sample date, dealer code, totlbs, numsold, traphauls,* and *thsod* were the selected data columns. From these categories four different measures of cpue were calculated for each sampling trip: lbs per trap haul (th), lbs per trap haul-set-over-day (thsod), number per trap haul, and number per thsod. The data columns *totlbs, numsold, traphauls*, and *thsod* were summed, and the overall yearly cpues were calculated. Mean and median cpue per sampling event, standard deviation, and coefficient of variance (std dev/mean) were calculated for each year using the per trip cpue numbers. A fifth measure of cpue, number per boat hour (num/boathr), was included later in the analysis and is not shown in the cpue statistics tables. It was calculated from the columns *boathrs* and *numsold* in the "daysum" file.

Sea sampling data was compiled from the database files "seanfo" and "seatrp." Data columns *fzone, date, traphauls, thsod, lbhard, lbsoft, lbcull*, and *lbselect* were used from "seanfo". Total pounds for each sample date were calculated by summing the four weight columns *lbhard, lbsoft, lbcull,* and *lbselect*. "Seatrp" was used to obtain numbers of legal lobsters from the column *totlegal*, and the column *sod* was used from "seatrp99" to calculate thsod because the thsod numbers were missing from "seanfo99". Columns *tot lbs* and *sumlegal* were added to the columns from the database and used to calculate the same four measures of cpue as was done for port sampling data: lbs/th, lbs/thsod, num/th, and num/thsod. The data columns were summed and overall yearly cpues were calculated. Mean and median cpue per sampling event, standard deviation, and coefficient of variance (std dev/mean) were calculated for each year using the per trip cpue numbers. The additional measure of cpue (num/boathr) was calculated from the *start* and *end* columns in the "seanfo" file, and from the *totlegal* column in "seatrp".

There were some questions as to whether pounds or numbers was a more appropriate measure of catch. The four measures of cpue were standardized for both port and sea sampling data sets from 1998-2000. The standardization consisted of subtracting the average cpue (for the

particular cpue measure) from the sample trip cpue and dividing that number by the corresponding standard deviation (for the particular cpue measure). This standardization gave the two sets of cpue the same scale, making them compatible. A regression analysis was performed for mean trip lbs/th vs. num/th for each year in both sea and port sampling data sets. We would consider there to be no difference in using pounds or numbers as a measure of catch if all the regression models had an r^2 greater than 90%, a slope estimate not significantly different from 1, and an intercept not significantly different from 0.

The comparison of port and sea sample cpues was done on a monthly time scale, using May to November for each program. The sea sampling program ran from May to November until 2000 when it was expanded further to include all twelve months. As a result, the analysis was constrained to this time period even though port sampling has run from April to December except for 2000 when sampling occurred in all twelve months. The time frame of a month was used because it averaged out the differences in sampling techniques (both in number of boats sampled per trip and number of trips per month) and would preserve a certain amount of variation over time.

A regression analysis was conducted with the port data as the independent or x variable and the sea data as the dependent or y variable. The measures of cpue used in the regression analysis were num/th, num/thsod, num/boathr, lbs/th, and lbs/thsod. The monthly means of the sampling trip cpues were plotted in one regression per year per measure of cpue, totaling fifteen regressions.

Another regression analysis compared mean num/thsod for each county. Sea sampling locations are categorized by lobster management area, whereas county categorizes port sampling locations. A table that lists each sea sampling location with the county that it is in was used to organize all locations according to county. Lincoln and Sagadahoc counties were combined because there were no sea sampling locations in Sagadahoc in 1998 and 2000. They are geographically adjacent and have smaller sample sizes on average than Cumberland or Knox counties (west and east of Lincoln and Sagadahoc). The mean sample trip num/thsod per county was calculated for 1998 to 2000. The regression analysis compared the two programs by county for each year.

Size composition between sea and port sampling was compared using a non-parametric test called the Kolmogorov-Smirnov test (Zar 1984). The test compares two independently sampled distributions to determine if the samples have been drawn from the same population. Lengths were obtained from the port sampling file "Inlob" and from the sea sampling file "Sealob" for years '98 to '00. The length categories followed the fourteen percent groupings used since 1989: 83-94mm, 95-108mm, 109-124mm, and 125-127mm. The frequency of each grouping was calculated for each month from May to November. The frequencies were then compared by the KS test.

Results

The standardized num/th and lbs/th were used to determine if there was a difference in using numbers or pounds as a measure of catch. Both sea and port sampling cpues were analyzed and the results are shown in Tables 13-14. The regression analysis showed no significant difference between the two measures of catch obtained from either program (r^2 greater than 0.90, slope not different from 1, intercept not different from 0), so we concluded that there was no difference in using numbers and pounds for describing the catch in estimating cpue.

The analysis of cpue, conducted on a monthly time scale, showed varying results. The cpue statistics are summarized in Tables 1-4. Mean sample trip cpue by month in four measures was tabled for each year and each sampling program (Tables 5-8). In addition to the first four measures (num/th, num/thsod, lbs/th, lbs/thsod), numbers per boat hour (num/boathr) was added as a way of comparing fishing fleet numbers. Results for the regression analysis of cpue by month includes slope, p-value, r^2 adjusted by sample size, and number of data pairs (sample size) for the model (Tables 15-17). Number per trap haul, number per trap haul set-over-day, and number per boat hour are shown. The analysis using pounds describing catch had similar results, so the numbers are not tabled. Regression plots of lbs/th are shown in Figure 5 for reference. A trend of improved relationship from 1998-2000 was seen in numbers per trap haul and numbers per boat hour (increased adjusted R^2 and smaller p-values: Tables 15 and 17). Numbers per trap haul set-over-day (Table 16) only showed this trend from 1998-1999. In 2000, the regression analysis showed no relationship between port and sea sampling data.

Cpue is used as a relative measure of fish stock abundance, so while the comparison of the absolute numbers of cpue is important, time series plots of cpue help give a more complete picture on differences in temporal variations of stock abundance implied by different measures of cpue. Four measures of standardized cpue were plotted from port and sea sample data on a monthly time scale for 1998-2000 (Figures 1-4). The variation from the mean was quite consistent between the two sampling programs from 1998-2000. The different measures of cpue showed different patterns of variation within the same year. The difference seemed to be caused by the measure of effort - trap hauls or trap haul set-over-days.

Counties were used to compare how the two sampling programs represented areas of the coast. Mean sample trip number per trap haul set-over-day was the measure of cpue used in the regression analysis (Tables 9,18). The relationship between the two programs was not significant in any of the three years ($P > 0.05$, Adj. $R^2 < .55$). Line plots show that the relationship improved from 1998 to 1999, but then degraded in 2000 (Figure 6). Standardized num/thsod plots show that the cpue from the two programs differs in variation from the mean (Figure 7).

The results for the Kolmogorov-Smirnov test of size compositions estimated from the two sampling programs show that they are very similar (Tables 10-12, 19). Over the three years they became less similar with November's composition being different in 1999 and 2000, and August's different in 2000.

Discussion

The comparison of the sea and port sampling program was conducted on an absolute scale and a relative scale. The absolute scale was concerned with statistical differences in the absolute cpue, while the relative scale looked at patterns over time between the two data sets. The strength of the statistical relationships between the two sampling programs varied depending on the measure of cpue, the year, and whether time or area was the classification variable. The overall pattern that emerged on both the absolute and relative scales was a closer relationship between sea and port sampling data over time from 1998-2000.

The per trip cpue data seem to be normally distributed for both programs with little difference between mean and median values (Tables 1-3), an indication of symmetric distribution of the data. Sea sampling tends to report higher values for monthly and area cpue (Tables 1-9). It also has larger variations for all four cpue measures in both 1999 and 2000 (but not 1998; Tables 1-3). This may be caused by the differences in the choice of fishermen sampled in the two programs. Sea sampling may select more successful fishermen, while port sampling selects from a range of fishermen. Port sampling also samples from a larger number of boats, which may explain why it has smaller variations in cpue estimates (Table 20). The standardized monthly cpue shows that the two data sets vary similarly around their means (Figures 1-4).

County cpue does not show this similarity and appears to vary differently around the yearly mean. This may be caused by a factor of time scale (year vs. month) as well as the measure of effort (only num/thsod for county means). Also, port sampling selects random dealers and may not sample in the same county more than once a month or not at all. Sea sampling makes trips three times a month in each of the seven zones. This may result in a difference in sample size depending on the county, contributing to variations in cpue (Table 21). By looking at Table 9, it is apparent that cpue estimates for each county can vary widely from year to year in either sampling program.

The regression analysis of monthly cpue showed slope values closer to 1, smaller p values, and higher adjusted R^2 values (Tables 15, 17). Measures of cpue with thsod as the measure of effort were the exception (Table 16). The strength of the statistical relationship between port and sea sampling decreased dramatically from 1999 to 2000. This may be a result of increased variation introduced by set-over-days. The variation would potentially increase as sample size increased as it did from 1998-2000 in the sea sampling program. The overall pattern of increasing relationship with time was still evident however, when standardized numbers and pounds per thsod were plotted in a monthly time series for the three years (Figures 2, 4). The degree and direction (positive or negative) of variation around the mean increased in similarity.

Finally, size composition of the legal catch recorded by each program was statistically the same for the majority of the months from May to November. The differences in 1999 and 2000 may have been caused by the large increase in number of measured lobsters in sea sampling, particularly in 2000 (Tables 11-12). Also of interest is that in November '98-'00, over 90% of the lobsters measured by port sampling were in the first grouping. In contrast, 84% or less of the measured catch in sea sampling was in the first grouping. Again, sample size may be the cause of this difference as well as the technique by which port sampling selects lobsters to be measured.

Acknowledgments

Carl Wilson, Gary Robinson, Jason Bartlett, Glenn Nutting, Norris Bowie, Robert Russell, and others collected all the data used by this report and were generous in sharing both the data and background knowledge associated with it. Dr. Linda Mercer directed financial support (as DMR Marine Studies Fellowship) and focus to this project. Financial support also comes from the University of Maine and Thistle Marine, LLC located in Ellsworth, Maine.

References

Zar, J. H. 1984. Biostatistical analysis. Second Ed. Prentice-Hall, Englewood Cliffs, New Jersey.

Sampling Progr	1998 Trip CPUE	mean	median	stdev	cv
Port	Lbs/Th	1.08	1.06	0.57	0.53
Sea	Lbs/Th	1.49	1.49	1.13	0.76
Port	Lbs/Thsod	0.27	0.24	0.26	0.94
Sea	Lbs/Thsod	0.32	0.32	0.21	0.65
Port	Num/Th	0.87	0.87	0.47	0.54
Sea	Num/Th	1.18	1.18	0.86	0.74
Port	Num/Thsod	0.22	0.20	0.20	0.91
Sea	Num/Thsod	0.25	0.25	0.17	0.65

Table 1: 1998 Comparison Statistics for four measures of CPUE

Sampling Pr	1999 Trip CPUE	Mean	median	stdev	cv
Port	Lbs/Th	1.07	1.01	0.56	0.52
Sea	Lbs/Th	1.44	1.44	1.00	0.69
Port	Lbs/Thsod	0.23	0.24	0.12	0.53
Sea	Lbs/Thsod	0.28	0.27	0.18	0.68
Port	Num/Th	0.86	0.81	0.45	0.52
Sea	Num/Th	1.12	1.12	0.78	0.70
Port	Num/Thsod	0.19	0.19	0.10	0.53
Sea	Num/Thsod	0.21	0.21	0.14	0.68

Table 2: 1999 Comparison Statistics for four measures of CPUE

Sampling Progr	2000 Trip CPUE	Mean	median	stdev	cv
Port	Lbs/Th	1.30	1.25	0.73	0.56
Sea	Lbs/Th	1.88	1.88	1.28	0.68
Port	Lbs/Thsod	0.30	0.25	0.20	0.66
Sea	Lbs/Thsod	0.39	0.39	0.30	0.77
Port	Num/Th	1.02	1.00	0.57	0.55
Sea	Num/Th	1.45	1.45	0.93	0.64
Port	Num/Thsod	0.24	0.20	0.15	0.65
Sea	Num/Thsod	0.29	0.29	0.22	0.75

Table 3: 2000 Comparison Statistics for four measures of CPUE

Sampling Progran	Year CPUE	1998	1999	2000
Port	Lbs/Th	1.12	1.22	1.51
Sea	Lbs/Th	1.46	1.45	1.91
Port	Lbs/Thsod	0.26	0.27	0.34
Sea	Lbs/Thsod	0.31	0.26	0.36
Port	Num/Th	0.90	0.97	1.17
Sea	Num/Th	1.16	1.13	1.46
Port	Num/Thsod	0.21	0.21	0.26
Sea	Num/Thsod	0.25	0.20	0.27

Table 4: 1998-2000 Comparison Statistics for four measures of CPUE

Mean Trip Lbs/Th	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
May	0.83	0.56	0.79	0.88	0.66	0.89
June	0.46	1.28	0.49	0.73	0.45	0.59
July	0.85	0.80	1.24	1.19	1.81	2.11
August	1.36	1.39	1.17	1.36	1.55	2.70
September	1.31	2.21	1.11	1.89	1.59	2.11
October	1.27	1.72	1.68	2.72	1.51	2.37
November	1.50	1.62	1.37	2.60	1.67	2.24

Table 5: Comparison Statistics for Pounds per Trap Haul: May-November,1998-2000

Mean Trip Lbs/Thsod	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
May	0.13	0.14	0.12	0.15	0.13	0.14
June	0.11	0.21	0.12	0.14	0.08	0.11
July	0.24	0.18	0.32	0.28	0.48	0.54
August	0.51	0.33	0.29	0.29	0.43	0.63
September	0.36	0.45	0.27	0.41	0.40	0.41
October	0.24	0.39	0.38	0.47	0.38	0.45
November	0.29	0.30	0.21	0.31	0.25	0.36

Table 6: Comparison Statistics for Pounds per Trap Haul-Set-Over-Day: May-Nov, 1998-2000

Mean Trip **Num/Th**	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
May	0.63	0.45	0.63	0.66	0.49	0.63
June	0.35	0.84	0.38	0.54	0.36	0.45
July	0.67	0.64	0.99	0.94	1.41	1.63
August	1.09	1.13	0.93	1.08	1.24	2.20
September	1.07	1.75	0.90	1.56	1.23	1.62
October	1.03	1.38	1.33	2.09	1.16	1.85
November	1.26	1.23	1.12	2.03	1.40	1.61

Table 7: Comparison Statistics for Numbers per Trap Haul: May-November, 1998-2000

Mean Trip **Num/Thsod**	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
May	0.10	0.12	0.09	0.11	0.10	0.10
June	0.08	0.14	0.09	0.10	0.06	0.08
July	0.19	0.15	0.25	0.22	0.37	0.42
August	0.40	0.27	0.23	0.23	0.35	0.50
September	0.29	0.36	0.22	0.33	0.31	0.31
October	0.19	0.31	0.30	0.37	0.29	0.35
November	0.24	0.23	0.18	0.24	0.21	0.25

Table 8: Comparison Statistics for Numbers per Trap Haul-Set-Over-Day: May-Nov, 1998-2000

Mean Trip Num/Thsod for Washington to York County: 1998-2000						
County	**Port 98**	**Sea 98**	**Port 99**	**Sea 99**	**Port 00**	**Sea 00**
Cumberland	0.20	0.29	0.18	0.23	0.18	0.26
Hancock	0.38	0.26	0.20	0.22	0.33	0.32
Knox	0.22	0.24	0.24	0.24	0.27	0.38
Lincln/Sagd	0.20	0.26	0.23	0.20	0.24	0.27
Washington	0.11	0.27	0.18	0.23	0.09	0.27
York	0.12	0.19	0.13	0.15	0.30	0.23

Table 9: Comparison Statistics for Numbers per Trap Haul-Set-Over-Day 1998-2000

1998 Size Composition by 14% Grouping						
Month	Program	83-94mm	95-108mm	109-124mm	125-127mm	Total Lobsters
May	Sea	82.76	17.24	0.00	0.00	29
May	Port	83.10	14.79	2.11	0.00	142
June	Sea	81.88	15.94	2.17	0.00	138
June	Port	83.71	15.43	0.86	0.00	350
July	Sea	85.16	13.60	1.24	0.00	728
July	Port	83.09	16.36	0.55	0.00	550
August	Sea	87.41	11.37	1.22	0.00	1398
August	Port	87.67	12.09	0.23	0.00	860
September	Sea	86.91	11.92	1.10	0.07	1451
September	Port	86.94	12.61	0.45	0.00	1110
October	Sea	84.82	14.68	0.20	0.30	1008
October	Port	88.02	11.73	0.25	0.00	810
November	Sea	84.92	12.81	2.26	0.00	398
November	Port	93.20	6.80	0.00	0.00	250
Mean	**Sea**	**84.84**	**13.94**	**1.17**	**0.05**	**735.71**
Mean	**Port**	**86.53**	**12.83**	**0.64**	**0.00**	**581.71**

Table 10: Percentage of 14% Grouping by Month for Sea and Port Sampling: 1998

1999 Size Composition by 14% Grouping						
Month	Program	83-94mm	95-108mm	109-124mm	125-127mm	Total Lobsters
May	Sea	83.68	14.58	1.74	0.00	631
May	Port	86.92	12.69	0.38	0.00	260
June	Sea	82.51	14.78	2.59	0.12	812
June	Port	84.47	13.40	2.13	0.00	470
July	Sea	86.99	12.40	0.60	0.00	1161
July	Port	85.64	13.66	0.69	0.00	1010
August	Sea	86.16	12.80	0.97	0.07	1438
August	Port	83.20	16.39	0.41	0.00	970
September	Sea	87.01	12.77	0.22	0.00	1801
September	Port	83.48	16.41	0.11	0.00	920
October	Sea	80.06	17.99	1.95	0.00	1284
October	Port	81.11	18.33	0.56	0.00	540
November	Sea	80.60	17.79	1.61	0.00	933
November	Port	92.58	7.42	0.00	0.00	310
Mean	**Sea**	**83.86**	**14.73**	**1.38**	**0.03**	**1151.43**
Mean	**Port**	**85.34**	**14.05**	**0.61**	**0.00**	**640.00**

Table 11: Percentage of 14% Grouping by Month for Sea and Port Sampling: 1999

2000 Size Composition by 14% Grouping						
Month	Program	83-94mm	95-108mm	109-124mm	125-127mm	Total Lobsters
May	Sea	82.57	15.29	2.03	0.12	1629
May	Port	86.07	12.14	1.43	0.36	280
June	Sea	84.80	13.55	1.54	0.10	1948
June	Port	83.40	15.06	1.54	0.00	259
July	Sea	84.46	14.98	0.49	0.07	8527
July	Port	80.40	19.20	0.27	0.13	750
August	Sea	83.24	16.37	0.36	0.03	11186
August	Port	87.97	11.73	0.30	0.00	1006
September	Sea	78.78	20.37	0.84	0.01	7006
September	Port	81.94	17.58	0.48	0.00	620
October	Sea	80.00	18.73	1.23	0.03	6566
October	Port	76.79	22.26	0.94	0.00	530
November	Sea	74.16	20.83	4.73	0.28	7504
November	Port	91.25	8.33	0.42	0.00	480
Mean	**Sea**	**81.14**	**17.16**	**1.60**	**0.09**	**6338.00**
Mean	**Port**	**83.97**	**15.19**	**0.77**	**0.07**	**560.71**

Table 12: Percentage of 14% Grouping by Month for Sea and Port Sampling: 2000

Standardized CPUE Comparison of Numbers vs. Pounds				
Regression Statistic	98	99	2000	
slope	0.996	0.997	0.997	Port Sampling Mean per Trip Num/th Vs. Lbs/th
p value	0.000	0.000	0.000	
intercept	0.000	0.000	0.000	
p value	1.000	1.000	1.000	
Adj R^2	0.99	0.99	0.99	
n	58	61	61	

Table 13: Comparison of numbers and pounds as a measure of catch: Port Sampling

Standardized CPUE Comparison of Numbers vs. Pounds				
Regression Statistic	98	99	2000	
slope	0.988	0.982	0.953	Sea Sampling Mean per Trip Num/th Vs. Lbs/th
p value	0.000	0.000	0.000	
intercept	0.000	0.000	0.000	
p value	1.000	1.000	1.000	
Adj R^2	0.98	0.96	0.91	
n	81	122	149	

Table 14: Comparison of numbers and pounds as a measure of catch: Sea Sampling

Monthly comparison regression numbers: May to November				
Regression Statistic	**98**	**99**	**2000**	
slope	0.97	1.75	1.38	**Mean per Trip Num/th By month**
p value	0.079	0.011	0.005	
Adj R^2	0.39	0.71	0.78	
n	7	7	7	

Table 15: Regression Statistics of Port vs. Sea Sampling CPUE: Numbers per Trap Haul

Monthly comparison regression numbers: May to November				
Regression Statistic	**98**	**99**	**2000**	
slope	0.41	0.97	0.05	**Mean per Trip Num/thsod By month**
p value	0.066	0.005	0.828	
Adj R^2	0.51	0.85	-0.23	
n	6	6	6	

Table 16: Regression Statistics of Port vs. Sea Sampling CPUE: Numbers per Trap Haul Set-Over-Day

Monthly comparison regression numbers: May to November				
Regression Statistic	**98**	**99**	**2000**	
slope	1.243	1.413	1.309	**Mean per Trip Num/boathr By month**
p value	0.044	0.009	0.002	
Adj R^2	0.508	0.728	0.845	
n	7	7	7	

Table 17: Regression Statistics of Port vs. Sea Sampling CPUE: Numbers per Boat Hour

County comparison regression numbers: Washington to York				
Regression Statistic	**98**	**99**	**2000**	
slope	0.41	0.57	0.20	**Mean per Trip Num/thsod By County**
p value	0.066	0.140	0.541	
Adj R^2	0.51	0.32	-0.12	
n	6	6	6	

Table 18: Regression Statistics of Port vs. Sea Sampling CPUE: Numbers per Trap Haul Set-Over-Day

Difference in Size Composition between Sea and Port Sampling by month and year

Month	98	99	2000	
May	TRUE	TRUE	TRUE	Kolmogorov-Smirnov Test No difference = TRUE Difference = FALSE
June	TRUE	TRUE	TRUE	
July	TRUE	TRUE	TRUE	
August	TRUE	TRUE	FALSE	
September	TRUE	TRUE	TRUE	
October	TRUE	TRUE	TRUE	
November	TRUE	FALSE	FALSE	
Frequency True	1.0000	0.8571	0.7143	
Percent True	100.00%	85.71%	71.43%	

Table 19: Size Composition Comparison of 14% Groupings by Month

Boats Sampled per Month per Year

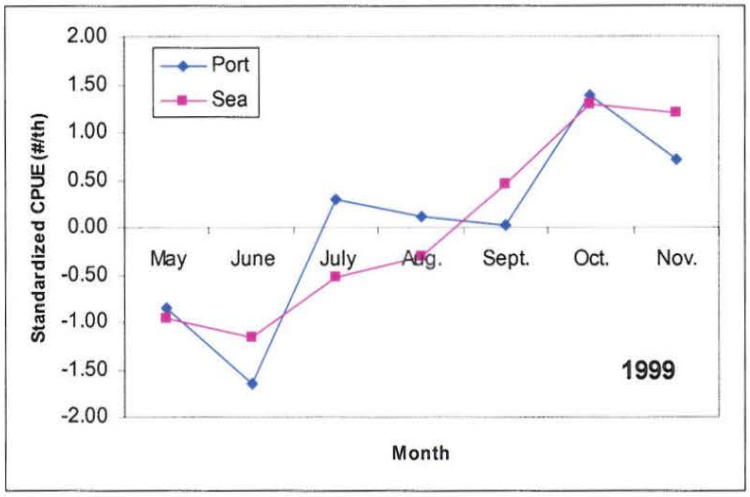
	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
January	0	0	0	0	8	0
February	0	0	0	0	2	0
March	0	0	2	0	2	0
April	30	0	8	0	13	1
May	15	2	26	20	28	16
June	35	4	48	23	26	23
July	55	17	101	19	75	24
August	86	18	97	21	101	23
September	111	16	92	19	62	21
October	81	15	54	11	53	20
November	25	9	31	9	48	21
December	11	0	7	0	15	0
Total	449	81	466	122	433	149

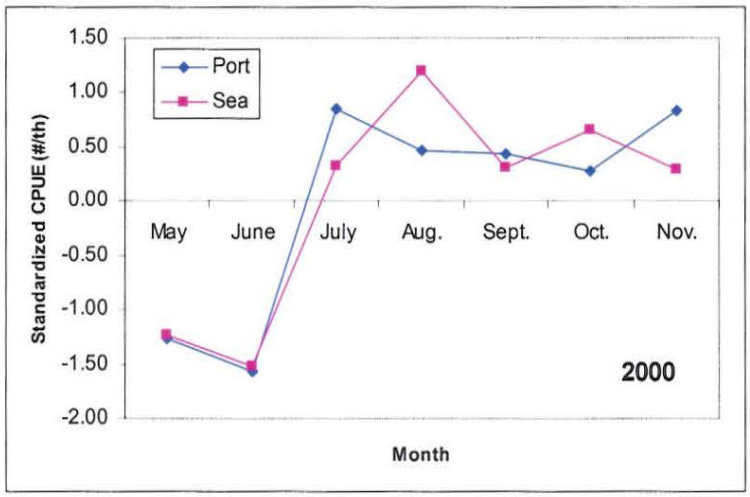
Table 20: Sampling Effort in Boats Sampled 1998-2000

Sample Events per County per Year

County	Port 98	Sea 98	Port 99	Sea 99	Port 00	Sea 00
Cumberland	10	10	11	19	11	19
Hancock	18	25	13	37	15	46
Knox	12	7	13	16	14	23
Lincoln	8	8	6	18	8	24
Sagadahoc	2	0	3	2	2	0
Washington	6	19	10	15	3	15
York	2	12	5	15	4	21
Total	58	81	61	122	57	148

Table 21: Sampling Effort in Number of Events 1998-2000





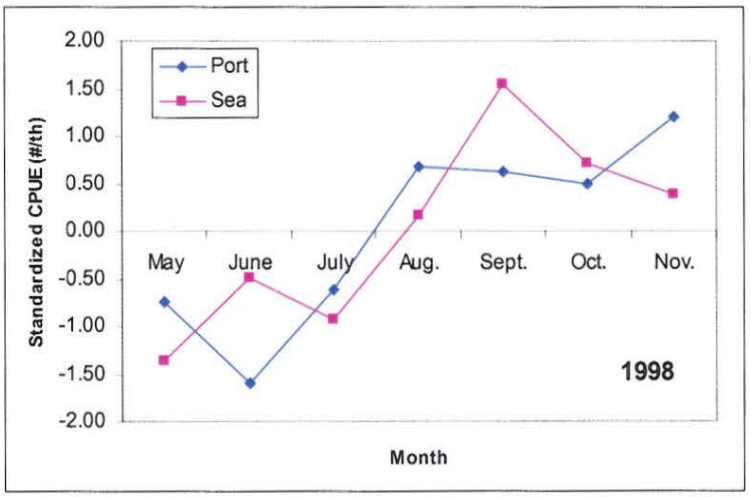
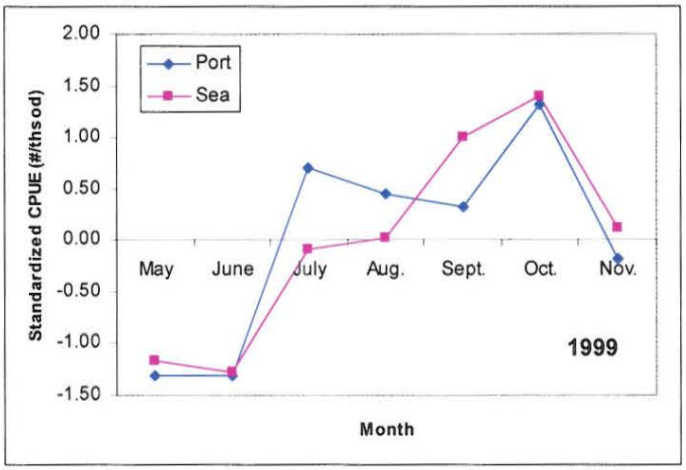
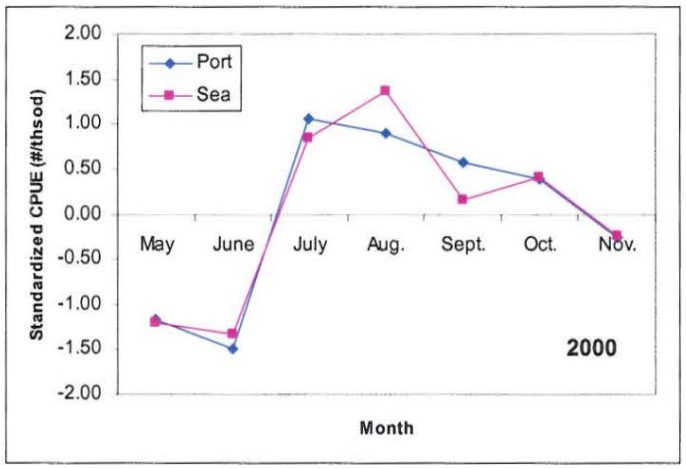


Figure 1: Standardized Number per Trap Haul 1998-2000





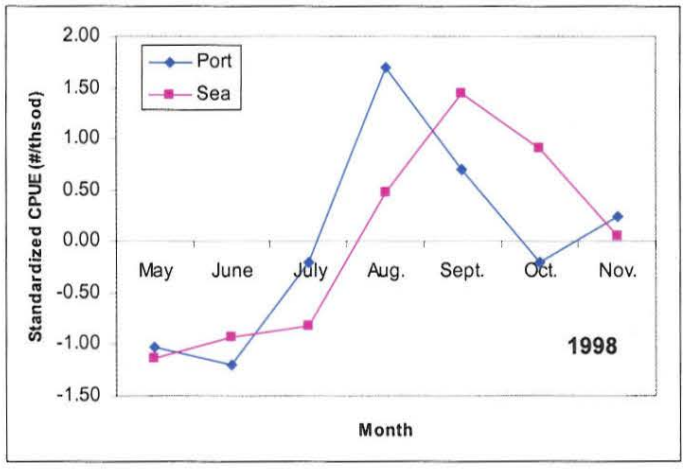
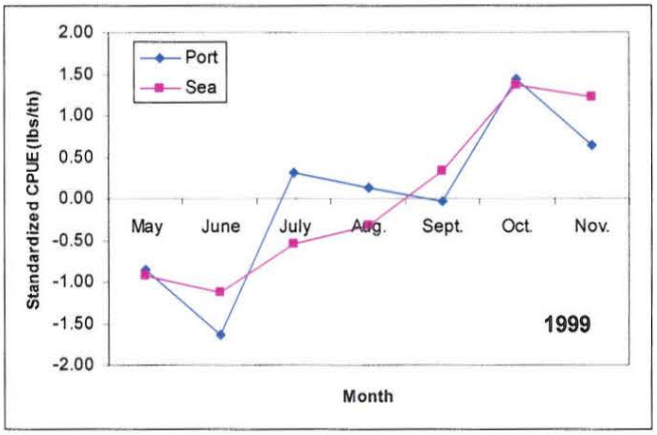
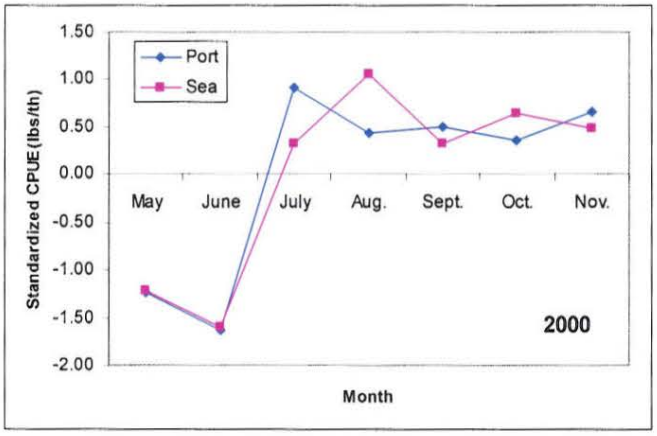


Figure 2: Standardized Numbers per Trap Haul Set-Over-Day 1998-2000





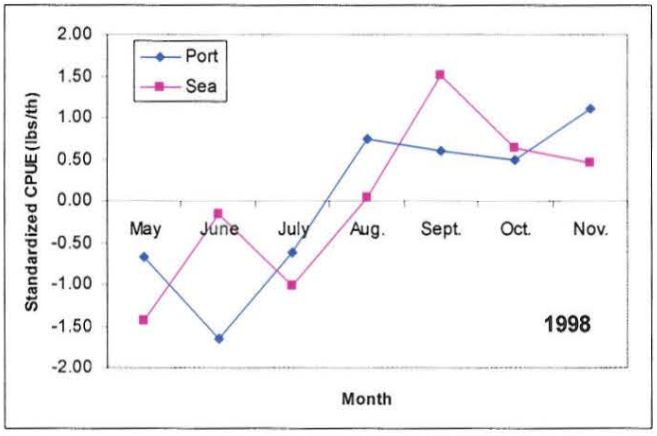
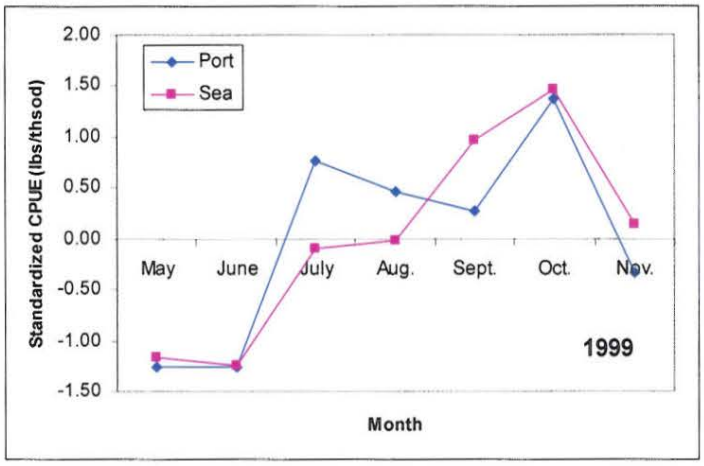
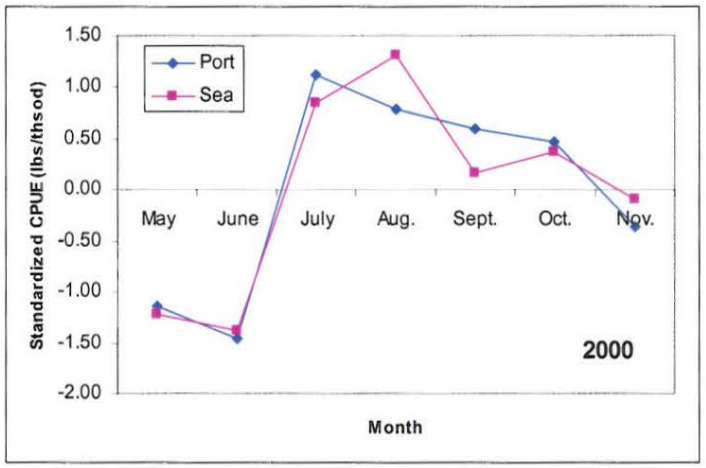


Figure 3: Standardized Pound per Trap Haul 1998-2000





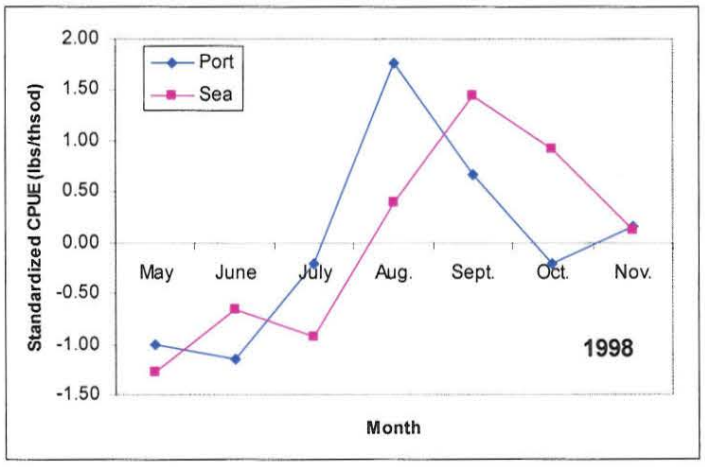


Figure 4: Standardized Pounds per Trap Haul Set-Over-Day 1998-2000

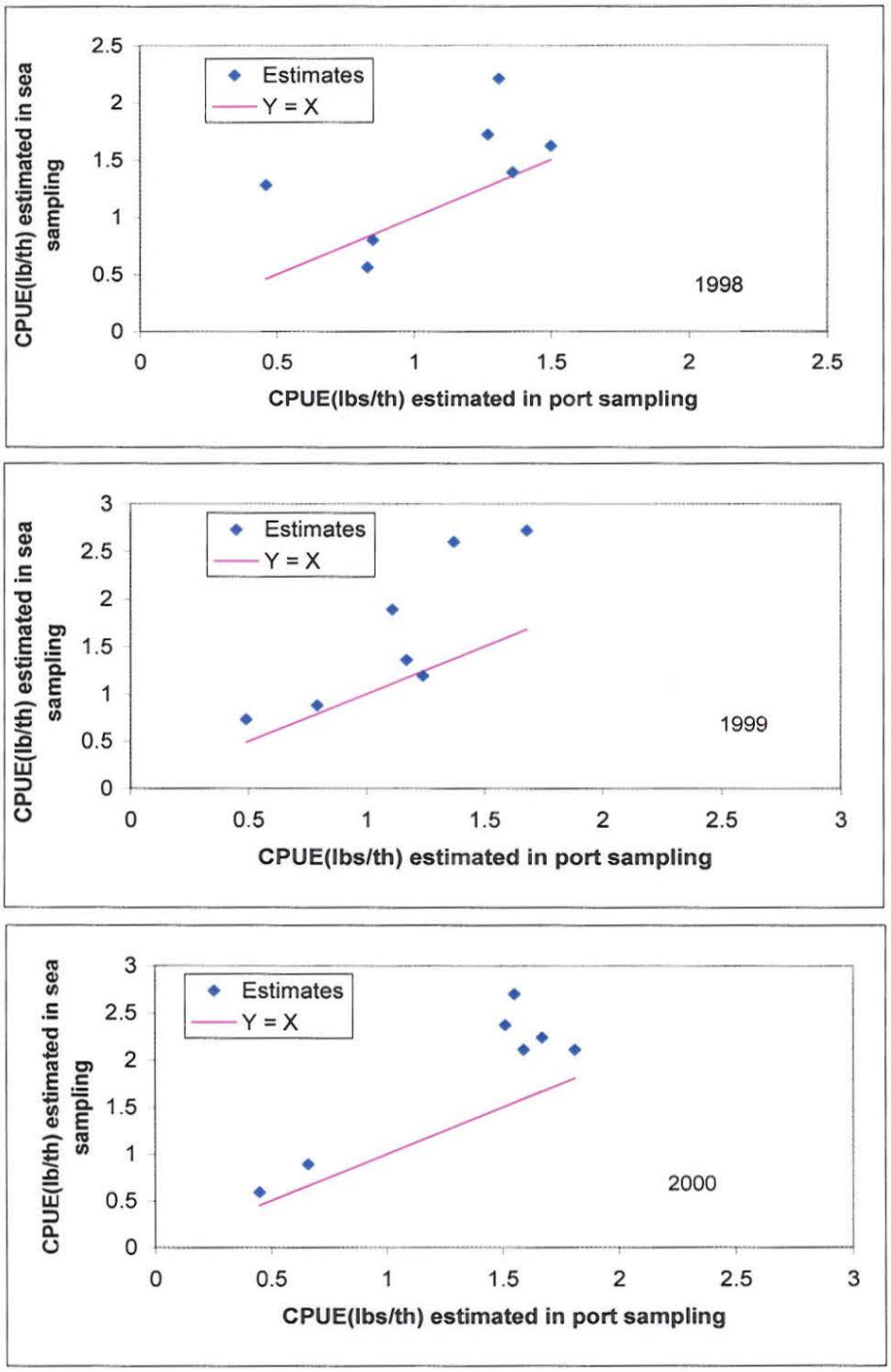


Figure 5: Pounds per Trap Haul Regression Plots 1998-2000

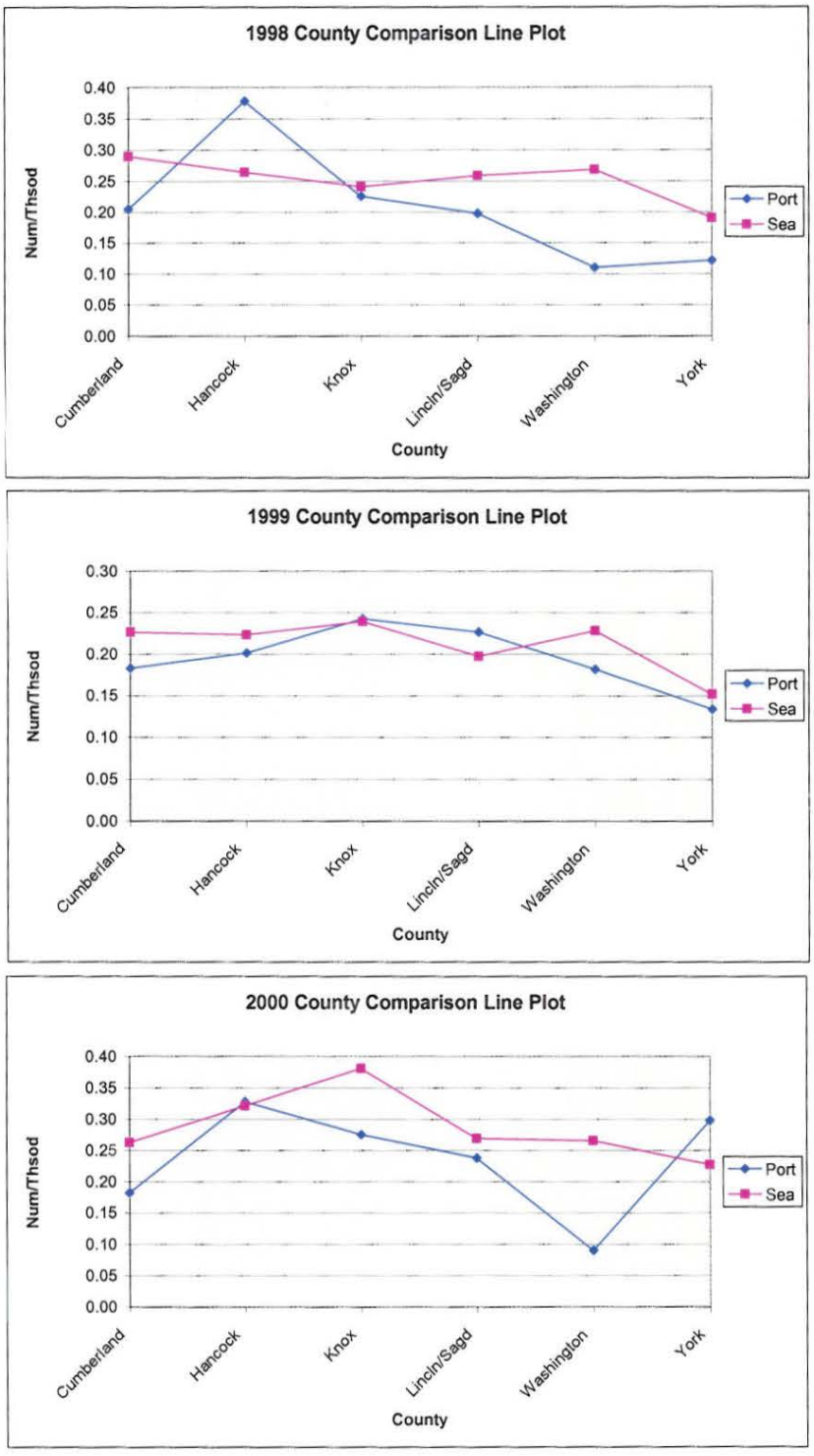


Figure 6: County Comparison Plots (Numbers per Thsod)1998-2000

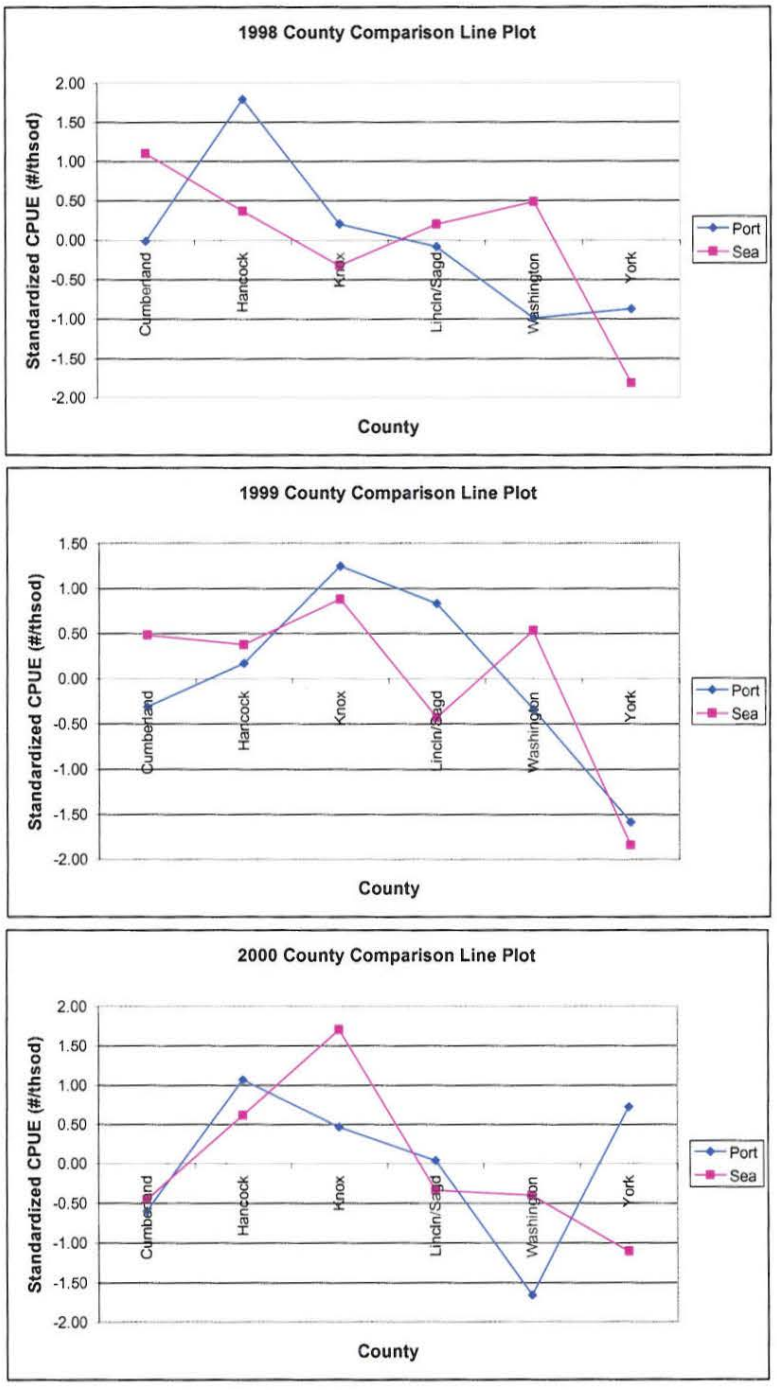
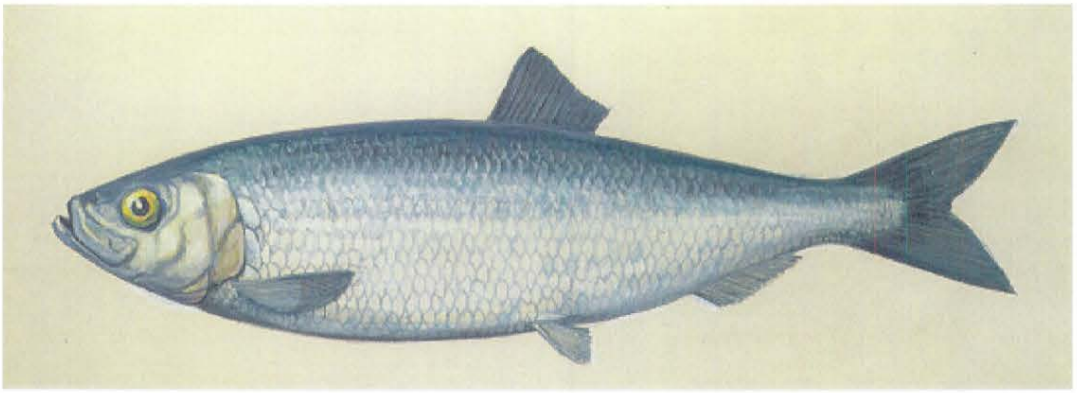


Figure 7: Standardized Numbers per Trap Haul Set-Over-Day 1998-2000

Annual Report

Atlantic Herring Resource and Management



Compiled by:
Matthew Cieri
David Libby
Kohl Kanwit
Eileen Brewer
Lisa Pinkham

 # NA16FI1089 3-IJ-180
Maine Department of Marine Resources
P.O. Box 8
West Boothbay Harbor, ME 04575

January-December, 2001

ATLANTIC HERRING

Resource Monitoring

Landings and Catch Data

Landings reports received from canneries and bait dealers during 2000 were processed as described in the 1999 IJF annual report (Project No. 3-IJ-154). In 2001 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 2001 is shown in Table 1. The totals in Table 1 for herring utilization show about 42,000 mt going to food (canned as sardines and stakes) while about 62,000 mt was put into bait mostly for the lobster fishery. Domestic dealer reports accounted for about 96% of harvester reported landings (Table 2). 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. These landing do not account for landings to foreign vessels (IWPs or JVs) during 2001.

Landings and catch data were also made available to the ASMFC and NEFMC Atlantic Herring Plan Development Team to be included in the "2000 Atlantic Herring Stock Assessment and Fishery Evaluation Report" (SAFE) and fishery regulation plans that were developed by both organizations during 2001. Catch and Sampling data collected by project staff will be used in the next Trans-boundary Assessment scheduled for January 2003.

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 (Figure 1) 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. A report of the herring fishery IVR call-in is presented in Appendix A. The IVR system for the timely reporting of herring catches was a success because of industry involvement. It should be noted that there are significant differences between IVR and VTR reporting for 2001.

VTR Reporting

Herring catch data was also complied from NMFS vessel trip reports (VTR). There were about 1350 trips (> 2 mt) 2001 compared to 1355 and 1470 trips in 2000 and 1999 respectively. Total 2000 herring catch from all fishing areas is presented in Figure 2. Catches by ten-minute square were well distributed along the New England and Mid-

Atlantic States for 2000. Catches in metric tons are shown for the four management areas (see Figure 3) for 2000 and 2001. Mid-water trawl gear (single and pair) was the dominant gear in both 2000 and 2001 (Figure 4). Most of the purse seine catches were during the last trimester and all were in Management area 1A. There were minimal herring catches from fixed gear in 2001. There were no reports of any fixed gear catches made in 2000.

Comparative herring catches for 1997 through 2001 for management area by month are shown in Table 2. Catches during 2001 were approximately 107,000 mt. Catches from the 1B exceeded that areas TAC by ~ 30%. It should be noted that there are significant reporting differences between IVR and VTR systems for 2001

Sample processing and ageing

Approximately 11,000 sampled herring were processed in 2001, 25% from fishing trips made in 2000 and 75% from 2001 trips. Otoliths were removed from approximately 3,000 fish for ageing purposes. Processing and ageing of the 2001 samples was completed in April 2000 and made available to the annual SAFE report. More samples were collected in 2001 (240) compared to 2000 (196) because of a grant from ACCSP to fund sample collection.

Spawning closures

As part of the alternative management plan, the State of Maine applied and was granted tolerance fishing during 2001. The spawning regulations of 2000 & 2001 prohibited the landing of spawn herring (subject to a 20% tolerance) caught anywhere three predefined areas (Figure 1) over a three month period (August-October). A spawn herring was defined to include only males or females in maturity stages IV, V and VI.

For the 2001 fishing season the spawning regulations were again changed to redefine the Eastern Maine Spawning area.

These changes are shown in the following excerpt from Chapter 36 of the 2000 Maine herring regulations:

"...(1) Spawning area restrictions.

It shall be unlawful to land in any State of Maine port or facility or to transfer at sea from any Maine registered vessel, any catch of spawn herring that exceeds 20% of the total catch harvested from the following described areas within ASMFC Management Area 1 and times:

(a)

Eastern Maine:

All waters bounded by the following coordinates:

Maine coast	68° 20.0' W,
43° 48.0' N	68° 20.0' W,
44° 25.0' N	67° 03.0' W,

North along the U.S./Canada border.

Western Maine:

All waters bounded by the following coordinates:

43° 30.0' N	Maine coast,
43° 30.0' N	68° 54.5' W,
43° 48.0' N	68° 20.0' W,

North to Maine coast at 68° 20.0' W.

Massachusetts/New Hampshire:

All waters bounded by the Massachusetts, New Hampshire and Maine coasts, and

43° 30.0' N	70° 00.0' W.

(b) Determination of starting dates for spawning areas

Closures in a given area will begin based on a pre-determined spawning condition of Atlantic herring indicated by commercial catch samples. This spawning condition will be defined as: female herring greater than or equal to 28 cm in length having reached a mean gonadosomatic index (GSI) of 20%; or female herring greater than 24 cm and less than 28 cm in length having reached a mean GSI of 15%. Closures in a given area will begin seven (7) days after the GSI determination is made. If sufficient samples are not available, closures will begin on area specific dates as follows: Eastern Maine – August 15, Western Maine – September 1, Massachusetts/New Hampshire – September 21.

(c) Duration of spawning area restrictions.

The closure period will extend for four (4) weeks. If catch sampling after the end of the initial restricted period determines that 25% or more mature herring, by number, have yet to spawn then the spawning restrictions would resume for an additional two weeks. The 20% tolerance shall be determined by examination of at least one hundred herring selected at random from the catch."

Project personnel worked closely with the Bureau of Marine Patrol in implementing a protocol that was used to collect and examine samples taken from fishing vessels that continued to fish (for juveniles and spent adults) during the restricted period. Marine Patrol officers were trained in sample collection and processing procedures, especially in how to distinguish spawning herring from non-spawning herring. A report filed with the Atlantic States Marine Fisheries Commission on tolerance fishing is included in Appendix B of this report.

Resource Assessment and Management

2000 catch at age

Length, weight, and age data generated from the 2000 samples were entered along with the 2000 catch data into a PC version of "BIOSTAT". The catch and sample data were treated by fishing area. The resulting "BIOSTAT" output estimates the numbers of herring caught at age by month, gear type, and fishing area and is presented in Appendix C. Mean weights at age were calculated and will be applied to an upcoming Gulf of Maine assessment and to the 2002 joint US / Canada herring stock assessment.

The results from weight and numbers at age show that adults (age 6) belonging to the 1994 year-class still dominate the catch in all areas. Figure 5 also suggest that the 1998 year-class is particularly strong. In general there is little truncation of age structure towards younger fish.

Historical Catch and Landings

Project staff are in the process of updating and verifying landings information from the present to 1964. This involves comparing landing data from NMFS and Maine landings, and adding catches that appear in one but not the other. Figure 6 shows additions to the historical landings. Once the data are completed and verified, a new catch at age matrix will be developed for each affected year.

Historical analysis of the samples reveals interesting information. Figure 7 shows length and weight at age data from 1960 to the present. Average weight at age has been trending downward since the mid-80's. A similar trend is noticeable in the total length at age for spawning fish inshore.

Herring Fishery Management

Project personnel participated in the development and implementation of the ASMFC and NEFMC fishery management plans for herring. The results of collected and analyzed catch and sample data plus other relevant biological data were presented to the Plan Development Team, Technical Advisory Committee and the Herring Section and Committee for their consideration

Figure 1. Management and Spawning Areas for Atlantic Herring

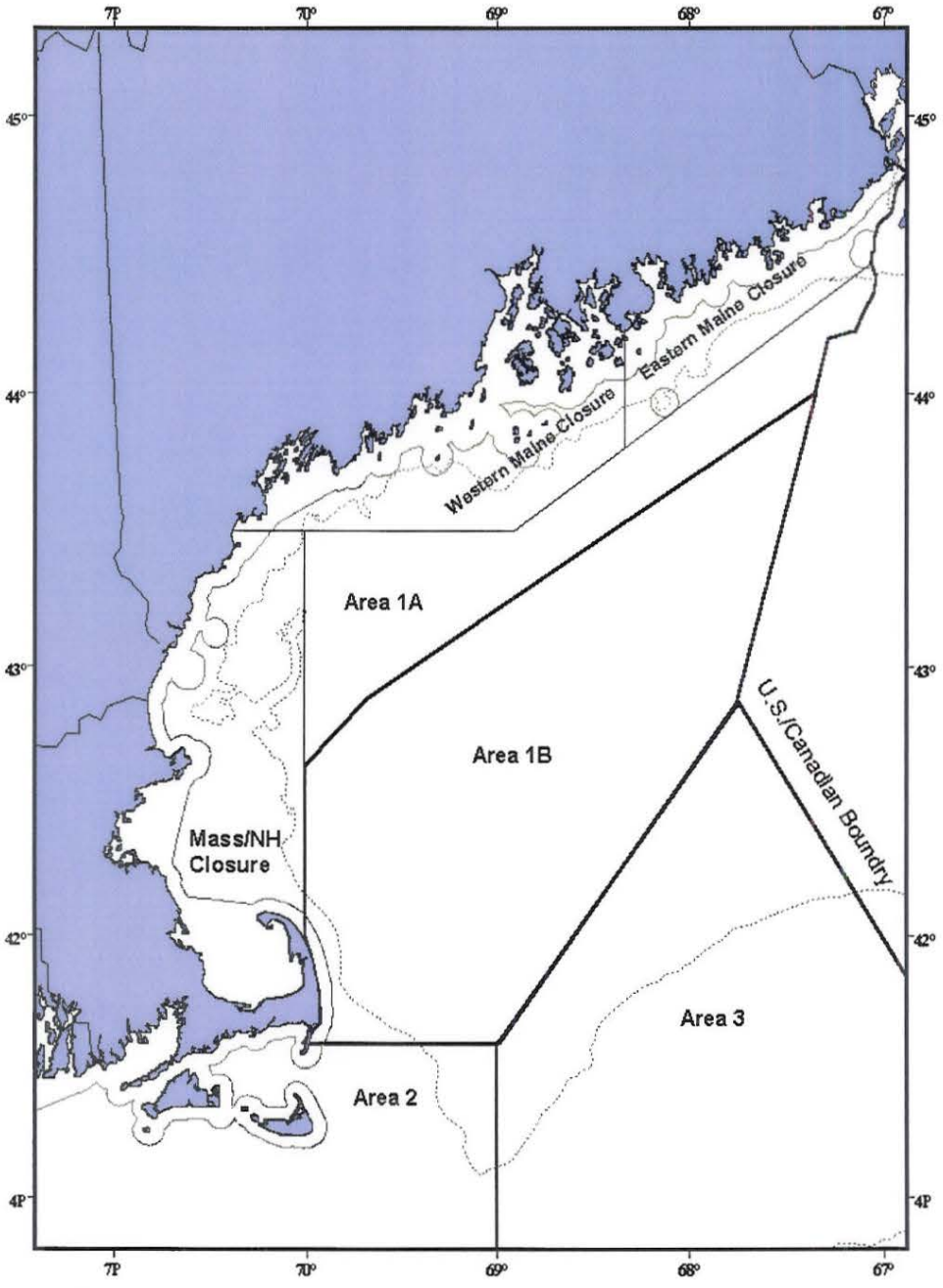


Figure 2. Atlantic herring catches for 2000

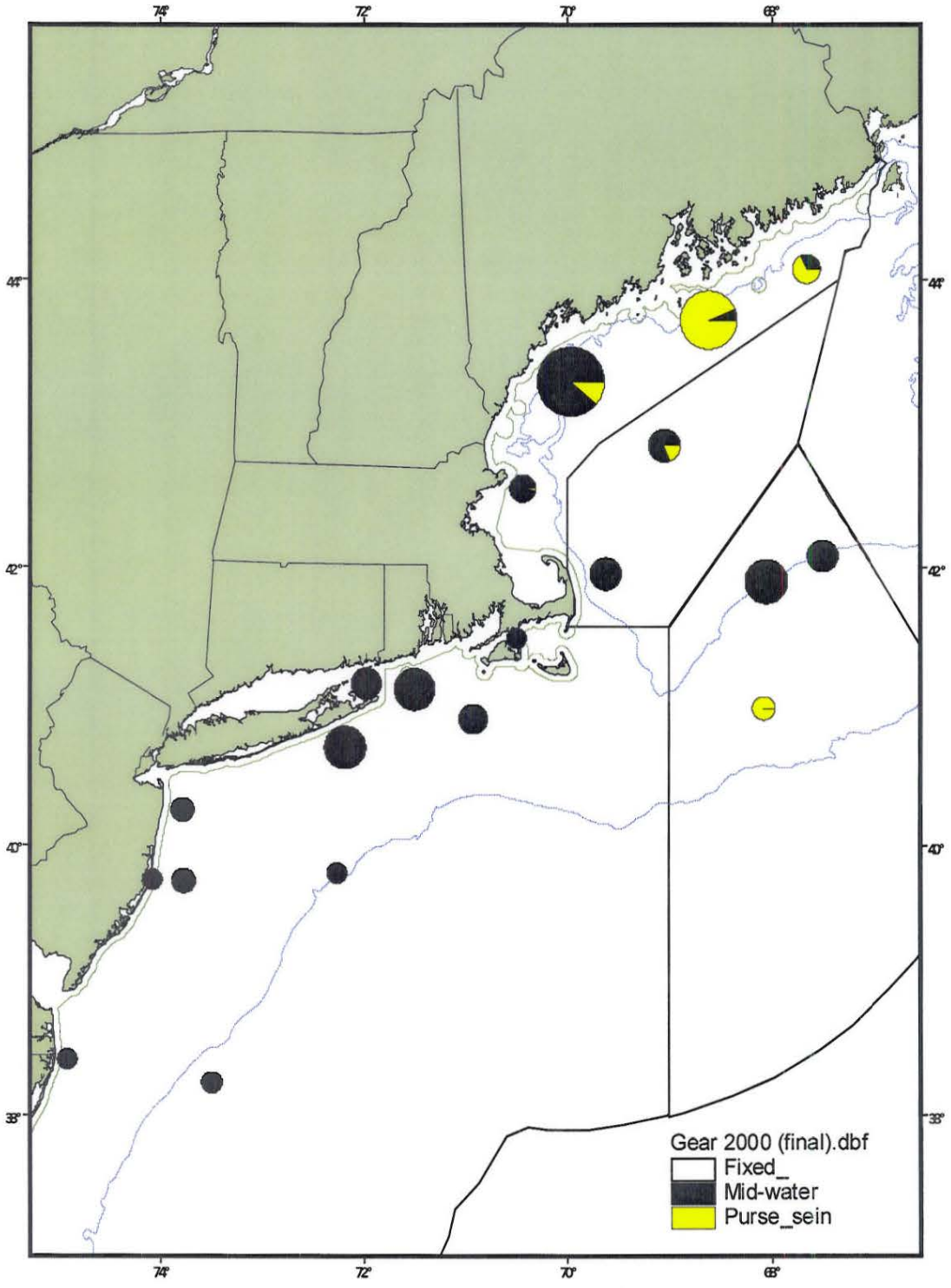
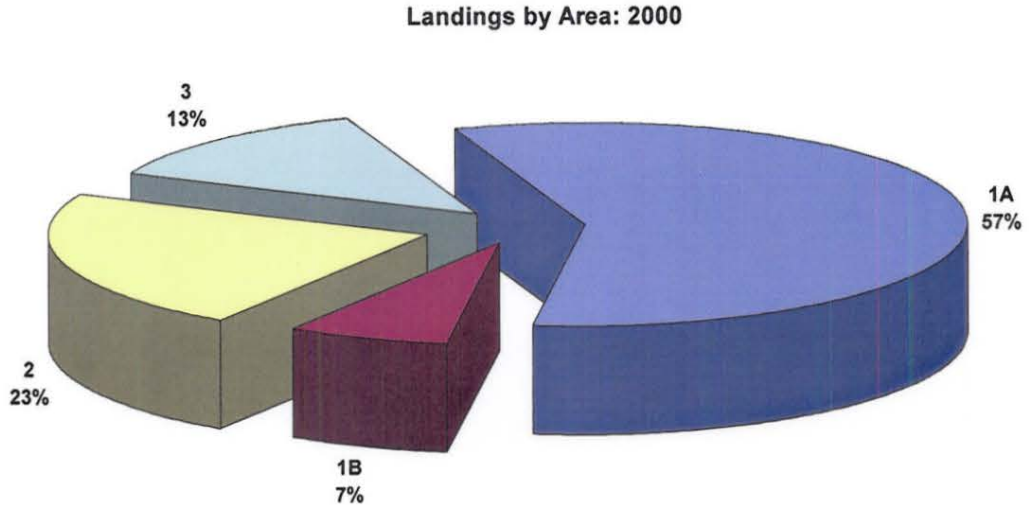


Figure 3. Herring Catch By Area for 2000 & 2001



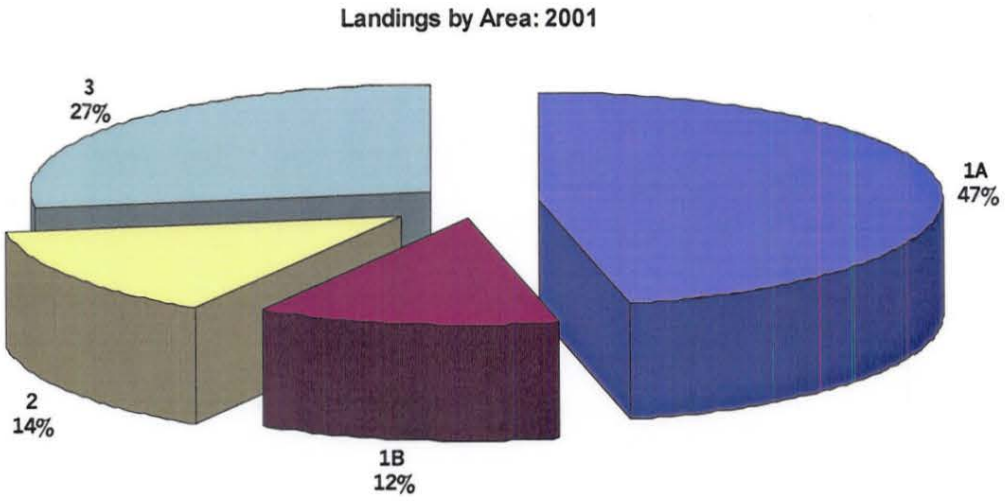


Figure 4. Herring Catch By Gear for 2000 & 2001

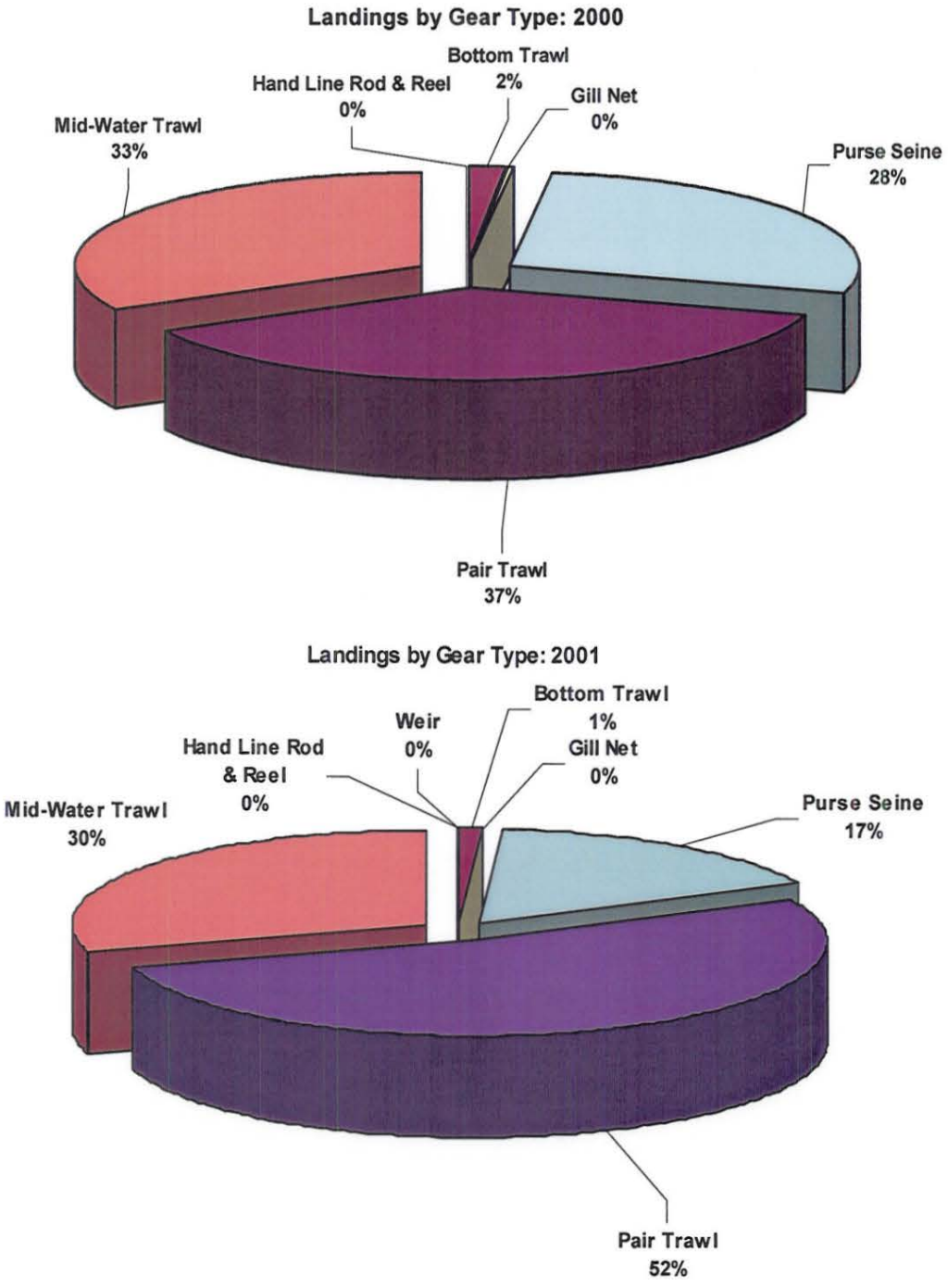
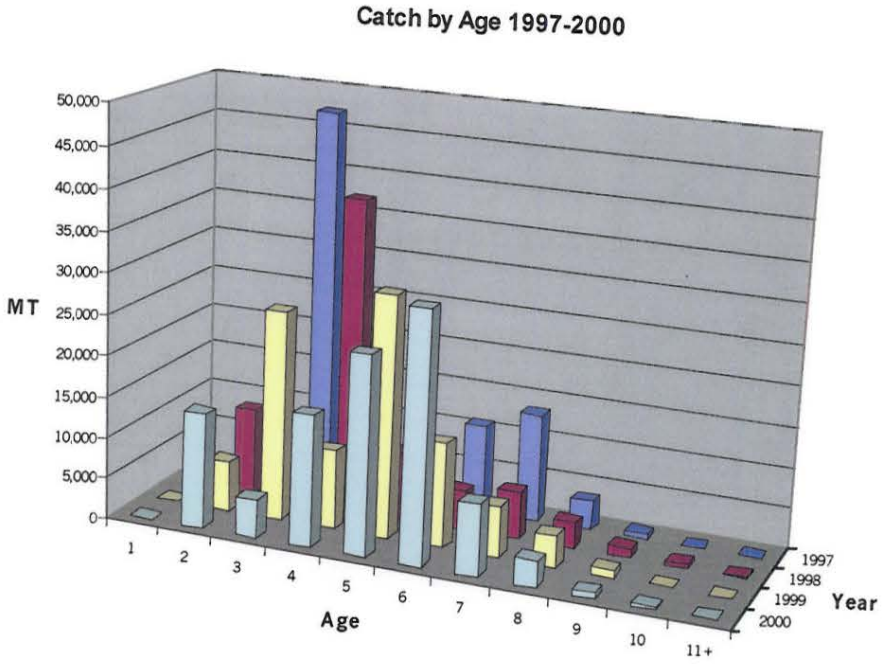


Figure 5. Catch (in MT and numbers) at Age for the 2000 fishery



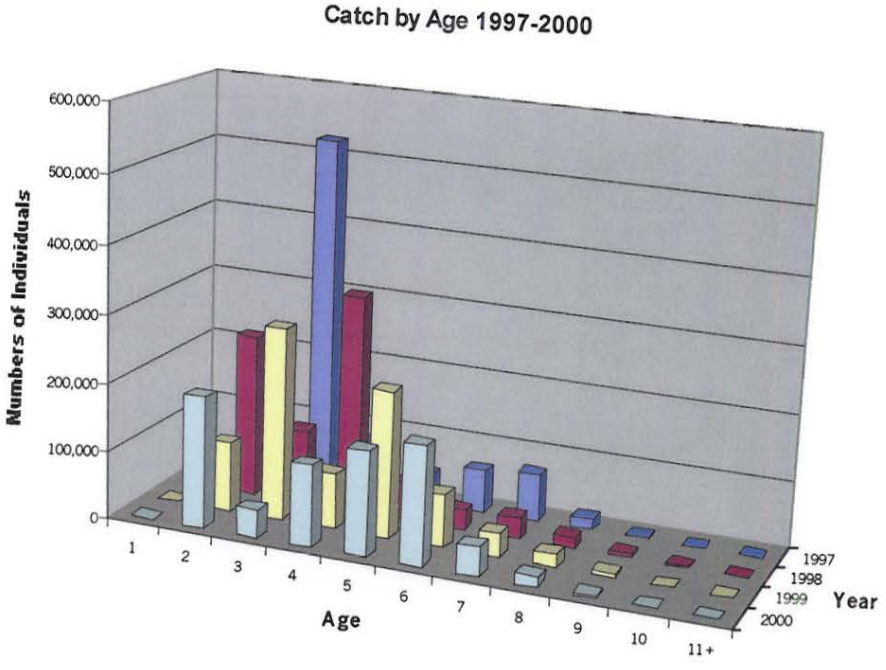


Figure 6. Herring Catch 1960 – 2000 with added data

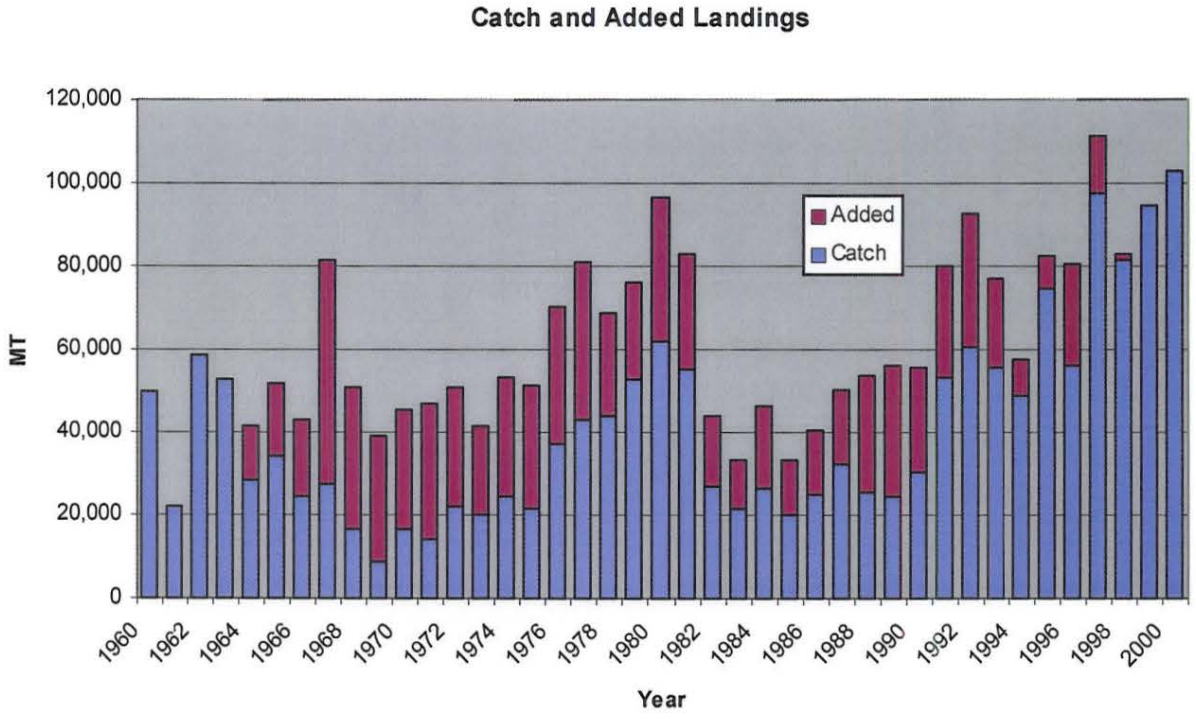
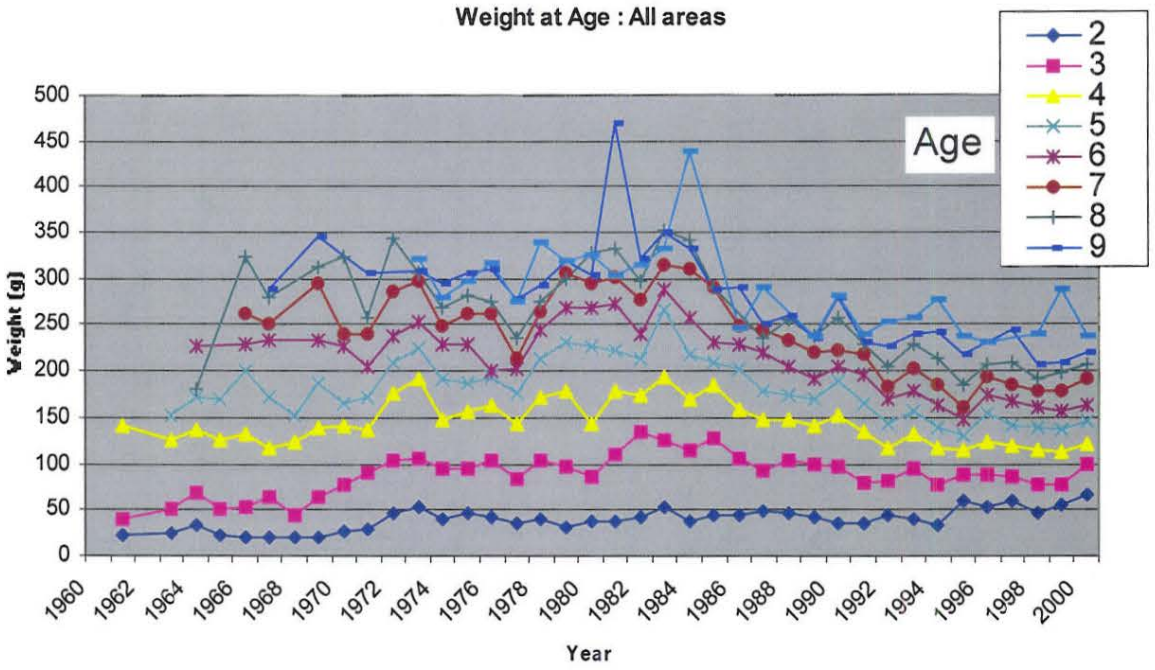


Figure 7. Weight at Age over the entire fishery and total length at age for inshore spawners



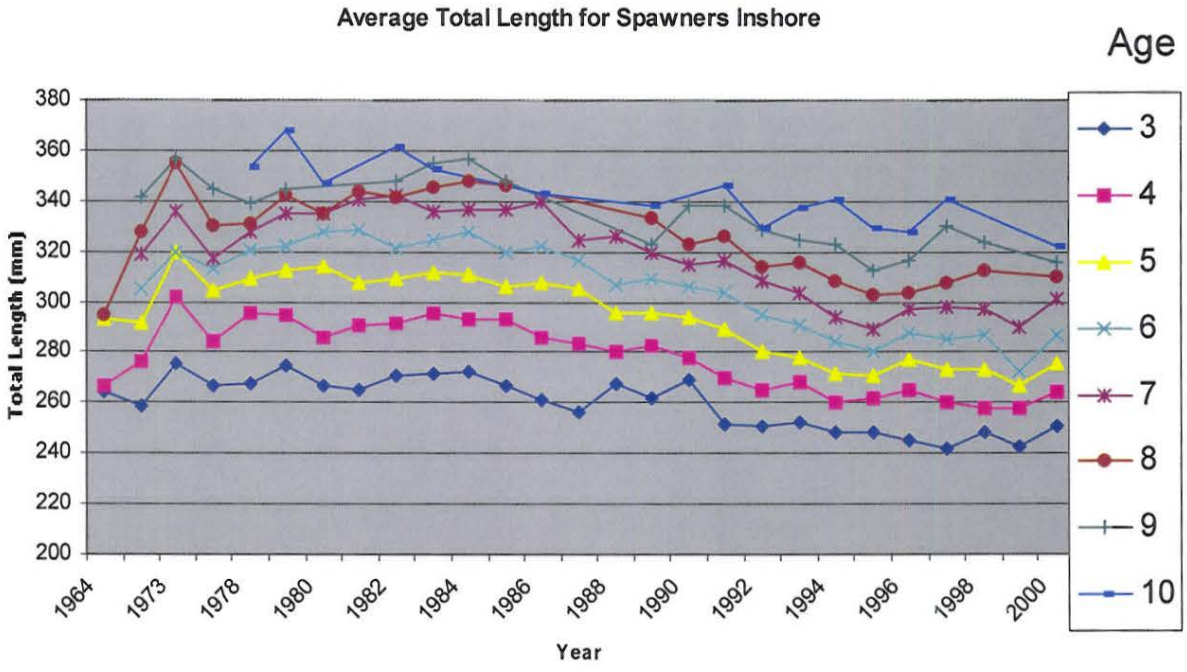


Table 1: Dealer data for 2001 Atlantic Herring Fishery

FOOD			BAIT			OTHER			TOTAL		
MONTH	MT	VALUE	MONTH	MT	VALUE	MONTH	MT	VALUE	MONTH	MT	VALUE
JAN	6,867	$ 773,144	JAN	2,113	$257,272	JAN	88	$4,470	JAN	9,067	$1,034,886
FEB	4,946	$ 556,450	FEB	1,374	$162,307	FEB	120	$0	FEB	6,440	$718,757
MAR	668	$ 76,033	MAR	889	$110,226	MAR	14	$1,836	MAR	1,571	$188,095
APR	67	$ 7,732	APR	2,307	$313,773	APR	0	$0	APR	2,375	$321,505
MAY	3,319	$ 380,012	MAY	7,156	$1,017,316	MAY	27	$0	MAY	10,501	$1,397,328
JUN	3,044	$ 492,095	JUN	5,682	$776,996	JUN	0	$0	JUN	8,727	$1,269,091
JUL	3,433	$ 534,265	JUL	10,441	$1,485,694	JUL	34	$0	JUL	13,908	$2,019,959
AUG	4,459	$ 553,206	AUG	9,985	$1,383,788	AUG	39	$1,200	AUG	14,483	$1,938,194
SEP	3,811	$ 462,876	SEP	9,623	$1,324,071	SEP	0	$0	SEP	13,434	$1,786,947
OCT	4,920	$ 555,241	OCT	7,668	$1,052,843	OCT	34	$0	OCT	12,622	$1,608,084
NOV	3,997	$ 449,194	NOV	3,032	$441,525	NOV	0	$0	NOV	7,029	$890,719
DEC	2,339	$ 260,966	DEC	1,457	$202,320	DEC	0	$0	DEC	3,796	$463,286
TOTAL	**41,871**	**$5,101,214**	**TOTAL**	**61,725**	**$8,528,131**	**TOTAL**	**355**	**$7,506**	**TOTAL**	**103,951**	**$13,636,851**

Table 2: VTR (Vessel Trip Reports) for 1997-2001 by Area

Herring catch (mt) - Management area by month, 1997 - 2001

2001*														
Mgt Area	1	2	3	4	5	6	7	8	9	10	11	12	Total	TAC
1A	3	1,716	1,292	2,476	6,437	8,605	6,978	6,895	3,798	7,913	3,888	57	**50,058**	**60,000**
1B	18	1	68	45	195	110		1,266	1,302	1,126	3,644	5,110	**12,885**	**10,000**
2	8,417	4,900	427	675	56	100	0	2	96	1	64	326	**15,065**	**50,000**
3						755	7,636	7,755	8,453	4,704	193	89	**29,586**	**50,000**
Total	**8,438**	**6,617**	**1,787**	**3,196**	**6,688**	**9,571**	**14,614**	**15,918**	**13,648**	**13,745**	**7,789**	**5,582**	**107,593**	**170,000**

* uncompleted catch data

2000	Month												
Mgt Area	1	2	3	4	5	6	7	8	9	10	11	12	Total
1A	3	3	76	1,339	7,076	10,390	14,355	12,818	4,334	8,525	812	0	**59,730**
1B		87	127		76	234	276	73	166	0	5,836	110	**6,985**
2	7,802	7,902	2,391	212	18	1	0	2	23	2	860	4,364	**23,578**
3	125		537	87	38		418	3,107	5,893	2,679			**12,884**
Total	**7,929**	**7,992**	**3,132**	**1,638**	**7,208**	**10,624**	**15,049**	**16,001**	**10,415**	**11,207**	**7,508**	**4,474**	**103,178**

1999	Month												
Mgt Area	1	2	3	4	5	6	7	8	9	10	11	12	Total
1A	628	120	93	3,264	4,975	8,055	12,939	9,415	9,497	5,907	8,644	5,110	**68,648**
1B	272		41		181	57		35	113	731	106	57	**1,593**
2	7,179	7,516	2,928	511	9	4	34	136	0	1	4	555	**18,878**
3		143	272	999	154	1,460	290	92	1,280	994			**5,685**
Total	**8,080**	**7,779**	**3,334**	**4,775**	**5,320**	**9,575**	**13,263**	**9,678**	**10,890**	**7,633**	**8,754**	**5,722**	**94,803**

1998	Month												
Mgt Area	1	2	3	4	5	6	7	8	9	10	11	12	Total
1A		193		2,705	3,831	4,014	7,200	4,092	5,101	5,973	6,004	4,473	**43,586**
1B				392		166	154	112	186	535	1,399	871	**3,815**
2	5,965	6,568	2,167	160	187	202	161		237	246	222	126	**16,242**
3				523	487	3,630	3,988	3,845	3,267	1,610	465	144	**17,959**
Total	**5,965**	**6,761**	**2,167**	**3,779**	**4,505**	**8,012**	**11,503**	**8,049**	**8,792**	**8,364**	**8,091**	**5,614**	**81,601**

1997	Month												
Mgt Area	1	2	3	4	5	6	7	8	9	10	11	12	Total
1A		6		2,801	3,302	5,885	10,311	12,530	12,841	11,647	7,303	983	**67,608**
1B				118	295	500	556	1,091	3	94	316		**2,972**
2	7,229	4,713	3,841	615	5					500	102	4,443	**21,448**
3			34		839	948	2,581		213	778			**5,393**
Total	**7,229**	**4,719**	**3,875**	**3,534**	**4,441**	**7,333**	**13,448**	**13,621**	**13,057**	**13,018**	**7,721**	**5,426**	**97,422**

Weight (mt) Harvested at age

	1	2	3	4	5	6	7	8	9	10	11 +	Total
1997	22	5,738	47,181	9,508	6,546	10,708	13,228	3,600	637	8	32	**97,208**
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**

Numbers (X 1000) Harvested at age

	1	2	3	4	5	6	7	8	9	10	11 +	Total
1997	1,442	101,286	523,940	77,892	45,343	63,572	71,456	16,970	2,506	24	92	**904,522**
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**

Appendix A

The Interactive Voice Response System and the Atlantic Herring Fishery in 2001.

The Atlantic Herring Fishery and the Interactive Voice Response System (IVR) – 2001

Background:

The state of Maine implemented regulations for the Atlantic herring fishery in 2000 that were designed to compliment the pending federal Atlantic Sea Herring Fisheries Management Plan (FMP). Under these regulations harvesters are required to report daily fishing activities using the federal Vessel Trip Report (VTR) forms. Weekly catch reports are also mandatory, and must be submitted using the Interactive Voice Response (IVR) system. This automated, phone-based reporting method was initially established for multi-species (groundfish) dealer reporting and was later modified to include herring catch reports. 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 for 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.

Annual Summary:

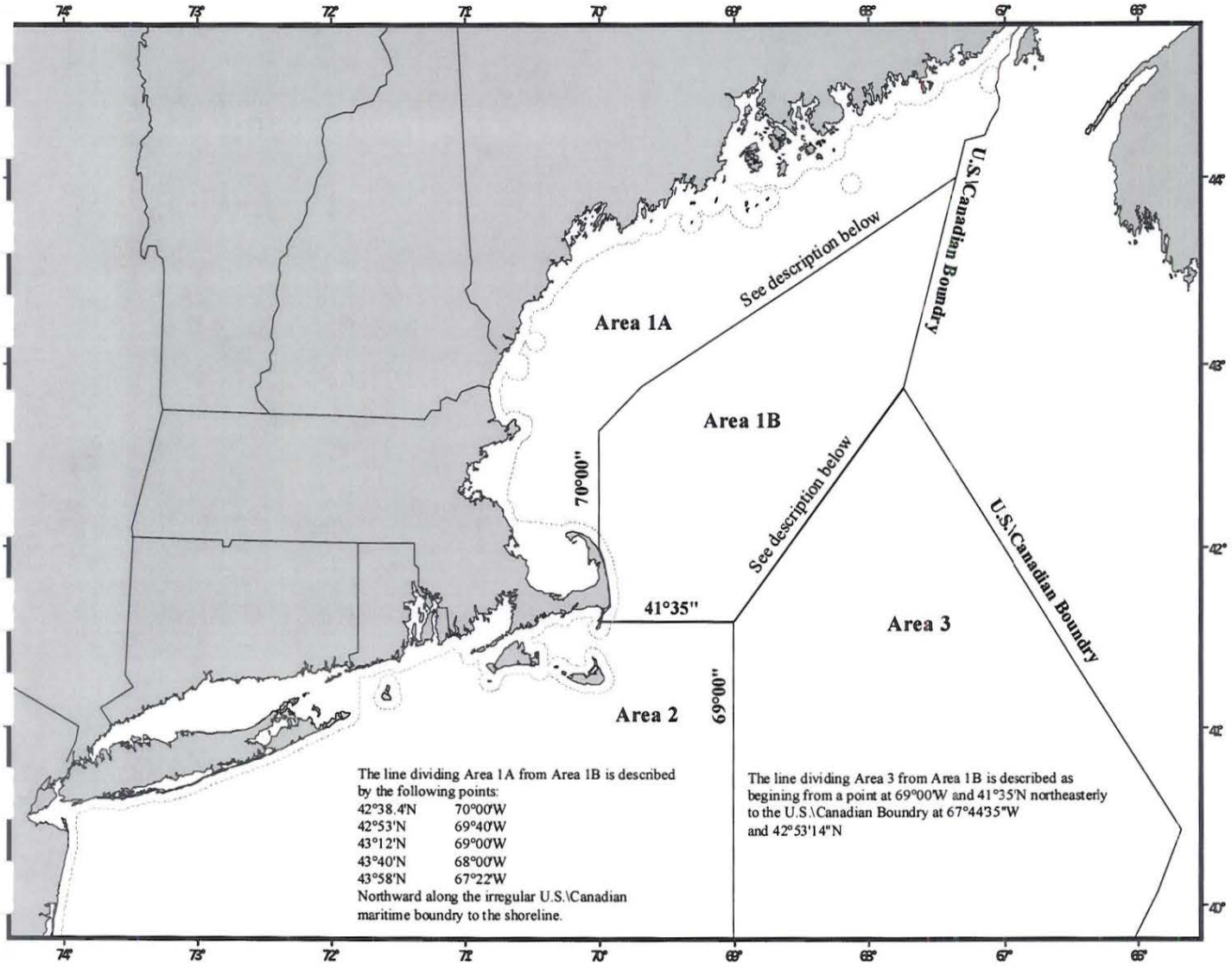
The 2001 season was the second year of state regulated IVR reporting for the Atlantic herring fleet, but the first year of federally mandated call-ins. Compliance was high with the majority of dedicated herring vessels making their weekly reports on a consistent basis. The total catch in 2001 reached 124,251 mt reported. The Area 1A harvest accounted for approximately 49% of the total catch while Area 3 contributed a significant portion, representing 30% of the total. The annual catch experienced a 17% increase from 2000, with the largest change in Area 3, which went from 16,415 mt to 37,701 mt in 2001. Discards accounted for 430 mt of the yearly harvest, with herring from Area 1A representing almost 80% of this total.

The catch numbers in this report reflect only those obtained through the IVR system and will most likely differ from VTR catch data.

IVR Updates:

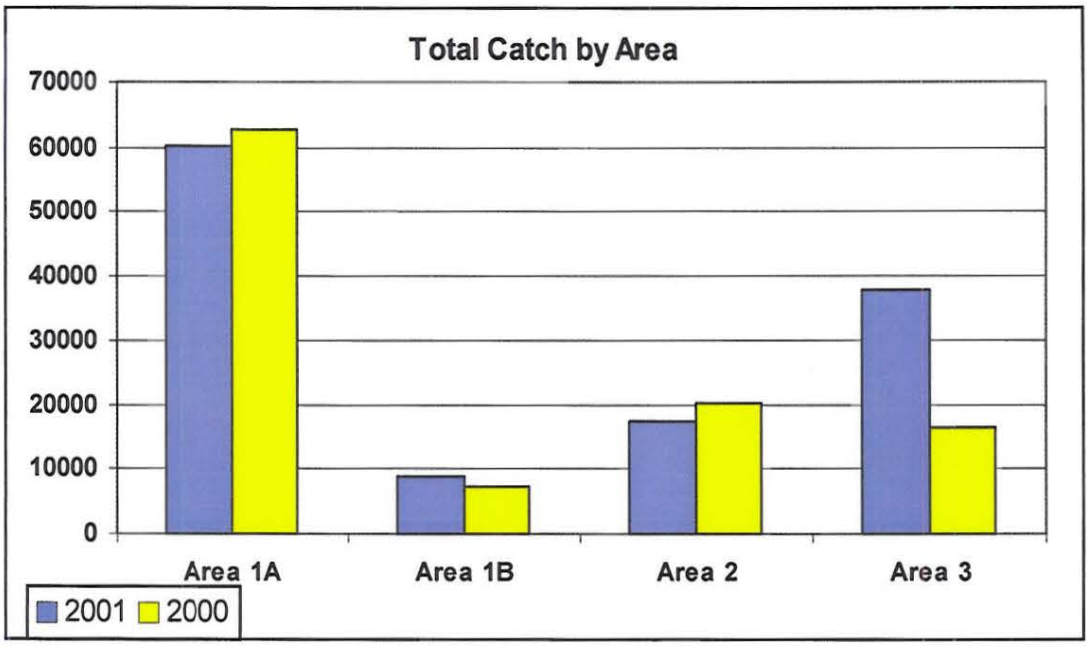
IVR catch updates are sent out on a weekly basis by email to individuals from the herring industry and management communities. Inaccurate or delayed reporting occasionally leads to slight adjustments in the data. Please use this annual summary to replace any weekly catch numbers you have received throughout 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).

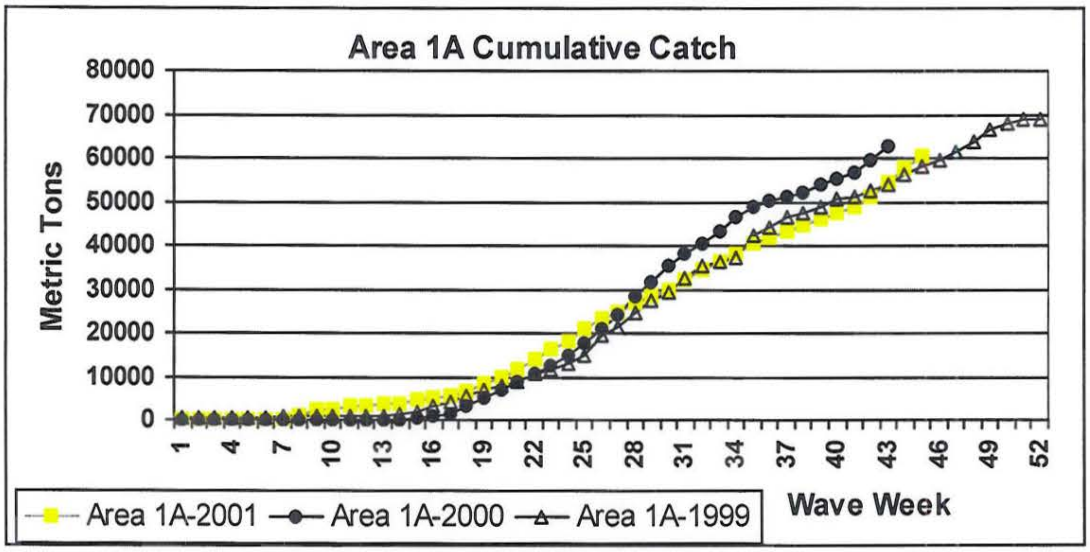
Atlantic Herring Management Areas

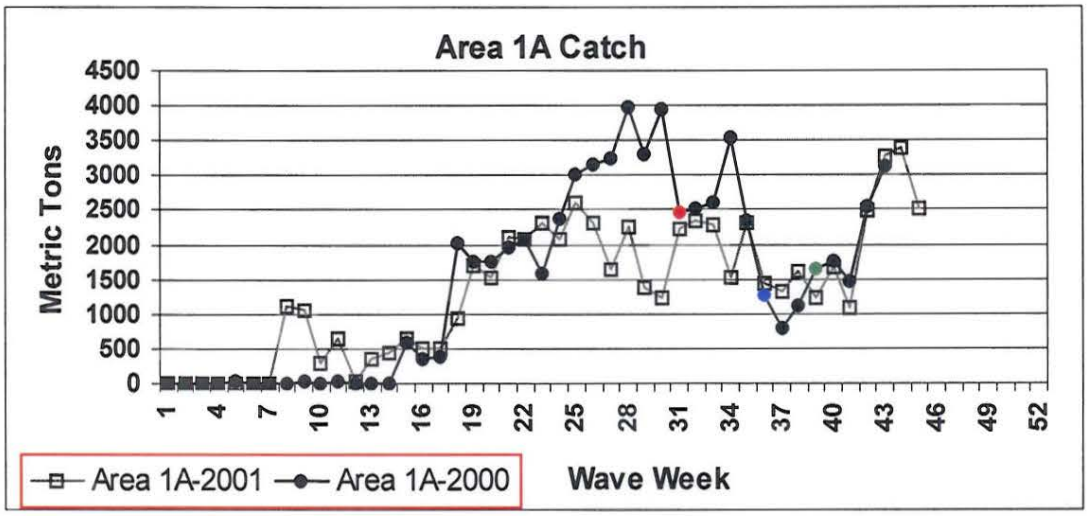


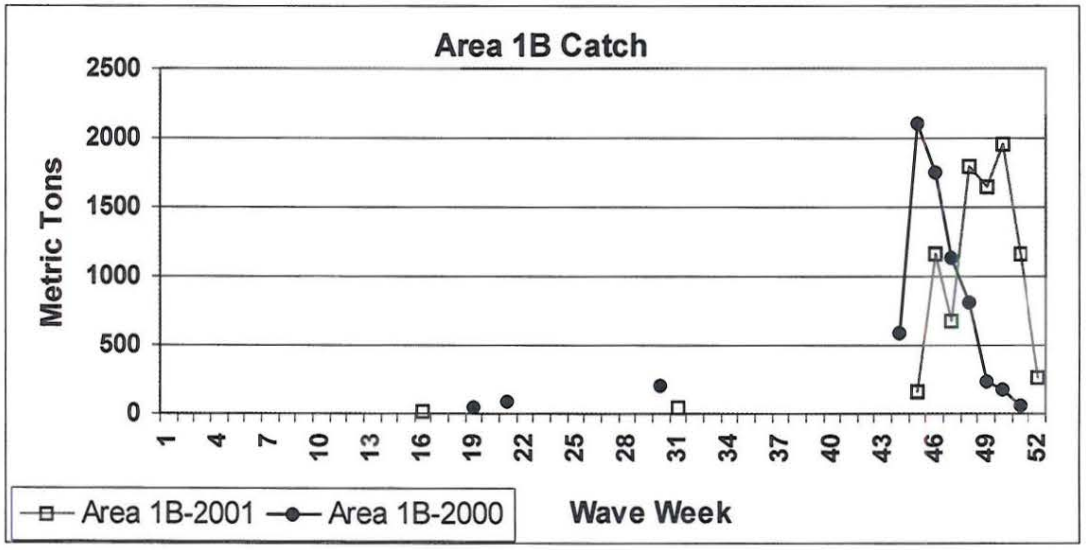
IVR Reported Catch in Metric Tons - 2001

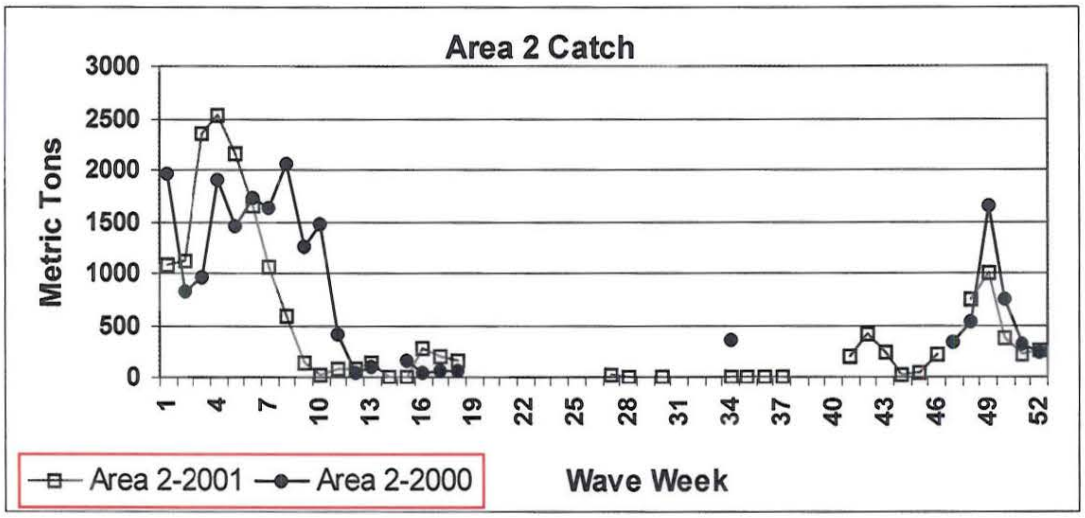
Week #	Area 1A	Area 1B	Area 2	Area 3	Total
53			1080		1080
02			1125		1125
03			2343		2343
04			2537		2537
05			2148		2148
06			1652		1652
07			1068		1068
08	1104		579		1683
09	1062		129		1191
10	304		25		329
11	641		79		721
12	36		86		122
13	357		136		493
14	434				434
15	637				637
16	483	20	272		775
17	504		197		701
18	931		152		1083
19	1707				1707
20	1524			5	1529
21	2090				2090
22	2065				2065
23	2304				2304
24	2087				2087
25	2608				2608
26	2296			625	2921
27	1641		19	1001	2661
28	2251			1848	4099
29	1374			2290	3664
30	1226			2452	3678
31	2213	40		1415	3668
32	2327			1536	3863
33	2293			1677	3970
34	1524			1523	3047
35	2323			2235	4558
36	1423			3074	4497
37	1328			3731	5059
38	1598			3462	5060
39	1237			2448	3685
40	1665			1921	3586
41	1093		190	3687	4970
42	2476		410	1353	4239
43	3285		234	953	4472
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		2637
50		1957	369		2326
51		1166	218		1384
52		270	256		526
Total	**60341**	**8887**	**17321**	**37701**	**124251**

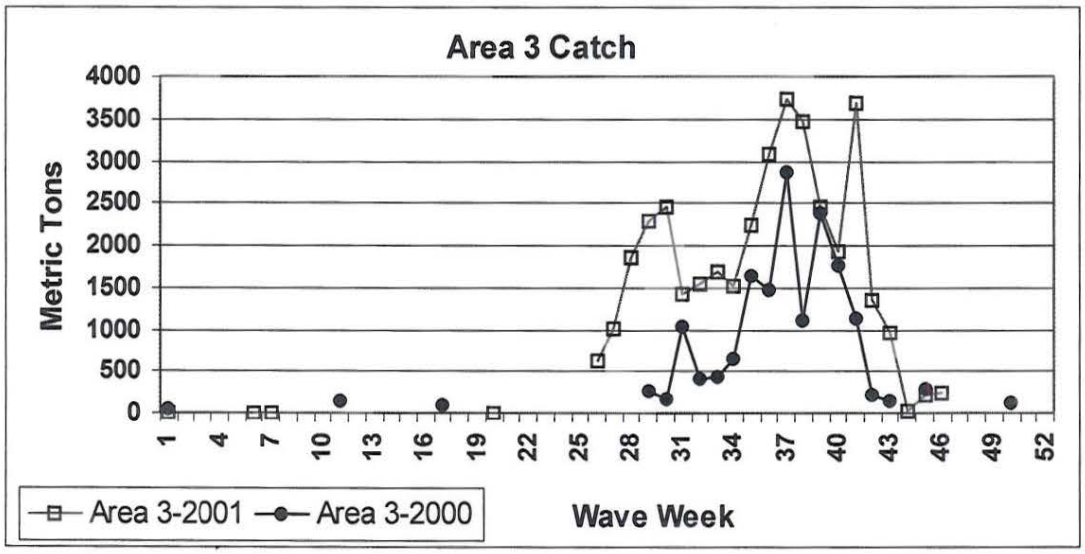

Total Catch by Area
70000
60000
50000
40000
30000
20000
10000
0
Area 1A
Area 1B
Area 2
Area 3
2001
2000


Area 1A Cumulative Catch
Metric Tons
80000
70000
60000
50000
40000
30000
20000
10000
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
Wave Week
Area 1A-2001
Area 1A-2000
Area 1A-1999


Area 1A Catch
Metric Tons
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
Area 1A-2001
Area 1A-2000
Wave Week


Area 1B Catch
Metric Tons
2500
2000
1500
1000
500
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
Area 1B-2001
Area 1B-2000
Wave Week


Area 2 Catch
Metric Tons
3000
2500
2000
1500
1000
500
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
Area 2-2001
Area 2-2000
Wave Week


Area 3 Catch
Metric Tons
4000
3500
3000
2500
2000
1500
1000
500
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
Area 3-2001
Area 3-2000
Wave Week

Appendix B

2001 Spawning Tolerance Report

The State of Maine: Spawning Tolerance Provision Report for Atlantic Herring

Background:
In June 2000 the ASMFC approved of Maine's proposal to continue spawning tolerance fishing under *Section 4.4.1* of Amendment 1(Alternative Management Regimes). In response to this decision, the Maine Department of Marine Resources (DMR) implemented an intensive inspection, documentation and sampling program for the herring fishery.

In 2001, three predefined spawning areas (Figure 1) were closed based on commercial catch sampling (Table 1). These spawning areas were subject to a 20% tolerance fishing regulation for vessels landing in Maine[1]. Each closure lasted four weeks, after which commercial catch samples were collected and examined for the presence of spawn. All of the samples collected after the closures were composed of spent fish; therefore a two-week extension was not necessary.

During the spawning closures 5,729 mt were taken from the three areas under the tolerance fishing provision (Table 2). Of the total landing from the spawning areas 498 mt (~ 9 %) were landed in states other than Maine. Data on spawning status, maturity, and age of fish landed to states other than Maine are unavailable. Of the 82 trips made during the spawning closure and landed in Maine 45 (55%) were either inspected by Marine Patrol or had their catch sampled by DMR Staff.

Enforcement Activities

Prior to the start of the spawning season Marine Patrol officers were trained on identification of spawning Herring by department staff. In all, Maine's Marine Patrol inspected approximately 67 trips during the spawning closure. Of these 67 trips 16 inspections were made of vessels that were fishing in spawning areas (Table 5). Evidence of fishing above the tolerance was not observed[1].

Catch Sampling:

The catch landed in Maine was comprised of 82 individual directed fishing trips (Table 3) of which 35% were sampled as part of Maine's commercial catch sampling program (Table 4). These samples were processed at the Department of Marine Resources' Boothbay lab and were not found to contain any stage 5 or 6 fish. The ratio of commercial sampling to landed fish during tolerance fishing was 0.006, much higher than the minimum 0.002 ratio recommended by the NMFS.

Commercial catch samples indicate that the catches made during the spawning closures were comprised of juveniles (< 230 mm: 60 %) and developing or spent adult sized fish (>230 mm: 40%). The catch data reveals that the total harvest during the closures in Area 1A was 8,844 mt of which 5,231 mt were a direct result of tolerance fishing. In all, tolerance fishing accounted for less than 10 % of all fish landed from area 1A and less than 5% from all areas for the year.

The tolerance provision allows for a continuity of product to the various herring markets. Additionally, the continuation of this provision will ensure adequate biological sampling of this fishery during spawning. In this next year, enforcement and sampling will be improved with the

[1] Tolerance fishing was defined as any catch with <20% stage 5 and 6 males and females.

use of the mandatory Vessel Monitoring Systems (VMS) and a dedicated commercial catch sampler.

Table1. Gulf of Maine Spawning Closures

Closures	Dates
Eastern Maine Closure	August 26-September 23
Western Maine Closure	September 2-September 30
New Hampshire/Massachusetts Closure	September 23-October 21

Table 2. Herring Catches for 2001 from Closed Areas

Closure	MT
E. Maine	**1,935**
W. Maine	**2,079**
NH/MA	**1,217**
To Other States	**498**
Total from Closed Areas	**5,729**

Table 3. Trips from Closed Areas

Closure	No. of Trips
E. Maine	26
W. Maine	35
NH/MA	21
To Other States	4
Total	**86**

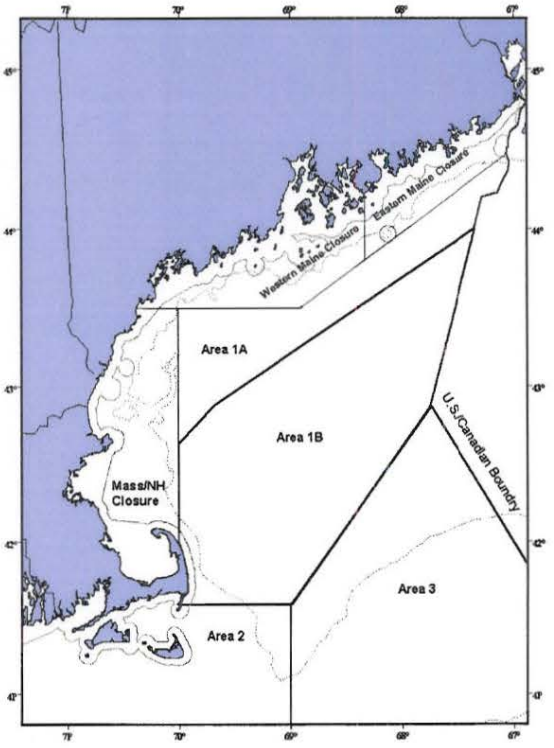
Table 4. Catch Samples from Closures

Closure	Samples	% of Trips
E. Maine	15	**58**
W. Maine	11	**31**
NH/MA	3	**14**
Total	**29**	
% of Trips Sampled (Maine Only)		**35**

Table 5. Marine Patrol Inspections

Closure	Inspections
E. Maine	4
W. Maine	2
NH/MA	10
Non-Closure	51
Total	**67**
% of Trips during Closures (Maine Only)	**20**

Figure 1. Herring Spawning Areas



Appendix C

2000 BIOSTAT (catch at age)

HERRING BIOSTAT REPORT FOR 2000 ESTALL00

PERCENT LENGTH FREQUENCY BY MONTH FOR ESTALL00

LENGTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20							0.031	0.037	0.037			
21							0.041	0.049	0.049			
22						0.038	0.082	0.097	0.097			
23						0.047	0.057	0.063	0.063	0.033		
24						0.038	0.044	0.037	0.037	0.058		
25						0.119	0.101	0.101	0.101	0.092		
26						0.178	0.129	0.131	0.131	0.208		
27						0.291	0.157	0.142	0.142	0.242		
28						0.184	0.189	0.179	0.179	0.200		
29						0.072	0.116	0.112	0.112	0.117		
30						0.022	0.031	0.034	0.034	0.033		
31						0.006	0.006	0.007	0.007			
32						0.006	0.016	0.011	0.011	0.017		
33												
34												
35												
36												
37												
38												
39												
40												
TOT %						1.00	1.00	1.00	1.00	1.00		
AVGLTH						27.0	26.5	26.3	26.3	27.3		

VARLTH	3.4	7.4	7.9	7.9	2.9
TOTSMP	320	318	268	268	120
	****	****		****	****

**** = BORROWED DATA

PERCENT WEIGHT FREQUENCY BY MONTH FOR
ESTALL00

WEIGHT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0												
50						0.07	0.19	0.22	0.22	0.03		
100						0.23	0.22	0.21	0.21	0.24		
150						0.53	0.34	0.32	0.32	0.49		
200						0.16	0.22	0.22	0.22	0.22		
250						0.02	0.03	0.02	0.02	0.03		
300												
350												
400												
450												
TOT %						1.00	1.00	1.00	1.00	1.00		
AVGWHT						165.1	157.3	154.0	154.0	171.7		
VARWHT						1571.4	2717.7	2842.0	2842.0	1426.9		
TOTSMP						320	318	268	268	120		
						****	****		****	****		

**** = BORROWED DATA

PERCENT AGE FREQUENCY BY MONTH FOR
ESTALL00

AGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2						0.06	0.15	0.17	0.17	0.05		
3						0.21	0.22	0.21	0.21	0.25		
4						0.17	0.16	0.16	0.16	0.18		
5						0.14	0.13	0.13	0.13	0.18		
6						0.24	0.19	0.19	0.19	0.23		
7						0.15	0.10	0.11	0.11	0.10		
8						0.01	0.02	0.02	0.02			
9						0.02	0.02	0.01	0.01	0.03		
10												
11+												
TOT %						1.00	1.00	1.00	1.00	1.00		
AVGAGE						4.9	4.5	4.4	4.4	4.7		
AVERAGE						2.9	3.3	3.3	3.3	2.6		
TOTSMP						95	99	84	84	40		
						****	****		****	****		

**** = BORROWED DATA

MEAN WEIGHTS (g) BY YEAR CLASS FOR
ESTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
6	**	84.0	114.1	148.0	181.2	196.1	224.6	216.0	281.5		
7	**	78.7	118.1	155.5	186.5	211.7	235.3	266.0	269.0		
8		78.3	118.2	156.0	183.9	212.3	234.9	266.0	269.0		
9	**	78.3	118.2	156.0	183.9	212.3	234.9	266.0	269.0		
10	**	84.5	116.0	158.6	183.9	208.7	234.3		269.0		

** = BORROWED DATA

AGE LENGTH KEY (by month) FOR
ESTALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	22		2										2
6	23		4	6									10
6	24			7	2								9
6	25			6	5	2							13
6	26			1	7	4	2						14
6	27				2	3	7	1					13
6	28					3	7	3					13
6	29					1	6	5					12
6	30						1	4	1				6
6	31							1		1			2
6	32									1			1
TOTAL			6	20	16	13	23	14	1	2			95

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
7	20		3										3
7	21		2										2
7	22		4										4
7	23		6	3									9
7	24			9									9
7	25			8	3	1							12
7	26			2	9	2							13
7	27				4	3	4						11
7	28					5	6						11
7	29					2	7	3					12
7	30						2	6					8
7	31							1	1				2
7	32								1	2			3
TOTAL			15	22	16	13	19	10	2	2			99

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
8	20		3										3
8	21		2										2
8	22		4										4
8	23		5	3									8

8	24		7							7
8	25		7	2	1					10
8	26		1	8	2					11
8	27			3	3	3				9
8	28				4	5				9
8	29				1	6	3			10
8	30					2	5			7
8	31						1	1		2
8	32							1	1	2
TOTAL		14	18	13	11	16	9	2	1	84

April 27, 2001 - 13:44

AGE LENGTH KEY (by month) FOR ESTALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
9	20		3										3
9	21		2										2
9	22		4										4
9	23		5	3									8
9	24			7									7
9	25			7	2	1							10
9	26			1	8	2							11
9	27				3	3	3						9
9	28					4	5						9
9	29					1	6	3					10
9	30						2	5					7
9	31							1	1				2
9	32								1	1			2
TOTAL			14	18	13	11	16	9	2	1			84

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
10	23		2	2									4
10	24			4									4
10	25			3	1	1							5
10	26			1	4	1							6
10	27				2	2	2						6
10	28					2	3						5
10	29					1	3	2					6
10	30						1	2					3
10	32									1			1
TOTAL			2	10	7	7	9	4		1			40

**** BORROWED DATA ****

PERCENT AGE COMPOSITION (by numbers) FROM SAMPLES

ESTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	**	0.06	0.13	0.19	0.19	0.32	0.11	0.00	0.01			1.00
7	**	0.19	0.15	0.17	0.18	0.24	0.06	0.01	0.01			1.00
8		0.22	0.14	0.16	0.17	0.22	0.06	0.01	0.01			1.00
9	**	0.22	0.14	0.16	0.17	0.22	0.06	0.01	0.01			1.00
10	**	0.02	0.17	0.24	0.23	0.27	0.06		0.02			1.00

** = BORROWED SAMPLE DATA

PERCENT AGE COMPOSITION (by weight) FROM SAMPLES

ESTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	**	0.03	0.08	0.16	0.20	0.37	0.15	0.01	0.02			1.00
7	**	0.09	0.11	0.17	0.21	0.31	0.08	0.01	0.02			1.00
8		0.11	0.11	0.16	0.20	0.30	0.09	0.02	0.01			1.00
9	**	0.11	0.11	0.16	0.20	0.30	0.09	0.02	0.01			1.00
10	**	0.01	0.11	0.21	0.24	0.32	0.08		0.03			1.00

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:44

2000 CATCH (mt) BY YEAR CLASS

ESTALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
6	**		1.6	4.8	9.3	11.2	21.1	8.5	0.3
7	**		10.5	12.3	18.6	22.9	34.8	9.1	1.6
8			106.2	103.4	154.5	192.7	289.3	87.8	15.1
9	**		23.5	22.9	34.2	42.7	64.1	19.5	3.4
10	**		1.2	15.9	31.4	35.7	46.9	11.9	
TOTAL			143.0	159.4	248.0	305.3	456.2	136.8	20.3

MONTH		1991	1990	1989+	TOTAL
6	**		0.9		57.6
7	**		2.0		111.8
8			9.2		958.3
9	**		2.0		212.4
10	**		3.7		146.8
TOTAL			17.8		1486.8

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:44

2000 CATCH IN NUMBERS BY YEAR CLASS (1000s)

ESTALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
6	**		18.9	41.8	62.9	61.9	107.5	37.7	1.2
7	**		133.6	104.3	119.5	122.8	164.3	38.9	5.8
8			1356.6	875.0	990.2	1048.1	1363.0	373.8	56.9
9	**		300.7	193.9	219.5	232.3	302.1	82.8	12.6
10	**		13.9	137.3	198.1	194.2	225.0	50.9	
TOTAL			1823.6	1352.3	1590.2	1659.2	2161.8	584.2	76.6

MONTH		1991	1990	1989+	TOTAL
6	**		3.1		335.2
7	**		7.3		696.5
8			34.1		6097.7
9	**		7.6		1351.4
10	**		13.9		833.2
TOTAL			66.0		9314.0

** = BORROWED SAMPLE DATA

HERRING BIOSTAT REPORT FOR 2000 CNTALL00

PERCENT LENGTH FREQUENCY BY MONTH FOR
CNTALL00

LENGTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16								0.001				
17							0.007	0.003	0.004	0.003		
18					0.007	0.004	0.012	0.014	0.048	0.027		
19					0.010	0.007	0.032	0.073	0.108	0.088		
20						0.002	0.048	0.119	0.186	0.155		
21					0.003	0.007	0.027	0.168	0.316	0.261		
22					0.013	0.016	0.009	0.093	0.242	0.297		
23					0.053	0.051	0.029	0.018	0.068	0.147		
24					0.057	0.056	0.041	0.043	0.018	0.016		
25					0.100	0.096	0.080	0.056	0.004	0.004		
26					0.180	0.196	0.159	0.086	0.004	0.001		
27					0.330	0.318	0.273	0.158		0.001		
28					0.187	0.187	0.178	0.123				
29					0.047	0.044	0.079	0.037	0.002			
30					0.010	0.016	0.017	0.006				
31					0.003	0.002	0.007	0.001				
32							0.001					
33												
34												
35												
36												
37												
38												
39												
40												
TOT %					1.00	1.00	1.00	1.00	1.00	1.00		
AVGLTH					26.8	26.8	26.3	24.2	21.4	21.7		

VARLTH	3.7	3.5	8.0	11.2	2.0	1.8
TOTSMP	300	450	748	943	500	750
	****					

**** = BORROWED DATA

PERCENT WEIGHT FREQUENCY BY MONTH FOR
CNTALL00

WEIGHT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0					0.01		0.01	0.02	0.04	0.02		
50					0.04	0.05	0.13	0.46	0.91	0.95		
100					0.23	0.25	0.17	0.14	0.04	0.03		
150					0.58	0.56	0.47	0.30				
200					0.13	0.12	0.21	0.07				
250					0.01	0.01	0.01					
300												
350												
400												
450												
TOT %					1.00	1.00	1.00	1.00	1.00	1.00		
AVGWHT					165.4	163.5	162.0	119.9	73.1	74.5		
VARWHT					1351.2	1306.4	2433.5	2969.9	280.2	177.6		
TOTSMP					300	450	748	943	500	750		
					****							

**** = BORROWED DATA

PERCENT AGE FREQUENCY BY MONTH FOR
CNTALL00

AGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2					0.07	0.05	0.12	0.44	0.86	0.92		
3					0.20	0.22	0.18	0.17	0.11	0.06		
4					0.19	0.19	0.21	0.11	0.02	0.01		
5					0.15	0.14	0.18	0.12		0.01		
6					0.26	0.24	0.19	0.14				
7					0.10	0.11	0.09	0.02	0.01			
8					0.03	0.05	0.03	0.00				
9					0.01	0.01	0.01					
10												
11+												
TOT %					1.00	1.00	1.00	1.00	1.00	1.00		
AVGAGE					4.8	4.9	4.5	3.4	2.2	2.1		
AVERAGE					2.7	2.7	2.7	2.5	0.4	0.2		
TOTSMP					92	139	171	223	117	156		
					****							

**** = BORROWED DATA

MEAN WEIGHTS (g) BY YEAR CLASS FOR
CNTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
5	**	55.5	107.2	131.2	160.1	186.6	207.2	231.3	294.0		
6		57.0	102.9	132.6	162.6	184.8	206.3	230.6	294.0		
7		61.9	112.7	151.2	178.9	200.5	226.0	255.6	261.0		
8		67.1	120.0	153.3	174.6	206.5	225.5	266.0			
9		69.9	113.3	162.0			226.0				
10		71.0	102.8	120.0	142.0						

** = BORROWED DATA

April 27, 2001 - 13:46

AGE LENGTH KEY (by month) FOR CNTALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	18		2										2
5	19		3										3
5	21		1										1
5	22			4									4
5	23			9									9
5	24			3	8								11
5	25			2	9	2							13
5	26					10	2						12
5	27					2	9	1					12
5	28						8	4					12
5	29						5	4					9
5	30								3				3
5	31									1			1
TOTAL			6	18	17	14	24	9	3	1			92

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	18		2										2
6	19		3										3
6	20		1										1
6	21		1	2									3
6	22			6									6
6	23			13									13
6	24			6	10								16
6	25			3	14	2							19
6	26				2	13	3						18
6	27					5	12	1					18
6	28						11	7					18
6	29						7	7					14
6	30								7				7
6	31									1			1
TOTAL			7	30	26	20	33	15	7	1			139

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
7	17		3										3
7	18		4										4

7	19	4								4
7	20	5								5
7	21	4								4
7	22	1	3							4
7	23		10							10
7	24		13	1						14
7	25		4	15	1					20
7	26		1	16	5	2				24
7	27			3	21	2				26
TOTAL		21	31	35	31	32	15	5	1	171

AGE LENGTH KEY (by month) FOR
CNTALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
8	16		1										1
8	17		1										1
8	18		11										11
8	19		19										19
8	20		20										20
8	21		22										22
8	22		19	1									20
8	23		6	7									13
8	24			15									15
8	25			13	6								19
8	26			1	15	4	1						21
8	27				3	14	3						20
8	28					7	13						20
8	29					1	15	1					17
8	30							3					3
8	31								1				1
TOTAL			99	37	24	26	32	4	1				223

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
9	17		2										2
9	18		7										7
9	19		20										20
9	20		20										20
9	21		20										20
9	22		18	1									19
9	23		14	3									17
9	24			7									7
9	25			2									2
9	26				2								2
9	29							1					1
TOTAL			101	13	2			1					117

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
10	17		2										2
10	18		12										12
10	19		20										20

10	20	26				26
10	21	28				28
10	22	28				28
10	23	27	1			28
10	24	1	6			7
10	25		2	1		3
10	26			1		1
10	27				1	1
TOTAL		144	9	2	1	156

PERCENT AGE COMPOSITION (by numbers) FROM SAMPLES

CNTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	**	0.02	0.10	0.11	0.22	0.43	0.11	0.01	0.00			1.00
6		0.02	0.11	0.13	0.24	0.38	0.11	0.02	0.00			1.00
7		0.13	0.10	0.20	0.29	0.21	0.06	0.01	0.00			1.00
8		0.47	0.10	0.10	0.17	0.14	0.01	0.00				1.00
9		0.95	0.05	0.00			0.00					1.00
10		0.97	0.02	0.00	0.00							1.00

** = BORROWED SAMPLE DATA

PERCENT AGE COMPOSITION (by weight) FROM SAMPLES

CNTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	**	0.01	0.06	0.09	0.21	0.48	0.14	0.01	0.01			1.00
6		0.01	0.07	0.10	0.24	0.43	0.14	0.02	0.00			1.00
7		0.05	0.07	0.19	0.32	0.26	0.09	0.02	0.00			1.00
8		0.26	0.10	0.13	0.25	0.24	0.02	0.00				1.00
9		0.91	0.07	0.01			0.01					1.00
10		0.96	0.03	0.00	0.00							1.00

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:46

2000 CATCH (mt) BY YEAR CLASS

CNTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992
5	**	1.1	10.4	14.5	35.2	79.7	22.9	2.3
6		16.2	201.8	308.3	713.8	1289.5	425.3	65.7
7		378.4	525.4	1449.4	2443.5	1999.1	691.9	157.8
8		1592.9	603.2	788.8	1505.1	1452.4	96.5	14.1
9		2373.8	189.8	23.2			16.2	
10		2508.4	80.6	11.6	6.9			
TOTAL		6870.8	1611.2	2595.8	4704.6	4820.7	1252.7	239.9

MONTH	1991	1990	1989+	TOTAL
5	**	1.0		167.1
6		12.0		3032.6
7		27.8		7673.4
8				6053.0
9				2603.0
10				2607.5
TOTAL		40.7		22136.5

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:46

2000 CATCH IN NUMBERS BY YEAR CLASS (1000s)

CNTALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992
5	**	20.0	97.3	110.2	220.0	427.1	110.3	10.0
6		285.1	1961.4	2324.8	4390.1	6977.2	2061.0	285.1
7		6116.8	4663.1	9588.0	13660.9	9970.6	3061.7	617.2
8		23756.3	5026.6	5147.1	8621.7	7034.3	427.9	53.1
9		33949.2	1675.0	143.4			71.7	
10		35354.1	784.4	96.8	48.4			
TOTAL		99481.4	14207.8	17410.2	26941.0	24409.2	5732.6	965.3

MONTH	1991	1990	1989+	TOTAL
5	**	3.3		998.2
6		40.7		18325.4
7		106.5		47784.8
8				50066.9
9				35839.2
10				36283.6
TOTAL		150.5		189298.1

** = BORROWED SAMPLE DATA

HERRING BIOSTAT REPORT FOR 2000 JEFALL00

PERCENT LENGTH FREQUENCY BY MONTH FOR
JEFALL00

LENGTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15					0.001							
16					0.010							
17					0.019							
18					0.043	0.003	0.007				0.003	
19					0.020		0.093			0.003	0.018	
20		0.012	0.012		0.004		0.140		0.100	0.020	0.033	
21	0.014	0.024	0.024		0.006	0.003	0.080	0.002	0.300	0.076	0.083	
22		0.060	0.060		0.009	0.005	0.013	0.002	0.440	0.129	0.113	
23	0.049	0.036	0.036		0.017	0.005	0.007	0.002	0.100	0.090	0.053	
24	0.147	0.060	0.060		0.016	0.008	0.027	0.010	0.040	0.029	0.030	
25	0.119	0.133	0.133	0.027	0.080	0.063	0.127	0.073		0.058	0.053	
26	0.196	0.108	0.108	0.193	0.168	0.162	0.287	0.198	0.020	0.127	0.115	
27	0.091	0.325	0.325	0.393	0.334	0.394	0.153	0.325		0.191	0.223	
28	0.105	0.108	0.108	0.247	0.178	0.217	0.053	0.263		0.183	0.175	
29	0.091	0.060	0.060	0.100	0.061	0.076	0.007	0.079		0.070	0.075	
30	0.112	0.060	0.060	0.040	0.019	0.048	0.007	0.029		0.017	0.020	
31	0.035	0.012	0.012		0.013	0.018		0.010		0.004		

```
0.008
   32   0.028                    0.001             0.006        0.001
0.003
   33   0.014
   34                                               0.002
   35
   36
   37
   38
   39
   40
-------------------------------------------------------------------------
-------
 TOT %   1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00
1.00
 AVGLTH  27.3  26.6  26.6  27.8  26.4  27.6  24.6  27.6  22.2  25.9
25.9
 VARLTH   6.4   5.2   5.2   1.1   9.4   2.0   9.3   1.8   1.3   7.4
8.7
 TOTSMP   143    83    83   150   691   396   150   520    50   753
400
         ****  ****
     **** = BORROWED DATA
```

April 27, 2001 - 13:54

PERCENT WEIGHT FREQUENCY BY MONTH FOR JEFALL00

WEIGHT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0					0.05							
50	0.10	0.12	0.12		0.07	0.02	0.33		0.92	0.32	0.30	
100	0.52	0.51	0.51	0.58	0.28	0.10	0.19	0.12	0.06	0.39	0.36	
150	0.22	0.31	0.31	0.41	0.55	0.66	0.41	0.64	0.02	0.28	0.32	
200	0.13	0.06	0.06	0.01	0.06	0.20	0.06	0.22		0.01	0.03	
250	0.01					0.03		0.02				
300												
350												
400												
450												
TOT %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
AVGWHT	145.6	139.0	139.0	151.1	150.1	182.6	130.9	180.8	80.2	124.9	127.6	
VARWHT	1821.8	1212.7	1212.7	307.5	1696.9	947.3	2455.0	931.8			209.0	1312.4	1610.5
TOTSMP	143	83	83	150	684	393	150	520	50	753	400	

**** ****

**** = BORROWED DATA

PERCENT AGE FREQUENCY BY MONTH FOR JEFALL00

AGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2					0.12	0.02	0.34	0.02	0.73	0.29	0.34	
3	0.06	0.15	0.15		0.08	0.06	0.22	0.08	0.18	0.11	0.08	
4	0.19	0.24	0.24	0.10	0.20	0.16	0.13	0.16	0.09	0.18	0.11	
5	0.12	0.09	0.09	0.29	0.15	0.19	0.16	0.27		0.16	0.14	
6	0.25	0.21	0.21	0.29	0.26	0.23	0.09	0.27		0.18	0.21	
7	0.18	0.15	0.15	0.29	0.11	0.21	0.06	0.12		0.05	0.07	
8	0.09	0.15	0.15	0.03	0.08	0.11		0.05		0.03	0.03	
9	0.03				0.01			0.02		0.01		

0.02											
10	0.05					0.02		0.01			
0.01											
11+	0.03							0.01			
TOT %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
1.00											
AVGAGE	6.1	5.4	5.4	5.9	5.0	5.8	3.6	5.4	2.4	4.1	
4.3											
AVERAGE											
	3.9	2.9	2.9	1.1	3.2	2.6	2.6	2.6	0.5	3.2	
4.3											
TOTSMP											
	67	33	33	31	191	103	32	128	11	221	132
	****	****									

**** = BORROWED DATA

MEAN WEIGHTS (g) BY YEAR CLASS FOR JEFALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
1 **			81.3	105.2	113.5	135.5	178.3	195.5	226.0	238.0	258.5
2 **			72.0	110.3	126.7	149.3	185.8	196.0			
3			72.0	110.3	126.7	149.3	185.8	196.0			
4				122.7	134.3	155.0	187.3	198.0			
5		52.8	98.3	130.7	147.0	170.6	196.7	219.9	222.0		
6		75.0	103.8	146.8	167.8	196.5	226.3	232.1		242.0	
7		73.4	127.0	144.5	179.4	200.0	225.0				
8		84.7	126.2	159.2	177.2	199.5	234.7	236.3	271.7	282.0	333.0
9		75.8	104.5	150.0							
10		81.6	112.8	128.5	150.2	164.0	191.2	200.1	209.0		
11		73.8	110.6	123.6	143.9	158.8	185.0	200.5	214.0	218.0	

** = BORROWED DATA

AGE LENGTH KEY (by month) FOR
JEFALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	21			2									2
1	23			2	4								6
1	24				6	2							8
1	25				2	5							7
1	26				1	1	7						9
1	27						8						8
1	28						2	5					7
1	29							5	2				7
1	30							2	3				5
1	31									1	1		2
1	32								1	1	2		4
1	33											2	2
TOTAL				4	13	8	17	12	6	2	3	2	67

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
2	20			1									1
2	21			2									2
2	22			2									2
2	23				2								2
2	24				2								2
2	25				3	1							4
2	26				1	2	1						4
2	27						4						4
2	28						2	2					4
2	29							2	2				4
2	30							1	2				3
2	31								1				1
TOTAL				5	8	3	7	5	5				33

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
3	20			1									1
3	21			2									2
3	22			2									2
3	23				2								2

3	24		2					2
3	25		3	1				4
3	26		1	2	1			4
3	27				4			4
3	28				2	2		4
3	29					2	2	4
3	30					1	2	3
3	31						1	1
TOTAL		5	8	3	7	5	5	33

April 27, 2001 - 13:54

AGE LENGTH KEY (by month) FOR JEFALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
4	25				3								3
4	26					6							6
4	27					3	3						6
4	28						6						6
4	29							6					6
4	30							3	1				4
TOTAL					3	9	9	9	1				31

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	15		1										1
5	16		4										4
5	17		4										4
5	18		4										4
5	19		4										4
5	20		2										2
5	21		4										4
5	22			5									5
5	23			7	3								10
5	24			2	9								11
5	25			1	18	4							23
5	26				7	15	4						26
5	27				1	8	18	1					28
5	28					1	26	1					28
5	29						1	15	3				19
5	30							4	5	1			10
5	31								6	1			7
5	32								1				1
TOTAL			23	15	38	28	49	21	15	2			191

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	18		1										1
6	21			1									1
6	22		1	1									2
6	23			2									2
6	24			1	2								3
6	25			1	9	1							11

6	26			5	9	2				16
6	27				10	6				16
6	28					12	4			16
6	29					3	10	2		15
6	30					1	6	6	1	14
6	31						2	3	1	6
TOTAL		2	6	16	20	24	22	11	2	103

AGE LENGTH KEY (by month) FOR JEFALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
7	18		1										1
7	19		2										2
7	20		3										3
7	21		3										3
7	22		2										2
7	23			1									1
7	24			2	1								3
7	25			4									4
7	26				3	2							5
7	27					3	1						4
7	28						2						2
7	29							1					1
7	30							1					1
TOTAL			11	7	4	5	3	2					32

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
8	21		1										1
8	22		1										1
8	23		1										1
8	24			4									4
8	25			6	7	1							14
8	26				12	10	1						23
8	27				2	16	6						24
8	28					6	16	1					23
8	29					1	10	4					15
8	30						1	7	5				13
8	31							3		2			5
8	32								1	1	1		3
8	34											1	1
TOTAL			3	10	21	34	34	15	6	3	1	1	128

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
9	20		2										2
9	21		2										2
9	22		2										2
9	23		2										2

9	24			2								2
9	26				1							1
TOTAL		8	2	1								11

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
TOTAL		63	25	40	35	39	11	7	1				221

April 27, 2001 - 13:54

AGE LENGTH KEY (by month) FOR JEFALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
11	19		5										5
11	20		8										8
11	21		10										10
11	22		12										12
11	23		9	1	1								11
11	24		1	5	2								8
11	25			5	6	1							12
11	26				5	8	1						14
11	27					6	8						14
11	28					3	10	1					14
11	29						8	5	1				14
11	30							3	1	2			6
11	31								2		1		3
11	32									1			1
TOTAL			45	11	14	18	27	9	4	3	1		132

April 27, 2001 -
13:54

PERCENT AGE COMPOSITION (by numbers) FROM SAMPLES

JEFALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	**		0.03	0.20	0.14	0.27	0.19	0.10	0.02	0.03	0.01	1.00
2	**		0.10	0.22	0.09	0.41	0.10	0.08				1.00
3			0.10	0.22	0.09	0.41	0.10	0.08				1.00
4				0.03	0.39	0.44	0.13	0.01				1.00
5		0.10	0.03	0.14	0.21	0.41	0.07	0.03	0.00			1.00
6		0.01	0.02	0.11	0.34	0.35	0.13	0.04		0.01		1.00
7		0.33	0.15	0.18	0.23	0.09	0.01					1.00
8		0.01	0.04	0.17	0.38	0.33	0.05	0.01	0.01	0.00	0.00	1.00
9		0.94	0.04	0.02								1.00
10		0.33	0.07	0.17	0.22	0.18	0.02	0.01	0.00			1.00
11		0.29	0.05	0.08	0.20	0.30	0.05	0.01	0.01	0.00		1.00

** = BORROWED SAMPLE DATA

PERCENT AGE COMPOSITION (by weight) FROM SAMPLES

JEFALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	**		0.02	0.14	0.11	0.25	0.23	0.13	0.04	0.05	0.03	1.00
2	**		0.05	0.18	0.08	0.44	0.14	0.12				1.00
3			0.05	0.18	0.08	0.44	0.14	0.12				1.00
4				0.02	0.35	0.46	0.16	0.01				1.00
5		0.04	0.02	0.12	0.21	0.47	0.10	0.05	0.01			1.00
6		0.00	0.01	0.09	0.31	0.37	0.16	0.05		0.01		1.00
7		0.19	0.15	0.20	0.31	0.14	0.02					1.00
8		0.00	0.03	0.15	0.37	0.36	0.07	0.02	0.01	0.00	0.00	1.00
9		0.91	0.05	0.04								1.00
10		0.21	0.06	0.18	0.26	0.24	0.04	0.02	0.00			1.00
11		0.17	0.04	0.08	0.23	0.38	0.07	0.02	0.02	0.00		1.00

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:54

2000 CATCH (mt) BY YEAR CLASS

JEFALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992
1	**			0.0	0.4	0.3	0.7	0.6
0.4								
2	**			4.5	15.9	7.2	39.3	12.6
10.5								
3				3.8	13.5	6.1	33.4	10.7
8.9								
4					29.1	465.4	610.5	216.4
17.6								
5			257.1	124.9	840.4	1459.7	3260.7	678.2
324.8								
6			15.4	77.5	639.8	2338.9	2790.5	1207.4
372.7								
7			1231.9	966.8	1316.8	2075.6	923.6	151.1
8			15.6	164.8	848.1	2159.3	2086.9	402.7
98.1								
9			1529.9	89.8	64.5			
10			1215.7	345.7	1018.3	1479.7	1386.4	199.4
110.1								
11			635.9	148.2	290.5	862.7	1422.1	269.3
81.1								
TOTAL			4901.5	1926.1	5077.2	10854.9	12554.1	3148.3
1024.1								

MONTH	1991	1990	1989+	TOTAL
1	** 0.1	0.1	0.1	2.7
2	**			90.0
3				76.3
4				1338.9
5	38.8			6984.7
6		62.7		7504.9
7				6665.8
8	50.0	17.3	20.4	5863.4
9				1684.1
10	15.0			5770.3
11	57.9	16.1		3783.8
TOTAL	161.9	96.2	20.5	39764.9

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:54

2000 CATCH IN NUMBERS BY YEAR CLASS (1000s)

JEFALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992
1	**			0.6	3.7	2.7	5.1	3.4 1.9
2	**			62.5	144.5	56.6	263.5	67.7 53.4
3				53.0	122.5	48.0	223.4	57.4 45.2
4					236.9	3464.8	3938.6	1154.9 88.8
5			4867.5	1270.4	6430.8	9929.8	19116.6	3447.9 1476.9
6			205.3	746.6	4358.5	13938.6	14204.0	5336.0 1605.9
7			16792.2	7612.5	9112.6	11569.8	4617.9	671.7
8			184.0	1305.8	5326.2	12185.5	10460.7	1715.6 415.3
9			20196.2	859.4	429.7			
10			14894.8	3063.9	7922.8	9853.2	8456.2	1043.0 550.0
11			8614.6	1340.7	2350.6	5993.4	8954.5	1455.5 404.3
TOTAL			65754.7	16315.2	36438.6	67042.5	70240.5	14953.1 4641.7

MONTH	1991	1990	1989+	TOTAL
1	** 0.5	0.6	0.3	18.7
2	**			648.1
3				549.4
4				8884.1
5	174.8			46714.7
6		259.1		40654.0
7				50376.7
8	184.0	61.3	61.3	31899.9
9				21485.4
10	72.0			45855.8
11	270.7	73.8		29458.1
TOTAL	702.0	394.9	61.6	276544.8

** = BORROWED SAMPLE DATA

HERRING BIOSTAT REPORT FOR 2000 AR2ALL00

PERCENT LENGTH FREQUENCY BY MONTH FOR
AR2ALL00

LENGTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17		0.001	0.007	0.007	0.007	0.009						
18												
19						0.005						
20	0.004	0.004						0.010	0.006		0.016	0.016
21	0.008	0.008	0.007	0.007	0.004	0.005			0.006	0.040	0.133	0.133
22	0.015	0.004	0.007	0.007	0.007	0.018		0.010	0.017	0.111	0.242	0.242
23	0.061	0.043	0.055	0.055	0.037	0.050			0.017	0.043	0.117	0.117
24	0.165	0.065	0.099	0.099	0.085	0.104		0.031	0.057	0.028	0.047	0.047
25	0.155	0.113	0.151	0.151	0.118	0.095		0.227	0.182	0.012	0.016	0.016
26	0.220	0.296	0.309	0.309	0.301	0.288		0.351	0.250	0.095	0.086	0.086
27	0.165	0.242	0.199	0.199	0.268	0.230		0.268	0.284	0.233	0.172	0.172
28	0.070	0.097	0.085	0.085	0.077	0.090		0.103	0.119	0.269	0.102	0.102
29	0.053	0.069	0.033	0.033	0.048	0.059			0.045	0.099	0.047	0.047
30	0.055	0.049	0.048	0.048	0.040	0.041			0.017	0.040	0.016	0.016
31	0.013	0.005			0.007	0.009				0.024	0.008	0.008
32	0.008	0.003								0.008		

```
   33   0.006
   34
   35
   36
   37
   38
   39
   40
-------------------------------------------------------------------------
-------
 TOT %   1.00  1.00  1.00  1.00  1.00  1.00        1.00  1.00  1.00
1.00  1.00
 AVGLTH  26.5  26.8  26.5  26.5  26.7  26.5        26.5  26.7  26.9
24.8  24.8
 VARLTH   4.6   3.2   3.4   3.4   3.3   4.2         1.4   2.4   6.5
7.6   7.6
 TOTSMP   472   759   272   272   272   222          97   176   253
128   128
                           ****  ****  ****        ****  ****  ****
****
     **** = BORROWED DATA
```

April 27, 2001 - 13:51

PERCENT WEIGHT FREQUENCY BY MONTH FOR AR2ALL00

WEIGHT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0			0.01	0.01	0.01	0.01						
50	0.15	0.07	0.11	0.11	0.08	0.11		0.02	0.03	0.21	0.54	0.54
100	0.64	0.69	0.71	0.71	0.65	0.66		0.29	0.27	0.26	0.29	0.29
150	0.15	0.22	0.16	0.16	0.24	0.20		0.62	0.59	0.42	0.16	0.16
200	0.06	0.02	0.01	0.01	0.02	0.02		0.07	0.10	0.09	0.01	0.01
250									0.01	0.02		
300												
350												
400												
450												
TOT %	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
AVGWHT	131.2	136.1	128.8	128.8	135.1	132.2		160.2	162.8	150.2	108.6	108.6
VARWHT	1181.9	717.1	650.4	650.4	735.9	851.5					582.6	1018.4
TOTSMP	472	759	272	272	272	222		97	176	253	128	128
			****	****	****			****	****	****	****	

**** = BORROWED DATA

PERCENT AGE FREQUENCY BY MONTH FOR AR2ALL00

AGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2		0.00	0.02	0.02	0.02	0.03		0.07	0.09	0.21	0.35	0.35
3	0.09	0.06	0.04	0.04	0.03	0.07		0.03	0.13	0.03	0.07	0.07
4	0.27	0.23	0.30	0.30	0.32	0.31		0.28	0.25	0.25	0.28	0.28
5	0.14	0.18	0.17	0.17	0.16	0.14		0.28	0.16	0.13	0.14	0.14
6	0.23	0.26	0.24	0.24	0.21	0.20		0.31	0.30	0.19	0.12	0.12
7	0.15	0.14	0.12	0.12	0.14	0.14		0.03	0.07	0.10	0.05	0.05
8	0.07	0.10	0.09	0.09	0.10	0.09				0.07		
9	0.02	0.03	0.01	0.01	0.02	0.04				0.02		

10	0.02											
11+	0.01											
TOT %	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AVGAGE	5.6	5.6	5.3	5.3	5.4	5.4	4.8	4.7	4.8	3.7	3.7	
AVERAGE	3.1	2.3	2.3	2.3	2.6	2.9	1.5	2.1	3.7	2.5	2.5	
TOTSMP	174	254	90	90	88	81	29	56	68	43	43	
				****	****	****	****	****	****	****		

**** = BORROWED DATA

MEAN WEIGHTS (g) BY YEAR CLASS FOR AR2ALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
1			80.3	102.7	118.6	138.9	171.8	201.6	215.0	239.3	258.5
2		39.0	79.3	104.5	122.8	144.3	168.2	188.2	209.3		
3		37.5	84.3	103.3	125.1	144.8	171.6	181.3	200.0		
4 **		37.5	84.3	103.3	125.1	144.8	171.6	181.3	200.0		
5 **		37.5	87.3	109.8	131.5	148.1	174.2	182.0	225.5		
6 **		37.5	78.3	104.1	127.2	146.6	172.6	182.9	219.0		
8 **		85.0	138.0	143.4	156.9	178.9	203.0				
9 **		82.6	124.6	146.0	168.0	193.0	233.8				
10 **		81.3	97.0	127.9	156.4	174.9	203.9	249.4	271.0		
11 **		77.5	99.0	128.8	148.8	166.4	201.5				
12		77.5	99.0	128.8	148.8	166.4	201.5				

** = BORROWED DATA

AGE LENGTH KEY (by month) FOR
AR2ALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	20			2									2
1	21			4									4
1	22			6									6
1	23			2	18								20
1	24			1	17	4							22
1	25				10	11							21
1	26				2	8	13						23
1	27					2	19	1					22
1	28						8	11					19
1	29							11	3				14
1	30							3	7	1			11
1	31								1	1	1		3
1	32								1	1	2		4
1	33										1	2	3
TOTAL				15	47	25	40	26	12	3	4	2	174

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
2	17		1										1
2	20			3									3
2	21			4	1								5
2	22			3									3
2	23			3	18								21
2	24			1	26	2							29
2	25				12	19	3						34
2	26				2	20	14						36
2	27					5	28	1					34
2	28						17	13	2				32
2	29						4	17	5	1			27
2	30							4	16	3			23
2	31								2	2			4
2	32								1	1			2
TOTAL			1	14	59	46	66	35	26	7			254

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
3	17		2										2
3	21			1									1

3	22		2							2
3	23		1	8						9
3	24			12						12
3	25			5	7					12
3	26			2	7	3				12
3	27				1	11				12
3	28					6	5			11
3	29					1	3	3		7
TOTAL		2	4	27	15	22	11	8	1	90

April 27, 2001 -
13:51

AGE LENGTH KEY (by month) FOR
AR2ALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
4	17		2										2
4	21			1									1
4	22			2									2
4	23			1	8								9
4	24				12								12
4	25				5	7							12
4	26				2	7	3						12
4	27					1	11						12
4	28						6	5					11
4	29						1	3	3				7
4	30						1	3	5	1			10
TOTAL			2	4	27	15	22	11	8	1			90

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	17		2										2
5	22			2									2
5	23			1	7								8
5	24				10								10
5	25				7	5							12
5	26				4	6	2						12
5	27					2	10						12
5	28					1	4	5	1				11
5	29						1	4	4				9
5	30						1	3	4				8
5	31									2			2
TOTAL			2	3	28	14	18	12	9	2			88

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	17		2										2
6	19			1									1
6	22			4									4
6	23			1	8								9
6	24				9								9
6	25				6	4							10

6	26			2	6	2				10
6	27				1	9				10
6	28					4	4	1		9
6	29						4	4		8
6	30					1	3	2	1	7
6	31								2	2

TOTAL	2	6	25	11	16	11	7	3	81

**** BORROWED DATA ****

April 27, 2001 - 13:51

AGE LENGTH KEY (by month) FOR AR2ALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
8	20		1										1
8	22		1										1
8	24			1	2								3
8	25				3	2	1						6
8	26				2	3	1						6
8	27					3	3						6
8	28				1		4	1					6
TOTAL			2	1	8	8	9	1					29

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
9	20		1										1
9	21		1										1
9	22		3										3
9	23			2									2
9	24			3	2								5
9	25			2	4	1	1						8
9	26				5	2	1						8
9	27				2	5	3						10
9	28				1		9						10
9	29					1	2	2					5
9	30						1	2					3
TOTAL			5	7	14	9	17	4					56

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
10	21		4										4
10	22		4										4
10	23		4	1									5
10	24		2	1	2								5
10	25				3								3
10	26				8	2							10
10	27				4	2	4						10
10	28					5	4	1					10
10	29						3	2					5
10	30						2	3	1				6

10	31					1	3					4
10	32						1	1				2
TOTAL		14	2	17	9	13	7	5	1			68

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
11	20	2											2
11	21	4											4
TOTAL		15	3	12	6	5	2						43

**** BORROWED DATA ****

April 27, 2001 -
13:51

AGE LENGTH KEY (by month) FOR
AR2ALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
12	20		2										2
12	21		4										4
12	22		4										4
12	23		4										4
12	24		1	3	1								5
12	25				2								2
12	26				5	1							6
12	27				4	1	1						6
12	28					4	1						5
12	29						2						2
12	30						1	1					2
12	31							1					1
TOTAL			15	3	12	6	5	2					43

April 27, 2001 -
13:51

PERCENT AGE COMPOSITION (by numbers) FROM SAMPLES

AR2ALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1				0.04	0.28	0.20	0.30	0.11	0.05	0.01	0.01	0.00	1.00
2			0.00	0.02	0.15	0.27	0.39	0.10	0.06	0.01			1.00
3			0.01	0.02	0.26	0.29	0.32	0.07	0.04	0.01			1.00
4	**		0.01	0.02	0.26	0.29	0.32	0.07	0.04	0.01			1.00
5	**		0.01	0.01	0.29	0.25	0.31	0.07	0.05	0.01			1.00
6	**		0.01	0.03	0.26	0.24	0.31	0.09	0.05	0.02			1.00
8	**		0.02	0.01	0.27	0.39	0.30	0.02					1.00
9	**		0.03	0.10	0.34	0.24	0.27	0.03					1.00
10	**		0.20	0.01	0.19	0.20	0.27	0.09	0.03	0.00			1.00
11	**		0.52	0.03	0.21	0.12	0.10	0.02					1.00
12			0.52	0.03	0.21	0.12	0.10	0.02					1.00

** = BORROWED SAMPLE DATA

PERCENT AGE COMPOSITION (by weight) FROM SAMPLES

AR2ALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1				0.03	0.22	0.18	0.31	0.14	0.08	0.02	0.02	0.01	1.00
2				0.01	0.12	0.24	0.41	0.12	0.08	0.02			1.00
3			0.00	0.01	0.21	0.28	0.35	0.09	0.05	0.01			1.00
4	**		0.00	0.01	0.21	0.28	0.35	0.09	0.05	0.01			1.00
5	**		0.00	0.01	0.23	0.25	0.34	0.09	0.07	0.01			1.00
6	**		0.00	0.02	0.21	0.22	0.34	0.11	0.07	0.02			1.00
8	**		0.01	0.01	0.24	0.38	0.34	0.02					1.00
9	**		0.01	0.07	0.30	0.24	0.32	0.04					1.00
10	**		0.11	0.01	0.17	0.21	0.32	0.13	0.05	0.01			1.00
11	**		0.37	0.03	0.25	0.17	0.16	0.03					1.00
12			0.37	0.03	0.25	0.17	0.16	0.03					1.00

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:51

2000 CATCH (mt) BY YEAR CLASS

AR2ALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
1				194.1	1662.3	1412.1	2420.0	1055.4	624.4
2			3.0	104.0	927.2	1906.2	3231.4	957.6	617.2
3			5.1	32.2	497.2	652.8	835.8	210.7	126.6
4	**		0.5	2.9	44.3	58.1	74.4	18.8	11.3
5	**		0.0	0.1	4.2	4.5	6.2	1.7	1.2
6	**		0.0	0.0	0.1	0.1	0.2	0.1	0.0
8	**		0.0	0.0	0.5	0.8	0.7	0.0	
9	**		0.3	1.7	6.8	5.5	7.2	1.0	
10	**		0.3	0.0	0.4	0.5	0.8	0.3	0.1
11	**		316.4	22.0	214.9	146.0	136.2	24.9	
12			1451.6	100.9	985.8	669.8	624.9	114.1	
TOTAL			1777.1	458.0	4343.7	4856.3	7337.7	2384.4	1380.8

MONTH		1991	1990	1989+	TOTAL
1		143.4	148.8	64.3	7724.8
2		155.7			7902.3
3		17.5			2377.8
4	**	1.6			211.7
5	**	0.2			18.2
6	**	0.0			0.5
8	**				2.0
9	**				22.5
10	**	0.0			2.3
11	**				860.2
12					3947.1
TOTAL		318.5	148.8	64.3	23069.6

** = BORROWED SAMPLE DATA

April 27, 2001 - 13:51

2000 CATCH IN NUMBERS BY YEAR CLASS (1000s)

AR2ALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
1				2418.8	16192.5	11902.0	17419.3	6142.8	3097.6
2			76.3	1312.3	8868.9	15522.5	22398.1	5694.2	3279.5
3			134.8	382.0	4814.9	5219.4	5773.2	1227.8	698.3
4	**		12.0	34.0	428.7	464.7	514.0	109.3	62.2
5	**		1.0	1.6	38.5	33.9	42.1	9.6	6.5
6	**		0.0	0.1	1.0	0.9	1.2	0.3	0.2
8	**		0.3	0.1	3.4	4.8	3.7	0.2	
9	**		3.9	13.4	46.9	32.7	37.4	4.1	
10	**		3.1	0.2	3.0	3.2	4.3	1.5	0.4
11	**		4083.8	222.1	1667.7	980.9	818.4	123.4	
12			18738.5	1019.0	7652.0	4500.6	3755.3	566.1	
TOTAL			23053.8	5403.7	39717.4	38665.6	50767.0	13879.4	7144.7

MONTH		1991	1990	1989+	TOTAL
1		667.2	621.9	248.8	58710.8
2		743.9			57895.8
3		87.6			18338.1
4	**	7.8			1632.7
5	**	1.0			134.2
6	**	0.1			3.8
8	**				12.5
9	**				138.3
10	**	0.1			15.8
11	**				7896.3
12					36231.6
TOTAL		1507.6	621.9	248.8	181009.9

** = BORROWED SAMPLE DATA

HERRING BIOSTAT REPORT FOR 2000 GEOALL00

PERCENT LENGTH FREQUENCY BY MONTH FOR
GEOALL00

LENGTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19			0.012	0.015	0.007							
20								0.006	0.003		0.009	0.020
21	0.010								0.003		0.022	0.050
22	0.005		0.024	0.030	0.015			0.018	0.014		0.049	0.110
23	0.057		0.036	0.037	0.030	0.014			0.009	0.008	0.098	0.210
24	0.145		0.107	0.119	0.075	0.014		0.018	0.032		0.044	0.100
25	0.109		0.071	0.060	0.082	0.101	0.105	0.178	0.155	0.008	0.009	0.010
26	0.187		0.274	0.276	0.291	0.333	0.368	0.296	0.270	0.072	0.093	0.120
27	0.124		0.250	0.261	0.336	0.435	0.316	0.231	0.282	0.232	0.227	0.220
28	0.098		0.107	0.097	0.082	0.087	0.211	0.213	0.170	0.416	0.284	0.120
29	0.098		0.083	0.075	0.060	0.014		0.012	0.034	0.152	0.102	0.040
30	0.109		0.012	0.015	0.007			0.024	0.026	0.056	0.031	
31	0.026		0.024	0.015	0.015			0.006	0.003	0.040	0.022	
32	0.021									0.016		

```
0.009
   33   0.010
   34
   35
   36
   37
   38
   39
   40
-------------------------------------------------------------------------
-------
 TOT %   1.00        1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00
1.00  1.00
 AVGLTH  27.2        26.7  26.6  26.7  26.8  27.0  26.9  26.9  28.4
27.0  25.4
 VARLTH   6.0         4.0   4.1   2.8   0.9   0.9   2.2   2.2   1.8
6.0   6.1
 TOTSMP   193          84   134   134    69    19   169   348   125
225   100
        ****              ****  ****  ****  ****  ****
****
     **** = BORROWED DATA
```

April 30, 2001 -
09:07

PERCENT WEIGHT FREQUENCY BY MONTH FOR
GEOALL00

WEIGHT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0			0.01	0.01	0.01							
50	0.12		0.08	0.10	0.06	0.01		0.02	0.02	0.01	0.22	0.48
100	0.53		0.64	0.64	0.60	0.42	0.16	0.31	0.25	0.10	0.21	0.34
150	0.23		0.23	0.22	0.31	0.48	0.58	0.57	0.59	0.66	0.44	0.18
200	0.11		0.04	0.03	0.03	0.09	0.26	0.09	0.11	0.18	0.10	
250	0.01							0.01	0.01	0.05	0.03	
300												
350												
400												
450												
TOT %	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AVGWHT	143.4		138.1	136.0	141.9	156.0	176.1	160.9	165.7	184.0	153.3	114.9
VARWHT	1658.5		906.4	880.9	693.4	503.5	553.7	828.2			986.9	1032.8
TOTSMP	193		84	134	134	69	19	169	348	125	225	100
	****			****	****	****	****	****			****	

**** = BORROWED DATA

PERCENT AGE FREQUENCY BY MONTH FOR
GEOALL00

AGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2								0.11	0.07		0.25	0.45
3	0.07		0.13	0.16	0.12	0.05		0.08	0.10	0.04	0.07	0.10
4	0.20		0.28	0.28	0.33	0.32	0.13	0.28	0.25	0.24	0.23	0.23
5	0.12		0.16	0.16	0.19	0.37	0.50	0.17	0.19	0.04	0.05	0.07
6	0.25		0.16	0.14	0.14	0.16	0.25	0.25	0.28	0.24	0.16	0.10
7	0.18		0.09	0.12	0.09	0.11	0.13	0.08	0.07	0.20	0.13	0.07
8	0.10		0.09	0.06	0.07			0.03	0.03	0.20		

0.09
  9   0.02   0.09 0.08 0.07   0.04
0.02
 10   0.04
 11+   0.02

 TOT %   1.00   1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
1.00 1.00
 AVGAGE   6.0   5.5   5.3   5.3   5.0   5.4   4.7   4.9   6.1
4.6   3.5
 AVERAGE
          3.7   3.6   3.4   3.1   1.2   0.8   2.4   2.1   2.8
4.5   2.7
 TOTSMP
           84   32   50   43   19   8   36   99   25   56
31
         ****   **** **** **** **** ****
****
     **** = BORROWED DATA

                        MEAN WEIGHTS (g) BY YEAR CLASS FOR
GEOALL00
==========
========
 MONTH   1999 1998 1997 1996 1995 1994 1993 1992 1991 1990
1989
    1 **   84.3 104.7 116.6 136.1 176.1 195.4 226.0 238.0
258.5
    3   75.5 106.1 138.0 155.0 166.0 179.3 219.0
    4 **   75.5 104.9 138.8 155.1 166.0 179.3 215.8
    5 **   79.2 116.4 145.8 158.2 175.0 179.3 219.0
    6 **   94.0 137.0 156.9 183.0 202.5
    7 **   147.0 155.5 187.5 203.0
    8 **   84.5 128.0 142.7 159.0 195.2 219.3 265.0
    9   83.0 125.4 149.2 175.7 195.7 231.6 258.3
   10   89.0 137.8 215.0 183.8 204.8 249.4 271.0
   11 **   79.2 95.8 134.2 168.0 176.8 198.9 249.4 271.0
   12   79.2 98.0 131.1 144.5 162.7 184.0

     ** = BORROWED DATA

April 30, 2001 -
09:07

AGE LENGTH KEY (by month) FOR
GEOALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	21			2									2
1	22			1									1
1	23			2	6								8
1	24			1	7	2							10
1	25				3	6							9
1	26				1	2	8						11
1	27						10						10
1	28						3	6					9
1	29							7	2				9
1	30							2	5				7
1	31									1	1		2
1	32								1	1	2		4
1	33											2	2
TOTAL				6	17	10	21	15	8	2	3	2	84

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
3	19			1									1
3	22			2									2
3	23			1	2								3
3	24				3								3
3	25				4								4
3	26					4							4
3	27					1	3						4
3	28						2	1	1				4
3	29							2	2				4
3	30									1			1
3	31									2			2
TOTAL				4	9	5	5	3	3	3			32

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
4	19			2									2
4	22			4									4
4	23			2	3								5
4	24				5								5
4	25				6								6

4	26			6					6
4	27			2	4				6
4	28				3	2	1		6
4	29					4	2		6
4	30							2	2
4	31							2	2
TOTAL		8	14	8	7	6	3	4	50

**** BORROWED DATA ****

AGE LENGTH KEY (by month) FOR
GEOALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
5	19			1									1
5	22			2									2
5	23			2	2								4
5	24				4								4
5	25				6								6
5	26				2	4							6
5	27					3	3						6
5	28					1	3	1	1				6
5	29							3	2				5
5	30									1			1
5	31									2			2
TOTAL				5	14	8	6	4	3	3			43

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
6	23			1									1
6	24				1								1
6	25				3	1							4
6	26				2	2							4
6	27					3	1						4
6	28					1	2	1					4
6	29							1					1
TOTAL				1	6	7	3	2					19

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
7	25				1	1							2
7	26					2							2
7	27					1	1						2
7	28						1	1					2
TOTAL					1	4	2	1					8

**** BORROWED DATA ****

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
8	20		1										1
8	22		3										3
8	24			2	1								3
8	25			1	4	1							6
8	26				4	2							6
8	27				1	3	2						6
8	28						5	1					6
8	29						2						2
8	30							2					2
8	31								1				1
TOTAL			4	3	10	6	9	3	1				36

**** BORROWED DATA ****

AGE LENGTH KEY (by month) FOR
GEOALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
9	20		1										1
9	21		1										1
9	22		5										5
9	23			2									2
9	24			4	2								6
9	25			4	9	1	1						15
9	26				10	4	2						16
9	27				3	10	5						18
9	28				1	3	13	1					18
9	29					1	6	2					9
9	30						1	4	2				7
9	31								1				1
TOTAL			7	10	25	19	28	7	3				99

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
10	23			1									1
10	25				1								1
10	26				4								4
10	27				1		3						4
10	28					1	2	1					4
10	29						1	2					3
10	30							2	1				3
10	31								3				3
10	32								1	1			2
TOTAL			1	6	1	6	5	5	1				25

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
11	20		2										2
11	21		2										2
11	22		4										4
11	23		4	1									5
11	24		2	2									4
11	25			1	1								2
11	26				8								8
11	27				4	1	3						8
11	28					2	4	1					7

11	29				2	4			6
11	30					2	1		3
11	31						3		3
11	32						1	1	2
TOTAL		14	4	13	3	9	7	5	1
56									

**** BORROWED DATA ****

April 30, 2001 - 09:07

AGE LENGTH KEY (by month) FOR GEOALL00

MON	LEN	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
12	20		2										2
12	21		2										2
12	22		4										4
12	23		4										4
12	24		2	2									4
12	25			1									1
12	26				4								4
12	27				3	1							4
12	28					1	2						3
12	29						1	2					3
TOTAL			14	3	7	2	3	2					31

April 30, 2001 -
09:07

PERCENT AGE COMPOSITION (by numbers) FROM SAMPLES

GEOALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	**		0.04	0.20	0.14	0.29	0.17	0.11	0.02	0.02	0.01	1.00
3			0.05	0.20	0.34	0.24	0.07	0.07	0.04			1.00
4	**		0.06	0.20	0.36	0.22	0.08	0.04	0.03			1.00
5	**		0.04	0.27	0.38	0.21	0.05	0.04	0.02			1.00
6	**		0.01	0.26	0.54	0.15	0.04					1.00
7	**			0.05	0.58	0.26	0.11					1.00
8	**	0.02	0.04	0.36	0.24	0.27	0.06	0.01				1.00
9		0.02	0.07	0.33	0.27	0.27	0.03	0.01				1.00
10			0.01	0.14	0.10	0.43	0.24	0.07	0.01			1.00
11	**	0.18	0.05	0.21	0.11	0.28	0.13	0.04	0.00			1.00
12		0.44	0.06	0.29	0.10	0.09	0.03					1.00

** = BORROWED SAMPLE DATA

PERCENT AGE COMPOSITION (by weight) FROM SAMPLES

GEOALL00

MONTH	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989+	TOTAL
1	**		0.03	0.14	0.11	0.28	0.21	0.14	0.03	0.04	0.02	1.00
3			0.03	0.15	0.33	0.27	0.08	0.09	0.06			1.00
4	**		0.03	0.15	0.37	0.25	0.10	0.05	0.05			1.00
5	**		0.02	0.22	0.39	0.23	0.06	0.05	0.03			1.00
6	**		0.01	0.23	0.54	0.18	0.05					1.00
7	**			0.05	0.53	0.29	0.13					1.00
8	**	0.01	0.03	0.31	0.24	0.32	0.08	0.01				1.00
9		0.01	0.05	0.29	0.28	0.31	0.04	0.02				1.00
10			0.00	0.10	0.12	0.42	0.26	0.09	0.01			1.00
11	**	0.09	0.03	0.19	0.12	0.33	0.17	0.06	0.01			1.00
12		0.31	0.05	0.33	0.12	0.14	0.04					1.00

** = BORROWED SAMPLE DATA

April 30, 2001 - 09:07

2000 CATCH (mt) BY YEAR CLASS

GEOALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
1	**			3.3	18.0	13.7	34.7	26.5	17.8
3				17.0	101.6	219.6	176.8	53.8	58.1
4	**			2.8	13.3	31.6	21.7	8.6	4.6
5	**			0.8	8.4	14.7	8.8	2.3	1.8
6	**			0.1	3.5	8.4	2.8	0.7	
7	**				19.2	223.2	122.4	53.0	
8	**		37.9	100.5	973.7	734.2	985.4	246.0	29.7
9			58.0	309.7	1704.0	1626.6	1845.9	256.3	92.1
10				10.0	268.1	315.2	1121.1	700.5	234.4
11	**		270.3	83.7	535.9	348.3	941.5	487.1	174.7
12			34.4	5.8	36.9	13.5	15.0	4.8	
TOTAL			400.6	533.7	3682.6	3549.1	5276.0	1839.7	613.2

MONTH		1991	1990	1989+	TOTAL
1	**	3.6	4.8	2.3	124.7
3		37.0			663.9
4	**	4.0			86.6
5	**	1.3			38.1
6	**				15.5
7	**				417.8
8	**				3107.4
9					5892.6
10		30.6			2679.9
11	**	22.8			2864.4
12					110.4
TOTAL		99.3	4.8	2.3	16001.4

** = BORROWED SAMPLE DATA

April 30, 2001 - 09:07

2000 CATCH IN NUMBERS BY YEAR CLASS (1000s)

GEOALL00

MONTH		1999	1998	1997	1996	1995	1994	1993	1992
1	**			38.5	171.8	117.8	254.7	150.7	91.1
3				225.3	957.7	1591.4	1140.8	323.9	323.9
4	**			37.5	126.5	228.0	139.7	51.5	25.8
5	**			10.0	71.9	100.6	55.9	13.3	10.1
6	**			1.4	25.5	53.6	15.1	3.6	
7	**				130.5	1435.6	652.5	261.0	
8	**		448.7	785.2	6823.5	4617.5	5047.5	1121.7	112.2
9			698.9	2469.3	11424.2	9256.0	9431.5	1106.9	356.6
10				112.8	1945.1	1465.9	6098.5	3420.4	939.7
11	**		3412.7	874.2	3992.7	2072.9	5326.1	2449.7	700.5
12			434.1	59.2	281.2	93.7	92.1	26.3	
TOTAL			4994.4	4613.4	25950.6	21033.1	28254.6	8929.1	2559.8

MONTH		1991	1990	1989+	TOTAL
1	**	15.8	20.3	9.0	869.8
3		169.0			4732.0
4	**	18.7			627.7
5	**	6.0			267.8
6	**				99.3
7	**				2479.7
8	**				18956.1
9					34743.4
10		112.8			14095.2
11	**	84.1			18913.0
12					986.6
TOTAL		406.3	20.3	9.0	96770.6

** = BORROWED SAMPLE DATA

ASSESSMENT REPORT

FOR

GULF OF MAINE NORTHERN SHRIMP -- 2001

Prepared
November 1, 2001
by the
Atlantic States Marine Fisheries Commission's
Northern Shrimp Technical Committee

Robert Glenn, (Massachusetts)
Margaret Hunter, Chair (Maine)
Josef Idoine, (NMFS NEFSC)
Clare McBane, (New Hampshire)
Dave McCarron, (CESS Appointee)
Michael Lewis (ASMFC)

With assistance from:
Mike Armstrong, (Massachusetts)
Charles Keith (NMFS NEFSC)
Daniel Schick, (Maine)

INTRODUCTION

Biological Characteristics

Northern shrimp 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 (*Pandalus borealis*) 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 2002. 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.

At its 2000 fall meeting, the Northern Shrimp Section approved an 83 day season composed of two parts. The winter season began on January 9, 2001 and ended March 17, 2001, with an additional spring season beginning April 16 and ending April 30, 2001. This was the first year since 1997 that the NSTC recommended an increase in days available to the fishery (51 opportunity days in 2000, 90 days in 1999, 105 days in 1998, 156 days in 1997, 152 days in 1996, 128 days in 1995, and 122 days in 1994). 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 2001 stock assessment. Analyses and recommendations are based on: 1) research vessel survey data collected by the Committee during summer and by 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, the DeLury, 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 (t) during 1969-1972 to about 400 t 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 t by 1987. Landings ranged from 2,300-4,400 t between 1988-1994, and then rose dramatically to 9,200 t in 1996, the highest since 1973. Landings declined between 1996 and 1999 to 1,816 t. This was followed by a slight increase to 2,390 t in the 2000 season. The 2001 fishing season landings dropped to 1,083 t, the lowest northern shimp landings since 1983.

Maine landed 78% (840 t) of the 2001 season total while New Hampshire and Massachusetts landed 18% (194 t) and 5% (49 t), respectively. The proportional distribution of landings changed in 2001. (Table 1, Figure 1). The proportion of New Hampshire landings to the total more than doubled from the 8% recorded in 2000, while the proportion landed in Maine decreased by 9% from the 87% recorded in the 2000 season. The relative proportion of landings by month remained similar to past years. The months of January and February yielded the highest proportion of the catch, while March and April exhibited the lowest (Table 2).

Size Composition of Landings

Size composition data (Figure 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 t (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 only average 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.

Effort and Distribution of Effort

Most northern shrimp fishing in the Gulf of Maine is conducted by otter trawls, although traps are also employed off the central Maine coast. Maine trapping operations accounted for 4% to 8% of the state's total number of trips from 1987 to 1994, and for 7% in 2001, according to 2001 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, 3,382 in 2000, and 2,963 in 2001 (Table 3).

Approximately 310 vessels participated in the shrimp fishery in 1997, 260 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. Vessel information for the 2000 and 2001 seasons has not been analyzed yet.

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

At the time this (2001) assessment was made, VTR landings exceeded dealer weighout landings, and the above expansion was not necessary. However, VTRs for 2001 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, 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. Since any 2002 fishery would also be primarily on a three-year-old yearclass (1999), this is the pattern of fishing that might be expected, if fishing occurs in 2002. 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.

Catch per Unit Effort

Catch per unit effort (CPUE) indices have been developed from NMFS interview data (1983-1994) and logbook data (1995-2000) 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 735 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 1,074 pounds. The 1995, 1996 and 1997 CPUEs, from logbooks, rose sharply to 1,362 pounds in 1995, rose again to 1,713 in 1996 and declined to 1,455 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 1,557 pounds per trip. In 2001, the catch per trip dropped to 771 pounds per trip, the lowest since 1993.

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). Inshore CPUE for 2001 was 100 lbs/hr, offshore was 135, and the season average was 109 lbs/hr, the lowest in the series since 1993. In general, CPUE has been dropping since 1996, with the exception of the 2000 season.

Year	Inshore (<55F)	Offshore (>55F)	Total	Catch/trip
1991	94	152	140	988
1992	132	93	117	974
1993	82	129	92	767
1994	139	149	141	1,074
1995	172	205	193	1,362
1996	340	203	251	1,713
1997	206	192	194	1,455
1998	158	151	154	1,317
1999	159	146	152	1,067
2000	288	337	292	1,557
2001	100	135	109	771

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

Experimental May Fishery

In May 2001, a small experimental fishery involving 6 commercial shrimp vessels was conducted southeast of the Loran 25600 line (Maine DMR and Gulf of Maine Aquarium, 2001). 132 tows (averaging about 2 hours each) were made using standard gear. Catches averaged 6.8 lbs of shrimp per towing hour.

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 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 2001 summer survey cruise are plotted in Figure 6. 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, with peaks in 1986, 1990 and 1994, reflecting 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 with passage of the 1992 year class through the fishery, the index rose sharply in 1998, reflecting recruitment of the 1996 year class at age 2 (trends for the NEFSC spring survey index are similar). This year class was reported to be of above average size in the 1997 and 1998 assessments. This year class predominated in NEFSC 1998 autumn survey catches, with catches from other year classes being minor. The 1999 NEFSC fall survey index remained high, indicating remaining strength in the 1996 year class (Table 6). 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.

Abundance and biomass indices (stratified mean catch per tow in numbers and weight) for the state-federal summer survey from 1984-2001 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.

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 the 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 and moderately strong year classes in 1987, 1992, 1993,

and 1996. The strong 1992 year class observed at (assumed) age 1 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 appears comparable to the 1993 year class (Table 4, Figures 8 and 9) with this exception: recruitment since 1993 has been poor, with the 1997 and 1998 year classes being among the weakest in the time series (Figure 9). Thus, up through 1999 the only significant source of potential recruitment to the future winter fisheries was that provided by the 1996 year class. The 1999 year class, seen for the first time in the summer 2000 survey, is comparable to the 1996 year class and thus is larger than recent year classes. The age 1.5 recruitment index was at a time series low in 2001, with a stratified mean of 32 individuals per tow on the transformed scale. This is the poorest recruitment index seen in the 18-year history of the survey.

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 5.3 kg/tow (transformed) since 1996. The 2001 index of 1.5 kg/tow represents the time series low. This is indicative of a smaller biomass available to the fishery during the 2002 fishing season.

The moderately strong 1999 year class generally lies between the age 1.5 and > 22mm shrimp, in size, and its strength is therefore not indicated in either of these two indices. It is, however, included in the mean total number per tow index (Table 4.). The 2001 value of this index, 451 on the transformed scale, is the second lowest in the history of the survey. The 1999 year class is also included in the mean weight per tow index described above.

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: modified DeLury analysis 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 on what levels of fishing are most productive and sustainable.

DeLury 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 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 2000 and increased slightly in the current year. Total stock biomass estimates averaged about 14,000 mt, with peaks at over 22,000 mt before the 1991 season, and a decrease to a time series low of 5,600 mt in 1999. Total stock biomass has increased slightly over the last two years to its current value of 6,100 mt (Table 5, Figures 10, 11).

Annual estimates of fishing mortality 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 0.30 (23% exploitation) in the 2000 season (Table 5; Figures 10, 11). In 2001, F rose

to 0.41 (30% exploitation), and the three year (1999-2001) average is 0.39 (29% exploitation). The recent pattern in F reflects the pattern in nominal fishing effort (Figure 5). Precision of DeLury estimates was assessed by "bootstrap" analysis, in which survey measurement errors were randomly shuffled 200 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 DeLury analysis. A surplus production model was fit to seasonal catch and survey biomass indices from 1968 to 2001 (summarized in Table 6). Estimates of F from the biomass dynamics model generally confirm the pattern of estimates from the DeLury model; F in 2001 (F = 0.1) has decreased from a peak of 0.55 in 1997. The starting biomass in 1999 (8,806 mt) was the lowest since 1980 (Figures 12 and 13) and has increased slightly to 9,572 mt in 2000, and 9,887 in 2001.

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 is 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).

Summary

The commercial prospects for the Gulf of Maine northern shrimp fishery are not favorable. The abundance of shrimp, as measured by the state/federal summer survey, estimated by analytical models, and corroborated by 2001 fishery landings and CPUE indices, is at or near its lowest level since the early 1980's, following the collapse of the stock in the late 1970's. Early-maturing females found in the 2001 summer survey may be a further indication of a stock responding to stress.

Strong fisheries have been associated with moderate to strong year classes, such as the back-to-back 1992 and 1993 year classes which supported sizeable 1995-98 fisheries. However, the 1998 and 1997 year classes, which would provide 4- and 5-year-old females for a 2002 fishery, are both unusually weak. There are indications that the 2000 year class will also be well below average – the index of age 1.5 shrimp from the 2001 summer survey was the lowest in the 18-year history of the survey. Thus there have been recruitment failures in 3 out of the last 4 (1997-2000) year classes. Concurrently, the seawater temperature in the Gulf of Maine has risen to levels last seen in the 1950's when shrimp landings virtually disappeared (Table 1).

The only year class currently of any strength is the 1999 year class, comparable to the 1996 year class, which supported the lower than average landings of 1999, 2000, and 2001.

Recommendations

The Northern Shrimp Technical Committee bases its recommendation to the Section on the biology of the species, and the need to rebuild the stock. Because of the low levels of abundance of large shrimp, the lack of new recruits, and the presence of a single year class of medium sized shrimp, the committee recommends that no fishing be conducted in the 2002 season. This would allow maximum protection for the remaining female

shrimp, and for the 1999 year class, which has not yet reached optimum size for either harvest or reproduction.

For insight into the characteristics of a potential 2002 fishery, it may be useful to examine the 1999 fishery. 1999 was similar in some ways to the coming year. In 1999, the principal component of the stock was the 3-year-old 1996 year class, comparable in strength to the current 1999 year class. Landings that year were the lowest in recent history up to that time. An unusually high proportion of trips were offshore. The entire season (90 days) was marked by catches with an unusually high proportion of males and immature females. Maine catches in December, January, April, and May were made up of more than 50% of these small shrimp. Catches for New Hampshire and Massachusetts were more than 50% small shrimp in all months of the season. The large proportion of smaller shrimp landed translated into a high number of shrimp caught, and a high fishing mortality rate (0.47), despite their low landed weight.

When a stock is harvested before individuals have reached their full potential weight, "growth overfishing" occurs. When a stock is harvested before individuals have reached their full reproductive potential, there is an increased risk of "recruitment overfishing". 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. Figure 15 shows that higher levels of spawning stock biomass consistently produce higher levels of recruits.

In 2002, the 1999 year class will be 3-year-old shrimp, in male, transitional and early-maturing female stages. They will be small, and generally expected to stay offshore. Because of the weak 1997 and 1998 year classes, it can be expected that harvesters will pursue these smaller shrimp offshore, as they did in 1999. The likelihood of committing both growth and recruitment overfishing, and attaining a high fishing mortality rate, is very great, if fishing is allowed this season.

In its last three annual assessments, the committee has recommended lowering fishing mortality to an admittedly arbitrary rebuilding level of $F_{50\%}$, or F=0.25. Although the Section has attempted to lower fishing mortality through reduced fishing seasons, the reductions have not met these goals. Fishing mortality over the past 3 years, (0.39 average), has been above the level recommended by the SARC for a sustainable fishery (0.34), in addition to being well above the rebuilding level.

If it were possible to predict if and when the large female shrimp will migrate inshore, drop their eggs, and return offshore, it might be possible to conduct a very short, directed fishery that achieves a low fishing mortality level. Since those predictions are impossible to make with any certainty, any 2002 fishing season at all will put the ability of this stock to rebuild at risk and increase the chance of further stock decline.

REFERENCES

Maine Department of Marine Resources and Gulf of Maine Aquarium. 2001. Testing Bycatch in an Observer-based Experimental Shrimp Fishery. August 17, 2001. 28pp.

NEFSC (Northeast Fisheries Science Center). 1996. Report of the 22nd Northeast Regional Stock Assessment Workshop (22nd SAW) Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NEFSC Reference Document 96-13. pp. 118-150.

Schick, D.F., S. Cadrin, D. McCarron, A. Richards and B. Smith. 1996. MS. Assessment Report for Gulf of Maine Northern Shrimp -- 1996. Atlantic States Marine Fisheries Commission's Northern Shrimp Technical Committee. October 18, 1996. 33pp. 4 tab., 13 fig.

ACKNOWLEDGMENTS

The Committee sincerely thanks all those people that have contributed to this assessment through their time and efforts as part of the scientific crew on the R/V Gloria Michelle shrimp survey, as port samplers, sample processors, and data entry personnel. Their hard work has made this effort possible.

Table 1. Commercial landings (mt) of northern shrimp in the western Gulf of Maine, 1958-2001.

Year	Maine		NH		Mass		Total	
1958	2.3		0.0		0.0		2.3	
1959	5.4		0.0		2.3		7.7	
1960	40.4		0.0		0.5		40.9	
1961	30.4		0.0		0.5		30.9	
1962	159.7		0.0		16.3		176.0	
1963	244.0		0.0		10.4		254.4	
1964	419.4		0.0		3.1		422.5	
1965	947.0		0.0		8.0		955.0	
1966	1,737.8		18.1		10.5		1,766.4	
1967	3,141.1		20.0		10.0		3,171.1	
1968	6,515.0		43.1		51.9		6,610.0	
1969	10,992.9		58.1		1,772.9		12,823.9	
1970	7,712.8		54.4		2,902.1		10,669.3	
1971	8,354.7		50.8		2,723.8		11,129.3	
1972	7,515.6		74.8		3,504.5		11,094.9	
1973	5,476.7		59.9		3,868.2		9,404.8	
1974	4,430.7		36.7		3,477.3		7,944.7	
1975	3,177.0		29.5		2,080.2		5,286.7	
1976	617.2		7.3		397.8		1,022.3	
1977	148.0		2.3		236.9		387.2	
1978	0.0		0.0		0.0		0.0	
1979	32.9		2.3		451.3		486.5	
1980	71.4		7.4		260.3		339.1	
1981	528.6		4.5		538.1		1,071.2	
1982	883.2	*(853.3)	32.8	(21.6)	658.5	(655.3)	1,574.5	(1,530.2)
1983	1,022.0	(892.5)	36.5	(46.2)	508.0	(458.4)	1,566.5	(1,397.1)
1984	2,564.7	(2,394.9)	96.8	(30.7)	565.3	(525.1)	3,226.8	(2,950.7)
1985	2,956.9	(2,946.4)	207.4	(216.5)	1,030.6	(968.0)	4,194.9	(4,130.9)
1986	3,407.3	(3,268.2)	191.1	(230.5)	1,085.6	(1,136.3)	4,684.0	(4,635.0)
1987	3,534.2	(3,673.2)	152.5	(157.8)	1,338.7	(1,422.2)	5,025.4	(5,253.2)
1988	2,272.4	(2,257.2)	173.1	(154.5)	631.5	(619.6)	3,077.0	(3,031.3)
1989	2,542.6	(2,384.0)	314.3	(231.5)	749.6	(699.9)	3,606.5	(3,315.4)
1990	2,961.5	(3,236.1)	447.3	(451.2)	993.2	(974.3)	4,402.0	(4,661.6)
1991	2,431.1	(2,488.1)	208.2	(282.2)	727.6	(801.1)	3,366.9	(3,571.4)
1992	2,973.9	(3,054.1)	100.1	(100.0)	291.6	(289.1)	3,365.6	(3,443.6)
1993	1,562.8	(1,492.2)	441.1	(357.4)	300.3	(292.8)	2,304.7	(2,142.9)
1994	2,815.5	(2,239.3)	520.9	(428.0)	374.4	(247.5)	3,710.8	(2,914.8)
1995		(5,022.7)		(764.9)		(678.8)		(6,466.4)
1996		(7,737.0)		(771.0)		(658.0)		(9,166.1)
1997		(6,050.0)		(666.3)		(362.8)		(7,079.1)
1998		(3482.0)		(445.2)		(247.2)		(4,174.4)
1999		(1523.4)		(217.0)		(75.7)		(1,816.1)
2000		(2067.3)		(212.3)		(109.9)		(2,389.5)
2001		**(839.6)		**(194.0)		**(49.1)		**(1,082.7)

*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, 1986-2001

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1986 Season*	1st					31st		
Maine	346.9	747.8	1,405.3	415.4	104.2	149.2	99.4	3,268.2
Mass.	154.3	213.4	221.2	200.7	111.2	84.8	150.7	1,136.3
N.H.	57.7	75.9	70.8	14.2	1.3	0.0	10.6	230.5
Total	558.9	1,037.1	1,697.3	630.3	216.7	234.0	260.7	4,635.0
1987 Season	1st					31st		
Maine	485.9	906.2	1,192.7	672.9	287.6	127.9	7.0	3,680.2
Mass.	103.5	260.0	384.9	310.2	180.8	182.8	5.7	1,427.9
N.H.	18.4	53.6	62.8	15.7	7.3	0.0	0.1	157.9
Total	607.8	1,219.8	1,640.4	998.8	475.7	310.7	12.8	5,266.0
1988 Season	1st					31st		
Maine	339.7	793.9	788.1	243.6	24.6	67.3	1.2	2,258.4
Mass.	14.4	225.8	255.0	104.9	8.6	10.9	0.0	619.6
N.H.	13.0	72.6	53.7	14.9	0.3	0.0	3.1	157.6
Total	367.1	1,092.3	1,096.8	363.4	33.5	78.2	4.3	3,035.6
1989 Season	1st					31st		
Maine	353.6	770.5	700.6	246.4	218.7	94.2		2,384.0
Mass.	26.2	197.5	154.9	104.8	160.9	55.6		699.9
N.H.	28.5	106.9	77.0	15.4	3.7	0.0		231.5
Total	408.3	1,074.9	932.5	366.6	383.3	149.8		3,315.4
1990 Season	1st					31st		
Maine	512.4	778.2	509.7	638.5	514.0	282.8	0.1	3,235.7
Mass.	75.6	344.4	184.8	100.2	158.9	110.0	4.3	978.2
N.H.	111.3	191.7	116.1	30.7	1.4			451.2
Total	699.3	1,314.3	810.6	769.4	674.3	392.8	4.4	4,665.1
1991 Season	1st					31st		
Maine	238.2	509.1	884.0	454.9	251.7	148.2	2.0	2,488.1
Mass.	90.5	174.7	175.9	131.2	93.3	133.8	1.6	801.0
N.H.	107.3	104.4	33.8	27.8	7.8	1.0		282.1
Total	436.0	788.2	1,093.7	613.9	352.8	283.0	3.6	3,571.2
1992 Season	15th					15th		
Maine	181.1	880.9	1,278.9	462.5	163.6	87.2		3,054.2
Mass.	17.1	148.2	73.3	47.5	2.9		0.1	289.1
N.H.	33.4	47.0	11.9	6.8	1.0			100.1
Total	231.6	1,076.1	1,364.1	516.8	167.5	87.2	0.4	3,443.7
1993 Season	14th				30th			
Maine	100.9	369.0	597.0	297.5	127.8			1,492.2
Mass.	19.6	82.0	81.9	62.3	42.0	5.0		292.8
N.H.	33.5	85.4	101.7	77.0	59.8			357.4
Total	154.0	536.4	780.6	436.8	229.6	5.0	0.4	2,142.8

* 1986: Season extended to June 21.

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1994 Season	15th				15th			
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
1995 Season**	1st				30th			
Maine	747.6	1,397.7	1,338.2	912.0	627.2			5,022.7
Mass.	210.7	154.0	104.1	111.0	99.0			678.8
N.H.	160.6	186.8	118.3	158.5	140.7			764.9
Total	1,118.9	1,738.5	1,560.6	1,181.5	866.9			6,466.4
1996 Season**	1st					31st		
Maine	1,124.1	1,678.3	3,004.6	785.2	350.4	794.5		7,737.1
Mass	167.9	106.7	188.7	67.8	66.5	60.3		657.9
N.H.	189.8	169.5	234.0	81.9	78.8	17.1		771.1
Total	1,481.8	1,954.5	3,427.3	934.9	495.7	871.9		9,166.1
1997 Season***	1st					27th		
Maine	1,178.5	1,114.9	1,713.1	758.4	754.8	530.3		6,050.0
Mass	90.2	110.4	111.4	49.0	1.2	0.5		362.7
N.H.	185.6	104.1	140.1	108.6	85.8	42.2		666.4
Total	1,454.3	1,329.4	1,964.6	916.0	841.8	573.0		7,079.1
1998 Season****	8th					22nd		
Maine	511.1	926.8	1,211.1	401.7	228.7	202.6		3,482.0
Mass	49.1	78.0	90.5	14.3	15.3	0.0		247.2
N.H.	89.4	106.9	143.5	54.3	49.0	2.1		445.2
Total	649.6	1,111.7	1,445.1	470.3	293.0	204.7		4,174.4
1999 Season*****	16th					27th		
Maine	79.9	192.7	590.8	240.6	204.5	214.9		1,523.4
Mass	25.0	23.8	16.0	2.5	8.4			75.7
N.H.	46.5	63.2	52.2	10.0	36.5	8.6		217.0
Total	151.4	279.7	659.0	253.1	249.4	223.5		1,816.1
2000 Season******		17th		15th				
Maine		607.4	1,271.4	188.5				2,067.3
Mass		17.4	78.7	13.8				109.9
N.H.		39.6	131.1	41.6				212.3
Total		664.4	1,481.2	243.9				2,389.5
2001 Season*******		9th			30th	Exp.		
Maine		477.0	317.2	23.9	21.5	0.1		839.6
Mass		38.5	8.7	1.9	0.0			49.1
N.H.		117.9	37.4	10.7	27.8			194.0
Total		633.4	363.4	36.5	49.3	0.1		1,082.7

** 1995 and 1996: One day per week off.
*** 1997: Two 5-day and four 4-day blocks off.
**** 1998: Dec 8 '97 - May 22, weekends off, Dec 25 - 31 and Mar 16 - 31 off.
***** 1999: Dec 16 '98 - May 27, weekends off, Dec 25 - 31 and Mar 16 - 31 off.
****** 2000: Jan 17 - Mar 15, Sundays off.
******* 2001: Jan 9 - Apr 30, Mar 18 - 31 off, small experimental offshore fishery in May, preliminary data.

Table 3. Distribution of fishing effort (number of trips) in the Gulf of Maine northern shrimp fishery by state and month, 1986-2001.

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1986 Season*	1st					31st		
Maine	590	1,309	2,798	831	224	133	68	5,953
Mass.	128	235	225	320	194	133	159	1,394
N.H.	156	163	165	51	3		17	555
Total	874	1,707	3,188	1,202	421	266	244	7,902
1987 Season	1st					31st		
Maine	993	2,373	3,073	2,241	617	340	16	9,653
Mass.	325	354	414	426	283	317	164	2,283
N.H.	67	164	175	95	28		32	561
Total	1,385	2,891	3,662	2,762	928	657		12,285
1988 Season	1st					31st		
Maine	972	2,183	2,720	1,231	193	122		7,421
Mass.	28	326	426	315	26	57		1,178
N.H.	72	231	236	99	3			641
Total	1,072	2,740	3,382	1,645	222	179		9,240
1989 Season	1st					31st		
Maine	958	2,479	2,332	936	249	84		7,038
Mass.	103	479	402	254	297	102		1,637
N.H.	120	369	312	69	16			886
Total	1,181	3,327	3,046	1,259	562	186		9,561
1990 Season	1st					31st		
Maine	1,036	1,710	1,529	1,986	897	238		7,396
Mass.	147	459	273	202	175	118		1,374
N.H.	178	363	284	157	6			988
Total	1,361	2,532	2,086	2,345	1,078	356		9,758
1991 Season	1st					31st		
Maine	568	1,286	2,070	1,050	438	139		5,551
Mass.	264	416	401	231	154	147		1,613
N.H.	279	285	135	82	22	1		804
Total	1,111	1,987	2,606	1,363	614	287		7,968
1992 Season	15th					15th		
Maine	411	1,966	2,700	1,222	318	141		6,758
Mass.	59	337	145	101	41			683
N.H.	96	153	76	29	3			357
Total	566	2,456	2,921	1,352	362	141		7,798
1993 Season	14th				30th			
Maine	249	1,102	1,777	1,032	227			4,387
Mass.	60	200	250	185	72			767
N.H.	76	246	275	256	151			1,004
Total	385	1,548	2,302	1,473	450			6,158

* Season extended to June 21.

	Dec	Jan	Feb	Mar	Apr	May	Other	Season Total
1994 Season	15th				15th			
Maine	265	1,340	1,889	1,065	122			4,681
Mass.	58	152	147	83	15			455
N.H.	169	228	266	173	18			854
Total	492	1,720	2,302	1,321	155			5,990
1995 Season**	1st				30th			
Maine	879	2,341	2,641	1,337	694			7,892
Mass.	145	385	275	157	109			1,071
N.H.	189	331	279	359	344			1,502
Total	1,213	3,057	3,195	1,853	1,147			10,465
1996 Season**	1st					31st		
Maine	1,341	2,030	3,190	1,461	444	457		8,923
Mass	299	248	325	269	106	126		1,373
N.H.	331	311	389	248	155	61		1,495
Total	1,971	2,589	3,904	1,978	705	644		11,791
1997 Season***	1st					27th		
Maine	1,674	1,753	2,737	1,178	793	530		8,665
Mass	184	226	245	114	7	1		777
N.H.	277	245	301	218	189	62		1,292
Total	2,135	2,224	3,283	1,510	989	593		10,734
1998 Season****	8th					22nd		
Maine	852	1,548	1,653	725	346	189		5,313
Mass	94	200	148	70	3	1		515
N.H.	141	216	182	134	83	22		778
Total	1,086	1,964	1,983	929	432	212		6,606
1999 Season*****	16th					27th		
Maine	190	556	1,125	553	324	172		2,920
Mass	39	57	71	9	40			216
N.H.	82	192	213	44	123	21		675
Total	311	805	1,409	606	487	193		3,811
2000 Season******		17th		15th				
Maine		591	1,944	418				2,953
Mass		17	105	36				158
N.H.		33	170	68				271
Total		641	2,219	522				3,382
2001 Season*******		9th			30th	Exp.		
Maine		1244	953	81	34	2		2,314
Mass		111	45	10				166
N.H.		288	143	24	28			483
Total		1,643	1,141	115	62	2		2,963

** 1995 and 1996: One day per week off.

*** 1997: Two 5-day and four 4-day blocks off.

**** 1998: Dec 8 '97 - May 22, weekends off, Dec 25 - 31 and Mar 16 - 31 off.

***** 1999: Dec 16 '98 - May 27, weekends off, Dec 25 - 31 and Mar 16 - 31 off.

****** 2000: Jan 17 - Mar 15, Sundays off.

******* 2001: Jan 9 - Apr 30, Mar 18 - 31 off, small experimental offshore fishery in May, preliminary data.

Table 4. Stratified mean numbers and weights, per tow,* of northern shrimp collected during R/V Gloria Michelle summer surveys 1984-2001.

Untransformed

Year	Total Number	Age-1.5 Number	>22 mm** Number	Weight (kg)	Weight** >22 mm (kg)
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	2,419	535	1,350	21.0	15.1
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	2,318	405	676	15.1	7.4
1999	1,648	414	719	11.9	7.8
2000	1,844	872	647	11.9	7.2
2001	870	34	281	6.3	2.9

Log_e Transformed

Year	Total Number	Age-1.5 Number	>22 mm** Number	Weight (kg)	Weight** >22 mm (kg)
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	306	773	14.8	8.6
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	756	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	100	174	5.8	1.9
2000	807	382	283	6.4	3.2
2001	451	32	146	4.3	1.5

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

**Will be fully recruited to the winter fishery.

Table 5. Summary of results from modified DeLury analysis of Gulf of Maine shrimp.

Fishing Season	New Recruits (millions)	Fully-Recruited (millions)	F (NR+FR)	Biomass (mt)
1985	983	944	0.10	13,995
1986	1,174	1,364	0.28	21,621
1987	980	1,490	0.40	22,393
1988	754	1,292	0.48	18,705
1989	1,172	982	0.18	14,154
1990	1,307	1,396	0.33	20,543
1991	826	1,512	0.44	22,083
1992	605	1,171	0.46	16,880
1993	509	877	0.42	12,337
1994	709	709	0.32	9,159
1995	973	805	0.33	12,337
1996	882	999	0.65	15,469
1997	533	762	0.87	10,981
1998	510	423	0.62	6,711
1999	371	391	0.47	5,565
2000	335	373	0.30	5,682
2001	474	409	0.41	6,389
2002	345	457		6,102
1985-95 average	908	1,140	**0.34**	16,746
1999-02 average	381	407	**0.39**	5,935

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

	Input				Results			
Fishing Season	Fall (kg/tow)	Maine (kg/tow)	Summer (kg/tow)	Catch (mt)	Biomass (mt)	F	B/Bmsy	F/Fmsy
1968	3.2	45.8		5,708	49,360	0.12	1.69	0.71
1969	2.7	31.2		12,140	46,550	0.29	1.59	1.73
1970	3.7	40.8		11,330	38,320	0.33	1.31	1.95
1971	3.0	9.4		10,590	31,670	0.37	1.08	2.22
1972	3.3	7.0		11,220	25,940	0.50	0.89	3.01
1973	1.9	7.8		9,691	19,310	0.60	0.66	3.59
1974	0.8	4.9		8,024	13,510	0.75	0.46	4.49
1975	0.9	6.7		6,142	8,387	1.04	0.29	6.22
1976	0.6	4.8		1,387	4,011	0.35	0.14	2.12
1977	0.2	1.6		372	3,845	0.09	0.13	0.52
1978	0.4	3.2		17	4,804	0.00	0.16	0.02
1979	0.5	4.4		487	6,475	0.07	0.22	0.40
1980	0.5	2.7		339	8,109	0.04	0.28	0.22
1981	1.5	3.0		1,071	10,350	0.10	0.35	0.57
1982	0.3			1,530	12,320	0.12	0.42	0.69
1983	1.0			1,397	14,210	0.09	0.49	0.54
1984	1.9		10.47	2,951	16,590	0.17	0.57	1.03
1985	1.6		17.69	4,131	17,680	0.23	0.60	1.40
1986	2.5		19.61	4,635	17,660	0.27	0.60	1.60
1987	1.7		15.40	5,253	17,100	0.32	0.58	1.92
1988	1.2		12.76	3,031	15,780	0.19	0.54	1.12
1989	1.8		16.95	3,315	16,660	0.20	0.57	1.17
1990	2.0		18.12	4,662	17,370	0.27	0.59	1.64
1991	0.9		11.68	3,571	16,740	0.21	0.57	1.26
1992	0.6		9.43	3,444	17,180	0.20	0.59	1.18
1993	1.6		9.14	2,143	17,830	0.11	0.61	0.68
1994	2.2		8.69	2,915	19,950	0.14	0.68	0.84
1995	1.8		13.29	6,466	21,500	0.32	0.73	1.90
1996	1.1		8.77	9,166	19,470	0.55	0.67	3.29
1997	1.3		7.73	7,154	14,270	0.59	0.49	3.53
1998	2.3		6.33	4,174	10,320	0.44	0.35	2.63
1999	2.5		5.78	1,816	8,806	0.20	0.30	1.19
2000	1.4		6.39	2,389	9,572	0.25	0.33	1.47
2001			4.33	1,083	9,887	0.10	0.34	0.60
2002					11,740		0.40	
				1971-74 average	22,608	0.55		
				1985-95 average	17,768	0.22		
				1999-02 average	10,001	0.18		

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						
Age	Length (mm)	Transition Rate (% Fem)	Fishery Selectivity	Male wt (g)	Female wt (g)	Fecundity at length	Total N	Male N	Female N	Male Catch	Female Catch	Yield (g)	Egg Production
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		1378
												% 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

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

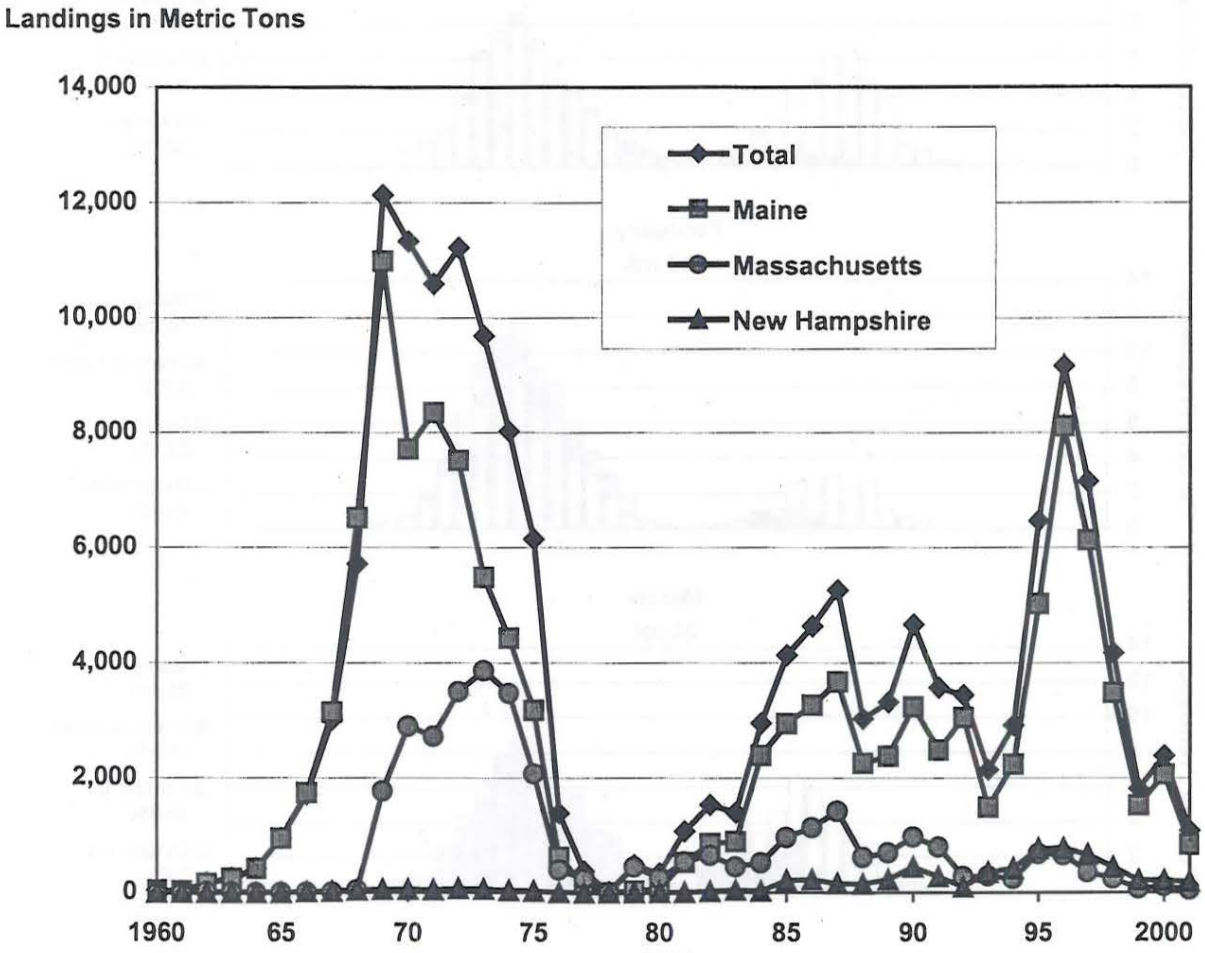


Figure 2. Length frequency distribution from samples of the Maine shrimp catch during the 2001 season.

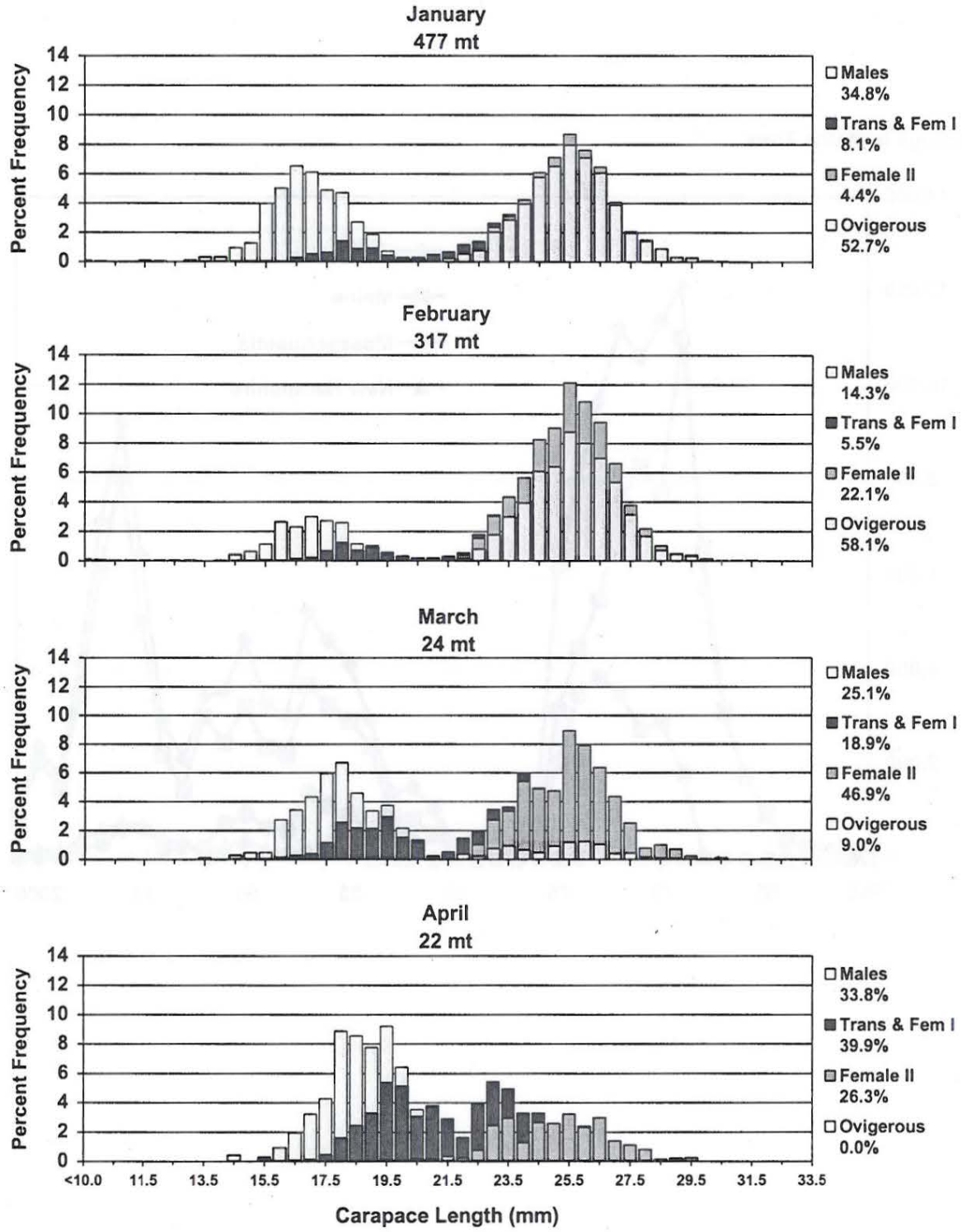
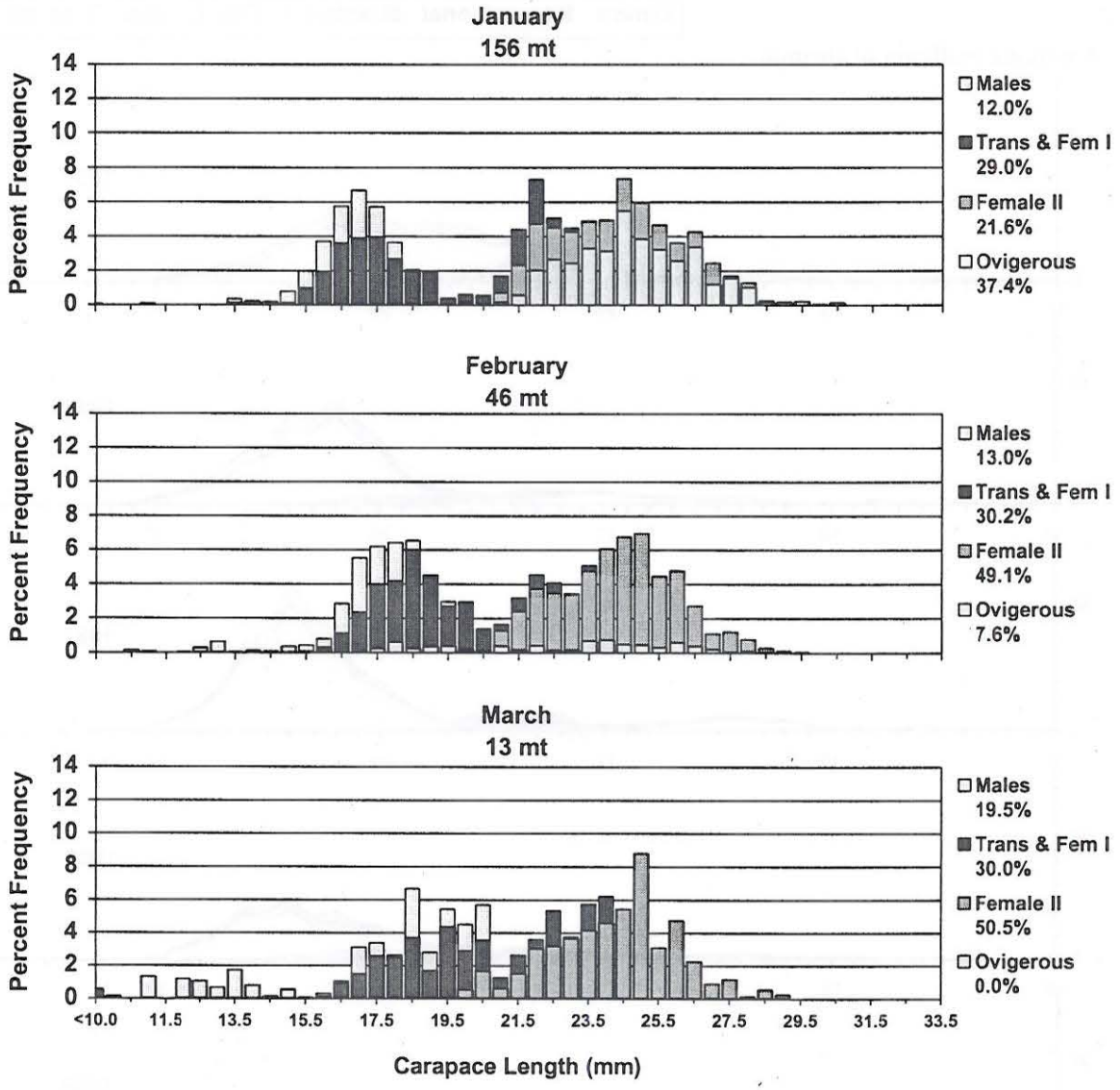


Figure 3. Length frequency distribution from samples of Massachusetts and New Hampshire shrimp catches during the 2001 season.



No samples taken in April, catch = 27.8mt

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

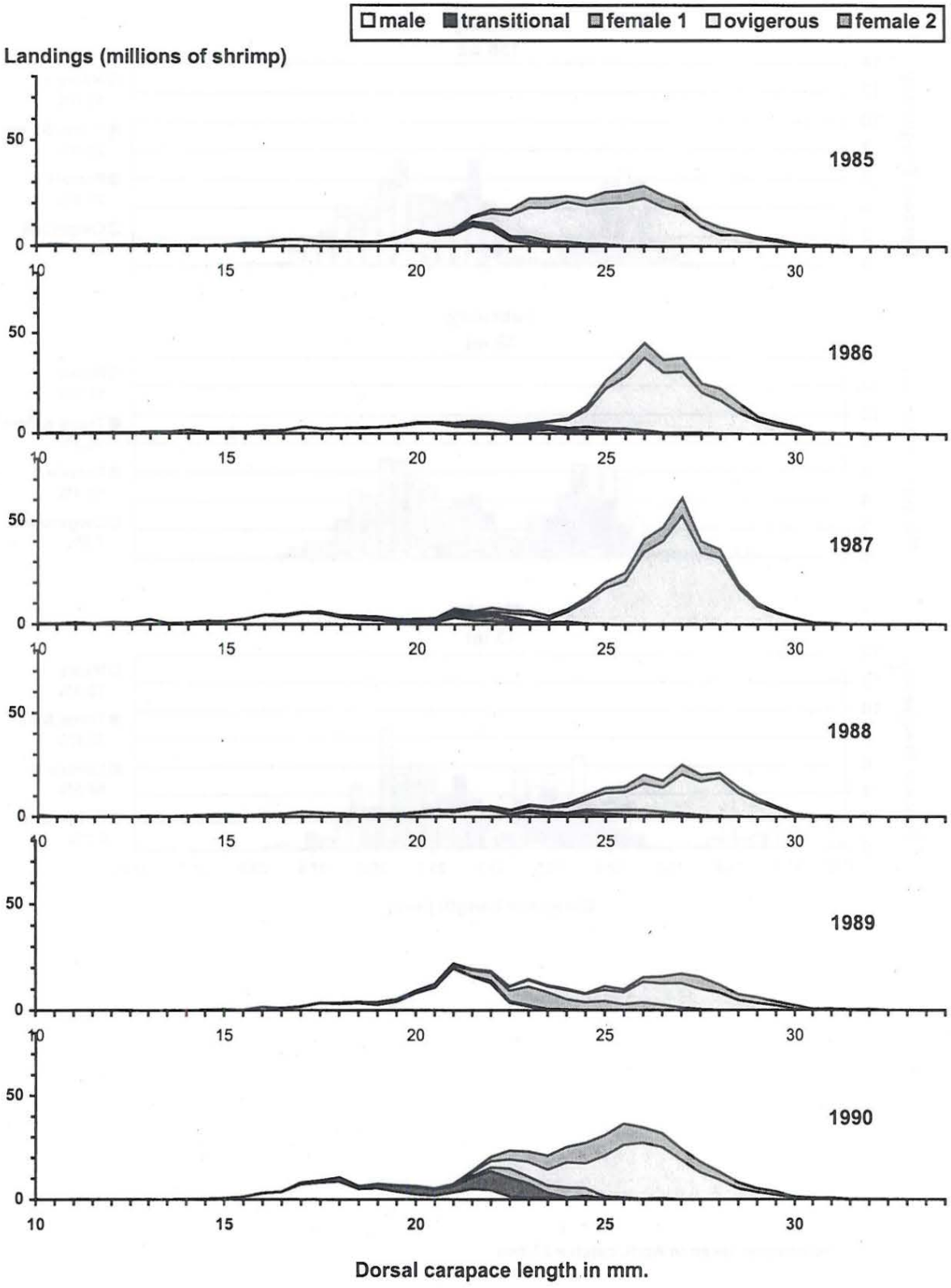


Figure 4. continued.

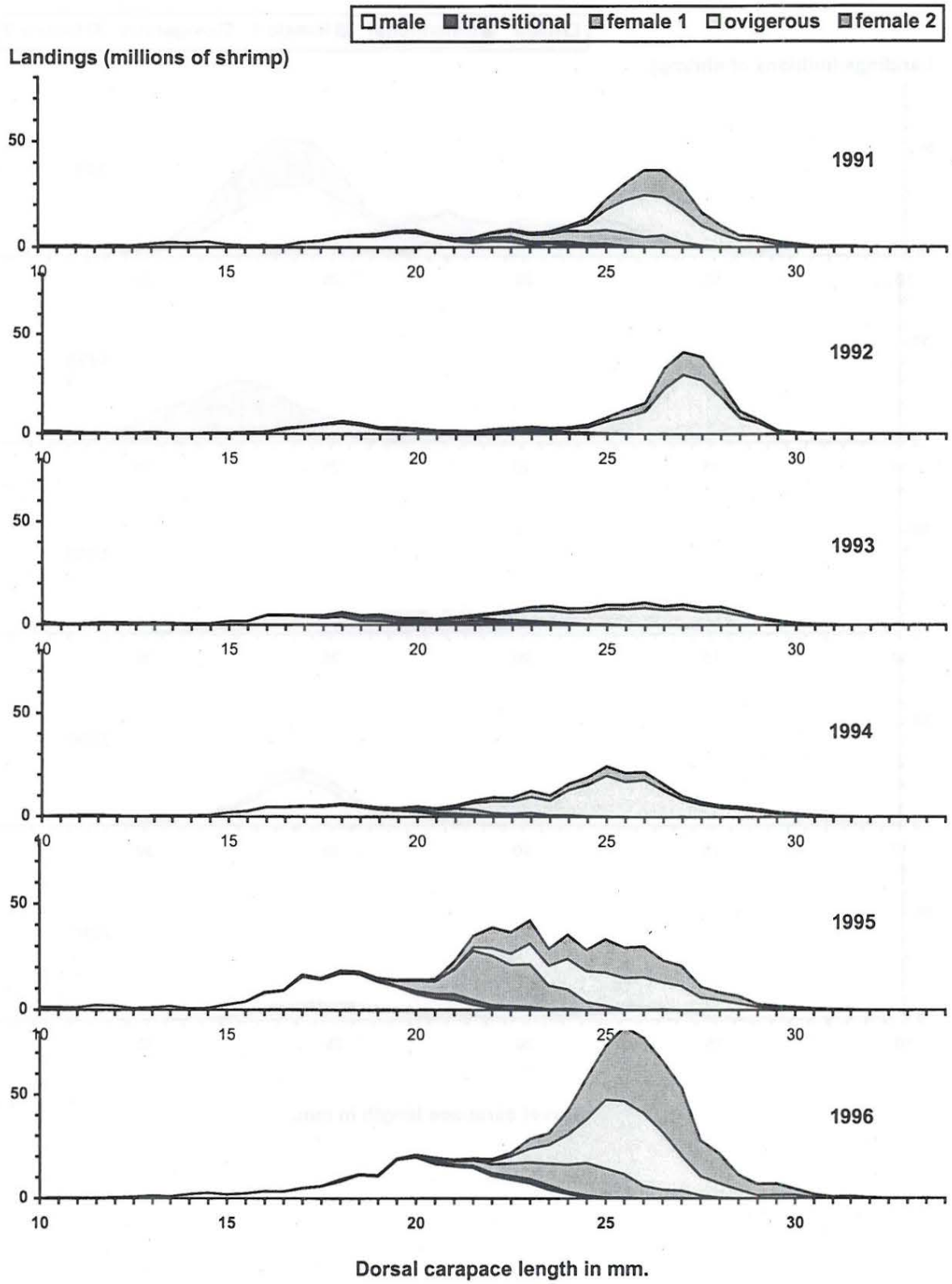


Figure 4. continued.

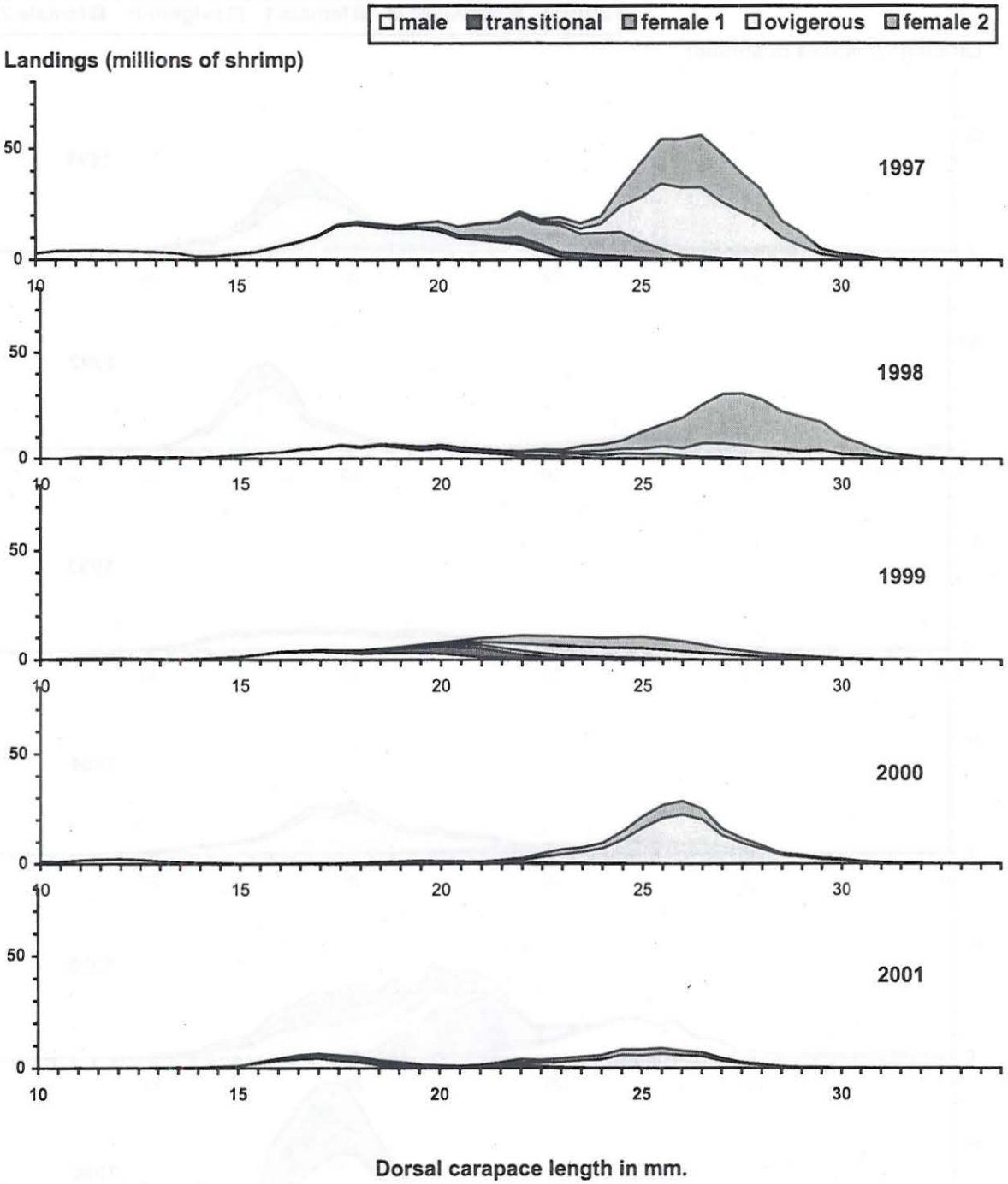
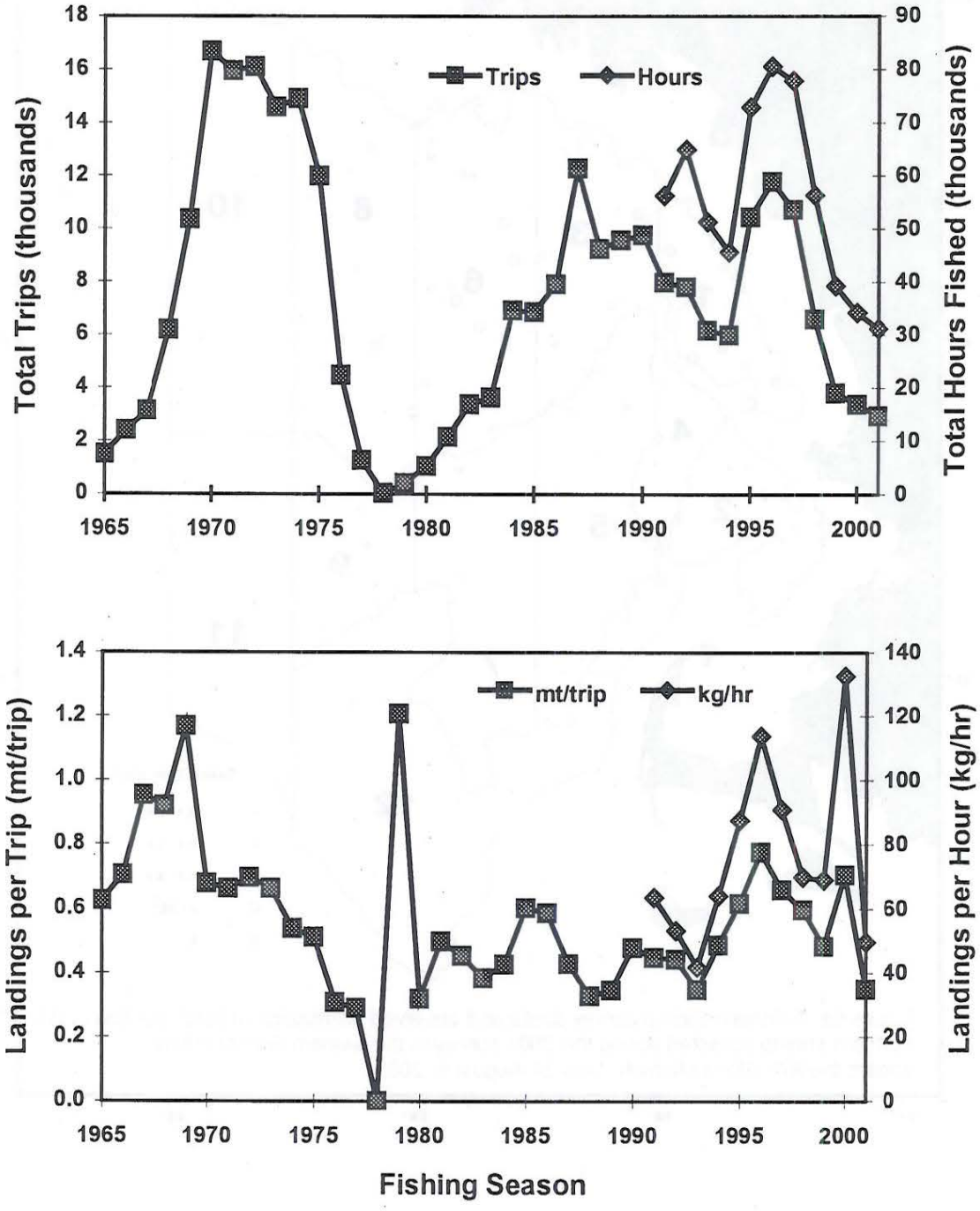


Figure 5. Nominal fishing effort (above) and catch per unit effort (below) in the Gulf of Maine northern shrimp fishery.



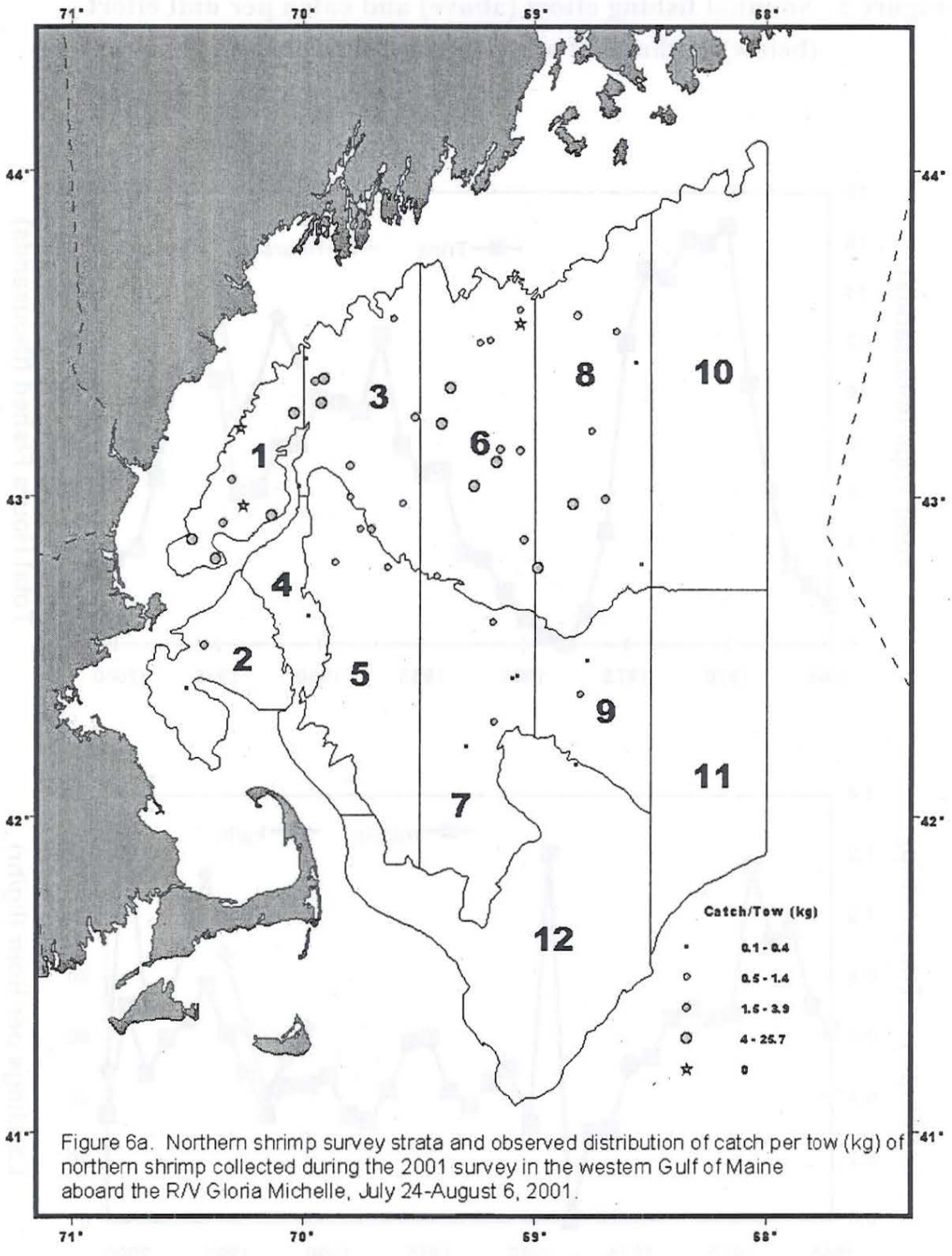


Figure 6a. Northern shrimp survey strata and observed distribution of catch per tow (kg) of northern shrimp collected during the 2001 survey in the western Gulf of Maine aboard the R/V Gloria Michelle, July 24-August 6, 2001.

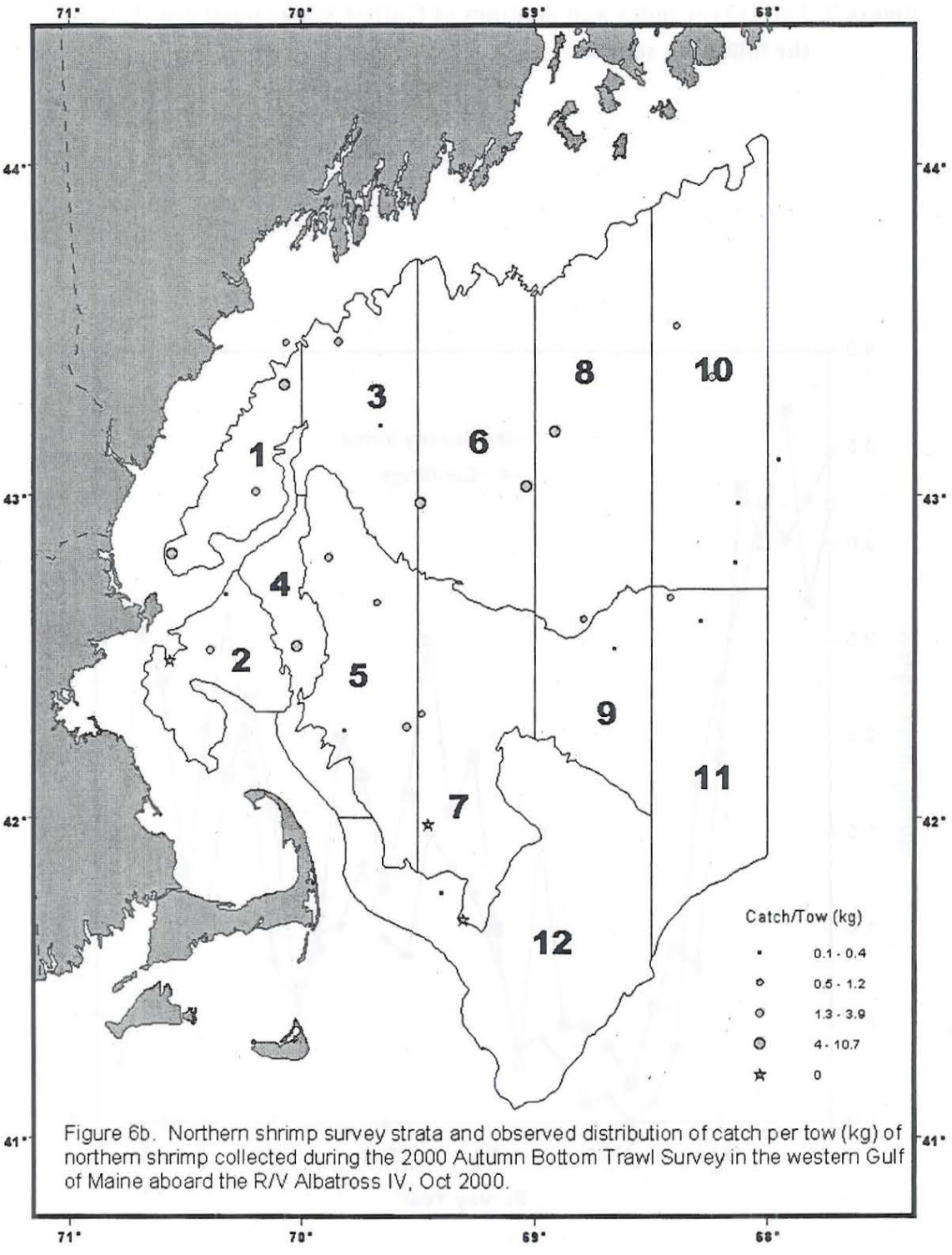


Figure 6b. Northern shrimp survey strata and observed distribution of catch per tow (kg) of northern shrimp collected during the 2000 Autumn Bottom Trawl Survey in the western Gulf of Maine aboard the R/V Albatross IV, Oct 2000.

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

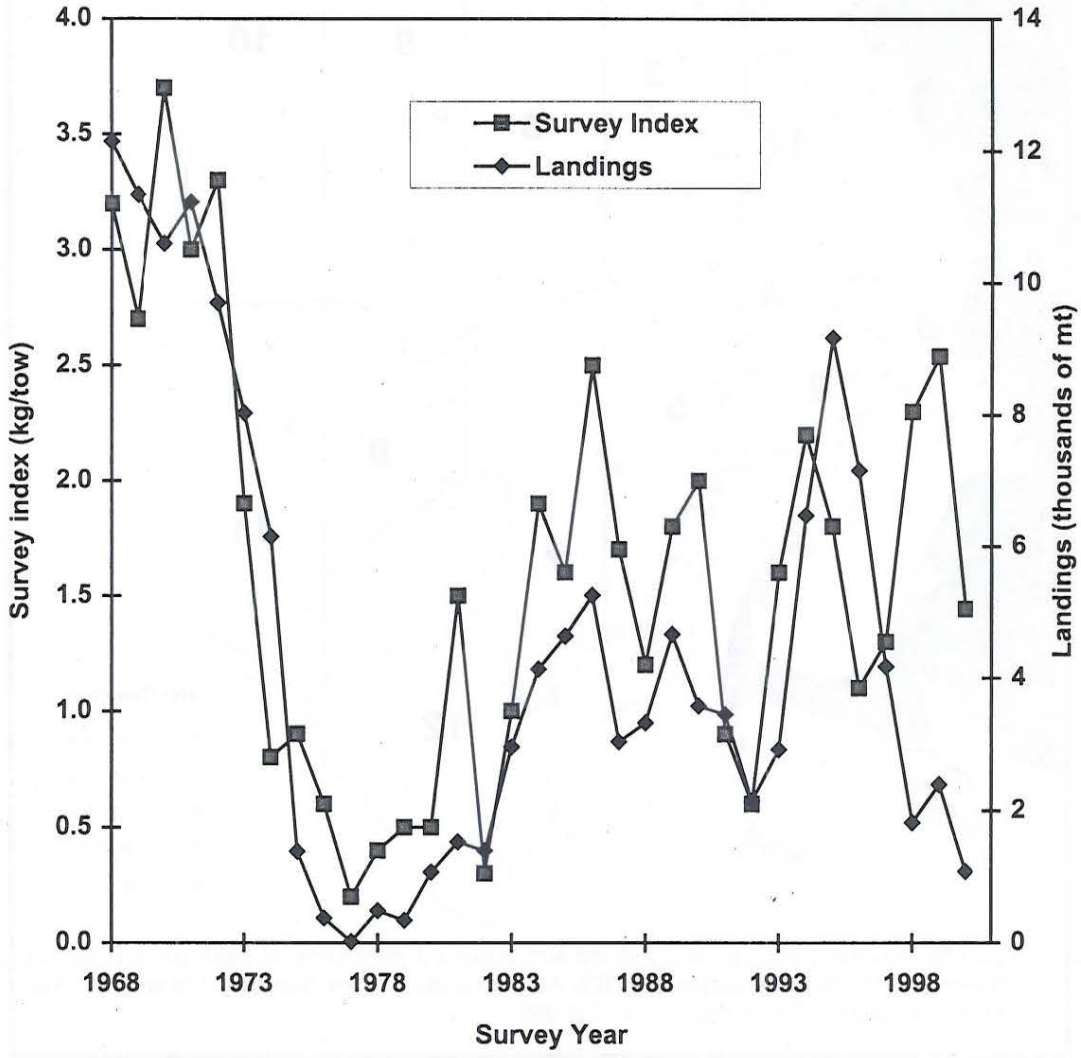


Figure 8. Gulf of Maine northern shrimp summer survey indices of abundance and biomass.

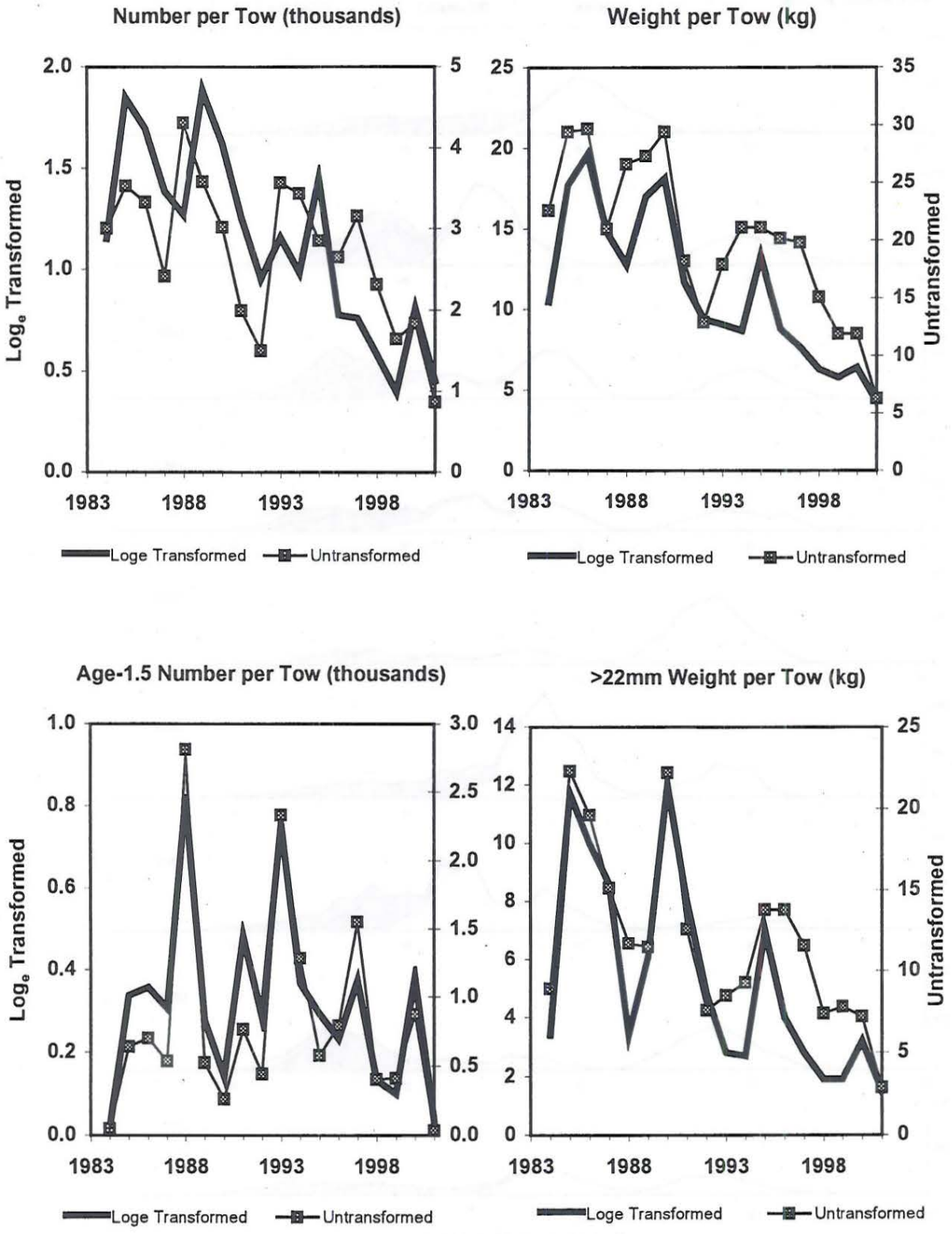


Figure 9. Gulf of Maine northern shrimp summer survey mean catch per tow by length and development stage.

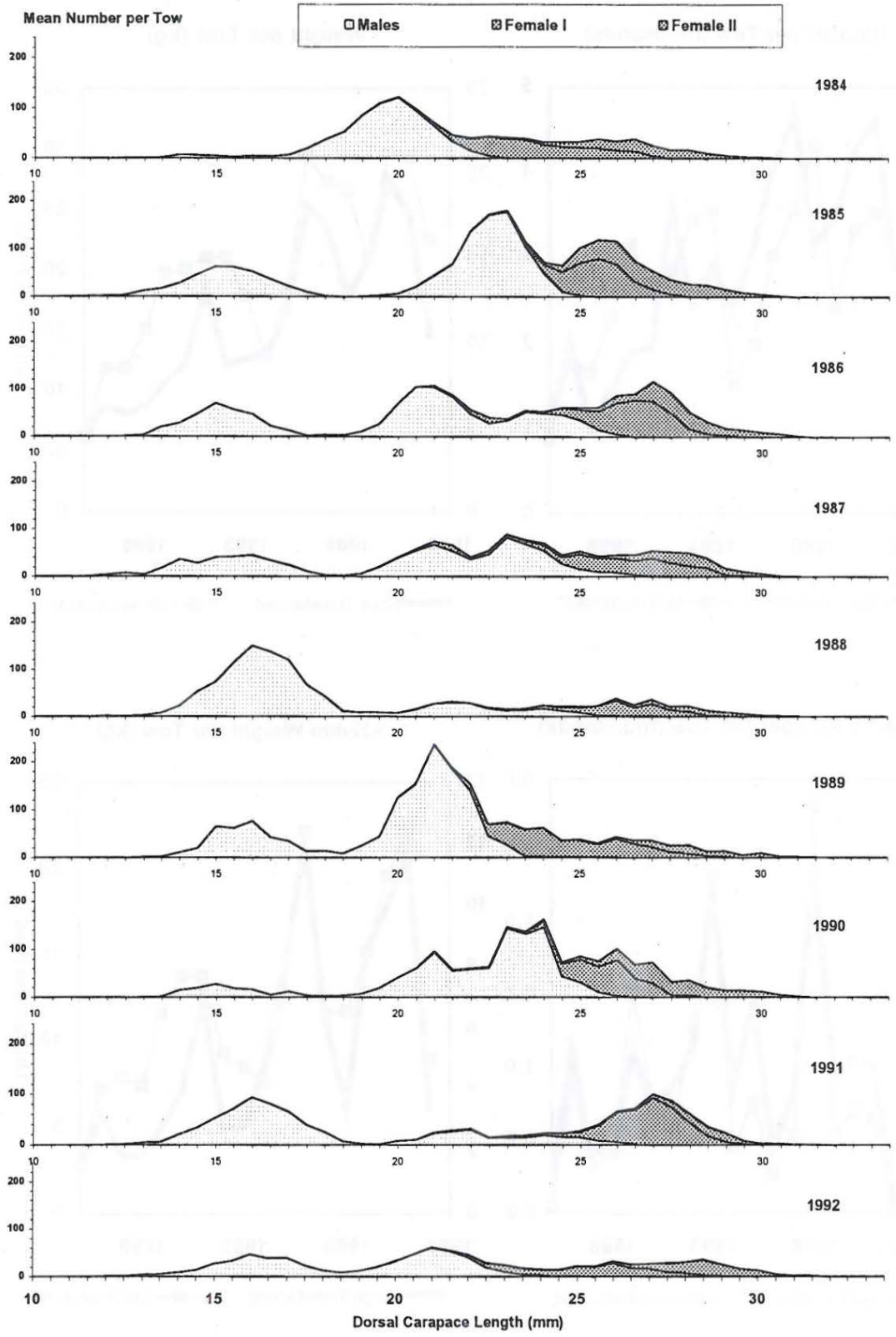


Figure 9. (continued)

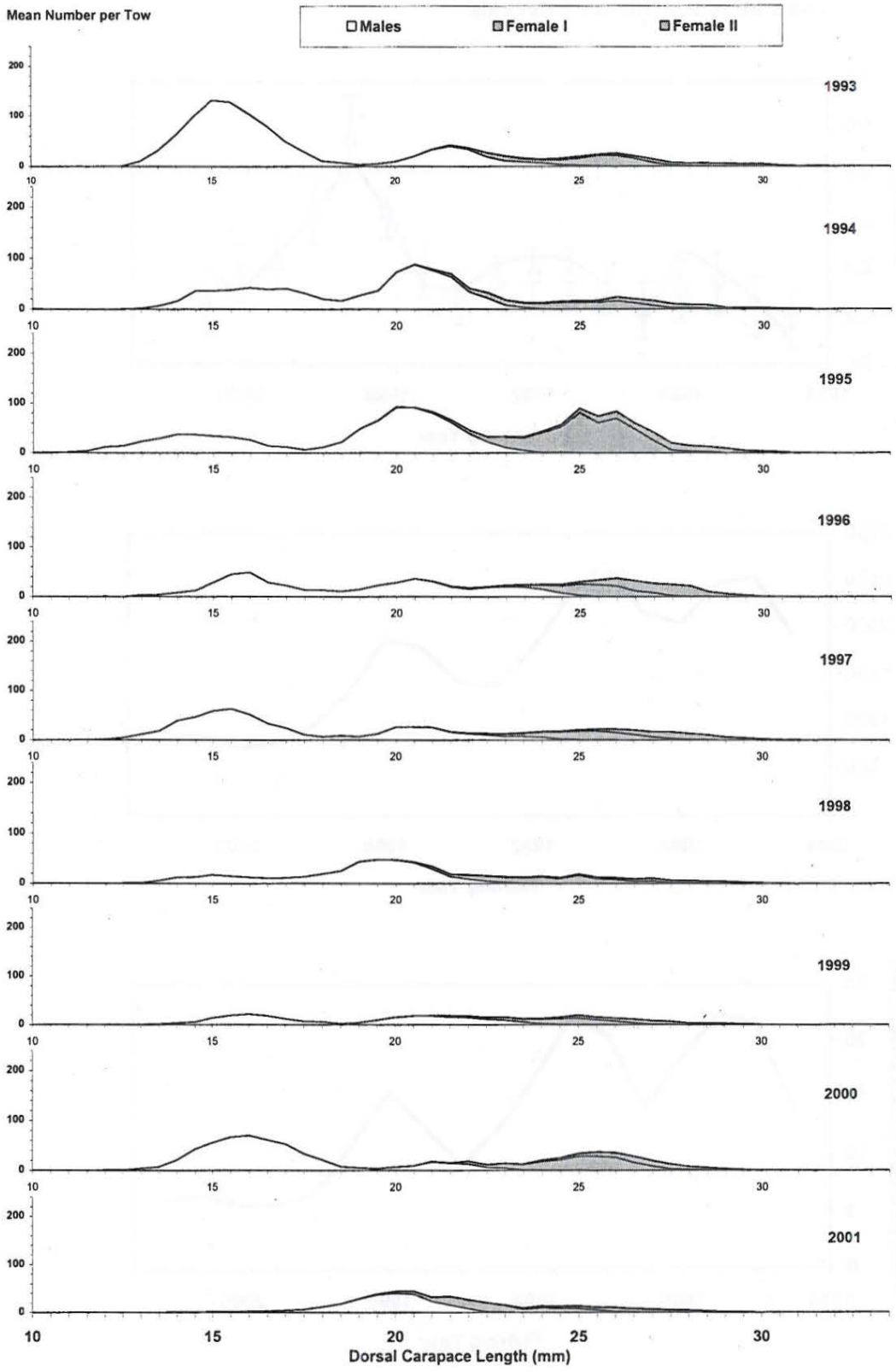
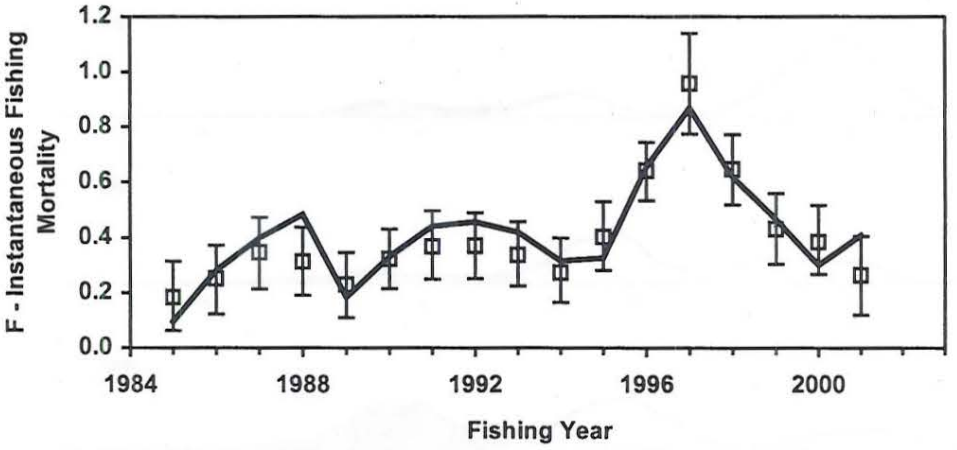
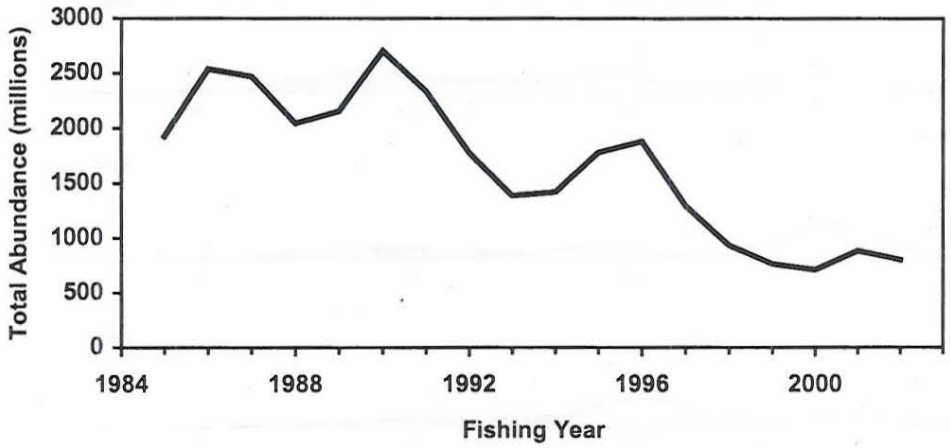


Figure 10. Fishing mortality, abundance, and biomass of Gulf of Maine northern shrimp, least squares estimates, bootstrapped means, and 80% confidence intervals.





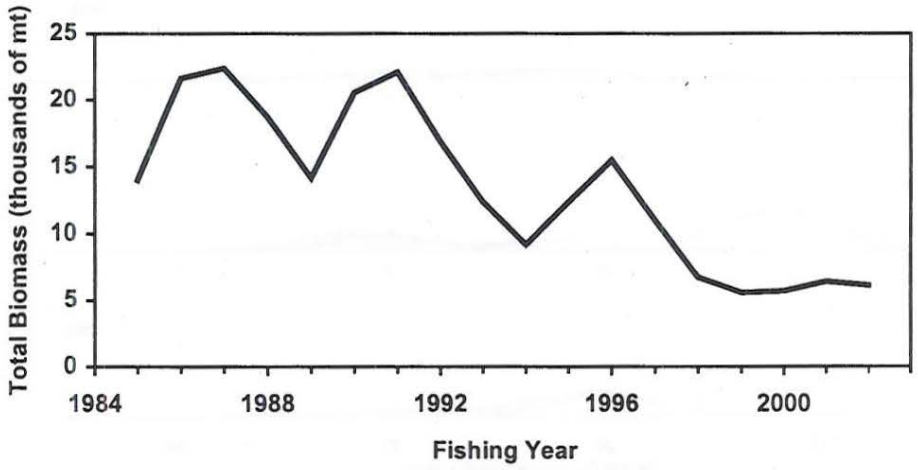
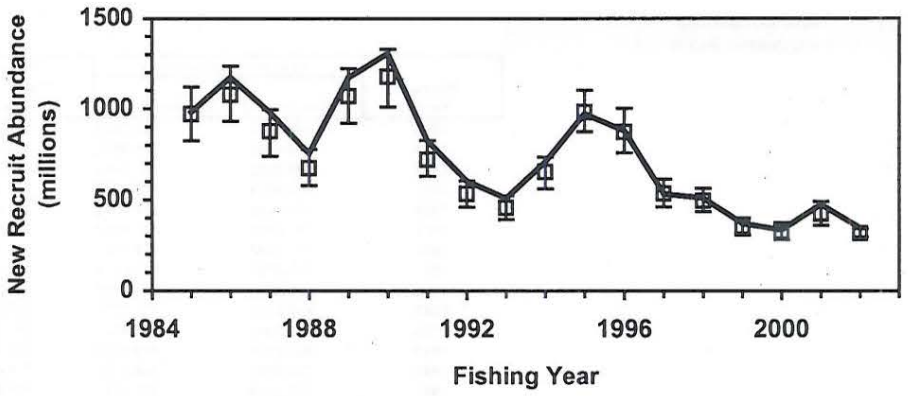
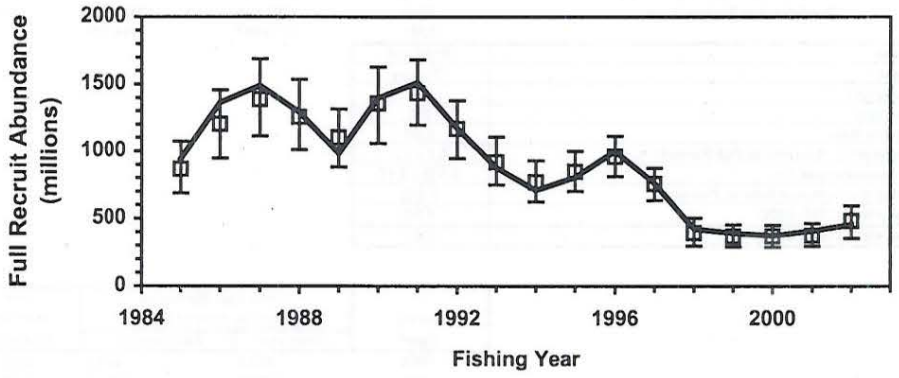
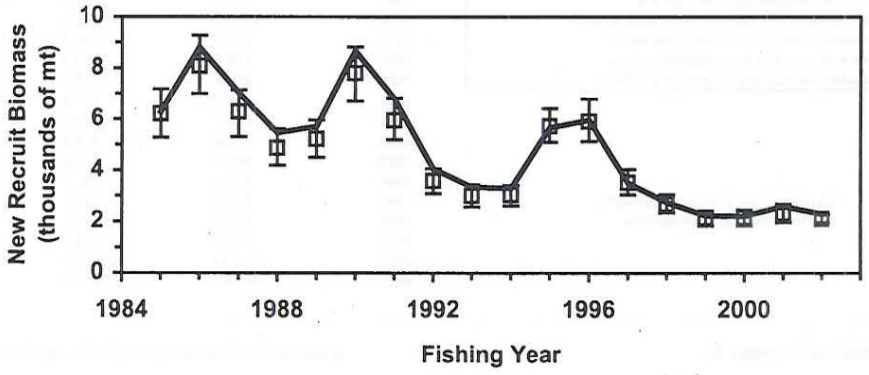


Figure 10. continued







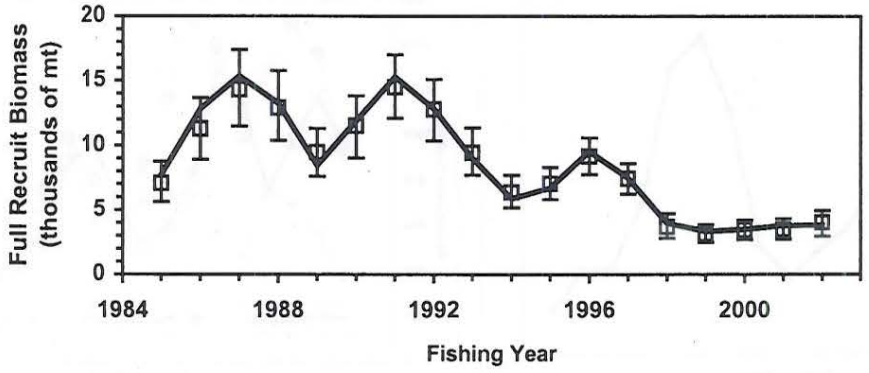


Figure 11. Catch - Survey Model (Modified DeLury) Input Data and Results

Northern Shrimp
using Summer Survey

Survey Year*	Indices of Abundance: Recuits	Indices of Abundance: Full Recruits	Total Catch Millions
1984	447.5578	479.0574	352.7928
1985	619.4558	925.4302	361.1710
1986	533.2922	848.5435	425.2945
1987	482.8976	766.9033	228.4345
1988	459.7546	387.7142	283.6468
1989	701.0930	817.9002	442.4292
1990	511.5206	907.5222	320.2898
1991	374.2766	612.0873	262.4338
1992	313.5948	444.3579	194.7883
1993	410.1957	320.7501	270.4058
1994	368.5900	364.3018	615.3185
1995	485.7855	653.3320	799.3678
1996	257.6521	348.6165	718.4332
1997	257.2984	267.1013	373.6801
1998	217.1338	226.6422	215.1221
1999	137.3895	174.6070	209.2793
2000	276.2806	288.1929	112.8590
2001	171.8085	196.356	

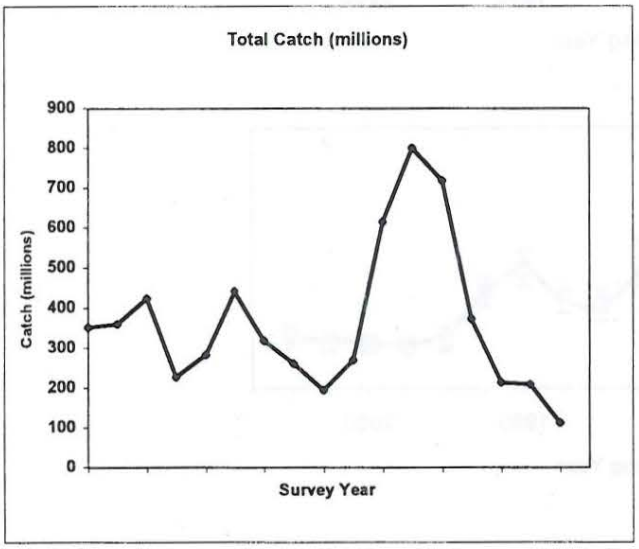
* Survey Year Data are applied to the following Fishing Year

Input File Name	R192.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	0.553 0.17
Average Partial Recruitment Rate to Fishery	0.552
Average Z_all sizes (1998-2000)	0.64
Average Z_all sizes (1999-2000)	0.61

Survey Year*	Stock Size Estimates millions at time of Survey: Recruits	Stock Size Estimates millions at time of Survey: Full Recruits	Total Mortality Z all sizes	Fishing Mortality All Sizes
1984	982.9	943.5	0.35	0.10
1985	1174.2	1363.6	0.53	0.28
1986	980.3	1490.5	0.65	0.40
1987	753.9	1292.2	0.73	0.48
1988	1171.7	982.3	0.43	0.18
1989	1307.5	1396.2	0.58	0.33
1990	825.6	1511.9	0.69	0.44
1991	605.4	1171.2	0.71	0.46
1992	509.2	877.0	0.67	0.42
1993	708.7	709.2	0.57	0.32
1994	972.9	805.2	0.58	0.33
1995	881.5	999.2	0.90	0.65
1996	533.4	761.7	1.12	0.87
1997	510.1	423.0	0.87	0.62
1998	370.9	391.4	0.72	0.47
1999	335.5	372.7	0.55	0.30
2000	474.034	408.508	0.66	0.41
2001	345.391	456.945		

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 1998

* Survey Year Data are applied to the following Fishing Year



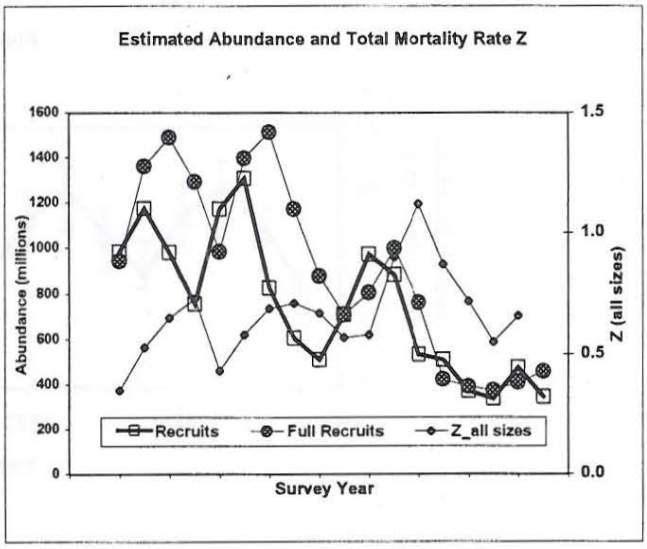
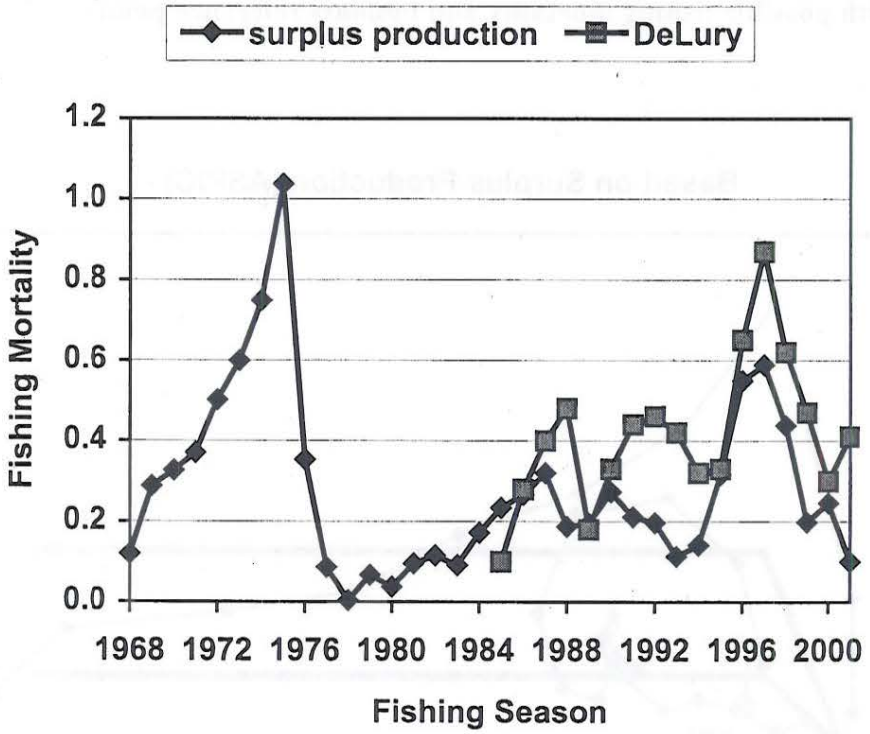


Figure 12. Estimates of fishing mortality (above) and stock biomass (below) for northern shrimp from DeLury and surplus production modeling.



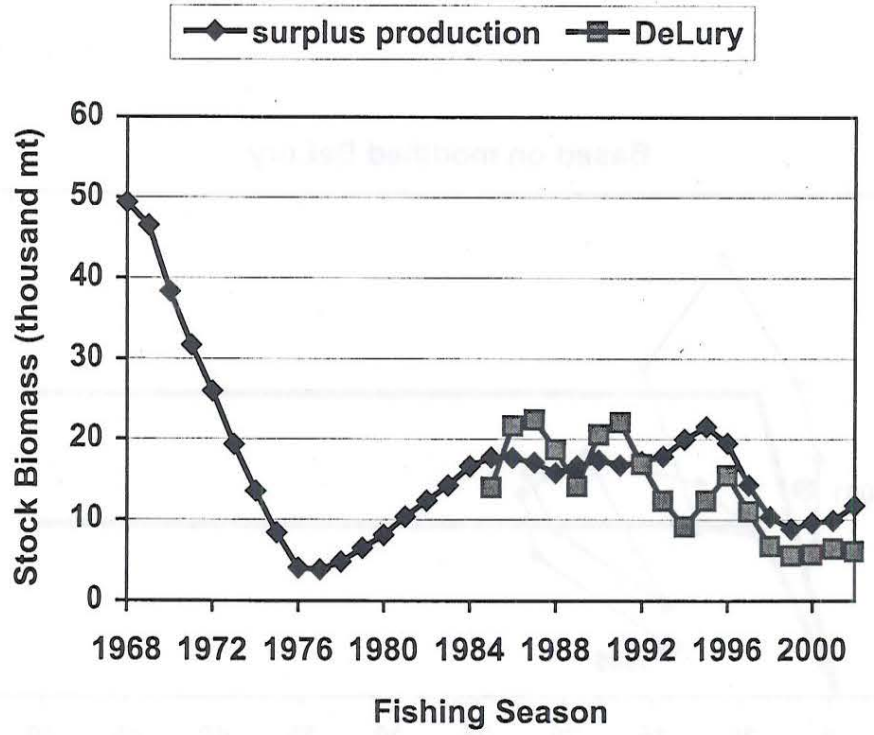
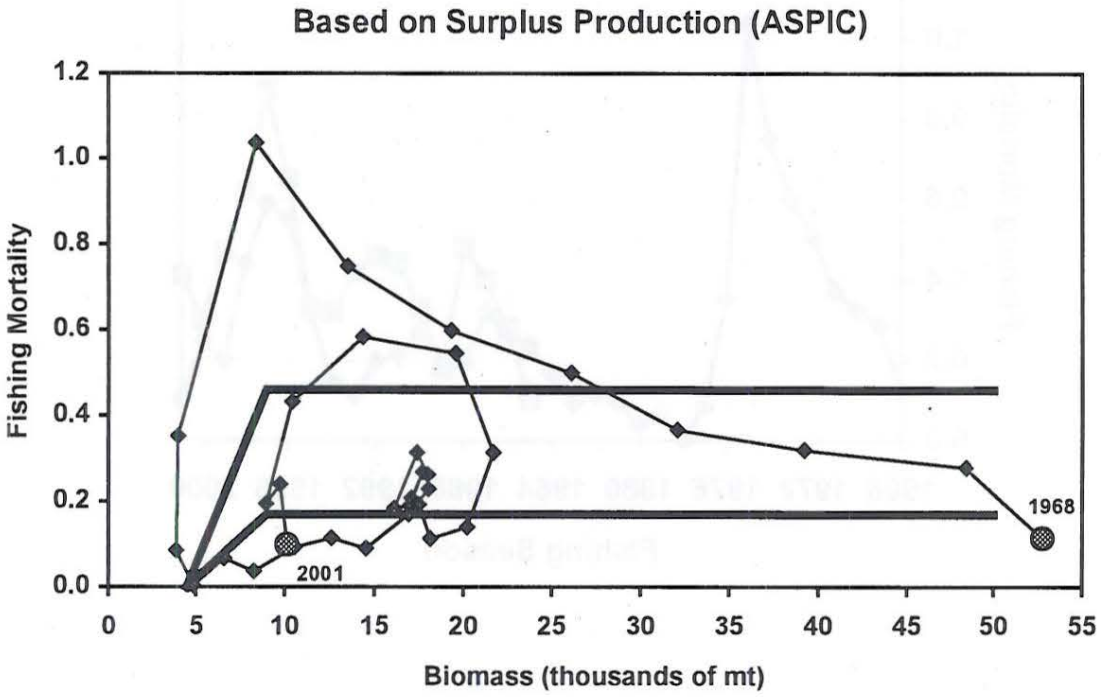


Figure 13. Biomass dynamics of the Gulf of Maine northern shrimp fishery, from surplus production (above) and modified DeLury (below) modeling, with possible fishing mortality and biomass reference points.



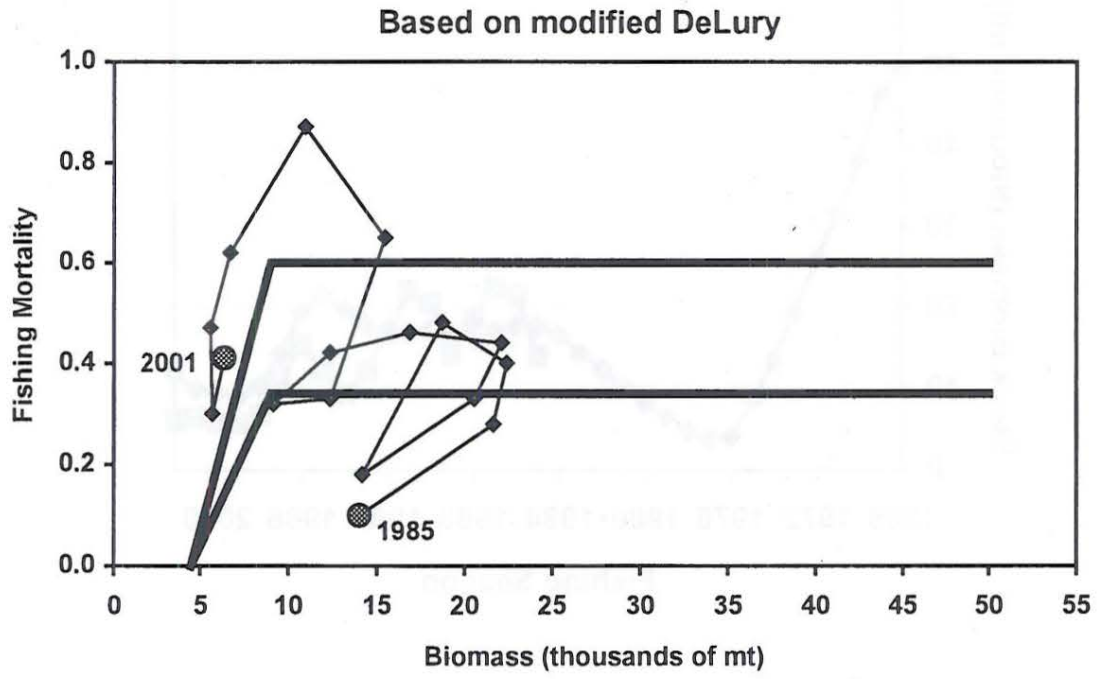
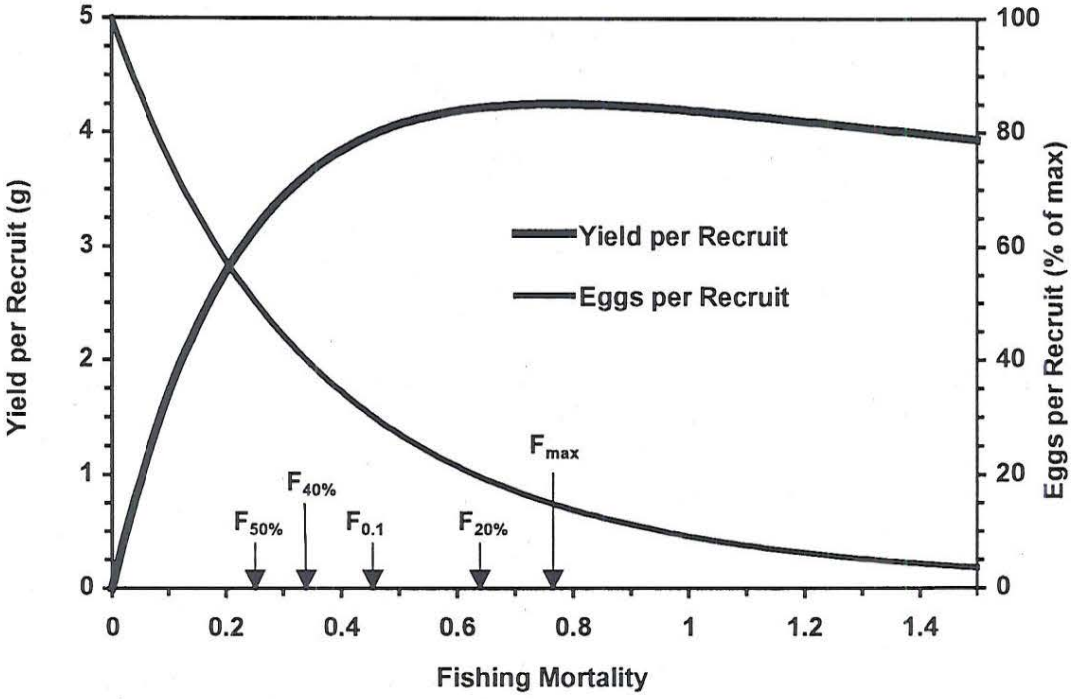


Figure 14. Yield and egg production per recruit.



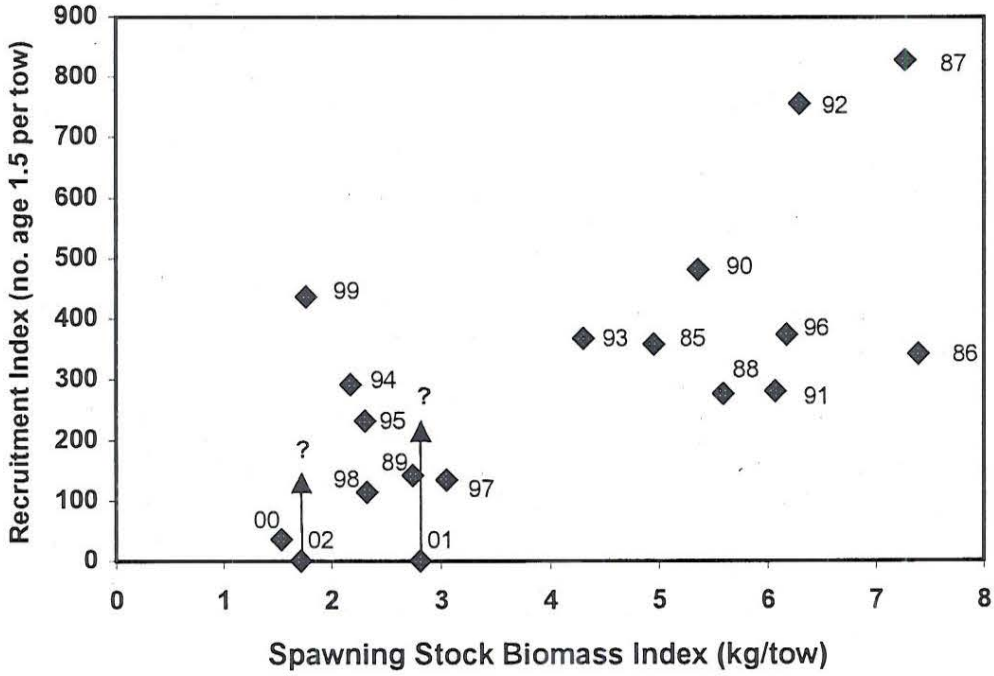


Figure 15. Relationship between summer survey index of Gulf of Maine female shrimp biomass the summer before spawning to age 1.5 abundance two years later.

ASSESSMENT REPORT

FOR

GULF OF MAINE NORTHERN SHRIMP -- 2001

Prepared
November 1, 2001
by the
Atlantic States Marine Fisheries Commission's
Northern Shrimp Technical Committee

Robert Glenn, (Massachusetts)
Margaret Hunter, Chair (Maine)
Josef Idoine, (NMFS NEFSC)
Clare McBane, (New Hampshire)
Dave McCarron, (CESS Appointee)
Michael Lewis (ASMFC)

With assistance from:
Mike Armstrong, (Massachusetts)
Charles Keith (NMFS NEFSC)
Daniel Schick, (Maine)

INTRODUCTION

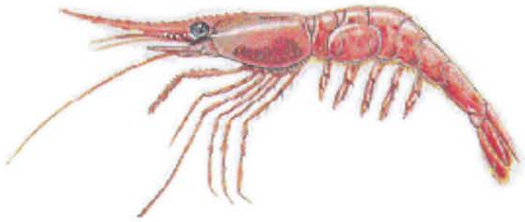
Biological Characteristics

Northern shrimp 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

2001 IJF Annual Report
Commercial Port Sampling of Northern Shrimp *(Pandalus borealis)* Along the Maine Coast

Annual Summary for January 1, 2001 - December 31, 2001

By
Lessie L. White Jr.
Marilyn Lash Metcalfe



State of Maine
Department of Marine Resources
Biological Monitoring and Assessment Division (BIOMASS)

IJF Annual Report January 1, 2001 - December 31, 2001

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 $3.00 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 by 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.

The shrimp season this year started on January 9, 2001 and ran through March 17, 2001. Then the season opened again for two weeks in April from April 16, 2001 through April 30, 2001 (last day of shrimping in the 2001 season). During the 2001 season 123 shrimp samples and corresponding captain interviews were obtained from 104 draggers (57 different draggers) and 19 trappers (15 different trappers) at 19 dealer locations from Portsmouth, NH to Winter Harbor, Maine. Fifty-two samples were collected in January from 11 different dealer locations from Portsmouth, NH to Winter Harbor, ME; 44 in February from 12 different dealer locations from Portsmouth, NH to Port Clyde, ME; 15 in March from 5 different dealer locations from Portland, ME to Bass Harbor, ME and 12 in April from 3 different dealer locations from Portland, ME to Southwest Harbor, ME. The length range of the boats sampled varied from 31' - 60'.

Draggers sampled in April had the highest average daily catch and highest average catch per unit of effort (CPUE), expressed in lbs/hr drag time. The average daily catch and average CPUE per dragger in January was 630.1 lbs/day, 98.8 lbs/hr; in February 757.1 lbs/day, 102.3 lbs/hr, in March 771.6 lbs/day, 93.3 lbs/hr and in April 1,472.5 lbs/day, 185.8 lbs/hr.

For the period January - April 2001, the average daily catch for the 104 draggers was 815.1 lbs with an average CPUE of 114.6 lbs/hr drag time. For the 19 trappers, the total catch was 8,309 lbs with an average catch of 4.0 lbs/trap and 1.03 lbs/trap/day.

Table 1 lists the 19 shrimp dealers where 123 shrimp samples were obtained from January 9, 2001 - April 30, 2001 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 January, 2001 - April, 2001: *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 boat 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.

Commercial Shrimp Port Sampling. Monthly Report for January, 2001 (days 1 – 23 of the 83 day season)

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

The opening of the 2001 shrimp season on January 9 was marked by small catches and low prices. Quality was also a problem as a lot of small shrimp (males) were mixed in with the larger females making for high counts per pound. Counts initially appeared to be highest in the western part of the state, but, up and down the coast, both counts and boat prices improved by the end of the month. Catches increased for about a week and then declined to prior levels.

Port sampling began on January 11, and during the 23 days allowed for shrimping between January 9 – 31 shrimp samples and corresponding captain interviews for catch information were obtained from 47 draggers and 5 trappers at 11 dealers from Portsmouth, NH to Winter Harbor, ME. The lengths of the sampled vessels ranged from 34' to 56'. The samples came from 30 different fishing grounds. The price ranged from $.55/lb to $1.09/lb, with the price around $1.00/lb at the end of the month.

Boats were sampled at the following 11 dealers: Winter Harbor Co-op, Winter Harbor; Beal's Lobster Pier, Southwest Harbor; Thorbjornson's Wharf, Port Clyde, South Bristol Co-op, South Bristol; New Harbor Co-op, New Harbor; Shaw's Wharf, New Harbor; Wotton's Lobster, Boothbay Harbor; Seahorse Fisheries, West Point; Cundys Harbor Wharf, Cundys Harbor; Portland Fish Exchange, Portland and the Portsmouth Fishermans Co-op, Portsmouth, NH.

Catches were much lower than in January 2000. Daily catches for the 47 draggers sampled ranged from 115 (gear problems) to 1,930 lbs, the average daily catch was 630 lbs. The range of catches in lbs/hr drag time (CPUE) was 22.7 – 241.3 lbs/hr, while the average CPUE was 98.8 lbs/hr. The average counts were in the low to mid 50's. (This compares with an average daily catch of 3,267.1 lbs and an average CPUE of 466.5 lbs/hr for 23 draggers sampled in January 2000. Counts for shrimp landed in January, 2000 were averaging 40/lb.) The 5 trappers sampled hauled 508 traps for a total of 1,939 lbs for an average catch of 3.8 lbs/trap and 0.8 lbs/trap/day. (Trappers sampled in January 2000 had an average catch of 11.9 lbs/trap and 2.9 lbs/trap/day.) Counts for trapped shrimp were averaging in the high 30's.

Commercial Shrimp Port Sampling. Monthly Report for February, 2001 (days 24 – 51 of the 83 day season)

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

The catches for the first week-and-a-half of February 2001 looked to be the peak for this season. The females dropped their eggs at this point and end of the month catches reflected this. The quality, in terms of counts, was better throughout February than it had been in January. During the last two weeks of February, weather hampered fishing with high winds on many of the days. This, combined with low catches near the end of the month, led to a low numbers of boats going out.

During the 28 days allowed for shrimping between February 1 – 28 shrimp samples and corresponding captain interviews for catch information were obtained from 36 draggers and 8 trappers at 12 dealers from Portsmouth, NH to Port Clyde, ME. The lengths of the sampled vessels ranged from 31' to 60'. The samples came from 20 different fishing grounds. The price ranged from $.95/lb to $1.15/lb, with the price around $1.00/lb at the end of the month.

Boats were sampled at the following 12 dealers: Thorbjornson's Wharf, Port Clyde; Massey's, South Bristol; Shaw's Wharf, New Harbor; Pemaquid Fishermens Co-op, Pemaquid; Wotton's Lobster, Boothbay Harbor; Robinson's Wharf, Southport; Cundys Harbor Wharf, Cundys Harbor; Portland Fish Exchange, Portland; A.L. Ryan, Portland; River Catch Inc., Portland; Kennebunkport Pier, Kennebunkport and the Portsmouth Fishermans Co-op, Portsmouth, NH.

Catches were much lower than in February 2000. Daily catches for the 36 draggers sampled ranged from 150 to 1,650 lbs, the average daily catch was 757.1 lbs. The range of catches in lbs/hr drag time (CPUE) was 25.0 – 286.5 lbs/hr, while the average CPUE was 102.3 lbs/hr. The average counts were in the low to mid 40's. (This compares with an average daily catch of 1,900.5 lbs and an average CPUE of 245.4 lbs/hr for 46 draggers sampled in February 2000.) The 8 trappers sampled hauled 1175 traps for a total of 5,143 lbs for an average catch of 4.4 lbs/trap and 1.12 lbs/trap/day. (Trappers sampled in February 2000 had an average catch of 10.7 lbs/trap and 4.73 lbs/trap/day.) Counts for trapped shrimp were averaging in the high 30's.

Many of the fishermen that we have interviewed this season have stated that they would like to see the fishing season open two weeks earlier and have the weekends closed to shrimping. They stated that this would give the shrimp a "rest" and allow them to regroup.

Commercial Shrimp Port Sampling. Monthly Report for March, 2001 (days 52 – 68 of the 83 day season)

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

The catches for the month of March 2001 were lower than those of February 2001. The females had started to migrate offshore and the areas that were being fished reflected this point. The quality, in terms of counts, was worse throughout March than it had been in February. During the month of March, weather hampered fishing with high winds on many of the days. This, combined with low catches led to a low number of boats going out. On one of the days this month the sampling team obtained samples from all of the shrimp boats in Maine that we know to have gone out.

During the 17 days allowed for shrimping between March 1 – 17 shrimp samples and corresponding captain interviews for catch information were obtained from 9 draggers and 6 trappers at 5 different dealers from Portland, ME to Bass Harbor, ME. The lengths of the sampled vessels ranged from 34' to 60'. The samples came from 11 different fishing grounds. The price ranged from $.75/lb to $1.00/lb, with the price around $.95/lb at the end of the month.

Boats were sampled at the following 5 dealers: C.H. Rich & Co., Bass Harbor; Osier's, South Bristol; Pemaquid Fishermens Co-op, Pemaquid; Wotton's Lobster, Boothbay Harbor and River Catch Inc., Portland.

Catches were lower than in March 2000. Daily catches for the 9 draggers sampled ranged from 45 to 1,200 lbs, the average daily catch was 771.6 lbs. The range of catches in lbs/hr drag time (CPUE) was 13.5 – 133.3 lbs/hr, while the average CPUE was 93.3 lbs/hr. (This compares with an average daily catch of 915.2 lbs and an average CPUE of 121.8 lbs/hr for 17 draggers sampled in March 2000.) The average counts were in the mid to upper 40's. The 6 trappers sampled hauled 396 traps for a total of 1,227 lbs for an average catch of 3.1 lbs/trap and .36 lbs/trap/day. (Trappers sampled in March 2000 had an average catch of 9.6 lbs/trap and 2.2 lbs/trap/day.) Counts for trapped shrimp were averaging in the high 30's.

Commercial Shrimp Port Sampling. Monthly Report for April, 2001 (days 69 – 83 of the 83 day season)

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

The catches for the month of April 2001 were higher than those of March 2001. The females still had not completed their migration offshore and the catches that were being brought in reflected this point. The quality, in terms of counts, was worse throughout April than it had been in March. This combined with low catches and the month off led to a low number of boats going out.

During the 15 days allowed for shrimping between April 16 – 30 shrimp samples and corresponding captain interviews for catch information were obtained from 12 dragged samples at 3 different dealers from Portland, ME to Southwest Harbor, ME. The lengths of the sampled vessels ranged from 36' to 60'. The samples came from 9 different fishing grounds. The price ranged from $.65/lb to $.70/lb, with the price around $.65/lb at the end of the month.

Boats were sampled at the following 3 dealers: Beal's Lobster Pier, Southwest Harbor; A.L. Ryan, Portland; and River Catch Inc., Portland.

There was no fishing in April 2000. Daily catches for the 12 dragged samples ranged from 150 to 2,500 lbs; the average daily catch was 1,472.5 lbs. The range of catches in lbs/hr drag time (CPUE) was 33.3 – 312.5 lbs/hr, while the average CPUE was 185.8 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.) The average counts were in the low 60's.

Table 1

Commercial Shrimp Port Sampling

A list of 19 shrimp dealers where 123 shrimp samples were obtained from January 9, 2001 (1st day of shrimp season) – April 30, 2001 (last day of shrimp season) with the total visits to each dealer, the number of samples obtained at each visit (number of boats sampled) and the total number of samples obtained at each dealer.

Dealer	No. Visits	Samples collected/visit	Total Samples
1. Wotton's Lobster, Boothbay Harbor	7	3,3,4,2,2,2,2	18
2. Osier's Wharf, South Bristol	1	2	2
3. A.L. Ryan, Portland	2	3,1	4
4. Shaw's Wharf, New Harbor	3	7,4,9	20
5. South Bristol Co-op, South Bristol	1	6	6
6. Cundys Harbor Wharf, Cundys Harbor	2	7,7	14
7. Portland Fish Exchange, Portland	4	6,1,2,1	10
8. Robinson's Wharf, Southport	1	1	1
9. Beal's Lobster Pier, Southwest Harbor	2	2,1	3
10. Massey's Inc., South Bristol	1	3	3
11. Winter Harbor Co-op, Winter Harbor	1	1	1
12. Pemaquid Fishermen's Co-op, Pemaquid	4	1,1,3,3	8
13. Kennebunkport Pier, Kennebunkport	1	1	1
14. Seahorse Fisheries, West Point	1	2	2
15. Thorbjornson's Wharf, Port Clyde	3	3,4,2	9
16. Portsmouth Fishermen's Co-op, Portsmouth, NH	2	2,2	4
17. River Catch Inc., Portland	6	2,2,4,2,1,3	14
18. New Harbor Co-op, New Harbor	1	2	2
19. C.H. Rich, Bass Harbor	1	1	1
Totals	**44**		**123**

Table 2

Commercial Shrimp Port Sampling January 9 - March 17, April 16 - April 30, 2001

	# Dealers Visited & Locations *1	# Samples Collected	Boats: # Different Draggers Sampled *2	Boats: # Trappers Sampled	Boats: Length Range (ft)	Boats: # Fishing Grounds	Total catch in (lbs) Draggers	Total catch in (lbs) Trappers	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 lbs./trap	Average lbs/trap haul set over day
Jan. 2001	11 Portsmouth, NH to Winter Harbor, ME	52	38	5	34' - 56'	19	29,615	1,939	47	630.1	299.66	98.8	508	21.5	3.8	0.79
Feb. 2001	12 Portsmouth, NH to Port Clyde, ME	44	29	8	31' - 60'	21	27,254	5,143	36	757.1	266.5	102.3	1175	27	4.4	1.12
Mar. 2001	5 Portland, ME to Bass Harbor, ME	15	7	6	34' - 60'	11	6,944	1,227	9	771.6	74.41	93.3	396	54	3.1	0.36
Apr. 2001	3 Portland, ME to Southwest Harbor, ME	12	3	0	36' - 60'	3	25,033	0	17	1,472.5	134.75	185.8	0	0	0	0
Season Totals:	19 Portsmouth, NH to Winter Harbor, ME different dealers	123	55 different draggers	15 different trappers	31' - 60'	47 different fishing grounds	88,846	8,309	109	815.1	775.32	114.59	2,079	102.5	4.0	1.03

*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.

MAINE DEPARTMENT OF MARINE RESOURCES

COMMERCIAL PORT SAMPLING AND MANAGEMENT OF GREEN SEA URCHINS (*STRONGYLOCENTROTUS DROEBACHIENSIS*) ALONG THE MAINE COAST

COMPLETION REPORT
January 1, 2001 – December 31, 2001

Margaret Hunter
Kerry Lyons
Robert Russell

Commercial Port Sampling for Sea Urchins
Maine Department of Marine Resources

Margaret Hunter
Kerry Lyons
Robert Russell
March 2002

Commercial Port Sampling Program

Commercial port sampling data collection

The commercial sea urchin port sampling program was initiated during the 1994-1995 season. During that season, interviews were collected coastwide 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 5-7 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 which 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.

During the 2000-2001 season, port samplers interviewed 273 divers and 66 draggers. The breakdown of diver interviews by county was York (9), Cumberland (5), Sagadahoc/Lincoln (41), Knox (108), Hancock (84), and Washington (26). Dragger interviews were in Knox (6), Hancock (15), and Washington (45). Port samplers also measured and weighed 5,919 urchins from 296 catches in both zones.

Catch, effort, CPUE, and size information from interviews and samples

A summary of information recorded from diver and dragger interviews during the 2000-2001 season is shown in Tables 1 and 2 respectively. Table 1 shows that the mean (average) diver age is 36.7, the mean minimum and mean maximum diver harvest depths are 9.8 and 27.0 ft. respectively, the mean catch per diver day is 571.4 lbs., the mean percent roe is 13.4%, and the mean number of bottom hours is 3.5. Table 2 shows that the mean dragger boat length is 35.2 ft., the mean minimum and mean maximum dragger harvest depths are 19.6 and 51.0 ft. respectively, the mean catch per dragger day is 575.3 lbs., the mean percent roe is 13.0%, the mean numbers of hours fished is 5.4, the mean number of minutes per tow is 7.5, and the mean number of tows per day is 35.5. Other

important parameters are also listed in Tables 1 and 2. Selected information mentioned above for the 2000-2001 season is compared with previous seasons in Table 3.

CPUE for both divers and draggers is presented in Table 4 and Figures 2, 3, and 4. A comparison of the pounds per bottom hour summarized from diver interviews conducted during 7 consecutive harvesting seasons (Fig. 4), shows that CPUE has been consistently higher in Zone 2 than in Zone 1, but that it has been declining steadily in Zone 2. Anecdotal information from harvesters, as well as our analytical analyses, tell us 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 continued to decline 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 10, which shows that the Zone 1 diver attrition rate has been 54% between 1995 and 2001, while Zone 2 diver attrition has been 34% for the same period.

No attempt will be made to draw conclusions from dragger CPUE information (Fig. 3 and Table 4) because of small sample sizes. The overall CPUE for draggers, expressed as lbs./foot drag width/ hour towed, has remained fairly constant during 7 seasons.

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 5, 6, and 7. Figure 5 shows that 4.3% of the landed catch in weight, which was 6.7% by number, are undersized (less than 2 inches or 51 mm in diameter). During the 1999-2000 season, 2.9% by weight or 5.2% by number were undersized. This suggests that a change in the allowable tolerance for undersized urchins from 10% to 5% (by number) that was enacted before the 2000-2001 season did not have the desired result of reducing the number of small urchins being caught. A maximum legal size of 3½ inches, also with a 5% tolerance, was enacted for the 2000-2001 season. We measured 2 urchins greater than 3½ inches (88mm) from the commercial catch in 2000-2001, compared with 6 in 1999-2000.

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 lbs. 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. Table 5 shows that landings peaked in 1993 at 42 million lbs. 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, and shortened seasons. Continued increases in the price have allowed the fishery to continue to maintain a value of about $20 million annually. Figure 8 illustrates the shift of the fishery from Zone 1 to Zone 2 over the years.

Season

The sea urchin harvesting season was 365 days long between 1987-1992 (Table 6). Beginning in 1993, the season length was gradually reduced to the 2000-2001 season of 110 days. The selection of these 110 days is the joint responsibility of the Department of Marine Resources and the members of the Sea Urchin Zone Council (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 2000-2001 season are shown in Table 7A and 7B.

Regulations and Statutes

Management of the sea urchin resource was initiated in 1992 and new regulations and statutes (laws) have been added on an annual basis since that time (Table 8).

Sea Urchin Mortalities

Sea urchin mortalities were reported from at least 24 locations along the Maine coast since the urchin-harvesting season opened in Zone 1 on Sept. 1, 1999. Locations reported by harvesters are shown in Table 9. For the most part, the die-offs were limited to Knox and western Hancock counties. Further mortalities have been reported during the early part of the 2000-2001 season, primarily in the Hancock county area from the Bar Harbor Shore to Corea.

Anecdotal information reveals that, for the most part, the mortality was confined to the band of productive, legal-sized urchins located in the shallow kelp-feeding zone. Smaller urchins in shallow water and unproductive urchins in deep water appeared to be unaffected. In some areas, divers reported that blue mussels and crabs were also affected. Industry representatives expressed a wide range of concerns. Some viewed it as a natural mortality of little significance. Others expressed extreme concern about the high mortality of productive urchins located around offshore islands and stated that harvesters were reluctant to inform DMR because they believed DMR would close the fishery if they knew the extent of the problem.

We speculate that, during 1999-2000 season, the urchins were severely stressed by longer than normal exposure to high water temperature or exposure to oxygen-depleted water

resulting from a die-off of a common marine phytoplankton, which was highly concentrated and distributed over a substantial portion of the coast. This concentration, which turned the water reddish to brownish, occurred early in Sept. and many urchins died during Sept. and Oct.. Some mortality was reported in the Schoodic Pt. Area as late as mid Nov. 1999. Apparently, large numbers of crabs (species not identified) attacked the urchins in their weakened condition and consumed their soft mouth parts leading many divers to believe that crabs were responsible for the mortality. The bacteria, **Vibrio,** was also associated with the mortality but it may have occurred as a secondary infection. We are uncertain about the presence or absence of **Paramoeba,** an organism that has been known to cause mass urchin mortalities along the coast of Nova Scotia and is also associated with higher than normal water temperatures. Although negative results were reported for samples analyzed for **Paramoeba**, we now know that the organism can shrivel up and disappear from the urchin once the water temperature drops below 12 degrees C (54 degrees F). In the future, the presence or absence of **Paramoeba** can only be confirmed through rapid analysis at the time of infection.

Urchin Dealer-Processor Logbook Program 2000-2001

All sea urchin buyers and processors who buy urchins from harvesters in Maine are required to maintain and submit logbooks in accordance with Title 12 – Chapter 623 §6759-S and DMR regulation Chapter 26.10. Failure to maintain a logbook is a Class D crime. Logbook data are protected by the confidentiality provisions of Chapter 607 §6173.

We recorded the status of 37 buyers and 18 processors during the 2000-2001 season. About 17 of these were not buying urchins directly from harvesters in Maine: they were either buying in Canada, not buying at all, just trucking, or buying solely from other buyers. The remaining 38 dealers, who buy directly from harvesters, sent in a total of 206 monthly logbooks describing 21,990 lots of urchins purchased. Each description includes date, transaction location, harvester license no., harvest method, pounds purchased, % roe (and test method) and price per lb. for each lot.

Data from logbooks were entered, checked, and summarized to make many calculations and analyses of importance in sea urchin fishery management including:

- Landings in pounds and value in dollars per month by county and harvest method.
- Urchin roe content by month, location (zone) and harvest method.
- Daily price fluctuations.
- Numbers of harvester-fishing days, and number of active harvesters.
- Average harvester catch size.

Sea Urchin Fishery-Independent Survey

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 first year of the survey provides a baseline of data with which future years can be compared. 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 (Figure 9). 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. 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.

Results

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 1), for each of the nine regions, and plotted in figures 10-11. These data provide a baseline with which future survey results can be compared, and will also provide abundance indices for our modeling efforts. 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) were almost entirely below the legal minimum size.

More analyses will be conducted to estimate total biomass, evaluate algal cover, and evaluate the efficiency of the survey design. Preliminary simulations show that in the future we will be able to reduce the number of quadrats at each site from 90 to 60 without significantly increasing the variability of the results.

Table 1. Maine Sea Urchin Diver Catch/Effort Summary for 2000-2001

Catch Location		Age (Yrs)	Exper (Yrs)	Depth Ft(Min)	Depth Ft(Max)	Depth M(Min)	Depth M(Max)	Weather *Code	Catch (per Diver-Day) Pounds	Price/Lb	Value($)	Net Roe %	Effort (per Diver-Day) BottmHrs	AwayHrs	Catch/Effort Statistics Lbs/AwayHr	$/AwayHr	Lbs/BotmHr	$/BotmHr
York	Mean	40.2	9.0	10.0	44.4	3.0	13.5	2.0	805.6	1.27	1,039.27	14.7	3.5	6.9	84.8	108.78	172.1	222.53
County	Std Dev	9.18	2.18	4.33	4.64	1.32	1.41	0.00	164.46	0.14	317.72	1.80	1.05	1.86	39.53	57.52	91.61	136.59
	Std Err	3.06	0.73	1.44	1.55	0.44	0.47	0.00	54.82	0.05	105.91	0.60	0.35	0.62	13.18	19.17	30.54	45.53
	N	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Cumberland	Mean	39.2	12.8	31.6	55.4	9.6	16.9	2.4	500.0	1.4	641.51	16.2	1.9	5.5	94.8	121.71	250.3	328.50
County	Std Dev	3.11	4.82	26.32	28.39	8.02	8.65	0.55	245.63	0.34	259.12	5.27	0.55	1.84	56.18	58.94	105.41	94.25
	Std Err	1.39	2.15	11.77	12.69	3.59	3.87	0.24	109.85	0.15	115.88	2.36	0.24	0.82	25.13	26.36	47.14	42.15
	N	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Sagadahoc	Mean	34.9	8.4	7.3	26.7	2.2	8.1	2.3	506.8	1.14	587.52	12.9	3.3	6.1	83.9	96.40	152.1	174.57
- Lincoln	Std Dev	6.90	3.30	5.75	12.34	1.75	3.76	0.79	259.22	0.29	377.71	2.63	1.08	1.73	39.19	55.98	59.92	90.39
	Std Err	1.08	0.52	0.90	1.93	0.27	0.59	0.12	40.48	0.05	58.99	0.41	0.17	0.27	6.12	8.74	9.36	14.12
	N	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Knox-Waldo	Mean	36.4	9.3	9.5	23.9	2.9	7.3	2.2	583.3	1.42	815.31	13.6	3.5	7.0	85.6	119.78	181.9	253.45
Counties	Std Dev	5.96	2.65	8.27	9.40	2.52	2.87	0.75	276.44	0.33	398.17	2.07	1.12	1.87	42.45	64.87	118.80	174.33
	Std Err	0.60	0.27	0.83	0.94	0.25	0.29	0.07	26.60	0.03	38.31	0.20	0.11	0.18	4.08	6.24	11.43	16.77
	N	99	99	99	99	99	99	99	108	108	108	108	108	108	108	108	108	108
Hancock	Mean	38.3	10.0	10.9	25.8	3.3	7.9	1.8	525.5	1.30	692.95	13.4	3.4	7.0	75.8	97.14	152.1	197.32
County	Std Dev	5.92	3.40	6.65	9.66	2.03	2.94	0.80	237.86	0.44	433.87	2.55	0.96	1.50	32.88	50.48	57.55	100.74
	Std Err	0.65	0.37	0.73	1.05	0.22	0.32	0.09	25.95	0.05	47.34	0.28	0.10	0.16	3.59	5.51	6.28	10.99
	N	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
Washington	Mean	34.4	8.6	7.6	26.8	2.3	8.2	2.5	705.2	1.10	755.18	12.1	3.6	6.1	114.2	120.66	202.3	211.63
County	Std Dev	7.38	2.43	6.95	11.05	2.12	3.37	0.73	294.52	0.23	335.36	2.03	1.03	2.21	39.70	46.20	78.19	78.22
	Std Err	1.54	0.51	1.45	2.30	0.44	0.70	0.15	57.76	0.05	67.07	0.41	0.21	0.45	8.28	9.85	16.30	16.68
	N	23	23	23	23	23	23	23	26	25	25	25	23	24	23	22	23	22
All	Mean	36.7	9.4	9.8	27.0	3.0	8.2	2.1	571.4	1.30	741.88	13.4	3.5	6.9	84.8	108.78	172.1	222.53
Combined	Std Dev	6.42	3.07	8.36	12.21	2.55	3.72	0.79	267.99	0.37	406.05	2.44	1.05	1.86	39.53	57.52	91.61	136.59
	Std Err	0.39	0.19	0.51	0.74	0.15	0.23	0.05	16.22	0.02	24.62	0.15	0.06	0.11	2.41	3.51	5.58	8.33
	N	272	272	272	272	272	272	272	273	272	272	272	270	271	270	269	270	269

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

Table 2. Maine Sea Urchin Dragger Catch/Effort Summary for 2000-2001

Catch Location		Boat (Ft)	No. of Crew	Depth Ft(Min)	Depth Ft(Max)	Depth M(Min)	Depth M(Max)	Weather *Code	Catch (per Dragger-Day) Pounds	Price/Lb	Value($)	Net Roe %
Knox-Waldo Counties	Mean	36.3	2.0	14.8	24.3	4.5	4.9	1.7	295.7	1.43	418.83	13.0
	Std Dev	2.88	0.00	4.31	7.59	1.31	4.22	0.82	159.36	0.27	222.52	0.63
	Std Err	1.17	0.00	1.76	3.79	0.54	1.72	0.33	65.06	0.11	90.84	0.26
	N	6	6	6	4	6	6	6	6	6	6	6
Hancock County	Mean	34.1	2.1	13.1	35.8	4.0	9.5	2.1	652.6	0.95	601.04	10.7
	Std Dev	5.91	0.59	7.53	14.50	2.30	5.61	0.52	336.56	0.57	505.89	1.62
	Std Err	1.53	0.15	1.94	4.02	0.59	1.45	0.13	86.90	0.15	130.62	0.42
	N	15	15	15	13	15	15	15	15	15	15	15
Washington County	Mean	35.4	2.3	22.4	57.7	6.8	17.6	2.4	586.8	1.16	627.47	13.8
	Std Dev	4.91	0.48	22.63	31.36	6.90	9.56	0.69	318.21	0.45	352.70	4.29
	Std Err	0.73	0.07	3.37	4.67	1.03	1.42	0.10	47.44	0.07	52.58	0.64
	N	45	45	45	45	45	45	45	45	45	45	45
All Combined	Mean	35.2	2.2	19.6	51.0	6.0	14.6	2.3	575.3	1.13	602.49	13.0
	Std Dev	4.99	0.50	19.43	29.71	5.92	9.53	0.70	321.84	0.48	382.99	3.83
	Std Err	0.61	0.06	2.39	3.77	0.73	1.17	0.09	39.62	0.06	47.14	0.47
	N	66	66	66	62	66	66	66	66	66	66	66

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

Catch Location		Effort (per Dragger-Day) Width(ft)	Width(M)	Away Hrs	Fish Hrs	Mins/Tow	Tows/Hr	Total Tows	Tow Hrs	Man-Hrs	Ft-TowHrs	Catch/Effort Statistics Lbs/TowHr	Kg/TowHr	Lb/ManHr	Lb/Ft-TowHr	Kg/M-TowHr	$/TowHr	$/ManHr	$/Ft-TowHr	$/M-TowHr
Knox-Waldo Counties	Mean	5.3	1.6	7.1	5.9	7.2	4.2	25.0	2.8	14.3	14.9	102.7	46.6	20.3	19.2	28.6	147.07	28.52	27.67	90.78
	Std Dev	0.26	0.08	0.85	1.14	3.13	0.75	7.94	1.27	1.70	6.50	23.11	10.48	10.37	3.93	5.85	38.98	13.31	7.42	24.33
	Std Err	0.11	0.03	0.35	0.46	1.28	0.31	3.24	0.52	0.69	2.66	9.44	4.28	4.23	1.60	2.39	15.91	5.44	3.03	9.93
	N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Hancock County	Mean	5.2	1.6	7.2	5.3	8.5	5.7	28.1	3.7	15.1	19.5	182.1	82.6	43.4	35.2	52.3	180.10	37.91	34.81	114.20
	Std Dev	0.41	0.13	1.52	1.42	2.56	4.03	13.57	1.31	5.97	7.38	87.52	39.70	16.60	17.31	25.76	170.37	22.15	34.03	111.64
	Std Err	0.11	0.03	0.39	0.37	0.66	1.04	3.50	0.34	1.54	1.91	22.60	10.25	4.29	4.47	6.65	43.99	5.72	8.79	28.82
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Washington County	Mean	5.3	1.6	6.7	5.4	7.3	7.2	39.3	4.0	15.8	21.1	180.3	81.8	39.2	34.5	51.4	184.31	40.12	35.04	114.96
	Std Dev	0.71	0.22	1.50	1.49	3.98	3.24	22.97	1.89	5.44	10.52	132.48	60.09	22.66	25.90	38.55	128.60	19.60	23.97	78.65
	Std Err	0.11	0.03	0.22	0.22	0.59	0.48	3.42	0.28	0.81	1.57	19.75	8.96	3.38	3.86	5.75	19.17	2.92	3.57	11.72
	N	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
All Combined	Mean	5.3	1.6	6.9	5.4	7.5	6.6	35.5	3.8	15.5	20.2	173.7	78.8	38.4	33.3	49.5	179.97	38.56	34.31	112.59
	Std Dev	0.62	0.19	1.45	1.44	3.63	3.41	20.84	1.74	5.31	9.65	118.67	53.83	21.25	23.24	34.58	132.95	19.76	25.44	83.46
	Std Err	0.08	0.02	0.18	0.18	0.45	0.42	2.57	0.21	0.65	1.19	14.61	6.63	2.62	2.86	4.26	16.37	2.43	3.13	10.27
	N	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66

Table 3. Summary of Selected Diver and Dragger Interview Data, 1994/1995 - 2000/2001 Maine Sea Urchin Seasons

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

Table 4. Maine Sea Urchin Catch/Effort Summary, 1994/1995 - 2000/2001 Seasons

Diver Lbs per Bottom Hour

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

Dragger Lbs per Foot Width - Tow Hour

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

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

Year	Pounds	Value $	Price/Lb
1987	1,440,161	236,391	0.16
1988	6,221,604	1,758,805	0.28
1989	9,657,058	3,698,118	0.38
1990	13,458,662	6,045,618	0.45
1991	20,535,411	11,158,425	0.54
1992	26,739,442	15,322,447	0.57
1993	42,141,138	27,103,054	0.64
1994	38,295,612	33,081,336	0.86
1995	34,690,310	36,154,579	1.04
1996	25,839,600	28,983,365	1.12
1997	19,380,256	21,103,986	1.09
1998	16,226,826	18,466,554	1.14
1999	15,278,725	19,780,181	1.29
2000	12,767,942	17,689,186	1.39
*2001	9,894,312	12,685,991	1.28

* Preliminary

Season	Diver Lbs	Dragger Lbs	Raker Lbs	Unknown	Total Lbs
1996-97	18,448,266	3,987,435	30,674	1,388,234	23,854,609
1997-98	13,859,985	3,028,436	28,595	31,684	16,948,700
1998-99	13,365,737	3,228,624	32,766	75,811	16,702,938
1999-00	10,960,385	2,900,783	22,445	171,502	14,055,115
2000-01	9,118,804	2,649,177	17,279	32,700	11,817,960

Table 6

The Annual or Seasonal 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

Table 7A.

2000 - 2001 Maine Sea Urchin Season for Zone 1

Divers, Rakers, and Trappers

X =Closed ☐ =Open

August 2000

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		

September 2000

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 2000

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 2000

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 2000

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 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			

February 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			

March 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

April 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					

Draggers

X =Closed ☐ =Open

August 2000

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		

September 2000

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 2000

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 2000

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

December 2000

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

January 2001

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

February 2001

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

March 2001

S	M	Tu	W	Th	F	S
				1	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 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					

Table 7B.

2000 - 2001 Maine Sea Urchin Season for Zone 2

Early Season for Divers, Draggers, Rakers, Trappers

[X]=Closed [ ]=Open

August 2000						
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		

September 2000						
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 2000						
S	M	Tu	W	Th	F	S
1 X	2	3	4	5	6 X	7 X
8 X	9	10	11	12	13 X	14 X
15 X	16	17	18	19	20 X	21 X
22 X	23	24	25	26	27	28 X
29 X	30	31				

November 2000						
S	M	Tu	W	Th	F	S
			1	2	3	4 X
5 X	6	7	8	9	10	11 X
12 X	13	14	15	16	17	18 X
19 X	20	21	22	23 X	24 X	25 X
26 X	27	28	29	30		

December 2000						
S	M	Tu	W	Th	F	S
					1	2 X
3 X	4	5	6	7	8	9 X
10 X	11	12	13	14	15	16 X
17 X	18	19	20	21	22	23 X
24 X	25 X	26	27	28	29	30 X
31 X						

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

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

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

April 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					

Late Season for Divers, Draggers, Rakers, Trappers

[X]=Closed [ ]=Open

August 2000						
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		

September 2000						
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 2000						
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 2000						
S	M	Tu	W	Th	F	S
			1	2	3	4 X
5 X	6	7	8	9	10	11 X
12 X	13	14	15	16	17	18 X
19 X	20	21	22	23 X	24 X	25 X
26 X	27	28	29	30		

December 2000						
S	M	Tu	W	Th	F	S
					1	2 X
3 X	4	5	6	7	8	9 X
10 X	11	12	13	14	15	16 X
17 X	18	19	20	21	22	23 X
24 X	25 X	26	27	28	29	30 X
31 X						

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

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

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

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

Table 8.
History of the Management Laws and Regulations
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)

1994

- Nighttime harvesting of urchins prohibited (DMR regulation)
- 10% tolerance on sea urchins less than 2 in. (reg)
- Urchin drag width restricted to 5½ ft. (reg)
- 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

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)
- 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

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

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)

- 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.

- **Table 9**

Locations Where Sea Urchin Die–Offs Were Reported

Sept./Oct. 1999

1.) Isle of Shoals
2.) Cape Neddick (periodic die-offs here)
3.) Mouth of Sheepscot River
4.) Monhegan Island (a major die-off occurred here in 1991-George Parr)
5.) Tenant's Harbor
6.) Big Green Island
7.) Little Green Island (North and East Side)
8.) Matinicus
9.) Wooden Ball Island
10.) Criehaven
11.) Two Bush Reef (Muscle Ridge Channel)
12.) East Penobscot Bay
13.) Stonington Area
14.) Isle au Haut (East and West Side)
15.) Swans Island
16.) Marshall Island
17.) East and West Sister Island (East side of Swans Island)
18.) Northeast Harbor
19.) Southwest Harbor (a small die-off here during the 1998/1999 season)
20.) Bar Harbor Shore
21.) Schoodic Point (die-off still occurring here in mid November 1999)
22.) Winter Harbor
23.) Tommy's Island (Milbridge)
24.) Douglas Island (Milbridge)

Sept./Oct. 2000

1.) Bar Harbor Shore
2.) Winter Harbor
3.) Corea

Sept./Oct. 2001

1.) Eastern Vinalhaven

Table 10. Maine Sea Urchin Licenses (issued annually)

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

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

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

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

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

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

1995	Zone 1	Zone 2	Totals
Divers	611	580	1,191
Draggers	237	404	641
Rakers/Trappers	3	5	8
Tenders			736
Buyers			96
Processors			18
Harvester Totals	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 Totals	2,725	2,004	1,075

Table 11. Number of urchins, and average urchins per quadrat, by region and depth, Maine Sea Urchin Survey, 2001

Region Name	Region Number	Depth Stratum	Total Urchins	Average Urchins	No. of Quadrats
Kittery to Phippsburg	1	1 (1-16ft)	139	0.28	515
	1	2 (16-33ft)	82	0.15	540
	1	3 (33-49ft)	60	0.13	471
	1	4 (49-140ft)	0	0.00	180
Phippsburg - Boothbay -	2	1	671	1.33	504
- Bristol - Bremen	2	2	2,013	4.08	493
	2	3	1,433	3.32	431
	2	4	0	0.00	150
Friendship - Port Clyde -	3	1	2,516	5.25	480
- Tenants - Rockland	3	2	1,485	3.09	480
(Zone boundary)	3	3	1,054	2.30	460
	3	4	0	0.00	160
Isleboro - Vinalhaven -	4	1	4,315	9.38	460
- Stonington	4	2	1,215	2.70	450
	4	3	726	1.73	420
	4	4	0	0.00	160
Blue Hill - Swans Is -	5	1	2,994	6.24	480
- Mount Desert Is	5	2	1,957	4.08	480
	5	3	1,739	3.78	460
	5	4	3	0.02	160
Frenchman Bay - Winter	6	1	4,763	9.92	480
Harbor - Corea - Steuben	6	2	5,737	11.95	480
	6	3	4,869	11.88	410
	6	4	21	0.13	160
Milbridge - Addison -	7	1	2,855	5.97	478
- Jonesport	7	2	4,289	9.13	470
	7	3	4,694	12.04	390
	7	4	3	0.02	160
Roque Is - Machiasport -	8	1	3,509	7.48	470
- Cutler - W. Quoddy Hd	8	2	8,555	17.82	480
	8	3	9,065	19.71	460
	8	4	45	0.28	160
Cobscook Bay	9	1	19,278	40.16	480
	9	2	18,116	37.74	480
	9	3	15,265	36.35	420
	9	4	389	2.43	160
Totals			123,855	7.52	14,072

Figure 1. Maine Sea Urchin Management Zones

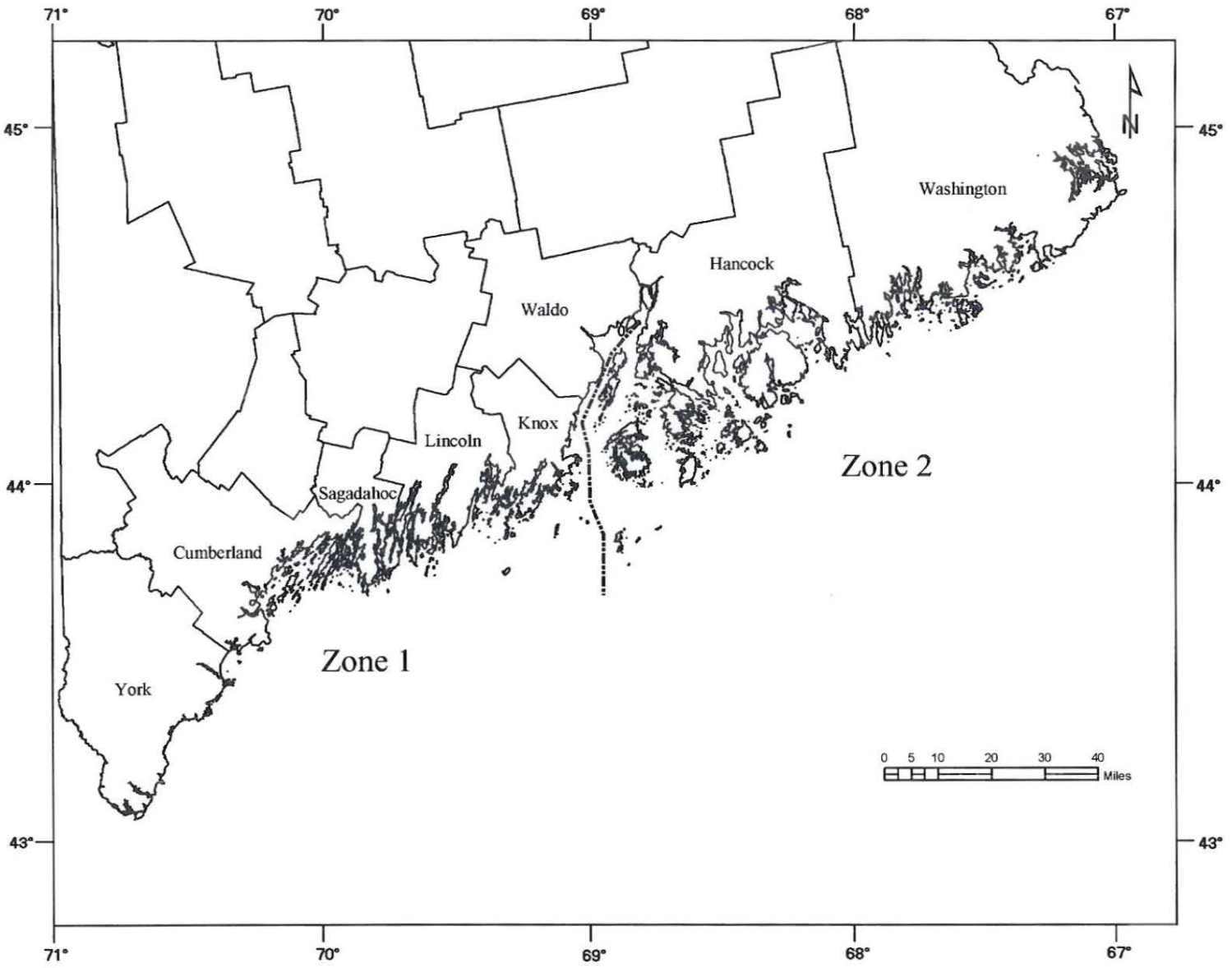


Figure 2.

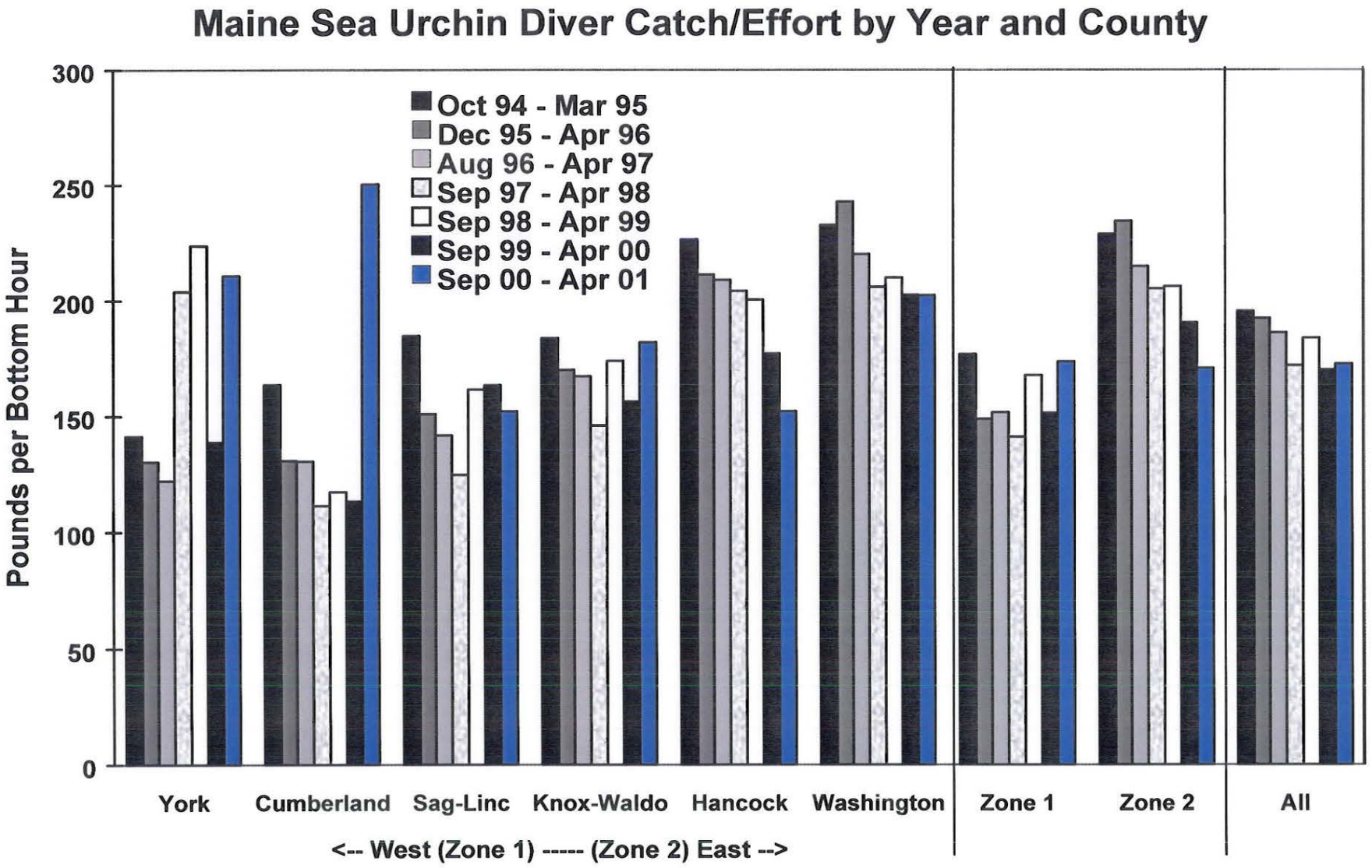

Maine Sea Urchin Diver Catch/Effort by Year and County
Pounds per Bottom Hour
300
250
200
150
100
50
0
Oct 94 - Mar 95
Dec 95 - Apr 96
Aug 96 - Apr 97
Sep 97 - Apr 98
Sep 98 - Apr 99
Sep 99 - Apr 00
Sep 00 - Apr 01
York
Cumberland
Sag-Linc
Knox-Waldo
Hancock
Washington
Zone 1
Zone 2
All
<-- West (Zone 1) ----- (Zone 2) East -->

Figure 3.

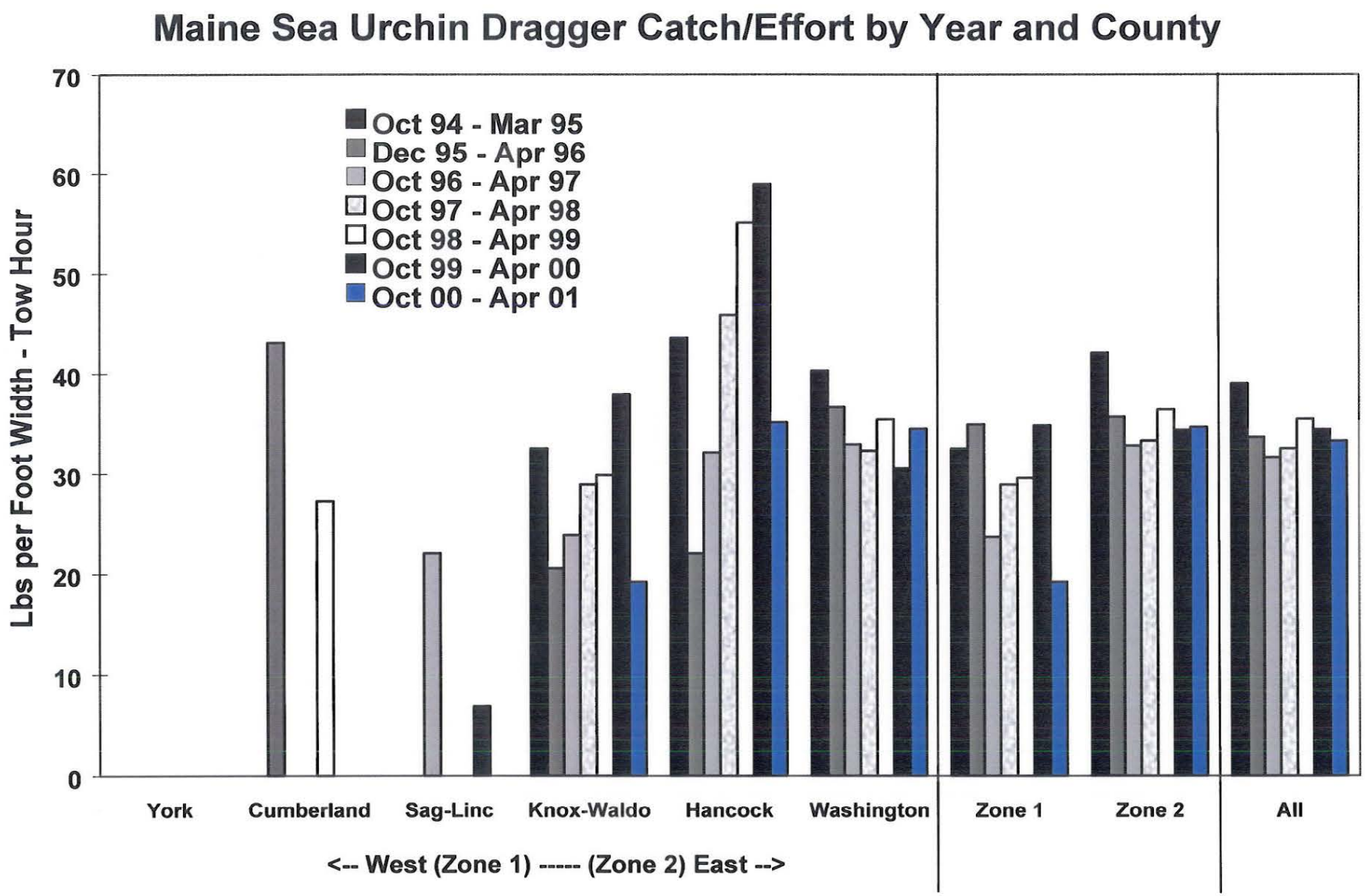

Maine Sea Urchin Dragger Catch/Effort by Year and County
Lbs per Foot Width - Tow Hour
70
60
50
40
30
20
10
0
Oct 94 - Mar 95
Dec 95 - Apr 96
Oct 96 - Apr 97
Oct 97 - Apr 98
Oct 98 - Apr 99
Oct 99 - Apr 00
Oct 00 - Apr 01
York
Cumberland
Sag-Linc
Knox-Waldo
Hancock
Washington
Zone 1
Zone 2
All
<-- West (Zone 1) ----- (Zone 2) East -->

Figure 4.

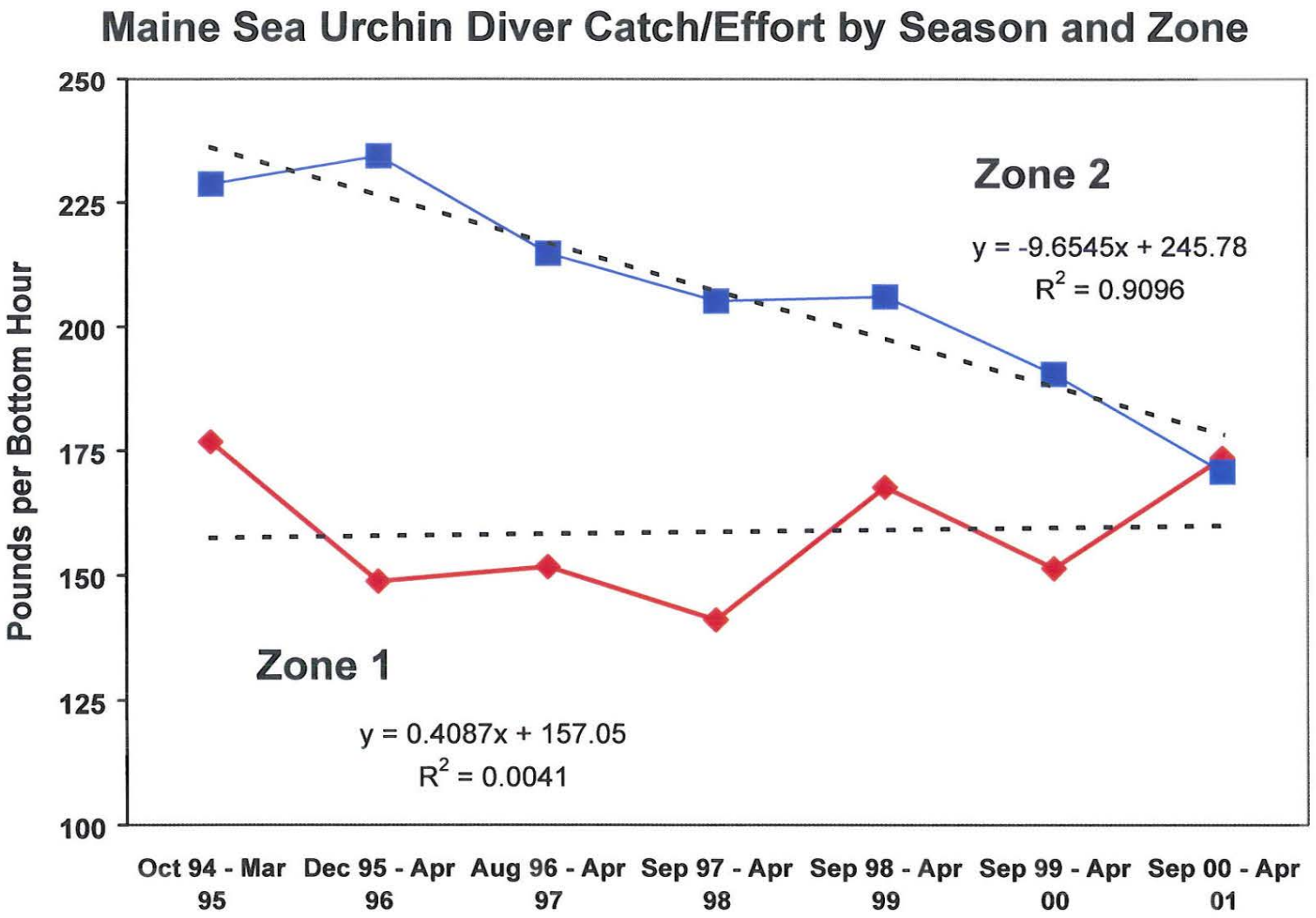

Maine Sea Urchin Diver Catch/Effort by Season and Zone
Pounds per Bottom Hour
250
225
200
175
150
125
100
Zone 2
y = -9.6545x + 245.78
R2 = 0.9096
Zone 1
y = 0.4087x + 157.05
R2 = 0.0041
Oct 94 - Mar 95
Dec 95 - Apr 96
Aug 96 - Apr 97
Sep 97 - Apr 98
Sep 98 - Apr 99
Sep 99 - Apr 00
Sep 00 - Apr 01

Figure 5. Size Frequency by Weight from the Commercial Catch, Zone 1

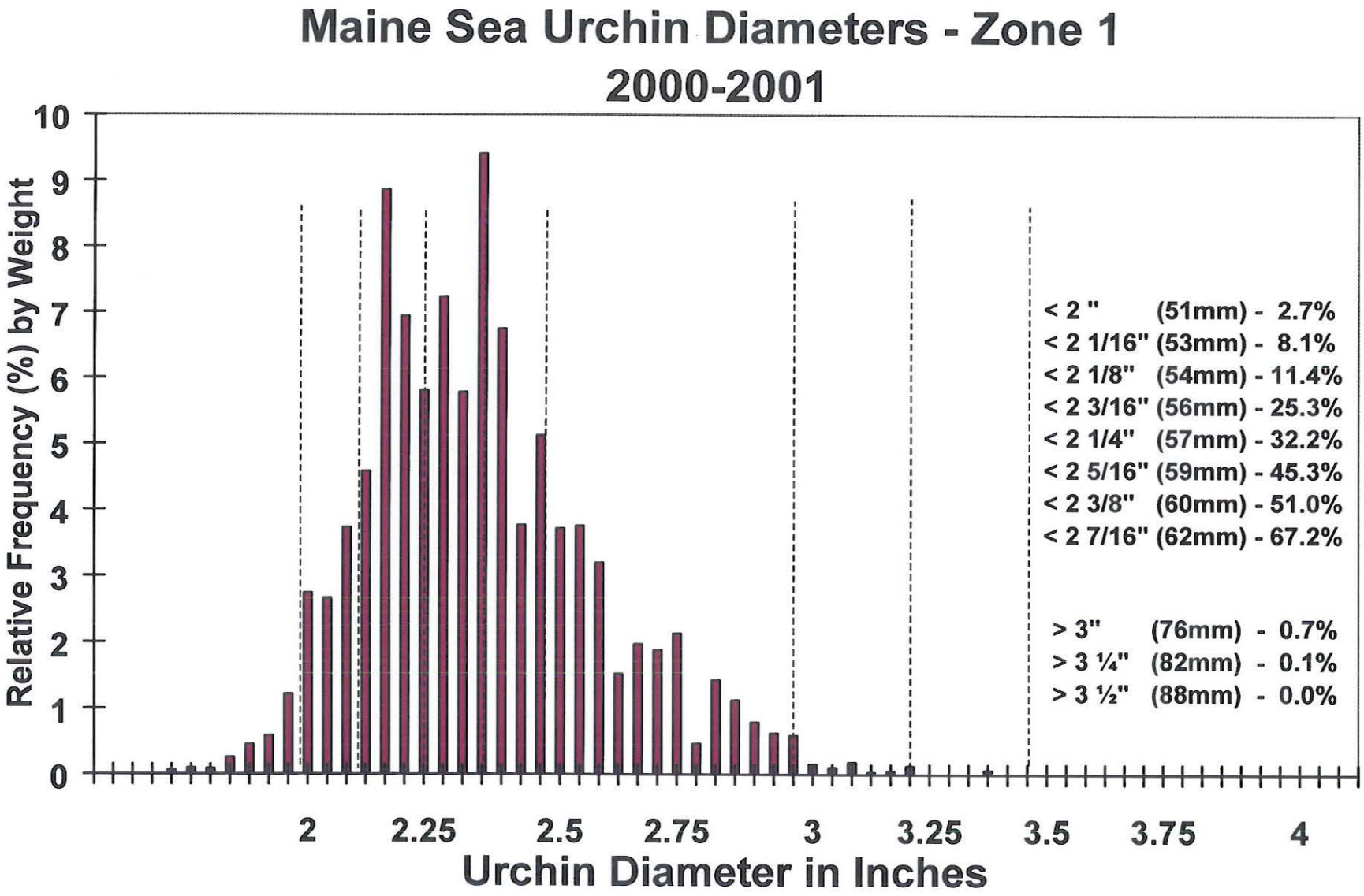


Figure 6. Size Frequency by Weight from the Commercial Catch, Zone 2

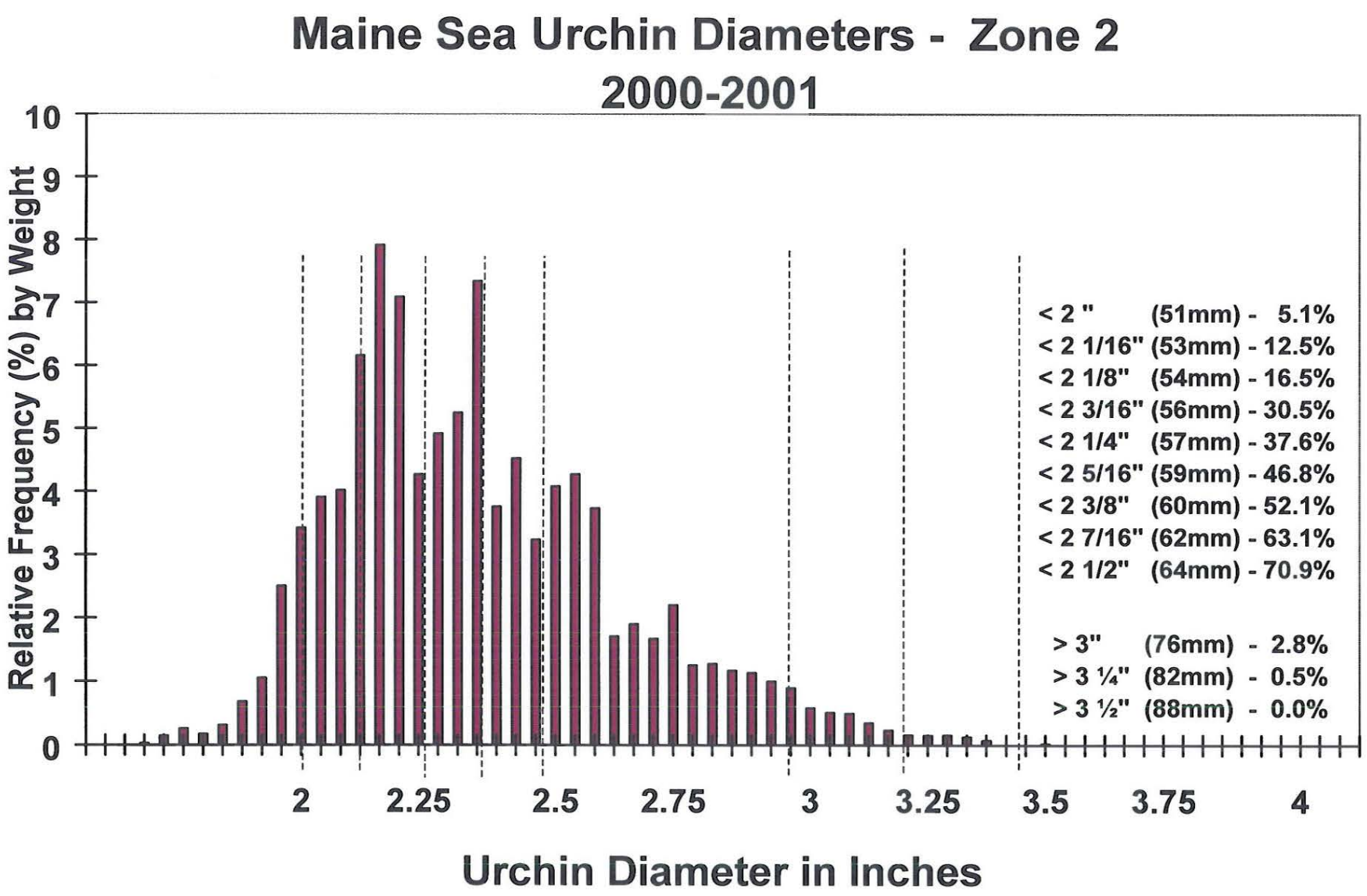


Figure 7. Size Frequency by Weight from the Commercial Catch, Both Zones

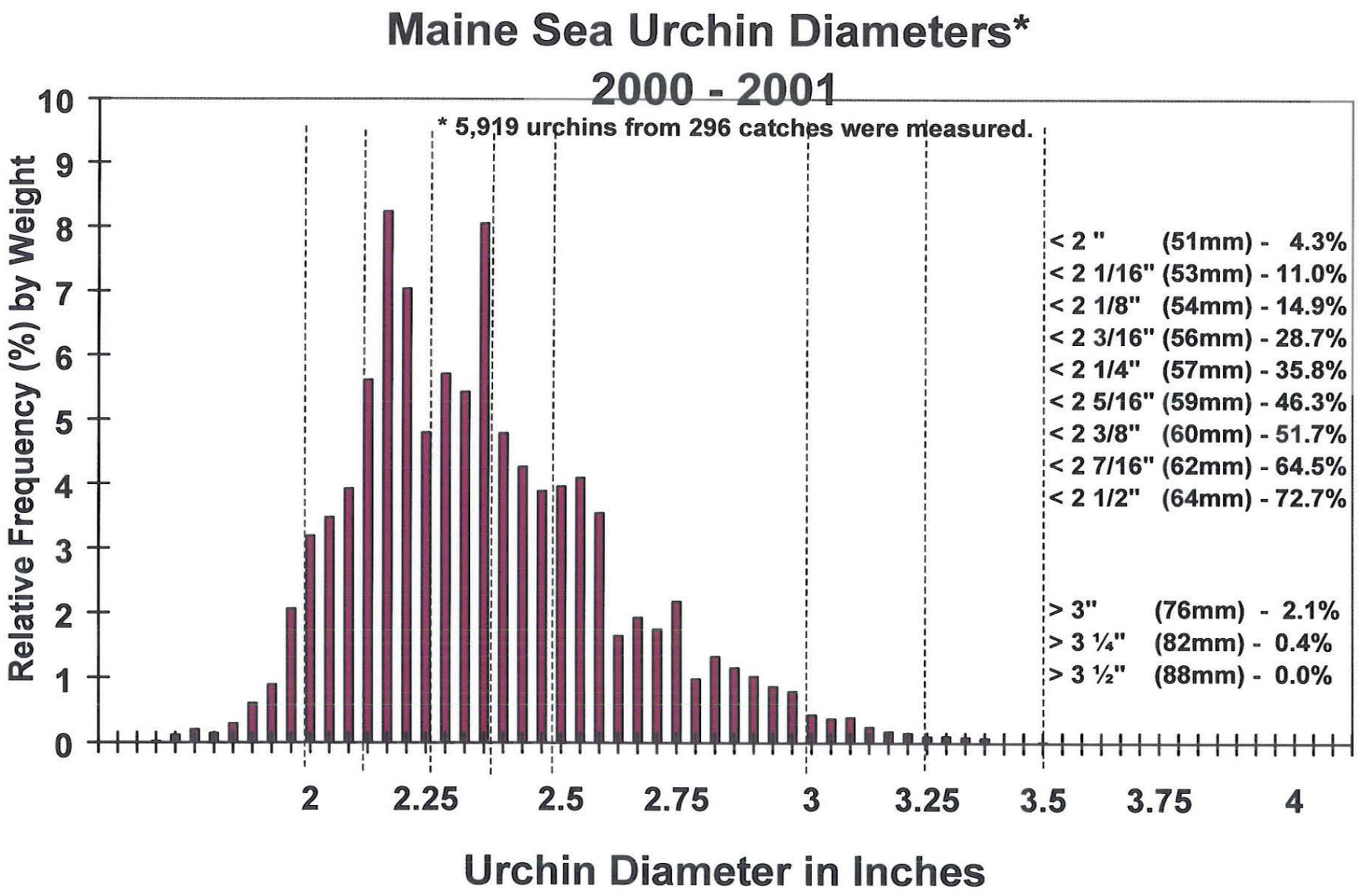


Figure 8.

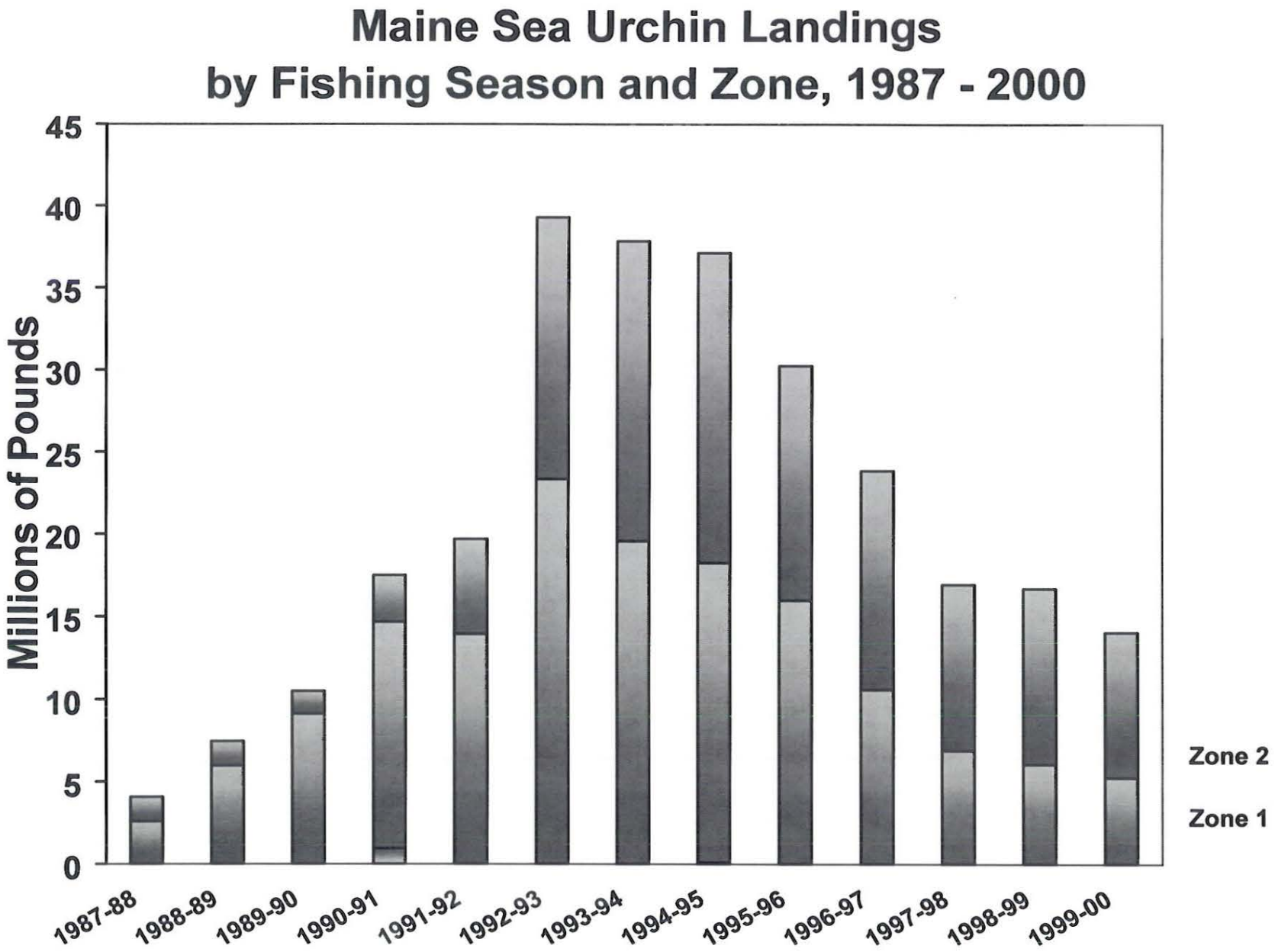

Maine Sea Urchin Landings
by Fishing Season and Zone, 1987 - 2000
Millions of Pounds
45
40
35
30
25
20
15
10
5
0
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
1993-94
1994-95
1995-96
1996-97
1997-98
1998-99
1999-00
Zone 2
Zone 1

Figure 9. Maine Sea Urchin Survey Dive Sites, 2001

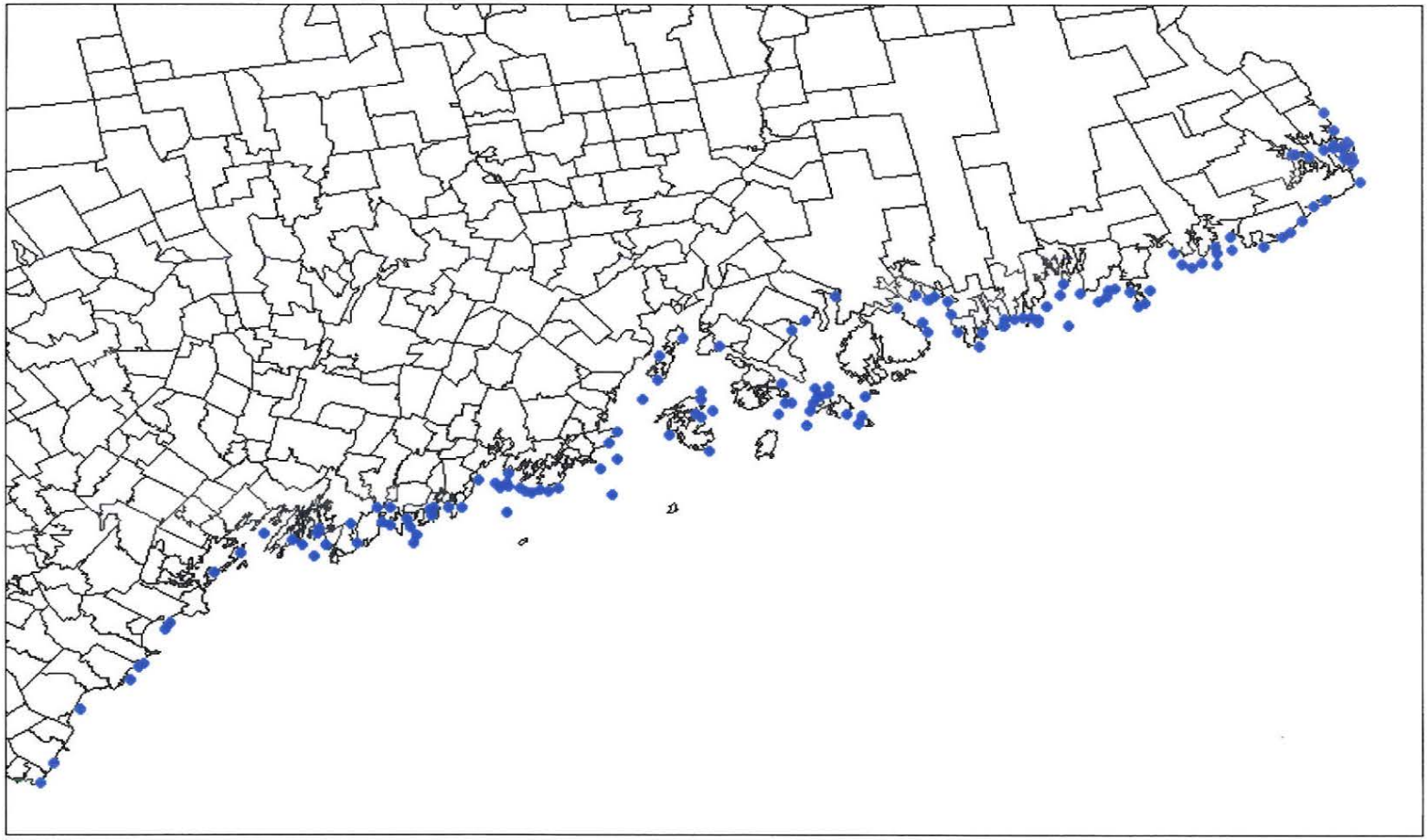


Figure 10. Maine Sea Urchin Survey, 2001

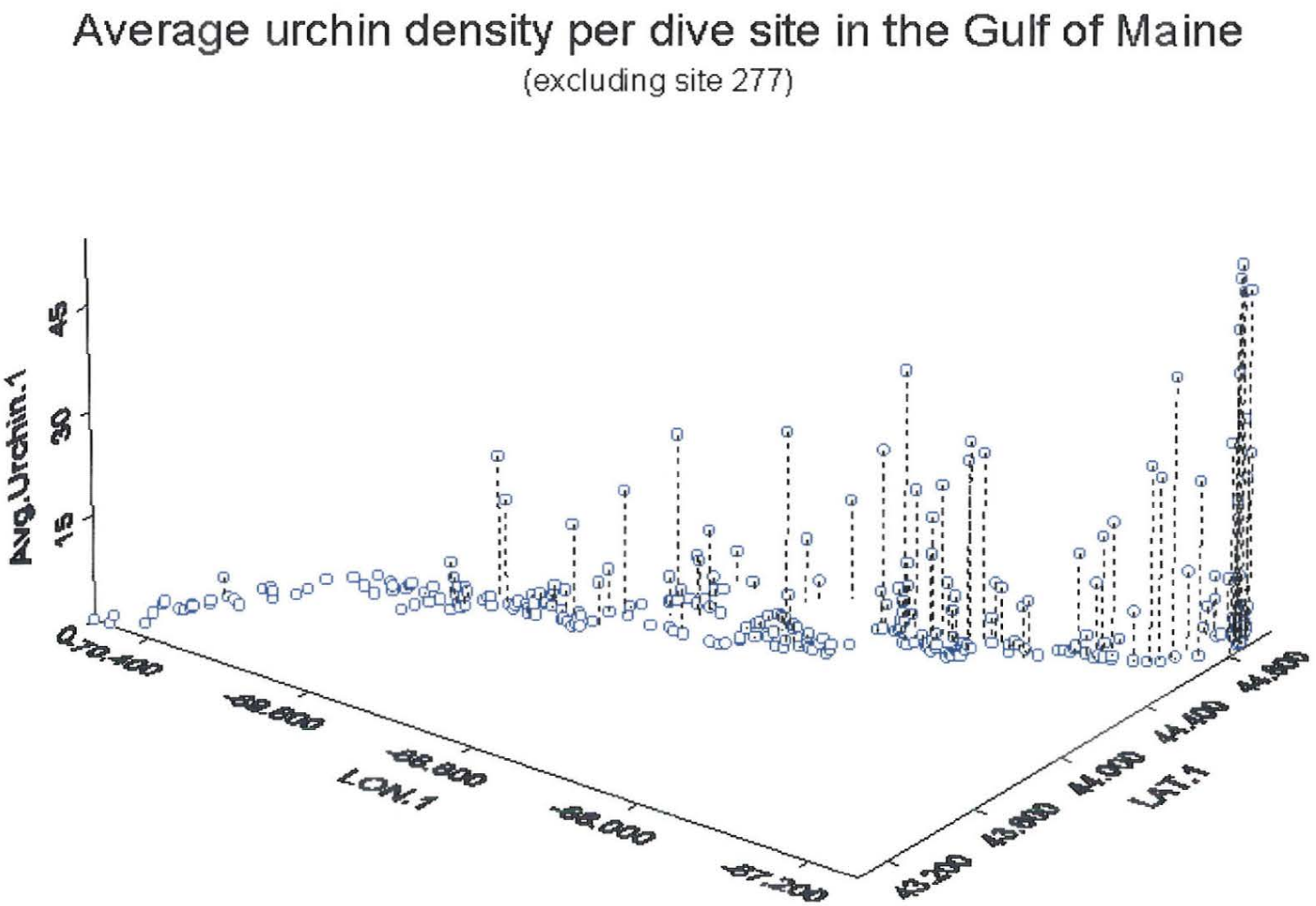
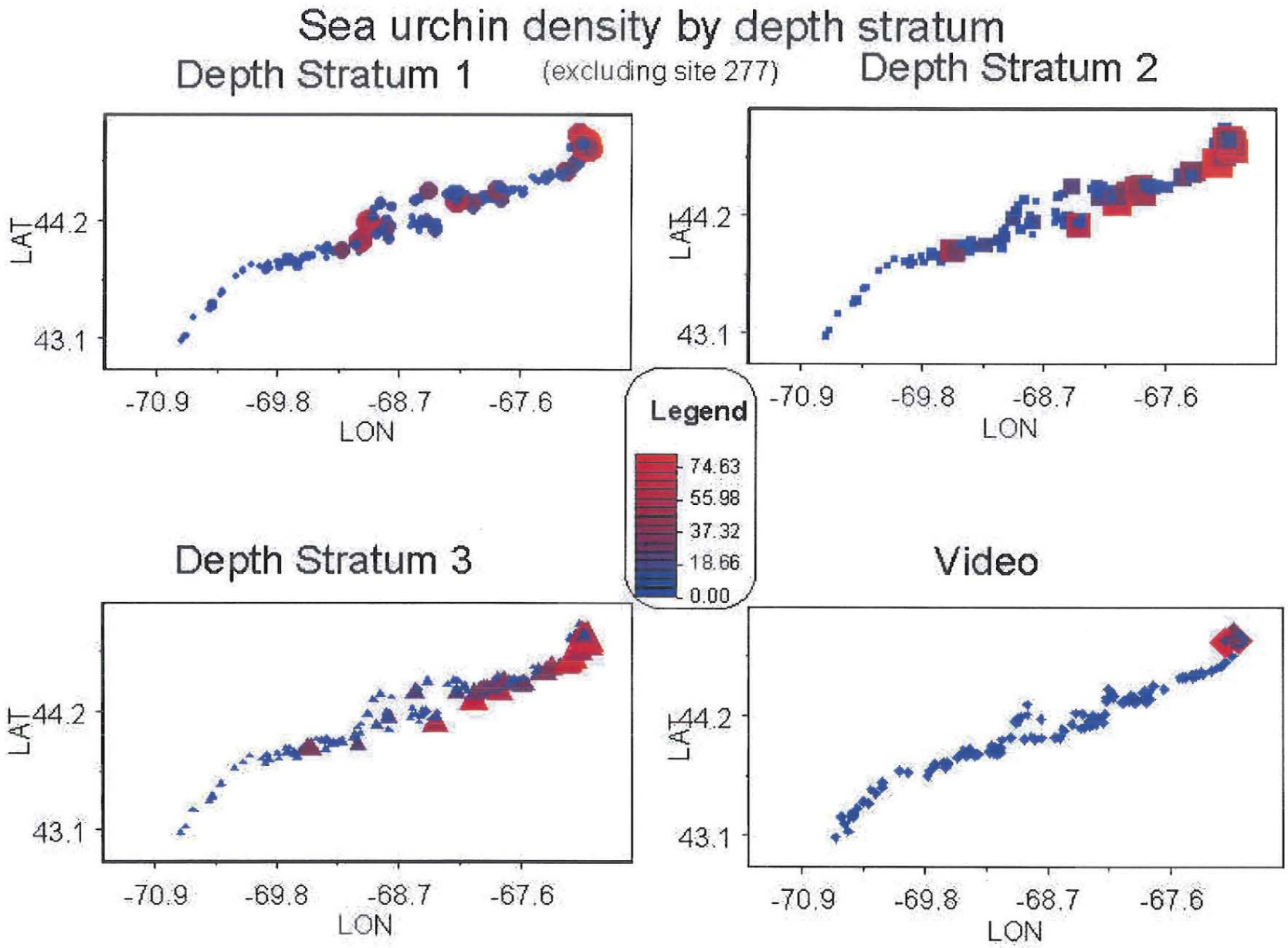


Figure 11. Maine Sea Urchin Survey, 2001



Multispecies (Groundfish) Assessment and Management

We participated in the activities of both the Groundfish Plan Development Team (GPDT) and the Multispecies Monitoring Committee (MSMC) of the New England Fishery Management Council (NEFMC) in 2001. The GPDT was mainly focused on development of Amendment 13 to the Northeast Multispecies Fishery Management Plan, until later in the year when attention shifted to proposed Framework 36.

Amendment 13 is to establish rebuilding programs for all overfished stocks, using the overfishing definitions of Amendment 9. Amendment 7 to the plan (which was implemented in 1996) addressed overfishing for only the five major groundfish stocks off the New England coast. The rebuilding requirements established by the Sustainable Fisheries Act upon which Amendment 13 will be based may necessitate replacement of some target fishing mortalities that were incorporated in Amendment 7. Amendment 13 was still in development at the end of the report period.

A proposed Framework 36 was developed in late 2001. Framework 36 potentially was to include measures such as seasonal closures, trip/possession limits, gear restrictions, effort control, recreational measures and changes to the western GOM year round closure. The purpose of this framework was to reduce fishing mortality (F) on Gulf of Maine (GOM) and Georges Bank (GB) cod stocks, reduce the high amount of discards in the GOM cod fishery and address the pending expiration of the western GOM closed area. GOM cod required a 63% reduction in fishing mortality (F) to achieve the Amendment 7 rebuilding target. Discards have become a significant source of mortality since trip limits have been in effect.

The GPDT did not feel that even the sum effect of the most stringent of the proposed measures would achieve a substantial reduction in F on GOM cod. Ultimately the NEFMC voted to stop development of Framework 36 and proceed with development of Amendment 13 for various reasons. It was the recommendation of the Multispecies Monitoring Committee (MSMC) (on which we also served) that because of the large reduction in F needed for GOM cod (and its associated social, biological and economic implications) that development of Amendment 13 should take precedence over the framework process.

The primary purpose of the MSMC is an annual review of the status of the northeast U.S. groundfish stocks, in particular Georges Bank haddock, Georges Bank and Gulf of Maine cod, and Georges Bank and southern New England yellowtail flounder. The MSMC is charged with monitoring the effectiveness of the current management plan established under Amendment 7, and to develop options for framework adjustments in order to meet plan objectives. As well as current resource status, the MSMC is asked for projected status for the remainder of the calendar year, target Total Allowable Catches (TACs) for major stocks, and options for consideration by NEFMC to meet plan objectives.

The MSMC noted that in 2000 Georges Bank haddock and Georges Bank yellowtail flounder stocks had continued to improve. Georges Bank cod, however, which has had poor recruitment, and southern New England yellowtail flounder, which has had low biomass and poor recruitment, are of particular concern to the MSMC. Further reductions in fishing would be necessary to achieve rebuilding targets. GOM cod, as discussed above, still requires a very substantial reduction in F. The MSMC stated this reduction would best be achieved by reductions in overall fishing effort and fleet capacity.

Maine DMR was also represented at planning meetings on groundfish research conducted by the National Marine Fisheries Service (NMFS) and the Manomet Center. These meetings were focused on two areas: a.) cod tagging, and b.) bycatch and discards in the northeastern U.S. groundfisheries. Funding is anticipated for work in these two areas, and input from industry and scientists was solicited in order to develop the overall programs.

Staff also developed a pre-proposal to the Northeast Consortium in 2001 entitled *"Industry Cooperative Survey of a Groundfish Closure Area in the Gulf of Maine"* in collaboration with the industry. We requested funding to monitor occurrence and abundance of groundfish, notably Atlantic cod, in one of the cod "rolling closure" areas in the Gulf of Maine before, during and after the closed period. A two-year study was proposed. Although the pre-proposal was encouraged for full development, the full proposal was not accepted. Subsequently, the industry members involved with this proposal voiced support for reworking the proposal for submission to NMFS. Portions of

the proposal were therefore revised and a new pre-proposal submitted to NMFS for funding consideration. This pre-proposal was not encouraged for development into a full proposal.

A staff scientist also served on the 33rd Stock Assessment Review Committee (SARC) in Woods Hole, MA in June. New assessments of white hake, redfish and Gulf of Maine cod were presented and reviewed by the SARC. Several prominent assessment scientists were present at the SARC/SAW making it particularly rewarding to participate in.