

Northwest Atlantic



Fisheries Organization

Serial No. N5058

NAFO SCR Doc. 04/88

SCIENTIFIC COUNCIL MEETING – SEPTEMBER 2004

Canadian Trawl Surveys on Flemish Cap (NAFO Division 3M) from 1949-2004.

by

W. B. Brodie

Science Branch, Department of Fisheries and Oceans, Northwest Atlantic Fisheries Centre,
P. O. Box 5667, St. John's, NL, Canada, A1C 5X1.

Abstract

Canadian research vessels have conducted trawl surveys on Flemish Cap (NAFO Division 3M) since 1949. Eight different vessels carried out over 2000 fishing sets during this period. Much of the work was directed toward obtaining estimates of abundance and distribution of groundfish species. A series of surveys was conducted from 1978 to 1985 in depths to 731 m. Following a complete survey of Flemish Cap in 1996, Canadian research vessels have restricted their survey efforts to the western portion of Div. 3M, generally in depths from 731 to 1462 m. This paper summarizes some of the Canadian trawl survey work done in Div. 3M. It examines some trends in abundance of key species on Flemish Cap during 1978-85 and 1996-2003, and draws some comparisons with surveys in the adjacent Grand Banks area. Although overlap in the two survey series was minimal, the data indicate major changes occurred in the Flemish Cap ecosystem from the 1980's to the mid 1990's.

Introduction

The Flemish Cap (NAFO Div. 3M) is part of a large continental shelf in the Northwest Atlantic (NAFO Subareas 2+3, see Fig. 1). All of Div. 3M is located outside the Canadian Exclusive Economic Zone, or 200 mile limit. Flemish Cap has been surveyed regularly by Canada, with much of the activity being conducted by research vessels based in St. John's, Newfoundland. The survey results have been used many times in the past to derive indices of abundance and biomass in the assessments of several stocks, and as the basis for numerous scientific papers on biology and ecology of various species. This paper examines these survey results, particularly the indices of abundance, and makes some comparisons between the various time periods, and to the trends in the surveys of the adjacent Grand Banks.

Methods and Materials

The computerized database belonging to Science Branch of the Department of Fisheries and Oceans, held at the Northwest Atlantic Fisheries Centre in St. Johns, NL, Canada, was examined. A total of 1 940 valid survey fishing sets on Flemish Cap by Canadian vessels from 1949 to 2004 was identified. This does not include numerous oceanographic surveys (biological and physical), plankton tows, etc. Eight vessels have been employed in these surveys, including 3 chartered commercial trawlers (Table 1). About 84% of all sets were survey-oriented, and these were chosen for further analysis. Other types of sets include tagging, longlining, and searching/sampling sets for various specific biological studies.

Original stratification of Flemish Cap (strata 501-519 in Fig. 2) covered depths to 731 m (400 fm). This stratification (Wells, 1977, later presented in Doubleday, 1981), was developed in 1977 by scientific and technical staff of the Department of Fisheries and Oceans in St. John's. Stratification to 1463 m (800 fm) was completed in 1994, as documented by Bishop (1994). These additions are shown as strata 520-539 in Fig. 2. From Fig. 2 it can be seen that

some strata in the extreme west and southwest regions of Flemish Cap actually extend into NAFO Div. 3L or 3N, but for practical purposes, these areas have always been considered to be part of Flemish Cap in Div. 3M. The Flemish Cap has a total area, from its shallowest point to a depth of 1 462 m, of 17 051 square nautical miles, which is about 20% of the area of the adjacent Grand Banks (Div. 3LNO).

Indices of biomass presented in this paper are based on survey catches and the swept area of the trawl gear, and are not absolute estimates of biomass. They were calculated using the Stratified Analysis Programs (STRAP) of Smith and Somerton (1981).

Results

1949-76: Early surveys (1949-58 on *Investigator II*, 1958-68 on *A.T. Cameron*) were focused mainly on cod and redfish. Some of these were exploratory in nature, and some used line transect designs. Surveys were not conducted on an annual basis, and no series of abundance indices were derived from these surveys. A few deep-water longline sets were conducted in Div. 3M from 1965-68 on *A.T. Cameron* as part of broader investigations in Subareas 2 and 3. There was very little survey activity by Canada in Div. 3M from 1969 to 1976 (Fig. 3).

1977-85: The first stratified random survey conducted by Canada on Flemish Cap was in 1977, on board the *A.T. Cameron*. This was followed by a series of annual stratified random trawl surveys, conducted on the *Gadus Atlantica* from 1978-85. The surveys were in January–February, and were done with an Engel 145 Hi-lift otter trawl, to a maximum depth of 731 m (400 fathoms). The surveys in 1978-85 covered an average of 126 stations per year, and Table 2 shows the coverage by year and stratum. With the exception of 1982, all 19 strata less than 731 m in depth were surveyed each year.

The primary objective of these surveys was to collect data on groundfish abundance and distribution. Catches were dominated by beaked (*Sebastes mentella* + *S. faciatus*) redfish, which comprised about two-thirds (averaged over 1978-85) of total estimated fish biomass. Cod comprised about 13% of the total on average, while flatfishes (Greenland halibut, American plaice, witch flounder) combined comprised about 5% or less of total fish biomass. Other common species encountered on these surveys include *Sebastes marinus* redfish, skates, grenadiers, eelpouts and wolffish. Shrimp biomass is not available, as the surveys were groundfish oriented, and the Engel 145 Hi-lift trawl used was not considered suitable for shrimp.

Declines in the biomass indices for cod, beaked redfish, and total finfish biomass were evident from 1978-85. There was a slight decline in American plaice biomass, and no trends were evident for Greenland halibut and thorny skate. These biomass indices are plotted in Fig. 4a and 4b; the 1982 results were omitted due to poor survey coverage (Table 2).

1991-95. Three deepwater trawl surveys were conducted during 1991, 1994, and 1995, mainly for Greenland halibut. These surveys, which covered parts of Div. 3M to a depth of 1463 m, all used a standard Engel 145 trawl, but were done on three different vessels (chartered commercial vessels *Cape Adair* and *Zandvoort* in 1991 and 1994, research vessel *Teleost* in 1995). The survey in 1991 used line transects, and results were later post-stratified using the new (1994) stratification of the deepwater area in Div. 3M. Biomass indices of G. halibut in comparable strata in 3M (only strata 528, 529, 530, and 532 were surveyed each year) were higher in 1991 than 1994-95 (Bowering and Power 1995). These surveys led to the deepwater surveys of Flemish Pass and western 3M, which have occurred from 1996 to the present.

1996-2004. Annual stratified random multispecies surveys from 1996 have covered the deepwater areas of Flemish Pass and western Flemish Cap in Div. 3M. The research vessels used were *Wilfred Templeman* and *Teleost*, and the fishing gear is the Campelen 1800 shrimp trawl. The 1996 survey is actually an exception, in that it covered all strata in Div. 3M less than 731 m and some deeper than 731 m. After 1996, only strata 528-536 (Fig 2), which are all deeper than 731 m, have been surveyed as part of the annual fall survey conducted by Canada in Div. 2GHJ + 3KLMNO. The 2003 fall survey in some areas, including Div. 3M, was actually completed in January of 2004.

In the 1996 survey, beaked redfish comprised almost half of the finfish biomass (Fig. 5), while cod and American plaice were at very low levels (Brodie *et al.*, 1997b). A swept-area biomass of northern shrimp, *Pandalus borealis*, was estimated at about 22 000 tons.

In the deepwater surveys from 1996 to 2003 (only the deepwater strata from 1996 were included for this comparison), invertebrates comprised about 56% of total catch weight. Sponge was dominant species group by far, at about 45% of the total catch weight. Five fish species (Fig. 6a) comprised about two-thirds of the total recorded catch weights. These 5 species (longnose eel, blue hake, Greenland halibut, roughhead grenadier, and roundnose grenadier, each made up about 12-15% of the overall catch.

The swept area biomass index for *G. halibut*, which is the species targetted in the fishery in the deepwater area of Div. 3M, ranged from 2 500 to 7 800 tons, with a decline in recent years (Dwyer *et al.*, 2004). Overall, *G. halibut* comprised about 3.9 to 12.4% of total biomass (all species) in these surveys (Fig 6b). The data for 1999 have not been included in this calculation, due to missing survey coverage in that year.

Discussion

In addition to a number of individual surveys with a variety of objectives, survey designs and fishing gears, two series of Canadian surveys exist on Flemish Cap (1978-85, 1996-2003). However, there is no continuous time series of surveys by comparable vessel-gears. After 1996, there was no overlap in survey coverage in Div. 3M; the shallow strata (<731 m) were surveyed in 1978-85, but only deep water strata (>731 m) were covered after 1996. As well, there was different timing for the surveys: winter in 1978-85, autumn in 1996-2003.

Primarily for these reasons, results from the 1978-85 Engel surveys have not been compared rigorously to the results of the 1996-2003 Campelen surveys. McCallum and Walsh (1996) discussed the substantial differences in the Engel and Campelen trawls used in the Canadian surveys, and comparative fishing exercises in 1994-95 involving these two trawls clearly showed major differences in the catches of these nets (Warren, 1996; Warren *et al.*, 1997). The results from these comparisons showed that the Campelen trawl is much more efficient in capturing most species, particularly at smaller sizes. Biomass estimates for American plaice in Div. 2J3K and 3LNO, for example, when converted into "Campelen equivalents", were about 2.5 to 3.3 times higher than those calculated from the original Engel data (Brodie *et al.*, 1998). For Greenland halibut in Div 2J and 3K, the mean biomass ratio was around 1.7 (Bowering *et al.*, 1996; Brodie *et al.*, 1997a).

In examining results from the 2 time series of surveys, it appears that there were substantial changes to the Flemish Cap ecosystem from 1985 to 1996, although beaked redfish comprised a substantial portion of the biomass in both surveys. Comparison of the 1985 Engel results with the 1996 Campelen survey (strata less than 731 m) showed large declines for many species, even allowing for improved efficiency of the Campelen trawl. For cod and American plaice, the swept-area biomass from the 1996 Campelen survey of the strata <731 m was only about 40% of what it was in 1985 (Fig 7). If we assume that the conversion factor for the 1985 Engel biomass for plaice is approximately 3, then this implies that *A. plaice* biomass in 1996 was only about 15% of the adjusted 1985 value. For Greenland halibut, a similar calculation shows that the biomass in 1996 was about 75% of the "converted" 1985 value.

Although these comparisons between Canadian survey results in 1985 and 1996 are somewhat crude, and subject to normal variability in survey estimates, there is confirmation of the trends from other sources. The severe declines in groundfish abundance suggested in the Canadian surveys from the mid-1980s to 1996 were seen in the EU surveys of Flemish Cap, particularly from the early years of the time series which began in 1988, until the mid to late-1990s (Casas, 2004). For example, the mean biomass index for cod from the EU surveys declined by almost 90% from 1988-91 until 1996-99. The major groundfish fisheries on Flemish Cap (cod, redfish, American plaice) also declined severely from the early- to the mid-1990s. In 1990, the estimated catch in Div. 3M of these 3 species combined was about 115 000 tons, compared to only about 9 000 tons in 1996 (NAFO SC Reports, 1992, 1998). New fisheries for Greenland halibut and northern shrimp emerged in the early-1990s on and around Flemish Cap. Catches of *G. halibut* averaged about 12 000 tons in Div. 3M from 1992-94 and have been lower since, while shrimp catches ranged from 25,000 to 50 000 tons from 1993-99, and have averaged in excess of 50 000 tons per year since then (NAFO SC Reports 2002/2003 Supplement).

In the adjacent area (Div. 3L), there were very large declines in biomass of most species between 1985 and 1996. The swept-area biomass estimate of all species combined, from spring Engel surveys in Div. 3L, declined from over 600 000 tons in 1985 to less than 30 000 tons in 1995. Large declines were observed for many species, particularly cod (Lilly *et al.*, 1998) and American plaice (Brodie *et al.*, 1998). Surveys from autumn 1995 to the present have been done with the Campelen trawl, and as is the situation on Flemish Cap, indicate no recovery of

these 2 species along with numerous others. Also like Flemish Cap, a shrimp fishery has begun in Div. 3L, following biomass increases from the mid to late-1990s (NAFO SC Reports, 2002/2003, Supplement). These changes in the Grand Banks and areas to the north were not unlike the major changes observed on Flemish Cap in the 1980s and 1990s.

References

- Bishop, C.A. 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO Subareas 2 and 3. NAFO SCR Doc. 94/43 (rev), Ser. No. N2413.
- Bowering, W.R. and D.Power. 1995. Distribution and abundance of Greenland halibut at the Continental Slope of Divisions 3KLMN based upon Canadian deepwater surveys in 1991, 1994 and 1995. NAFO SCR Doc. 95/52, Ser. No. N2563. 11 p.
- Bowering, W.R., W.B. Brodie, and M.J. Morgan, D. Power, and D. Orr. 1996. The Status of the Greenland halibut Resource in the Management Area of NAFO Subarea 2 and Divisions 3KLMNO. NAFO SCR Doc. 96/73, Ser. No. N2748, 34p.
- Brodie, W. B., W. R. Bowering, D. Power, and D. Orr. 1997a. An assessment of Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO. NAFO SCR Doc. 97/52, Ser.No. N2886.
- Brodie, W.B., M.J. Morgan, and E.F. Murphy. 1997b. Results for selected species from a Canadian research vessel survey on Flemish Cap, NAFO Div. 3M, in 1996. NAFO SCR Doc. 97/42, Ser. No. N2876. 15 p.
- Brodie, W. B., W. R. Bowering, D. Orr, D. Maddock Parsons, and M. J. Morgan. 1998. Assessment data for Divisions 3LNO American plaice. NAFO SCR Doc. 98/69, Ser.No. N3061 (30 pages).
- Casas, J. M. 2004. Results from bottom trawl survey on Flemish Cap of July 2003. NAFO SCR Doc. 04/21, Ser. No.N4969
- Doubleday, W.B. 1981 Manual on groundfish surveys in the Northwest Atlantic. NAFO Sci. Coun. Studies 2:55p.
- Dwyer, K.S., W.R. Bowering, and B.P. Healey. 2004. Greenland halibut (*Reinhardtius hippoglossoides*) in NAFO Subarea 2 and Divisions 3KLMNO: Stock trends based on annual Canadian Research Vessel survey results during 1978-2003. NAFO SCR Doc. 04/48. Ser. No.N5001.
- Lilly, G.R., P.A. Shelton, J. Bratney, N. Cadigan, E.F. Murphy, D.E. Stansbury, M.B. Davis, and M.J. Morgan. 1998. An assessment of the cod stock in NAFO Divisions 2J+3KL. Can. Stock Assess. Secretariat Res. Doc. 98/15.
- McCallum, B.R. and S.J. Walsh. 1996. Groundfish survey trawls used at the Northwest Atlantic Fisheries Centre, 1971 to present. NAFO SCR Doc. 96/50, Ser. No. N2726.
- Smith, S.J. and G.A. Somerton. 1981. STRAP : A user oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: iv + 66 p.
- Warren. W.G. 1996. Report on the comparative fishing trial between the *Gadus Atlantica* and *Teleost* . NAFO SCR Doc 96/28, Ser No. N2701, 16 p.
- Warren, W., W. Brodie, D. Stansbury, S. Walsh, J. Morgan, and D. Orr. 1997. Analysis of the 1996 Comparative Fishing Trials between the *Alfred Needler* with the Engel 145 trawl and the *Wilfred Templeman* with the Campelen 1800 trawl. NAFO SCR Doc. 97/68, Ser. No. N2902, 12p.
- Wells, R. 1977. Stratification scheme used and age composition of cod catches taken on Flemish Cap, 2-15 February 1977 by RV *A.T. Cameron*. ICNAF Research Document 77/VI/29, Ser. No. 5054. 2 p.

Table 1. Vessels used in Canadian surveys of Flemish Cap, 1949-2004.

Vessel	Range of years	Total sets
Investigator II	1949-1958	119
A.T.Cameron	1958-1978	259
Cape Farewell	1973	26
Gadus Atlantica	1978-1985	1137
Wilfred Templeman	1984-1996	85
Cape Adair	1991	39
Zandvoort	1994	52
Teleost	1995-2004	223

Table 2. The number of survey sets, by stratum, from Canadian surveys on Flemish Cap from 1978-85.

		YEAR								
STRATUM	Depth Range (m)	1978	1979	1980	1981	1982	1983	1984	1985	Total
501	128-146	4	4	4	5	5	5	4	4	35
2	147-183	11	6	11	11	11	11	10	10	81
3	184-256	10	6	8	8	8	8	8	8	64
4	"	6	4	4	5	5	5	4	4	37
5	"	10	6	8	9	9	9	8	8	67
6	"	8	6	6	7	7	7	6	6	53
7	257-366	8	6	10	11	11	11	10	10	77
8	"	9	6	8	9	9	9	8	8	66
9	"	4	4	4	4	4	4	4	4	32
10	"	14	6	12	13	12	13	12	12	94
11	"	11	6	10	11	11	11	10	10	80
12	367-549	5	6	8	9	4	9	8	8	57
13	"	4	4	3	3	3	3	3	3	26
14	"	8	6	7	8	8	8	7	7	59
15	"	7	4	8	9		9	8	8	53
16	550-731	4	6	8	9		9	8	8	52
17	"	4	3	3	3		3	3	3	22
18	"	2	3	3	3		3	3	3	20
19	"	5	3	5	5		5	5	5	33
	Total	134	95	130	142	107	142	129	129	1008

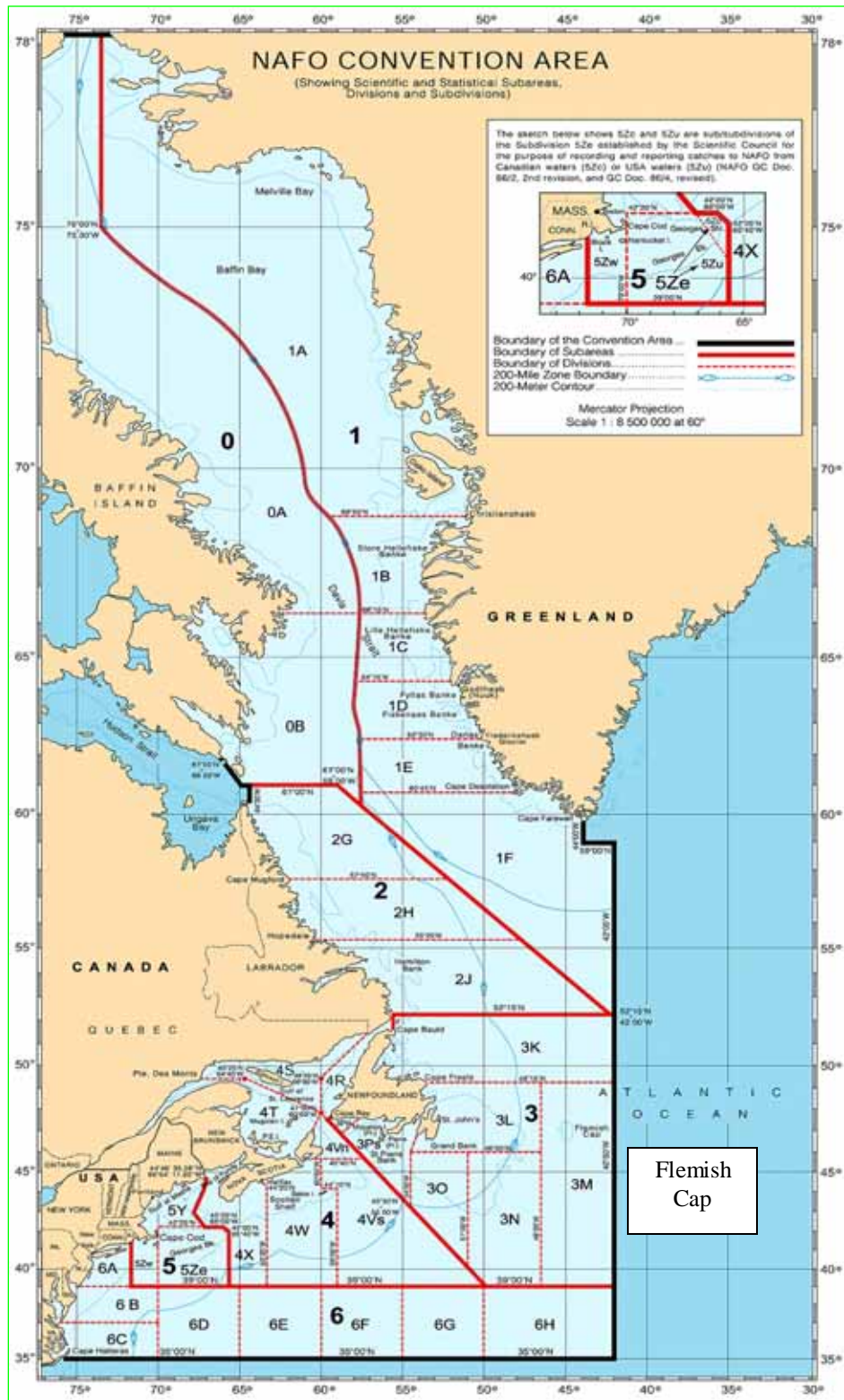


Fig. 1. Map of NAFO convention area, showing Flemish Cap in Division 3M (from NAFO Website).

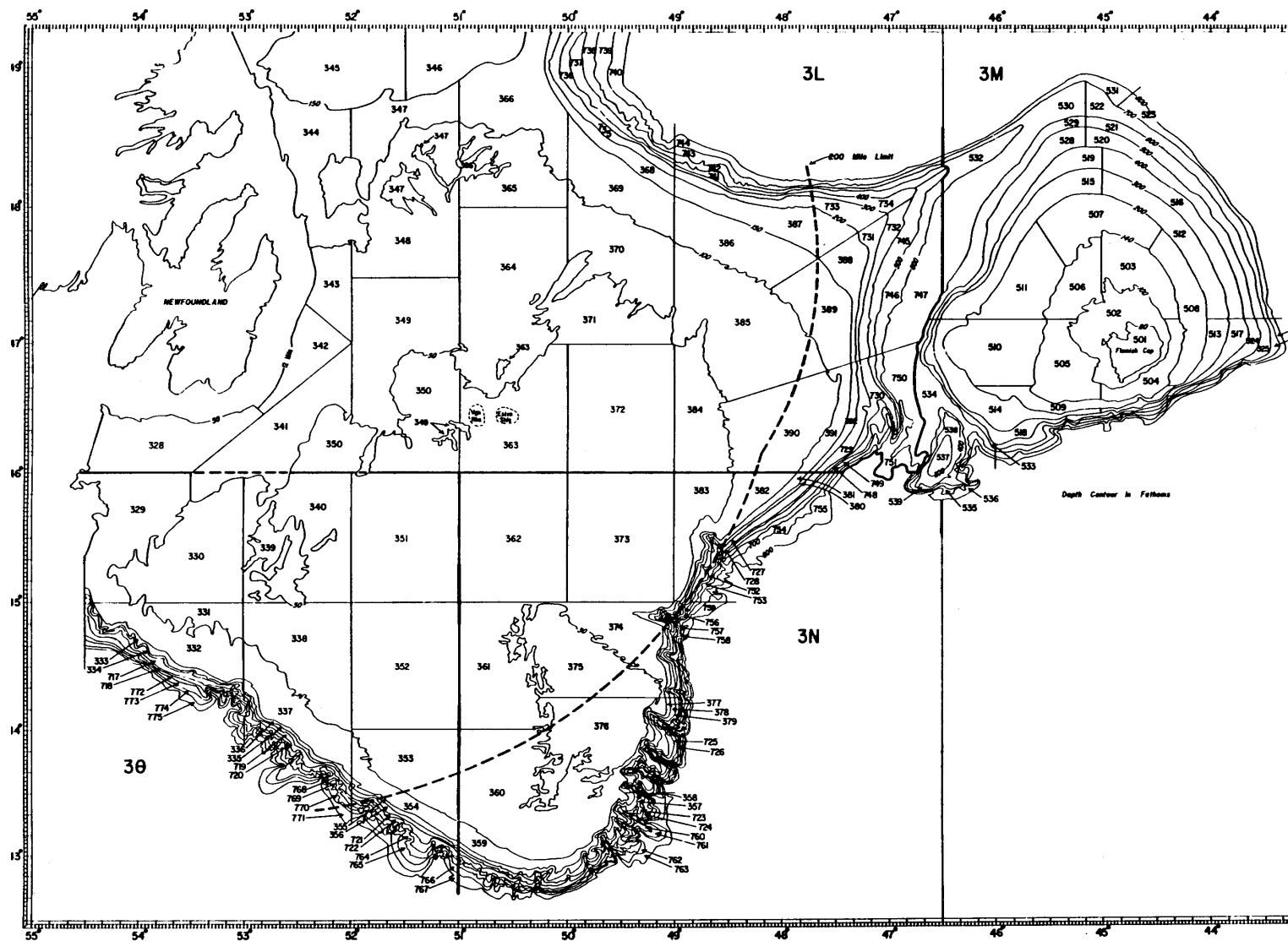


Fig. 2. Map showing stratification systems used for surveys in Div 3M, and Div. 3LNO.

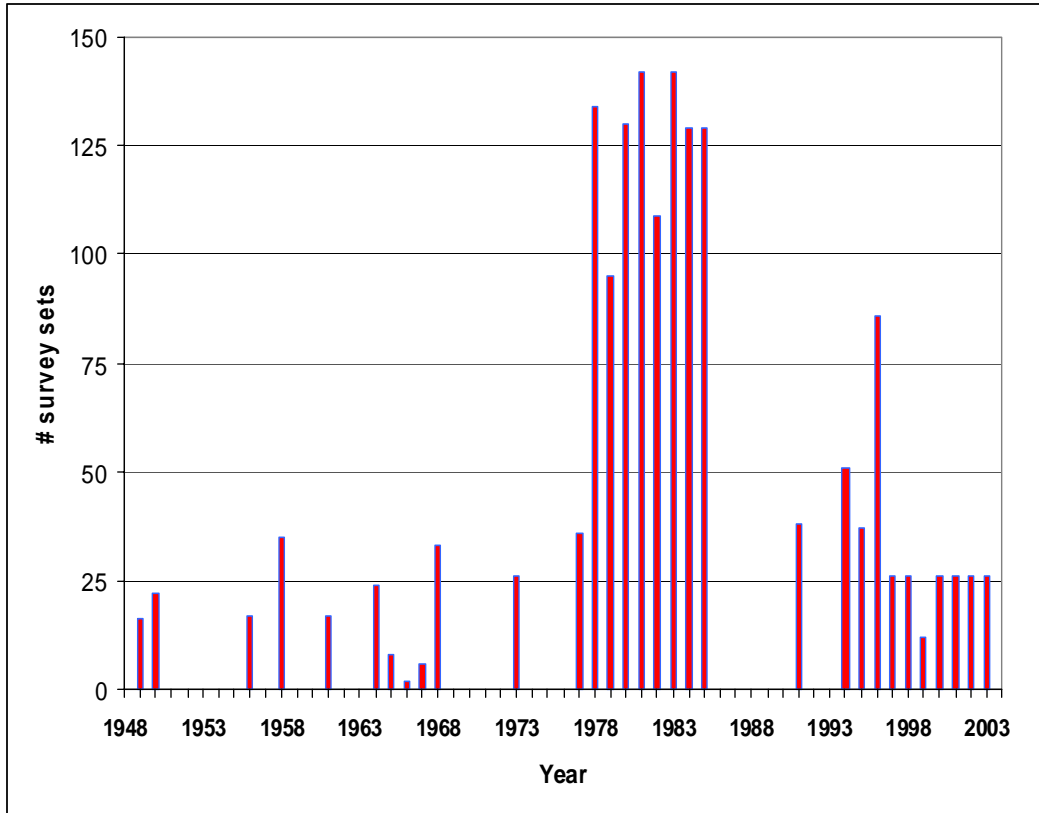


Fig 3. Number of survey sets conducted by Canadian research and charter vessels, from 1949 to 2003.

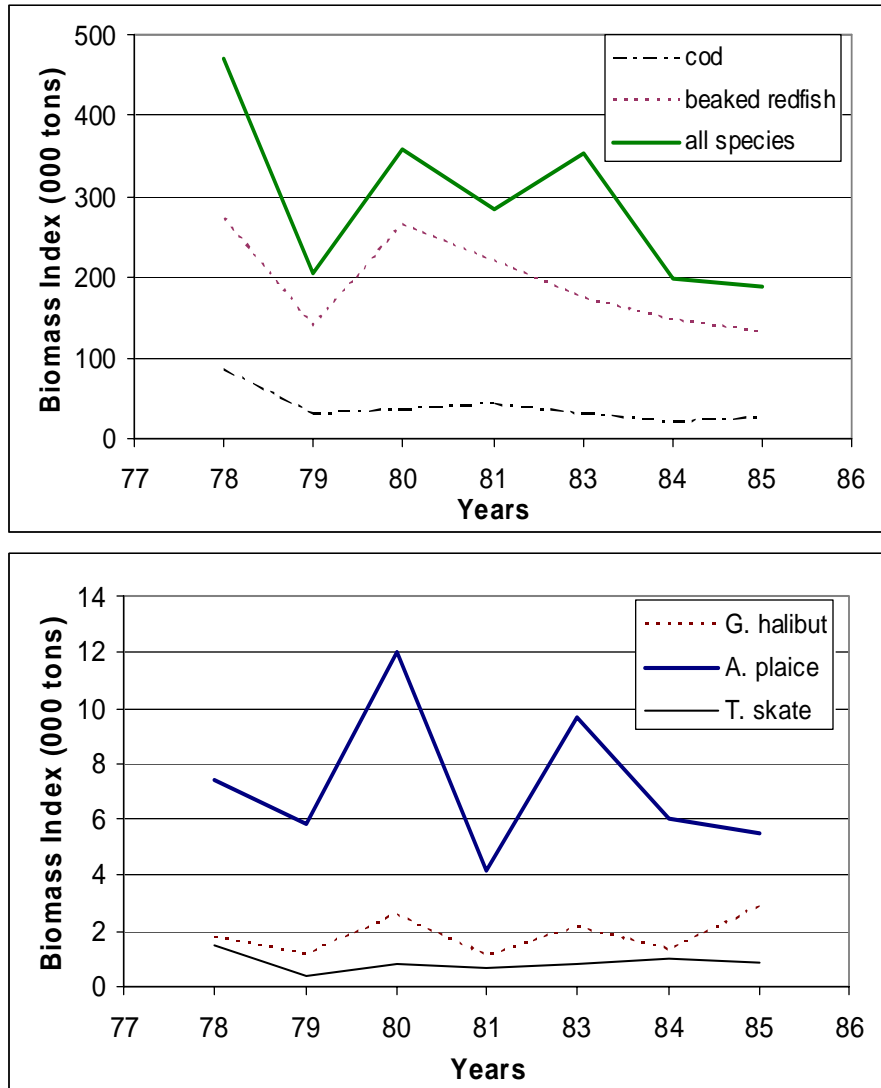


Fig 4a, b. Trends in biomass indices from Flemish Cap surveys done by Canada from 1978-85.

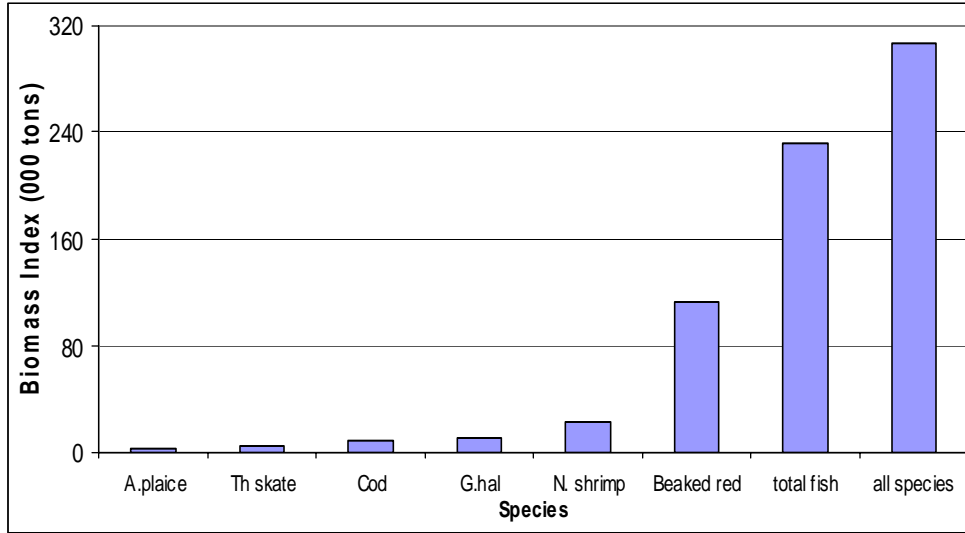


Fig. 5. Swept-area biomass estimates for selected species, from Canadian survey of Flemish Cap in 1996.

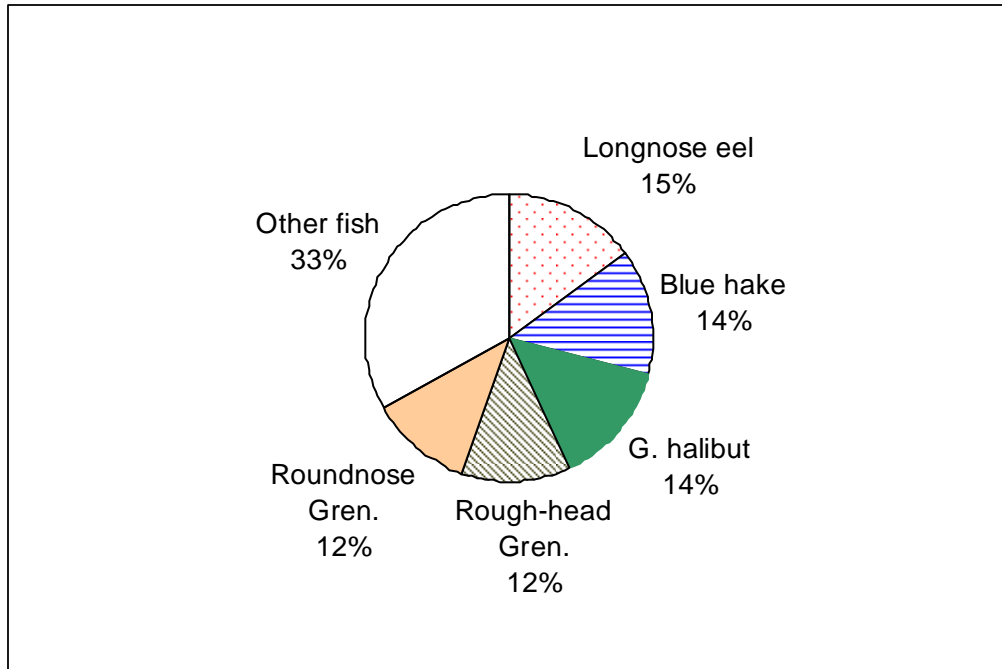


Fig 6a. Average composition of catch weights from surveys of deepwater (>731 m) areas of Div. 3M from 1996-2003.

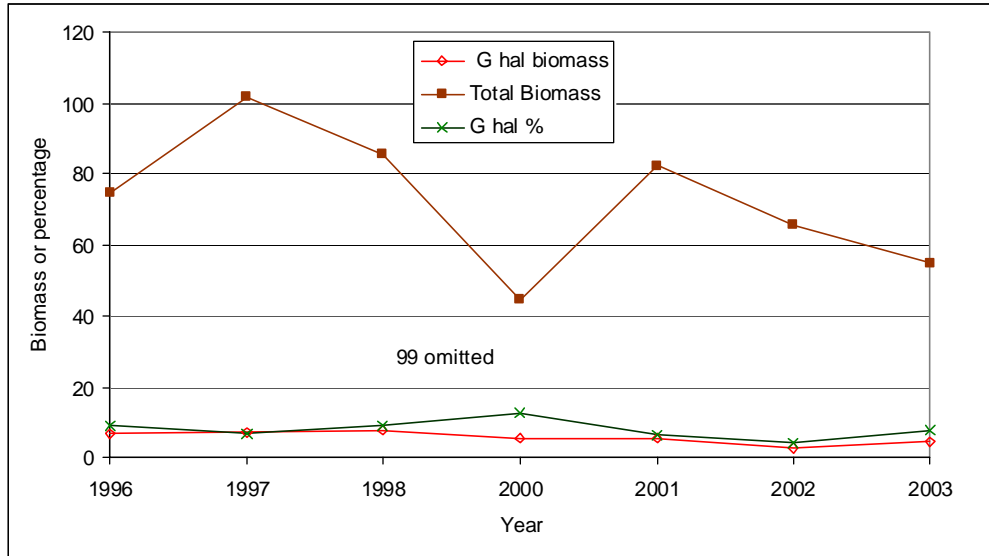


Fig. 6b. Estimates of total biomass and Greenland halibut biomass from surveys of deepwater (>731 m) areas of Div. 3M from 1996-2003.

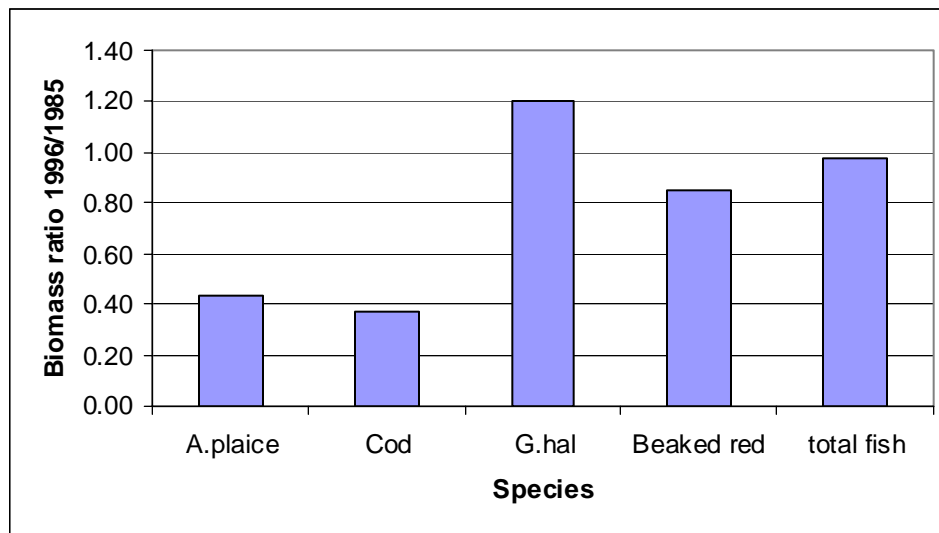


Fig. 7. Ratio of swept-area biomass estimates for selected species from the 1996 Campelen survey and the 1985 Engel survey on Flemish Cap. Data used are from strata less than 731 m only.