Northwest Atlantic Fisheries Organization

Serial No. N732

NAFO SCR Doc. 83/IX/67

FIFTH ANNUAL MEETING - SEPTEMBER 1983

Larval Herring Surveys in Maine (USA) and New Brunswick (Can.) Waters of the Eastern Gulf of Maine, 1982

by

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Introduction

American scientists (Maine Department of Marine Resources, Bigelow Laboratory and University of Maine) and Canadian scientists (Department of Fisheries and Oceans) joined in a series of larval herring research cruises during the autumn, 1982 in the coastal and immediate offshore waters of the state of Maine and those adjacent to Grand Manan Island of Canada (Fig. 1). The surveys were pursued to study the distribution, drift, and food and feeding of larval herring. The information obtained will permit an examination of herring spawning and stock continuity in U.S. and Canadian waters in Maine and New Brunswick.

Methods

Sampling occurred during the period from 4 Oct to 3 December to anticipate the peak of larval hatching and its cessation. The Canadian research vessel J.L. Hart surveyed the sampling area (Fig. 1) during 4-7 Oct and 29 Nov-3 Dec. The Canadian research vessel, E.E. Prince, included this area within its overall sampling region encompassing the Bay of Fundy and the Gulf of Maine off southwest Nova Scotia during 27 Oct-9 Nov. Only the results of the two Hart cruises are presented in this paper.

Aboard the Hart, paired 61-cm Bongo nets (Posgay and Marak, 1980), with a .505 mm mesh, were fished in a double oblique tow. Deployment was at 50 m min^{-1} and hauling at 20 m min^{-1} with a ship's speed of 3.5 kn (6.5 km hr^{-1}). A Boothbay Depressor trawl (BB5), with a 1 mm meshed liner, was deployed at a "dead fall" and retrieved at 20 m min^{-1} with a ship's speed of 3.5 kn. The purpose in deploying the trawl at 14 of the 27 stations fished with Bongo nets during the second cruise was to determine whether proportionately larger larvae might be captured by the larger mouth of the trawl (1.45 m^2) during similar conditions of deployment. A comparison of larval lengths suggested there was no disparity. Thus, total length frequencies for the second cruise included larvae caught in both gear whereas larval distributions were based only on larvae captured in the Bongo nets.

Of the 28 stations selected for sampling (Fig. 1) all but station A11 were sampled during the first Hart cruise and A7 during the second. Numbered stations in Figure 1 were occupied during a previous cruise in 1972 (Graham, 1982). Those prefaced by the letter C were occupied previously by Canadian scientists (Anonymous, 1972). Those prefaced by the letter A were added to enhance coverage of larval distribution.

Results

Larval Distribution

Catch rates were particularly high during the survey in early October when 11,387 larvae were captured in 27 paired net bongo tows and low on November and December when only 320 were captured. In October, catch rates were distributed largely between Machias Bay and Frenchman Bay (Fig. 2). Rates exceeding 200 larvae/m^2 of sea surface were located in the concentration. Larvae located off Grand Manan Island were much less abundant. Approximately two months later two groups of larvae were present, one in the eastern and one in the western sectors of the sampling area.

Larval Lengths

Small (<10 mm) recently hatched larvae were abundant during the October cruise and scarce during the November-December cruise (Fig. 3). Larvae from the first cruise ranged in length from 5 to 20 mm with possible modal lengths at 8 and 17 mm. Likely modal lengths from the second cruise appeared approximately at 20 and 26 mm. During October recently hatched larvae (<10 mm) were abundant in the western sector of the sampling area and catch rates ranged from 150 to slightly less than 200 larvae/m^2 of sea surface in the center of their concentration and declined either to zero or low catch rates offshore and toward Grand Manan Island. Larger larvae (10-15 mm) were concentrated in three sectors of the sampling area generally decreasing in abundance from west to east. One concentration (>30 m^{-2}) was located in the western sector where recently hatched larvae were abundant. A second (>10 m^{-2}) occurred south of Machias Bay where the abundance of recently hatched larvae appeared as an eastward bulge in the 5 m^{-2} catch rate isoline. A third group occurred off Grand Manan Island where almost no recently hatched larvae were present. The largest larvae (>15 mm) were concentrated south of Machias Bay and off Grand Manan Island, but not in the western sector where catch rates for smaller larvae were high.

Two months later, only a trace of recently hatched larvae was present in the western sector (Fig. 5). Larger larvae were equally scarce but the largest larvae occurred not far from the October concentrations evident in the western sector and south of Machias Bay. The latter group was located further eastward than in October and possibly it was associated with the previous concentration off Grand Manan Island.

Discussion

Continuity of Larval Concentrations

The concentration of larvae in the western sector of the sampling area included all sizes during both the October and November-December cruises, although it was considerably depleted by mortality and drift by the time of the second cruise. (Graham and Chenoweth (1973) found that, when hatching ceased, 75% of recently hatched larval herring died within four days on Georges Bank). A larval concentration was also evident in the same locality during cruises in 1972 (Graham, 1982) and 1980 (Graham et al., 1982). Compared to 1972, when a similar unit of effort was used to capture larvae, the catch rate of more than 150 recently hatched larvae/m^2 of sea surface in 1982 was much higher than that obtained previously (30). However, the peak abundance of larvae was perhaps missed in 1972 because of the high and rapid mortality of recently hatched larvae. The larval concentration south of Machias Bay (Fig. 4) has also been reported previously, but it was located somewhat closer to Cutler Harbor (Graham, 1982; Graham et al., 1982). The eastern concentration near Grand Manan Island was not as evident in earlier years but the distribution of catch rates prompted an expansion of sampling (Fig. 1) in the direction of the Island and its associated shoals during 1982. Presumably, the 1982 concentration contained few recently hatched larvae and was not sustained through the two months between cruises.

One explanation for the decline in the abundance of concentrations from west to east is that they represent a gradient in spawning time delayed progressively from east to west. Thus, the relative abundance of recently hatched and larger larvae (<10 mm, 10-15 mm) decreased from west to east during the October sampling (Fig. 4); these size groups were present almost entirely in the west during the November-December cruise (Fig. 5). Additional evidence to support this possibility may be available from the samples gathered during the intervening November cruise by Canadian scientists.

Larval Sources and Destinations

Whether demersal beds of herring eggs underly the concentrations of recently hatched larvae is not known, nor is it known to which spawning units the larvae belong. Possibly, the aggregations of recently hatched larvae are more closely related to the currents retaining them than to the exact positioning of egg beds. However, previous publications (Graham, 1982; Graham et al., 1982) suggest that larvae from these concentrations drift westward entering the inshore embayments and estuaries. Larvae enter Sullivan Harbor at the head of Frenchman Bay (Fig. 1) and also the Sheepscot River estuary in central-western Maine where they mix with larvae hatched in that coastal area. In 1982, larvae that hatched in the sampling area (Fig. 4) appeared in Sullivan Harbor in October and continued to arrive reaching a small peak in abundance during November (Fig. 6).

Larval cohorts in the estuaries and embayments represent groups which hatch in abundance over a brief period of time, usually 1-2 weeks. In 1980, three cohorts entered Sullivan Harbor. One, identified by its otolith growth increments, eventually entered the Sheepscot estuary as well. In 1981, two and possibly a third entered the Harbor, but none could be traced in abundance to the Sheepscot estuary, although its larvae were present in the intervening coastal water. Aggregations of cohorts are probably lost in the coastal water as in inshore waters to mortality (Graham, 1982). Catch rates in the Harbor during 1982 were similar to those of 1980 when three cohorts were represented (Graham et al., 1982); catch rates in the Sheepscot estuary suggested that two cohorts hatched late (November-December) as in previous years (Townsend and Graham 1981; Graham, 1982).

The authors plan to continue to monitor larval abundance in Sullivan Harbor and the Sheepscot estuary and to determine the patterns of larval distribution and dispersal in eastern Maine coastal waters during 1983-84. Continued cooperation with Canadian scientists will permit an extension of the coastal survey results into the area around Grand Manan Island. Additional work will include studies of 1) the reproductive characteristics of adult herring which spawn in eastern Maine and 2) the food and feeding of larval herring which are produced in the area. Attention will focus on understanding the factors which affect larval survival and year-class size.

Acknowledgements

Dr. T.D. Iles, A/Chief of the Marine Division of the Department of Fisheries and Oceans, Canada provided the vessel J.L. Hart for the October and November cruises and assisted us in initial planning. Pete Hurley and Mike Powers handled much of the Canadian logistics and Ken Abott was Scientist in charge during the cruises. Francis Guptill, captain of the Hart was most helpful. Dr. R.W. Langton, Director of the Bureau of Marine Sciences, Maine Department of Marine Resources assisted in the initial planning and in the logistics. Lee Stevens of the U.S. Department of State was also helpful in logistics. Dr. David Mountain of the U.S. National Fisheries Service kindly supplied hydrographic equipment necessary for the first cruise. The services of David Hodges of the University of Maine during the later cruises are gratefully acknowledged.

Obviously, the combined efforts of a number of persons were necessary to the successful completion of the larval cruises and we are indebted to all.

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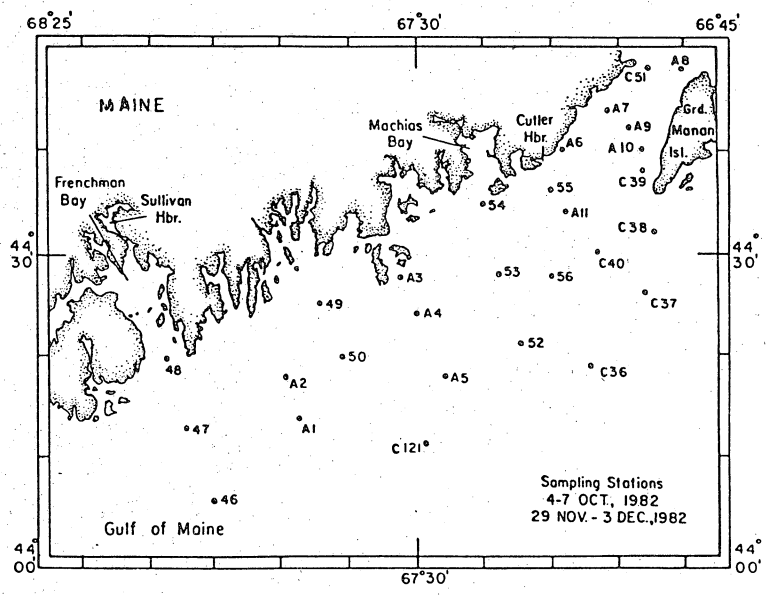

Figure 1. Station positions occupied during "Downeast" larval herring cruises. Numbered stations were occupied in 1972 during a previous survey. Stations prefaced by the letter C were Canadian locations occupied annually. Stations prefaced by the letter A were added to enhance coverage of larval distribution.

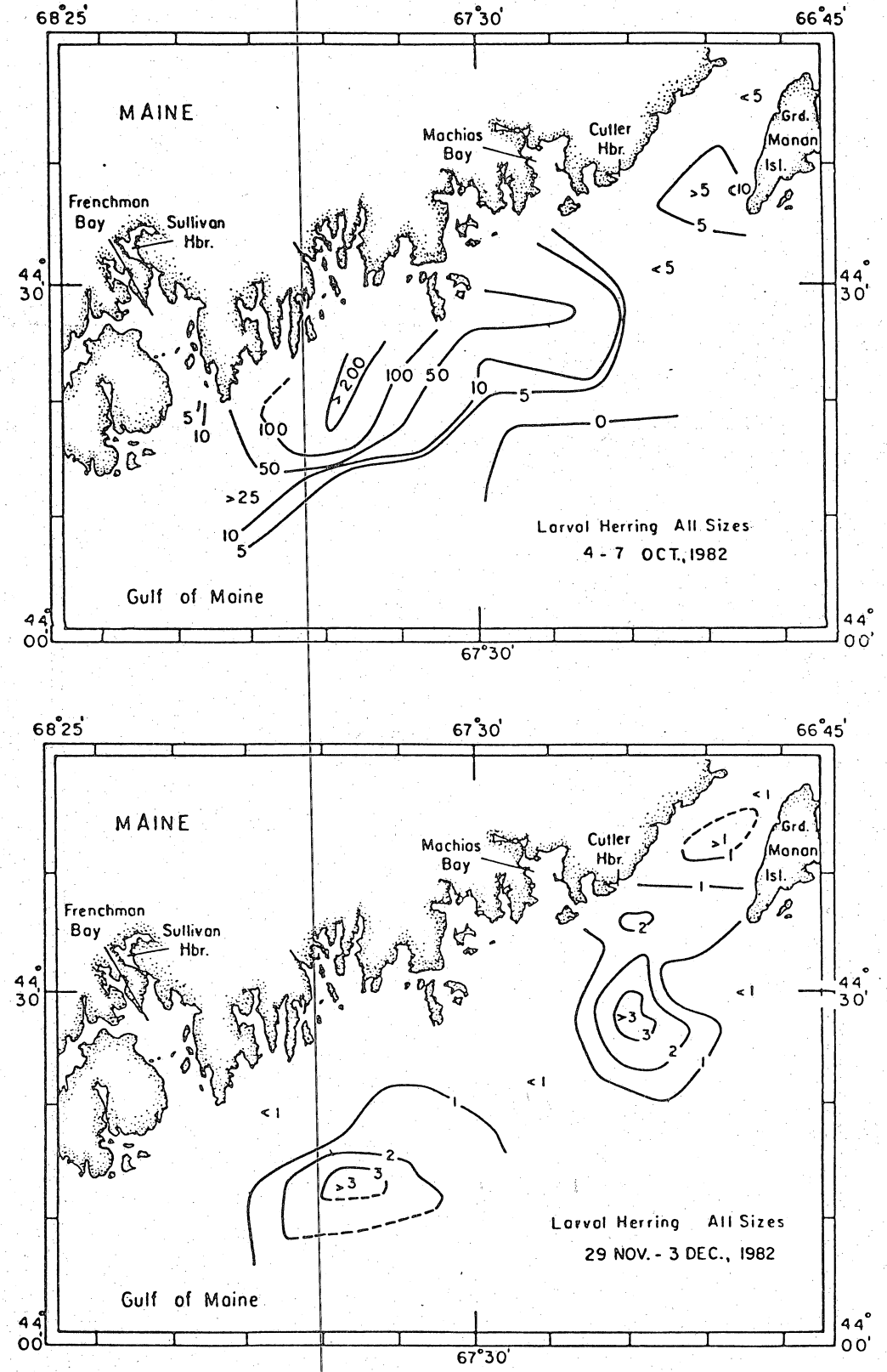

Figure 2. Distribution of larval herring, all sizes. Contours are in numbers of larvae/m^2 of sea surface. Upper panel - Oct. cruise, Lower panel - Nov.-Dec. cruise.

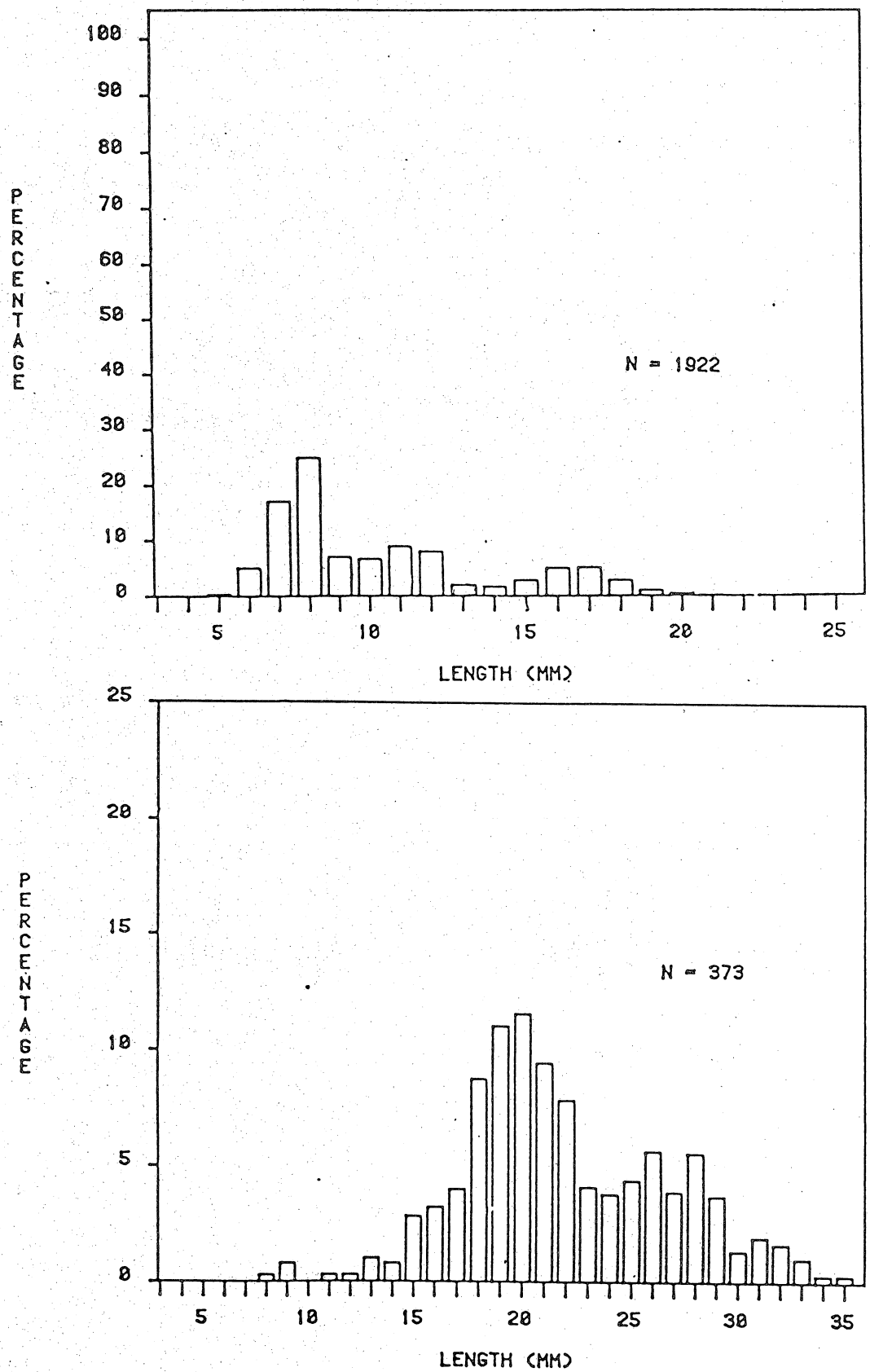

Figure 3. Length frequencies of larval herring from all sample stations. Upper panel - Oct. cruise, Lower panel - Nov.-Dec. cruise.

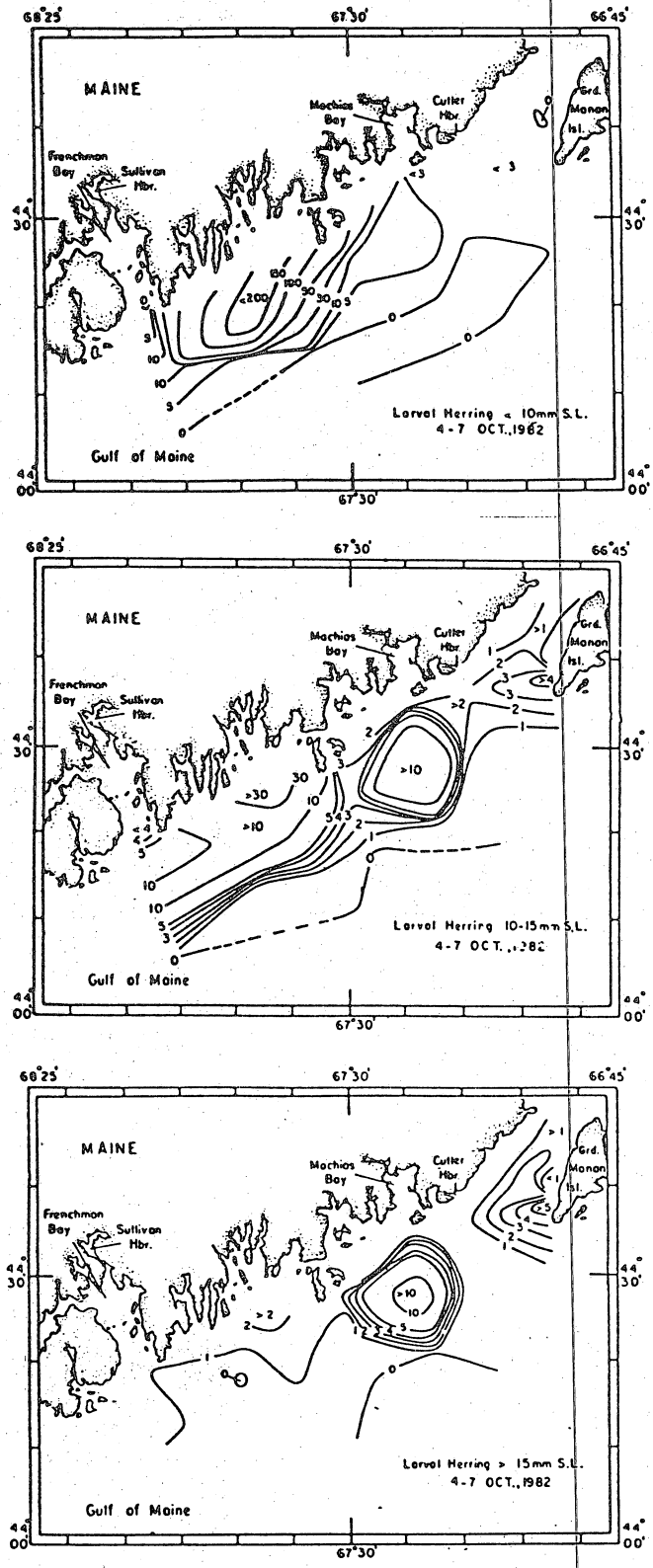

Figure 4. Distribution of three length groups during Oct., 1982.

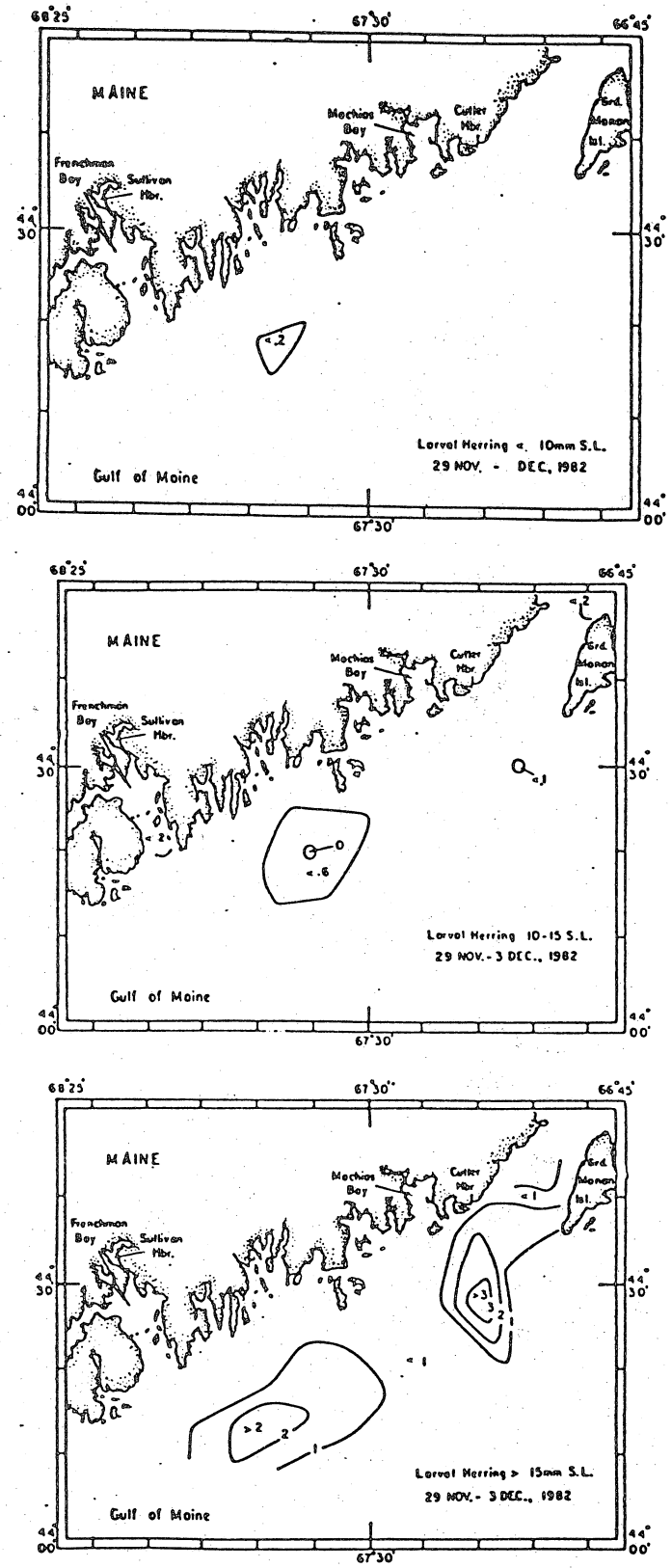

Figure 5. Distribution of three length groups during late Nov., 1982.

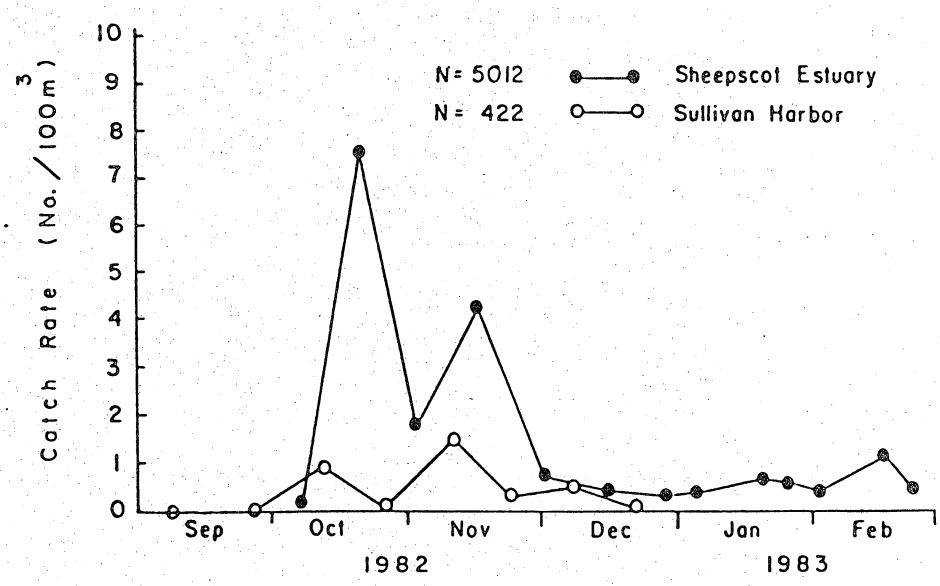

Figure 6. Inshore larval catch rates from the eastern coastal sector (Sullivan Harbor) and the central-western sector (Sheepscot River estuary).