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Inshore/Offshore Distributions and Abundances of Pelagic 0-Group Cod in NAFO Divisions 3K and 3L in Fall of 1991 and 1992

by

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1 Introduction

Fall surveys for pelagic 0-group cod and capelin were initiated in the fall of 1991 as part of the Northern Cod Science Program. One objective of these surveys is to sample the distribution and abundance of cod in the early fall, prior to settlement. The distribution of cod several months after spawning, following the period of egg and larval drift, can be used to test modelled predictions of drift. Such distributions may also be useful in delineating juvenile nursery areas. Finally, studies of Browns Bank cod and Arcto-Norwegian cod have demonstrated that year-class strength is largely determined prior to settlement, during the first few months of life. Therefore, relative abundance measured during these surveys may be an early indicator of year-class strength for cod within the 2J3KL management area.

2 Methods

A survey grid at 30 nmile spacing was carried out in 1991 and 1992, with stations spaced from nearshore, over the shelf areas to the shelfbreak. This design was similar to that used in September 1981 to sample 0-group capelin, except that we also surveyed within each of the major bays along the NE coast of Newfoundland (Conception, Trinity, Bonavista and Notre Dame Bays). Stations were chosen within each bay at approximately 30 nmile spacing. In 1991 the survey was carried out using a 4.5 m^2 Tucker trawl towed obliquely 0-100 m at 1.25-1.5 m s^{-1}. The Tucker trawl was monitored with an electronic system that measured depth, distance towed, volume filtered, temperature, salinity and depth in real time. In 1992 both Tucker and IYGPT trawls were used. The IYGPT trawl was monitored with Scanmar sensors mounted on the doors, wings and headrope, to measure net opening while speed was recorded by the ships speed log. The IYGPT trawl was fished at 50 m depth for 30 minutes, towing at 1.25-1.5 m s^{-1}. Due to equipment problems, the IYPGT trawl was not used at all stations and, due to time constraints, the Tucker trawl was not used during the last part of the survey. There were 11 stations where both the Tucker and IYGPT trawls were fished, sequentially. To compare catches between the different trawls and surveys, catches were standardized to the number of cod caught m^{-3}.

3 Results

The surveys were carried out between 11-22 October 1991 and 28 September - 16 October 1992. In 1991 pelagic cod were only caught at seven stations, all within the inshore areas of Conception, Trinity and Notre Dame Bays (Figure 1). The catches ranged from 1-2 cod per tow, which represented from 1.1 to 3.1 cod 10,000m^{-3}. The largest catches were in Notre Dame Bay. A total of 15 pelagic 0-group cod were caught in 1991.

In 1992 cod caught in the Tucker trawl were more abundant and more widely distributed than in 1991, being observed within Conception, Trinity and Bonavista Bays, and at some locations on the Grand Bank (Figure 2). Catches from the Tucker trawl in 1992 ranged from 1-16 cod per tow, and represented from 1.6 to 21.3 cod

10,000m^{-3}. Results from the IYGPT trawl demonstrated that pelagic cod occurred within each of the inshore bays sampled and extended onto the adjacent shelf (Figure 3). Notably, cod were caught at all stations fished by the IYPGT trawl with Notre Dame and Bonavista Bays. Catches from the IYGPT trawl ranged from 1-271 cod per tow, and represented from 0.1 to 13.4 cod 10,000m^{-3}.

The IYGPT trawl caught cod from 28-67 mm length, normally distributed about a mean of 45.3 mm (sd=6.88, n=328) (Figure 4). The Tucker trawl caught cod from 29-51 mm length and these were relatively evenly distributed between approximately 35-50 mm length (Figure 4). The mean size of cod in the Tucker trawl was 39.8 mm (sd=5.88, n=47).

Comparison of the catches at 11 stations sampled by the two trawls indicates that the Tucker trawl undersampled cod present in the water. For example, at six of the 11 stations the IYGPT trawl caught from 3-102 cod whereas the Tucker trawl catches were zero. At stations where both trawls caught cod the Tucker trawl catches ranged from 7-100% of the IYGPT trawl catches. Comparing standardized catches for the 5 stations where both trawls caught cod, the Tucker trawl averaged 4.3 cod 10,000m^{-3} while the IYGPT trawl averaged 1.2 cod 10,000m^{-3}. For the six stations where the IYGPT trawl caught cod and the Tucker trawl did not, the mean abundance was 1.4 cod 10,000m^{-3}.

Based on the comparisons between IYGPT and Tucker trawl catches, the standardized catch rates of the Tucker trawl were multiplied by 0.27 to equate to IYGPT trawl catches. The combined data set was plotted to generate a single distribution of pelagic cod in 1992 (Figure 5). This figure indicates that pelagic 0-group cod were caught within all the inshore bays along the NE coast of Newfoundland, on the inner part of the NE Newfoundland Shelf and on the northern Grand Bank. The most abundant catches were in Notre Dame Bay.

4 Discussion

Comparing the Tucker trawl catches between years it is apparent that more pelagic cod occured in 1992. The survey dates overlapped by 6 days, with the cruise mid-date being approximately one week earlier in 1992. This difference in timing is considered too small to have effected the difference in catches observed. Therefore, we conclude that more pelagic cod occurred in 1992, indicating a relatively higher year-class abundance compared to 1991.

The distribution of cod in 1991 and 1992 indicates that cod were found predominantly within the inshore bays, and less so on the NE Newfoundland Shelf and Northern Grand Bank. These distributions contrast with that observed in a 1981 survey which observed pelagic cod distributed widely over the NE Newfoundland Shelf and Northern Grand Bank (Anderson et al. 1993). In the 1981 survey cod lengths were similar (mean length 38.1 mm, range 17-70 mm) while standardized abundances were approximately two orders of magnitude higher (op. cit.). Recruitment from the 1981 year-class was relatively high. Therefore, a qualitative comparison between the abundance of pelagic cod in measured 1981 to that observed in this study, indicates that year-class strength will be relatively small in 1991 and 1992.

Modelled predictions of cod egg and larval drift demonstrated that cod eggs spawned on the NE Newfoundland Shelf will stay on the shelf and not be advected to the inshore areas (Helbig et al. 1992). Only cod eggs spawned on the inner shelf, and upstream, might be advected to inshore areas such as Notre Dame and Bonavista Bays (deYoung et al., in prepartion). Therefore, the distribution of pelagic cod observed in 1981 is consistent with the a predominant spawning of cod offshore and a subsequent offshore occurence of pelagic cod. The distributions of pelagic cod observed in 1991 and 1992 is not consistent with cod spawning predominantly offshore, unless this spawning was confined to the inner shelf area. Alternatively, the distributions observed in 1991 and 1992 would be consistent with cod spawning within the inshore bays. Given the paucity of observations for spawning cod in either 2J or the northern part of 3K in 1991 and 1992, it may be that the distributions of cod observed in 1991 and 1992 resulted primarily from inshore spawning.

It has been hypothesized that the coastal (inshore) abundance of the NE-Arctic cod is determined by available habitat and not by year-class strength (Solemdal 1986, referenced by Olsen and Soldal 1989). Observations during two years of low year-class strength supported this hypothesis (Olsen and Soldal 1989). This description is consistent with our observations for Northern Cod. In this way, 0-group cod may always be observed in inshore areas where habitat is suitable, but will only be observed more widely distributed when year-class strength is high.

A demersal survey for young cod was carried out in December 1992 (Dalley and Anderson MS1993). 0-group cod were only caught in Conception and Trinity Bays,

at one location in Notre Dame Bay and at one location on the Northern Grand Bank (op. cit.). No 0-group cod were sampled over the NE Newfoundland Shelf. In general, the distribution of demersal 0-group cod matched that of pelagic 0-group cod sampled two months previously. This comparison indicates that the distribution of pelagic cod sampled during September-October represented where these cod settled to a demersal habitat.

The size and age of cod settlement from a pelagic to demersal habitat is largely unknown. However, there are several lines of evidence which indicate that 0-group cod were still predominantly pelagic in our study area during September and October:

1. Perry and Nielson (1988) speculated that cod make the transition to a predominantly demersal habitat at 70-80 mm length. These lengths represent the upper range of pelagic cod sampled in 1981, 1991 and 1992. Alternatively, cod eggs spawned in April, with the prolonged development rates expected at the cold temperatures observed for this area and expected larval growth rates, would be approximately 40-50 mm length during September-October. These predicted sizes correspond with the mean sizes of pelagic cod observed in different years. Analyses of the 1981 data indicated that the cod sampled during September represented the cod eggs spawned during April-May, based on backcalculations for representative growth and mortality rates (Anderson et al. 1993).

2. The distribution of pelagic 0-group cod in September-October 1992 compared with demersal 0-group cod sampled in December 1992 was very similar. Therefore, the demersal survey confirmed that the distribution of pelagic cod was representativley sampled.

3. The cod length-frequency distribution sampled by the IYGPT trawl was not negatively skewed (Figure 4), as might be expected if these cod had already begun a significant transition to a demersal habitat. The mean length of cod sampled by the IYGPT trawl was 45.3 mm, while demersal 0-group cod sampled during the December averaged 81.0 mm (Dalley and Anderson MS1993). The mid-dates of these cruises differed by 63 days. Therefore, nominally, growth rate estimated for 0-group cod sampled as pelagic juveniles in September-October to those measured demersally in December is 0.57 mm d^{-1}. This growth rate compares to 1.61 mm d^{-1} for demersal cod 45-90 mm length (Olsen and Soldal 1989), and estimated growth rates of 0.39-0.59 mm d^{-1} for pelagic cod which averaged 25 mm length (Suthers et al. 1989). Therefore, our estimate of growth rate is probably mid-range or low for juvenile cod. However, consider the bias in estimating growth rate if cod had largely aquired a demersal habitat by September-October. In this case, only small cod at the lower end of the true length-frequency distribution would have been sampled. Therefore, an estimate of growth rate based on means would be biased high. This was clearly not the case in 1992, indicating that cod were still predominantly pelagic during September-October.

5 Summary

1. In 1991 pelagic 0-group cod were only observed at a few locations within the inshore bays, and catches were very low compared to Tucker trawl catches 1992. In 1992 the distribution of pelagic 0-group cod was much broader than in 1991 and the abundances were higher. These comparisons indicate that the 1992 year-class may be greater than in 1991.

2. Comparison of catch rates between 1981 and those obtained in 1991 and 1992, plus the considerable difference in distributions, indicates that year-class strength in 1991 and 1992 may be relatively small.

3. The predominant occurrence of pelagic cod within the inshore bays is not consistent with significant offshore spawning in 1991 and 1992. The observed distributions are consistent with spawning on the inner shelf and/or within the inshore bays.

4. The distribution of pelagic cod in 1992 compared favourably with demersal 0-group cod sampled two months later (Dalley and Anderson MS1992).

5. Available evidence indicates that 0-group Northern Cod are predominantly pelagic during September and October.

6 References

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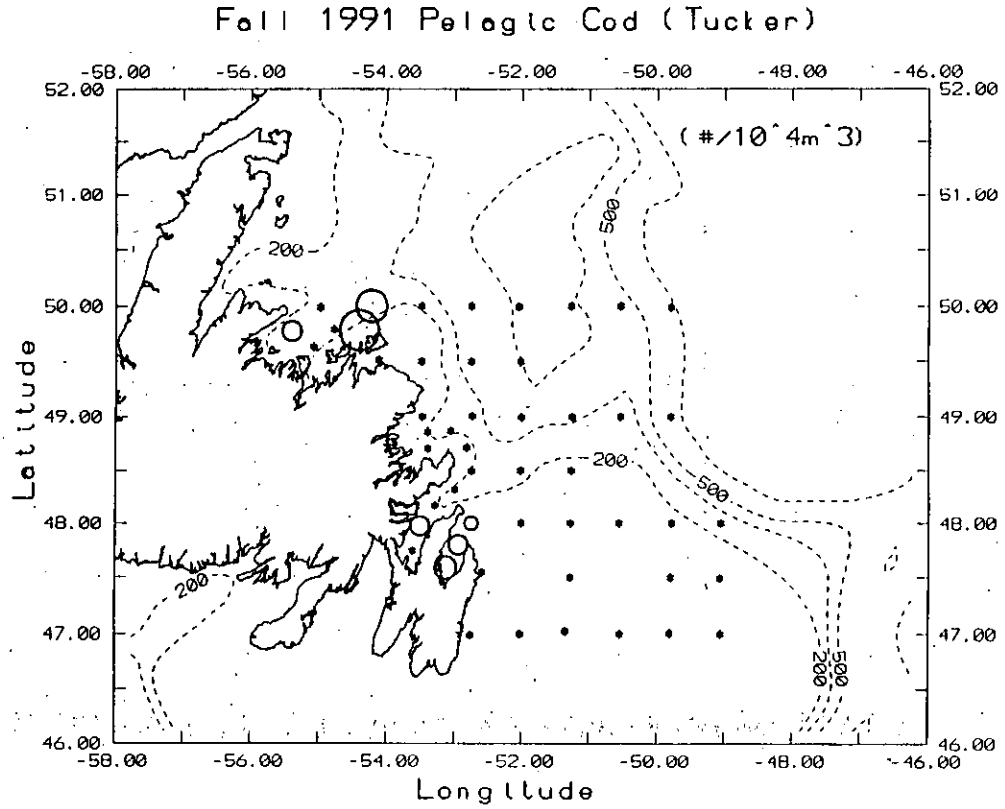

Figure 1. Abundance distribution of pelagic 0-group cod caught during 10-22 October 1991, using a 4.5 m^2 Tucker trawl ($\log_{10}$ number $10{,}000m^{-3}$).

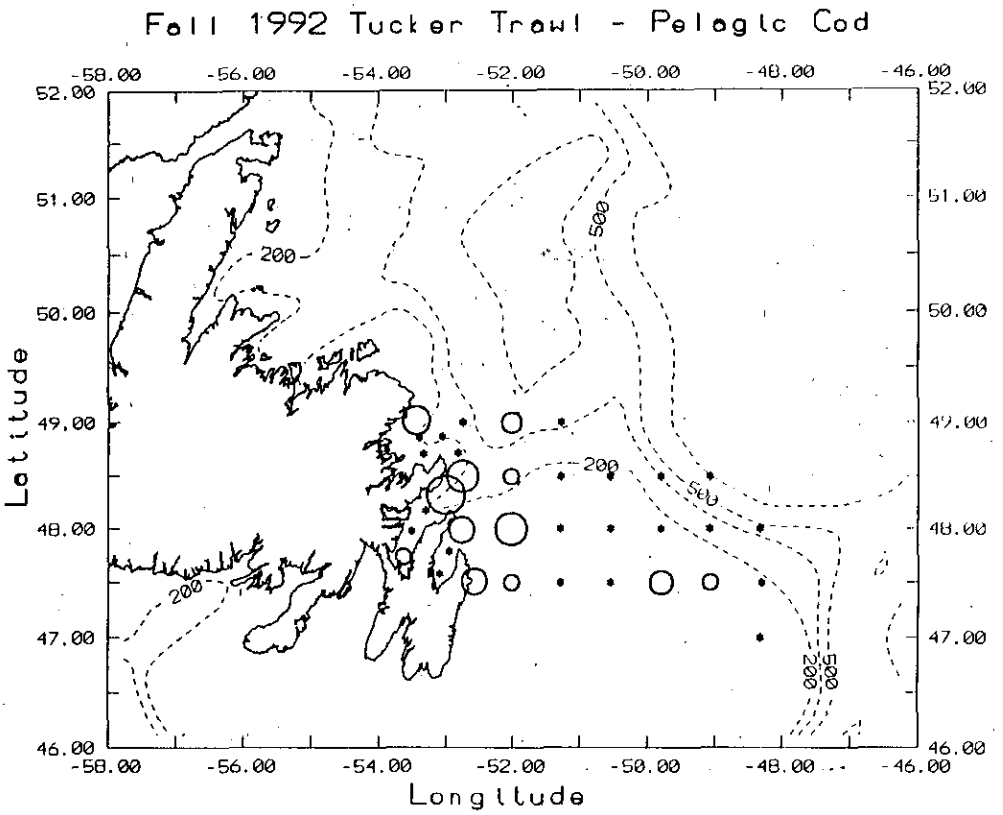

Figure 2. Abundance distribution of pelagic 0-group cod caught during 28 September to 16 October 1992, using a 4.5 m^2 Tucker trawl ($\log_{10}$ number caught per tow).

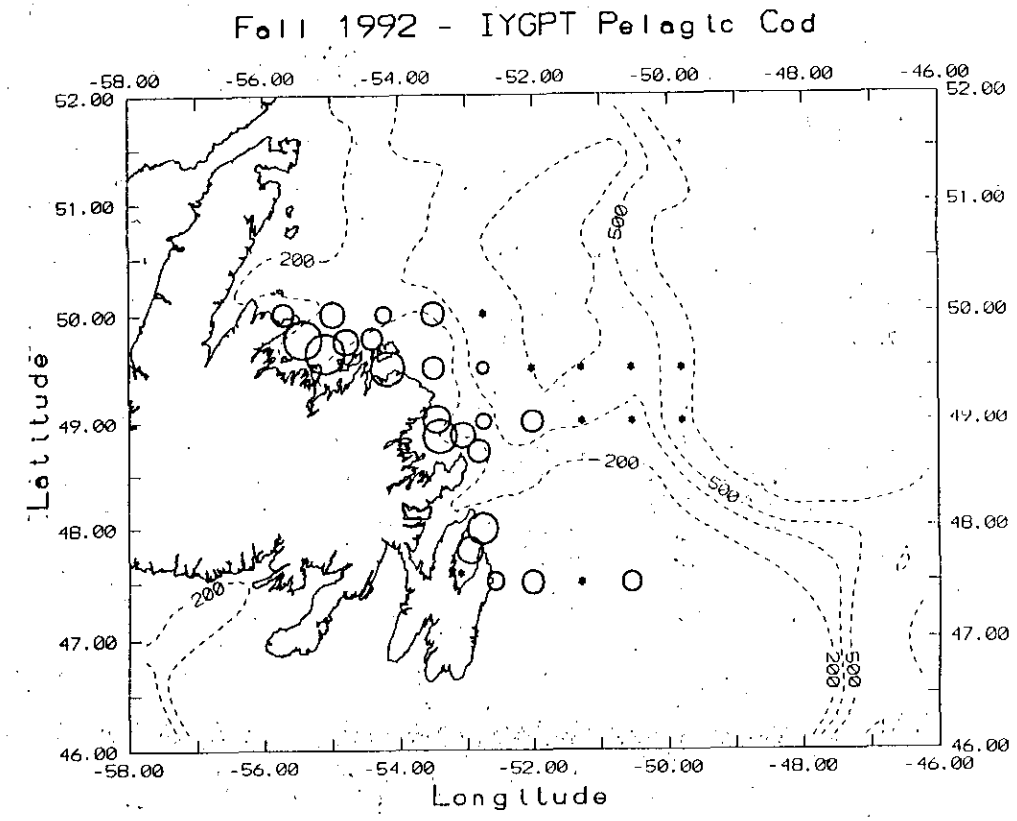

Figure 3. Abundance distribution of pelagic 0-group cod caught during 28 September to 16 October 1992, using a 100 m^2 International Young Gadoids Pelagic Trawl (IYGPT) ($\log_{10}$ number caught per tow).

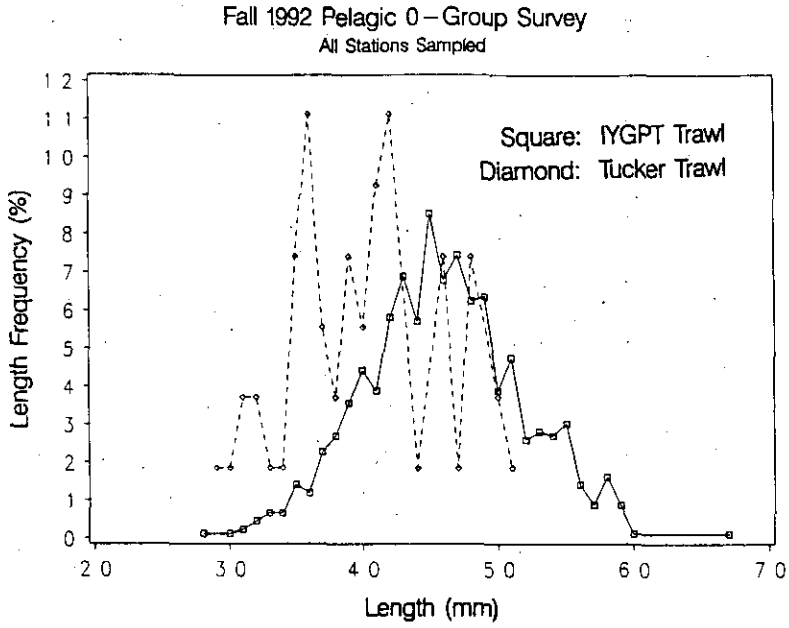

Figure 4. Length frequency distributions of cod caught in Tucker and IYGPT trawls during the fall 1992.

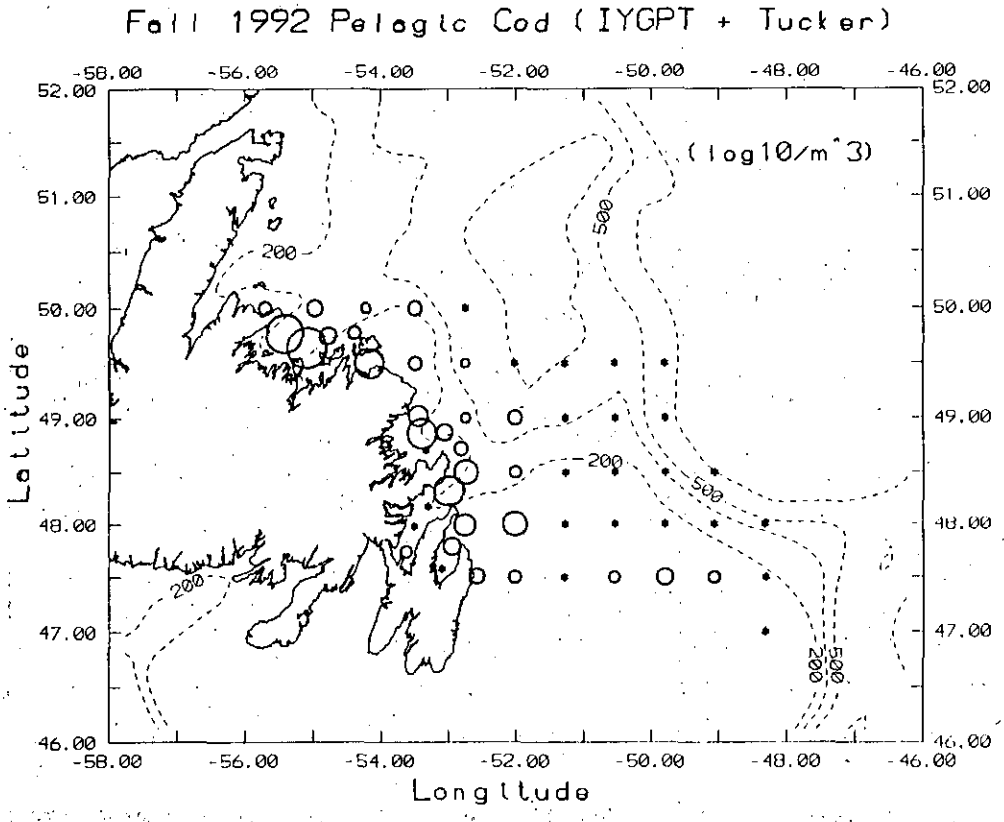

Figure 5. Abundance distribution of pelagic 0-group cod for the combined Tucker and IYGPT trawl catches during 28 September to 16 October 1992 ($\log_{10}$ number 10,000m^{-3}).