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DISTRIBUTION AND RELATIVE ABUNDANCE OF LOBSTER LARVAE OFF SOUTHWESTERN NOVA SCOTIA, 1977-1978

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ABSTRACT

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Lobster larvae (Homarus americanus) were surveyed off southwestern Nova Scotia by means of plankton gear during 28 cruises from July to September 1977 and 1978. The objective was to determine the relative temporal and spatial abundance of the four planktonic larval stages both inshore (between St. Mary's Bay and Port LaTour) and offshore to the edge of the continental shelf beyond Browns Bank. A total of 2314 larvae was collected in 1678 plankton gear tows in the surface and near-surface nets. The deep tows with Isaacs-Kidd trawl at 2-20 m below the surface caught only 11 larvae in 160 tows. Lobster larvae were most concentrated in the top 0.15 m of the water. They were found throughout the survey area starting in early July, with catches increasing to a peak in August and decreasing rapidly by early September. Catch per unit effort offshore was approximately 2.5 times greater than inshore in both years. Only the stage IV larvae showed a diurnal pattern of concentration at the surface during the night and some vertical dispersal during daytime. There was a marked scarcity of early stage larvae, particularly stages II and III, possibly as a result of a band of low temperatures (<10°C) off southwestern Nova Scotia which could prevent larval development beyond stage IV, thus causing a "piling up" in stage IV and giving the appearance of disproportionately low abundance of the early stages.

Key words: lobster larvae surveys, depth distribution, spatial distribution, relative abundance, southwestern Nova Scotia

RÉSUMÉ

Stasko, A. B., and D. J. Gordon. 1983. Distribution and relative abundance of lobster larvae off southwestern Nova Scotia, 1977-1978. Can. Tech. Rep. Fish. Aquat. Sci. 1175: iii + 23 p.

Le présent rapport porte sur un levé de larves de homard (Homarus americanus) échantillonnées à l'aide d'engins à plancton de juillet à septembre 1977 et 1978 lors de 28 expéditions au large de la côte sud-ouest de la Nouvelle-Écosse. Il s'agissait de déterminer l'abondance temporelle et spatiale relative des individus aux quatre stades larvaires planctoniques dans les eaux côtières (entre la baie Sainte-Marie et Port-La-Tour) et les eaux hauturières jusqu'au bord de la plate-forme continentale, au-delà du banc de Brown. Au total, 2 314 larves ont été capturées dans les filets de surface et près de la surface au cours de 1 678 traits d'engins à plancton. Seulement onze larves ont été prises à l'aide de chaluts de type Isaacs- Kidd lors de 160 traits dans les eaux profondes de 2 à 20 m. Les larves étaient surtout concentrées dans la partie supérieure, jusqu'à 0,15 m. Elles étaient présentes dans toute la zone explorée à partir du début juillet; les prises ont augmenté à un maximum en août et diminué rapidement au début de septembre. La prise par unité d'effort au large des côtes était environ 2,5 fois plus élevée que dans les eaux côtières au cours des deux années. Seules les larves du stade IV démontraient un schème diurne de concentration à la surface pendant la nuit et une certaine dispersion verticale pendant le jour. La rareté prononcée des jeunes larves, surtout celles des stades II et III, peut être du à la couche de basses températures (10°C) au large de la côte sud-ouest de la Nouvelle-Écosse, températures qui empêcheraient le développement des larves au-delà du stade IV créant ainsi un "amoncellement" des individus parvenus à ce stade et donnant l'impression que les autres sont peu abondants.

INTRODUCTION

The establishment of a Canadian fishery for lobsters in the Browns Bank area and along the northeastern edge of Georges Bank in the early 1970's (Stasko and Pye 1980a, 1980b) raised concern about the effect of this fishery on inshore lobster stocks along the coast of southwestern Nova Scotia (SWNS). It has been hypothesized that adult lobsters from the Browns Bank area are a source of additional larvae to the SWNS inshore stocks which are fished heavily before they reach a size at which females reproduce (Stasko 1978; Stasko and Campbell 1980).

Information on larval lobsters off SWNS is scarce. Several surveys in the late 1960's and early 1970's yielded only 12 larvae (Graham and Wilder 1966; McKenzie 1966a, 1966b; Wilson and Wilder 1967; Wilder and Graham 1973). A summer plankton survey on the Scotian Shelf in 1976 indicated a concentration of lobster larvae in the Browns Bank area (Stasko 1977). This led to surveys in 1977 and 1978 along the coast of SWNS and out to the Browns Bank area during July to September, the period when lobster larvae are known to be in surface waters. The present paper reports the results and preliminary analyses of the 1977-78 surveys off southwestern Nova Scotia.

METHODS

Offshore, starting as close as 5 naut. mi (9.3 km) from shore and extending to the Fundian Channel and the edge of the continental shelf beyond Browns Bank (Fig. 1), 29 stations were sampled up to six times in 1977. In 1978 five stations were deleted (marked with an asterisk in Fig. 1), but 12 new stations on northeast Georges Bank were sampled once in July (Appendix I). The remaining 24 stations were sampled up to six times during July-August, 1978 (Appendix II). For analysis, the offshore stations were grouped into two areas: north of latitude 42°55' and south of 42°55'.

The inshore stations (Fig. 2) were within 2 naut. mi (3.85 km) of the shore, except for station 405 which was near the exposed rocks at Trinity Ledge 5 naut. mi from shore. These stations (Appendix III) were combined into five groups, each of which could be sampled in one day. For analysis the groups were further combined into 'East' (day 1), 'Middle' (days 2 and 3) and 'West' (days 4 and 5). After some initial trials, 33 inshore stations were routinely sampled during seven cruises in 1977, and 31 stations were sampled during ten cruises in 1978 (Appendix IV).

On most cruises some stations were missed due to a variety of circumstances (mostly weather and limited duration of the charters). The number of stations sampled per cruise varied between 11 and 33 offshore, and between 26 and 33 inshore. All inshore sampling and the 1978 offshore sampling were done during daylight. On the 1977 offshore cruises sampling was done around the clock.

Three types of plankton gear were used (Fig. 3). The neuston net, towed with the bottom of the net approximately 0.15 m below the surface (Fig. 4), swept a surface area of approximately 3570 m^2 and strained 535 m^3 of water during a standard 30-min tow at 4 knots (2.06 m/sec). The meter net, with a bag identical to the one used with the neuston gear, was towed in 1977 with the top of its ring approximately 0.3 m below the surface. In 1978, the shallow and deep (also called 'heavy') meter nets were towed with the top of their rings approximately 0.15 and 1 m below the surface, respectively (Fig. 4). During a 30-min tow at 4 knots (2.06 m/sec) the meter nets strained 2910 m^3 of water. The Isaacs-Kidd trawl was towed in three 10-min steps: at 20, 10 and 2 m below the surface, except in shallow inshore areas where in a few cases the deepest step was less than 20 m to avoid the substratum. During a 30-min tow at 4 knots (2.06 m/sec) 2735 m^3 of water were strained (912 m^3 at each of three depths), though much of the water passed through the coarse section of the bag. All gear remained open while being brought up through the surface waters with the boat drifting.

To minimize any disturbance from the boat's wake and its bow wave, the nets were towed from a 3-m boom over the side amidship and approximately a meter above the water. The nets were weighted to keep the tow line short and the nets within 5-10 m of the boom (except the Isaacs-Kidd trawl that was towed far behind depending on the tow depth). Towing was done in a straight line in 1977. In 1978 the tow path was circular. Towing speed was estimated with a flowmeter (General Oceanics Model 2035) towed over the side of the boat.

Routine handling of each sample involved washing the net into tubs. Large matter, such as seaweed, jellyfish and tunicates, was rinsed twice and examined visually for lobster larvae before discarding. The remaining plankton was preserved in jars (5% buffered formalin) for later sorting, staging, counting and measuring of lobster larvae. Staging was done as per Herrick (1911). Absolute numbers were converted to number per 1000 m^3 of water filtered.

Environmental conditions during each tow were recorded and included data on wind direction and speed, cloud cover, fog, precipitation and sea state. Surface temperatures were taken to the nearest 0.1°C. Ship location at the beginning and end of each tow was determined by radar, Decca or Loran. Depth was determined by echo sounder. Surface and seabed drifters were released and water temperature and salinity profiles were taken at selected offshore sites to aid in determining ocean current patterns in the survey area. The hydrographic data are deposited with R. Trites at the Bedford Institute of Oceanography, Dartmouth, N.S.

RESULTS

The surface and near-surface nets (excluding Issacs-Kidd net) caught 2314 larvae in 1678 tows on 17 inshore and 12 offshore cruises from early July to mid-September, 1977-78 (Table 1a). Of these larvae, 805 (0.82/gear tow) were caught inshore and 1509 (2.15/gear tow) offshore. Thus, catch per unit effort offshore was about 2.5 times greater than inshore. In general, catches were low in early July, peaked in August and dropped sharply by mid-September (Table 1a). The Isaacs-Kidd trawl caught only 11 larvae in 160 tows in 1977 (eight stage I, one stage II, and two stage IV). Its use

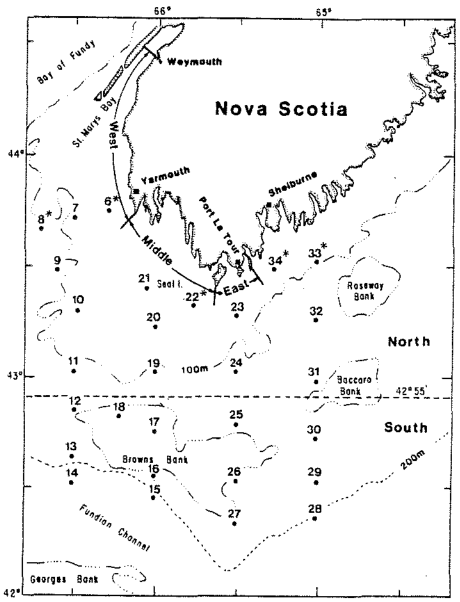

Fig. 1. Study area, showing location of offshore sampling stations and the three inshore areas (West, Middle, East). Sampling at the five stations marked with an asterisk was discontinued in 1978. For analysis, the 29 offshore stations were divided into two areas: north of latitude 42°55'N (16 stations) and south of latitude 42°55'N (13 stations).

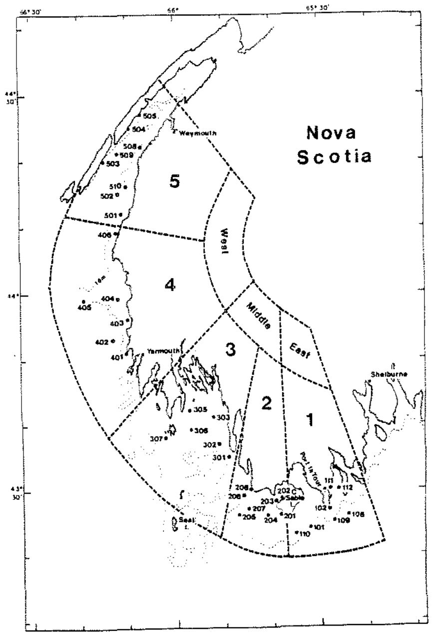

Fig. 2. Inshore study area showing individual stations and grouping of stations into five one-day sampling units (6 to 8 stations per day). For analysis, the five areas were further grouped as West, Middle and East.

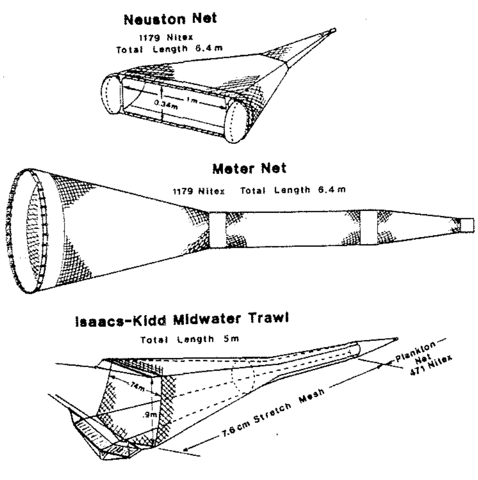

Fig. 3. Sketch of the three types of plankton gear used during the survey.

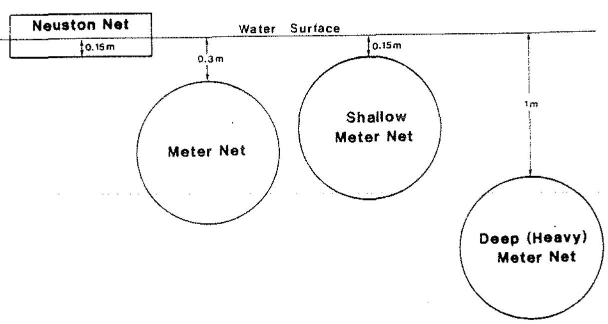

Fig. 4. Position of gear mouth (front view) relative to the water surface, drawn to scale.

was therefore discontinued in 1978 and the Issacs-Kidd data are excluded from subsequent analyses. Detailed catch data for each cruise, showing numbers of larvae (by stage) caught at each station by all gears combined (excluding Isaacs-Kidd net) are displayed graphically in Appendix II for offshore stations, and in Appendix IV for inshore stations.

The surface nets (neuston net and meter nets extending down to 2 m below surface) caught 1043 larvae in 643 tows in 1977 (Table 1b) and 1271 in 1035 tows in 1978 (Table 1c). The neuston net outfished the meter net in all areas in both years, especially when larvae were relatively abundant. In 1978, the low inshore catches in the shallow meter net reflect its use only during the first three cruises early in the season when lobster larvae were scarce. Geographically, the overall catch rates 1977/1978 in sequence from high to low were offshore north (2.63/2.55), offshore south (2.17/1.53), inshore east (1.27/1.06), inshore middle (0.94/0.71), and inshore west (0.82/0.63).

Stage IV larvae were the most numerous in the catches both inshore and offshore (Table 2a), constituting 66% of the catch. They first appeared mid to late July, reached a peak in late August and were still present in reduced numbers by mid September (Table 2b). Stage I larvae were the next most numerous, constituting 39% of the catch. They first appeared in early July, catches peaked early to mid August, then decreased sharply by mid September. Few stage II and III larvae were caught in either year, especially inshore (9 larvae in 976 tows inshore, 110 larvae in 702 tows offshore). They were present during the same time period as stage I.

The neuston net catches, for 1977 (Table 3a) and 1978 (Table 3b) combined, represent 63% of all larvae in the surface and near-surface nets. In 1977 and again in 1978 the offshore neuston net catch rates were at least twice those of inshore areas. Stage I larvae appeared first in the "middle" inshore area in both years. By early August, 1977, stage I larval catch rates offshore were higher than inshore. In 1978, however, offshore catch rates of stage I larvae were less than those inshore.

Stage IV larvae appeared first in the offshore catches in both years. In 1977, offshore catches peaked south of latitude 42°55' (10.21 larvae/1000 m^3) during 1 to 5 August and, subsequently, north of this latitude from 22 to 25 August (5.23 larvae/1000 m^3). Similarly, inshore catches of stage IV larvae peaked during late August. Thus, there appears to be an increase in relative abundance towards the coast with time during the month of August. In 1978, the pattern of peak catches was similar (Table 3b), though the peaks occurred slightly later.

Trends in the meter net catches (Tables 4a, 4b, 5) are, in general, similar to those for the neuston net, but with lower catch rates in the deeper nets.

The catch rates as a measure of relative abundances should be interpreted cautiously because of the patchy nature of the larval distribution. Great variability exists between catches from station to station (see Appendix II, IV). On any one cruise there were always stations with no lobster larvae in the neuston net, i.e. in the most successful gear type. The maximum neuston net catch at one station was 97 larvae which is 4.2% of the total larvae caught.

Changes in depth distribution of larvae between day and night are shown in Table 6. Only the offshore data for 1977 are examined, using only paired neuston-meter samples from simultaneous tows. Paired tows with no larvae in either gear are excluded. The data are the number of larvae per tow uncorrected for volume of water strained (the meter net strains over 5 times more water). More stage I larvae were caught per tow in the shallower neuston net than in the meter net, both in the daytime as well as at night. However, for stage IV larvae the relative catches at the two depths changed, with fewer stage IV larvae found in the top 15 cm of water during the daytime than at night.

DISCUSSION

The July to September sampling period appears to bracket the time when lobster larvae are present in the surface waters off southwestern Nova Scotia. This period of larval presence is slightly later than previously reported for Connecticut and southern Massachusetts (Lund and Stewart 1970) and the southern Gulf of St. Lawrence (Scarratt 1964, 1973) where water temperatures rise faster and higher than off SWNS.

Stage I larvae first appeared in early July, but stage IV larvae soon dominated catches. Few stage I, II, and III larvae were caught. Such a distribution of stages is inconsistent with observations in the Gulf of St. Lawrence (Scarratt 1964) and off Connecticut and southern Masachusetts (Lund and Stewart 1970), but has been noted in the Gulf of Maine (Sherman and Lewis 1967), and on the Scotian Shelf in 1976 (Stasko 1977).

The number of larvae per standard neuston net tow for stages I, II, III, and IV averaged for the two years was 0.48, 0.06, 0.03, and 1.27, respectively. These estimates are not directly comparable to work carried out from 1948 to 1963 in Northumberland Strait (Scarratt 1964) because Scarratt's gear sampled a 60-cm layer in contrast to our shallower depth of 15 cm. However, about the same surface area was covered by the two neuston nets (3570 m^2 in SWNS and 3430 m^2 in Northumberland Strait).

For comparison, mean numbers of larvae per tow in each stage were computed from Scarratt's (1964) intensive sampling over a 13-yr period in Northumberland Strait. Numbers per tow were 34.76, 6.02, 2.06 and 1.53 for stages I, II, III and IV respectively. Thus, the number of larvae per unit volume strained in the Northumberland Strait survey was about 70, 100, and 70 times greater than off SWNS, for stages I, II, and III, respectively. However, the number of stage IV larvae per unit volume strained was similar at the two locations (1.53 for the Strait and 1.27 for SWNS). Such comparisons between the two studies are valid only if the lobster larvae are mostly in the top 15 cm below surface.

Another way of evaluating the relative abundance of the different stages is to calculate the number/1000 m^3 of early stage larvae that should be available in the samples to produce the observed number of stage IV larvae (i.e. 1527, as per Table 2a) based on the duration of each stage. Table 7 shows the duration of each stage at various constant temperatures (Templeman 1936). The calculated numbers of early stages at the right of Table 7 are minimum numbers based on the extremely conservative (and unrealistic) assumptions that 1) stage IV larvae remain in surface waters until they molt into stage V, and 2) there is no larval mortality from stage I through stage IV. Yet even with such conservative assumptions the required numbers of stage II and III larvae greatly exceed the observed numbers (bottom of Table 7).

Several possibilities can be considered to explain the low numbers of stage II and III larvae relative to stage IV observed in our samples. There may be a real scarcity of early stage larvae in the study area. This is unlikely because of the abundance of berried females in the Browns Bank area (Stasko 1980) and the large area sampled (more than 60 x 60 naut. mi, not counting the few samples on Georges Bank). Alternatively, the numbers of early stage larvae in the samples may not be representative of the ratio of the larval populations in the study area due to inadequate sampling (e.g. depth distribution, patchiness). The early stages might conceivably be thinly dispersed throughout the water column while stage IV is concentrated at the surface. This was not evident in our limited sampling with the Isaacs-Kidd midwater trawl, nor in the earlier oblique bongo-net tows (Stasko 1977).

Another possibility is the inability of lobster larvae to develop beyond stage IV at temperatures of 9°C or less (Templeman 1936). Thus, if stage IV larvae encountered such low temperatures, the amount of time spent in stage IV would increase relative to the time spent in stages I to III. Such "piling-up" of larvae in Stage IV would be seen as an apparent greater relative abundance of stage IV. In the study area, measurements indicate that there is, in fact, a band of low temperatures offshore in the vicinity of stations 7, 10 and 19-24 (Fig. 1), and inshore in area 1 (Fig. 2). Temperatures of 6 to 12°C persist here through July-August-September.

Thus, larvae originating in the coldwater band or drifting through it could be blocked, at least temporarily, from developing into stage V, leading to an accumulation of stage IV larvae. This cannot be the entire explanation, however, since in the southern part of the offshore sampling area where water temperatures are higher there was still a preponderance of stage IV larvae in the catches.

The present data neither confirm nor contradict the hypothesis (Stasko 1978) that larvae from offshore drift towards SWNS on the prevailing currents to contribute to recruitment of lobsters inshore. In a simple model of the hypothesis one would expect later stage larvae to be progressively more abundant from offshore to inshore as the prevailing currents (Bumpus and Lauzier 1965) carry more larvae shoreward. In our survey the data from both inshore and offshore areas show such a preponderance of stage IV larvae and so few intermediate stage larvae as to not fit expected ratios of early-to-late stages that allow for natural mortality.

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Table 1a. Number of lobster larvae caught (left of hyphen), corresponding number of tows (right of hyphen) and larvae per tow (in brackets) with the neuston net (N in 1977 and 1978), meter net (M in 1977 only), shallow meter net (SM in 1978 only) and heavy meter net (HM in 1978 only) at inshore and offshore stations.

PERIOD	INSHORE					OFFSHORE				
	1977	1978	HM	M+SM	N	1977	1978	HM	M+SM	N
Early July	June 28-July 6	July 3-7	0-8 (0)	2-29 (0.07)	5-59 (0.08)	July 5-7	July 7	0.3 (0)	1-13 (0.08)	0-15 (0)
Mid-July	July 8-14	July 11-15	10-25 (0.40)	19-41 (0.46)	13-56 (0.23)	July 19-23	July 12-15 } July 24-27 }	7-62 (0.11)	16-82 (0.20)	24-82 (0.29)
Late July	July 26-30	July 24-28	9-27 (0.33)	29-53 (0.55)	26-58 (0.45)					
Early August		July 31-Aug 6 } Aug 7-11 }	32-57 (0.56)	18-26 (0.69)	116-91 (1.27)	Aug 1-5	Aug 1-4	13-24 (0.54)	110-52 (2.12)	401-69 (5.81)
	Aug 8-12					Aug 8-11 }	Aug 14-18 }	96-24 (4.00)	213-52 (4.10)	229-52 (4.40)
Mid-August	Aug 16-20	Aug 14-18	21-30 (0.70)	9-24 (0.38)	103-59 (1.74)					
Late August	Aug 22-27	Aug 21-25 } Aug 28-Sept 2 }	43-59 (0.73)	20-24 (0.83)	289-87 (3.32)	Aug 22-25	Aug 21-24	18-24 (0.75)	142-43 (3.30)	222-47 (4.72)
September	Sept 12-18	Sept 4-10 } Sept 18-22 }	12-46 (0.26)	4-27 (0.15)	25-90 (0.28)	Sept 12-16		0-0 (-)	7-29 (0.24)	10-29 (0.34)
TOTAL:	7 cruises	10 cruises	127-252(0.50)	101-224(0.45)	557-500(1.15)	6 cruises	6 cruises	134-137(0.98)	489-271(0.98)	886-294(3.01)
COMBINED GEARS				805-976 (0.82)					1509-702(2.15)	

GRAND TOTAL INSHORE + OFFSHORE, BOTH YEARS: HM 261-389, M+SM 590-495, N 1463-794, for a total of 2,314 larvae in surface and near-surface gear, plus 11 additional in the 160 Isaacs-Kidd tows in 1977 only, equals 2,325 lobster larvae overall.

Table lb. Number of lobster larvae caught (left of hyphen) and corresponding number of tows (right of hyphen) in 1977, listed by gear type (N - neuston net, M - meter net), by cruise and by geographical areas, separately for inshore and offshore (Fig. 1).

INSHORE	M	N	M	N	M	N	M	N
Cruise date	West		Middle		East		W+M+E	
June 28-July 6	0-0	0-10	0-0	5-13	0-0	0-7	0-0	5-30
July 8-14	0-3	2-12	7-12	6-14	6-3	3-4	13-18	11-30
July 26-30	4-10	3-12	20-10	22-12	1-3	0-4	25-23	25-28
Aug. 8-12	6-10	31-12	5-12	14-14	7-4	3-6	18-26	48-32
Aug. 16-20	3-10	14-12	4-9	16-10	2-5	7-7	9-24	37-29
Aug. 22-27	6-8	34-9	9-11	33-12	5-5	47-7	20-24	114-28
Sept. 12-18	0-10	4-12	0-12	4-14	4-5	0-7	4-27	8-33
Total	19-51	88-79	45-66	100-89	25-25	60-42	89-142	248-210
Larvae/tow	(0.37)	(1.11)	(0.68)	(1.12)	(1.00)	(1.43)	(0.63)	(1.18)
Combined gears	107-130		145-155		85-67		337-352	
Larvae/tow	(0.82)		(0.94)		(1.27)		(0.96)	

OFFSHORE	M	N	M	N	M	N
Cruise date	North		South		N+S	
July 5-7	0-5	0-7	1-5	0-5	1-10	0-12
July 19-23	3-9	1-9	2-11	6-11	5-20	7-20
Aug. 1-5	19-16	174-25	17-12	175-20	36-28	349-45
Aug. 8-11	30-16	66-16	11-12	7-12	41-28	73-28
Aug. 22-25	75-12	57-16	20-7	25-7	95-19	82-23
Sept. 12-16	0-16	3-16	7-13	7-13	7-29	10-29
Total	127-74	301-89	58-60	220-68	185-134	521-157
Larvae/tow	(1.72)	(3.38	(0.97)	(3.24)	(1.38)	(3.32)
Combined gears	428-163		278-128		706-291	
Larvae/tow	(2.63)		(2.17)		(2.43)	

Inshore & Offshore, Total	1977:	1043	larvae in	643	gear	tows	(Table 1b)
	1978:	1271	" "	1035	"	"	(Table 1c)
		2314	" "	1678	"	"	

[a]An additional 11 larvae were caught in 1977 in 160 stepwise oblique tows with the Isaacs-Kidd net.

Table 1c. Number of larvae caught (left of hyphen) and corresponding number of tows (right of hyphen) in 1978 , listed by gear type (N - neuston net, SM - shallow meter net, HM - heavy meter net), by cruise and by geographical areas, separately for inshore and offshore.

INSHORE	HM	SM	N	HM	SM	N	HM	SM	N	HM	SM	N
Cruise date	West			Middle			East			Total W+M+E		
July 3-7	0-4	0-11	0-11	0-3	2-12	0-12	0-1	0-6	0-6	0-8	2-29	0-29
July 11-15	0-10	0-7	0-10	10-12	6-13	2-13	0-3	0-3	0-3	10-25	6-23	2-26
July 24-28	2-11	0-11	0-11	6-11	4-13	0-13	1-5	0-6	1-6	9-27	4-30	1-30
July 31-Aug 6	9-11	0-0	11-11	10-11	0-0	19-12	1-5	0-0	3-6	20-27	0-0	33-29
Aug. 7-11	7-11	0-0	27-11	4-13	0-0	3-13	1-6	0-0	5-6	12-30	0-0	35-30
Aug. 14-18	7-11	0-0	38-11	13-13	0-0	9-13	1-6	0-0	19-6	21-30	0-0	66-30
Aug. 21-25	3-10	0-0	8-10	11-13	0-0	8-13	17-6	0-0	12-6	31-29	0-0	28-29
Aug. 28-Sept. 2	3-11	0-0	22-11	5-13	0-0	80-13	4-6	0-0	45-6	12-30	0-0	147-30
Sept. 4-10	1-9	0-0	2-9	4-12	0-0	1-12	5-6	0-0	12-6	10-27	0-0	15-27
Sept. 18-22	0-1	0-0	1-11	1-13	0-0	1-13	1-5	0-0	0-6	2-19	0-0	2-30
Total	32-89	0-29	109-106	64-114	12-38	123-127	31-49	0-15	97-57	127-252	12-82	329-290
Larvae/tow	(0.36)	(0)	(1.03)	(0.56)	(0.32)	(0.97)	(0.63)	(0)	(1.70)	(0.50)	(0.15)	(1.13)
Combined gears	141-224			199-279			128-121			468-624		
Larvae/tow	(0.63)			(0.71)			(1.06)			(0.75)		

OFFSHORE	HM	SM	N	HM	SM	N	HM	SM	N
Cruise date	North			South			N + S		
July 7	0-3	0-3	0-3	0-0	0-0	0-0	0-3	0-3	0-3
July 12-15	0-10	0-10	1-10	4[a]-28	5[a]-28	1[a]-28	4[a]-38	5[a]-38	2[a]-38
July 24-27	1-11	0-11	1-11	2-13	6-13	14-13	3-24	6-24	15-24
Aug. 1-4	3-11	25-11	15-11	10-13	49-13	37-13	13-24	74-24	52-24
Aug. 14-18	50-11	112-11	83-11	46-13	60-13	73-13	96-24	172-24	156-24
Aug. 21-24	6-11	29-11	110-11	12-13	18-13	30-13	18-24	47-24	140-24
Total	60-57	166-57	210-57	74-80	138-80	155-80	134-137	304-137	365-137
Larvae/tow	(1.05)	(2.91)	(3.68)	(0.93)	(1.73)	(1.94)	(0.98)	(2.22)	(2.66)
Combined gears	436-171			367-240			803-411		
Larvae/tow	(2.55)			(1.53)			(1.95)		

[a]Includes 36 gear tows (12 stations) on the northeast tip of Georges Bank with a total of 5 larvae (HM - 2; SM - 3).

Table 2a. Number (% in brackets) of lobster larvae caught in all gears combined (excluding Isaacs-Kidd trawl) listed by larval stage.

Larval stage	Inshore 1977	Inshore 1978	Inshore Total(%)	Offshore 1977	Offshore 1978	Offshore Total(%)	Inshore and offshore 1977	Inshore and offshore 1978	Inshore and offshore TOTAL(%)
I	186	128	314 (39)	266	88	354 (23)	452	216	668 (29)
II	1	6	7 (1)	50	23	73 (5)	51	29	80 (3)
III	1	1	2 (0.2)	12	25	37 (3)	13	26	39 (2)
IV	149	333	482 (60)	378	667	1045 (69)	527	1000	1527 (66)
Total	337	468	805 (100)	706	803	1509 (100)	1043	1271	2314 (100)

Table 2b. Number of lobster larvae caught per 1000 m^3 water filtered (1977 and 1978 combined), listed by gear type, time period, and larval stage.

Gear Type	Period	INSHORE Vol. '000 m^3	INSHORE No. of Larvae	INSHORE Larval Stage I	II	III	IV	I-IV	OFFSHORE Vol. '000 m^3	OFFSHORE No. of Larvae	OFFSHORE Larval Stage I	II	III	IV	I-IV
Neuston	Early July	36	5	0.14	0	0	0	0.14	11	0	0	0	0	0	0
	Mid-late July	67	39	0.54	0	0	0.04	0.58	51	24	0.08	0.02	0.14	0.24	0.47
	Early-mid Aug.	85	219	0.99	0	0	1.59	2.58	70	630	2.91	0.53	0.20	5.40	9.05
	Late August	49	289	0.80	0.02	0.02	5.07	5.91	26	222	0.42	0.34	0.11	7.59	8.47
	September	51	25	0.06	0	0	0.43	0.49	16	10	0	0	0	0.62	0.62
	Total	288	577	0.58	0	0	1.42	2.00	174	886	1.26	0.27	0.14	3.44	5.10
Meter and shallow meter	Early July	105	2	0.01	0.01	0	0	0.02	47	1	0.02	0	0	0	0.02
	Mid-late July	286	48	0.16	0	0	0.01	0.17	267	16	0.04	0	0.01	0.01	0.06
	Early-mid Aug.	146	27	0.13	0	0	0.05	0.19	303	323	0.22	0.03	0.01	0.81	1.07
	Late August	70	20	0.14	0	0	0.14	0.29	126	142	0.12	0.09	0	0.92	1.13
	September	79	4	0.01	0	0	0.04	0.05	85	7	0	0	0	0.08	0.08
	Total	686	101	0.11	0	0	0.03	0.15	828	489	0.11	0.02	0.01	0.45	0.59
Heavy meter	Early July	29	0	0	0	0	0	0	11	0	0	0	0	0	0
	Mid-late July	157	19	0.12	0	0	0	0.12	208	7	0.01	0	0.01	0	0.03
	Early-mid Aug.	253	53	0.16	0.01	0	0.04	0.21	140	109	0.26	0.04	0.03	0.45	0.78
	Late August	172	43	0.05	0.01	0	0.20	0.25	70	18	0.06	0	0	0.20	0.26
	September	134	12	0.02	0.01	0.01	0.05	0.09							
	Total	745	127	0.10	0.01	0	0.07	0.17	429	134	0.10	0.01	0.01	0.18	0.31
Overall total		1719	805					0.47	1431	1509					1.05

Table 3a. Number of lobster larvae per 1000 m^3 of water filtered by neuston net in 1977, listed by area, cruise, and larval stage.

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
INSHORE:	West							Middle							East						
June 28–July 6	5	0	0	0	0	0	0	7	5	0.69	0	0	0	0.69	4	0	0	0	0	0	0
July 8–14	7	2	0.30	0	0	0	0.30	8	6	0.77	0	0	0	0.77	2	3	1.27	0	0	0	1.27
July 26–30	7	3	0	0	0	0.43	0.43	8	22	2.89	0	0	0	2.89	3	0	0	0	0	0	0
Aug. 8–12	7	31	3.31	0	0	1.15	4.47	8	14	1.24	0	0	0.50	1.74	4	3	0	0	0	0.83	0.83
Aug. 16–20	7	14	0.58	0	0	1.44	2.02	5	16	2.64	0	0	0.20	2.81	4	7	0.72	0	0	0.96	1.69
Aug. 22–27	5	34	0	0	0.19	6.43	6.63	7	33	3.68	0	0	1.18	4.85	4	47	0.24	0	0	11.08	11.33
Sept. 12–18	7	4	0	0	–	0.58	0.58	8	4	0.25	0	0	0.25	0.50	4	0	0	0	0	0	0
Combined			0.64	0	0.02	1.29	1.95			1.66	0	0	0.29	1.95			0.28	0	0	2.11	2.39
Total	45	88	29	0	1	58		51	100	85	0	0	15		25	60	7	0	0	53	
OFFSHORE:	North							South							Total (N+S)						
July 5–7	5	0	0	0	0	0	0	4	0	0	0	0	0	0	8	0	0	0	0	0	0
July 19–23	5	1	0	0	0	0.19	0.19	6	6	0.33	0	0.16	0.49	0.98	11	7	0.18	0	0.09	0.35	0.62
Aug. 1–5	15	174	7.79	0.92	0.20	2.49	11.39	12	175	3.29	0.33	0.58	10.21	14.42	28	349	5.80	0.66	0.36	5.91	12.46
Aug. 8–11	9	66	3.60	0.90	0	2.92	7.42	7	7	0.30	0	0	0.75	1.05	16	73	2.18	0.51	0	1.99	4.69
Aug. 22–25	9	57	0.56	0.45	0.11	5.23	6.34	4	25	1.54	1.28	0	3.60	6.43	13	82	0.85	0.70	0.08	4.74	6.37
Sept. 12–16	9	3	0	0	0	0.33	0.33	7	7	0	0	0	0.97	0.97	16	10	0	0	0	0.62	0.62
Combined			2.99	0.50	0.08	2.20	5.77			1.27	0.23	0.20	3.87	5.57			2.25	0.38	0.13	2.92	5.68
Total	52	301	156	26	4	115		40	220	50	9	8	153		92	521	206	35	12	268	
INSHORE:															Total (W+M+E)						
June 28–July 6															17	5	0.30	0	0	0	0.30
July 8–14															17	11	0.65	0	0	0	0.65
July 26–30															17	25	1.27	0	0	0.17	1.44
Aug. 8–12															18	48	1.78	0	0	0.81	2.58
Aug. 16–20															17	37	1.31	0	0	0.89	2.21
Aug. 22–27															16	114	1.62	0	0.06	5.41	7.09
Sept. 12–18															19	8	0.10	0	0	0.31	0.42
Combined																	1.00	0	0.01	1.04	2.05
Total															121	248	121	0	1	126	

Table 3b. Number of lobster larvae per 1000 m^3 of water filtered by neuston net in 1978, listed by area, cruise, and larval stage.

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
INSHORE:	West							Middle							East						
July 3–7	8	0	0	0	0	0	0	8	0	0	0	0	0	0	4	0	0	0	0	0	0
July 11–15	7	0	0	0	0	0	0	9	2	0.22	0	0	0	0.22	2	0	0	0	0	0	0
July 24–28	5	0	0	0	0	0	0	6	0	0	0	0	0	0	4	1	0.24	0	0	0	0.24
July 31–Aug. 6	6	11	0.65	0	0	1.14	1.80	8	19	2.69	0	0	0.15	2.84	4	3	0.30	0	0	0.60	0.90
Aug. 7–11	6	27	0	0	0	4.41	4.41	7	3	0.14	0	0	0.28	0.41	4	5	1.20	0	0	0.30	1.50
Aug. 14–18	6	38	0	0	0	6.21	6.21	7	9	0.14	0	0	1.11	1.24	4	19	0	0	0	5.69	5.69
Aug. 21–25	5	8	0.54	0	0	0.90	1.44	7	8	0	0	0	1.11	1.11	3	12	0	0	0	3.59	3.59
Aug. 28–Sept 2	6	22	0	0	0	3.59	3.59	7	80	1.38	0.14	0	9.54	11.07	3	45	0	0	0	13.47	13.47
Sept. 4–10	5	2	0	0	0	0.40	0.40	7	1	0.15	0	0	0	0.15	3	12	0	0	0	3.59	3.59
Sept. 18–22	6	1	0	0	0	0.16	0.16	7	1	0	0	0	0.14	0.14	3	0	0	0	0	0	0
Combined			0.12	0	0	1.69	1.81			0.45	0.01	0	1.22	1.69			0.18	0	0	2.69	2.87
Total	60	109	7	0	0	102		73	123	33	1	0	89		34	97	6	0	0	91	
OFFSHORE:	North							South							Total (N+S)						
July 7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
July 11–15	7	1	0	0	0.14	0	0.14	12	1	0	0	0.08	0	0.08	27[a]	2	0	0	0.08	0	0.08
July 24–28	7	1	0	0.16	0	0	0.16	8	14	0.28	0	0.55	1.11	1.94	14	15	0.15	0.07	0.30	0.60	1.12
July 31–Aug. 4	6	15	0.16	0	0	2.29	2.45	7	37	0	0	0.28	4.84	5.12	13	52	0.07	0	0.15	3.67	3.90
Aug. 14–18	6	83	0.16	0	0.16	13.24	13.56	7	73	1.11	1.52	0.14	7.33	10.10	13	156	0.67	0.82	0.15	10.04	11.69
Aug. 21–25	6	110	0	0	0	17.97	17.97	7	30	0	0	0.28	3.87	4.15	13	140	0	0	0.15	10.34	10.49
Combined			0.06	0.03	0.06	6.12	6.27			0.25	0.27	0.25	3.04	3.81			0.15	0.15	0.15	4.02	4.45
Total	34	210	2	1	2	205		41	155	10	11	10	124		82[a]	365	12	12	12	329	

INSHORE:	Total (W+M+E)						
July 3–7	20	0	0	0	0	0	0
July 11–15	18	2	0.11	0	0	0	0.11
July 24–28	19	1	0.07	0	0	0	0.07
July 31–Aug. 6	16	33	1.43	0	0	0.62	2.05
Aug. 7–11	17	35	0.30	0	0	1.80	2.10
Aug. 14–18	17	66	0.06	0	0	3.90	3.96
Aug. 21–25	16	28	0.19	0	0	1.55	1.74
Aug. 28–Sept. 2	17	147	0.60	0.06	0	8.15	8.81
Sept. 4–10	15	15	0.07	0	0	0.93	1.00
Sept. 18–22	17	2	0	0	0	0.12	0.12
Combined			0.28	0.01	0	1.69	1.97
Total	167	329	46	1	0	282	

[a]Includes one cruise on Georges Bank. No larvae were caught in 7.64 x 1000 m^3 of water filtered.

Table 4a. Number of lobster larvae per 1000 m^3 of water filtered by meter net in 1977, listed by area, cruise, and larval stage.

INSHORE: West

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 8–14	9	0	0	0	0	0	0
July 26–30	29	4	0.07	0.03	0	0.03	0.14
Aug. 8–12	29	6	0.17	0	0	0.03	0.21
Aug. 16–20	29	3	0.03	0	0	0.07	0.10
Aug. 22–27	23	6	0.04	0	0	0.21	0.26
Sept. 12–18	29	0	0	0	0	0	0
Combined			0.06	0.01	0	0.06	0.13
Total	148	19	9	1	0	9	

INSHORE: Middle

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 8–14	35	7	0.20	0	0	0	0.20
July 26–30	33	20	0.58	0	0	0.03	0.61
Aug. 8–12	35	5	0.11	0	0	0.03	0.14
Aug. 16–20	26	4	0.15	0	0	0	0.15
Aug. 22–27	32	9	0.25	0	0	0.03	0.28
Sept. 12–18	35	0	0	0	0	0	0
Combined			0.21	0	0	0.02	0.23
Total	196	45	42	0	0	3	

INSHORE: East

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 8–14	9	6	0.69	0	0	0	0.69
July 26–30	11	1	0.09	0	0	0	0.09
Aug. 8–12	12	7	0.26	0	0	0.34	0.60
Aug. 16–20	14	2	0.14	0	0	0	0.14
Aug. 22–27	14	5	0.07	0	0	0.27	0.34
Sept. 12–18	15	4	0.07	0	0	0.21	0.27
Combined			0.19	0	0	0.15	0.33
Total	75	25	14	0	0	11	

OFFSHORE: North

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 5–7	18	0	0	0	0	0	0
July 19–23	27	3	0.04	0.04	0	0.04	0.11
Aug. 1–5	47	19	0.26	0	0	0.15	0.41
Aug. 8–11	47	30	0.47	0.06	0	0.11	0.64
Aug. 22–25	35	75	0.17	0.11	0	1.84	2.12
Sept. 12–16	47	0	0	0	0	0	0
Combined			0.19	0.04	0	0.35	0.57
Total	221	127	41	8	0	78	

OFFSHORE: South

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 5–7	18	1	0.05	0	0	0	0.05
July 19–23	32	2	0.06	0	0	0	0.06
Aug. 1–5	35	17	0.26	0	0	0.23	0.49
Aug. 8–11	35	11	0	0	0	0.31	0.31
Aug. 22–25	20	20	0.34	0.34	0	0.29	0.98
Sept. 12–16	38	7	0	0	0	0.18	0.18
Combined			0.11	0.04	0	0.18	0.33
Total	178	58	19	7	0	32	

OFFSHORE: Total (N+S)

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 5–7	36	1	0.03	0	0	0	0.03
July 19–23	59	5	0.05	0.02	0	0.02	0.08
Aug. 1–5	81	36	0.26	0	0	0.18	0.44
Aug. 8–11	82	41	0.27	0.04	0	0.20	0.50
Aug. 22–25	56	95	0.23	0.20	0	1.27	1.70
Sept. 12–16	85	7	0	0	0	0.08	0.08
Combined			0.15	0.04	0	0.28	0.46
Total	399	185	60	15	0	110	

INSHORE: Total (W+M+E)

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I–IV
July 8–14	52	13	0.25	0	0	0	0.25
July 26–30	73	25	0.30	0.01	0	0.03	0.34
Aug. 8–12	76	18	0.16	0	0	0.08	0.24
Aug. 16–20	70	9	0.10	0	0	0.03	0.13
Aug. 22–27	70	20	0.14	0	0	0.14	0.29
Sept. 12–18	78	4	0.01	0	0	0.04	0.05
Combined			0.16	0	0	0.05	0.21
Total	419	89	65	1	0	23	

Table 4b. Number of lobster larvae per 1000 m^3 of water filtered by shallow meter net in 1978, listed by area, cruise, and larval stage.
larval stage.

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV
OFFSHORE:	North							South							Total (N+S)						
July 7	11	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
July 11-15	36	0	0	0	0	0	0	62	2	0.03	0	0	0	0.03	138[a]	5[a]	0.02	0	0.01	0	0.04[a]
July 24-28	32	0	0	0	0	0	0	38	6	0.11	0	0.03	0.03	0.16	70	6	0.06	0	0.01	0.01	0.09
July 31-Aug. 4	32	25	0.03	0.03	0	0.72	0.78	38	49	0.11	0	0.03	1.16	1.29	70	74	0.07	0.01	0.01	0.96	1.06
Aug. 14-18	32	112	0.19	0.06	0.03	3.22	3.50	38	60	0.32	0.05	0.05	1.16	1.59	70	172	0.26	0.06	0.04	2.10	2.46
Aug. 21-25	32	29	0	0	0	0.91	0.91	37	18	0.05	0	0	0.42	0.48	70	47	0.03	0	0	0.64	0.67
Combined			0.04	0.02	0.01	0.88	0.95			0.11	0.01	0.02	0.49	0.63			0.07	0.01	0.02	0.61	0.71[a]
Total	175	166	7	3	1	155		213	135	24	2	4	105		429[a]	304[a]	32	5	7	260	

INSHORE:	Total (W+M+E)[b]						
July 3 - 7	105	2	0.01	0.01	0	0	0.02
July 11 - 15	84	6	0.07	0	0	0	0.07
July 24 - 18	77	4	0.05	0	0	0	0.05
Combined			0.04	0.004			
Total	226	12	11	1	0	0	

[a]Includes one cruise on Georges Bank. The number of larvae caught was one stage I and two stage III in 40 x 1000 m^3 of water filtered.

[b]All the 12 larvae inshore were from the Middle area.

Table 5. Number of lobster larvae per 1000 m^3 of water filtered by heavy meter net in 1978, listed by area, cruise, and larval stage.

Cruise date	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV	Vol.	No.	Stage I	Stage II	Stage III	Stage IV	Stage I-IV
INSHORE:	West							Middle							East						
July 3-7	15	0	0	0	0	0	0	11	0	0	0	0	0	0	4	0	0	0	0	0	0
July 11-15	37	0	0	0	0	0	0	43	10	0.23	0	0	0	0.23	11	0	0	0	0	0	0
July 24-28	24	2	0.08	0	0	0	0.08	24	6	0.25	0	0	0	0.25	18	1	0.05	0	0	0	0.05
July 31-Aug. 6	32	9	0.28	0	0	0	0.28	32	10	0.31	0	0	0	0.31	15	1	0	0	0	0.07	0.07
Aug. 7-11	32	7	0.19	0	0	0.03	0.22	38	4	0.11	0	0	0	0.11	18	1	0.06	0	0	0	0.06
Aug. 14-18	32	7	0	0	0	0.22	0.22	38	13	0.29	0.05	0	0	0.34	17	1	0	0	0	0.06	0.06
Aug. 21-25	28	3	0.03	0	0	0.07	0.10	38	11	0.11	0.03	0	0.16	0.29	17	17	0	0	0	0.97	0.97
Aug. 28-Sept. 2	32	3	0	0	0	0.09	0.09	38	5	0.05	0	0	0.08	0.13	17	4	0.06	0	0	0.17	0.23
Sept. 4-10	26	1	0.04	0	0	0	0.04	35	4	0.03	0.03	0.03	0.03	0.11	17	5	0	0	0	0.29	0.29
Sept. 18-22	3	0	0	0	0	0	0	38	1	0.03	0	0	0	0.03	15	1	0	0	0	0.07	0.07
Combined			0.07	0	0	0.05	0.12			0.15	0.01	0	0.03	0.19			0.02	0	0	0.19	0.21
Total	261	32	19	0	0	13		335	64	49	4	1	10		149	31	3	0	0	28	
OFFSHORE:	North							South							Total (N+S)						
July 7	11	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0
July 11-15	36	0	0	0	0	0	0	62	2	0.02	0	0.02	0	0.03	138[a]	4[a]	0.01	0.01	0.01	0	0.03[a]
July 24-28	32	1	0	0	0	0.03	0.03	38	2	0.05	0	0	0	0.05	70	3	0.03	0	0	0.01	0.04
July 31-Aug. 4	32	3	0	0	0	0.09	0.09	38	10	0.11	0	0.03	0.13	0.26	70	13	0.06	0	0.01	0.11	0.19
Aug. 14-18	32	50	0.12	0.06	0.06	1.31	1.56	38	46	0.77	0.08	0.03	0.34	1.22	70	96	0.47	0.07	0.04	0.79	1.37
Aug. 21-25	32	6	0.03	0	0	0.16	0.19	37	12	0.08	0	0	0.24	0.32	70	18	0.06	0	0	0.20	0.26
Combined			0.03	0.01	0.01	0.29	0.34			0.18	0.01	0.01	0.13	0.34			0.10	0.01	0.01	0.18	0.31[a]
Total	175	60	5	2	2	51		213	72	39	3	3	27		429[a]	134[a]	44	6	6	78	

INSHORE:	Total (W+M+E)						
July 3-7	29	0	0	0	0	0	0
July 11-15	91	10	0.11	0	0	0	0.11
July 24-28	66	9	0.14	0	0	0	0.14
July 31-Aug. 6	79	20	0.24	0	0	0.01	0.25
Aug. 7-11	87	12	0.13	0	0	0.01	0.14
Aug. 14-18	87	21	0.13	0.02	0	0.09	0.24
Aug. 21-25	85	31	0.06	0.01	0	0.30	0.37
Aug. 28-Sept. 2	87	12	0.03	0	0	0.10	0.14
Sept. 4-10	79	10	0.03	0.01	0.01	0.08	0.13
Sept. 18-22	55	2	0.02	0	0	0.02	0.04
Combined			0.10	0.01	0	0.07	0.17
Total	745	127	71	4	1	51	

[a]Includes one cruise on Georges Bank. The number of larvae caught was one stage II and one stage III larvae in 40 x 1000 m^3 of water filtered.

Table 6. Depth distribution of offshore (North & South)* larvae, 1977, in daytime vs. night as shown by the number of larvae per tow caught in neuston and meter nets. Numbers in brackets are the total number of larvae in each sample. Only paired samples (neuston & meter) from simultaneous tows are included; pairs with no larvae in either gear are excluded.

Gear (depth in cm)	Stage I		Stage IV	
	Day	Night	Day	Night
Neuston (0–15)	6.43(45)	6.37(121)	1.37(59)	6.58(125)
Meter (30–130)	2.57(18)	2.05 (39)	2.30(99)	0.42 (8)

Table 7. Observed numbers of larvae at each stage, 1977–1978, all three gears combined, compared to the theoretical (but unrealistic) minimum numbers of stages I to III needed to produce 1527 stage IV larvae at various temperatures. The duration-at-stage data are from Templeman (1936).

Water Temp °C	Duration (d) of larval stages				Theoretical minimum no. of early stage larvae needed to produce 1527 stage IV			
	I	II	III	IV	I	II	III	IV
9	---- No development of larvae beyond stage IV ---							
10	14	16	25	47	455	520	812	1527
15	6	7	10	23	398	464	664	1527
19	3	4	6	16	286	382	573	1527
Observed numbers of larvae (from Table 2a)					668	80	39	1527

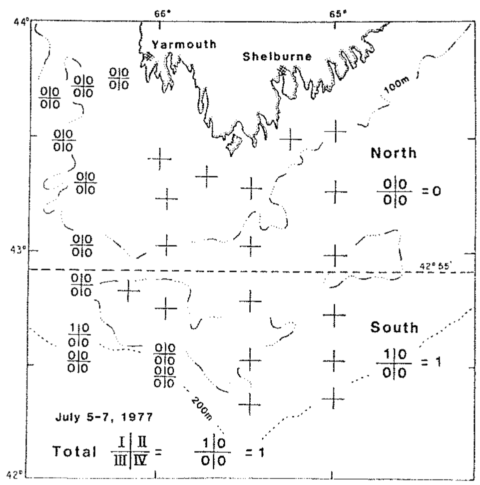
APPENDIX I

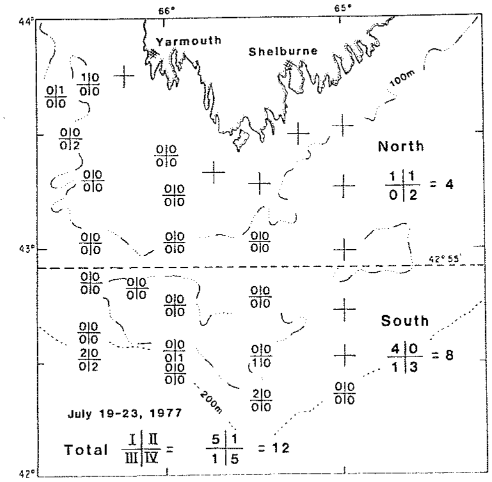
Offshore station locations 1977-1978; sampling at the five stations marked with a single asterisk was discontinued in 1978. The 12 stations marked with a double asterisk were occupied only once in July 1978.

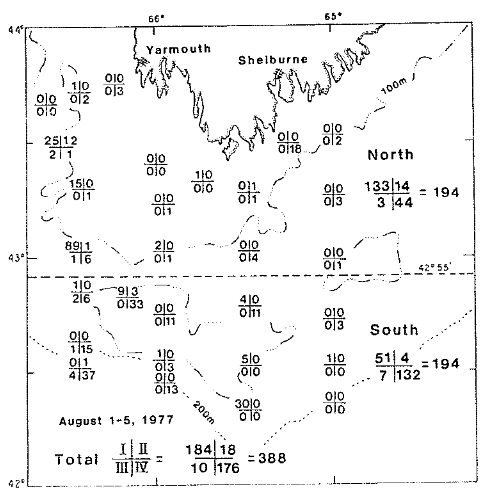
	Station No.	Lat.	Long.	Range (m)	
North of 42°55'					
	6*	43°45'N	66°17'W	55	64
	7	43 43	66 29	77	80
	8*	43 40	66 41	110	119
	9	43 29	66 36	97	99
	10	43 18	66 28	59	62
	11	43 01	66 29	110	121
	19	43 02	66 00	95	99
	20	43 14	66 00	40	44
	21	43 24	66 01	33	37
	22*	43 20	65 45	29	37
	23	43 17	65 30	46	53
	24	43 02	65 30	113	117
	31	42 59	65 00	113	115
	32	43 16	65 00	155	157
	33*	43 32	65 00	77	88
	34*	43 30	65 16	33	40
South of 42°55'					
	12	42°51'N	66°29'W	143	154
	13	42 38	66 30	172	174
	14	42 31	66 30	250	250
	15	42 27	66 00	216	219
	16	42 33	66 00	124	128
	17	42 45	66 00	75	77
	18	42 50	66 13	37	40
	25	42 47	65 30	113	113
	26	42 32	65 30	97	97
	27	42 20	65 30	106	108
	28	42 22	65 00	146	150
	29	42 32	65 00	115	117
	30	42 44	65 00	102	102
** NE Georges Bank	53**	42°10'N	65°00'W	1536	1554
	54**	42 15	66 00	238	240
	55**	42 03	65 43	311	320
	56**	41 52	66 00	95	95
	57**	41 42	65 54	112	113
	58**	41 30	65 48	1573	1591
	59**	41 25	66 00	293	311
	60**	41 22	66 14	124	126
	61**	41 37	66 30	75	77
	62**	41 56	66 30	77	80
	63**	42 08	66 30	95	99
	64**	42 20	66 30	274	278

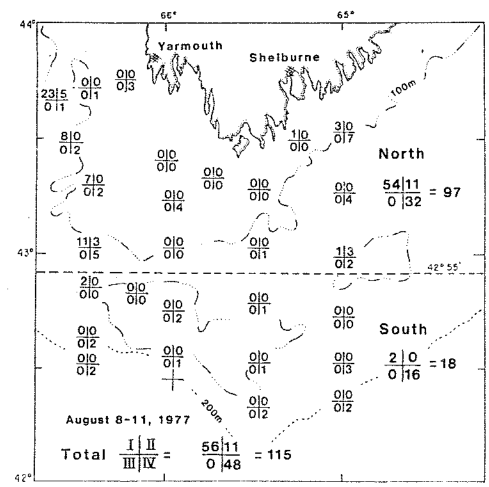
APPENDIX II

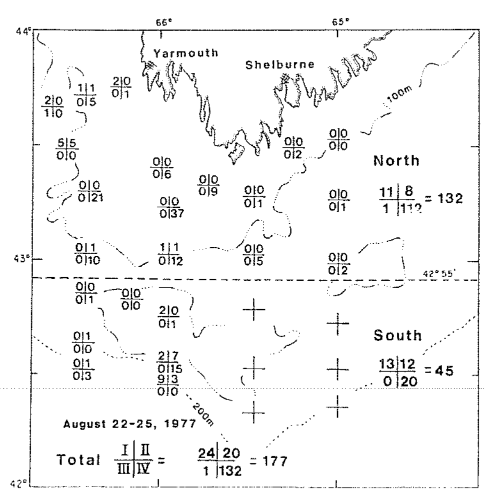
Total catches (all gears combined, including Isaacs-Kidd) of lobster larvae offshore 1977-78 by stage, by station, by cruise. Number of larvae of each stage are shown as follows: stage I top left, stage II top right, stage III bottom left, and stage IV bottom right. Subtotals for stations north and south of 42°55' as well as a total for the cruise are shown on each panel. The cruise on July 7, 1978, is not shown, since only three stations (7, 9, 10) were occupied and no lobster larvae were caught.

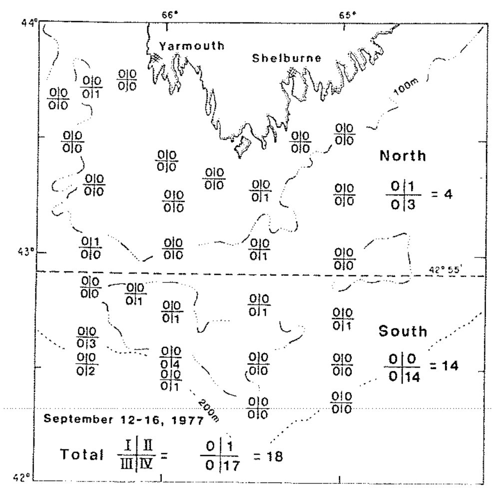


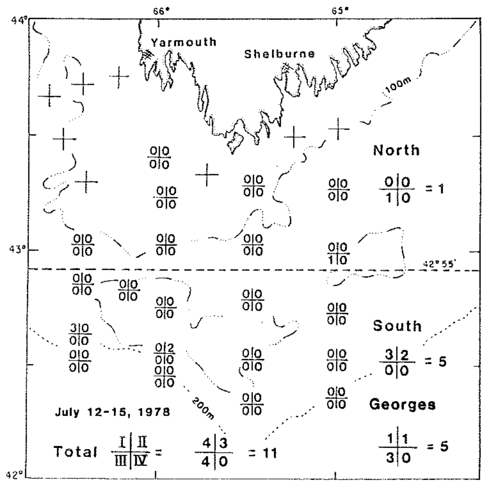


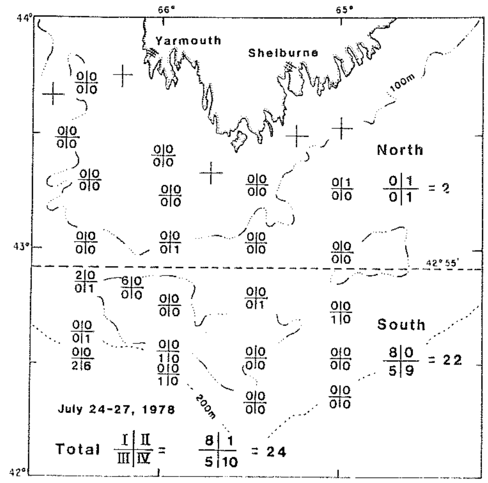


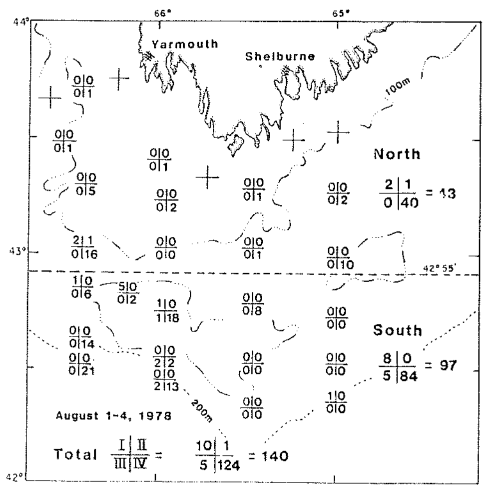


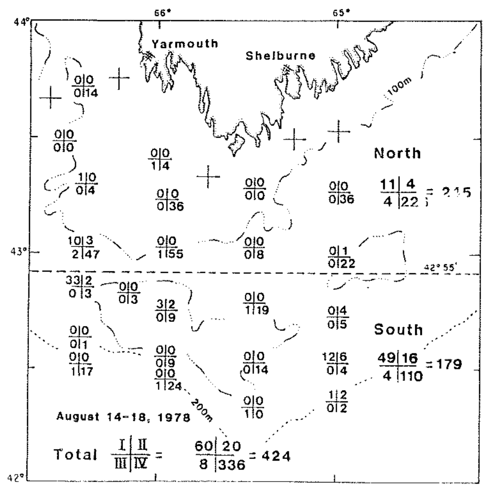


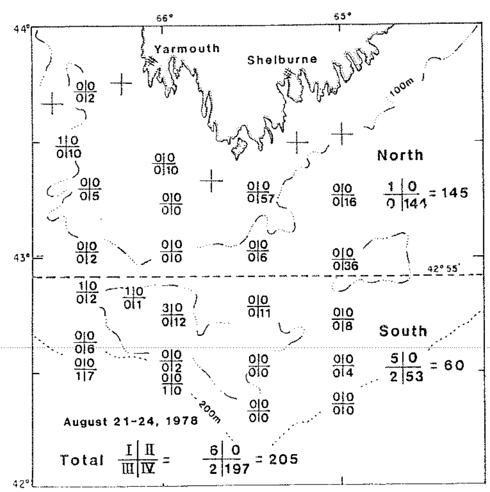



Yarmouth
Shelburne
100m
200m
42°55'
North
South
Georges
July 12-15, 1978
Total


Yarmouth
Shelburne
100m
200m
42°55'
North
South
July 24-27, 1978
Total


Yarmouth
Shelburne
100m
200m
42°55'
North
South
August 1-4, 1978
Total


Yarmouth
Shelburne
100m
200m
42°55'
North
South
August 14-18, 1978
Total


Yarmouth
Shelburne
100m
200m
42°55'
North
South
August 21-24, 1978
Total

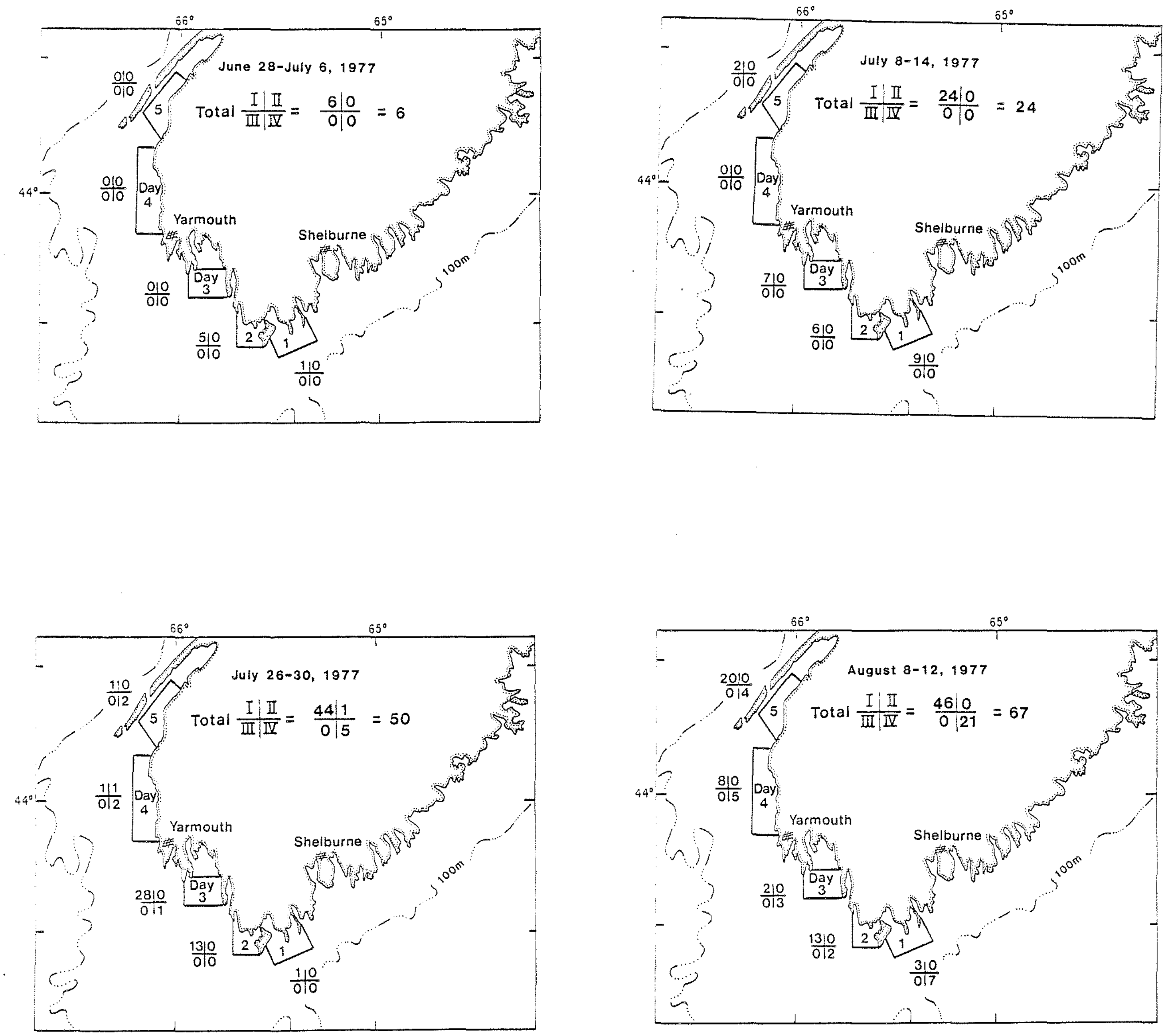
APPENDIX III

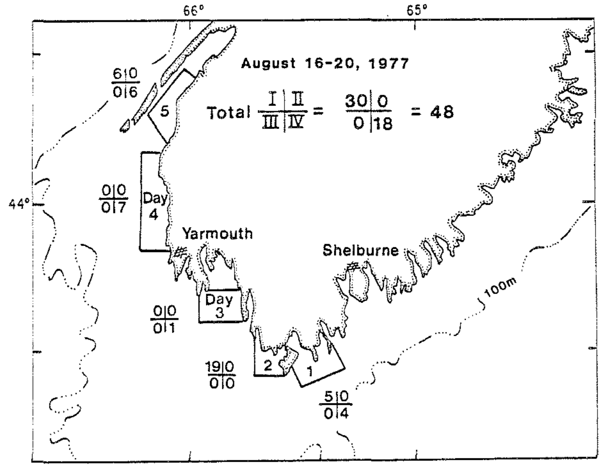
Inshore station locations 1977-1978; stations marked with an asterisk were sampled in 1977 only. Stations marked with ≠ were sampled in 1978 only. Eight other stations (not shown) were sampled up to two times early in 1977, then discontinued.

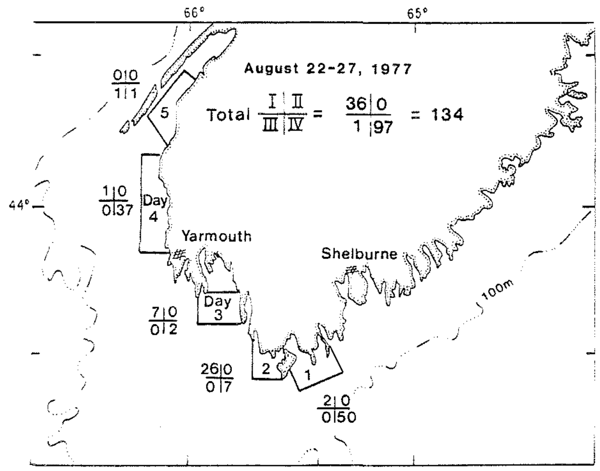
	Station No.	Lat.	Long.	Range (m)
East				
Day 1	101	43°24'N	65°32'W	11 27
	102	43 27	65 28	2 9
	108	43 26	65 24	33 44
	109*	43 25	65 27	20 22
	110	43 23	65 35	20 27
	111	43 30	65 28	2 9
	112	43 30	65 26	4 11
Middle				
Day 2	201	43°26'N	65°38'W	2 15
	202	43 28	65 38	2 13
	203	43 28	65 39	2 7
	204	43 26	65 41	16 24
	205	43 26	65 47	15 37
	206	43 29	65 46	5 11
	207	43 27	65 45	2 5
	208	43 30	65 44	4 13
Day 3	301	43°35'N	65°49'W	4 11
	302	43 37	65 51	9 22
	303	43 41	65 52	2 11
	305	43 42	65 57	2 7
	306	43 39	65 57	9 16
	307	43 38	66 02	9 27
West				
Day 4	401	43°51'N	66°10'W	4 7
	402	43 53	66 13	2 18
	403	43 56	66 10	2 7
	404	43 59	66 12	16 29
	405	43 59	66 19	2 18
	406	44 09	66 12	4 13
Day 5	501	44°12'N	66°11'W	5 18
	502	44 15	66 12	26 46
	503	44 20	66 15	11 26
	504*	44 25	66 10	7 20
	505*	44 27	66 07	18 26
	508*	44 22	66 07	2 11
	509≠	44 21	66 12	20 35
	510≠	44 16	66 10	4 13

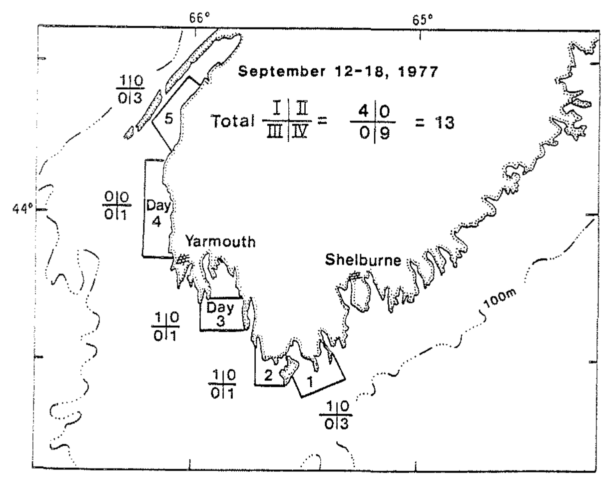
APPENDIX IV

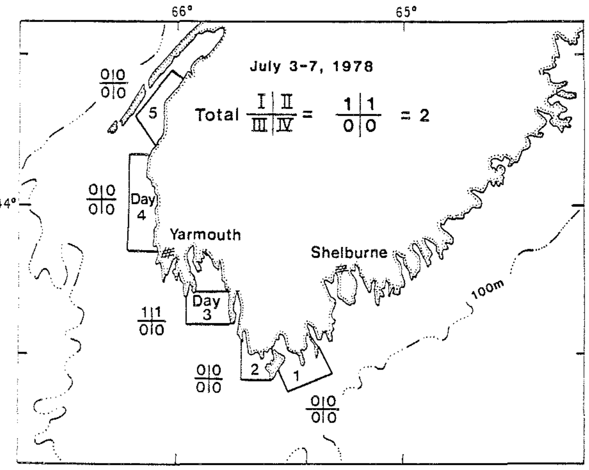
Total catches (all gears combined, including Isaacs-Kidd) of lobster larvae inshore 1977-78, by stage, by areas, by cruise. Number of larvae of each stage are shown as follows: stage I top left, stage II to top right, stage III bottom left, and stage IV bottom right. A total for each cruise is shown at top of each panel.

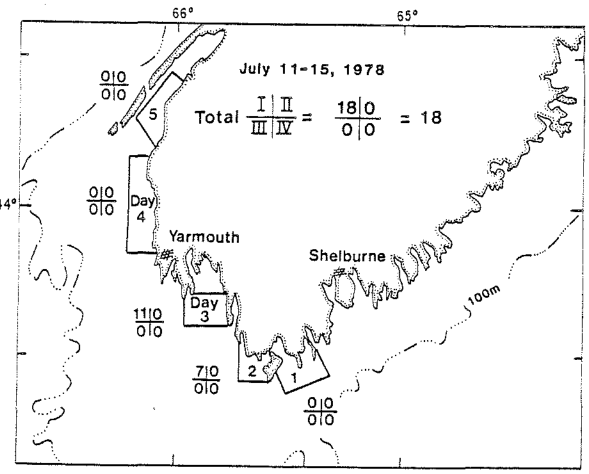


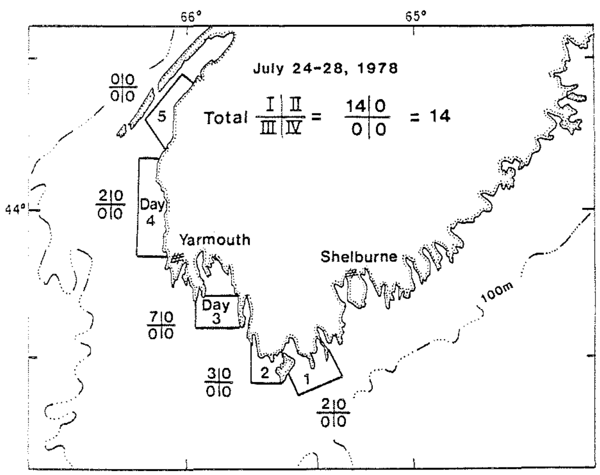

66°
65°
44°
August 16-20, 1977
Total I|II / III|IV = 30|0 / 0|18 = 48
6|0 / 0|6
5
0|0 / 0|7
Day 4
Yarmouth
Shelburne
100m
Day 3
0|0 / 0|1
19|0 / 0|0
2
1
5|0 / 0|4

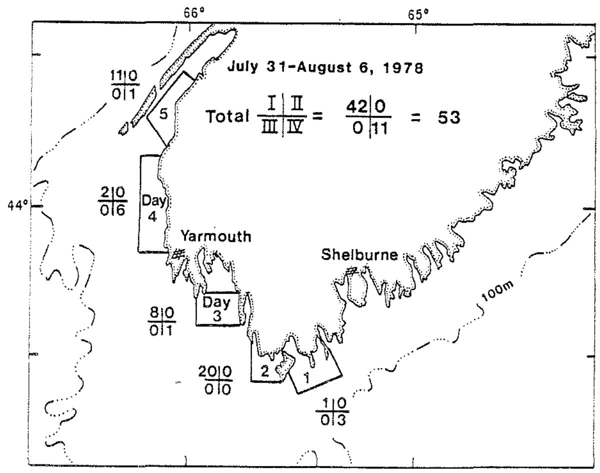

66°
65°
44°
August 22-27, 1977
Total I|II / III|IV = 36|0 / 1|97 = 134
0|0 / 1|1
5
1|0 / 0|37
Day 4
Yarmouth
Shelburne
100m
Day 3
7|0 / 0|2
26|0 / 0|7
2
1
2|0 / 0|50

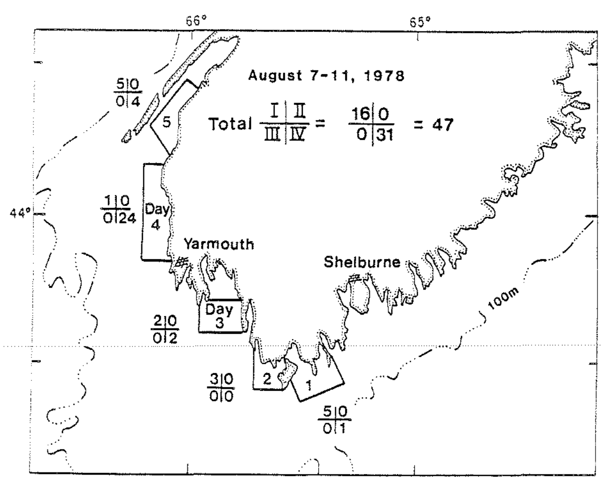

66°
65°
44°
September 12-18, 1977
Total I|II / III|IV = 4|0 / 0|9 = 13
1|0 / 0|3
5
0|0 / 0|1
Day 4
Yarmouth
Shelburne
100m
Day 3
1|0 / 0|1
1|0 / 0|1
2
1
1|0 / 0|3

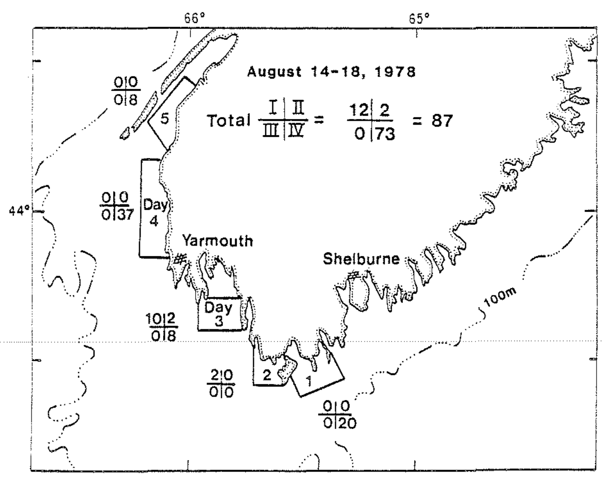

66°
65°
44°
July 3-7, 1978
Total I | II / III | IV = 1 | 1 / 0 | 0 = 2
0|0 / 0|0
0|0 / 0|0
1|1 / 0|0
0|0 / 0|0
0|0 / 0|0
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m

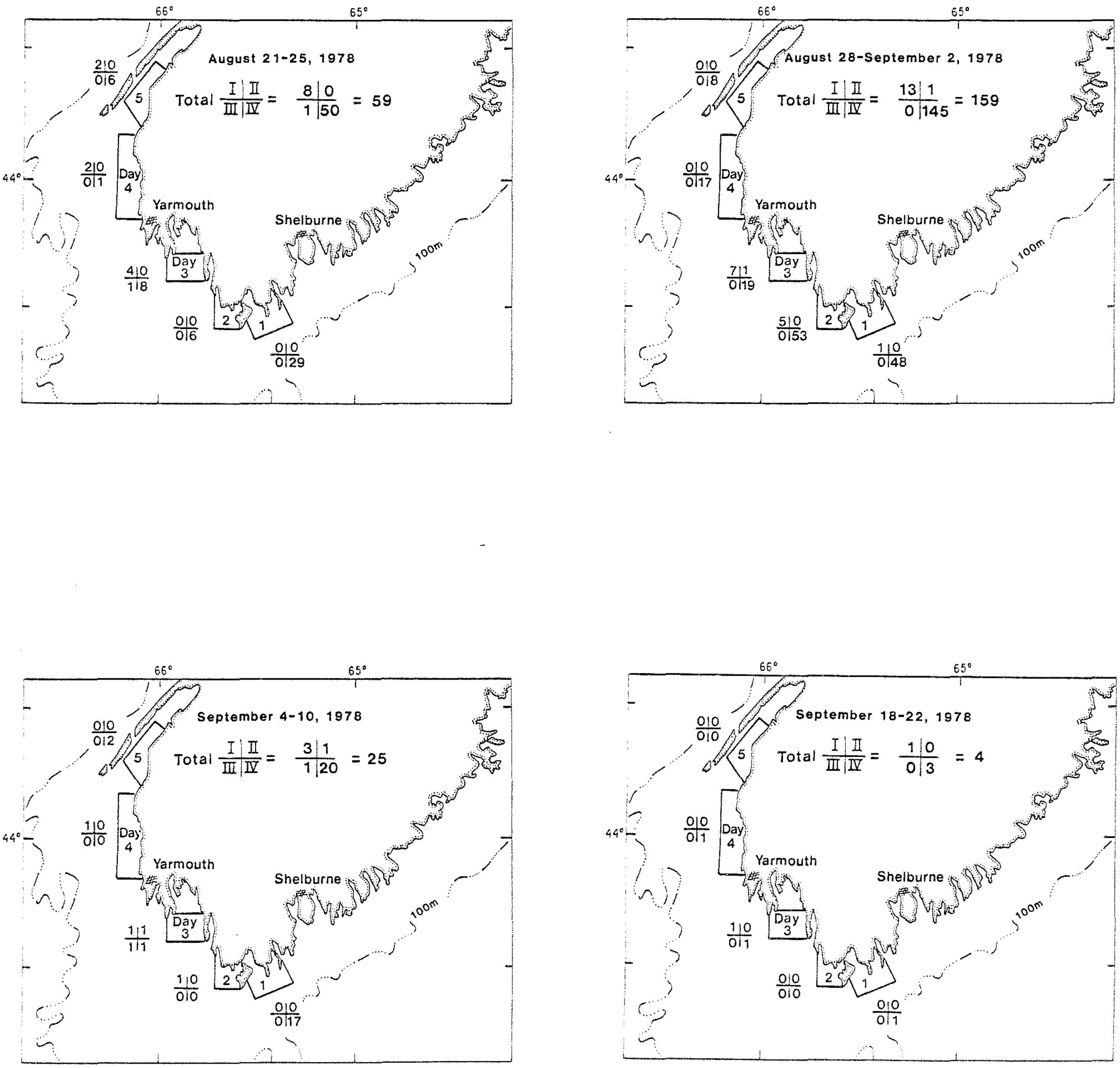

66°
65°
44°
July 11-15, 1978
Total I | II / III | IV = 18 | 0 / 0 | 0 = 18
0|0 / 0|0
0|0 / 0|0
11|0 / 0|0
7|0 / 0|0
0|0 / 0|0
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m


66°
65°
44°
July 24-28, 1978
Total I | II / III | IV = 14 | 0 / 0 | 0 = 14
0|0 / 0|0
2|0 / 0|0
7|0 / 0|0
3|0 / 0|0
2|0 / 0|0
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m


66°
65°
44°
July 31-August 6, 1978
Total I | II / III | IV = 42 | 0 / 0 | 11 = 53
11|0 / 0|1
2|0 / 0|6
8|0 / 0|1
20|0 / 0|0
1|0 / 0|3
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m


66°
65°
44°
August 7-11, 1978
Total I | II / III | IV = 16 | 0 / 0 | 31 = 47
5|0 / 0|4
1|0 / 0|24
2|0 / 0|2
3|0 / 0|0
5|0 / 0|1
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m


66°
65°
44°
August 14-18, 1978
Total I | II / III | IV = 12 | 2 / 0 | 73 = 87
0|0 / 0|8
0|0 / 0|37
10|2 / 0|8
2|0 / 0|0
0|0 / 0|20
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m


66°
65°
44°
August 21-25, 1978
Total I|II / III|IV = 8|0 / 1|50 = 59
2|0 / 0|6
2|0 / 0|1
4|0 / 1|8
0|0 / 0|6
0|0 / 0|29
5
Day 4
Day 3
2
1
Yarmouth
Shelburne
100m
August 28-September 2, 1978
Total I|II / III|IV = 13|1 / 0|145 = 159
0|0 / 0|8
0|0 / 0|17
7|1 / 0|19
5|0 / 0|53
1|0 / 0|48
September 4-10, 1978
Total I|II / III|IV = 3|1 / 1|20 = 25
0|0 / 0|2
1|0 / 0|0
1|1 / 1|1
1|0 / 0|0
0|0 / 0|17
September 18-22, 1978
Total I|II / III|IV = 1|0 / 0|3 = 4
0|0 / 0|0
0|0 / 0|1
1|0 / 0|1
0|0 / 0|0
0|0 / 0|1