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Pelagic Juvenile Cod (*Gadus Morhua*) in the Newfoundland Region (2J3KLNO), 1994 and 1995

by

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Introduction

A research program to develop a multi-species, pre-recruit survey was carried out during 1991-1993, as part of the Northern Cod Science Program. Beginning in 1994, a two-ship survey was initiated to measure pre-recruit abundances of cod and capelin throughout NAFO Divisions 2J3KLNO, including both inshore and offshore areas (Figure 1). Large (International Young Gadoids Pelagic Trawl, IYGPT) and small (0.61 cm Bongo) gear types are used to sample the upper water column for the abundance of pelagic juvenile cod, as well as eggs and larvae. The survey is carried out at the end of August, beginning of September; timed to sample pelagic juvenile cod, before they settle to the bottom, and larval capelin, released from beach and bottom sediments, as well as any late summer spawning by marine fish.

The purpose of this paper is to report on the results of Atlantic cod (*Gadus morhua*) from the 1995 survey, and to compare these results to the 1994 survey. We examine abundances, distributions, length frequencies, ages and hatch dates for the 1995 year-class. In addition, we develop a pre-recruit abundance index that combines both abundance and geographic distribution. Results of the multi-species aspects of the 1994 and 1995 surveys were presentedduring the Newfoundland Region and Atlantic Zone Fisheries and Oceanography committee meetings in January and March 1996 (Anderson and Dalley, 1996). Results of capelin year-class strength estimates were presented during the Newfoundland Region Capelin Assessment meeting in March 1996 (Anderson and Dalley 1996).

Materials and Methods

The survey design is based on a random stratified grid, where stations are spaced 54 km apart (Figure 1). At each station a CTD is profiled to measure temperature, salinity, density and fluorescence. This is followed by a double oblique bongo tow to 100 m depth, and finally by a 30 minute IYGPT (International Young Gadoids Pelagic Trawl) tow which samples the 20-60 m depth stratum. Details of the methods used and the sample processing procedures are outlined in Anderson and Dalley (1995). The survey was carried out from September 5-22, 1995, which was approximately two weeks later than the 1994 two-ship survey.

An abundance index is developed based on a number of selected areas, following the method of Randa (1982). These Index Areas were chosen to represent different regions for inshore and offshore locations (Figure 1). The index is dependent on all stations being sampled within each area for a given year. When two or more areas have been sampled, an area weighted overall index of abundance can be derived. The basic index for a unit area is calculated as,

$$I_j = \overline{X}_j \cdot p_j$$

where, I_j is the index of abundance for area$_j$, $\overline{X}_j$ is the geometric mean abundance ($\log_e$) and p_j is the proportion of non-zero catches. The geometric mean abundance is calculated for each Index Area as,

$$\overline{X_j} = \frac{1}{N_{ij}} \cdot \sum_{i=1}^{N_{ij}} ln(X_{ij})$$

where N_{lj} is the number of non-zero catches and the variance of $\overline{X_j}$ is calculated as,

$$S_j^2 = \frac{1}{N_{lj} - a} \cdot \sum_{i=1}^{N_{lj}} \cdot (ln(X_{ij} - \overline{X}_j))$$

where a is the number of zero catches. Finally the Index Area is weighted by the size of each area as,

$$P_j = a_j \cdot I_j$$

where a_j is area of each Index Area (km^2).

An overall index for several areas can be estimated as either the sum of the weighted Index Area values

$$SUM_{P_j} = \sum_{j=1}^{k} P_j$$

where k is the total number of Index Areas, or as weighted mean, where

$$M = \frac{1}{A} \sum_{j=1}^{k} \cdot a_j \cdot P_j$$

where A is the total area (km^2) of all areas used in the calculation and the standard error of this overall index is

$$MSE = \sqrt{\frac{1}{A^2} \sum_{j=1}^{k} \frac{a_j^2 \cdot S_j^2}{N_{lj}}}$$

An area weighted proportion for these areas is calculated as

$$Q = \frac{1}{A} \sum_{j=1}^{k} a_j \cdot p_j$$

and the standard error of the weighted proportion is calculated as

$$SEQ = \sqrt{\frac{1}{A^2} \sum_{j=1}^{k} a_j^2 \cdot S_{pj}^2}$$

A final logarithmic index of year-class strength is than estimated as

$$L = M \cdot Q$$

Results

Lengths

Cod ranged in length from 34-76 mm in 1995 compared to 30-73 mm in 1994 (Figure 2). There may have been two modes in 1995, centered around 40-45 mm and 53-57 mm, and possibly a third mode at 65-67 mm. In 1994 there was a single mode centered around 42-47 mm (Figure 3).

Ages and Growth

Cod averaged 68.8 days of age in 1995, for a range in length aged which ranged from 30-70 mm, averaging 45.8 mm in length. In 1994 cod averaged 80 days of age.

In 1995, cod grew at an average rate of 0.60 mm/d, compared to 0.48 mm/d in 1994 (Figure 4). These growth rates compare to those measured in 1992 of 0.65 mm/d and in 1993 of 0.64 mm/d.

Hatching and Spawning Times

In 1995, hatching occurred primarily during the last half of June through to the third week of July (Figure 5). Assuming egg developmental times of approximately 25-30 days, this indicates spawning occurred in May and June of 1995. In 1994, hatching occurred primarily in June, indicating spawning occurred in May.

Distributions

In 1995, cod were distributed throughout the inshore areas sampled, being most abundant in Notre Dame Bay and least abundant in Trinity Bay (Figure 6). Cod were also observed nearshore off southern Labrador as far north as we sampled. There were few cod observed offshore on the Northeast Newfoundland Shelf. Cod were only observed at one station on the northern Grand Bank and one station on the southern Grand Bank (Figure 6). The inshore distribution was similar in 1994. However, offshore cod were sampled abundantly throughout the offshore on the Northeast Newfoundland Shelf, as well as over the southern Grand Bank (Figure 7).

Abundances

The Weighted Index Areas estimate for commonly sampled areas were similar for the inshore in 1994 and 1995. However, offshore the index value was lower in 1995 than 1994. Overall, the index value for 1995 is lower than 1994.

Discussion

Acknowledgements

A number of people contributed to the successful completion of the 1995 survey, including Arnold Murphy, Eugene McDonald, Denise Davis, Greg Redmond, David Orr, Darlene Gillet, Gus Cossitt and Wayne Edison. Arnold Murphy was responsible for assembly of the considerable amount of electronic gear that are used by the two ships. Denise Davis has been responsible for wrestling with complex data sets being generated and producing the tabulated and graphical results. In particular, we thank the captains and crews of the Wilfred Templeman and Teleost for excellent cooperation and assistance in carrying out our two ship survey.

References

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Table 1. Weighted Index Areas values estimated for all available areas sampled in 1994 and 1995.

INSHORE

Year	CB	TB	BB	NDB	WB
1992	32.0	—	73.3	132.9	—
1993	31.8	34.9	61.7	54.0	—
1994	10.2	39.3	—	94.8	48.2
1995	33.7	19.5	29.8	102.6	36.9

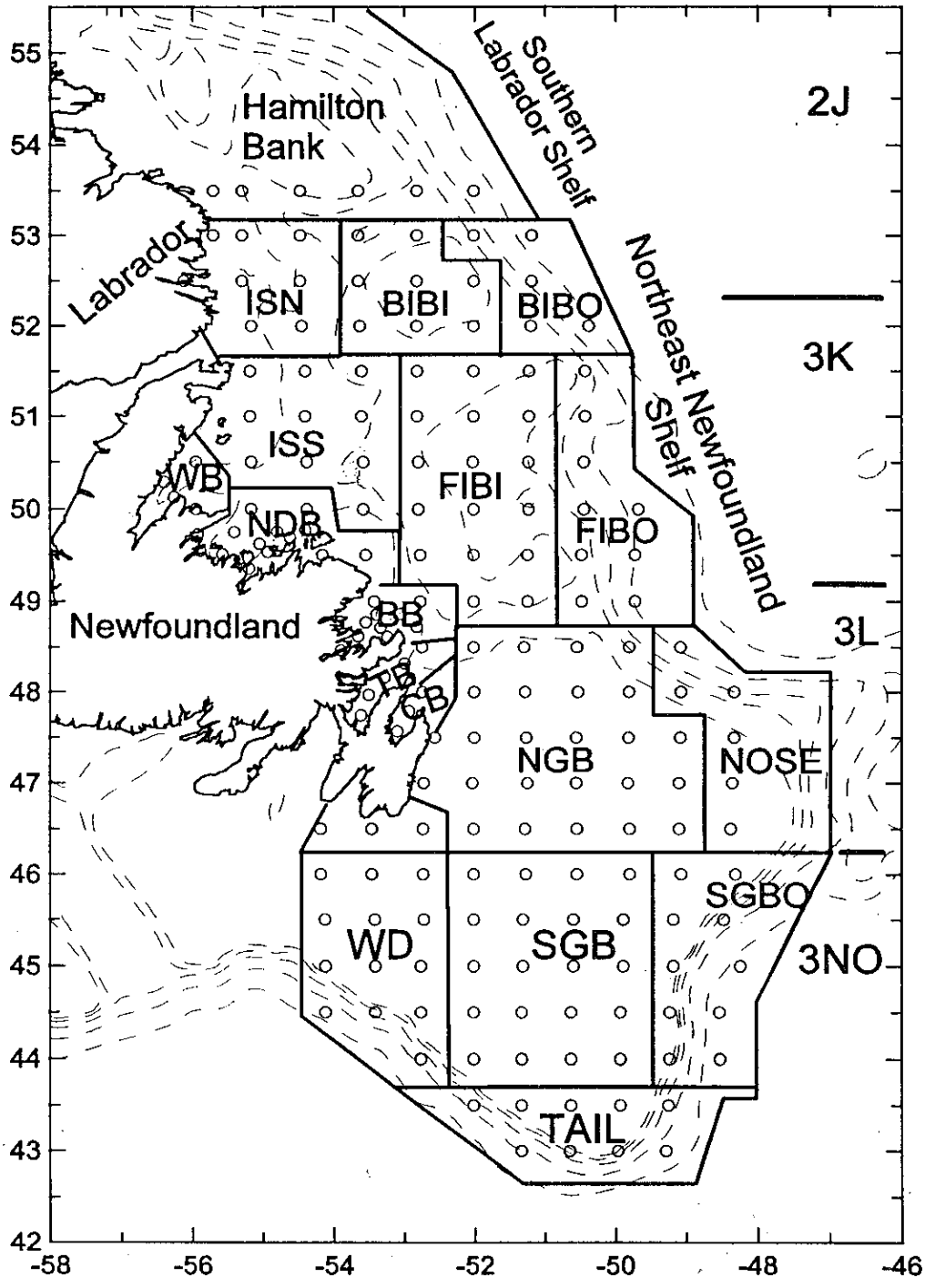
OFFSHORE

Year	BIBI	FIBI	ISN	ISS	NGB	SGB	NGBW
1992	—	—	—	—	—	—	—
1993	—	—	—	—	—	—	—
1994	—	7.1	—	99.9	—	67.0	10.4
1995	6.0	12.0	18.4	47.0	9.1	7.7	—

Table 2. Combined Weighted Index Area estimates for all commonly sampled Index Areas in 1994 and 1995.

INSHORE & OFFSHORE

Area	1994	1995
Inshore	192.5	192.7
Offshore	174.0	66.7
Total	366.5	259.4



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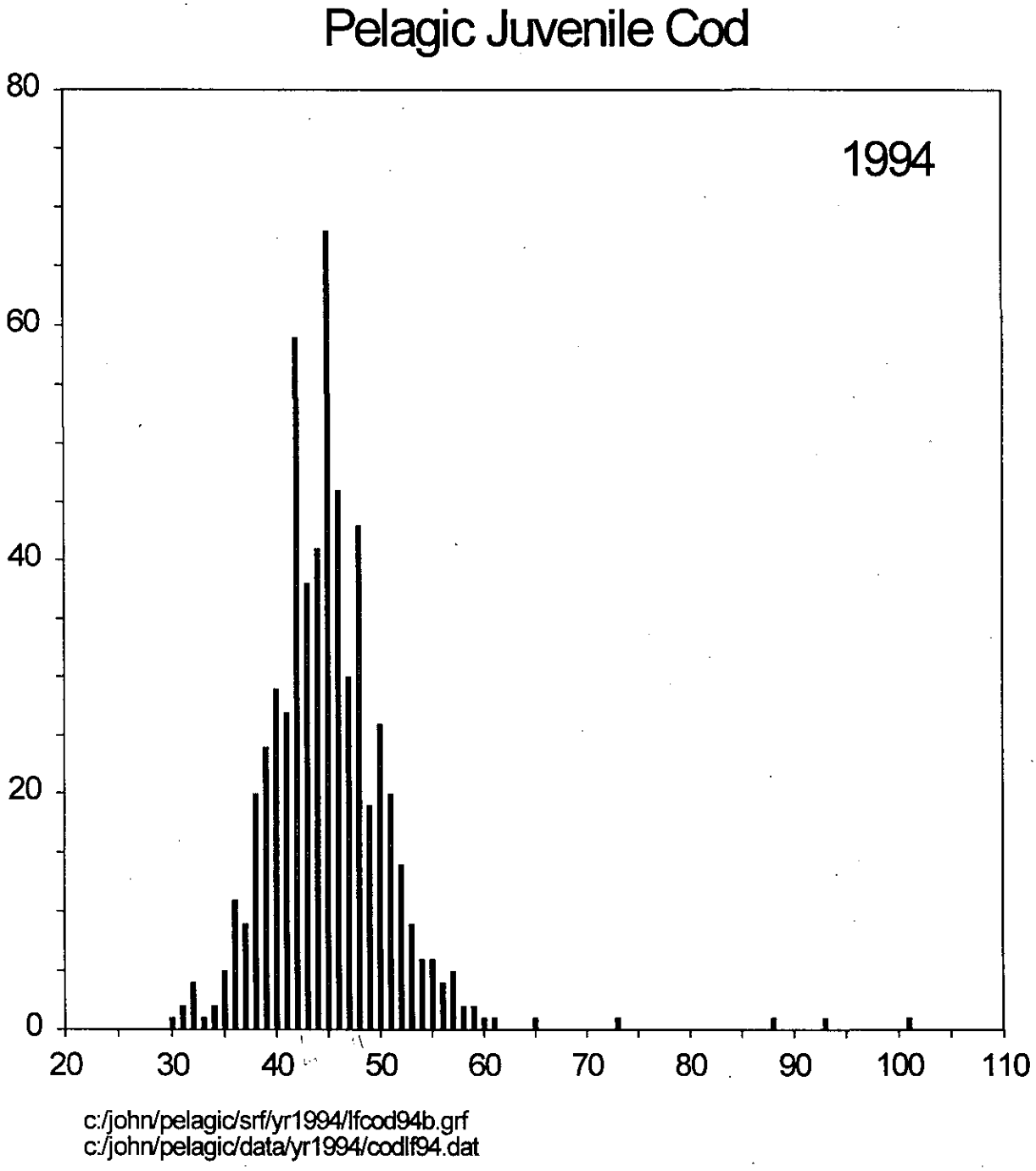
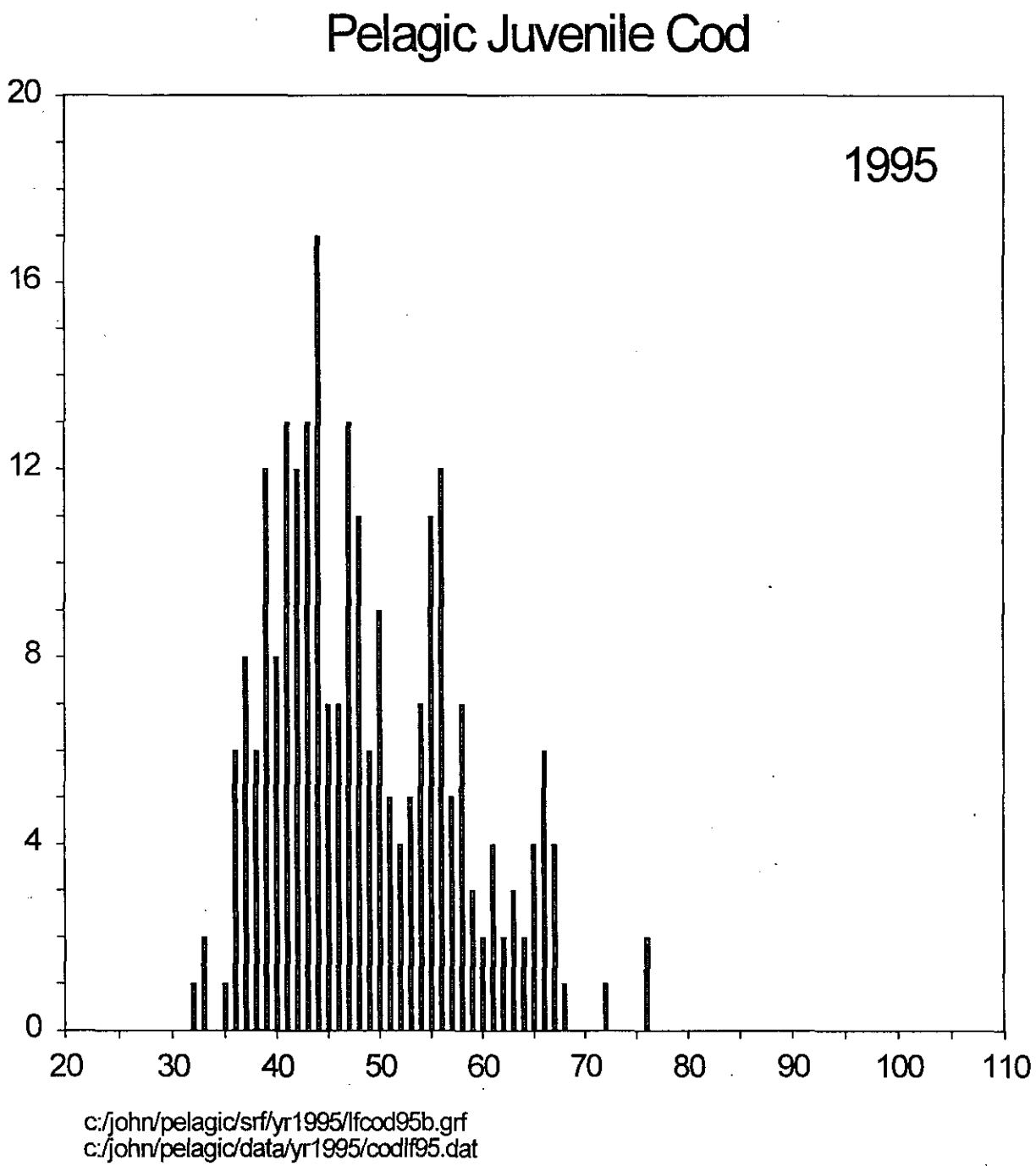
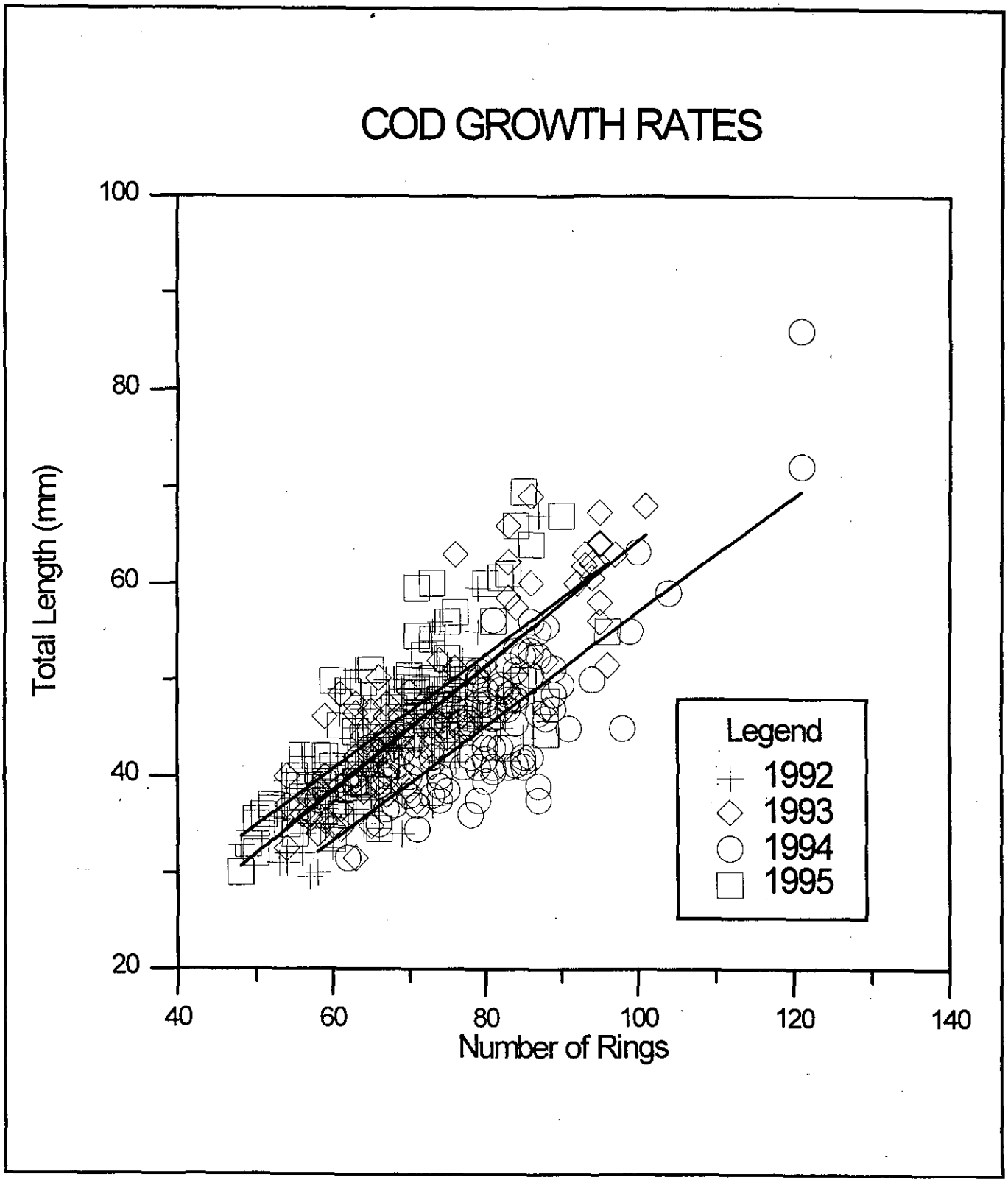
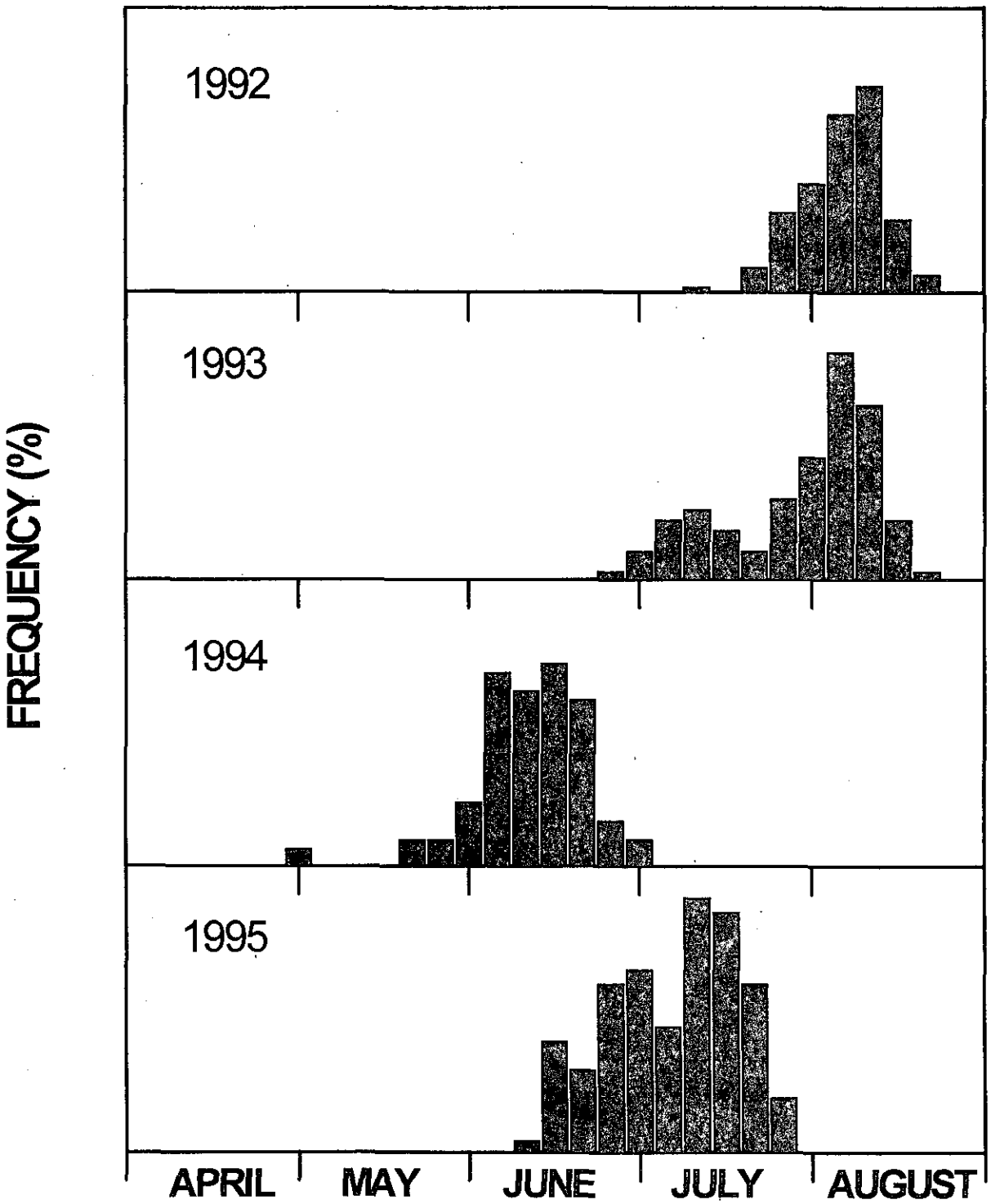
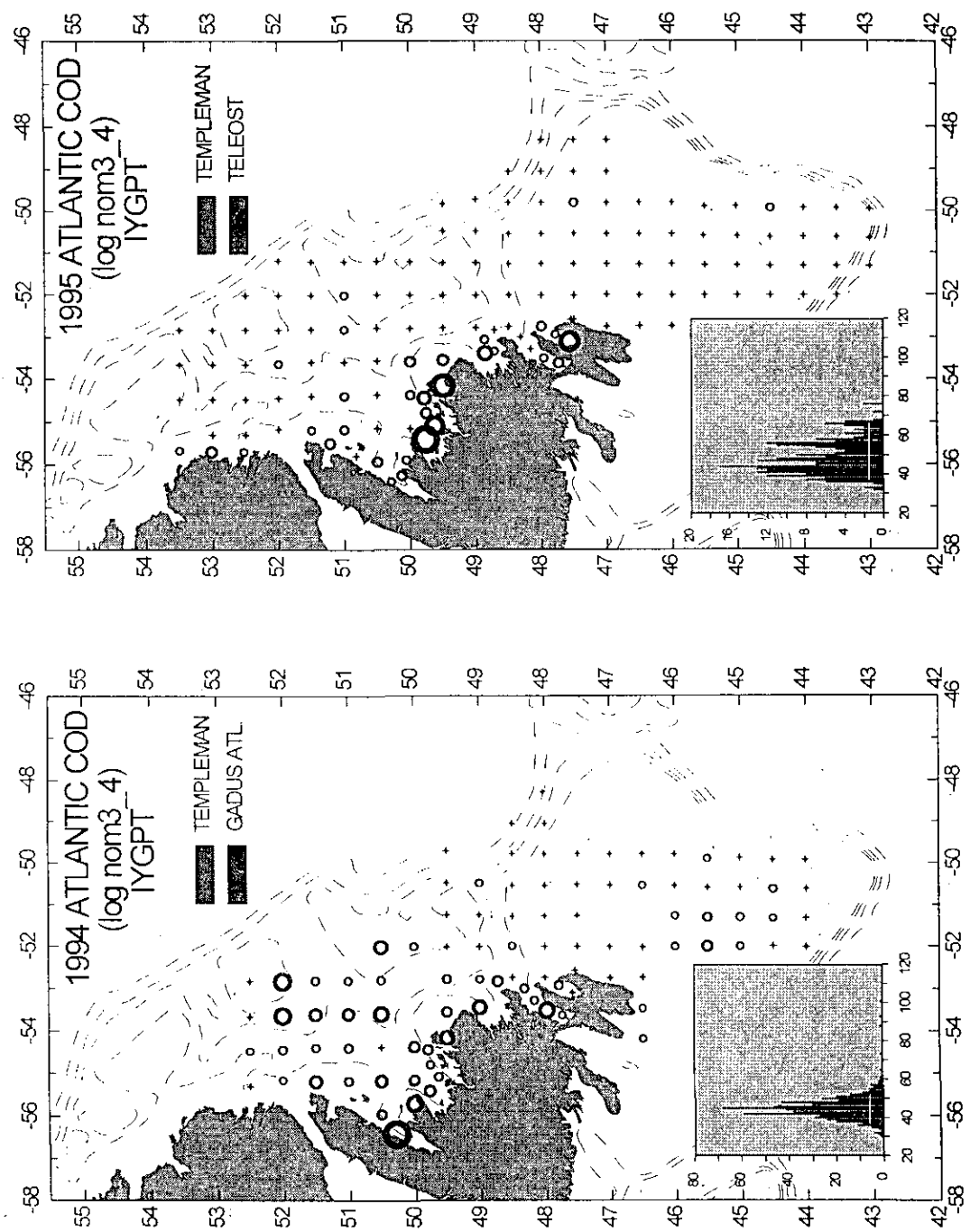

Pelagic Juvenile Cod
1994
80
60
40
20
0
20
30
40
50
60
70
80
90
100
110
c:/john/pelagic/srf/yr1994/lfcod94b.grf
c:/john/pelagic/data/yr1994/codlf94.dat


Pelagic Juvenile Cod
1995
20
16
12
8
4
0
20
30
40
50
60
70
80
90
100
110
c:/john/pelagic/srf/yr1995/lfcod95b.grf
c:/john/pelagic/data/yr1995/codlf95.dat


COD GROWTH RATES
Total Length (mm)
100
80
60
40
20
40
60
80
100
120
140
Number of Rings
Legend
1992
1993
1994
1995


1992
1993
1994
1995
FREQUENCY (%)
APRIL
MAY
JUNE
JULY
AUGUST


1994 ATLANTIC COD
(log nom3_4)
IYGPT
TEMPLEMAN
GADUS ATL.
1995 ATLANTIC COD
(log nom3_4)
IYGPT
TEMPLEMAN
TELEOST