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Zooplankton-Larval Herring Relations in the Eastern Coastal Gulf of Maine, Fall 1982

by

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Introduction

In 1982, scientists from the United States and Canada (Department of Fisheries and Oceans) began a study to determine the factors influencing the production of larval herring (Clupea harengus) in the eastern coastal Gulf of Maine. Attention was focused on this spawning area (Graham, 1982) partly because, in recent years, spawning has all but ceased entirely on the once important offshore Georges Bank (Anthony and Waring, 1980). It was realized that recruitment variability of the coastal spawning groups was becoming increasingly more important to the viability of the Gulf of Maine herring fishery. The objectives of our ongoing research project were to relate production, dispersal and survival of larval herring in the eastern coastal waters of the Gulf to: (a) biological spawning characteristics of the adult populations, (b) dynamics of the zooplankton forage organisms, and (c) the local hydrographic regime. This report presents the preliminary results of our investigations into the relations between zooplankton and herring larvae for 1982.

Materials and Methods

Zooplankton and herring larvae were sampled at the locations shown in Fig. 1 on two cruises on the Canadian research vessel J.L. HART during 4-7 October and 29 November - 3 December, 1982. Zooplankton was sampled at the stations shown in Fig. 1 using an 80 cm diameter .080 mm mesh net hauled vertically from near the bottom to the surface at about 1 m/s. These samples were preserved in buffered 5% formalin. A 61 cm bongo net (Posgay and Marak, 1981) was used to sample the herring larvae. Each side of the bongo was fitted with .505 mm mesh nets and General Oceanics digital flowmeters. The nets were towed in a double oblique manner to within a few meters of the bottom at a ship's speed of 3.5 knots. The samples were preserved in buffered 5% formalin. A Boothbay De-

pressor trawl (Graham and Vaughan, 1966) was used in addition to the bongo tows at 14 of the 27 stations sampled on the second cruise. It was used to test whether more larger larvae might be caught with the trawl; a comparison between the trawl and bongos showed no differences in the sizes of larvae caught in the two gears.

The herring larvae were sorted from the preserved samples and catch rates per m^2 of sea surface were calculated. The zooplankton samples were allowed to settle overnight in Imhoff cones, diluted to 10-20 times the settled volume and a 1 ml aliquot was examined with a Sedgwick-Rafter cell. The zooplankton identifications were made to species level, when possible, but only the broad groups (naupliar and post-naupliar) of copepods are reported here.

Results and Discussion

The distributions and abundance of naupliar and post-naupliar copepods for each cruise are shown in Figures 3 and 4. During the 4-7 October period, both the naupliar and post-naupliar copepods displayed two groupings, an area of high abundance in the western part of the sample area, continuing to increase toward the west, and a smaller one in the east. The groupings during the 29 November - 3 December period were not obvious but rather there was a general increase in abundance from east to west.

The dominant species during each cruise included the calanoid copepods Pseuocalanus sp., Centropages typicus, Acartia longiremis, a cyclopoid Oithona sp. and a hacpacticoid, Microsetella nowegica. Also present, but much lower in abundance, were Centropages hamatus, Temora longicornis, Calanus finmarchicus, Microcalanus pygmaeus, Paracalanus parvus and Metridia lucens. The tintinnids Tintinnopsis sp. and Parafavella gigantea were very abundant on the first cruise and, like the copepods and herring larvae, much lower on the second.

A summary of the catch rates of herring larvae is presented for each cruise in Fig. 2. Two concentrations of larvae were detected on the 4-7 October cruise; one southwest of Grand Manan Island (with mean lengths of 15-16 mm S.L.), and another larger group to the west (with a mean length of about 8 mm S.L.). The latter group represented recently hatched larvae while the group off Grand Manan was older. There were also two groups of larvae on the second cruise (29 November - 3 December, Fig. 2), but they were much less abundant than in October. The numbers were apparently depleted by larval drift to the west in the prevailing coastal current (Bigelow, 1927) and mortality. Graham and Chenoweth (1973), for instance, found that approximately 75% of recently hatched herring larvae die within 4 days. The abundance of larvae between cruises declined by about 98%; an unknown fraction of this decline was due to larval drift, both along the coast and into inshore areas (Graham et al. 1983), and the remainder to mortality. It is interesting to note that the larval distributions between the October cruise and the November - December cruise appeared to be displaced to the west but remained identifiable.

Preliminary analyses of the gut contents of the larvae collected on these cruises showed, not surprisingly, that immature calanoid copepods were the more common food items, similar to findings already reported (Sherman and Honey, 1971). The percentage of larvae with food in the gut in our study (62%) and the average number of food items in the gut per feeding larva (1.9) might suggest that the larvae were not feeding at an optimal rate. Various studies, for instance, have shown that anywhere from 13 to 800 copepod nauplii, or relevent food items, per liter are the optimal food densities for feeding herring larvae (Rosenthal and Henipel, 1970; Schnack, 1972; Beyer and Laurence, 1979; Werner and Blaxter, 1980). During our 4-7 October cruise, we observed a density of about 5-15 copepods per liter, of all developmental stages, in the general area of maximum larval herring abundance (Fig. 2). The other dominant zooplankter, Tintinnopsis sp., averaged about 5 individuals per liter but the feeding

incidence on this group was low (ca. 5%). These results suggest that the larvae may have been starving as a result of low food density during the 4-7 October period; conditions were even worse during the later cruise (Fig. 4).

It is difficult to say for certain the extent to which larval drift and mortality contributed to the decrease in larval herring abundance between cruises. The results presented here are only preliminary but point to the possibility that larval survival is limited by food supply. Future efforts will be aimed at determining age-specific mortalities and relative condition of larvae sampled over a known egg bed. These measures will be used together with estimates of larval drift to assess the spawning success of the coastal stocks.

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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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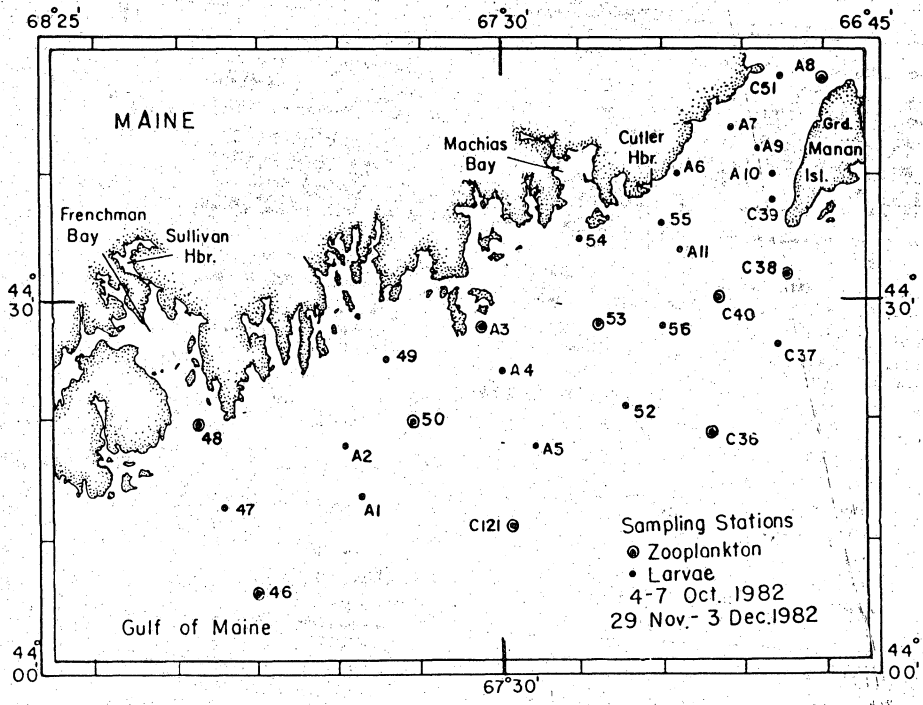

Figure 1. Sampling stations for the two fall cruises of 1982. Herring larvae and zooplankton were sampled at the zooplankton stations.

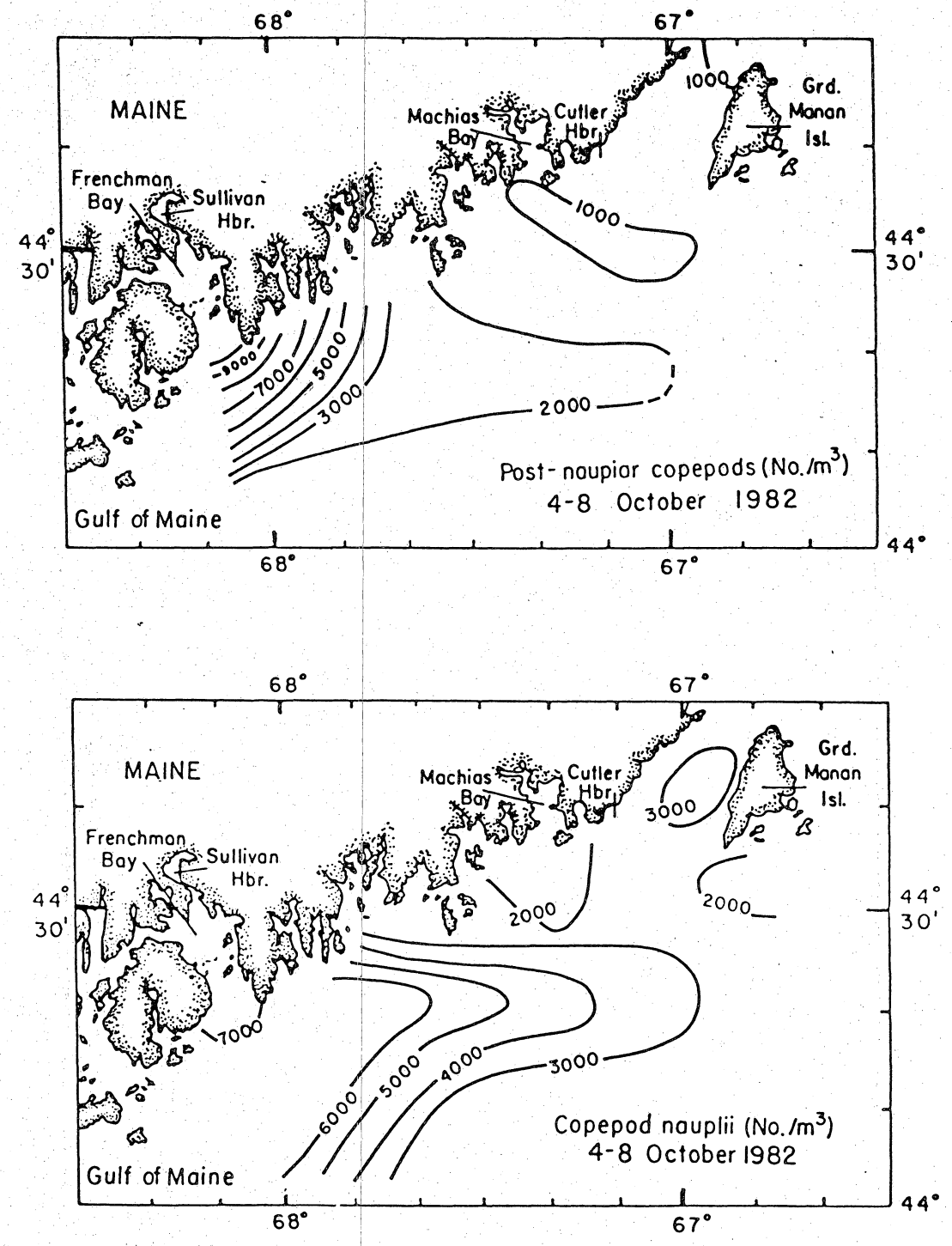

Figure 2. Contours of density (No./m^3) of post-naupliar copepods and copepod nauplii for the October cruise.

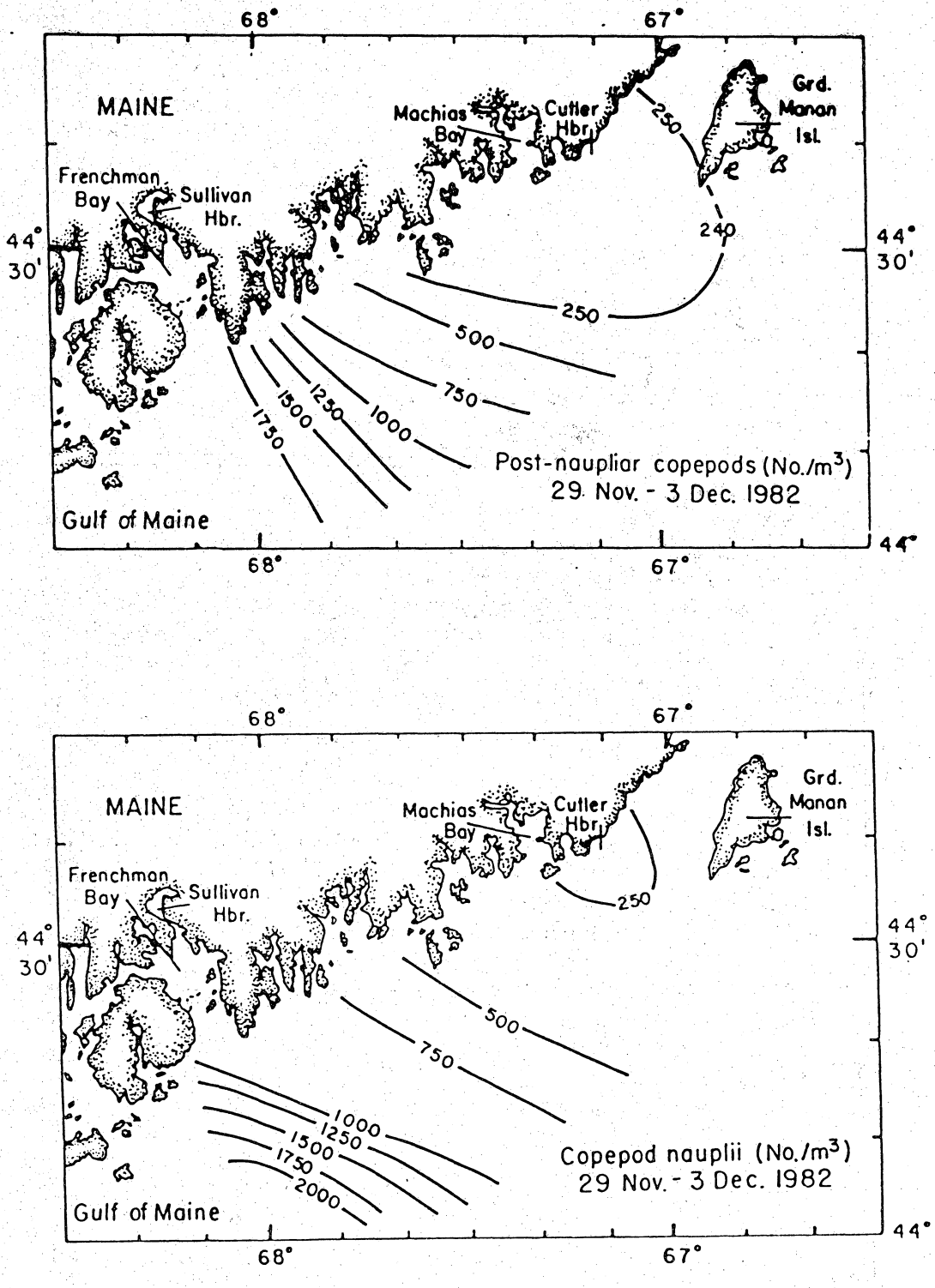

Figure 3. Contours of density (No./m^3) of post naupliar copepods and copepod nauplii for the 29 November - 3 December cruise.

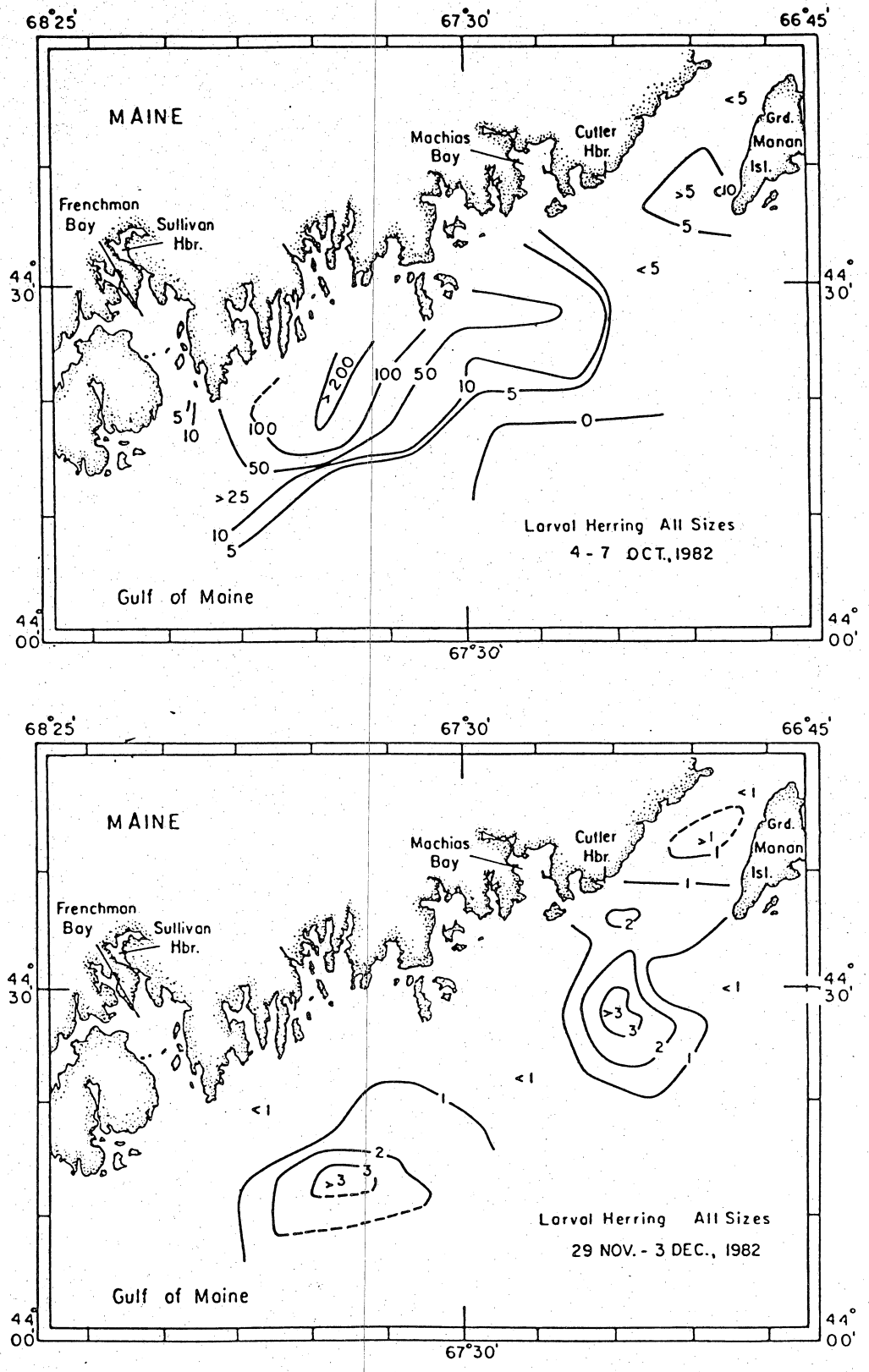

Figure 4. Contours of total larval herring abundance (No./ m^2 sea surface) for both cruises.