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Acoustic Surveys of cod spawning aggregations in Placentia Bay, May 1997

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Abstract

An adaptive 2-stage survey design was used to estimate the abundance of cod on major spawning grounds in Placentia Bay in May 1997. Surveys were conducted from the RV Innovation (10 m) using BioSonics DT4000 digital echosounders (120 and 38 kHz). Two spawning aggregations were located in May, at Perch Rock and Bar Haven, and another at Oderin Bank in June. Only the Perch Rock aggregation will be reported on here. Acoustic transects were run on days 143, 144, and 146, during the peak in spawning (approximately 50% of mature females had hydrated oocytes). A full grid of the entire aggregation was run on day 144, consisting of 9 transects across the aggregation at nominally 0.5 nmiles apart. Fish of ages 8, 7, and 5 (1989, 1990 and 1992 year classes) were heavily represented in catches by feather hooks deployed from automatic jigging reels. Transect densities ranged from 0.1 to 0.9 fish m-2 re: TS of -31.6 dB. The mean biomass estimate was approximately 38,000 t comprising approximately 18 million fish.

Résumé

Un modèle adaptatif de relevé à deux étapes a été utilisé pour estimer l'abondance de la morue dans les principales zones de frai de la baie Placentia en mai 1997. Des relevés ont été effectués à l'aide du navire de recherche Innovation (10 m) équipé d'échosondeurs numériques BioSonics DT4000 (120 et 38 kHz). Deux concentrations de géniteurs ont été décelées en mai, à Perch Rock et à Bar Haven, et une autre en juin, sur le banc Oderin. Le présent document ne traite que de celle de Perch Rock. Des transects acoustiques ont été effectués aux jours 143, 144 et 146 pendant le maximum du frai (50 % environ des femelles matures présentaient des oocytes hydratés). La totalité de la concentration a fait l'objet de relevés à la grandeur de la grille au jour 144 dont neuf transects ont été réalisés à intervalles nominaux de 0,5 mille marin. Les poissons d'âge 8, 7 ou 5 (classes d'âge de 1989, 1990 et 1992) étaient fortement représentés dans les captures réalisées par hameçons munis de plumes sur turluttes automatiques. La densité des transects variait de 0,1 à 0,9 poisson au mètre carré re: Indice de cible de –31.6 dB. La biomasse moyenne a été estimée à 38 000 t environ correspondant à quelque 18 millions de poissons.

Introduction

Acoustic surveys and related research on cod distribution and movement has been conducted seasonally in Placentia Bay since 1995 (Rose 1996). In the spring of 1997, systematic searches for cod aggregations were made with echosounders from April until June. Once located, aggregations were subject to a second stage and detailed survey. Of several aggregations located, two were large spawning shoals. Estimates of the abundance and biomass of one of these groups (hereafter the Perch Rock group) are given in this paper.

Methods

In the spring of 1997, Placentia Bay was surveyed along a regular grid of transects in April, May, and June (surveying continued near monthly year-round) (Fig. 1). Second stage adaptive transects were conducted where fish were located at densities approximately > 0.01 fish m^{-2} (e.g. Fig. 2). BioSonics DT4000 digital echosounders (120 and 38 kHz) were used from the RV Innovation (10 m) from transducers housed in a dead weight towed body. Editing and analyses were conducted with the FASIT (Fisheries Assessment and Species Identification Toolkit) analytical package developed at Memorial University of Newfoundland. Only results from the 38 kHz system are used here. Calibration factors were [SL=220 dB; RS=-52 dB counts; beam pattern=-30 dB; at 5 pings s^{-1}], confirmed with a tungsten carbide standard target. Target strength scaling utilized the relationship: TS = 20 log L - 67.5 (Rose, unpublished) which is indistinguishable from that recommended by Foote et al. (1987).

Fish were caught at random throughout the aggregations with feather-hooked jigs (automatic reels and hand lines). The selectivity of this method of capture is not known.

Aging was done under contract to Norman Batten.

Results

Two spawning aggregations were located: 1) Perch Rock, and 2) Bar Haven (Fig. 1). The Perch. For the Perch Rock group, acoustic transects were run over the group on days 143, 144, and 146, while peak spawning was occurring in May (approximately 50% of mature females with hydrated eggs). A full grid was run on day 144, and this offers the best (likely most precise) estimate of the full abundance. The other two days will be used for comparison but their data have not been fully analyzed yet.

The day 144 grid consisted of 9 transects across the aggregation, which measured approximately 5 nmiles long by 1 nmile wide. Transect intervals were nominally 0.5 nmiles but in reality varied (calculations of true spacing (GPS) are used for areal extrapolations of densities). All transects were edited to achieve the best possible bottom-fish separation. The DT4000 dynamic range and resolution, and the ability of FASIT to show that level of detail, assists greatly in separating fish from bottom, which at times

can be a large source of error in groundfish acoustic estimates (Fig. 2). We believe that detectability is the major problem with inshore acoustic surveying for semi-demersals (see Lawson and Rose 1999).

Age-frequencies indicated that fish of ages 5 and 7 were most heavily represented, with ages 8 and 6 also strong (Table. 1). A wide range of sizes was sampled.

Table 1. Age frequency for cod at Perch Rock spawning aggregtion, May 1997

Age	Frequency
3	1
4	5
5	35
6	17
7	38
8	25
9	9
10	0
11	4
12	1
Total	135

Transect mean densities varied from 0.1 to 0.9 fish m^{-2} (relative to an overall TS of -31.6 dB) (Table 2). Under this scaling, maximum densities were near 7 fish m^{-2}. Mean densities and SE's were calculated by resampling the basic density data at random 10 times at a rate of 75% (leaving 25% of the data out of each calculation). The 10 means were then used to calculate the mean and SE. These densities were extrapolated over the block area they represent (Table 2). An estimated 18 million fish were present in the Perch Rock aggregation, weighing approximately 38,000 t (Table 2). The aggregation was dominated by fish of age 5 (1992 year class) and 7 and 8 (1989 and 1990 year classes) (Fig. 3).

Table 2. Summary of acoustic survey data from Perch Rock, May 1997.

Transect	Density(m^{-2})	Area (km2)	Abundance (millions)	Biomass (95% CI's)
1	.37	2.9	1.1	2273 (2150-2400)
2	.22	3.6	.8	1677 (1525-1830)
3	.67	3.6	2.4	5045 (4600-5500)
4	.48	5.1	2.5	5166 (4740-5600)
5	.72	4.8	3.5	7230 (6880-7700)
6	.09	5.6	.5	1060 (1025-1100)
7	.88	5.0	4.4	9230 (8800-9650)
8	.39	4.7	1.8	3840 (3640-4035)
9	.26	4.8	1.3	2630 (2430-2830)
Totals		40.2	18.2	38201 (35785-40617)

Uncertainties in this estimate are low because of the sampling design. However, they are based only on sampling variation. The true uncertainty is likely somewhat larger but a full treatment of uncertainty in acoustic estimates has not yet been accomplished (e.g., Rose et al., submitted).

Summary:

1) Three spawning aggregations were located in Placentia Bay in the spring of 1997 (supported by egg sampling - no aggregations were likely missed).
2) Second stage sampling grids were conducted at high resolution on these aggregations (and on other non-spawning aggregations not reported here).
3) The biomass of the Perch Rock aggregation was approximately 38,000 t comprised for the most part of the 1989, 1990, and 1992 year classes.

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Fig. 1. Map of Placentia Bay study area and 2nd stage transects across the Perch Rock spawning aggregation on day 144, May 1997.

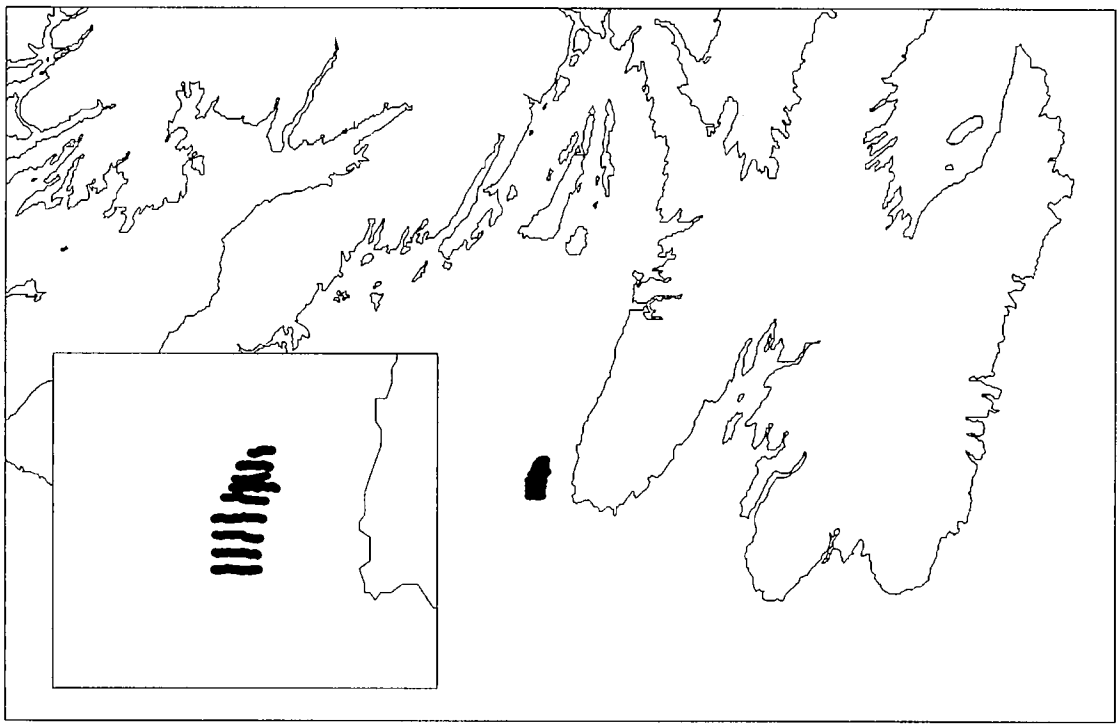

Fig. 2. Echogram showing typical structures of spawning cod aggregation on day 144, May, 1997. Echogram produced from BioSonics DT4000 38 kHz data with FASIT (Fisheries Assessment and Species Identification Toolkit) software (LeFeuvre et al., in press).

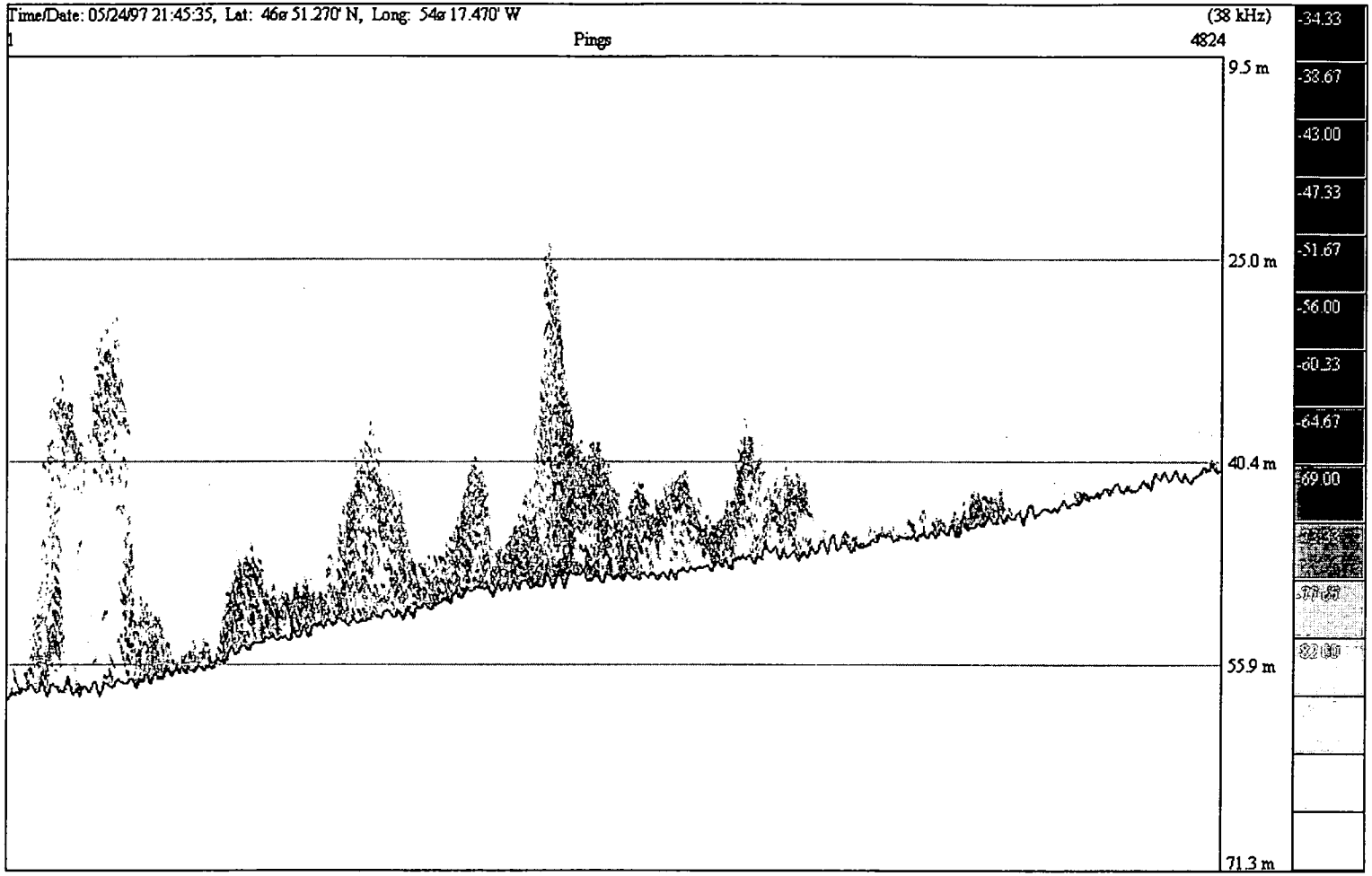

Fig. 3. Abundance (top) and biomass (bottom) at age for Perch Rock spawning aggregation, May 1997.