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MONITORING OF THE AMERICAN LOBSTER RESOURCE

AND FISHERY IN NEW HAMPSHIRE

Abstract

The New Hampshire lobster population was monitored in 1994 by two means: SCUBA captured lobster and commercial lobstermen sea sampling.

Sampling for small, sub-legal lobsters was conducted by SCUBA diving on a monthly basis along the New Hampshire coast and in an estuarial river. Three sampling areas were delineated based on environmental differences in marine habitat. These areas consisted of an upper river estuarine, a lower river estuarine and a nearshore coastal. A total of 1571 lobsters were captured, measured, sexed and checked for shell hardness. Individuals captured ranged between 8 and 90 mm carapace length (mmCL) and averaged 51.5 mmCL. Catch-per-unit-effort (CPUE) overall was highest in the lower river area. CPUE and mean carapace length were generally high during the summer/fall months and lower in the winter/spring months. Molting took place from June to October with a peak period observed in October. A total of 11 tagged individuals were recaptured in 1994 with all taken from the original tagging site. Growth ranged from 9.2% - 12.2% for those lobsters which molted between captures.

Sea sampling of adult lobsters was done aboard commercial lobster boats. Sampling areas were the same as in previous years; lower river estuarine, coastal and offshore Isles of Shoals. Over 11,000 lobsters were tallied during the months of June through October in 1994. Legal sized lobsters were sampled from nearly every trawl and sublegal lobsters were sampled from randomly selected trawls to obtain catch characteristics for commercial operations. Data taken on lobsters were the same as for those sampled by SCUBA with the exception that no commercially captured lobsters were tagged and legal lobsters were retained by commercial lobstermen for sale. Lobsters sampled ranged in size from 52 mmCL to 127 mmCL and averaged 77.3 mmCL and 87.7 mmCL for sublegal and legal respectively. An expanded proportional calculation of the total catch average carapace length gave a value of 79 mmCL. Catch-per-unit-effort was highest for the river and lowest for the Isles of Shoals. The smallest mean size lobsters were caught in the river and largest at the Isles of Shoals.

Introduction

Lobsters are the most economically valuable fishery resource in the northeastern United States. Commercial U.S. harvesting occurs from the Canadian border to the mid-Atlantic United States. Important quantities of lobster are landed at ports in each of the coastal states from Maine to North Carolina. A commercial lobster fishery exists along the New Hampshire coast in both state and federal waters with about one and a half million pounds harvested annually. The estimated dollar value for New Hampshire 1993 landings was over 5.5 million dollars.

Management of the northeastern U.S. lobster stock in offshore federal waters is accomplished under a Fishery Management Plan developed by the New England Fishery Management Council. In addition, lobsters from waters out to 3 miles from shore are managed by various state regulations. In order to have effective management plans it is important to determine as much as possible about the stock characteristics of lobsters in New Hampshire coastal waters. Identification of critical habitat and monitoring of population trends is also an important component for making sound management decisions regarding New Hampshire's lobster resource.

The objectives of this study were to:

1. monitor the relative abundance of lobsters in the New Hampshire coastal waters;
2. obtain information on habitat use by lobsters along the New Hampshire coast.
3. monitor catch characteristics in the New Hampshire commercial lobster fishery.

Study Area

The study area encompasses the lower reach of the Great Bay Estuary System located on the Piscataqua River and the coastal area of New Hampshire out to and including the Isles of Shoals (Figure 1). This area is divided into 4 sampling areas based upon overall habitat characteristics:

Area 1 - (upper river) - From just east of Dover Point to the US 1 By-pass bridge. This area is characterized by a deep narrow channel and strong tidal currents (approximately 4 knots).

Area 2 - (lower river) - From the US 1 By-pass bridge downstream to the mouth of the Piscataqua River at Portsmouth Harbor. Tidal currents are strong in the main channel, the river is wider and shallower than in Area 1.

Area 3 - (coastal) - Coastal area from the Maine border south to the Massachusetts border within 3 miles of shore. This area is characterized by moderate tidal and wind driven currents.

Area 4 - (Isles of Shoals) - Shelf area surrounding the Isles of Shoals characterized by shallow water and low velocity currents.

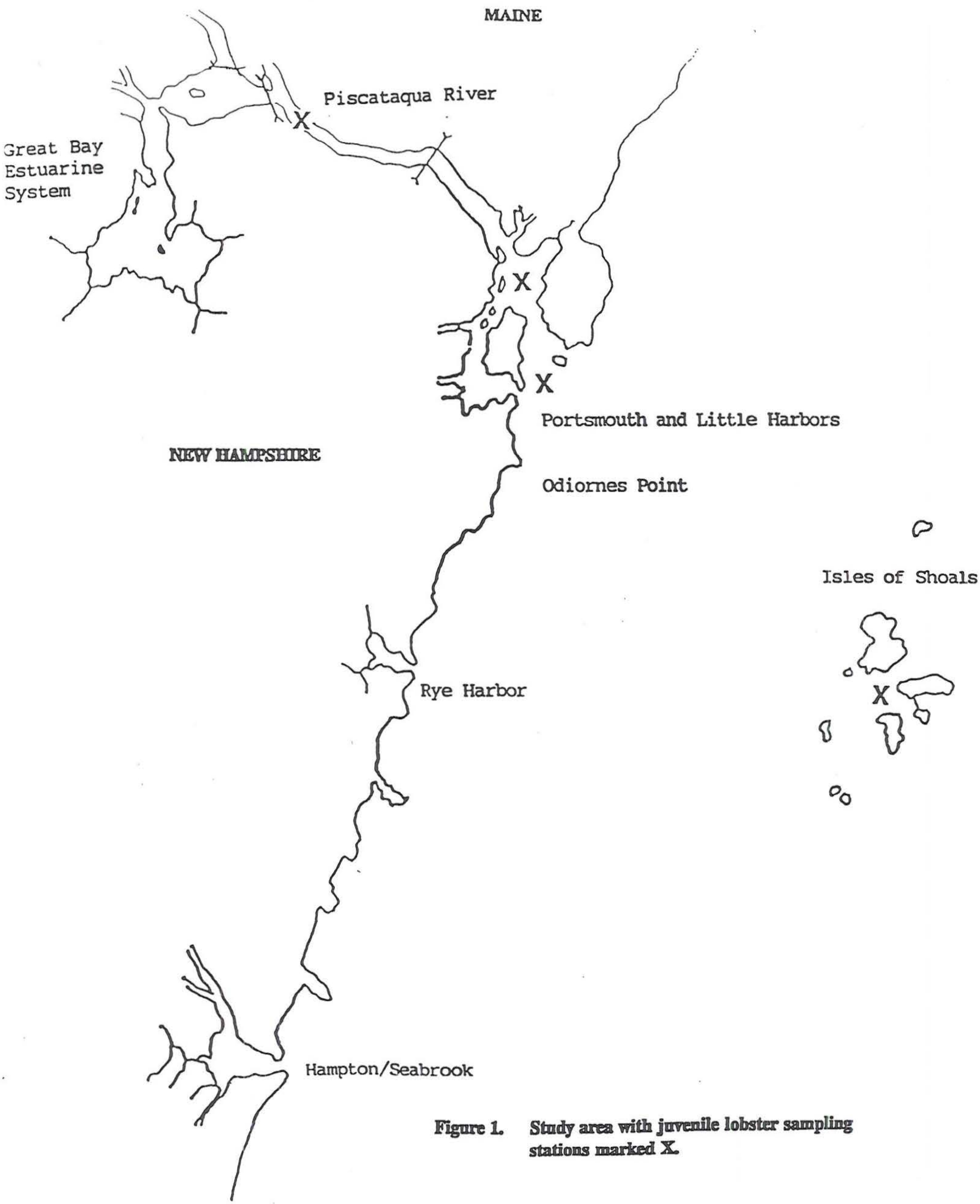


Figure 1. **Study area with juvenile lobster sampling stations marked X.**

Job 1 (SCUBA)

Objective

The objective of Job 1 was to monitor the abundance and habitat selection of sub-legal, juvenile lobsters in New Hampshire.

Methods

Lobster were sampled on a monthly basis from February to December at Area 3, April to December at Area 1 and April to December (except for September) at Area 2 (Figure 1).

A fourth sampling area, the offshore Isles of Shoals, has been sampled in previous years during the warm water months of June through September but it was not sampled in 1994. This was due to a combination of adverse weather conditions, an aging dive boat that is only marginally safe for the eight mile trip out to the sampling station and a temporary staffing shortage. Each sample consisted of two SCUBA divers searching the bottom for lobsters. Lobsters encountered during dives were captured by hand (capture rates were **not** 100%) and were stored in catch bags until the end of the dive. Bottom time was measured for each dive and used as a measure of sampling effort. Since the objective of this portion of the project was to gather information on smaller, sublegal (i.e. juvenile) lobsters, some large lobsters (those that appeared to have carapace lengths greater than about 80 mm) were occasionally passed over in favor of capturing greater numbers of small lobsters. Also because smaller lobsters are generally in burrows under smaller more easily moved rocks this tends to bias the lobster catch size downward.

Following the completion of the dive, the lobsters were briefly held in the water in catch bags until they were processed. All lobsters captured were sexed, measured (mid-dorsal carapace length to the nearest millimeter), noted for shell hardness, tagged and released. Any previously tagged lobsters encountered were processed in a similar manner and the tag number was recorded before their return to the water. Recapture information was used for determination of growth and movement throughout the study area. The date, location, surface temperature, and salinity were also recorded with each dive.

Lobsters were tagged using serially numbered sphyrion tags with a stainless steel hook-shaped anchor that was implanted beneath the dorsal extensor muscle using a hypodermic needle. Lobsters that incurred damage to the carapace or abdomen during the capture, holding, or sample processing period were not tagged; they were recorded as mortalities and released. Other lobsters were measured and sexed but not tagged if they were considered too small to tag (< 26 mmCL) or if they were to be given to the University of New Hampshire for research programs. Each tag contained a phone number for lobstermen to call with capture date and location information. It was anticipated, though, that few tagged juveniles would be encountered by lobstermen due to the size selectivity of commercial traps (i.e. most juvenile lobsters can easily leave a commercial trap through required escape vents).

Differences in lobster size were analyzed using analysis of variance (ANOVA) with sample month, sample area and sex as the categorical variables. An ANOVA was run for all areas and months February to December. In addition multi-year ANOVA were run for two groups; lobster from area 3 and months 2 to 12 and for lobster data from all areas and months 4 to 8 and 10 to 12. Where ANOVA detected significant differences in mean length among categories either length frequency distributions were plotted for the various categories (e.g. sample area) or the mean length was plotted for each category (e.g. sample month mean). This was done to further analyze possible trends. Mean CPUE was plotted for each area by month to analyze trends. The percent of the sample population with softshells was plotted by month for each area to analyze trends in molting frequency and occurrence. Some growth rate estimates were obtained from lobsters that had undergone molts between the time of initial capture and their recapture.

Results

A total of 1,571 lobsters were captured during sampling in 1994. Of these, 1,433 individuals were tagged. Of the 138 that were captured but not tagged 11 were recaptures, 57 were too small to tag, 66 were mortalities and 4 were untagged due to miscellaneous reasons. All captured lobsters were included in the data analysis.

Size composition

The ANOVA for SCUBA-sampled lobsters from sample areas 1, 2, and 3 for months 2 through 12 revealed significant ($P \leq 0.05$) differences for mean lobster size for sample area (= sitecode) and sample month but no significant difference for sex (Table 1). The length frequency plots (Figure 2) for SCUBA-caught lobsters show discernable differences in the distribution patterns of areas (1 - upper river, 2 - lower river, 3 - coastal). The mean carapace length was largest for the lower river area (60.5 mmCL) and smallest for the coastal area (44.9 mmCL). All three areas showed length frequency plots that approximated normal curves. Individual area size ranges are similar, running from about 16 to 88 mmCL.

The ANOVA comparing juvenile lobster data for the 1991 through 1994 field seasons for area 3, months 2-12 (Table 2), revealed significant differences in mean carapace length among the four years. There were also significant differences for sample month. There was no significance for lobster sex however. The ANOVA comparing similar variables but for all areas in months 4-8 and 10-12 (Table 3) showed significance generally in line with the other multi-year comparison. Five years length means (mmCL) for all areas showed 1990 = 55.0, 1991 = 53.7, 1992 = 51.6, 1993 = 50.8 and 1994 = 51.5 (Figures 3A and 3B). The slightly smaller mean in more recent years compared to 1990 and 1991 may be due to the increased skill of the collectors in finding and capturing very small lobsters. This same possibility must be considered too when making comparisons of catch per effort year to year.

The plot of mean carapace length by month (Figure 4) suggests a trend with mean carapace length being smaller during the cold-water months increasing in the spring and peaking in the late summer or early fall. Mean carapace length then decreases through the late fall into early winter. This plot also shows monthly area differences. The Lower River site produced the largest mean size lobster throughout the year. Coastal site lobsters are generally smaller than those from other areas.

Plots of CPUE for the different areas over the various months suggest some general trends (Figure 5). Data for both river areas showed that CPUE was low in winter months, increased through the spring, peaked in warm water months, then dropped off as the water became colder. The coastal area showed an erratic pattern of monthly CPUEs however. The highest catch rate for all areas was in June. Some seemingly anomalous low monthly CPUEs such as July

Table 1. Analysis of variance for juvenile lobster carapace length by sex, area and month for areas 1-3 for the months 2-12 in 1994.

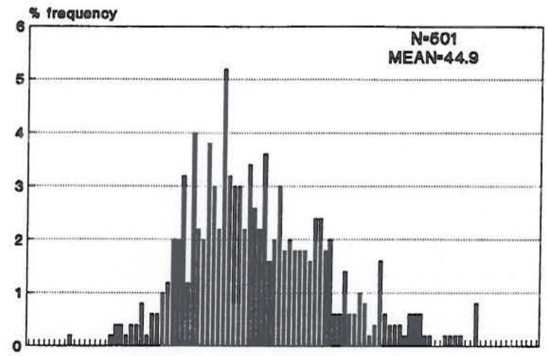
* * * A N A L Y S I S   O F   V A R I A N C E * * *

CARPLEN
BY SEX
SITECODE
MONTH

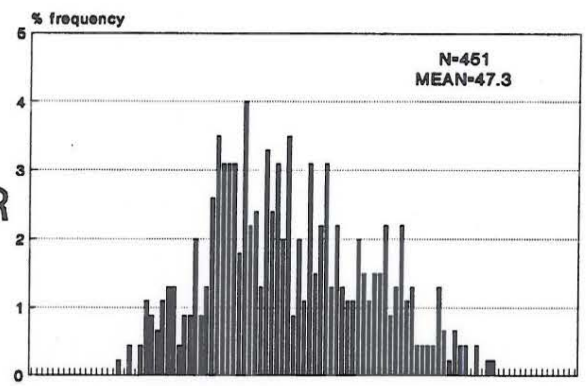
Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	99431.792	13	7648.599	41.661	.000
SEX	420.412	1	420.412	2.290	.130
SITECODE	58621.861	2	29310.930	159.654	.000
MONTH	26117.321	10	2611.732	14.226	.000
Explained	99431.792	13	7648.599	41.661	.000
Residual	285850.939	1557	183.591		
Total	385282.731	1570	245.403		

Figure 2. Length f[illegible]uency distribution of SCUBA-caught lo[illegible]ers in 1994 by area.

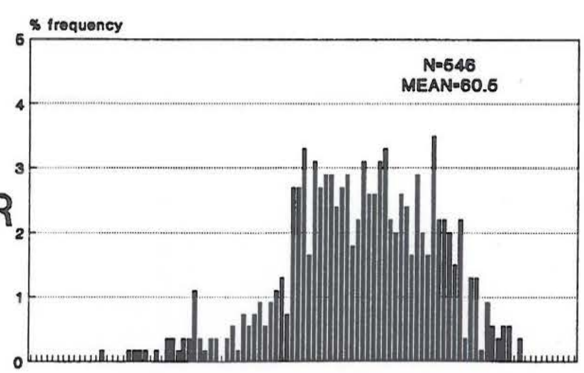
COASTAL



UPPER RIVER



LOWER RIVER



CARAPACE LENGTH (mm)

Table 2. Analysis of variance for juvenile lobster carapace length by sex, for sample years 1991, 1992, 1993 and 1994, months 2-12 in area 3.

* * * A N A L Y S I S   O F   V A R I A N C E * * *

CARPLEN
BY SEX
MONTH
YEAR

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	77476.852	14	5534.061	28.139	.000
SEX	635.485	1	635.485	3.231	.072
MONTH	58561.021	10	5856.102	29.777	.000
YEAR	8435.548	3	2811.849	14.298	.000
2-way Interactions	27805.487	43	646.639	3.288	.000
SEX MONTH	2432.290	10	243.229	1.237	.262
SEX YEAR	382.534	3	127.511	.648	.584
MONTH YEAR	24617.285	30	820.576	4.172	.000
Explained	105282.339	57	1847.059	9.392	.000
Residual	488913.072	2486	196.667		
Total	594195.412	2543	233.659		

2737 Cases were processed.
193 Cases (7.1 PCT) were missing.

Table 3. Analysis of variance for juvenile lobster carapace length by sex, for sample years 1991, 1992, 1993 and 1994, months 4-8 and 10-12 in areas 1-3.

* * * A N A L Y S I S O F V A R I A N C E * * *

CARPLEN
BY SEX
SITE
MONTH
YEAR

Source of Variation		Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects		308981.165	13	23767.782	125.029	.000
SEX		3799.286	1	3799.286	19.986	.000
SITE		210436.957	2	105218.478	553.496	.000
MONTH		64906.136	7	9272.305	48.776	.000
YEAR		10142.006	3	3380.669	17.784	.000
2-way Interactions		45227.977	53	853.358	4.489	.000
SEX	SITE	2807.813	2	1403.906	7.385	.001
SEX	MONTH	1930.964	7	275.852	1.451	.180
SEX	YEAR	768.161	3	256.054	1.347	.257
SITE	MONTH	16063.335	14	1147.381	6.036	.000
SITE	YEAR	3451.356	6	575.226	3.026	.006
MONTH	YEAR	18141.833	21	863.897	4.544	.000
Explained		354209.143	66	5366.805	28.232	.000
Residual		1082037.641	5692	190.098		
Total		1436246.783	5758	249.435		

8503 Cases were processed.
2744 Cases (32.3 PCT) were missing.

Figure 3A. Length frequency distribution for SCUBA-caught lobsters sampled, 1990-1993.

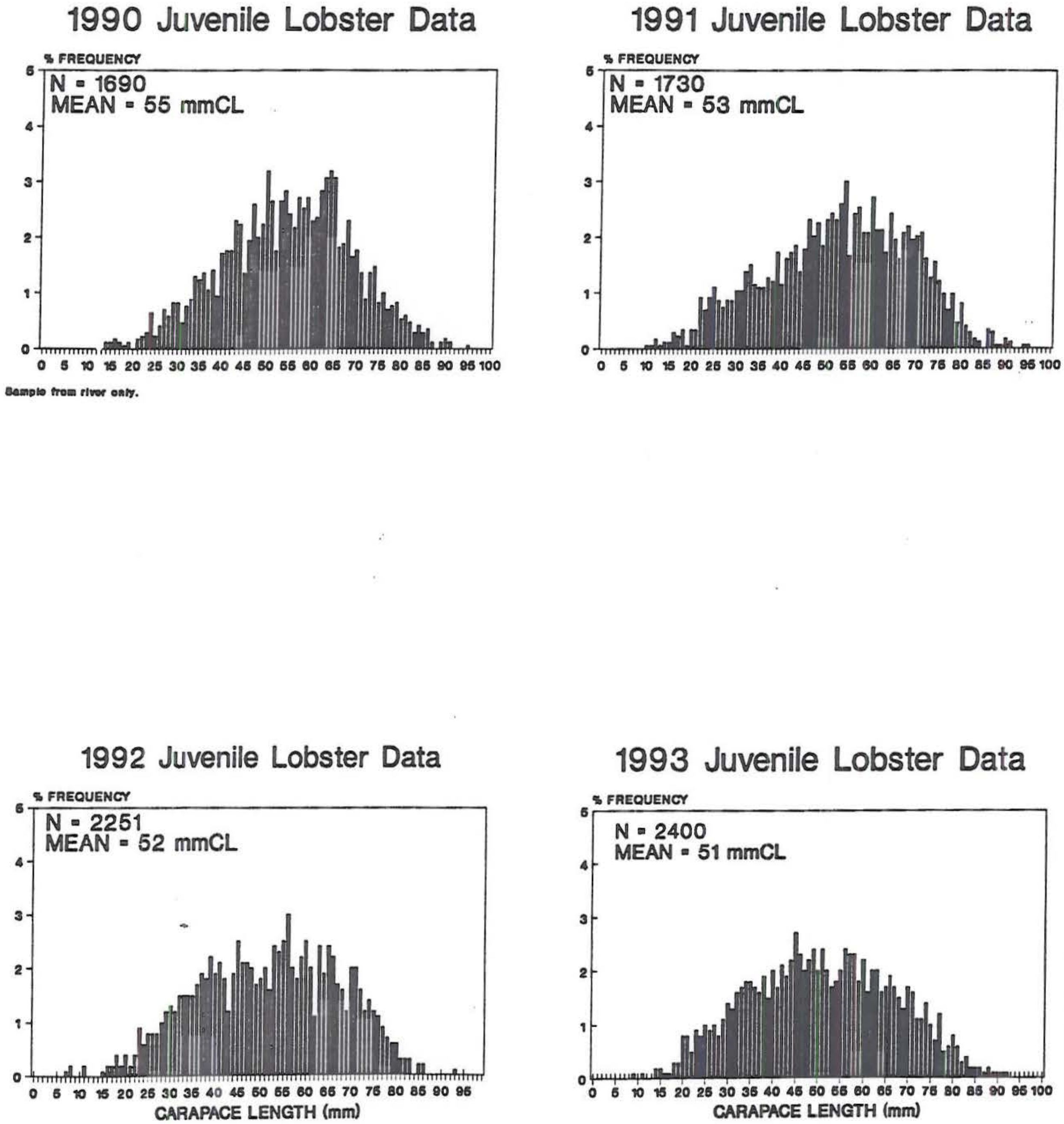


Figure 3B. Length frequency distribution for SCUBA-caught lobsters sampled in 1994.

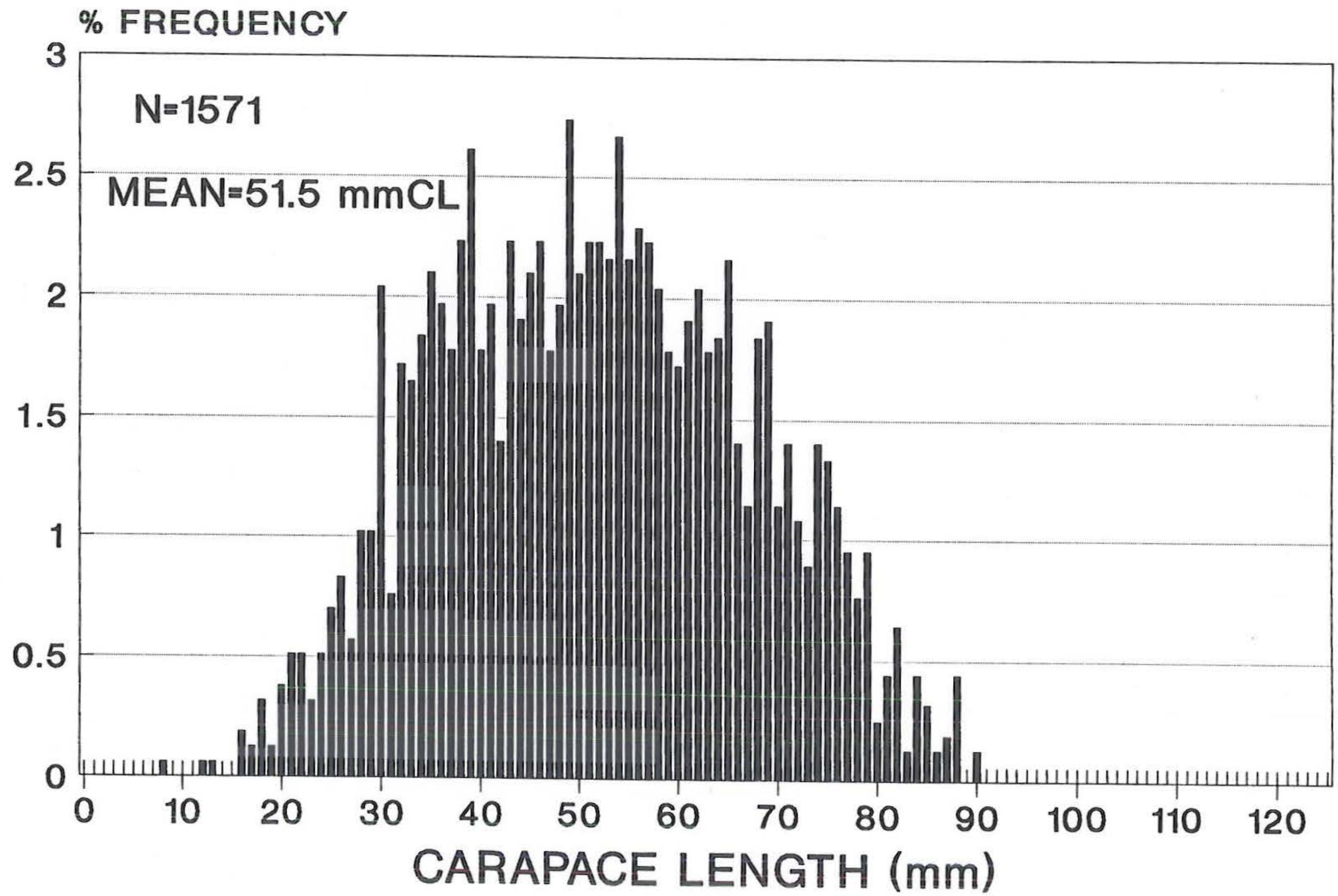


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Figure 4. Mean Carapace length by month and area for SCUBA-caught lobsters, 1994.

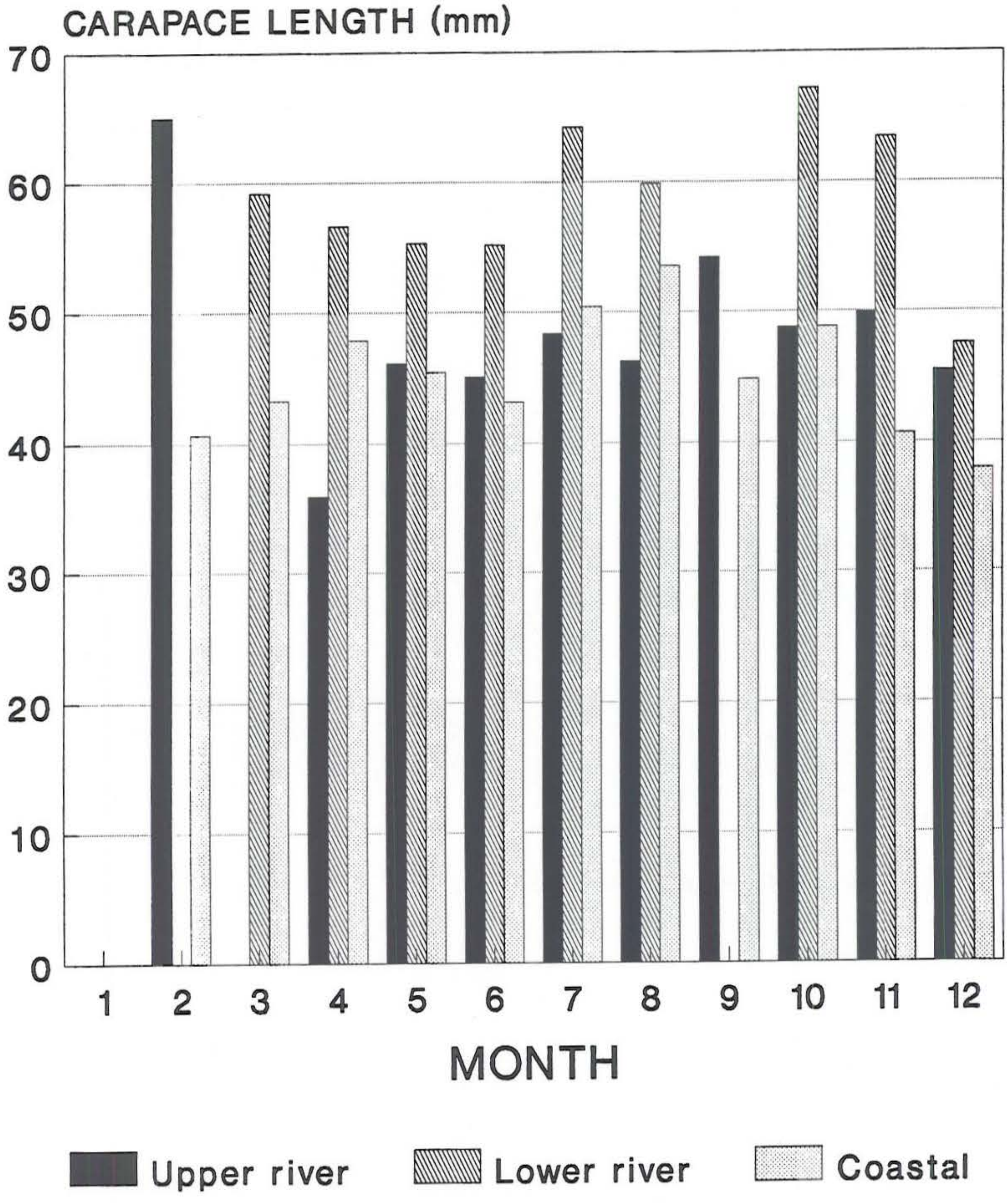
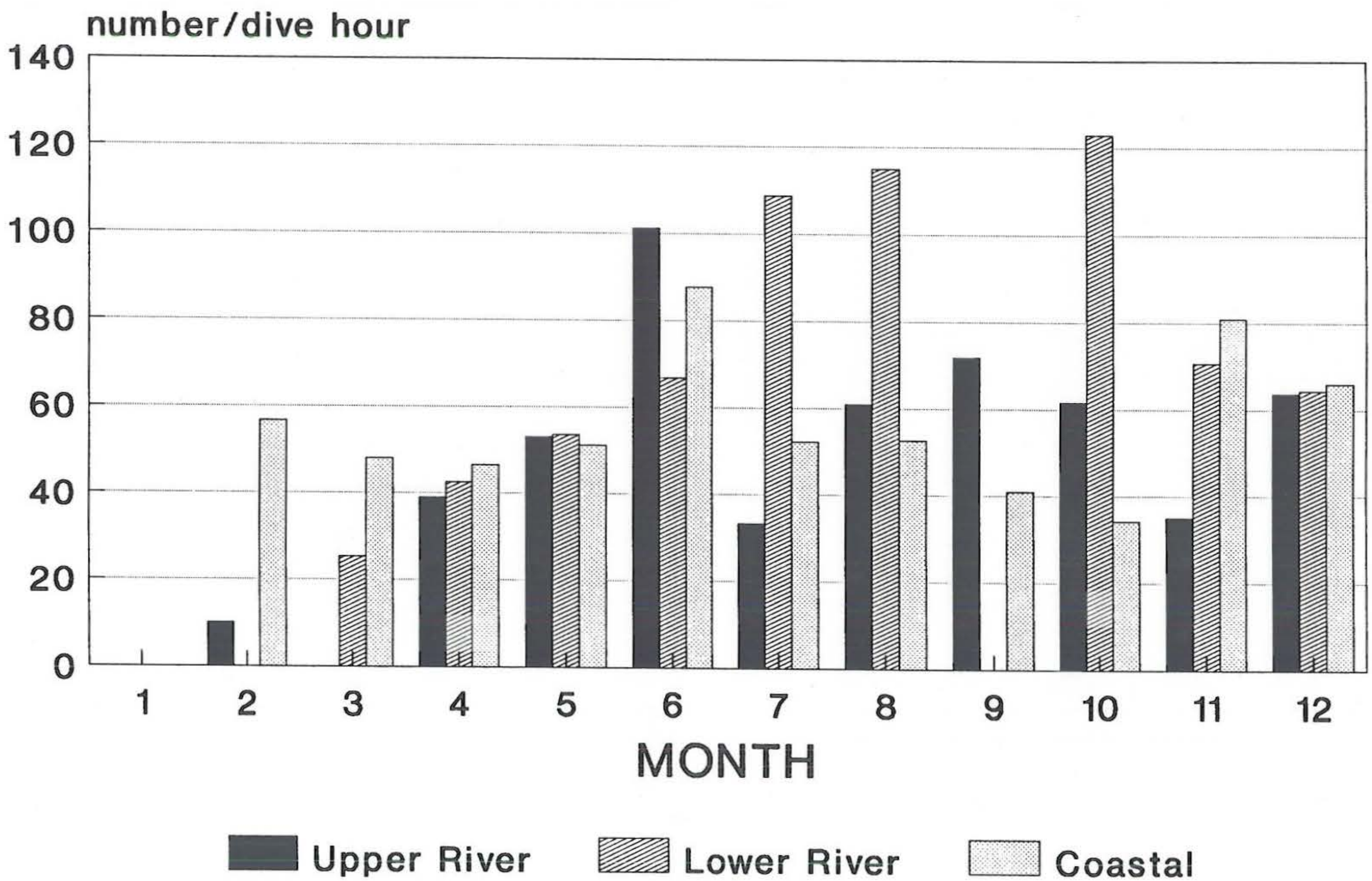


Figure 5. Catch rate of SCUBA-caught lobsters by month and area, 1994.



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upper river are likely the result of poor visibility dive days.

Analysis of time of molting (Table 4) indicates that in 1994 there were two molt peaks when all areas are combined. One peak occurred in July and a higher peak in October. The peak month for individual areas varied however, with high molting frequencies as follows: upper river June - 12.7%, lower river October - 19.5% and coastal September - 19.5%. The area displaying the highest incidence of molting over the entire sampling period was the lower river followed by the coast and upper river.

There were 11 recaptures from which to obtain growth data and from these recaptures only three showed size changes (Table 5). Two of these size changes showed 9.2% growth and the remaining one showed growth of 12.2%. Recaptured lobsters were all taken from the location where they were initially caught and tagged.

Table 4. **Percentage of 1994 SCUBA caught lobsters that were soft shell (i.e. recently molted) by sample site and month.**

MONTH	SAMPLE SITES			
	Upper River	Lower River	Coast	All Sites
June	12.7	0	0	3.4
July	0	14.9	17.0	12.1
August	3.0	7.8	5.2	5.8
September	7.6		19.5	11.7
October	0	19.5	9.8	13.9
ALL MONTHS	3.1	7.4	4.6	5.3

Table 5. **1994 Recapture data for lobsters initially captured and tagged via SCUBA diving.**

INITIAL CAPTURE					RECAPTURE				
TAG#	SIZE (mmcl)	SEX	DATE	SITE	SIZE (mmCL)	SEX	DATE	SITE	% GROWTH
6935A	49	F	7/93	18	54	F	4/94	18	9.2
7956A	75	F	11/93	3	75	F	5/94	3	-
9177A	59	F	3/94	3	59	F	6/94	3	-
9572A	50	F	6/94	3	57	F	7/94	3	12.2
9266A	65	F	4/94	3	65	F	7/94	3	-
9550A	49	F	6/94	3	54	F	7/94	3	9.2
9665A	65	F	7/94	3	65	F	8/94	3	-
8893A	78	M	4/94	3	78	M	8/94	3	-
9593A	63	F	6/94	3	62	F	8/94	3	*
9706A	38	F	7/94	18	39	F	8/94	18	*
10279A	57	M	10/94	1	57	M	10/94	18	-

* When capture/recapture dates were close and size differences slight the disparity was not attributed to molt but rather to field measurement error.

Discussion

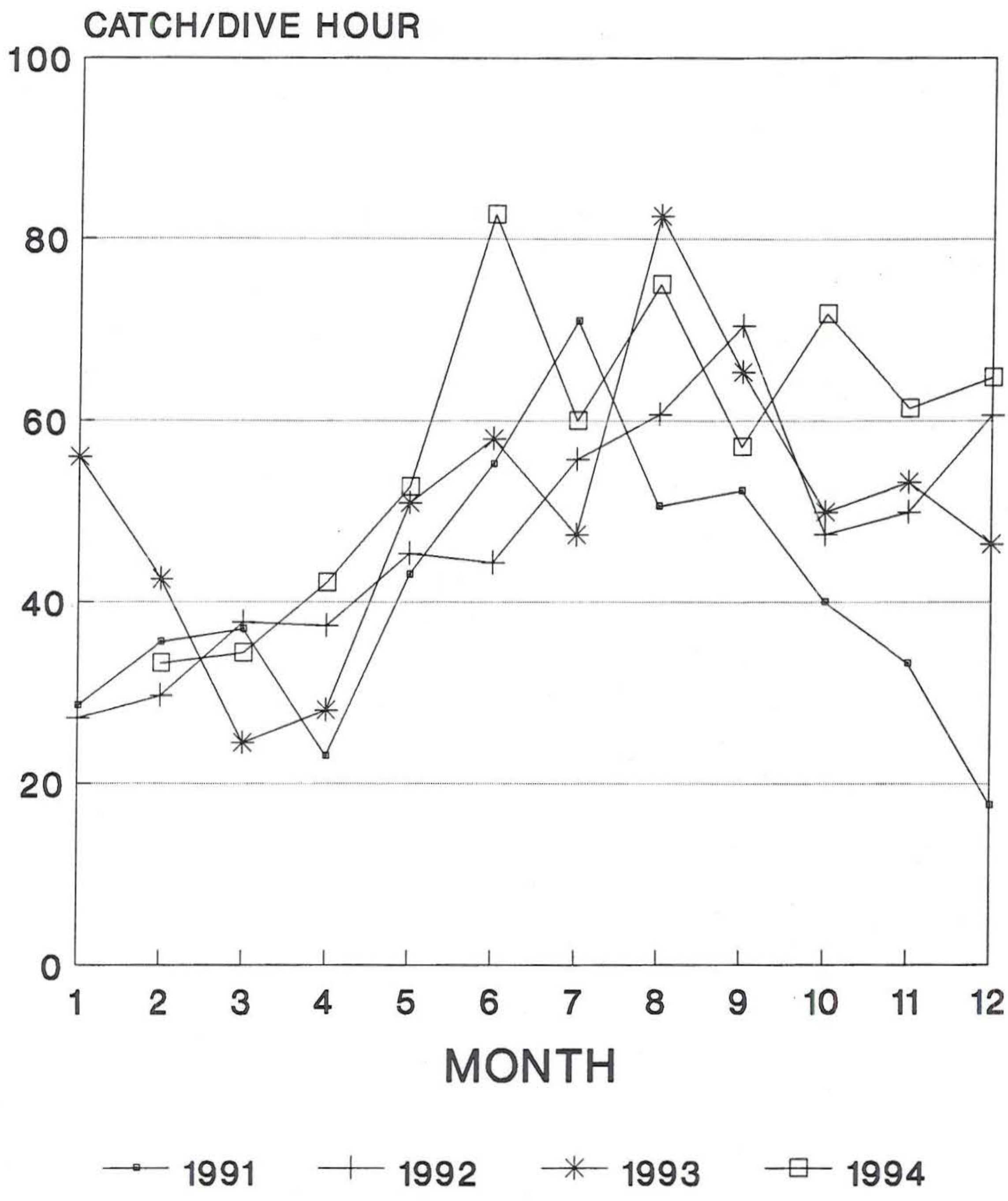
Results from the 1994 SCUBA-caught lobster data show significant differences in mean lobster size by month and by area. Mean size of SCUBA-caught lobsters by month for 1994 repeated similar patterns observed in all earlier study years (NHF&G, 1993 and 1994). Mean size is smallest during the winter months, shows an increase in summer - early fall, and decreased again with the onset of winter. The reason for this trend is not fully understood and could in fact be a combination of several factors. Growth could account for increase in juvenile lobster mean length through the late summer/fall as supported by molt frequency data. The decrease in mean length over the late fall and winter is probably due to removal of newly recruited legal lobsters and temperature related migration of larger lobsters out of the study area in late fall and through the winter. Following this same logic, the warm water increase in mean juvenile lobster length during summer and fall could in part be the result of immigration of larger lobsters into the study area. This sort of seasonal movement by larger (i.e. legal-sized) lobsters is well known (Herrick, 1909, Phillips at al, 1980, Duggan and Duggan, 1989, Robichaud and Campbell, 1991).

The marginally significant difference in carapace length between sexes is similar to that seen in previous years. Reasons for such a difference may result from two things. Males undergo molting more frequently than females once sexual maturity is reached. Therefore, for the sexually mature lobsters taken in this study, one might expect equivalent aged individuals to show some slight size difference depending on their sex.

The results from analysis of catch per unit of effort revealed some general trends in the relative availability of SCUBA-caught lobsters throughout the season. For most stations sampled, CPUE was low in cold water months (i.e. February, March, April), increased during summer months then dropped off as the water once more became colder. Exceptions to this general trend are believed to be due to unfavorable visibility days which make lobster capture difficult. It is also possible a good visibility day may result in catches higher than otherwise expected.

A comparison between 1991, 1992, 1993 and 1994 SCUBA-caught CPUEs is presented in Figure 6. No consistent year to year pattern that would suggest an increasing or decreasing abundance of lobsters can be seen from this comparison. Overall annual CPUEs for these four years are: 1991-40.58, 1992-

Figure 6. Comparison of SCUBA-caught lobster catch per unit effort for the years 1991-1994.

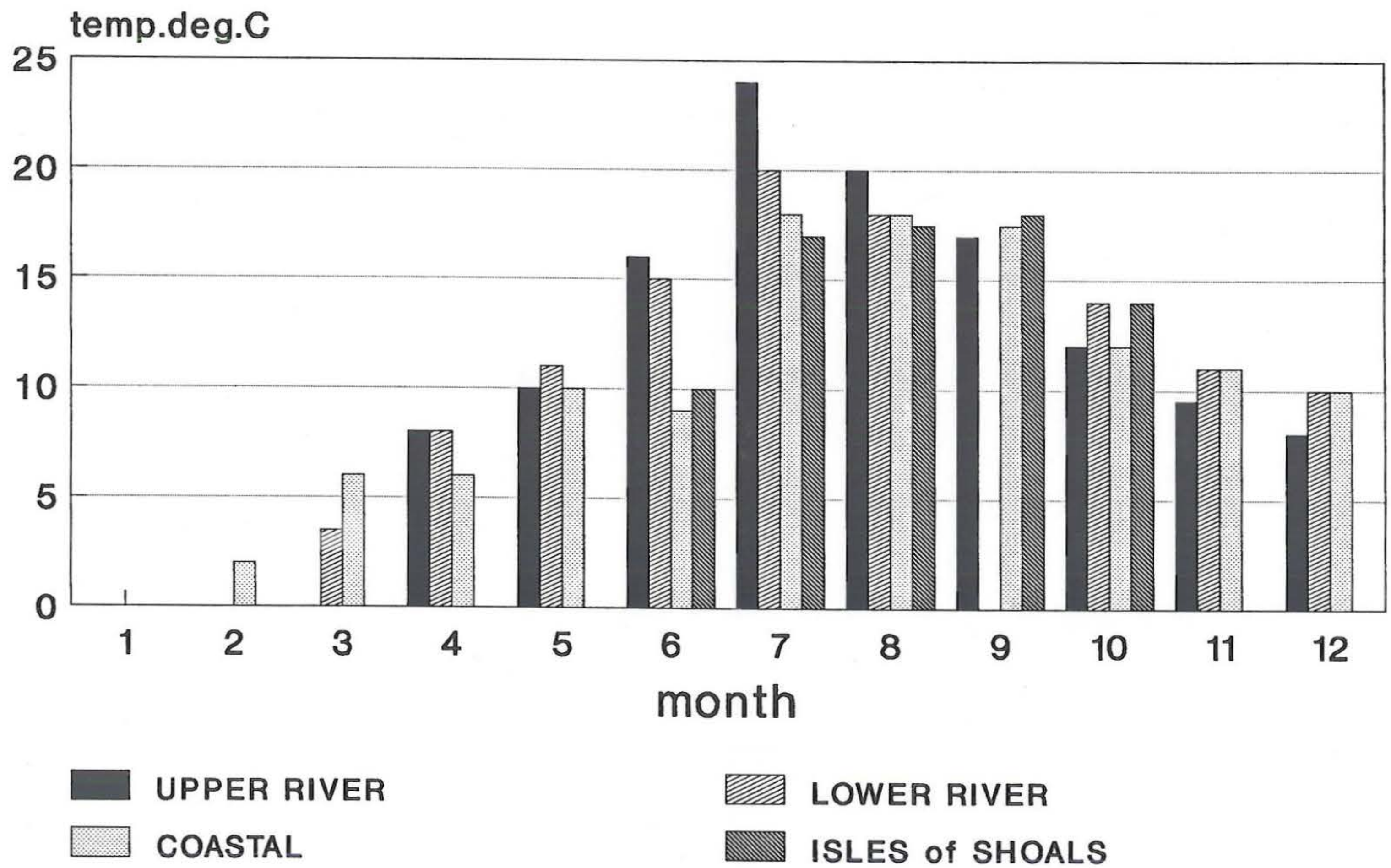


45.73, 1993-50.38 and 1994-63.69. While this might argue for a increasing abundance during the four year period it is doubtful these numbers are truly meaningful considering the bias of improved lobster capture efficiency as the study has progressed. Nevertheless this year to year CPUE comparison provides some assurance that lobster abundance within the study area is stable and that the 1994 season was a year of relatively high lobster abundance.

The results of the analysis of SCUBA-caught lobster data by area showed that the largest lobsters were found at the lower river station followed by the upper river. The coastal area lobsters were the smallest on average. This information coupled with an analysis of the length frequency distribution point to the possible importance of the coastal area as a rearing area for juvenile pre-recruit lobsters. The majority of lobsters from this area are in the smaller size classes from 30-50 mm. This distribution is slightly different from other areas. This may be the result of several factors including tidal drift patterns that carry early stage larvae to this area, available cover/habitat for juvenile lobsters, and/or lower predator pressure. It is also possible that the generally clearer coastal waters provide better chance for capture of smaller lobsters. Further characterization of larval distribution, available habitat, predator abundance, and other environmental conditions that may influence early benthic stage lobster survival would be needed to better understand this.

Timing of molting appeared to be temperature dependent with molting occurring in the various areas only after the surface temperature in the respective areas reached about 13 C° (Figure 7). The second peak observed in October has been noted in the earlier years of this study and is likely the result of second season molts by small size class river station lobsters and the relatively delayed molts of lobsters at those stations offshore where seasonal water temperature rises lag behind those in the river.

Figure 7. Plot of water temperature by month for the four areas.



Job 2 (Sea Sampling)

Objective

The objective of Job 2 is to monitor the abundance and distribution of trap-captured sub-legal and legal size lobsters in New Hampshire waters and to monitor the catch characteristics of the commercial lobster fishery.

Methods

Lobsters were sampled on a monthly basis from June through October in the lower river (Area 2), coastal (Area 3), and Isles of Shoals (Area 4). Samples were taken during day trips aboard a commercial lobster boat fishing New Hampshire waters. An individual day trip would typically be either one combining river and coastal samples or a trip to the offshore Isles of Shoals. The basic unit of effort was the trap haul set over day. Most trawls consisted of a 10 trap set line (i.e. 10 traps tied to one haul rope). During each trip, legal size lobsters were sampled from nearly every trawl and representative numbers of sublegal lobsters were sampled from randomly selected trawls. Data collected on sea sampled lobsters were the same as with SCUBA captured lobsters with the exception that none were tagged and all legal lobsters were retained by the lobstermen. Additionally v-notched and ovigerous females were counted.

A length frequency distribution was plotted for the total sea sample catch. To calculate the total sample size frequency distribution it was necessary to proportionally expand the limited sublegal catch. This was done by converting all sublegal measurements to group frequency percentages then applying these percentages to the total number of sublegals caught. Catch per unit of effort (CPUE) was plotted by month for all areas to identify trends. The percent of the sample population with soft shells was plotted by month for each area to analyze trends in molting frequency and occurrence.

Results

A total of 11,119 lobsters were tallied during thirteen sea sampling days in 1994. Of the total number caught, 1,999 legals (83mm or greater) and 879 sublegals (less than 83mm) were measured and sexed. All measured and sexed lobsters were used for characterization of length and sex frequencies.

V-notched females comprised 13.1% of the trapped legal sized females and 8.2% of these females were ovigerous (Table 6). These, of course, were all

Table 6. **Percentage of 1994 sea sampled legal female lobsters that were ovigerous and (V-notched) by sample area and by month.**

MONTH	SAMPLE SITES			
	River	Coast	Isles of Shoals	All Areas
June	4.8(14.3)	10.7(27.4)	20.0(17.7)	14.3(21.5)
July	4.5(14.4)	6.9(20.7)	8.1(12.8)	6.7(16.1)
August	4.2(3.1)	16.3(16.3)	10.5(7.4)	11.1(9.6)
September	8.3(6.6)	6.6(22.1)	6.0(19.6)	6.9(17.0)
October	3.4(2.7)	3.4(6.2)	10.0(11.6)	5.7(7.1)
All Months	5.1(6.9)	8.3(17.4)	10.3(13.1)	8.2(13.1)

released in accordance with New Hampshire law. June was the month of greatest ovigerous female abundance and October showed the lowest percentage. The Isles of Shoals produced the highest percentage of ovigerous females and the coastal area was second. The relative presence of V-notched females is greatest in the coastal area with Isles of Shoals second. Table 6 shows some monthly area agreement between V-notch and ovigerous percentages but overall there is no consistent relationship shown for these two conditions. Future examination of these lobster types with regard to areal and temporal distribution may yield useful information.

To develop a total sea sample length frequency distribution and mean carapace length a proportional expansion of the sublegal data was accomplished. The resulting graphic (Figure 8) shows a size frequency peak around 78 to 82 mmCL and a precipitous drop as the 83 mmCL (legal) size is reached. A figure showing legal sized lobster lengths by sample area (Figure 9) illustrates a general increase in lobster length as one progresses from the estuarine river area to the offshore Isles of Shoals area. All length frequency distributions showed peaks around the length groups nearest the legal limit and sharp declines thereafter. The Isles of Shoals showed the greatest mean length (88.6 mmCL) followed by the coast (87.3 mmCL). The river area produced the lowest mean length (87.1 mmCL). Legal males sampled had an average carapace length of 87.7 mmCL while females averaged 87.6 mmCL.

A comparison of mean carapace length by month for all areas showed a general size increase from June to October.

An analysis of catch per unit of effort (CPUE) data for sea sampled lobsters revealed that catch rates were highest during the month of July for the lower river, September for the coastal area, and highest in October for the Isles of Shoals area (Figure 10).

Time and location of molting for sea sampled lobsters is generally in agreement with similar data from the SCUBA-captured juveniles (Table 7). Overall peaks in molting occur in June/July and October. The river, with warmer early summer temperatures, seems more conducive to June/July molting than colder coastal and offshore waters. It is possible too that annual multiple molts for river lobsters may occur.

Figure 8. Length frequency distribution of sea sampled lobsters, 1994.

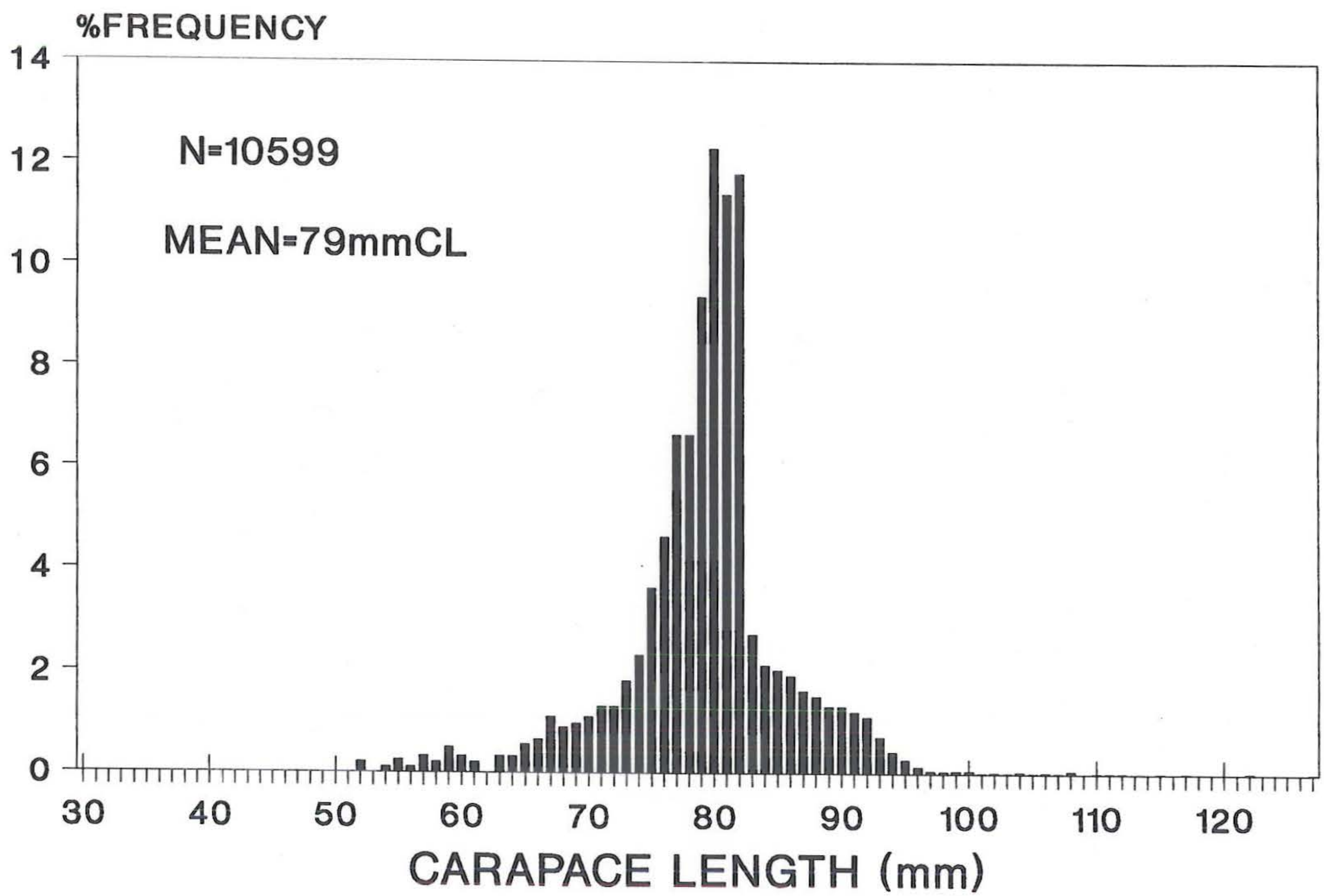


Figure 9. Length frequency distribution of sea sampled, legal sized lobsters, 1994.

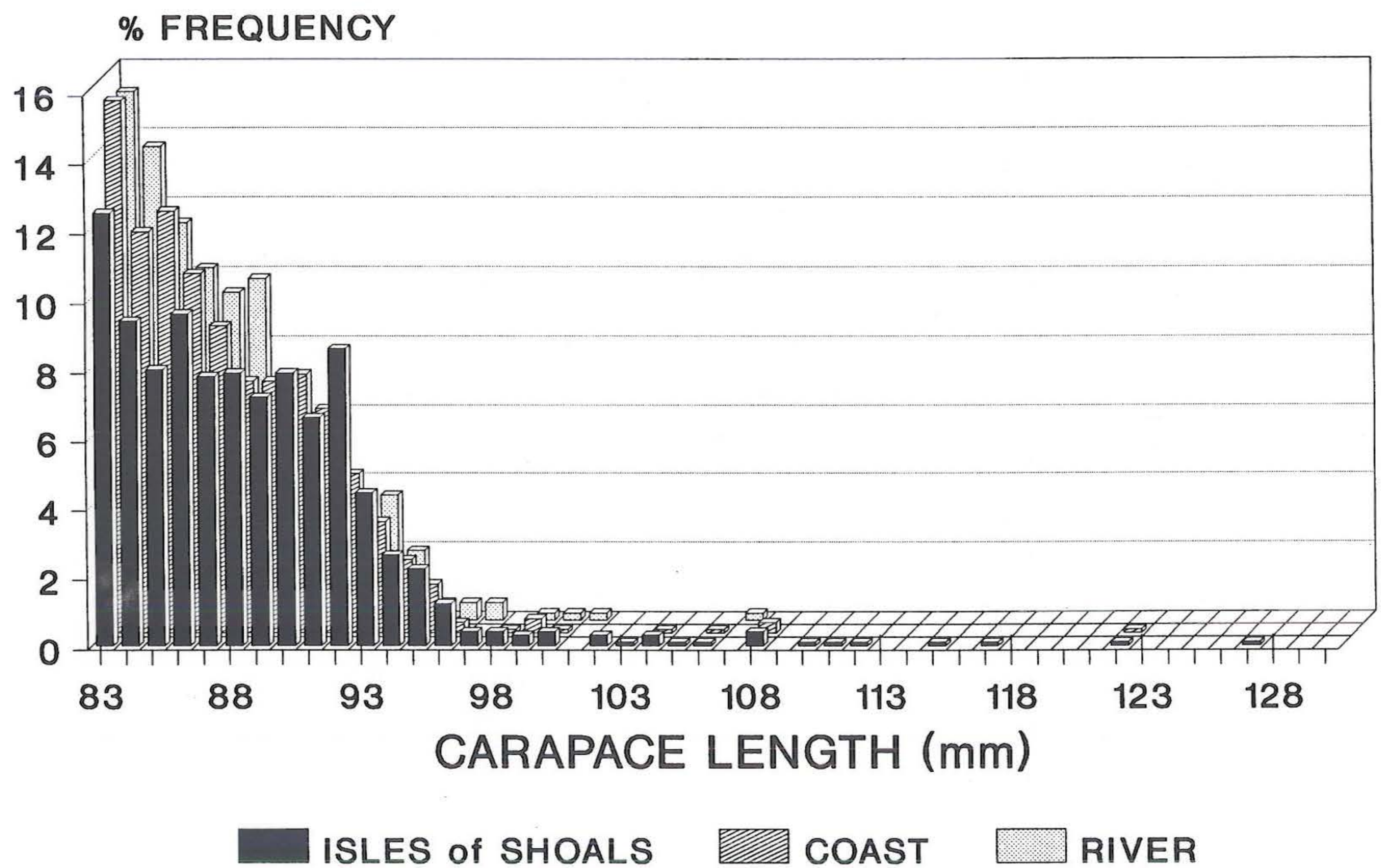
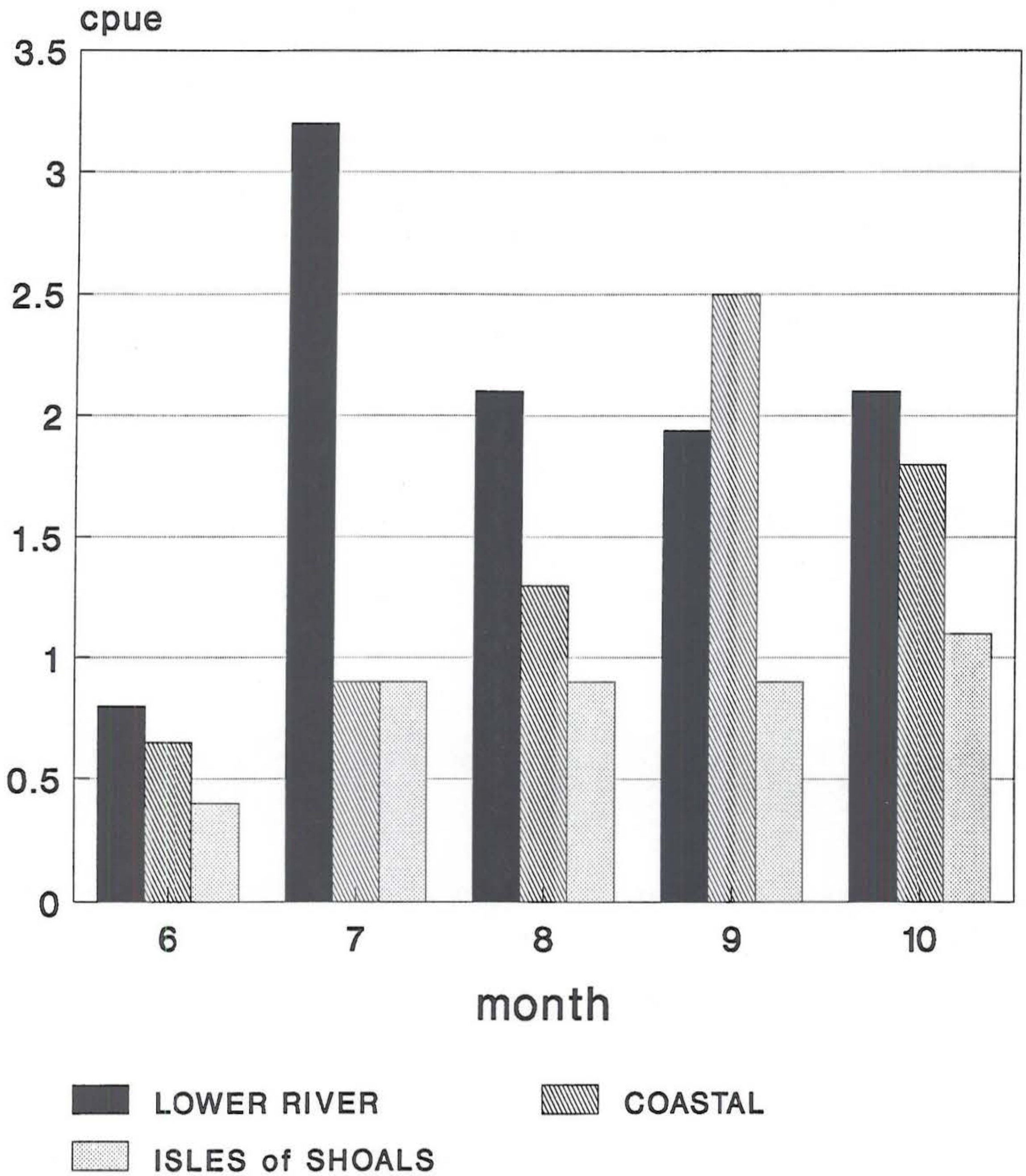


Figure 10. Catch rate of 1994 sea sampled lobsters by area and month.



cpue = catch/trap setover day

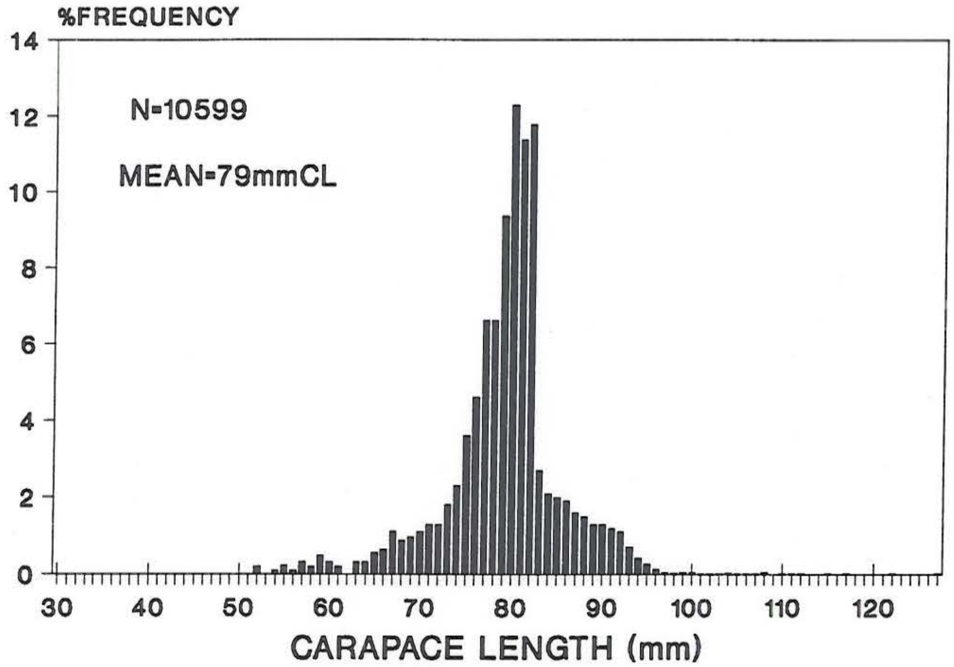
Table 7. **Percentage of 1994 sea sampled lobsters that were soft shell (i.e. recently molted) by sample site and month.**

MONTH	SAMPLE SITES			
	River	Coast	Isles of Shoals	All Sites
June	40	2.3	0	6.8
July	3.7	0	13.4	7.1
August	2.3	6.7	6.1	5.7
September	4.7	4.2	2.7	3.9
October	4.7	8.8	4.6	6.2
ALL MONTHS	5.4	5.7	6.2	5.8

A comparison of the length frequency distributions for SCUBA sampled juvenile lobsters and commercially trapped sea sampled lobsters shows the differences between the two sampling techniques (Figure 11). SCUBA sampling is directed towards smaller lobster; they are more numerous in the shallow coastal waters. On the other hand, commercial traps selectively catch larger lobsters because of trap net mesh size and escape vents which allow small lobsters to move out of a trap after their entry. These facts generally dictate the disparate size frequency distributions for these two sampling methods. Furthermore, this clearly shows the importance of a program that uses both collection methods if an accurate description of total population size frequency is to be generated.

Year to year (i.e. 1992-94) catch rates for the three study areas are shown in Figure 12. For the river area, 1992 CPUEs exceeded 1993 and 1994 for August and September. The 1994 year, however, was a very productive year with comparatively high CPUE for most months. The coastal area shows a different pattern; 1992 exceeded other years in July and August but 1994 was most productive in September and October. The four month comparison at the Isles of Shoals shows 1994 to be the highest CPUE rate for all years. In general, for all areas, 1994 was a very productive year compared to other years.

Figure 11. Comparison of the length frequency distributions of lobsters captured by SCUBA and sea sampling in 1994.



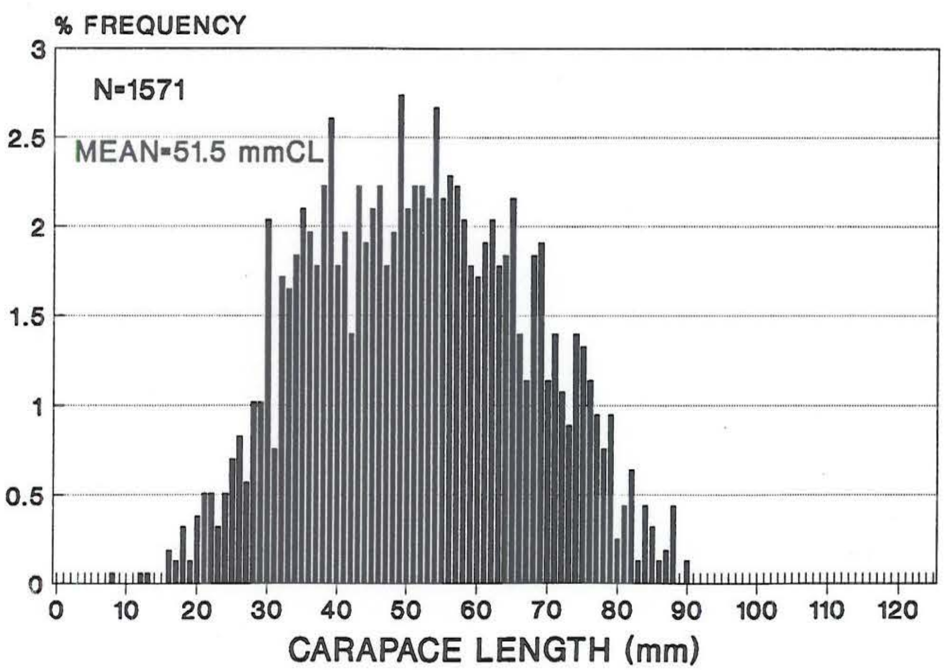
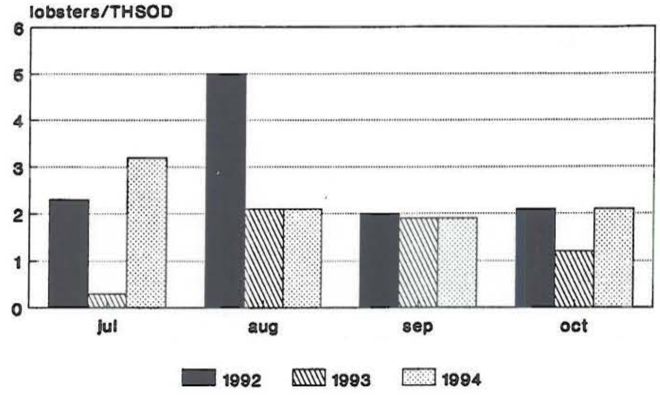


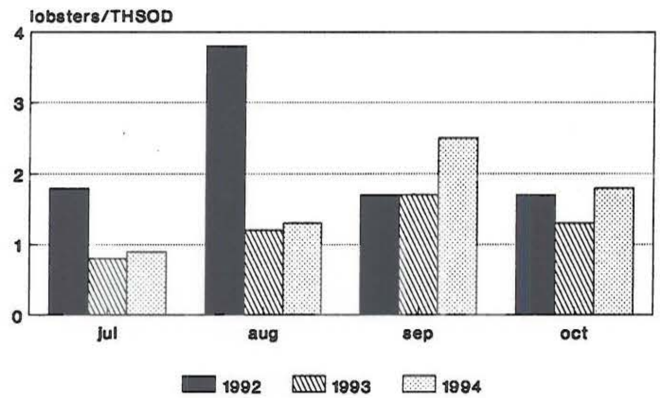
Figure 12. Comparison of sea sampled lobster catch per unit effort for 1992 to 1994.

CPUE 92 to 94 -RIVER
catch/trap setover day



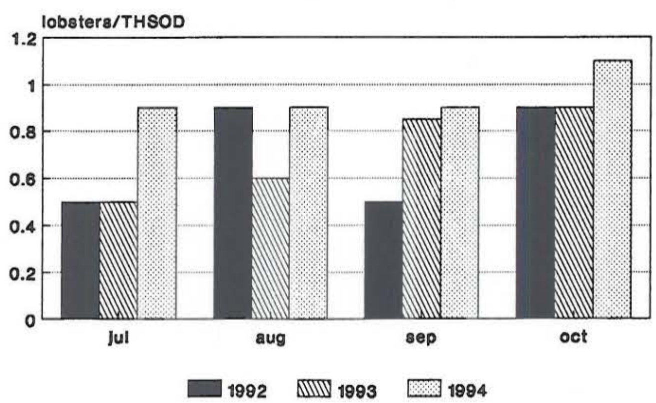
from sea sample data

CPUE 92 to 94 -COAST
catch/trap setover day



from sea sample data

CPUE 92 to 94 -SHOALS
catch/trap setover day



from sea sample data

Discussion

Results from the 1994 sea sampling year show differences in mean lobster size by area, by month and by sex. The largest mean size for legal lobsters were those taken at the Isles of Shoals and the smallest in the river. Both the SCUBA and sea sample data suggest a preference of larger lobsters for offshore areas. Though there is little information from the data presented above as to actual migration of lobsters, it is possible the larger size noted for offshore lobster compared to those in the river is the result of an overall net movement seaward as they mature. Such a movement for lobsters might be directed by several things: variable life stage temperature or salinity preferenda, size influenced physical habitat selection, some inherent natural dispersion mechanism or by combinations of these possibilities or others not yet explained.

Alternatively this mean size gradient seen inshore to offshore may only reflect variable fishing pressure with the less intensively fished offshore area merely containing more large lobster due to the historically reduced catches there in comparison to more heavily fished inshore areas. If this is indeed the case then continued fishing in the offshore area should eventually reach the point that this areal size disparity is not seen. On the other hand a continuing mean size differential between inshore and offshore areas argues in favor of the net movement of larger sized lobster seaward.

Monthly size differences also seen with SCUBA-sampled lobsters are likely due to molt and growth occurrence which shows a bimodal frequency. Also playing a role in seasonal size differences may be the well known inshore/offshore movement of reproductive lobster which should result in larger sized lobster inshore during the molt and copulation period (Herrick, 1909, Phillips et al, 1980, Duggan and Duggan, 1989, Robichaud and Campbell, 1991). Since sea sampling only occurs during the five warm water months this supposition cannot be tested.

The marginally disparate sex difference for carapace length has been seen in previous years and is probably due to the more frequent molting of male lobsters compared to females.

Year to year comparisons that focus on monthly CPUE information show some marked early season (July-August) variations for the three years examined. Less variable CPUEs are shown by September-October catches. While it is doubtful these data are suitable for further rigorous statistical analysis it nevertheless provides some suggestion that 1994 was overall a better season for lobster landings than were the years 1992 and 1993. This will likely be confirmed by NMFS lobster catch records when they become available.

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