Age and Growth of Larval Atlantic Herring, *Clupea harengus harengus* Linnaeus 1958 (Osteichthyes; clupeidae), in the Sheepscot Estuary

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Introduction

The herring industry is the largest fishery in the State of Maine. The popularity of the "sardine size" herring is important to the economics of coastal Maine. Because of its importance, research of the herring has been extensive along the northern New England-Canadian coast. A large amount of the research was prompted due to a decline in the sardine size herring. One important aspect of the research is the forecasting of recruitment to the fishery by the Department of Marine Resources.

Herring deposit their eggs on the bottom during autumn in coastal waters. The eggs hatch after eight to nine days at an average temperature of $10^{o}C$ (Lough et al., 1982). The larvae drift with currents along the coast and then enter the numerous estuaries and embayments.

This paper considers the age and growth of larval Atlantic herring, *Clupea harengus harengus*, in an estuary. The data are basic to understanding the mechanisms of recruitment to the fishery.

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Methods

Estimates on age and growth are based on larval herring samples from the Sheepscot estuary of Maine. The estuary is located in the Boothbay region of central Maine. Sampling was conducted in a narrow channel at the head of the lower estuary. The channel is 8 km long, 1/2 km wide and 21 meters deep. The semidiurnal tide flow does not exceed two knots within the channel.

Buoyed and anchor plankton nets were used to strain the larvae from the tide flows. The nets consisted of four nets with a mesh opening of .5 - .75 mm and a mouth opening of .5 meters. Fishing depths were: the surface 10, 15, and 20 (bottom) meters. They were set at dusk and retrieved at dawn. The nets were set for approximately 12 hours each on a tidal cycle (Graham and Davis, 1971).

In the laboratory, larvae were sorted from the samples and a portion frozen for later mounting of their otoliths. Later, the larvae were thawed and then measured at standard length in millimeters. The two sagittae, the largest of three otolith types, were removed from both sides of the posterior section of the head. The sagittae were then placed on a slide, mounted in permount and covered with a coverslip. Otolith rings or growth increments were counted under a compound microscope at 400X magnification. An ocular micrometer provided up to ten divisions for counting the growth increments from the nucleus to the edge. Growth increments were counted in each division and totaled. This technique was repeated and the totals compared. If the difference between them exceeds 5% of the total count, then those divisions showing unusual differences were recounted to determine any errors. In this technique, it was not necessary to recount the entire otolith.

The resulting data were entered into a computer providing a graph of length versus the number of increments. A statistical analysis by linear regression was used to determine the average rate of growth. The term $y = a + bx$ was used where: y is length; x is the number of increments; a is the intercept; b is the coefficent of growth.

The data on larvae herring age and growth is based on the assumption that there is a daily periodicity in otolith increments.

Results

The data in Figure 1 show rapid growth of the larvae from about 10 to 60 increments and a definite retardation of growth from 70 to 120 increments. The rapid growth occurs during October through December, and the retardation occurs from December to February. Individual increment counts display a considerable variation with regard to larval lengths. Even though there is variation, a trend is present (Figure 2). Simply, this trend indicates that the number

of increments increases with an increase in length. A single trend of regression line can not be fitted to the data, because there appear to be two growth stanzas (Figure 2); since growth was faster at a smaller size than at a larger.

Discussion

In addition to the two growth stanzas in this study, a third stanza of rapid spring growth is reported by Townsend and Graham (1981) in the Sheepscot estuary. In Lough's (1982) data from the Maine coast, only the first two stanzas are present, as in the Sheepscot estuary (Figure 1). The separation into three growth stanzas is caused by a slowdown of growth during midwinter (Townsend and Graham, 1981). This retardation or cessation of growth is evident for each of the larval groups or cohorts that enters the estuary during the autumn and early winter regardless of larval length. The mixing of data from different cohorts in Figures 1 and 2 is probably responsible for a growth rate (1.3 mm/wk.) lower than that obtained previously for individual cohorts (2 mm/wk.). Despite this confounding, the data suggest that the analysis of larval growth in the Sheepscot estuary using otoliths can be repeated reliably.

References

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Figure 2

LARVAL HERRING OTOLITH DATA
FROM THE SHEEPSCOT RIVER (SITE=1), 1982 YEAR CLASS
COLLECTED BY THE MAINE DEPARTMENT OF MARINE RESOURCES, 1982-83
ACTUAL LENGTHS ('.') VS. THOSE PREDICTED BY ABOVE MODEL ('*')

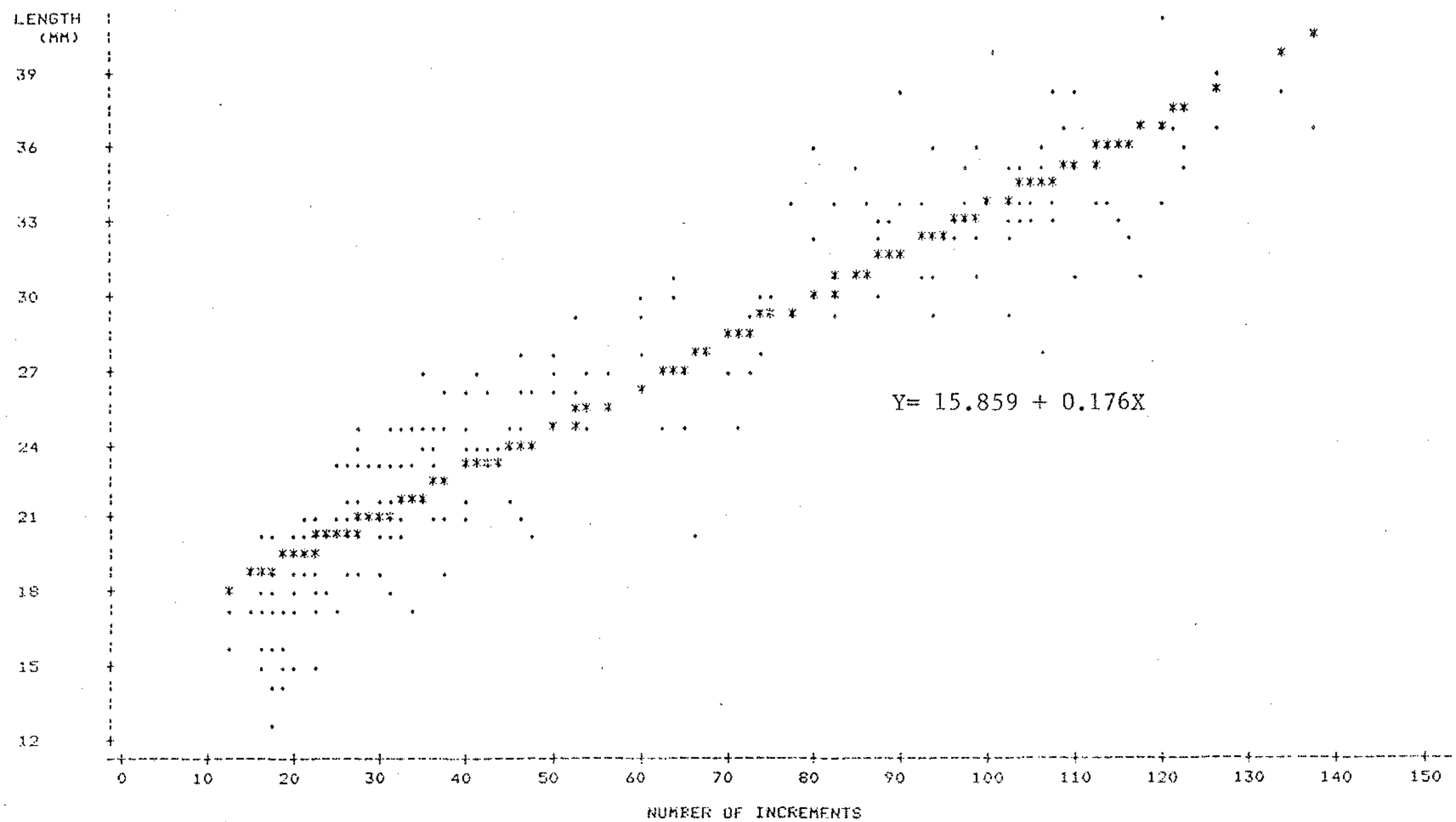
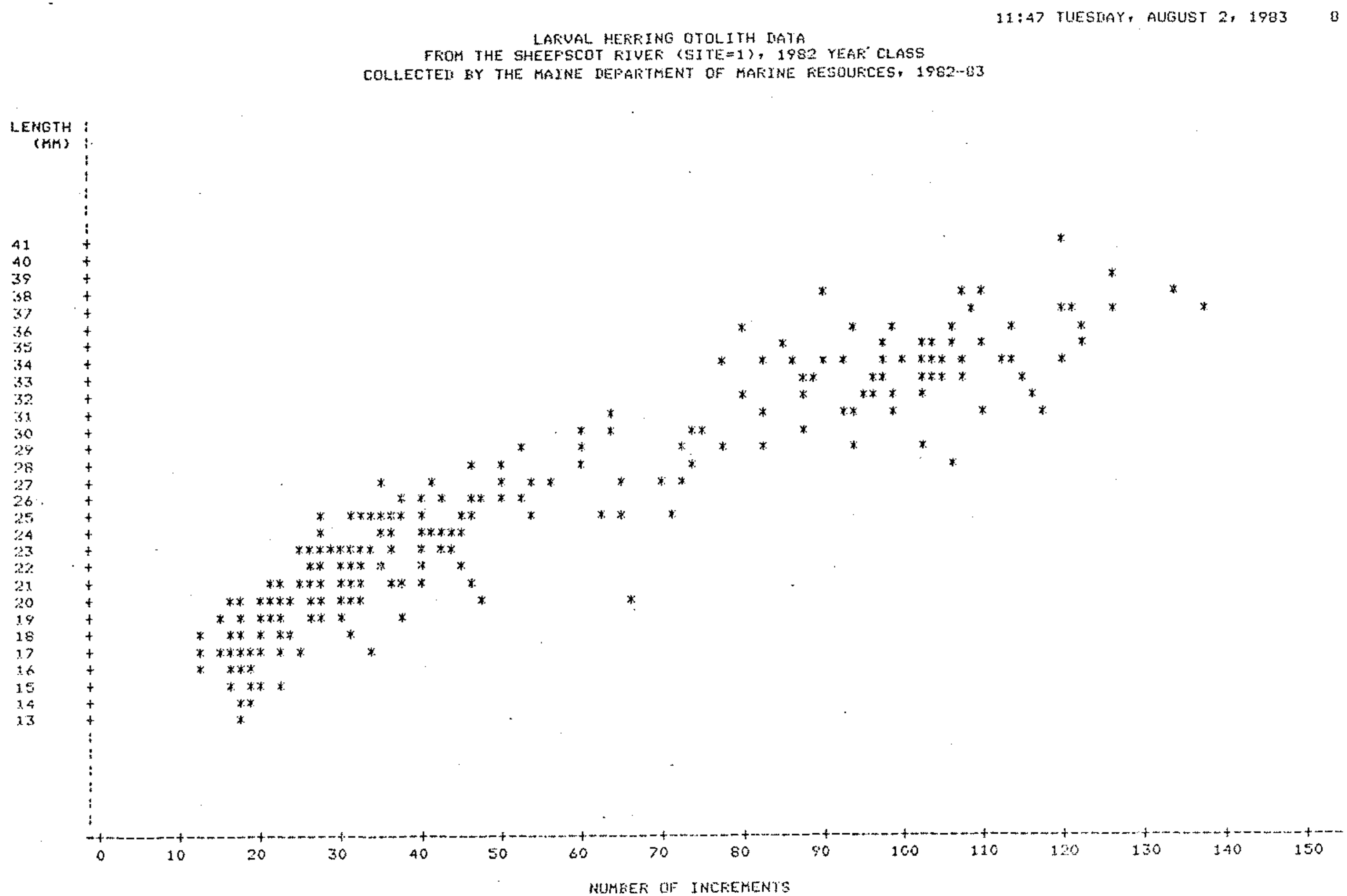


Figure 1


11:47 TUESDAY, AUGUST 2, 1983 8
LARVAL HERRING OTOLITH DATA
FROM THE SHEEPSCOT RIVER (SITE=1), 1982 YEAR CLASS
COLLECTED BY THE MAINE DEPARTMENT OF MARINE RESOURCES, 1982-83
LENGTH (MM)
41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
NUMBER OF INCREMENTS