

Summary of Pollock Hydroacoustic Surveys on the Scotian Shelf

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ABSTRACT

Perley, P., and Neilson, J.D. 2007. Summary of pollock hydroacoustic surveys on the Scotian Shelf. Can. Tech. Rep. Fish. Aquat. Sci. 2725: iii + 32 p.

Three acoustic surveys were completed between 1999 and 2002 to help determine the feasibility of using hydroacoustics as an index of abundance for pollock (*Pollachius virens*). The surveys searched areas of the Scotian Shelf in NAFO Divisions 4W, 4X and 5Z in an attempt to locate aggregations of pollock. A summary of these surveys is documented for sets and species caught, both by weight (kg) and proportion of the total weight caught, and, in areas where pollock aggregations were located, transects, species composition and length information were documented.

RÉSUMÉ

Perley, P., and Neilson, J.D. 2007. Summary of pollock hydroacoustic surveys on the Scotian Shelf. Can. Tech. Rep. Fish. Aquat. Sci. 2725: iii + 32 p.

Trois relevés acoustiques ont été réalisés entre 1999 et 2002 afin d'aider à déterminer la faisabilité d'utiliser les relevés hydroacoustiques comme indice d'abondance de la goberge (*Pollachius virens*). On a effectué des relevés dans des zones du plateau néo-écossais situées dans les divisions 4W, 4X et 5Z de l'OPANO, afin d'essayer de repérer des rassemblements de goberge. On présente un résumé de ces relevés, plus particulièrement en ce qui concerne les traits et les espèces capturées selon le poids (kg) et la proportion du poids total des prises que l'espèce représente. Dans les zones où l'on a repéré des rassemblements de goberge, on a alors documenté les données prélevées dans chaque transect, la composition des prises selon l'espèce et la longueur des prises.

INTRODUCTION

Pollock (*Pollachius virens*) is a semi-pelagic fish that inhabits the ocean bottom, but at times congregates up in the water column. For these reasons, standard research vessel surveys using bottom trawls are of limited value for providing indices of abundance. In a 1998 report, the Fisheries Resource Conservation Council recommended that, given the high degree of uncertainty expressed in the pollock assessment for 1999, DFO Science should take whatever actions are required to investigate and implement alternate/additional methods of estimating abundance throughout the stock range to be used in future assessments of this stock (FRCC 1998).

In response, the Department initiated a program to determine the feasibility of using hydroacoustics to obtain indices of pollock abundance, as well as to investigate the ecology and behaviour of pollock. Three acoustic surveys were conducted from 1999–2002. An industry vessel was also made available, as part of an industry-government joint effort, to evaluate the acoustic approach for studying pollock aggregations.

Several publications have resulted from these surveys to date. Neilson et al. (2003a) described the diel vertical distributions and migrations of pre-spawning aggregations of pollock at two locations on the Scotian Shelf from data collected and analyzed from the first survey conducted in September 1999. Neilson et al. (2003b) summarized the positive and negative factors concerning the effectiveness of hydroacoustic approaches for describing the abundance of pollock. Carruthers et al. (2005) reported on the prey of pollock and compared the information to an earlier period.

While much of the results from the three surveys have been documented, there remains a need to provide a general description of the types of data collected, and the location of data, should further analyses be envisioned. These data are of special interest, since they include collections made outside of the area usually included in the standard DFO RV Survey or at times of the year other than the summer, the time of the annual groundfish survey conducted by the Scotia Fundy Region of DFO.

METHODS

ACOUSTIC REGISTRATION

The recordings were made with a 38-kHz Simrad EK500 scientific sounder with split beam hull mounted transducers. Acoustic data was collected at a speed of 6.0 knots and during bottom trawls at 3.5 knots and a depth of 0–500 m.

CALIBRATION

The performance of the EK500 was measured prior to the start of the trip while the vessel was moored in a deep-water cove by two bow and two stern anchors. A 38-mm tungsten carbide

sphere was suspended under the vessel by three monofilament lines at a range of approximately 27 m below the transducer. A vertical cast was made with a CTD to acquire data for calculation of the sound speed at the depth of the sphere. This value was used to determine a target strength (TS) value for the sphere. Also, the CTD data were used to compute the average sound speed for the range from the transducer face to the sphere. This value was entered into the EK500 via the Sound Speed Menu. The calibration was completed using the TS measurement, area backscattering coefficient (S_a) measurement and LOBE software procedures described in the calibration of the EK500/EY500 Section of the Simrad EK500 Manual. The TS and backscattering strength (S_v) transducer gains were estimated to be 26.13 dB and 26.11 dB, respectively. The values for beamwidth provided by the “FIT” procedure of the LOBE program were: 6.8° for the athwartships direction and 7.0° for the alongships direction. Using these beamwidth estimates, the equivalent 2-way beam angle was computed to be -20.9 dB.

ACOUSTIC ESTIMATION

Acoustic data were collected onboard the “Teleost” when the ship was steaming along transects at 6.0 knots, and during bottom trawls, typically conducted at 3.5 knots. The EK500 was configured with a ping interval of 1.0 s/pulse, a pulse length of 1.0 ms and a bandwidth setting of “Auto”. The data acquisition software known as CH1 (Simard et al. 1998) was used to record volume S_v data. The S_v data were edited and integrated using CH2 software (Simard et al. 2000). The editing procedure involved removing ambient noise associated with the operation of the ship’s acoustic net mensuration system, and identifying the bottom relative to fish concentrations.

SCANMAR

Door spread, wing spread, headline height and trawl depth were measured using SCANMAR hydroacoustic instrumentation mounted on each trawl door, on the headline at the wing ends, and on the square 1.0 m behind the centre of the headline. SCANMAR signals and DPGS navigational information were logged at 5-s intervals on a custom data acquisition software package (SEATRAWL) (McCallum and Walsh 2002).

FISHING TRAWL

The Campelen 188 is a four-panel shrimp trawl with cut-away lower wings and is rigged with a rockhopper footrope. For further details on the net design see McCallum and Walsh (2002).

FISH SAMPLING

In 1999, the initial year of the survey, total weight and numbers and length frequencies for pollock and total weight for all other species were collected from all successful sets and, when time permitted, length-frequency information for all species was also collected. In subsequent years, the same sampling procedure was employed with additional information also collected. For length stratified samples, individual length, weight and maturity were determined for pollock in 2000 and cod, haddock and pollock in 2002. Pollock stomach contents were also collected in 2000 and 2002 for length stratified samples.

All sampling and set information was entered using an onboard data entry and editing system (GSE). All information has been edited and resides on an ORACLE database in St Andrews, New Brunswick, and can be made available by contacting the authors.

HYDROGRAPHIC OBSERVATIONS

CTD casts were conducted at all fishing areas where pollock were abundant. A salinity sample and a surface temperature observation were collected at each fishing area at a sample depth of 10 m, and a bottom salinity and temperature from one set per survey area was collected for calibration purposes.

RESULTS

The table below shows the dates and number of sets completed for each of the surveys and Fig. 1 shows the locations and names of the areas surveyed using acoustics; the details of each of the surveys follow below.

Mission	Dates of Mission	Number of Sets
TEL1999083	Sep 27 - Oct 5, 1999	42
TEL2000308	Sep 15 - Sep 25, 2000	31
TEL2002393	Jan 28 - Feb 10, 2002	54 (10 tagging sets)

MISSION TEL1999083

In the first year of the acoustic survey series, the vessel covered eight areas in 4X and 4W in search of aggregations of pollock (Fig. 2). A total of 42 sets were made and total weight for the major species is shown in Table 1. The distribution of pollock (kg) caught during the survey is shown in Fig. 3. Two large aggregations were located with the EK500 and confirmed with trawl sets at two locations.

The first location, the 'Banana', a local name given to a bathymetric feature, was surveyed with acoustics twice during the trip. The first was a 48-h period between September 30 and October 1 to investigate diel variability in aggregations. An expanding square survey design (Fig. 4) was used to determine the horizontal range of the aggregation, and periodic trawl sets were made to determine the species composition of the aggregation, as well as examining the size range of the pollock caught. The second time period occurred on October 4, 1999, where it was found that the aggregation still persisted at the same location. Again, an expanding square survey design was used to determine the size of the aggregation, as well as a set of parallel transects (Fig. 4) mapping the high density portions of the aggregation. Periodic trawling was done to assess the species composition and size of the pollock caught. The transects, as well as the kriged area of backscatter with the lighter shades indicating the densest portion of the aggregation, are shown in Fig. 4. Temperature and salinity data were collected at this site and are shown in Fig. 5.

Table 2 shows the proportion of species caught by weight by set. For those sets made on the aggregations at the Banana, pollock made up more than 95% of the total catch, with the remaining 5% or less distributed among such species as cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), redfish (*Sabastes* sp.) and several other minor species. Examination of the lengths of pollock at this area indicates that larger fish are associated with the core of the aggregation, while smaller fish are associated with the edges of the aggregation (Fig. 6).

The Scotian Shelf Edge aggregation was surveyed following parallel transects to map the size of the aggregation. Periodic trawling sets were made to assess the species composition as well the length frequency of pollock. Transects and the kriged area of backscatter from the acoustics are shown in Fig. 7; again, the lighter portions represent the densest portion of the aggregation. Temperature and salinity data were collected at this site and are shown in Fig. 8.

Table 2 shows the proportion of species caught by weight by set for those sets made on the aggregation at the Scotian Shelf Edge and again, the proportion of pollock exceeded 95% of the catch where sets were made on the aggregation. The remaining 5% or less was made up of redfish, blackbelly rosefish (*Helicolenus dactylopterus*), silver hake (*Merluccius bilinearis*) and haddock along with several minor species of fish. Identification of blackbelly rosefish was sometimes problematic during this survey. However, this species only occurred in relatively deep tows near the Scotian Shelf Edge. Length composition of the Scotian Shelf Edge pollock is shown in Fig. 9. When compared, pollock on the Shelf Edge were generally larger than pollock at the Banana (43.04 cm and 49.78 cm). Figure 10 shows how the species composition changes with depth. Pollock was the predominant species from a depth of 200–250 m and redfish at a depth of 250–300 m. An industry vessel was made available the last 2 d to jointly survey and fish a concentration of pollock with the research vessel. The purpose of this collaboration was to assess the possibility of using acoustic data logging systems as part of a commercial fishing operation, and results can be found in Neilson et al. (2002).

MISSION TEL2000308

In the second year of the acoustic survey series, 14 areas in 4X and 4W were surveyed with the EK500 and 31 trawl sets made (Fig. 11). The distribution of pollock by weight (kg) for the survey is shown in Fig. 12. Tables 3 and 4 show catches by major species by set by total weight (kg) and the proportion of major fish species caught by weight by set during the survey.

Of the areas surveyed, only the Scotian Shelf Edge was found to have a concentration of pollock, although not as prominent as the aggregation found in 1999. No aggregations were found on the Banana, the area where a large aggregation had been mapped the previous year. The lack of pollock aggregations may be due in part to the survey being conducted 2 wk earlier than in 1999. The Scotian Shelf Edge, where pollock was located, was extensively surveyed using acoustics and periodic trawl sets over a 4-d period following parallel transects which included the area covered in 1999 (Fig. 13). Temperature and salinity data were collected at this site and are shown in Fig. 14.

Although the aggregations were not as well defined as in 1999, trawl sets made in the aggregation indicated that the percentage of pollock was greater than 95% (Table 4). Notable species making up the remaining 5% are haddock, redfish and black belly rosefish. Examination of the length frequencies of pollock on the Scotian Shelf Edge (Fig. 15) showed a significant difference (Mann-Whitney U -test, $U = 868535.5$, $p < .001$) in fish lengths from the 1999 survey (mean length = 49.78) with the 2000 lengths (mean length = 44.15 cm). Figure 16 shows the species composition by proportion at the various depth ranges at the Scotian Shelf Edge, with pollock being predominant at 150–250 m and redfish at 250–300 m.

MISSION TEL2002393

The timing of the 2002 survey, the last in the acoustic series, was changed from September to February to coincide with the peak spawning period of pollock which occurs from November to February. Twelve locations from 4X, 4W and 5Z were surveyed with the EK500 and 54 sets were carried out (Fig.17). Of the 54 sets, 10 sets for obtaining cod for tagging were made. The distribution of pollock caught (kg) is shown in Fig. 18. Tables 5 and 6 show catches by major species and set by total weight (kg) and the proportion of major fish species caught by weight by set during the survey.

The Banana and Scotian Shelf Edge, areas where in previous years large aggregations of pollock were found, were again surveyed following parallel transects. No pollock aggregations were found at either area, even after expanding the coverage on the Scotian Shelf Edge. An aggregation of pollock was located at an area known as the Crump. The Crump, the immediate depth ranges and two areas on the Northeast peak of Georges Bank were surveyed following parallel transects or following the depth contour with hydroacoustics along with some periodic trawling (Fig.19). Data was collected for species composition and other morphometrics such as length, weight, maturity and stomachs for analysis. The data collected from pollock stomachs were part of a study to determine the type of food pollock feed on over an extended period of time and results can be found in Carruthers et al. (2005).

Catches were typically greater than 95% pollock in areas where aggregations were found, with redfish and haddock making up the remainder of the catch (Table 6). Around the Crump, at depths greater than 250 m, redfish was the predominant species caught whereas pollock were caught at shallower depths of 200–250m (Fig. 20). The proportion of pollock at length is shown in Fig. 21, and Fig. 22 shows a comparison of lengths for all areas surveyed for all years. Temperature and salinity data were collected on the Crump and are shown in Fig. 23.

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Table 1. Total weight (kg) of the major species caught in 1999.

SET #	Stratum	Dist	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	472	0.75	0.35				64.60			2.05		8.60	3.65	LaHave B
2	472	0.75	0.85	1.40		129.05	2.30		29.95	680.40		0.001	0.39	LaHave B
3	471	0.75	3.35	4.65	1.00	5.25	9.40		7.75	11.90		5.85	6.80	Starvation Corner
4	464	0.77	11.70			326.00		0.03	217.45	57.00		2.20		Slipper
5	462	0.77				248.90	1.65		2.70	13.60		0.95	1.20	Slipper
6	462	0.75				70.95	14.05	10.00		5.20		35.20		Slipper
7	462	0.75				18.80	6.15	0.30				32.45		McKenzie Spot
8	462	0.77	7.65			99.50	0.22		3046.30	30.50		3.60		Banana
9	462	0.75							313.10					Banana
10	462	0.75	4.80			21.00			6594.00	19.00				Banana
11	462	0.31	2.00			11.00	0.20		1655.00	5.00		0.20	2.00	Banana
12	462	0.25	2.30	2.00		44.00	0.97		4312.00	27.00		0.13		Banana
13	462	0.25	1.69			10.00			166.25	7.25		8.00		Banana
14	462	0.25	2.60			15.90	0.22		134.20	8.60		34.30	0.69	Banana
15	461	0.75				2.50	5.00		24.00	80.00		97.00	24.00	Banana
16	462	0.12	0.40			3.00			2946.00	4.00		3.00	0.70	Banana
17	461	0.15					1.50		12.20	0.70		59.00		Banana
18	461	0.21	1.30			1.50	5.40		27.00	38.00		45.00	6.00	Banana
19	462	0.15	0.01			0.02				1.30		33.00	4.00	Banana
20	461	0.15								0.46		46.10	1.30	Banana
21	462	0.15	5.50		0.55					0.00		14.00		Banana
22	461	1.00					0.80					2.65		Banana
23	465	0.75	13.00			198.00		4.00	13.00	1.00		0.50	3.00	108 Cove
24	466	0.75				7.50			3.55	23.25		3.15	0.19	108 Cove
25	466	0.75	1.35	2.10		36.00		3.10		5.40		12.00	0.65	Shelf Edge
26	478	0.66	2.50			28.50		0.01	8.20	1.80	31.45	5.00		Shelf Edge
27	478	0.18							874.00	4.50	8.70	2.60		Shelf Edge
28	478	0.75	0.20		1.40	6.20			19.00	38.50	36.70	16.00	9.70	Shelf Edge
29	478	0.33	3.50			10.00			1220.00	21.00		4.00		Shelf Edge
30	478	0.37							6.00	59.45		1.55		Shelf Edge
31	478	0.33				4.05			3.35	39.50	39.50	1.35		Shelf Edge

SET #	Stratum	Dist	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
32	478	0.21				3			4.00		38.00			Shelf Edge
33	478	0.25								156.40	23.00		3.70	Shelf Edge
34	478	0.25							96.00	14.00	13.00	0.70		Shelf Edge
35	478	0.25				2.10				2.10	10.20	4.40		Shelf Edge
36	462	0.75	8.60		41.50	70.30	1.80		14.00	29.20	0.16	9.80		Banana
37	461	0.75	4.40		1.60	2.10	43.70		9.70	51.00		170.40	15.20	Banana
38	461	0.54	7.00			4.50	3.00		11.00	63.00		186.00	4.00	Banana
39	462	0.65	0.15							35.00		85.00	1.60	Banana
40	462	0.75	1.00			0.08	27.00		1.40	22.00		252.00	18.00	Banana
41	462	0.47							335.50					Banana
42	462	0.12	5.00			33.00			1208.00	15.00		2.00		Banana

Table 2. Total weight by proportion of the major species caught in 1999.

SET #	Stratum	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	472	0.43	0.00	0.00	0.00	78.73	0.00	0.00	2.50	0.00	10.48	4.45	LaHave B
2	472	0.10	0.16	0.00	15.13	0.27	0.00	3.51	79.78	0.00	0.00	0.05	LaHave B
3	471	5.22	7.25	1.56	8.18	14.65	0.00	12.08	18.55	0.00	9.12	10.60	Starvation Point
4	464	1.86	0.00	0.00	51.86	0.00	0.00	34.59	9.07	0.00	0.35	0.00	Slipper
5	462	0.00	0.00	0.00	85.49	0.57	0.00	0.93	4.67	0.00	0.33	0.41	Slipper
6	462	0.00	0.00	0.00	40.64	8.05	5.73	0.00	2.98	0.00	20.16	0.00	Slipper
7	462	0.00	0.00	0.00	23.64	7.73	0.38	0.00	0.00	0.00	40.81	0.00	McKenzie Spot
8	462	0.24	0.00	0.00	3.12	0.01	0.00	95.39	0.96	0.00	0.11	0.00	Banana
9	462	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	Banana
10	462	0.07	0.00	0.00	0.32	0.00	0.00	99.32	0.29	0.00	0.00	0.00	Banana
11	462	0.12	0.00	0.00	0.66	0.01	0.00	98.56	0.30	0.00	0.01	0.12	Banana
12	462	0.05	0.05	0.00	1.00	0.02	0.00	98.22	0.62	0.00	0.00	0.00	Banana
13	462	0.86	0.00	0.00	5.10	0.00	0.00	84.81	3.70	0.00	4.08	0.00	Banana
14	462	1.30	0.00	0.00	7.97	0.11	0.00	67.25	4.31	0.00	17.19	0.35	Banana
15	461	0.00	0.00	0.00	1.06	2.13	0.00	10.20	34.02	0.00	41.24	10.20	Banana
16	462	0.01	0.00	0.00	0.10	0.00	0.00	99.60	0.14	0.00	0.10	0.02	Banana
17	461	0.00	0.00	0.00	0.00	1.95	0.00	15.82	0.91	0.00	76.52	0.00	Banana
18	461	1.04	0.00	0.00	1.20	4.31	0.00	21.54	30.31	0.00	35.90	4.79	Banana
19	462	0.02	0.00	0.00	0.05	0.00	0.00	0.00	3.22	0.00	81.78	9.91	Banana
20	461	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	95.41	2.69	Banana
21	462	25.25	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	64.28	0.00	Banana
22	461	0.00	0.00	0.00	0.00	23.19	0.00	0.00	0.00	0.00	76.81	0.00	Banana
23	465	5.57	0.00	0.00	84.89	0.00	1.71	5.57	0.43	0.00	0.21	1.29	108 Cove
24	466	0.00	0.00	0.00	19.62	0.00	0.00	9.29	60.83	0.00	8.24	0.50	108 Cove
25	466	2.20	3.43	0.00	58.75	0.00	5.06	0.00	8.81	0.00	19.58	1.06	Shelf Edge
26	478	2.49	0.00	0.00	28.44	0.00	0.01	8.18	1.80	31.38	4.99	0.00	Shelf Edge
27	478	0.00	0.00	0.00	0.00	0.00	0.00	97.75	0.50	0.97	0.29	0.00	Shelf Edge
28	478	0.09	0.00	0.61	2.71	0.00	0.00	8.31	16.83	16.04	6.99	4.24	Shelf Edge
29	478	0.28	0.00	0.00	0.79	0.00	0.00	96.93	1.67	0.00	0.32	0.00	Shelf Edge
30	478	0.00	0.00	0.00	0.00	0.00	0.00	8.63	85.46	0.00	2.23	0.00	Shelf Edge
31	478	0.00	0.00	0.00	4.33	0.00	0.00	3.58	42.23	42.23	1.44	0.00	Shelf Edge
32	478	0.00	0.00	0.00	6.11	0.00	0.00	8.15	0.00	77.39	0.00	0.00	Shelf Edge

SET #	Stratum	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
33	478	0.00	0.00	0.00	0.00	0.00	0.00	0.00	71.48	10.51	0.00	1.69	Shelf Edge
34	478	0.00	0.00	0.00	0.00	0.00	0.00	71.16	10.38	9.64	0.52	0.00	Shelf Edge
35	478	0.00	0.00	0.00	10.28	0.00	0.00	0.00	10.28	49.95	21.55	0.00	Shelf Edge
36	462	4.50	0.00	21.73	36.80	0.94	0.00	7.33	15.29	0.08	5.13	0.00	Banana
37	461	1.43	0.00	0.52	0.68	14.20	0.00	3.15	16.57	0.00	55.38	4.94	Banana
38	461	2.44	0.00	0.00	1.57	1.05	0.00	3.84	21.99	0.00	64.92	1.40	Banana
39	462	0.11	0.00	0.00	0.00	0.00	0.00	0.00	26.57	0.00	64.52	1.21	Banana
40	462	0.30	0.00	0.00	0.02	8.09	0.00	0.42	6.59	0.00	75.51	5.39	Banana
41	462	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	Banana
42	462	0.40	0.00	882	1302	0.00	0.00	1722	2142	0.00	0.16	2562	Banana

Table 3. Total weight (kg) of the major species caught in 2000.

SETNO	Stratum	DIST	Cod	Cusk	Dogfish	Haddock	Herring	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	492	0.3	1		2178		16		12		254	18	North East Bank
2	492	0.17			122	1	1334						
3	492	0.15	3		263	15	4430				0	1	Southwest Bank
4	485	0.3											
5	485	0.24	12			3	2	20	2	0	5		Crowell
6	485	0.3	3	8		6	1	42	0	0	1		Crowell
7	484	0.3		11		2	8	4	2		8		Crowell
8	482	0.58				8	8	17	3	2	28	9	97 Hump
9	999	0.58	5			118		22					Crump
10	482	0.58	3			10		1			0		Heel of Browns
11	482	0.58		1		11		6	18	0	0		Heel of Browns
12	472	0.58	10			39	10	363	903		4	4	The Ridge
13	472	0.87				19			11		16		Starvation Pt
14	462	0.87	4			10	96	412	162		17	5	The Slipper
15	460	0.87							2	1	1		SE Sambro
16	999	0.58				3		7	157	44	2	2	The Edge
17	478	0.58	1			14		810	49	66	9	1	The Edge
18	478	1.72	1			5				1	0		The Edge
19	466	0.3		1		22		142	21	174	2	4	The Edge
20	478	1.75				6		1097	4	13	1		The Edge
21	478	0.58	3			3		302	5	6	0	2	The Edge
22	466	0.3				9		466	0	4	1	1	The Edge
23	466	0.47	2			7		11	0	7		6	The Edge
24	466	0.46								0			The Edge
25	999	0.35		3		11		204	13	15	1		The Edge
26	466	0.87				8		180		86	5	1	The Edge
27	466	0.88	2	3		6		265	49		3	6	The Edge
28	466	0.87				5		179	33		2	2	The Edge
29	466	0.87	4	1		40		7	2	9	0	2	The Edge
30	466	0.78	1	3		7	4	220	36		2	6	The Edge
31	460	0.87	0	3		6	4	189	31		2	6	The Bat

Table 4. Total weight by proportion of the major species caught in 2000.

SETNO	Stratum	Cod	Cusk	Dogfish	Haddock	Herring	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	492	0.04	0.00	87.62	0.00	0.66	0.00	0.48	0.00	10.22	0.73	North East Bank
2	492	0.00	0.00	8.28	0.04	90.46	0.00	0.00	0.00	0.00	0.00	
3	492	0.05	0.00	5.58	0.32	93.95	0.00	0.00	0.00	0.01	0.01	Southwest Bank
4	485	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5	485	15.29	0.00	0.00	4.31	3.14	26.26	3.00	0.13	6.79	0.00	Crowell
6	485	4.58	11.85	0.00	10.12	1.58	66.22	0.71	0.03	2.05	0.00	Crowell
7	484	0.00	27.24	0.00	5.30	21.19	9.08	4.04	0.00	21.19	0.00	Crowell
8	482	0.00	0.00	0.00	10.14	10.80	22.00	4.48	1.98	37.14	12.25	97 Hump
9	999	3.40	0.00	0.00	77.39	0.00	14.26	0.00	0.00	0.00	0.00	Crump
10	482	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Hell of Browns
11	482	10.47	0.00	0.00	31.08	0.00	4.58	0.00	0.00	0.52	0.00	Hell of Browns
12	472	0.00	2.46	0.00	26.78	0.00	15.09	41.40	0.40	0.58	0.00	The Ridge
13	472	0.71	0.00	0.00	2.86	0.75	26.81	66.65	0.00	0.26	0.28	Starvation Point
14	462	0.00	0.00	0.00	29.40	0.00	0.00	16.40	0.00	25.45	0.00	The Slipper
15	460	0.49	0.00	0.00	1.40	13.39	57.33	22.48	0.00	2.40	0.71	SE Sambro
16	999	0.00	0.00	0.00	0.00	0.00	0.00	12.28	7.02	3.01	0.00	The Edge
17	478	0.00	0.00	0.00	1.48	0.00	3.32	72.36	20.43	0.88	0.92	The Edge
18	478	0.12	0.00	0.00	1.45	0.00	81.67	4.98	6.67	0.86	0.11	The Edge
19	466	6.26	0.00	0.00	36.02	0.00	0.00	0.00	6.11	0.47	0.00	The Edge
20	478	0.00	0.27	0.00	5.60	0.00	35.87	5.27	43.92	0.38	1.06	The Edge
21	478	0.00	0.00	0.00	0.55	0.00	96.59	0.31	1.12	0.04	0.00	The Edge
22	466	0.99	0.00	0.00	0.86	0.00	93.09	1.67	1.70	0.09	0.56	The Edge
23	466	0.00	0.00	0.00	1.90	0.00	95.28	0.08	0.84	0.10	0.14	The Edge
24	466	5.32	0.00	0.00	18.34	0.00	28.44	1.06	18.87	0.00	15.68	The Edge
25	999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	The Edge
26	466	0.00	0.99	0.00	4.13	0.00	74.81	4.62	5.43	0.42	0.00	The Edge
27	466	0.00	0.00	0.00	2.34	0.00	56.22	0.00	26.74	1.69	0.46	The Edge
28	466	0.46	0.82	0.00	1.64	0.00	72.21	13.24	0.00	0.79	1.64	The Edge
29	466	0.00	0.00	0.00	2.17	0.00	72.06	13.42	0.00	0.68	0.68	The Edge
30	466	5.06	1.69	0.00	51.50	0.00	8.69	2.21	11.93	0.09	2.59	The Edge
31	460	0.20	1.12	0.00	2.28	1.51	77.06	12.52	0.00	0.63	2.24	The Bat

Table 5. Total weight (kg) of the major species caught in 2002.

SET #	Stratum	Dist	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	462	0.75	17			127	2		37	15		68		Banana
2	465	0.84				49	2	17	0			683	1	108 Cove
3	465	0.29				1		2				41	0	108 Cove
4	465	0.29				1				0		50		108 Cove
5	472	0.9	0			737	2		125	1343		0		The Ridge
6	478	0.57				1				540	30	140	12	Edge
7	478	0.61				20	1		1	8	14	188	19	Edge
8	478	0.58	2			19	4		7	4	4	160	6	Edge
9	472	0.85	7	1		16	24		26	45		7	1	Starvation Pt
10	472	0.30				2	1	1	5	11836		4		La Have Basin
11	476	0.58				68	0					1	1	Browns-Baccaro
12	481	0.60	5			361	1	8	1			1		Top of Browns
13	481	0.60			0									Francois
14	481	0.24	6		7	39			9					Francois
15	481	0.88	202	3	133	553		9	246					Francois
22	482	0.58	1	6					0		0			Heel of Browns
24	482	0.30	1		5	1	0		1					Heel of Browns
25	999	0.14			2	2			204	0	0			Crump
26	999	0.15		0						0		3		Crump
27	999	0.27							2					Crump
28	999	0.29				3			16	0			3	Crump
29	999	0.30							28	1772			10	Crump
30	999	0.17		4		3			75	233				Crump
31	999	0.30		5		2			14	2			1	Crump
32	999	0.29	3	1		3			4		0		4	Crump
33	999	0.29	1			1			1198	2				Crump
34	999	0.30								22				Crump
35	5Z1	0.19				6	1		0					Georges 3
36	999	0.30				9				2		1		Georges 3
37	999	0.30	1	0		5			54	3	0			Georges 3
38	5Z1	0.60	1			9			181				1	Georges 3
39	5Z1	0.58				5		6	2			2		120-140 contour

SET #	Stratum	Dist	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
40	5Z1	0.70	11			13				88	0	16	11	130 contour
41	999	0.58	6	0		5			455	22				120-140 contour
42	999	0.18							4043	2				Crump
43	5Z2	0.58	8		1	19								Georges Bank
44	5Z2	0.58			5	18								Georges Bank
45	5Z2	0.47			4	7	1							Georges Bank
46	5Z2	0.58			30	10			309					Georges Bank
47	5Z2	0.58	1		47	2	6							Georges Bank
48	5Z1	0.35								5		3	1	120-140 contour
49	999	0.29		1		2				20		4	2	120-140 contour
50	5Z1	0.47				1	0		1	11		1	0	120-140 contour
51	999	0.12							731	0			1	Crump
52	481	0.58	0	1	2	154			1					Francois
53	481	0.87			1	78								Francois
54	480	0.88		3		9								Francois

Table 6. Total weight by proportion of the major species caught in 2002.

SET #	Stratum	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
1	462	6.70	0.00	0.00	51.52	0.71	0.00	15.20	6.19	0.00	27.67	0.00	Banana
2	465	0.00	0.00	0.00	6.31	0.30	2.14	0.04	0.00	0.00	88.68	0.11	108 Cove
3	465	0.00	0.00	0.00	0.65	0.00	1.71	0.00	0.00	0.00	31.89	0.10	108 Cove
4	465	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.02	0.00	34.00	0.00	108 Cove
5	472	0.01	0.00	0.00	40.01	0.13	0.00	6.80	72.91	0.00	0.03	0.00	The Ridge
6	478	0.00	0.00	0.00	0.08	0.00	0.00	0.00	56.13	3.13	14.54	1.24	Edge
7	478	0.00	0.00	0.00	6.27	0.45	0.00	0.48	2.62	4.42	60.08	6.19	Edge
8	478	0.70	0.00	0.00	6.59	1.29	0.00	2.40	1.23	1.41	55.68	2.02	Edge
9	472	5.66	0.95	0.00	14.08	20.73	0.00	22.76	38.91	0.00	6.26	0.48	Starvation Pt
10	472	0.00	0.00	0.00	0.01	0.00	0.00	0.02	39.95	0.00	0.01	0.00	La Have Basin
11	476	0.00	0.00	0.00	81.72	0.12	0.00	0.00	0.00	0.00	1.68	1.64	Browns-Baccaro
12	481	1.07	0.00	0.00	71.28	0.10	1.62	0.25	0.00	0.00	0.14	0.00	Top of Browns
13	481	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Francois
14	481	2.40	0.00	2.94	15.60	0.00	0.00	3.68	0.00	0.00	0.00	0.00	Francois
15	481	19.92	0.25	13.08	54.60	0.00	0.91	24.29	0.00	0.00	0.00	0.00	Francois
22	482	8.55	41.30	0.00	0.00	0.00	0.00	1.64	0.00	0.57	0.00	0.00	Heel of Browns
24	482	4.91	0.00	21.88	3.48	0.41	0.00	5.93	0.00	0.00	0.00	0.00	Heel of Browns
25	999	0.00	0.00	0.20	0.15	0.00	0.00	18.31	0.00	0.01	0.00	0.00	Crump
26	999	0.00	1.61	0.00	0.00	0.00	0.00	0.00	0.58	0.00	10.28	0.00	Crump
27	999	0.00	0.00	0.00	0.00	0.00	0.00	19.00	0.00	0.00	0.00	0.00	Crump
28	999	0.00	0.00	0.00	4.31	0.00	0.00	27.69	0.51	0.00	0.00	5.74	Crump
29	999	0.00	0.00	0.00	0.00	0.00	0.00	0.62	39.02	0.00	0.00	0.23	Crump
30	999	0.00	0.28	0.00	0.24	0.00	0.00	5.38	16.77	0.00	0.00	0.00	Crump
31	999	0.00	8.28	0.00	3.44	0.00	0.00	23.70	2.71	0.00	0.00	1.80	Crump
32	999	6.41	1.55	0.00	5.63	0.00	0.00	7.47	0.00	0.12	0.00	8.15	Crump
33	999	0.03	0.00	0.00	0.03	0.00	0.00	38.52	0.08	0.00	0.00	0.00	Crump
34	999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.61	0.00	0.00	0.00	Crump
35	5Z1	0.00	0.00	0.00	17.86	1.79	0.00	1.30	0.00	0.00	0.00	0.00	Georges 3
36	999	0.00	0.00	0.00	27.09	0.00	0.00	0.00	5.26	0.00	3.82	0.00	Georges 3
37	999	0.52	0.07	0.00	3.18	0.00	0.00	33.95	1.82	0.09	0.00	0.00	Georges 3
38	5Z1	0.44	0.00	0.00	3.30	0.00	0.00	64.90	0.00	0.00	0.00	0.50	Georges 3
39	5Z1	0.00	0.00	0.00	18.84	0.00	20.10	8.15	0.00	0.00	6.88	0.00	120-140 contour

SET #	Stratum	Cod	Cusk	Dogfish	Haddock	Herring	Monkfish	Pollock	Redfish	Rosefish	Sliver Hake	White Hake	Area
40	5Z1	6.21	0.00	0.00	6.97	0.00	0.00	0.00	48.16	0.03	8.84	6.04	130 contour
41	999	0.98	0.00	0.00	0.81	0.00	0.00	71.97	3.45	0.00	0.00	0.00	120-140 contour
42	999	0.00	0.00	0.00	0.00	0.00	0.00	23.99	0.01	0.00	0.00	0.00	Crump
43	5Z2	17.49	0.00	2.65	43.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Georges Bank
44	5Z2	0.00	0.00	12.16	42.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Georges Bank
45	5Z2	0.00	0.00	16.16	28.82	4.80	0.00	0.00	0.00	0.00	0.00	0.00	Georges Bank
46	5Z2	0.00	0.00	6.36	2.03	0.00	0.00	64.58	0.00	0.00	0.00	0.00	Georges Bank
47	5Z2	0.96	0.00	44.98	1.91	5.31	0.00	0.00	0.00	0.00	0.00	0.00	Georges Bank
48	5Z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.00	0.00	7.30	3.32	120-140 contour
49	999	0.00	1.27	0.00	2.00	0.00	0.00	0.00	20.89	0.00	4.64	2.43	120-140 contour
50	5Z1	0.00	0.00	0.00	5.52	0.59	0.00	2.17	44.73	0.00	1.97	1.38	120-140 contour
51	999	0.00	0.00	0.00	0.00	0.00	0.00	15.81	0.01	0.00	0.00	0.02	Crump
52	481	0.20	0.63	0.65	67.07	0.00	0.00	0.52	0.00	0.00	0.00	0.00	Francois
53	481	0.00	0.00	1.56	86.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Francois
54	480	0.00	12.30	0.00	31.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Francois

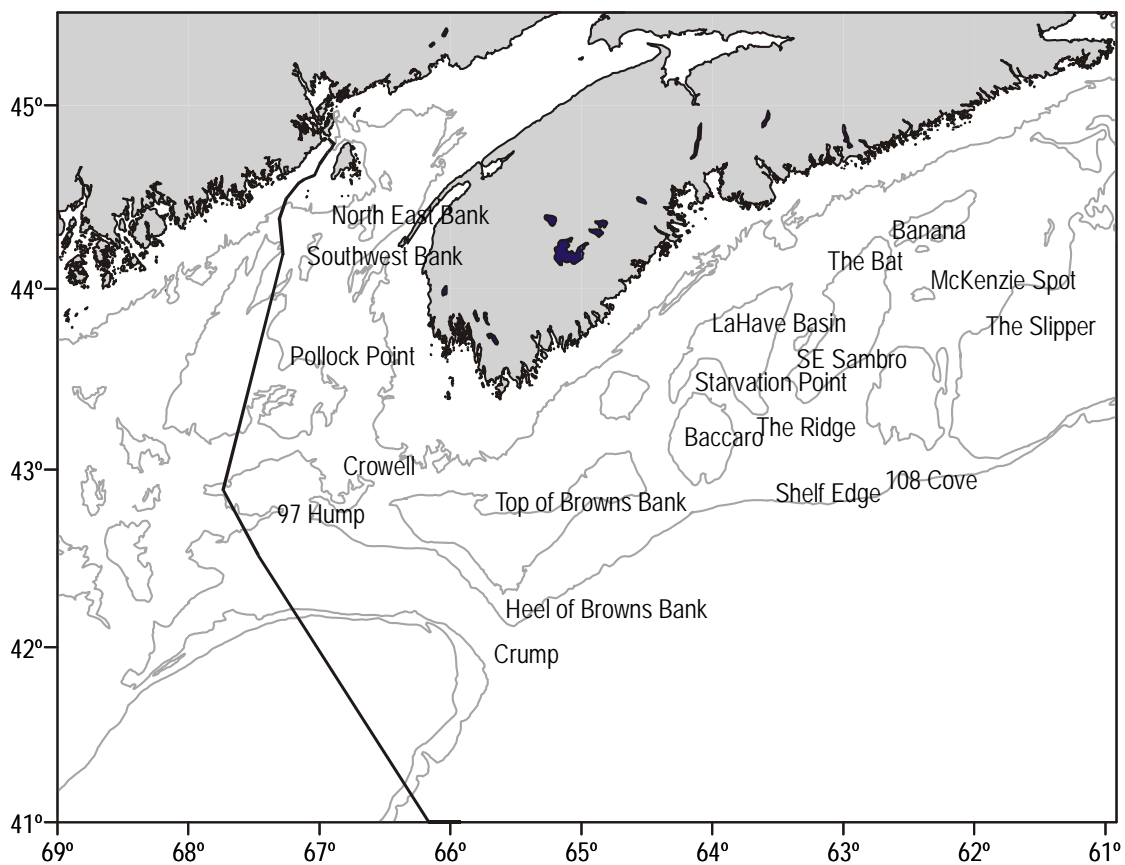


Fig. 1. Locations names of areas surveyed from 1999-2002.

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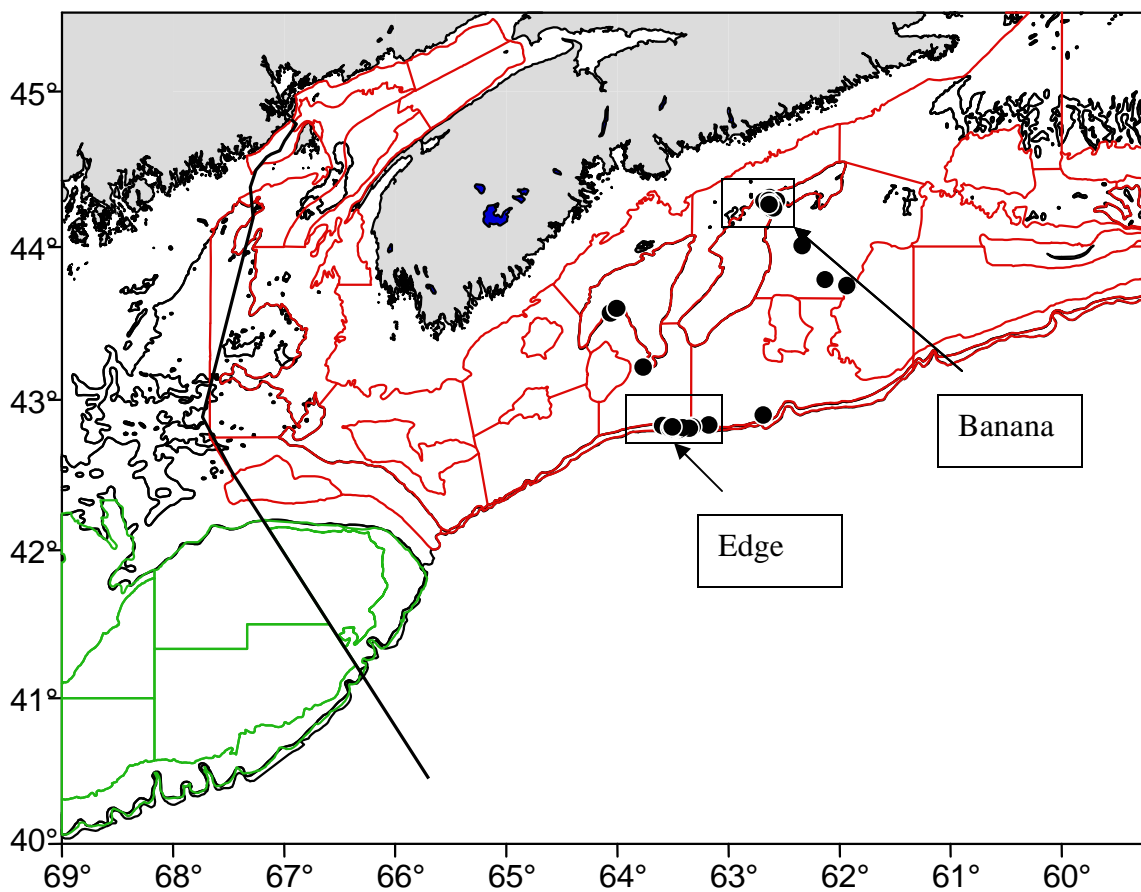


Fig. 2. Set locations and study areas during the September–October 1999 hydroacoustic survey. Groundfish survey strata are shown to relate with the areas surveyed in both the July Scotian Shelf groundfish survey and the February Georges Bank survey. The shaded circles indicate set locations.

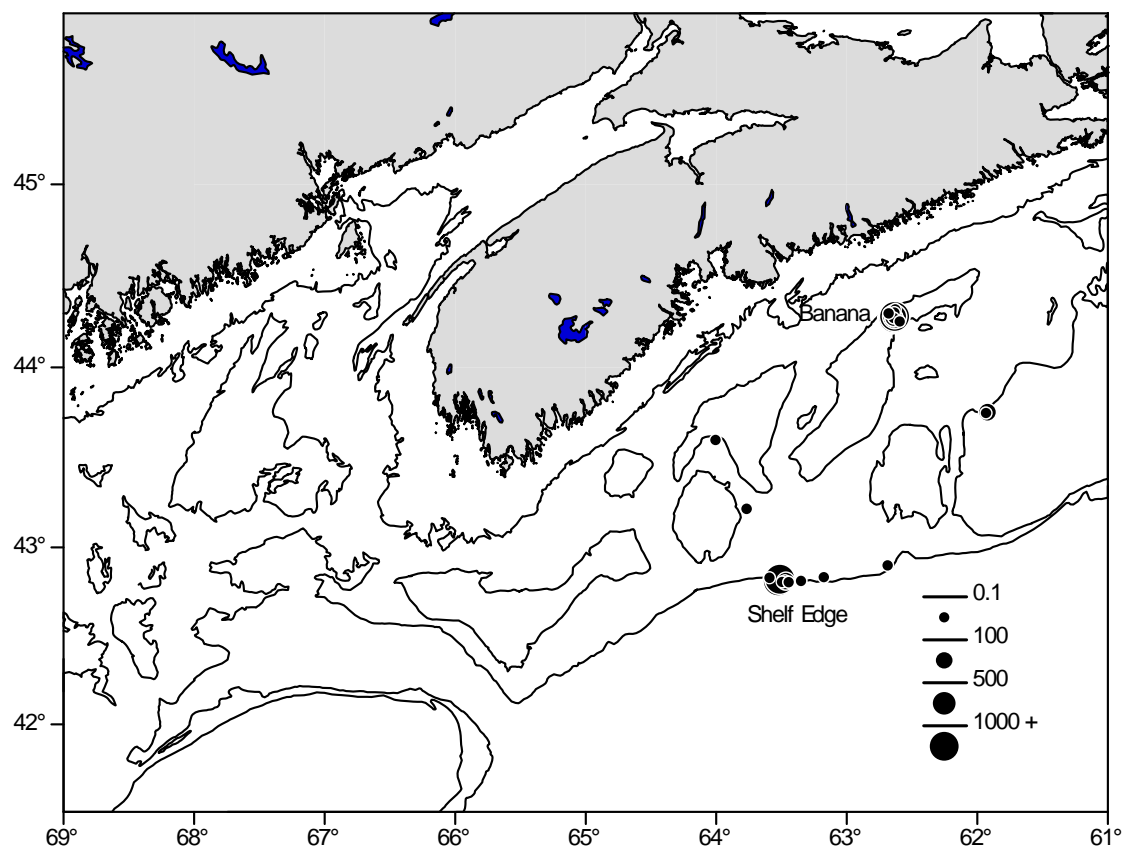


Fig. 3. Standardized pollock weight (kg) for sets where pollock was caught during the 1999 pollock acoustic survey. Weight standardized to 0.75 nm.

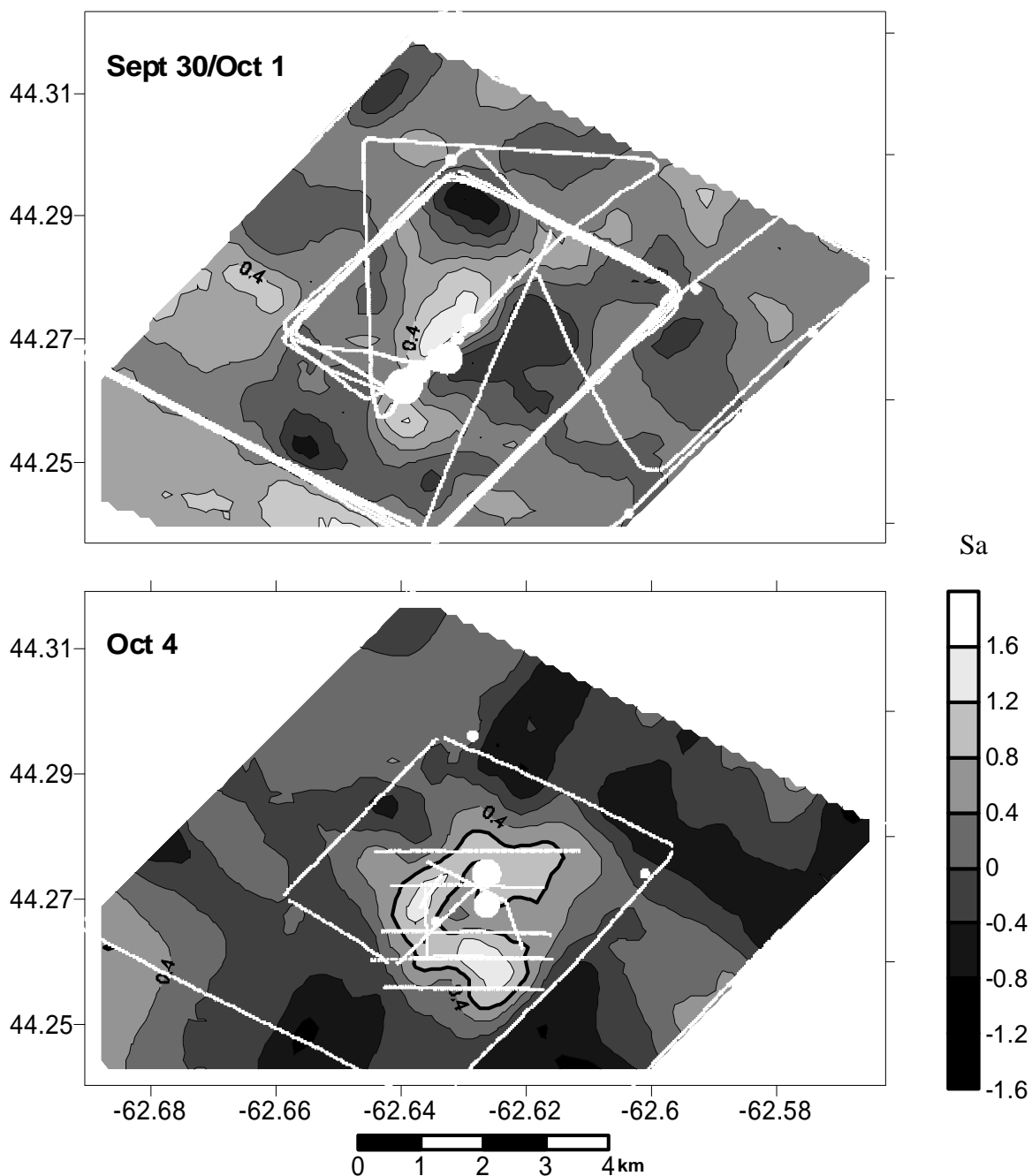


Fig. 4. The distribution of pollock at the Banana during two periods (September 30/October 1 and October 4, 1999). The contours represent kriged area backscattering coefficients (S_a), the expanding circles represent catches from bottom trawl, with circle size proportional to catch (min 0.001 MT, max 16 MT). The white lines represent the track of the research vessel. The heavy black contour defines the core area referred to in the analyses of length-frequency information.

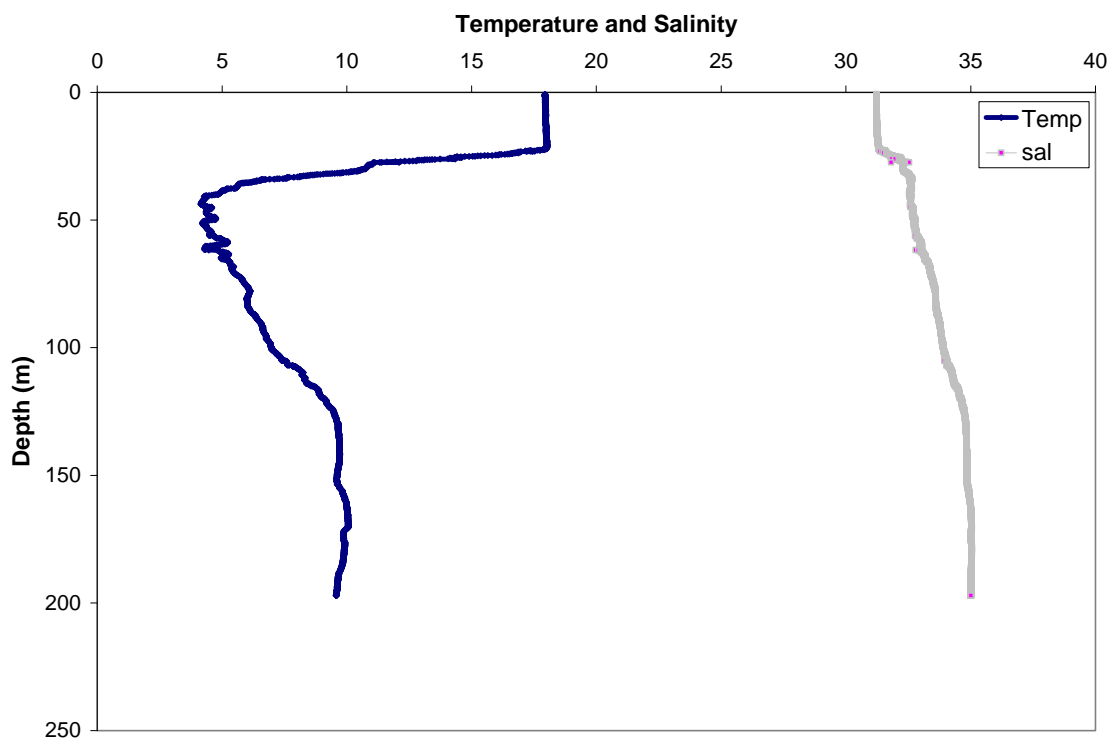


Fig. 5. Temperature and salinity profile from the area known as the “Banana”.

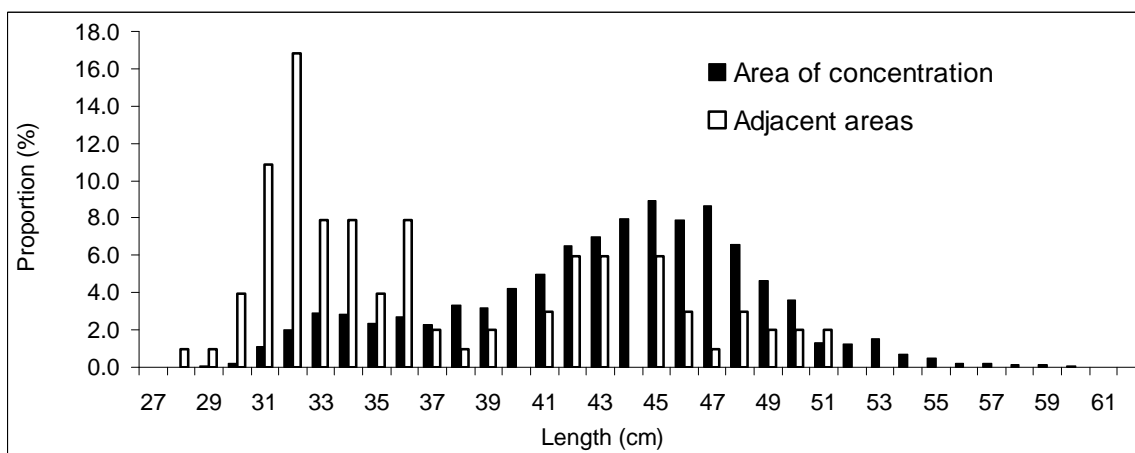


Fig. 6. Pollock length frequencies from the area known as the “Banana”, showing the proportion of fish at length both in the core of the area of concentration and the areas adjacent to the area of concentration (Neilson et al. 2003a).

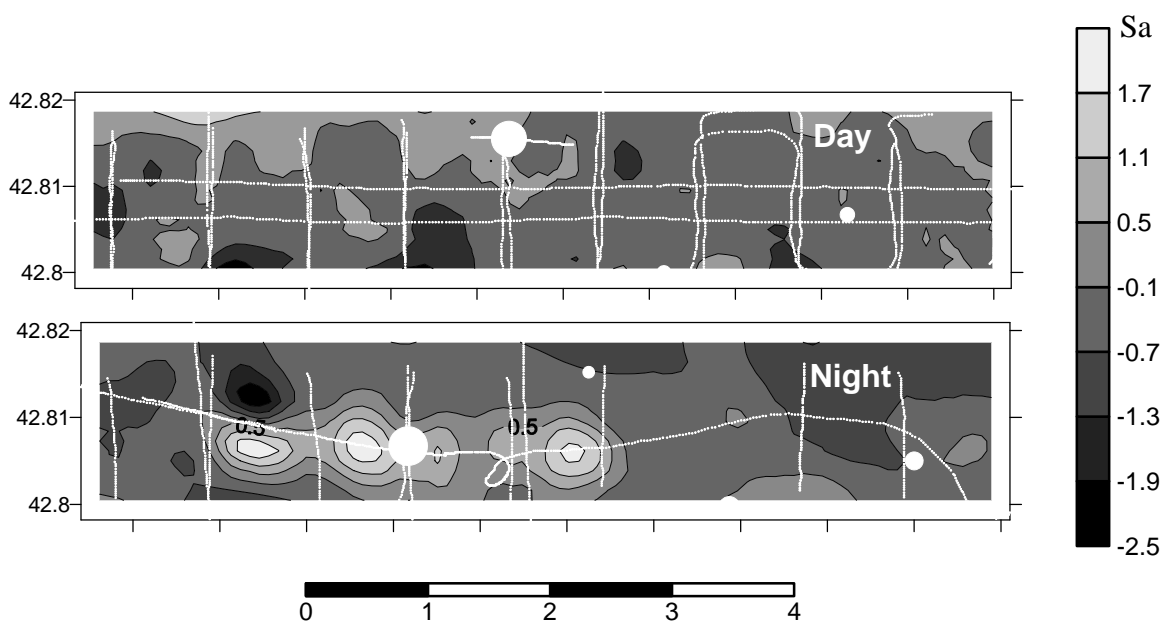


Fig. 7. The night and day distribution of pollock at the Shelf Edge (October 2/3, 1999). The contours represent kriged area backscattering coefficients (S_a). The expanding white circles represent the standardized net catches by a research vessel, scaled from a minimum of 0.001 MT to a maximum catch of 4 MT. The white lines represent the track of the research vessel.

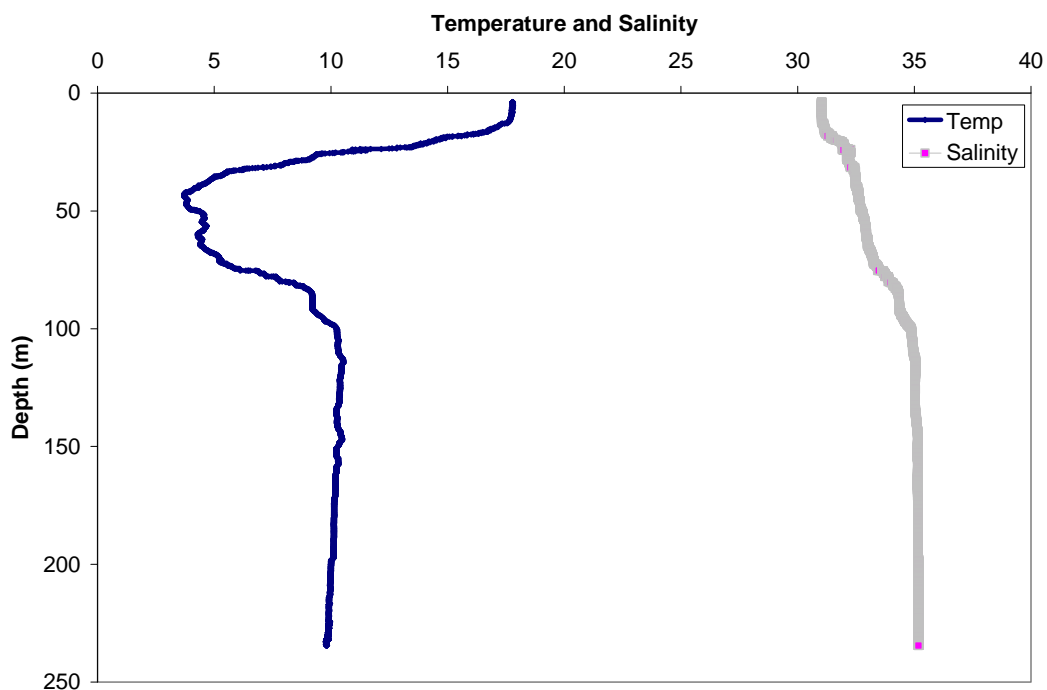


Fig. 8. Temperature and salinity profile from the Scotian Shelf edge.

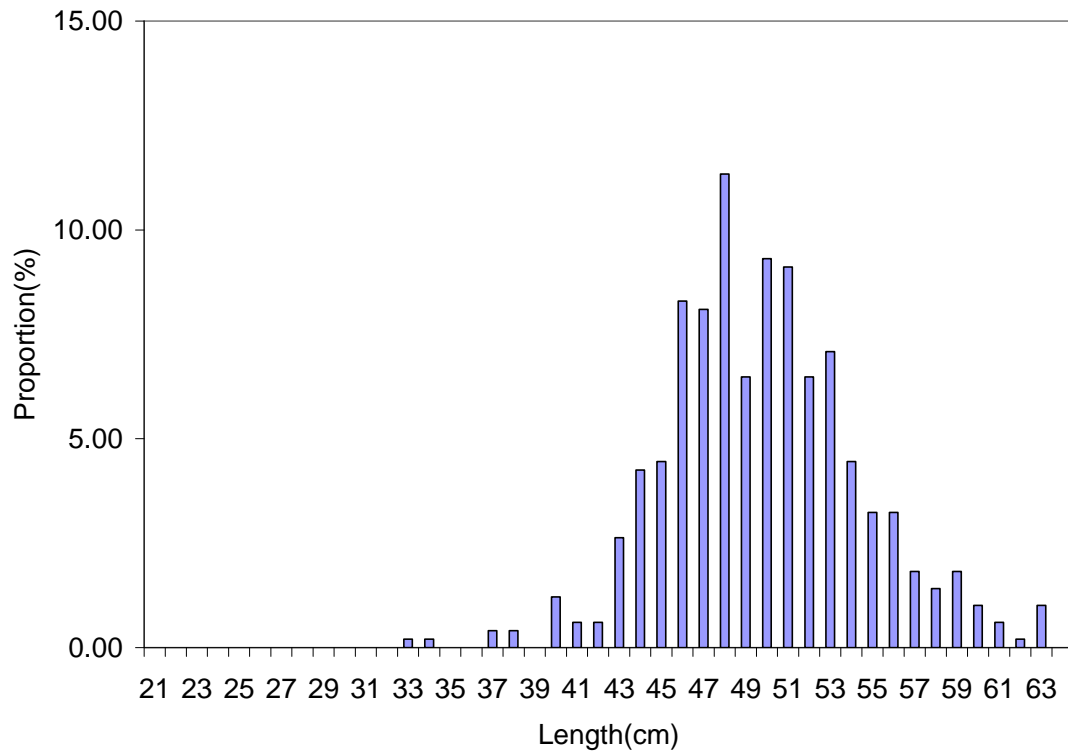


Fig. 9. Length Frequency by proportion at length for pollock caught on the Scotian Shelf Edge in October 1999.

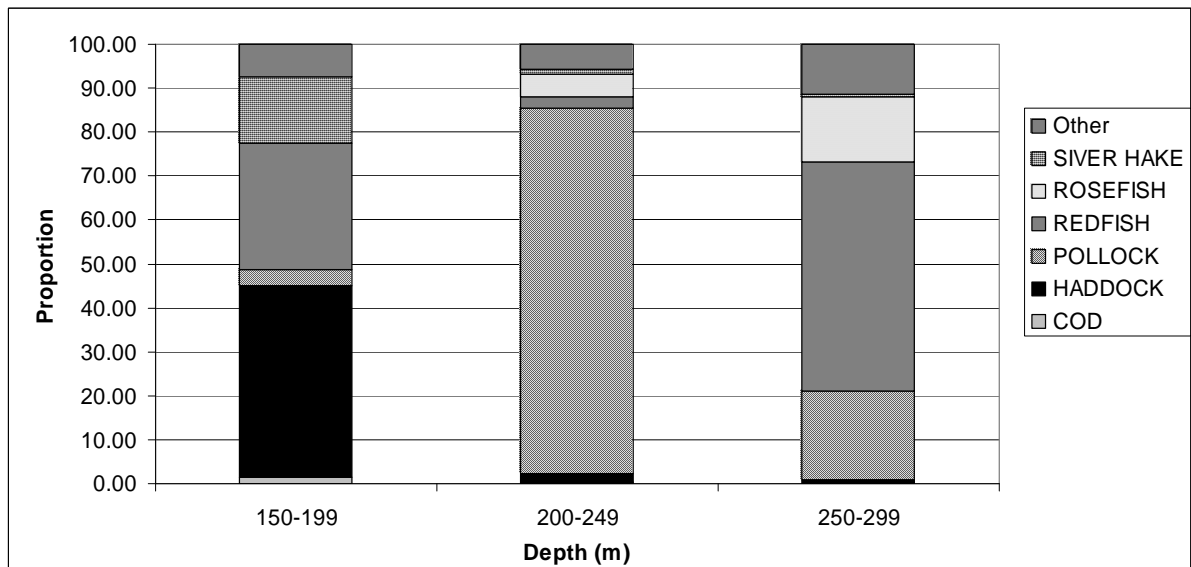


Fig. 10. Species composition from sets at various depth ranges at the Scotian Shelf Edge in 1999.

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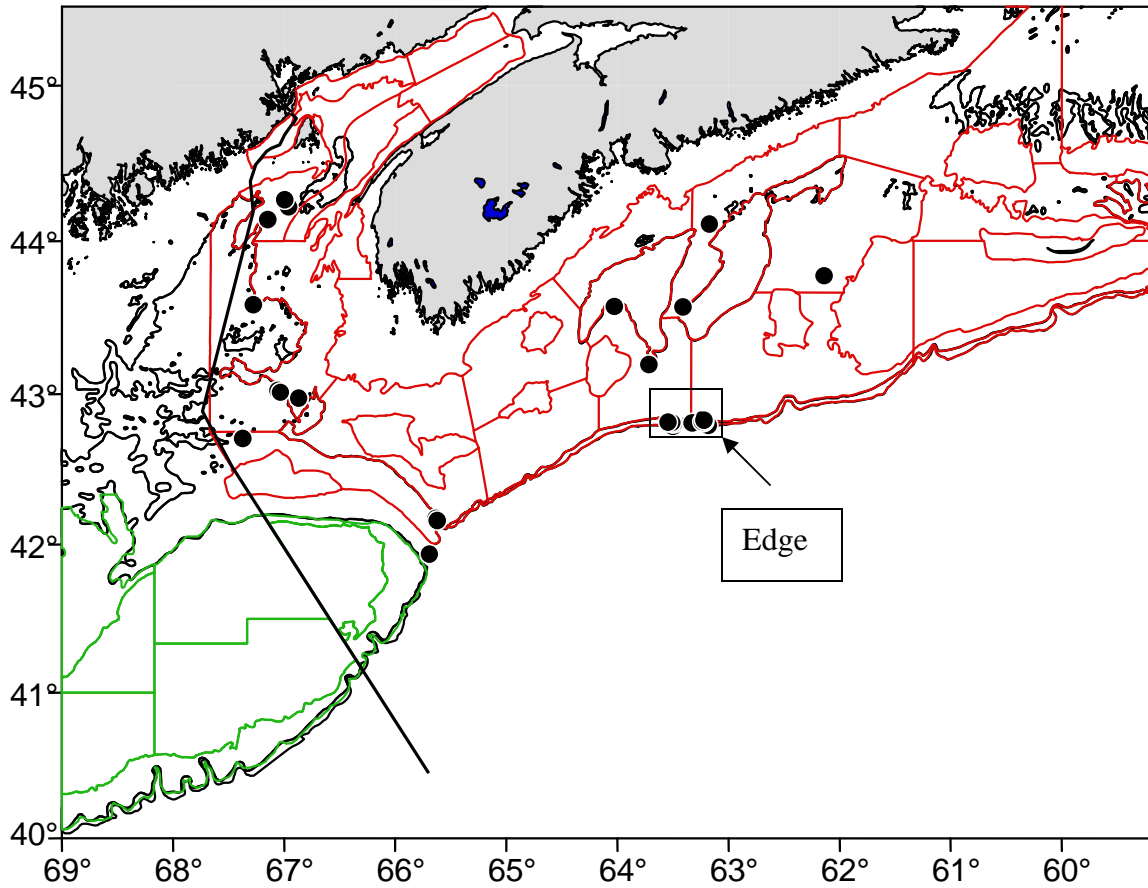


Fig. 11. Set locations and study area during the September, 2000 hydroacoustic survey. Groundfish depth strata are shown to relate with the areas surveyed in both the July Scotian Shelf groundfish survey and the February Georges Bank survey. The shaded circles indicate set locations.

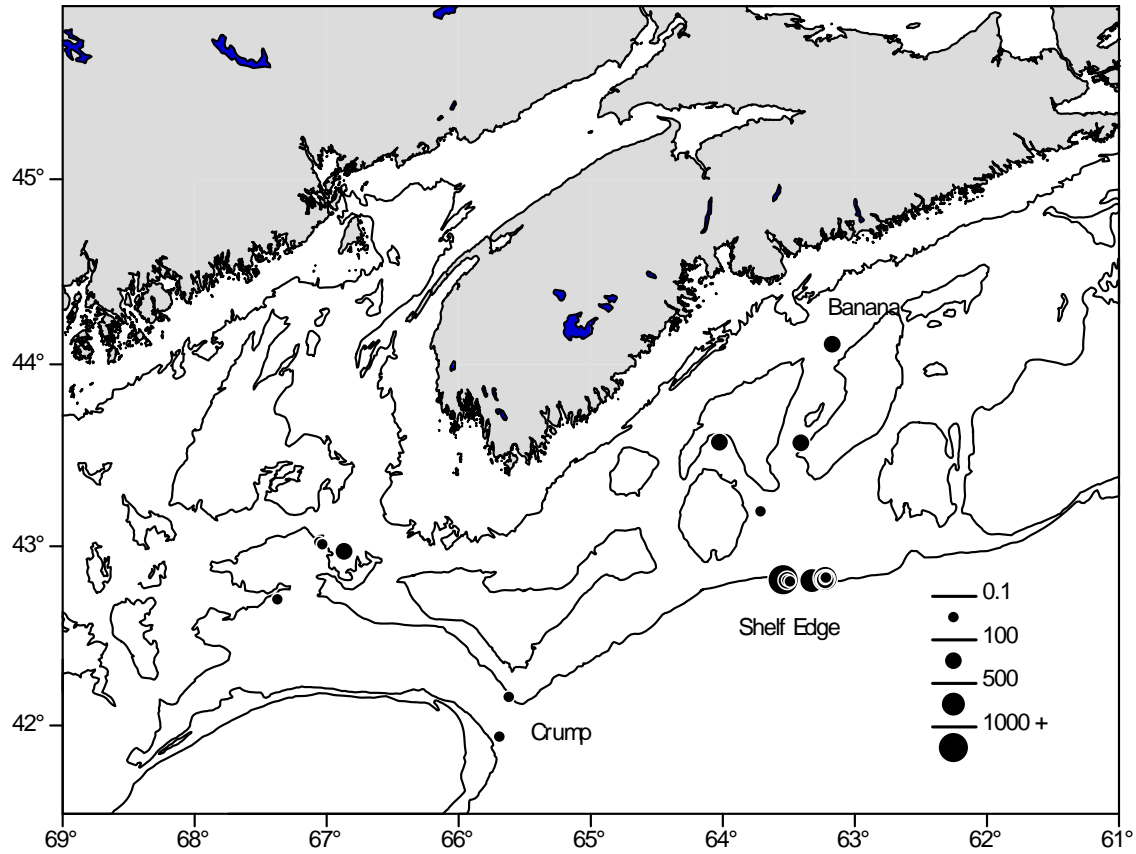


Fig. 12. Standardized pollock weight (kg) of sets where pollock was caught during the 2000 pollock acoustic survey. Weight standardized to 0.75 nm.

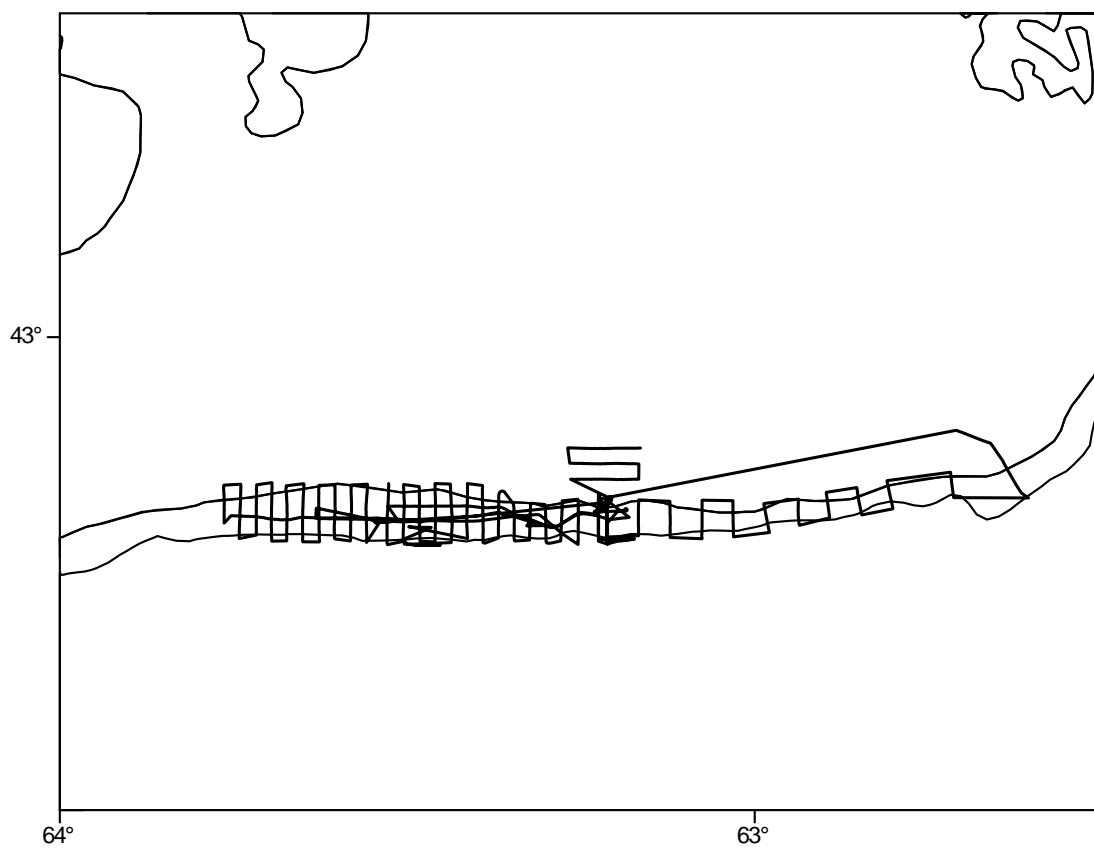


Fig. 13. Survey cruise track following parallel transects on the Scotian Shelf Edge.

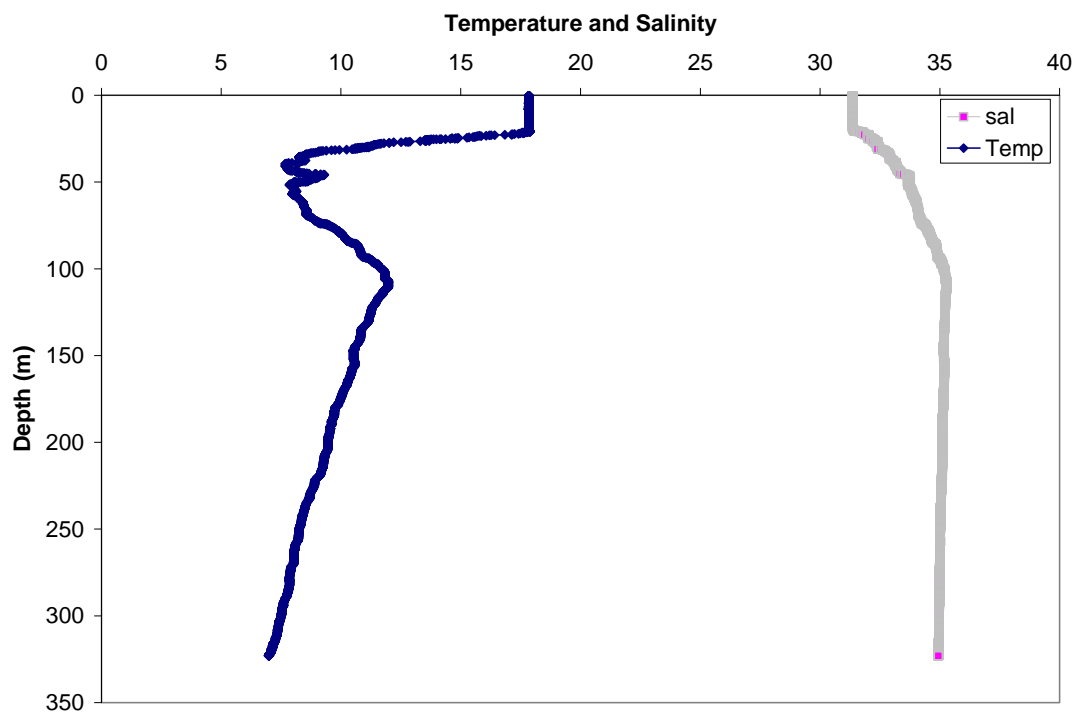


Fig. 14. Temperature and salinity profile from the Scotian Shelf edge in 2000.

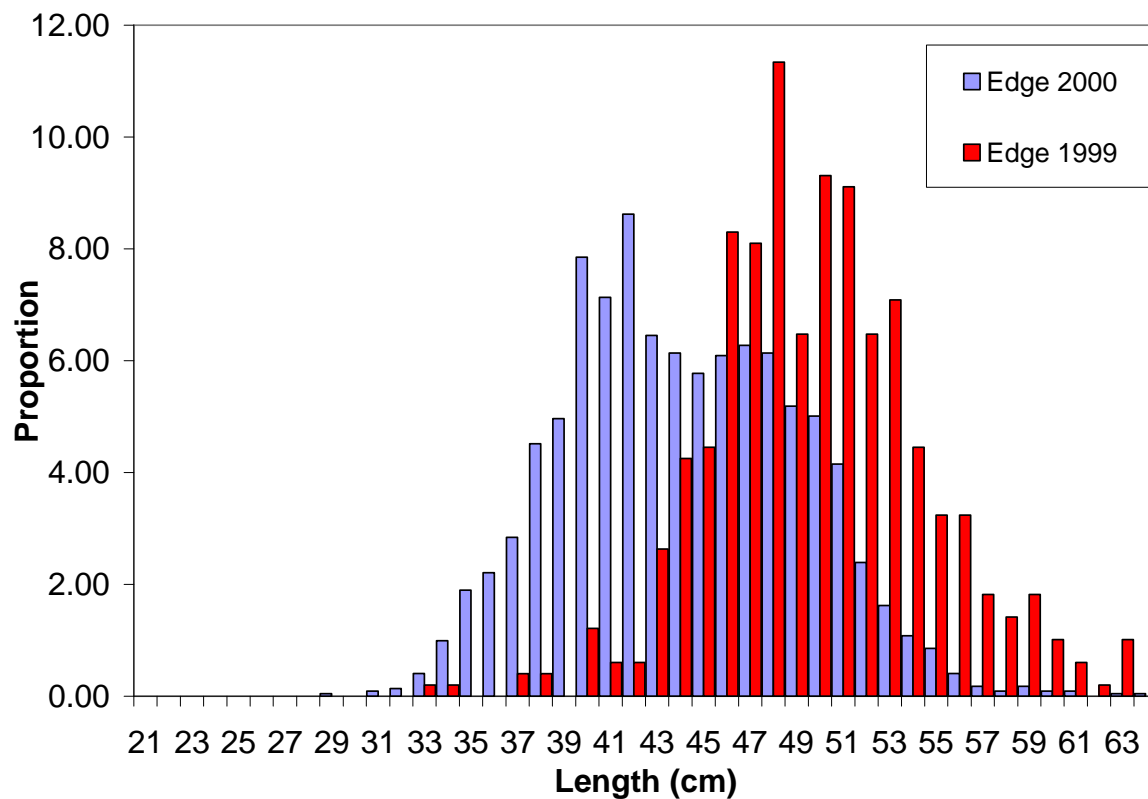


Fig. 15. Comparison of pollock length frequencies from the Shelf edge from surveys in 1999 and 2000.

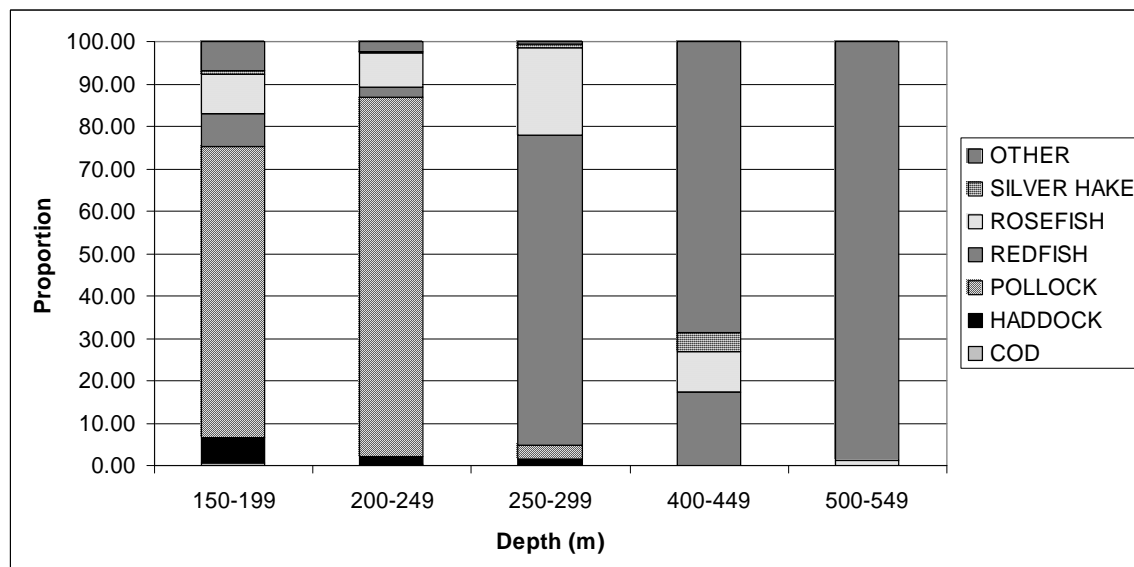


Fig. 16. Species composition from sets at various depth ranges at the Scotian Shelf Edge in 2000.

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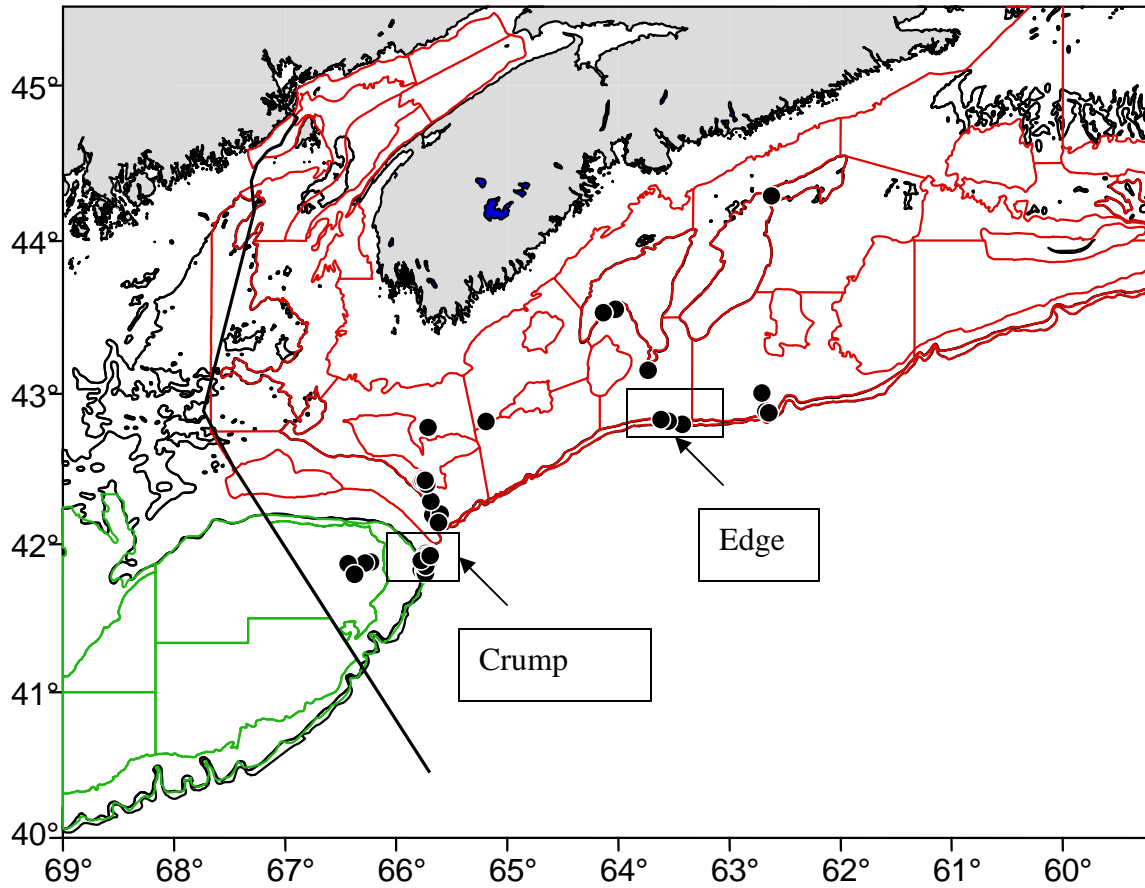


Fig. 17. Set locations and study area during the January, 2002 hydroacoustic survey. Groundfish depth strata are shown to relate with the areas surveyed in both the July Scotian Shelf groundfish survey and the February Georges Bank survey. The shaded circles indicate set locations.

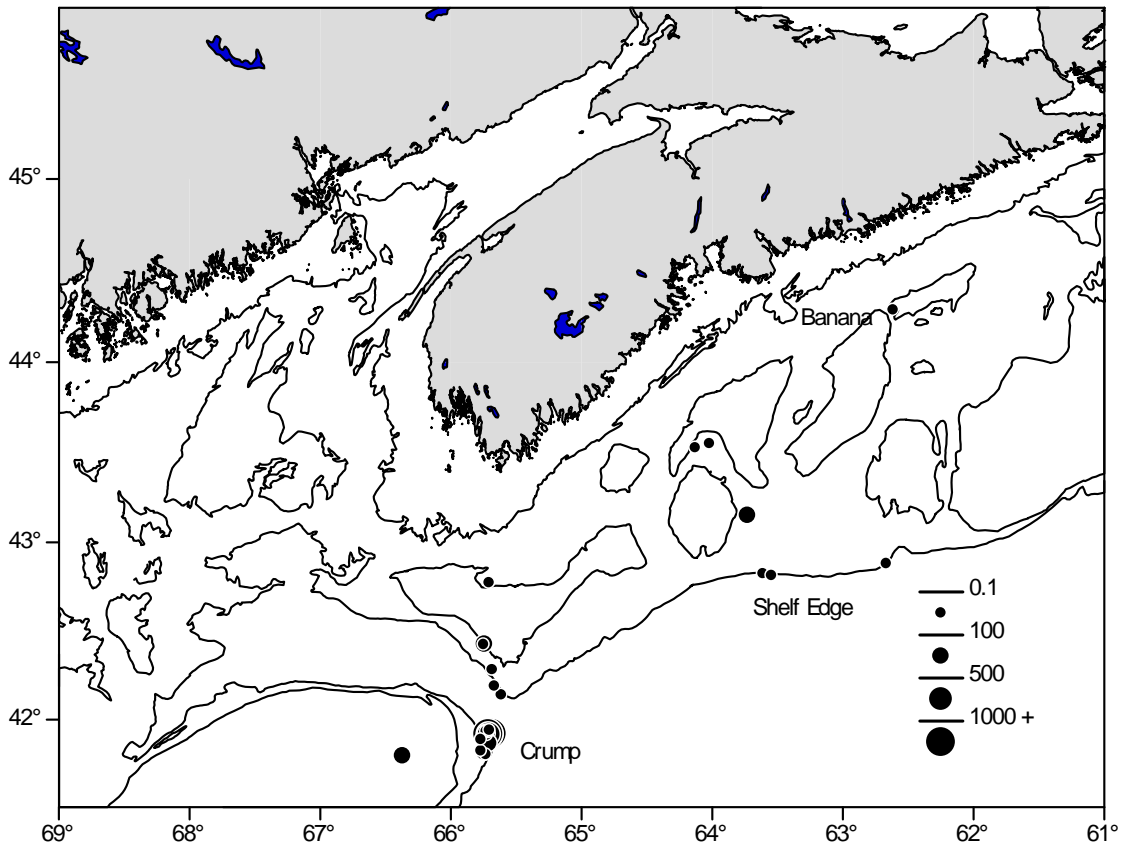


Fig. 18. Standardized pollock weight (kg) from sets where pollock was caught during the 2002 pollock acoustic survey. Weight standardized to 0.75 nm.

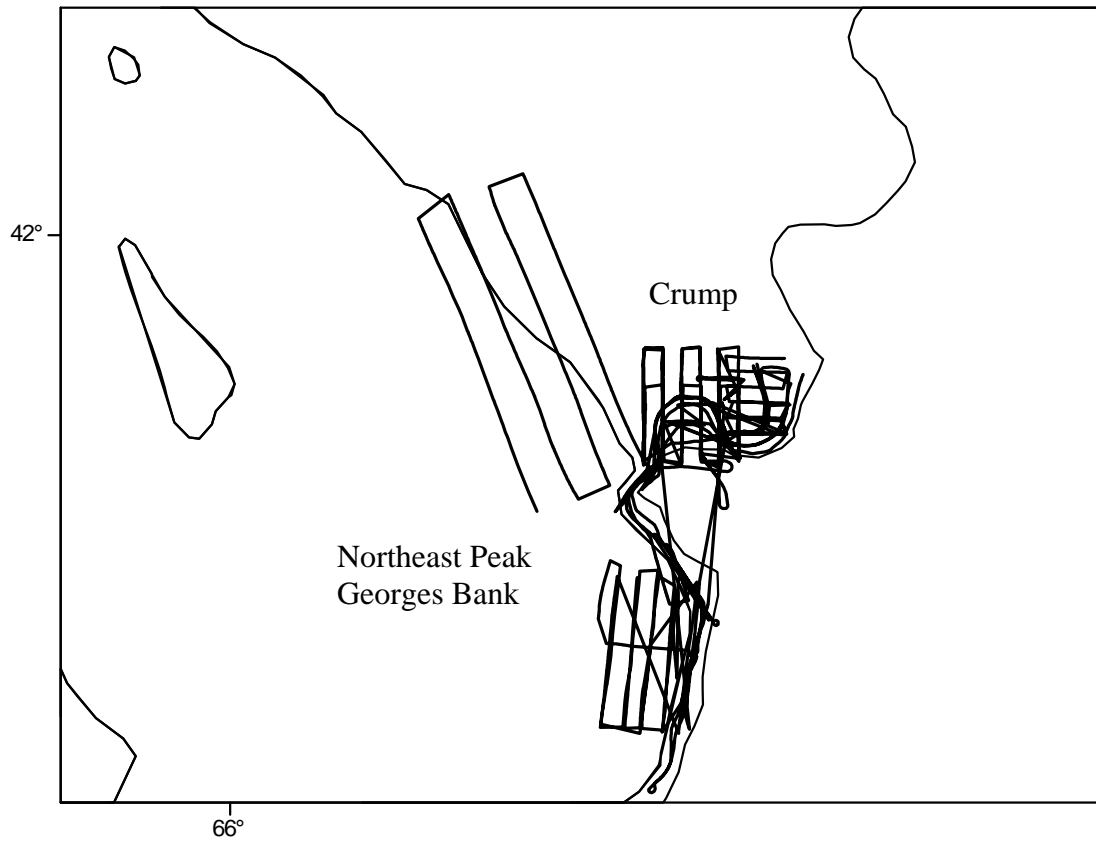


Fig. 19. Survey transects on Georges Bank, The Crump and the various depth contours in 2002.

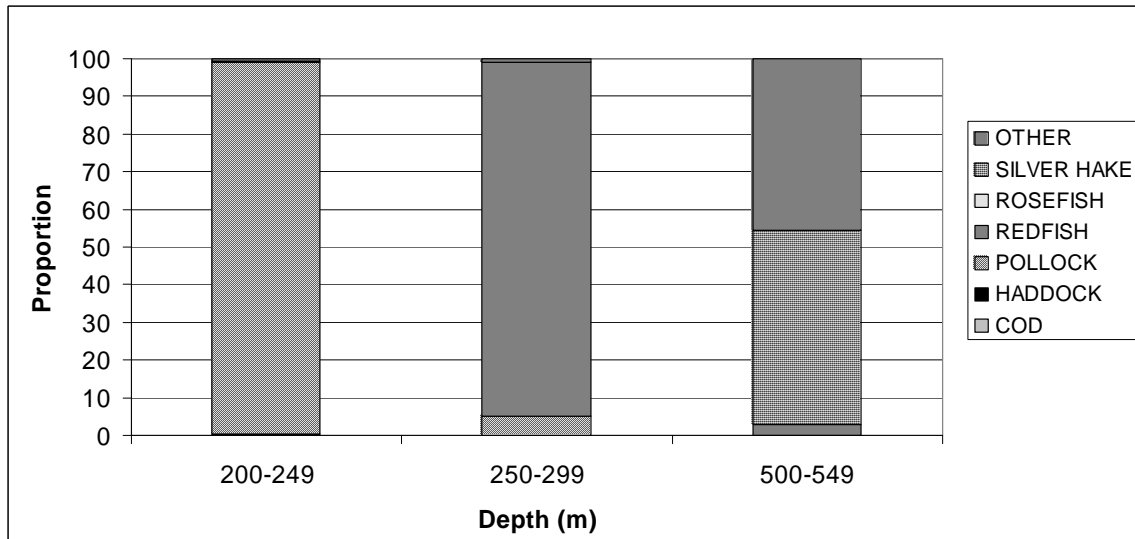


Fig. 20. Species composition from sets at various depth ranges around the area known as the 'Crump' in 2002.

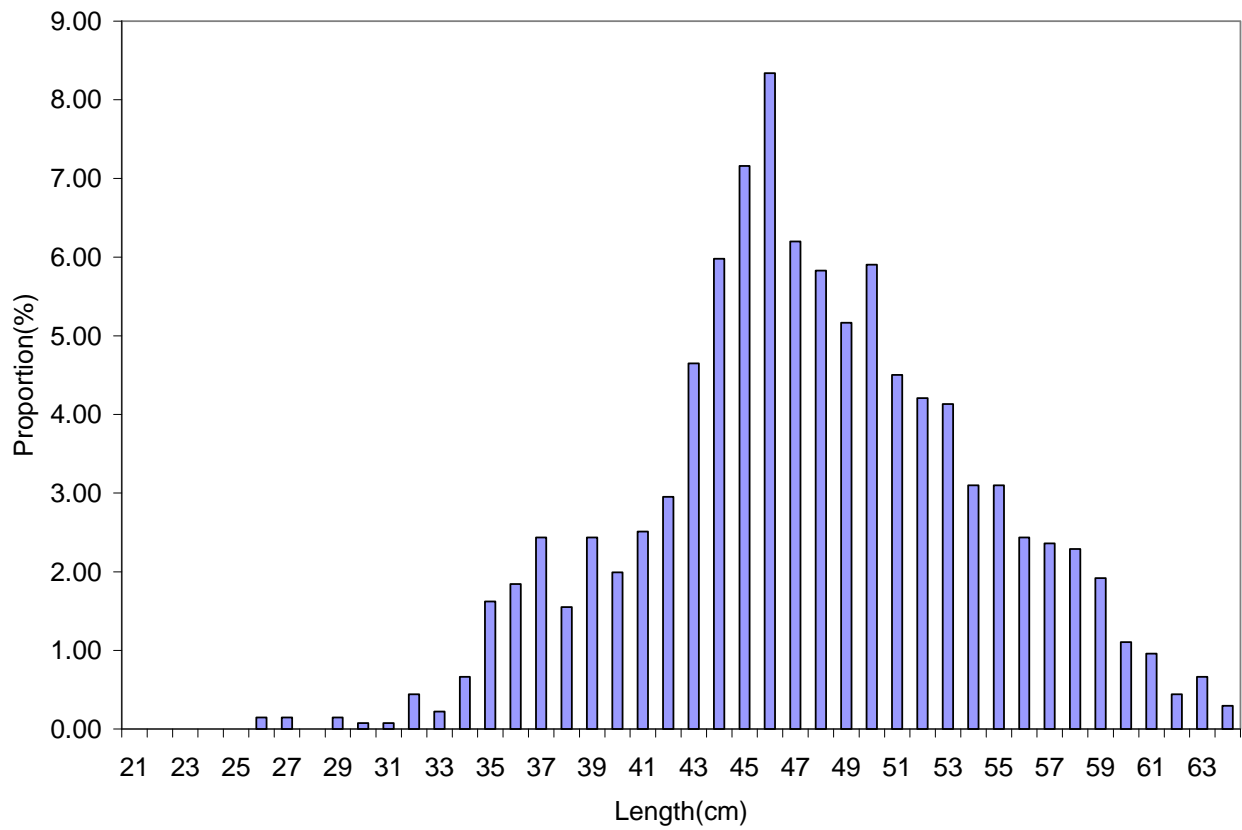


Fig. 21. Length frequency of pollock caught on the Crump.

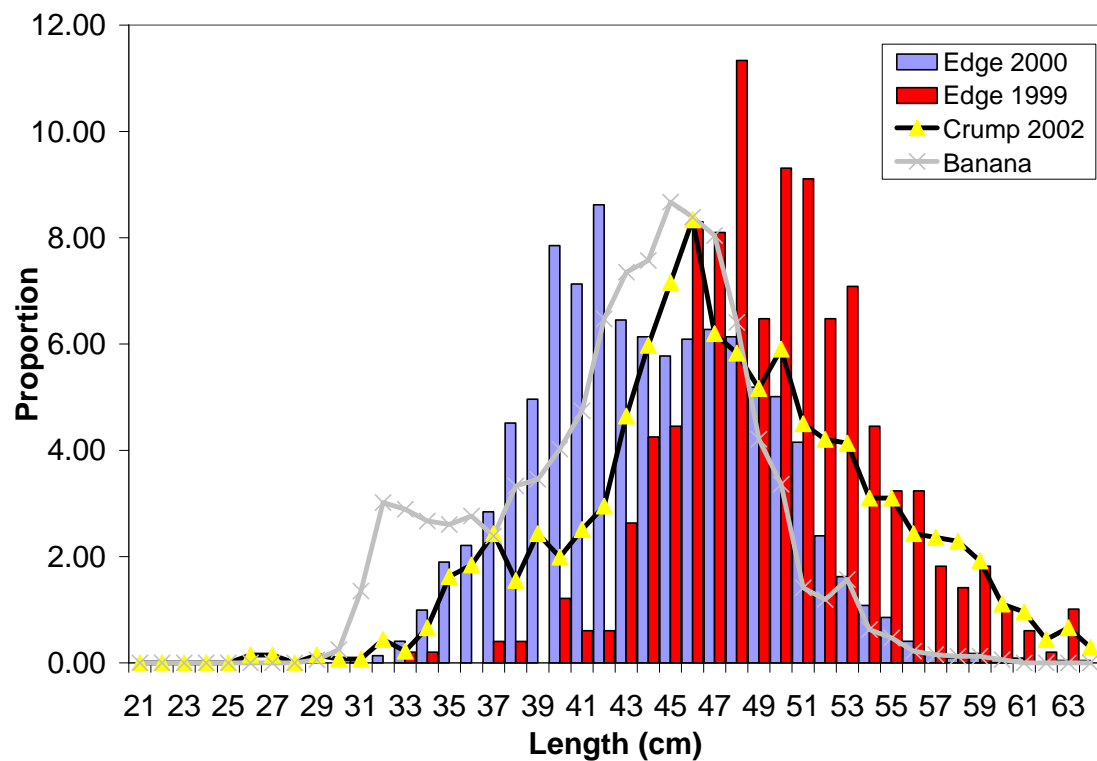


Fig. 22. Comparison of lengths frequencies at sites of pollock aggregations for all years and surveys.

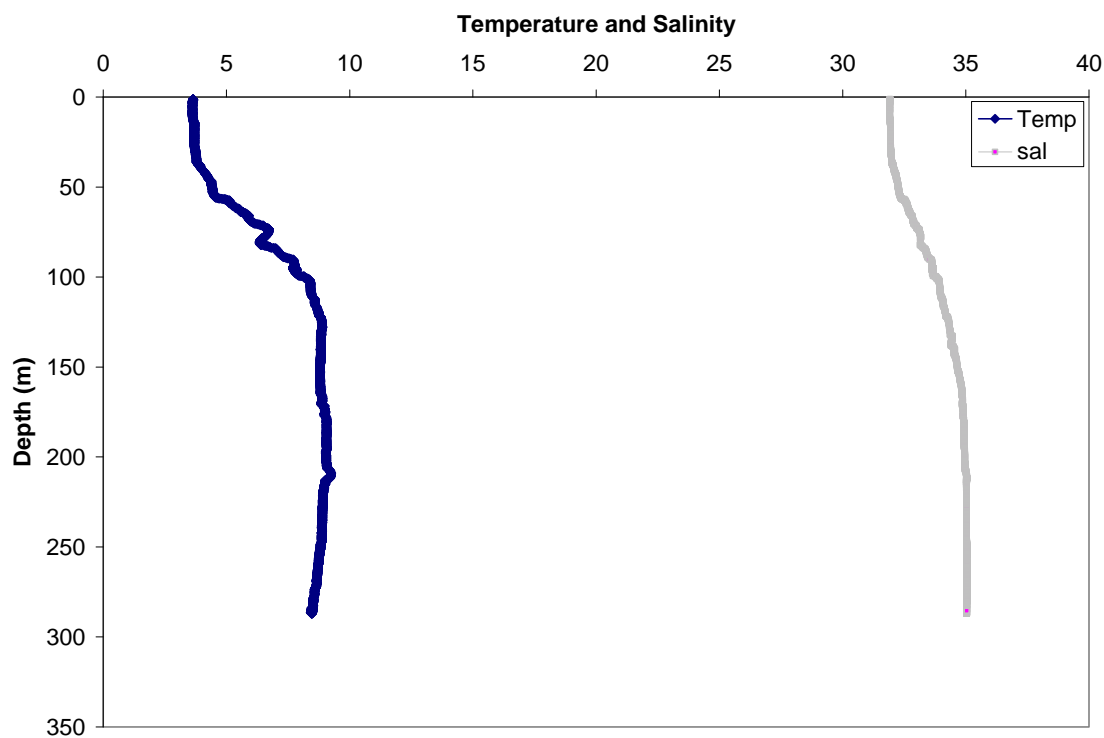


Fig. 23. Temperature and salinity profile of the Crump in February, 2002.