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80-35

DISTRIBUTION AND ABUNDANCE OF LARVAL LOBSTERS (Homarus americanus) IN BUZZARDS BAY, MASSACHUSETTS IN 1976-79.

by

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INTRODUCTION

The National Marine Fisheries Service (NMFS) at Woods Hole began sampling planktonic larval stages of lobsters, Homarus americanus, in Buzzards Bay in May 1976. This effort has continued each year since then with sampling beginning in early May, before the hatching of lobster eggs begins, and ending in early August, after the larvae have settled out of the plankton. The sampling was begun as part of a joint study of the distribution and abundance of lobster larvae in Cape Cod Bay, the Cape Cod Canal, and Buzzards Bay. We at NMFS, as our part of the study, sampled the middle section of Buzzards Bay, an area which is close to our base of operations at the Northeast Fisheries Center in Woods Hole (Figure 1). Since this joint study has already been described in the initial report of this volume (Collings and Lawton, 1980), we will not repeat the details here.

Buzzards Bay varies in depth from less than 5 m at the Cape Cod Canal end to about 30 m at the bay mouth. Sediments consist largely of sand and silt, although there are numerous areas of rocky bottom and, along the northwest shore, rock ledge.

Figure 1.

The bay, which lies entirely within Massachusetts territorial waters, is closed by state law to fishing with trawls or nets. There are, however, active commercial and recreational trap fisheries for lobsters from spring to late fall, as this species is relatively abundant. In these fisheries lobsters caught that are less than 81 mm carapace length or are ovigerous must be returned to the water. Precise lobster landings from Buzzards Bay

are not known, although catch reports filed to the state by lobster fishermen each year indicate that they are considerable[1/]. Based on these data we suggest that an estimate of about one million pounds landed per year from the bay probably is reasonable.

SAMPLING PROCEDURES

Numerous reports have indicated that planktonic lobster larvae are positively phototactic and are found at or near the water surface during daylight hours (Smith, 1873; Herrick, 1896; Templeman, 1937; Templeman and Tibbo, 1945; Sherman and Lewis, 1967). The gear that we used for sampling therefore was a neuston net (1x2 m mouth, 9 m length). The mesh size of the net was 0.97 mm, bar measure, which retained all sizes of lobster larvae as well as many smaller animals. The net was towed with the mouth from one-half to two-thirds submerged. The towing was done from a research vessel 12 m in length. The tows were made in a straight line, and the point of towing was the end of a boom extended 2.5 m outboard amidships over the starboard rail. The net rode about 20 m astern of the towing vessel and, for the most part, was out of the wake. The towing speed in 1976, based on distance covered, was estimated at 4.6-5.6 km/h (2.5-3.0 K); in 1977-79 it was 6.0 km/h (3.25 K), and this was determined with an electronic log.

Except where there was significant net clogging, the tows were one-half hour in duration. At 6 km/h the estimated surface area sampled in a one-half hour tow was 6,000 m^2, and the estimated volume of water filtered was 3,000 m^3, assuming that the net sampled a surface layer of water 0.5 m deep. At the lower towing speeds used in 1976 the estimated volume filtered in a one-half hour tow ranged from 2,200-2,750 m^3. The volume filtered may,

of course, vary considerably depending on depth of the net in the water, extent of clogging, and, as Scarratt (1973) pointed out, the amount of wind and wave action. The water volumes filtered that we have used therefore must be considered approximate.

Where net clogging occurred due to algal blooms or concentrations of ctenophores, the usual clogging organisms, the volume filtered was reduced. Tows in which clogging was apparent were abbreviated, a few being of only 5 minutes duration because of this. Clogging often occurred from mid-July to early August and it affected about 10% of the total tows in a season.

At the completion of a tow the catch was washed from the codend into one or more plastic buckets. Floating weeds frequently occurring in catches were rinsed free of organisms and discarded. The catch then was strained with a sieve, placed in jars, and preserved in 2% formaldehyde. The lobster larvae were sorted from these samples in the laboratory.

The net was washed with a hose after each tow to clear blocked meshes. If it was badly fouled we turned it inside out and dragged it in the vessel's wake at cruising speed for 5 or 10 minutes to clean it.

Weather permitting, all stations were sampled once each week during the May-August sampling season. In 1977-79 we sampled six stations in two transects, each of which was nine km in length (Figure 1). In 1976 we sampled only the easternmost transect, which we divided into four stations (Figure 1). Sampling usually began by about 0800 h (EST) and was completed by about 1400 h. On one occasion, in 1976, we sampled during early evening hours and after dark.

The surface water temperature was recorded to the nearest $0.1^{o}C$ at the beginning of each tow, using a mercury thermometer. Surface to bottom temperatures were obtained with an electronic probe in 1977 and part of 1978. Wind and cloud cover observations were noted on each tow log.

RESULTS

Over the four years sampled a total of 16,679 larval lobsters were caught, for an average of 23.3 per 1,000 m^3 of water filtered (Table 1). Numbers of larvae varied considerably from year to year with totals ranging from 1,284 in 1976, when there were fewer stations, to 10,303 in 1979. The unusually high numbers in 1979 resulted largely from high catches on a single sampling date.

Table 1

There was a marked variation also in the composition of the catch by stage of development, both within and between years (Table 1). Stage II predominated in 1976 and 1977; stage IV, in 1978; and stage III, in 1979. The large numbers of stage IV larvae in most years seemed unusual, even though the longer life of this stage increases the chance of capture. In 1978, when this was most pronounced, there were more than twice as many stage IV's as the other stages combined (Table 1).

Estimates of the abundance of larvae by sampling date for all stations combined in each year in terms of catch per 1,000 m^3 of water filtered (Figure 2) show that the larvae began to appear in the catch in the latter half of May, reached peak numbers in mid to late June, and had completed pelagic stages by early August. The surface water temperature when larvae first were caught was about 13-15°C; the temperature at the bottom usually was 1 or 2 degrees lower than at the surface (Figure 2). The temperature at the peak of larval production was about 19°C at the surface and 17°C at the bottom. These temperatures for initiation of hatching and peak of larval production agree rather closely with the findings of Hughes and Matthiessen (1962). Water temperatures as high as about 24°C at the surface were recorded in July and early August (Figure 2).

Figure 2

There was no consistent pattern in total abundance by station, although catches usually were higher at stations 1-3 than at station 4-6. The largest

catches generally were made at station 3. The water temperature was higher by about 1-2°C at stations 4-6, where the depth was 10-12 m, than it was at stations 1-3, where the depth was about 15 m, but it was not clear if these temperature or depth differences affected larval abundance.

The high numbers of larvae caught in 1979 were due largely to catches on one sampling date (June 18) when 6,746 larvae were caught in the 5 tows (Table 1). The mean total catch per 1,000 m^3 of water filtered for June 18 was 450 larvae (Figure 2). The year 1979 was, however, one of generally high abundance in Buzzards Bay (Figure 2).

The abundance of lobster larvae by developmental stage for each year and sampling date show the general progression of stages through the hatching season (Figure 3). The abundance of stage I larvae usually peaked around mid-June and stage IV peaked in late June. Larvae were caught from late May to early August, encompassing a period of about 11 or 12 weeks. Generally there was a small peak in abundance of stage I larvae in late May and well before the seasonal peak in Mid-June (Figure 3); this has been noted previously by Collings, et al. (1980)[2/] in the northeastern part of Buzzards Bay.

Figure 3

In 1976 the pattern of larval abundance by stage (Figure 3) showed early stage larvae to be more abundant than late stage ones. In 1977 and, especially, 1978 the late stages were as abundant or more so than early ones. In 1979 the very high numbers of all stages caught on June 18 greatly altered the pattern of abundance for that year.

In order to examine day-night differences in the larval catch, in 1976 we made 3 daylight and 3 night tows on the evening of June 9 at stations 2, 3, and 4 of the 1976 transect (Figure 1). Only the first 3 larval stages were caught, as stage IV larvae had not yet appeared in catches (Figure 4). Station

2, 1820-1850 h EST, yielded 257 larvae, the largest catch of the 1976 season. At station 3, 1855-1925 h, 113 larvae were caught, and at station 4, 1930-2000 h, 31 larvae were taken. These were the 3 daylight tows, although the light was fading through the last 2 of these. Sunset this date was 1921 h. For the night tows the times and catches were: station 4, 2025-2055 h, 45 larvae; station 3, 2100-2130 h, 28 larvae; and station 2, 2135-2205 h, 17 larvae. As these data show, the catch dropped rapidly as the light level decreased. Further, the catch composition by stage changed greatly, with stage I larvae dominating during daylight and stage III larvae making up much of the catch after dark.

Figure 4

DISCUSSION

The results from this study and from those of Collings, et al. (op. cit.), indicate that the numbers of lobster larvae caught in Buzzards Bay considerably exceed those caught in other New England areas, such as the Maine coast (Sherman and Lewis, 1967), Cape Cod Bay (Anderson and Schotton, 1978)[3/], Vineyard Sound (Herrick, 1896), Block Island Sound (Bibb and Hersey, 1979)[4/], and Long Island Sound (Lund and Stewart, 1970). Indeed, it appears, when Canadian studies are considered as well, that the larvae are at least as numerous here as in any other location.

The abundance of early stage larvae in an area depends on the numbers of ovigerous lobsters present. Lobster fishermen of the Woods Hole area that we have talked with have said that ovigerous lobsters are up to three to four times more abundant in Buzzards Bay than in adjacent Vineyard Sound. In addition, they reported that ovigerous lobsters in Buzzards Bay are smaller than in Vineyard Sound, suggesting earlier maturation in the bay. Collings, et al. (op. cit.) presented data which indicated that Buzzards Bay lobsters matured at a younger age and smaller size than those in Cape Cod Bay, presumably due

to lower water temperatues in the latter area. This is consistent with the results of Templeman (1936) who found indications that lobsters matured at smaller sizes in the warmer water areas off Canada than colder ones.

The above would suggest that conditions are more favorable in Buzzards Bay for the production of larvae than in adjacent waters. Buzzards Bay, which is shallower than adjacent areas and has a slower flushing rate, is warmer from spring to fall (the season of rapid growth) than either Vineyard Sound (Sumner, et al., 1913) or Cape Cod Bay (Collings, et al, op. cit.). The high numbers of larvae caught in Buzzards Bay compared with the lower numbers in Vineyard Sound (Herrick, 1896) and in Cape Cod Bay (Anderson and Schotton, op. cit.), would appear to support this suggestion.

Collings, et al. (op. cit.) indicated that there appeared to be more sublegal ovigerous lobsters in Buzzards Bay than in Cape Cod Bay. In addition, lobster fishermen have told us that sublegal ovigerous lobsters are more common in Buzzards Bay than in adjacent areas. Thus more female lobsters in Buzzards Bay may spawn at least once before they are caught as legal lobsters, increasing larval production there. This may be an important factor in the apparent high larval production in this bay.

The results in several larval lobster studies have shown that stage I larvae dominated catches, although this varied somewhat depending on when in the pelagic phase the sampling was done (Templeman, 1937; Templeman and Tibbo, 1945; Scarratt, 1964; Sherman and Lewis, 1967; Lund and Stewart, 1970; Scarratt, 1973). If the larvae are evenly distributed horizontally and vertically one might expect this pattern, because of a likely high mortality through the pelagic stages. The results from our sampling, however, as earlier indicated, showed stage II, III, and IV larvae dominating the catch in the four years sampled (Table 1, Figure 3), a pattern that was similar to that concurrently obtained by Collings, et al. (op. cit.) in northeast Buzzards Bay. A possible

reason for this apparent anomaly in Buzzards Bay is that it stemmed from differences in vertical distribution of the various stages in relation to light intensity. Templeman and Tibbo (1945) found that under bright sunlight conditions stage I and II larvae moved down somewhat from the surface layer. They concluded that, "sunlight tends to drive first and second stage larvae at least below the surface but has less repelling effect on third and fourth stages than on second and second than on first. The larvae are strongly attracted to the surface by dull sunlight." Scarratt (1973) also found considerable numbers of stage I larvae in depths of 0.6-1.2 m on sunny days in the Gulf of St. Lawrence.

Most of our sampling in Buzzards Bay was done under sunny conditions, and it is therefore possible that some early stages were missed because they had moved deeper than the 0.5 m level that our net sampled. Our data do not cover enough light conditions, however, to draw any conclusions in this regard.

The presence of the observed large numbers of stage IV larvae in 1978 may also be partly explained by the results of Templeman and Tibbo (1945) and quoted above. Another possible factor may be related to the life span of stage IV larvae. Data from Herrick (1896) indicate that at Woods Hole stages I and II molt within 5 days or, more usually, less, and stage III molts in 2-8 days. Stage IV larvae, however, do not molt for 10-19 days and thus are exposed to capture for a longer period than earlier stages.

Still another factor may be the effect of surface drift in dispersing the larvae. Scarratt (1964) suggested that the levels of stage I abundance reflected the location of the parent stock. Significant drift of the larvae as they pass through pelagic stages could result in a somewhat different

distribution of stage I compared with stage IV, and limited sampling, as was the case in this study, could result in undersampling some stages.

High catches of larval lobsters in this study frequently coincided with high catches of zoea and megalops stages of crabs. This has been noted also by Templeman (1937). At the peak catches of lobster larvae in mid to late June, we caught up to 2 liters of crab larvae in a one-half hour tow. These all were smaller than the lobster larvae. Many were larvae of the rock crab (Cancer irroratus); however, larvae of green crab (Carcinus maenas) and lady crab (Ovalipes ocellatus) also were frequent components of the catch at this time. Larvae of the porcelain crab (Porcellana spp.) were abundant through much of July into early August. The significance of the presence of crab larvae in relation to larval lobsters is unkown.

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FOOTNOTES TO TEXT

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4/ Bibb, B. G., and R. Hersey. 1979. Distribution and abundance of lobster larvae in Block Island Sound, 1978. 1978 Final Rept., Raytheon Environ. and Oceanogr. Serv. 89 p. (New England Power Co., 20 Turnpike Rd., Westboro, Ma 01581.)

Table 1.--Total numbers of tows, numbers of tows containing larval lobsters, total numbers of lobster larvae of each stage, mean total numbers per 1,000 m^3, and percentage frequency by stage (in parentheses) for Buzzards Bay neuston sampling in 1976-79 and all years combined.

Year	Number of tows		Numbers of larvae of each stage				Total number	Number per 1000 m^3
	Total	With larvae	I	II	III	IV		
1976	50	32	433	484	290	77	1,284	10.1
			(33.7)	(37.7)	(22.6)	(6.0)	(100.0)	
1977	80	56	706	1,064	759	932	3,461	18.8
			(20.4)	(30.8)	(21.9)	(26.9)	(100.0)	
1978	62	41	90	103	243	1,195	1,631	9.6
			(5.5)	(6.3)	(14.9)	(73.3)	(100.0)	
1979	88	56	2,413	2,640	3,962	1,288	10,303	43.7
			(23.4)	(25.6)	(38.5)	(12.5)	(100.0)	
All years	280	185	3,642	4,291	5,254	3,492	16,679	23.3
			(21.8)	(25.7)	(31.5)	(21.0)	(100.0)	

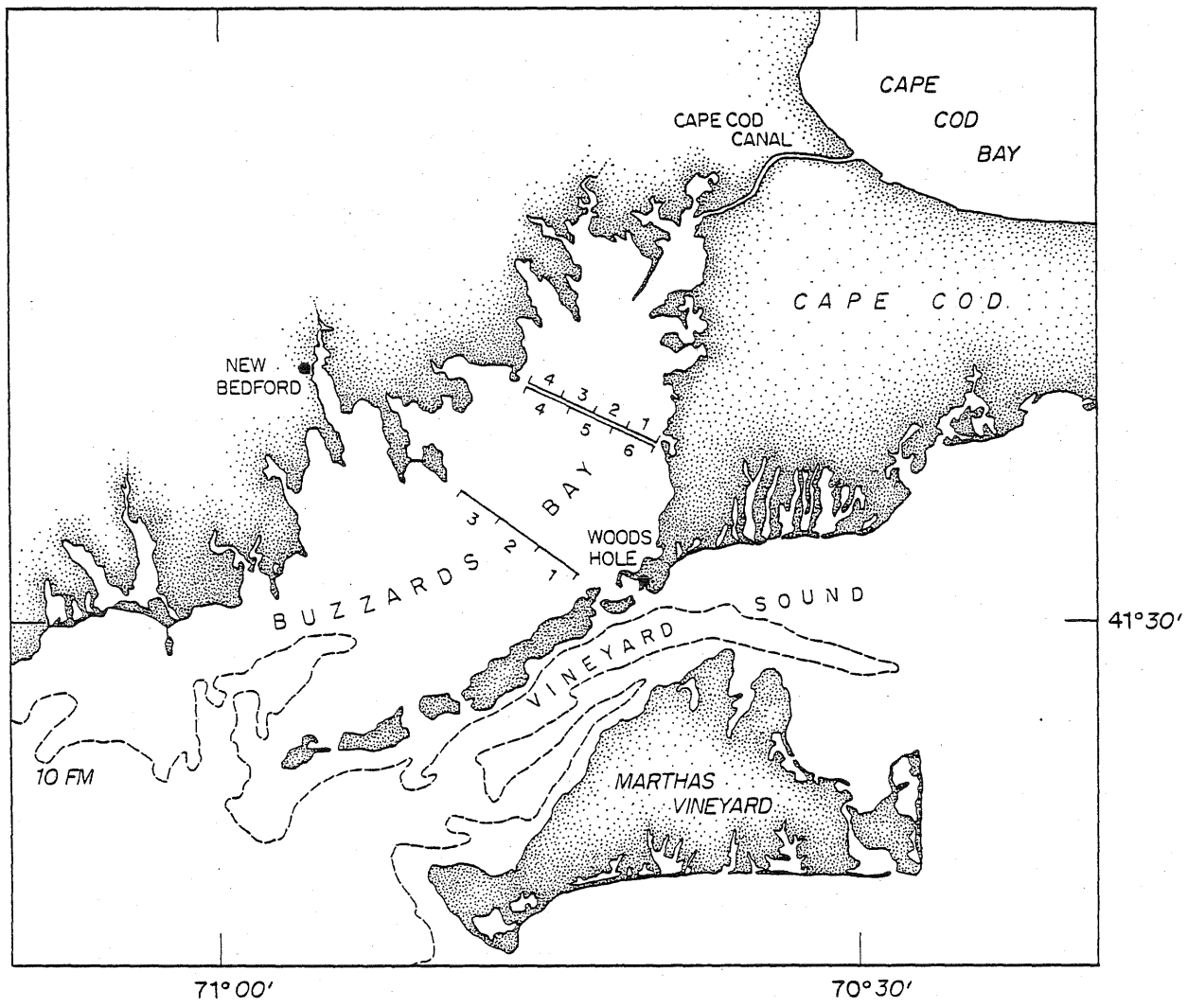

Figure 1.--Sampling stations for neuston tows in Buzzards Bay, Massachusetts, 1976-79. In 1976 stations 1-4 (upper transect) were sampled; in 1977-79 stations 1-6 (lower and upper transects) were sampled.

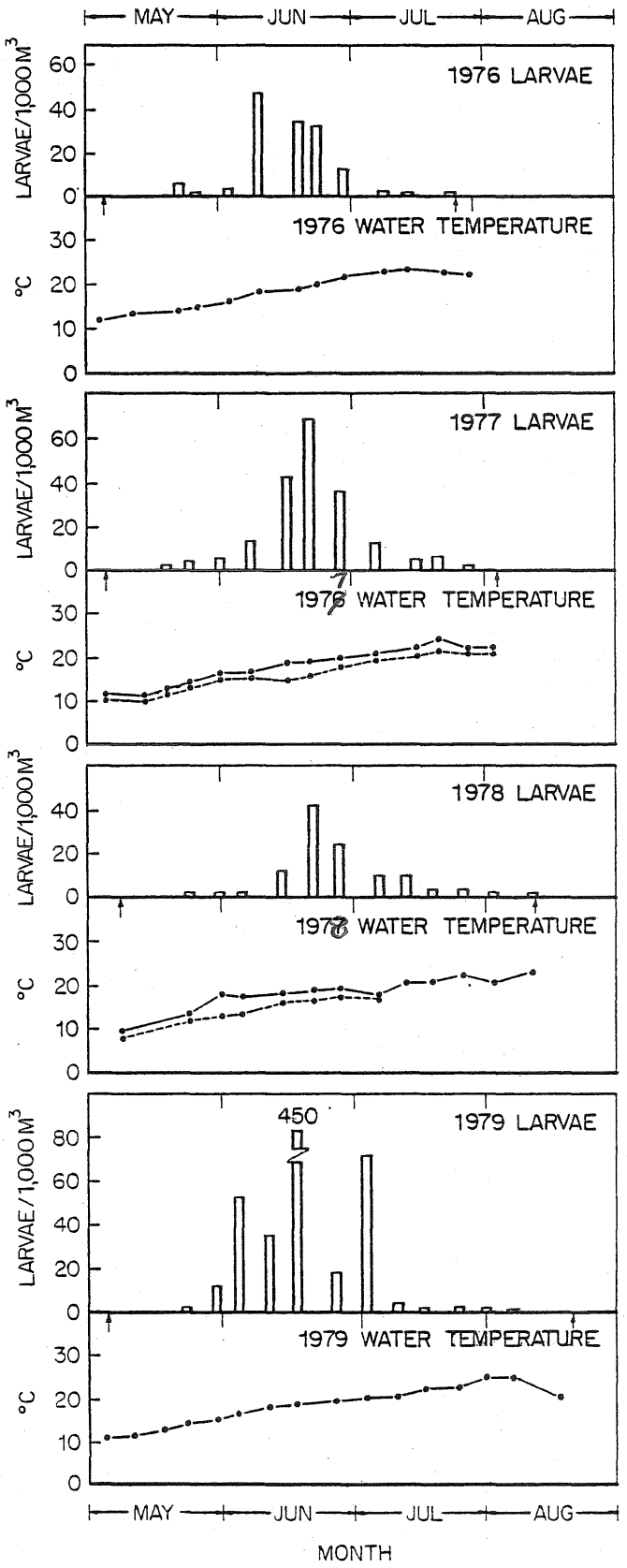

Figure 2.--Numbers of lobster larvae caught per 1,000 m^3 of water filtered and average water temperature for each sampling date in Buzzards Bay neuston sampling, 1976-79. (Surface temperature ————; bottom temperature -------- ; vertical arrows indicate starting and ending dates for sampling in each year.)

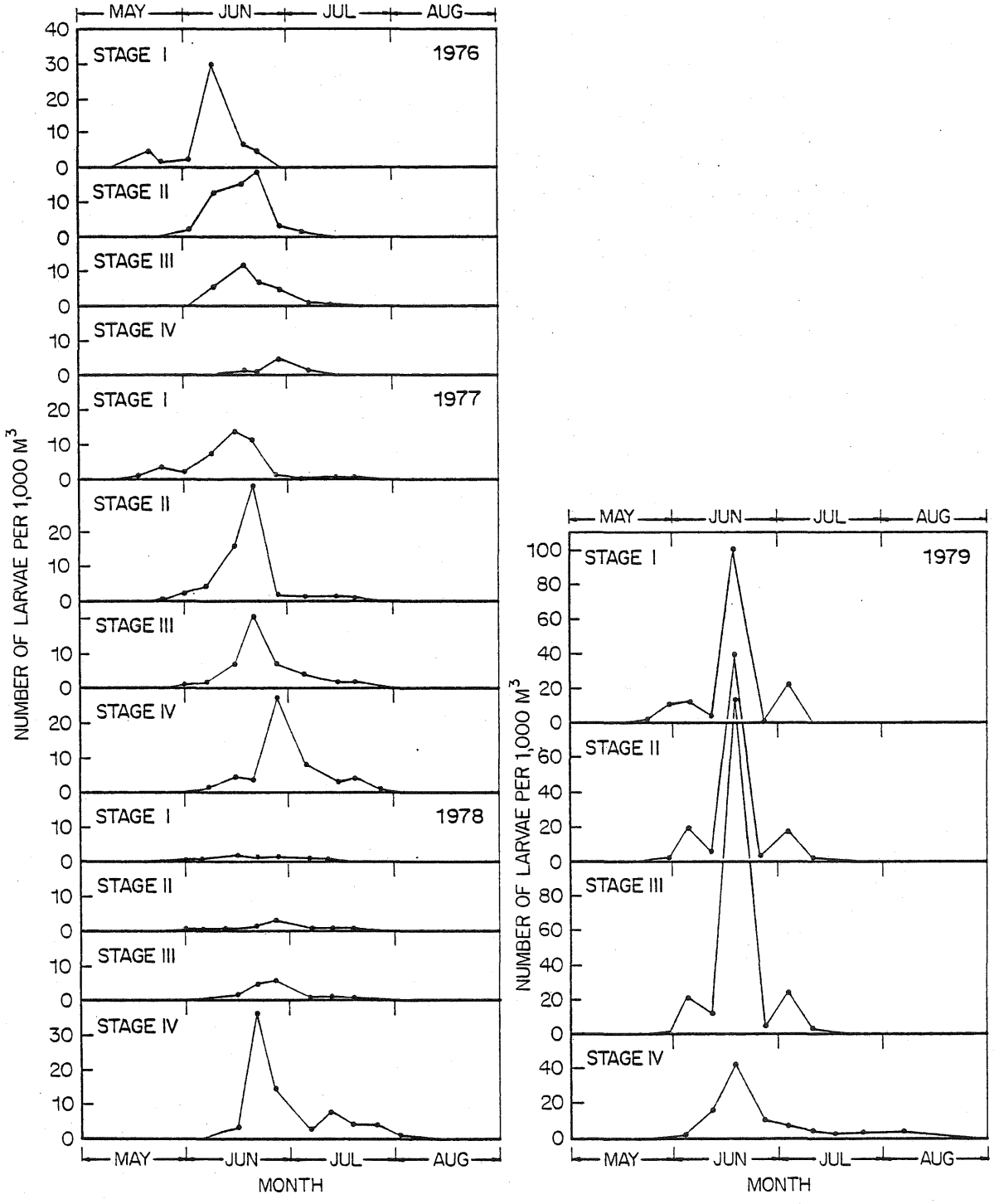

Figure 3.--Numbers, by development stage, of lobster larvae caught per 1,000 m^3 of water filtered for each sampling date in each year, 1976-79.

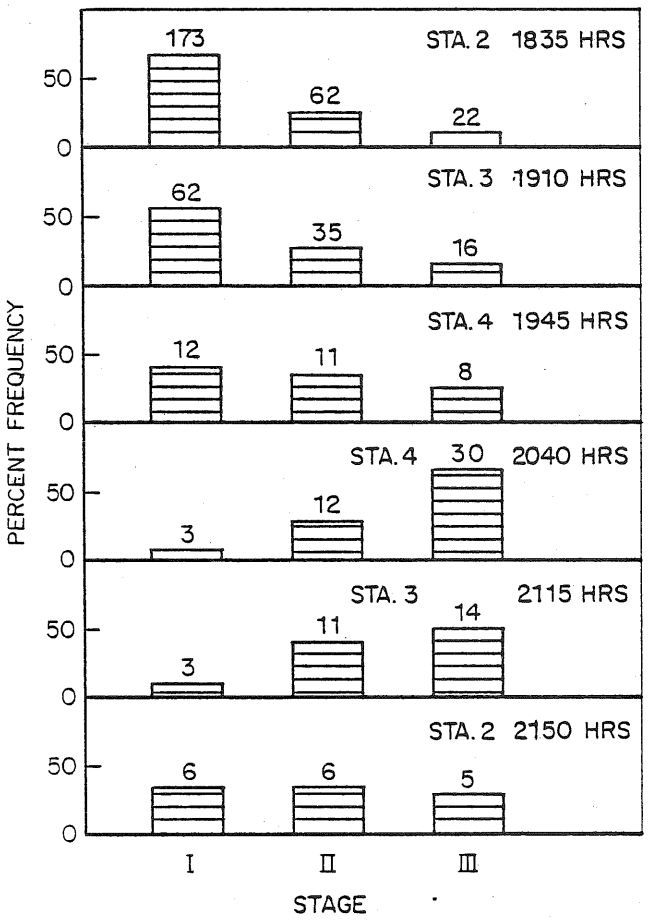

Figure 4.--Percent frequency distributions of lobster larval stages caught during six day-night neuston tows in Buzzards Bay, June 9, 1976. (The times given are EST at the tow midpoints; numbers above each graph are actual numbers of larvae caught; the top three graphs are for the daylight tows, the lower three for those after dark.)

APPENDIX

Tables A-1 to A-15. Catch data by station for larval lobsters caught in neuston tows in Buzzards Bay, Massachusetts in 1976-79.

Table A-1 .--Larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered for all Buzzards Bay neuston stations combined, by sampling dates, in 1976 .

Date	Number of tows	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
May 3	4	–	–	–	–	–	–
" 10	4	–	–	–	–	–	–
" 21	4	57	–	–	–	57	5.1
" 24	4	12	–	–	–	12	1.1
June 2	4	20	23	–	–	43	3.9
" 9*	3	247	108	46	–	401	48.4
" 9+	3	12	29	49	–	90	10.9
" 18	2	30	72	54	5	161	35.0
" 22	4	54	213	74	8	349	32.5
" 28	4	–	36	58	53	147	12.9
July 7	4	–	3	8	10	21	1.9
" 12	4	–	–	1	–	1	0.2
" 20	4	–	–	–	–	–	–
" 26	2	1	–	–	1	2	0.4
Totals	50	433	484	290	77	1,284	

*Daylight + Dark

Table A-2 .--Larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered for all Buzzards Bay neuston stations combined, by sampling dates, in 1977 .

Date	Number of tows	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
May 4	6	–	–	–	–	–	–
" 13	3	–	–	–	–	–	–
" 18	5	6	–	–	–	6	0.4
" 23	6	73	1	–	–	74	4.1
" 31	6	35	48	4	–	87	4.8
June 7	6	126	80	36	10	242	13.4
" 15	6	254	292	127	83	756	42.0
" 20	6	203	599	373	63	1,238	68.7
" 27	6	4	18	116	510	648	36.0
July 5	6	1	11	62	138	212	11.8
" 14	6	3	12	23	56	94	5.2
" 19	6	1	3	28	70	102	5.7
" 26	6	–	–	–	2	2	0.3
August 1	6	–	–	–	–	–	–
Totals	80	705	1,064	759	932	3,461	

Table A-3.--Larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered for all Buzzards Bay neuston stations combined, by sampling dates, in 1978 .

Date	Number of tows	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
May 8	2	–	–	–	–	–	
" 22,23	6	1	–	–	–	1	
" 30	3	11	–	–	–	11	
June 1	3	–	1	–	–	1	
" 5	5	1	1	–	–	2	
" 13,16	6	32	9	27	53	121	
" 21	6	17	29	94	623	763	
" 26,27	6	24	51	100	261	436	
July 6	2	1	1	2	12	16	
" 11,13	6	3	10	19	146	178	
" 18	3	–	1	1	33	35	
" 25	6	–	–	–	61	61	
August 2	3	–	–	–	5	5	
" 11	5	–	–	–	1	1	
Totals	62	90	103	243	1,195	1,631	

Table A-4 .--Larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered for all Buzzards Bay neuston stations combined, by sampling dates, in 1979 .

Date	Number of tows	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
May 3	6	–	–	–	–	–	–
" 9	3	–	–	–	–	–	–
" 17	2	–	–	–	–	–	–
" 22	6	13	–	–	–	13	0.7
" 29	6	196	42	1	–	239	13.3
June 4	6	223	343	384	2	952	52.9
" 11	6	62	80	219	263	624	34.7
" 18	5	1,507	1,779	2,832	628	6,746	449.7
" 26	6	17	48	77	195	337	18.7
July 3	6	395	346	435	132	1,308	72.7
" 10	6	–	.2	12	54	68	3.8
" 16	6	–	–	–	7	7	0.4
" 24	6	–	–	1	4	5	0.5
" 30	6	–	–	1	1	2	0.2
August 6	6	–	–	–	2	2	0.1
" 17	6	–	–	–	–	–	–
Totals	88	2,413	2,640	3,962	1,288	10,303	

Table A-5.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1976.

Stations 1 and 2.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
		STATION NO. 1					
May 3	11.9	–	–	–	–	–	–
" 10	13.0	–	–	–	–	–	–
" 21	14.5	3	–	–	–	3	1.09
" 24	15.0	2	–	–	–	2	0.72
June 2	15.8	1	–	–	–	1	0.36
" 18	19.0	20	39	23	1	83	30.07
" 22	20.6	36	80	29	3	148	56.27
" 28	21.7	–	7	11	1	19	7.04
July 7	23.0	–	2	2	2	6	2.17
" 12	23.7	–	–	–	–	–	–
" 20	22.8	–	–	–	–	–	–
" 26	22.5	1	–	–	1	2	0.82
Total		63	128	65	8	264	8.75
		STATION NO. 2					
May 3	11.8	–	–	–	–	–	–
" 10	13.2	–	–	–	–	–	–
" 21	14.4	14	–	–	–	14	5.07
" 24	14.8	5	–	–	–	5	1.81
June 2	15.7	–	6	–	–	6	2.17
" 9 *	18.6	173	62	22	–	257	93.11
" 9 +	18.0	6	6	5	–	17	6.16
" 18	19.0	10	33	31	4	78	42.39
" 22	20.4	10	20	4	4	38	14.44
" 28	21.6	–	6	13	9	28	10.22
July 7	23.1	–	1	4	8	13	4.54
" 12	23.5	–	–	–	–	–	–
" 20	23.0	–	–	–	–	–	–
" 26	22.7	–	–	–	–	–	–
Total		218	134	79	25	456	12.73

* Daylight
\+ Dark

Table A-6.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1976.

Stations 3 and 4.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
		STATION NO. 3					
May 3	11.8	–	–	–	–	–	–
" 10	12.9	–	–	–	–	–	–
" 21	14.0	4	–	–	–	4	1.45
" 24	14.0	5	–	–	–	5	1.81
June 2	15.6	8	10	–	–	18	6.52
" 9 *	18.5	62	35	16	–	113	40.94
" 9 +	18.0	3	11	14	–	28	10.14
" 22	20.7	6	58	11	–	75	27.57
" 28	21.5	–	17	21	24	62	19.47
July 7	22.9	–	–	2	–	2	0.73
" 12	23.5	–	–	–	–	–	–
" 20	22.9	–	–	–	–	–	–
Total		88	131	64	24	307	9.57
		STATION NO. 4					
May 3	12.2	–	–	–	–	–	–
" 10	13.4	–	–	–	–	–	–
" 21	14.1	36	–	–	–	36	13.04
" 24	14.5	–	–	–	–	–	–
June 2	15.5	11	7	–	–	18	6.52
" 9 *	18.5	12	11	8	–	31	11.23
" 9 +	19.3	3	12	30	–	45	16.30
" 22	21.2	2	55	30	1	88	32.00
" 28	22.0	–	6	13	19	38	13.67
July 7	22.9	–	–	–	–	–	–
" 12	23.9	–	–	1	–	1	0.36
" 20	23.0	–	–	–	–	–	–
Total		64	91	82	20	257	8.13

* Daylight
\+ Dark

Table A-7.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1977.

Stations 1 and 2.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
			STATION	NO. 1			
May 4	12.0	-	-	-	-	-	-
" 13	11.2	-	-	-	-	-	-
" 18	12.4	-	-	-	-	-	-
" 23	14.5	12	-	-	-	12	4.0
" 31	16.0	-	-	-	-	-	-
June 7	15.0	8	1	-	-	9	3.0
" 15	17.9	141	130	41	20	332	110.7
" 20	18.6	27	37	66	8	138	46.0
" 27	19.2	1	1	2	4	8	2.7
July 5	21.0	-	5	33	27	65	21.7
" 14	21.0	1	1	3	5	10	3.3
" 19	23.4	1	1	2	2	6	2.0
" 26	22.1	-	-	-	1	1	0.3
August 1	21.6	-	-	-	-	-	-
Total		191	176	147	67	581	13.8
			STATION	NO. 2			
May 4	12.2	-	-	-	-	-	-
" 13	10.9	-	-	-	-	-	-
" 18	12.6	1	-	-	-	1	0.3
" 23	14.5	12	1	-	-	13	4.3
" 31	15.9	22	33	2	-	57	19.0
June 7	15.7	6	3	-	1	10	3.3
" 15	18.2	13	33	16	9	71	23.7
" 20	18.5	40	101	34	6	181	60.3
" 27	19.5	2	4	11	100	117	39.0
July 5	21.0	-	-	5	12	17	5.7
" 14	21.4	2	10	11	6	29	9.7
" 19	23.5	-	1	2	4	7	2.3
" 26	22.1	-	-	-	-	-	-
August 1	22.1	-	-	-	-	-	-
Total		98	186	81	138	503	12.0

Table A-8.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1977.

Stations 3 and 4.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
			STATION	NO. 3			
May 4	12.2	-	-	-	-	-	-
" 13	10.9	-	-	-	-	-	-
" 18	14.1	-	-	-	-	-	-
" 23	14.4	23	-	-	-	23	7.7
" 31	15.9	11	15	2	-	28	9.3
June 7	16.3	7	6	9	4	26	8.7
" 15	18.1	59	47	26	4	136	45.3
" 20	18.5	135	448	207	8	798	266.0
" 27	19.6	-	12	77	137	226	75.3
July 5	20.9	-	3	17	19	39	13.0
" 14	21.5	-	1	7	4	12	4.0
" 19	23.8	-	-	1	2	3	1.0
" 26	22.0	-	-	-	-	-	-
August 1	22.1	-	-	-	-	-	-
Total		235	532	346	178	1,291	30.7
			STATION	NO. 4			
May 4	11.4	-	-	-	-	-	-
" 18	13.8	4	-	-	-	4	1.3
" 23	14.5	4	-	-	-	4	1.3
" 31	17.0	2	-	-	-	2	0.7
June 7	17.0	47	35	11	2	95	31.7
" 15	19.0	6	8	1	7	22	7.3
" 20	18.9	-	7	23	10	40	13.3
" 27	20.7	1	-	13	46	60	20.0
July 5	22.4	-	-	2	28	30	10.0
" 14	23.7	-	-	2	10	12	4.0
" 19	24.5	-	1	9	20	30	10.0
" 26	22.1	-	-	-	-	-	-
August 1	23.2	-	-	-	-	-	-
Total		64	51	61	123	299	7.1

Table A-9.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1977.

Stations 5 and 6.

Date	Surface °C	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
			STATION	NO. 5			
May 4	11.5	–	–	–	–	–	
" 18	13.2	1	–	–	–	1	0.3
" 23	14.5	14	–	–	–	14	4.7
" 31	16.9	–	–	–	–	–	–
June 7	16.7	52	31	4	3	90	30.0
" 15	19.4	11	19	10	11	51	17.0
" 20	18.7	–	3	16	15	34	11.3
" 27	20.4	–	1	12	127	140	46.7
July 5	21.4	–	–	1	18	19	6.3
" 14	23.5	–	–	–	19	19	6.3
" 19	24.0	–	–	7	23	30	10.0
" 26	22.8	–	–	–	1	1	.3
August 1	23.2	–	–	–	–	–	
Total		78	54	50	217	399	9.5
			STATION	NO. 6			
May 4	11.6	–	–	–	–	–	–
" 23	14.9	7	–	–	–	7	2.3
" 31	16.8	–	–	–	–	–	–
June 7	16.6	6	4	2	–	12	4.0
" 15	19.6	24	55	33	32	144	48.0
" 20	18.8	1	3	37	16	47	15.7
" 27	20.9	–	–	1	96	97	32.3
July 5	21.4	1	3	4	34	42	14.0
" 14	23.6	–	–	–	12	12	4.0
" 19	25.0	–	–	7	19	26	8.7
" 26	22.9	–	–	–	–	–	–
August 1	23.0	–	–	–	–	–	–
Total		39	65	74	209	387	9.2

Table A-10.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1978.

Stations 1 and 2.

Date	Surface °C	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
			STATION	NO. 1			
May 8	9.5	–	–	–	–	–	–
" 22	12.6	–	–	–	–	–	–
" 30	16.5	9	–	–	–	9	3.0
June 5	16.8	–	–	–	–	–	–
" 13	17.7	11	–	–	–	11	3.7
" 21	18.4	5	1	4	80	90	30.0
" 26	19.7	11	30	19	31	91	30.3
July 6	17.8	1	1	1	9	12	4.0
" 11	20.4	2	2	2	24	30	10.0
" 18	20.5	–	–	–	2	2	0.7
" 25	21.6	–	–	–	8	8	2.7
August 2	20.2	–	–	–	5	5	1.7 *
" 11	22.2	–	–	–	1	1	0.5 *
Total		39	34	26	160	259	
			STATION	NO. 2			
May 8	10.0	–	–	–	–	–	–
" 22	12.5	–	–	–	–	–	–
" 30	16.8	–	–	–	–	–	–
June 5	17.4	–	–	–	–	–	–
" 13	17.8	–	–	–	–	–	–
" 21	17.9	2	–	4	80	86	28.7
" 26	19.7	1	–	9	56	66	22.0
July 6	18.1	–	–	1	3	4	2.0
" 11	20.5	1	2	3	16	22	7.3
" 18	20.8	–	1	1	13	15	5.0
" 25	22.3	–	–	–	7	7	2.3
August 2	21.2	–	–	–	–	–	–
" 11	22.5	–	–	–	–	–	–
Total		4	3	18	175	200	

* There was considerable net clogging in these tows; estimate of volume strained therefore is rough.

Table A-11--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1978.

Stations 3 and 4.

Date	Surface °C	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
			STATION	NO. 3			
May 22	12.3	–	–	–	–	–	–
" 30	16.3	2	–	–	–	2	0.7
June 5	17.0	–	–	–	–	–	–
" 13	17.5	–	–	1	–	1	0.3
" 21	18.3	10	26	65	128	229	76.3
" 26	19.1	1	3	4	34	42	14.0
July 11	20.7	–	3	5	8	16	5.3
" 18	21.3	–	–	–	18	18	6.0
" 25	22.7	–	–	–	17	17	5.7
August 2	–	–	–	–	–	–	–
" 11	–	–	–	–	–	–	–
Total		13	32	75	205	325	
			STATION	NO. 4			
May 23	14.0	1	–	–	–	1	0.3
June 1	19.4	–	–	–	–	–	
" 5	17.9	1	1	–	–	2	0.7
" 16	17.9	4	–	1	16	21	7.0
" 21	19.7	–	–	5	136	141	47.0
" 27	20.0	–	–	5	64	69	23.0
July 13	21.2	–	3	7	38	48	16.0
" 25	24.2	–	–	–	12	12	4.0
August 11	23.7	–	–	–	–	–	
Total		6	4	18	266	294	

Table A-12--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1978.

Stations 5 and 6.

Date	Surface °C	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
			STATION	NO. 5			
May 23	14.3	–	–	–	–	–	–
June 1	18.8	–	–	–	–	–	–
" 5	17.7	–	–	–	–	–	–
" 16	17.9	17	8	16	24	65	21.7
" 21	19.8	–	1	11	96	108	36.0
" 27	20.0	–	1	7	30	38	12.7
July 13	21.4	–	–	2	27	29	9.7
" 25	–	–	–	–	12	12	4.0
Total		17	10	36	189	252	
			STATION	NO. 6			
May 23	14.4	–	–	–	–	–	–
June 1	20.0	–	1	–	–	1	0.3
5	NO	TOW	MADE	THIS	DATE		
16	17.8	–	1	9	13	23	7.7
21	19.3	–	1	5	103	109	36.3
27	20.0	11	17	56	46	130	43.3
July 13	21.4	–	–	–	33	33	11.0
25	23.7	–	–	–	5	5	2.5
August 11	24.3	–	–	–	–	–	–
Total		11	20	70	200	301	

Table A-13.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1979.
Stations 1 and 2.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
			STATION	NO. 1			
May 3	11.3	–	–	–	–	–	–
" 9	12.0	–	–	–	–	–	–
" 17	13.4	–	–	–	–	–	–
" 22	14.2	5	–	–	–	5	1.7
" 29	14.8	75	2	–	–	77	25.7
June 4	17.0	92	110	39	–	241	80.3
" 11	17.2	44	18	9	14	85	28.3
" 18	19.0	335	427	641	94	1,497	499.0
" 26	18.2	3	3	7	13	26	17.3
July 3	19.8	71	9	34	18	132	44.0
" 10	19.6	–	–	–	1	1	.3
" 16	20.6	–	–	–	–	–	–
" 24	21.9	–	–	–	–	–	–
" 30	24.9	–	–	–	–	–	–
August 6	25.1	–	–	–	–	–	–
" 17	20.5	–	–	–	–	–	–
Total		625	569	730	140	2,064	
			STATION	NO. 2			
May 3	11.6	–	–	–	–	–	–
" 9	12.0	–	–	–	–	–	–
" 17	13.4	–	–	–	–	–	–
" 22	14.2	3	–	–	–	3	1.0
" 29	15.0	2	–	–	–	2	0.7
June 4	17.0	7	37	26	–	70	23.3
" 11	18.7	1	4	5	27	37	12.3
" 18	18.7	322	436	841	149	1,748	582.7
" 26	18.6	9	22	40	39	110	36.7
July 3	20.0	268	22	28	3	321	107.0
" 10	19.9	–	–	–	2	2	0.7
" 16	22.0	–	–	–	3	3	1.0
" 24	22.5	–	–	–	–	–	–
" 30	24.9	–	–	–	1	1	0.5
August 6	25.2	–	–	–	1	1	0.3
" 17	20.5	–	–	–	–	–	–
Total		612	521	940	225	2,298	

Table A-14.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1979.
Stations 3 and 4.

Date	Surface °C	Numbers of larvae of each stage I	II	III	IV	Total number	Number per 1,000 m^3
			STATION	NO. 3			
May 3	11.3	–	–	–	–	–	–
9	12.0	–	–	–	–	–	–
22	14.3	5	–	–	–	5	1.7
29	15.2	3	4	–	–	7	2.3
June 4	16.6	78	37	36	–	151	50.3
11	18.8	11	26	55	10	102	34.0
18	18.8	813	809	1,072	191	2,885	961.7
26	19.1	1	9	24	66	100	33.3
July 3	20.1	29	10	8	7	54	18.0
10	19.8	–	–	–	1	1	0.3
16	21.9	–	–	–	3	3	1.2
24	22.8	–	–	–	1	1	0.7
30	25.1	–	–	–	–	–	–
August 6	25.1	–	–	–	–	–	–
17	20.5	–	–	–	–	–	–
Total		940	895	1,195	279	3,309	
			STATION	NO. 4			
May 3	11.5	–	–	–	–	–	–
" 22	16.0	–	–	–	–	–	–
" 29	15.2	–	1	–	–	1	0.3
June 4	17.8	5	–	–	–	5	1.7
" 11	19.2	2	10	58	101	171	57.0
" 18	20.1	31	94	254	166	545	181.7
" 26	20.2	–	7	1	17	25	8.3
July 3	21.3	8	95	115	31	249	83.0
" 10	21.3	–	–	1	7	8	2.7
" 16	23.7	–	–	–	–	–	–
" 24	23.3	–	–	1	2	3	1.2
" 30	25.1	–	–	–	–	–	–
August 6	25.9	–	–	–	–	–	–
" 17	20.9	–	–	–	–	–	–
Total		46	207	430	324	1,007	

Table A-15.--Surface water temperature and larval lobster catches in numbers by stage, total numbers, and estimated total numbers per 1,000 m^3 of water filtered at Buzzards Bay neuston stations, by sampling date, in 1979.

Stations 5 and 6.

Date	Surface °C	Numbers of larvae of each stage				Total number	Number per 1,000 m^3
		I	II	III	IV		
			STATION	NO. 5			
May 3	11.5	-	-	-	-	-	-
" 22	16.1	-	-	-	-	-	-
" 29	16.3	46	23	-	-	69	23.0
June 4	17.6	-	3	8	1	12	4.0
" 11	19.6	4	19	74	95	192	64.0
" 18	19.5	6	13	24	28	71	23.7
" 26	20.3	4	4	2	26	36	12.0
July 3	21.4	19	197	215	51	482	160.7
" 10	20.7	-	-	1	6	7	2.3
" 16	23.7	-	-	-	-	-	-
" 24	23.5	-	-	-	-	-	-
" 30	26.1	-	-	-	-	-	-
August 6	25.9	-	-	-	-	-	-
" 17	21.2	-	-	-	-	-	-
Total		79	259	324	207	869	
			STATION	NO. 6			
May 3	11.7	-	-	-	-	-	-
" 22	15.5	-	-	-	-	-	-
" 29	16.3	70	12	1	-	83	27.7
June 4	17.5	41	156	275	1	473	157.7
" 11	19.8	-	3	18	16	37	12.3
" 26	20.5	-	3	3	34	40	13.3
July 3	-	-	13	35	22	70	23.3
" 10	21.3	-	2	10	37	49	16.3
" 16	-	-	-	-	1	1	0.3
" 24	24.0	-	-	-	1	1	0.7
" 30	26.3	-	-	-	-	-	-
August 6	26.0	-	-	-	1	1	0.7
" 17	20.9	-	-	-	-	-	-
Total		111	189	342	113	755	