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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 92/81

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 92/81

**Subdivision 4Vn Cod (May-December):
Update of Stock Status for 1991**

by

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ABSTRACT

Catches have declined substantially during the past few years. In particular the longline fishery has been particularly hard hit and has not been able to land enough to fill recent allocations. Availability of fish appears to have shifted away from summer months to late autumn, thus accounting for the difficulty of maintaining catches with fixed gear, traditionally mainly deployed during summer months.

Until recently the fishery has had little difficulty in filling the TAC set for 4Vn. However, it appears now that a large proportion of the total catch has comprised migrant Gulf of St. Lawrence (4T) cod. Thus it is probable that while total catch levels for the May to December period were being maintained by 4T cod, resident 4Vn cod were undergoing a serious decline.

Stock mixing in 4Vn has defeated attempts to assess cod population sizes by routine methods such as VPA. Evidence of this mixing can be detected in both research and commercial samples; high variability in a number of biological indices results.

RESUME

Les prises ont diminué considérablement au cours des dernières années. La pêche à la palangre a souffert particulièrement et ses débarquements n'ont pas atteint les allocations récentes. Un changement semble s'être produit dans la disponibilité du poisson, celui-ci apparaissant non plus l'été, mais à la fin de l'automne, ce qui explique la difficulté à maintenir les prises aux engins fixes, ceux-ci étant habituellement surtout utilisés durant l'été.

Jusqu'à récemment, les pêcheurs parvenaient assez facilement à atteindre le TPA fixé pour 4Vn. Toutefois, il apparaît maintenant qu'une forte proportion des prises totales était imputable aux migrations de morue en provenance du golfe du Saint Laurent (4T). Il est donc probable que les prises de mai à décembre se soient maintenues à cause de la morue de 4T, mais que la morue originaire de 4Vn ait subi un important recul.

En raison du mélange des stocks dans 4Vn, il s'est avéré impossible d'évaluer la population au moyen des méthodes habituelles comme l'APV. Ce mélange se manifeste tant dans les échantillons scientifiques que dans ceux de la pêche commerciale. Il en résulte une très forte variabilité d'un certain nombre d'indices biologiques.

INTRODUCTION

The cod fishery in NAFO Subdivision 4Vn has declined drastically over the past five years. Whereas catch quotas were easily attained up until the late 80's, they have not been reached in the last two years. The area fished by fixed gear has diminished in recent years. Longlining has virtually been abandoned in the western half of Sydney Bight and Smokey Bank. Two areas that have continued to support viable fishing levels are Scaterie Bank and an area 20 to 30 km north-east of Glace Bay. However, even the former of these has now become borderline. Handlining occurs during the summer months but is mainly confined to the "Red Grounds" just off Sydney Harbour. Most of the 4Vn catch is taken now along the southern bank of the Laurentian Channel by mobile gear, the so-called "Edge fishery".

Subdivision 4Vn, a transition area between the Gulf of St. Lawrence and the Scotian Shelf, is where substantial mixing of cod stocks occurs. It is here that most of the 4T (Gulf of St. Lawrence) cod overwinter. Thus depending on the time of year, the catch in this region can comprise cod in variable proportions from stocks originating in 4T, 4Vn and to a lesser extent, 4Vs. This mixing defeats any attempt to assess the 4Vn "stock" with standard techniques such as VPA analysis. Further, the majority of the fishery is prosecuted by the longline fleet from which little effort information is available; therefore it is difficult to quantify the overall exploitation rate, let alone that of the constituent stocks present in the mix.

Recent evidence seems to suggest that the failure to identify the proportion of resident fish within the overall catch has reduced this stock to dangerously low levels. Its progressive reduction was hidden during a period when catch rates were sustained while the proportion of 4T fish in the catch increased as that of 4Vn resident fish declined. This report will summarise the cod fishery for 1991 and also attempt to illustrate the decline of the stock over the past few years by looking at changes in fishing patterns and examining trends in biological parameters derived from commercial and research samples.

OVERVIEW

The nominal catch for 1991 was 4602 t, less than one half of the TAC of 10000 t (Fig 1, Table 1). Fixed gear managed to take only one quarter of their 6600 t quota (Fig 2, Tables 2 & 3). Most of the mobile fleet operating in 4Vn was regulated by individual transferable quotas (ITQ's). The fixed gear sector was controlled by trip limits. Due to the inability of the fixed gear fishery to obtain its allocation, quota was transferred to the mobile fishery at the end of the season. At this time, boats fishing mobile gear that had reached their limit were made eligible for an increment of 20 tons each. In addition, 57 tons were transferred to Gulf of St. Lawrence based boats. It was reported that the introduction of ITQ's this year led to increased "highgrading"; that is, discarding of small fish in favour of larger. The allocation schedule and list of management measures implemented during 1991 are detailed in the Appendix.

As in past years, fishermen reported large runs of "small" fish appearing in November. These were presumably early arrivals of migrating 4T fish. Almost one half of the annual catch in 4Vn was taken during the last two months of the year (Table 4).

COMMERCIAL CATCH

Otter trawl catch has remained relatively stable over the past five years; whereas, longliner catch has decreased over the same period, reaching its lowest level in 15 years in 1991. Four and five year old fish dominated the catch (Table 5). Together, these two year classes comprised 59% of the total catch (Table 6). The 1987 year-class appears strong in relation to the abundance of 4 yr-olds in past years.

The temporal fishing pattern of longliners has remained quite stable since 1985 with the bulk of the catch being taken during the May to October period (Fig 3). However, otter trawlers, which took about 90% of their catch during these same months up until 1988, have shown in the past three years a steep decline in the proportion of annual catch taken during this period, and a concurrent increase in catch during the last two months of the year (Fig 4). Since 1985, the percentage of total catch of otter trawlers taken during November and December has risen in the order of four and eight times, respectively. In the past two years, the catch in December alone has exceeded that taken in all other months combined.

This shift in the pattern of landings does not seem to be due to a change in seasonal fishing effort. Figure 5 compares the amount of fishing effort expended and the rate of return realized during the periods May to October and November/December by tonnage-class 2 boats, which form the major part of the mobile gear fleet. In neither case does there appear to be any marked change in the average number of days fished per month by a boat; if anything there is possibly a slight decrease in fishing effort during the November/December period. While the trends in effort are similar between the two periods, it should be noted that the average total number of fishing days reported per month during the summer are about half that of the winter period (eg. in 1991; 16 for May to October and 32 for November/December). This, together with higher catch rates in the winter (approx. double the summer months), accounts for the higher landings in the early winter period. A consideration of the data from all tonnage classes of the entire mobile fleet does not change substantially the patterns illustrated in Fig. 5. However, fishing effort levels should be viewed with caution since less than one half of the mobile fleet reports this information (that reported from longliners is much lower - less than 20%). Nevertheless, trends in these data are probably reasonably representative.

From 1982 to about 1988 there was a slight upward trend in the average age of cod sampled from commercial landings (Fig 6). Also, as the same figure shows, there was a corresponding downward trend in the average length and weight of these fish over the same period. This seems to indicate an increasing proportion of slower growing cod. After 1988, there was a rapid decrease in all three of these indices. Mean age in particular dropped; from about 6.5 years to 5.5 years from 1988 to 1991. This reflects the large increase in the number of three and four year-old fish and decrease in older fish over this period (Fig. 7 & Table 6).

Average weight at age and length at age (Tables 7 & 8) have shown considerable variability over the years. Inspection of these tables reveal numerous instances of apparent negative growth and abnormally high growth between years. This is no doubt a result of annual variability in the proportions of the components comprising the mixed stock. Gulf of St. Lawrence cod grow more slowly than cod on the Scotian Shelf and hence are much smaller at age.

A comparison was made of length frequency at age based on three age length keys derived from samples of otter trawl landings taken in 4Vn in 1990 during the periods, January to April, May to August and September to December. The first of these keys presumably represent for the most part slower growing Gulf cod (4T) overwintering in Sydney Bight. There is no correspondence between length modes at age when comparing 4TVn (Jan-Apr) and the May to August periods (Fig 8). However, except for notably ages 4 and 8, there is a close correspondence of

length modes at age when comparing 4TVn (Jan-Apr) and September to December periods (Fig 9). These data imply substantial numbers of Gulf cod present in 4Vn during the September to December period. The same comparisons made for longliners showed little or no correspondence between any of the age-length keys.

JULY GROUND FISH SURVEY

Four year old fish dominated the catch which averaged 25.2 kg per tow, continuing the sharp downward trend since 1989 (Fig 10, Table 9). The survey area is stratified according to depth; 4Vn has three strata: 440, 100 to 200 fathoms; 441, 50 to 100 fathoms, and 442, <50 fathoms. No cod were taken in the deepest stratum, 440 and 80.1 and 13.4 cod per set were caught in strata 441 and 442, respectively. The most abundant year classes in decreasing order of abundance were 1987, 1986 and 1985 (Fig 11).

Research vessel catch numbers are extremely variable and the three large peaks (1981, 1985 and 1989) were all associated with coefficients of variation exceeding 0.5. This variability appears to be the result of both sampling and biological factors. Up until 1985, nine sets were taken in 4Vn (three per stratum); thereafter about 15 sets have been allocated to the area during the July research cruise. Even with the more recent average of five sets per stratum, one large set can greatly affect the mean value for the stratum, and indeed, the whole subdivision. The three peaks noted above stemmed largely from one set in each year that was substantially larger than all the others. The other sources of variability are probably more biological in origin than statistical. Catch has varied much more in stratum 440 than the others (see text table below). This stratum has often yielded few or no fish on the survey and indeed

RV July Survey (1978-1991) - Mean Number per Tow by Stratum

	<u>440</u>	<u>441</u>	<u>442</u>
Number	7.33	109.64	62.51
Coeff. of Var.	1.57	0.92	0.98

is little fished by the commercial fleet during the summer months. Figure 11 illustrates another cause of variability in the research catch record; there appears to be a complete change in the makeup of the cod population between 1989 and 1990. The 1982 and 1984 year-classes appear dominant and can be followed up to 1989 but then seem to disappear suddenly in 1990. Thereafter, the 1987 year-class alone is dominant and can be tracked to 1991. Whether this event is real or a sampling artifact is uncertain, but it has occurred on at least three occasions in the past 15 years.

Mean length of cod taken in research catches between 1982 and 1991 were, not surprisingly, more variable than the same measure of cod sampled from commercial catches over the same period; however, the trend is the same (Fig 12). Note the drastic change in mean length between 1984 and 1985; this marks another of the apparent population changes described above.

Total mortality estimates were made using the survey mean numbers at age for the past ten years. As Fig 13 shows, these data are highly variable and obviously cannot be used to determine any reliable estimate of fishing mortality. Nevertheless, there does appear to be an increasing trend.

NEW FIELD RESEARCH

A field research programme has been initiated in Sydney Bight to address the problem of stock mixing. The primary goal is to estimate the size of the diminished local stock and determine its distribution within Sydney Bight. Six cruises, each of about 10 days duration, were carried out at roughly monthly intervals between April and November in 1991. These cruises were planned using information on probable spawning areas and bottom topography provided by local fishermen.

Ichthyoplankton sampling (132 stations) and bottom trawling (27 sets) were carried out and hydrographic information (112 CTD casts) was also routinely collected. Sampling revealed spring spawning of cod in Bras d'Or Lake and in the western Bight (Fig 14). Analysis of plankton samples taken during the first cruise in early May indicates quite low levels of spawning. However, water temperatures were exceptionally low at this time and could be responsible for the sparse spawning activity. It is not yet possible to say how well spawning was monitored or to give any indication of the number of spawning cod until analysis of plankton samples is completed. Plankton tows in later cruises were successful in sampling the larval cod population.

Preliminary analysis of cod taken in bottom trawl sets in the Smokey Bank area indicate a high degree of segregation by size. Cod were more plentiful closer to shore (Fig 15) and the near shore to offshore gradient in fish size with depth noted in previous years (Smith & Sinclair 1985) within the larger scale July groundfish survey was evident on a smaller scale in these nearshore surveys (Fig 16). Aggregations of juvenile cod were located and found consistently at one of the stations in the vicinity of Bird Islands (Fig 17).

TAGGING

An analysis was begun of accumulated recaptures of cod tagged in the Gulf of St. Lawrence and on the Scotian Shelf between roughly 1950 and 1980. Apart from a brief review of those findings which have a direct bearing on the 4Vn fishery, the bulk of the results will be reported elsewhere (Stobo and Lambert, in preparation). It must be stressed that percentage returns presented in this section should not be considered reliable since numbers have not been weighted in any way to account for the greater likelihood of tags being returned from areas experiencing greater fishing effort.

Tags returns showed evidence of at least two stocks of cod in the southern Gulf of St. Lawrence; one occurred mostly in the western Gulf in the Bay de Chaleur - Gaspé region and the other frequented the southern and southeastern Gulf. These correspond to stocks identified by McKenzie and Smith (1955) and supported by Templeman (1962). These authors provided evidence in the form of vertebral counts and tag returns for four possible stocks of cod; 1) Gaspé, 2) Chaleur Bay, 3) Prince Edward Island and 4) Western Cape Breton. Confirmation for at least two of these stocks appears to be provided by the identification of two major cod spawning areas by ichthyoplankton studies carried out by the Fisheries Research Board during the 1960's (see Figure 4 in Lett 1980). These accumulations of cod eggs occurred between New Brunswick and the western end of Prince Edward Island (The Shediac Valley), and off the west coast of Cape Breton Island, Nova Scotia. The present analysis showed that cod tagged in the western Gulf of St. Lawrence during summer and early autumn began to move into 4Vn in November. By December about 40% of tag returns for that month came from 4Vn, about another 40% were collected from the region where the cod were originally tagged, and most of the remainder came from the area in between the two (Fig 18). From January to April the majority of tags collected

from cod tagged in the Gulf were taken in 4Vn. The return migration of Gulf cod began in April and the majority had left by May. In June, about 4% of tags returned in that month came from 4Vn; thereafter, virtually no Gulf tagged cod were taken outside the Gulf.

Cod tagged off the west coast of Cape Breton in the autumn migrated in a manner similar to the cod of the western Gulf. The main difference between these two groups of Gulf cod was in their summer distribution. Whereas "western" cod appeared to spend all of the summer and most of the autumn in the western Gulf of St. Lawrence (in fact about 75% of all tag returns accumulated over about 30 years came from this region; see Fig 19a), the "southeastern" cod returns came mainly from the southern and southeastern Gulf during summer and autumn. In addition during this same period, in contrast to western Gulf tagged cod, between 5 and 10% of the "southeastern" tags were returned each month from 4Vn. Overall the majority of fish tagged off western Cape Breton were returned from 4Vn (19b).

About 70% of cod tagged in the Sydney Bight area of 4Vn during the early autumn were recovered in this same subdivision, with the next highest returns (about 10%) coming from 4Vs (Fig. 20a). The bulk of these 4Vs returns were during the period from February to May. There was also a trend for cod tagged closer to shore within the Bight to roam less than cod tagged further from shore; however it was not possible to determine with any accuracy how many cod tagged inshore were returned from offshore locations still within 4Vn. Cod tagged in 4Vn during the winter, as expected, showed a pattern of returns with characteristics of both 4Vn and 4T (20b).

Cod tagged in 4Vs were returned from 4Vn in all months of the year. However, these cod represented only about 5% of all returns of 4Vs tagged fish. 4Vs returns in 4Vn seemed to occur most often during winter months.

DISCUSSION

In the past year, a number of interviews were held with fishermen in Cape Breton representing different gear sectors in areas bordering on 4Vn. All agreed that cod are very scarce in Sydney Bight proper. The bulk of the cod are now caught on the southern slope of the Laurentian Channel, the centre of which forms the north east boundary of the Subdivision. A large portion of the fleet follows the migrating cod stocks from the Gulf of St. Lawrence south-east along the "edge" toward Banquereau Bank and then back north-west with the retreat of the ice in the spring.

These opinions are consistent with the information provided here. Longliner catch, particularly that of the smaller (<45') boats, is down drastically. Most of the effort of these boats is directed inshore during summer months, largely out of the path of migrating 4T cod. The July research catch has dropped sharply in the past two years and there appears to be an upward trend in the total mortality estimate. Although not particularly reliable because of inadequate fleet representation, the CPUE index for mobile gear operating from May to October has fallen in recent years. Otter trawlers, which concentrate their effort in the offshore along the Laurentian Channel edge are catching an increasing proportion of their catch in November and December, and there is evidence of an increasing proportion of slower growing fish in the catch. These facts lead to the conclusion that catch rates in 4Vn have probably been maintained during the past two or three years by cod originating from the Gulf of St. Lawrence and that the local cod stock has been reduced to a low level.

Evidence for mixing of cod stocks in 4Vn can be found at all times of the year. The most obvious is the arrival of migrating Gulf cod in 4Vn in November. However, irregularities in data collected during the summer tend to imply mixing; specifically, abnormal fluctuations in apparent growth rate as deduced from length at age data, discontinuities in the series of annual age frequency plots and high variability in overall mortality estimates calculated from research vessel data. Although results of tagging studies show that cod from 4Vs and the southeastern Gulf have been recaptured in 4Vn during summer months, the latter stock is more easily implicated in the anomalies mentioned. Cod on the Scotian Shelf grow faster and are larger at age than 4T cod and presumably, the growth of resident 4Vn cod would be more similar to that of the former than the latter.

ACKNOWLEDGEMENTS

The competent assistance of Scott Wilson in the collection and analysis of research data is gratefully acknowledged. I also wish to thank Jim Fennell for his exemplary cooperation and able field support, and also for keeping me up to date with the operations of the cod fishery in 4Vn.

I am grateful to Ralph Halliday for reviewing the draft of this manuscript.

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Table 1. Nominal cod catch (t) by country in Subdivision 4Vn (May - December).

Year	Canada	France	Spain	Portugal	Others	Total	TAC
1970	8701	34	1141		12	9888	
1971	8469	1	2161			10631	
1972	6729	745	1171	459		9104	
1973	5245		241	189	73	5748	
1974	4836		852	84	212	5984	10000
1975	3363		89	360	186	3998	10000
1976	5746	211				5957	10000
1977	7786	135				7921	3500
1978	5496	53				5549	3500
1979	6301	73				6374	3400
1980	9976	214				10190	5000
1981	12476	172				12648	*
1982	12101	232				12333	**
1983	9192	170				9362	14000
1984	10443				1	10444	14000
1985	12491				3	12494	12000
1986	11766	4			1	11771	12000
1987	10541	10			1	10552	9000
1988	9001					9001	7500
p 1989	7569					7569	7500
p 1990	5205					5205	7500
p 1991	4602					4602	10000

- * Initially set at 7500 t, increased in September to 10000 t.
 ** Initially set at 10500 t, increased in November to 14000 t.
 p Preliminary statistics.

TABLE 2. Nominal catch (t) of cod in Subdivision 4Vn (May-December) by gear type for all countries, 1970-1991.

YEAR	OTTER TRAWL	SEINE	LONGLINE	HANDLINE	MISC.	TOTAL
1970	4859	83	3229	495	1222	9888
1971	5308	109	3728	696	790	10631
1972	4418	121	3185	286	1094	9104
1973	2099	143	1982	404	1120	5748
1974	2842	138	1469	568	967	5984
1975	1851	100	875	360	812	3998
1976	4375	83	620	310	569	5957
1977	4613	554	1805	595	354	7921
1978	1600	326	3035	466	122	5549
1979	624	278	4483	640	349	6374
1980	1150	561	6440	1820	219	10190
1981	1488	557	9801	741	61	12648
1982	2785	724	7287	1360	177	12333
1983	2448	863	5101	924	26	9362
1984	3344	1112	4831	1112	45	10444
1985	5081	1162	4823	1408	20	12494
1986	3552	1258	5764	1182	15	11771
1987	2034	1285	6369	848	16	10552
1988	1377	1109	5858	626	31	9001
1989	p 2202	865	3603	709	190	7569
1990	p 2098	592	1887	594	32	5205
1991	p 2213	694	1249	389	49	4602

p Provisional statistics.

TABLE 3. Nominal catch (1991) by Canadian vessels in 4Vn (May - December) by tonnage class and gear.

TONNAGE	OTTER TRAWL	SEINE	LONGLINE	HANDLINE	OTHER	TOTAL
0-24.9	58	205	337	121	15	736
25-49.9	780	292	347	1		1420
50-149.9	732	174	37		3	946
150-499.9	268	7	69		25	369
500-999.9	362					362
1000+	14					14
Unknown		16	459	267	14	756
TOTAL	2213	694	1249	389	57	4602

TABLE 4. Nominal Canadian catch (1991) of 4Vn cod by month.

GEAR	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
Longline	113	99	107	175	214	247	273	21	1249
Handline	1	32	152	76	65	53	9	1	389
Otter trawl	434	73	22	80	138	157	327	983	2214
Seine	170	91	25	66	73	65	175	29	694
Other	27	9	11	9					56
TOTAL	745	304	317	406	489	523	784	1034	4602

TABLE 5. 4Vn Cod, (May - December). Numbers (thousands) landed at age by major gears in 1991.

AGE	MAY & JUNE		JULY - OCT		NOV & DEC		TOTAL	
	MOBILE	FIXED	MOBILE	FIXED	MOBILE	FIXED	MOBILE	FIXED
1								
2				1				1
3			4	41	26	6	30	47
4	11	3	121	353	521	31	653	387
5	183	12	255	214	320	62	758	288
6	108	12	47	97	233	33	388	142
7	55	16	19	42	123	65	197	123
8	53	6	31	28	99	8	183	42
9	21	18	20	31	72	9	113	58
10	2	4	4	18	27	2	33	24
11	5	3	2	15	11	7	18	25
12	3	1	1	4	7	<1	11	5
13	1	4	<1	4	<1	<1	2	8
14				<1	<1	<1	<1	1
15		1			<1	<1	<1	1
	442	80	504	848	1440	224	2386	1153

TABLE 6. Numbers (thousands) landed at age for 1983-1991.

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	9	1
3	25	14	18	4	21	35	61	347	77
4	222	394	152	222	125	364	485	822	1040
5	876	1146	1473	1086	853	567	1219	765	1046
6	945	1591	1510	2226	1124	1011	1010	667	530
7	538	927	1648	1126	1492	994	949	315	320
8	821	452	933	695	705	930	604	358	225
9	288	372	395	361	384	375	473	159	171
10	219	223	316	191	252	150	156	145	57
11	65	91	105	89	112	89	49	35	43
12	46	30	37	56	65	53	14	15	16
13	21	11	19	21	34	18	5	6	10
14	7	5	5	8	20	6	7	1	1
15	7	6	6	5	7	6	3	0	1

Table 7. 4Vn cod (May - December): Average weight (kg) at age for total landings.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0.56	0.32
3	0.60	0.60	0.51	0.53	0.53	0.51	0.53	0.61	0.61	0.59
4	0.93	0.94	0.79	0.81	0.86	0.75	0.82	0.85	0.87	0.74
5	1.34	1.25	1.14	1.17	1.14	1.10	1.10	1.05	1.11	1.06
6	1.80	1.63	1.45	1.45	1.45	1.23	1.46	1.25	1.41	1.33
7	2.10	2.21	2.00	1.94	1.98	1.59	1.69	1.64	1.65	1.72
8	3.00	2.47	2.38	2.26	2.42	2.21	2.07	1.83	2.42	1.75
9	3.99	3.67	2.77	2.94	2.95	2.97	2.91	2.05	2.27	2.40
10	5.56	4.41	3.15	3.19	3.83	3.56	4.81	2.75	2.40	2.84
11	6.37	6.04	4.22	4.16	5.00	5.46	6.04	4.03	3.25	3.30
12	7.48	8.26	7.10	7.03	5.86	6.72	6.88	7.69	6.76	4.35
13	8.91	9.95	8.21	8.14	6.70	7.51	8.93	9.28	9.10	6.03
14	9.05	11.44	10.75	10.27	9.44	7.19	11.68	10.49	3.53	9.53
15	9.58	11.71	12.84	15.55	11.00	10.82	11.56	11.69	14.53	16.47

Table 8. 4Vn cod (may - December): Average length (cm) at age for total landings.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	40.00	0
3	40.53	40.39	39.11	38.83	38.87	39.17	38.22	41.16	40.75	40.96
4	47.32	47.05	45.02	44.90	45.89	44.38	44.34	46.02	46.00	44.14
5	53.70	51.98	50.90	50.67	50.53	50.47	48.94	49.33	49.69	49.23
6	59.49	56.81	54.67	54.94	54.95	52.39	53.96	52.30	53.63	52.55
7	62.75	63.02	60.24	61.00	61.16	57.12	56.76	57.25	56.24	56.84
8	71.07	65.50	63.35	64.63	65.54	63.77	60.79	59.40	63.43	56.96
9	78.46	74.93	69.17	67.97	70.22	70.37	68.20	61.69	61.75	61.53
10	88.14	79.75	71.10	70.88	76.80	74.77	80.93	67.92	59.33	63.94
11	92.38	88.80	77.69	78.07	84.21	86.23	87.48	77.10	66.86	68.57
12	97.70	98.79	92.65	92.65	88.96	92.43	91.44	95.54	88.18	71.55
13	103.84	105.25	97.29	97.19	93.17	95.91	99.94	101.67	98.42	81.16
14	104.41	110.38	105.17	106.22	104.94	94.52	109.50	105.88	69.43	94.54
15	106.52	111.24	120.81	112.63	110.62	108.35	109.10	109.78	114.26	117.06

TABLE 9. 4Vn cod (May-Dec) Research vessel abundance indices (mean number per tow) by age group.

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13+	NK	NO. TOW	KG. TOW
1970	0	6.35	1.77	4.78	10.9	10.46	4.50	2.59	0.84	0	0.29	0.14	0.13	0.21	42.96	57.47
1971	0	1.17	42.40	10.09	26.51	16.16	10.65	3.59	1.97	0.54	0	0	0.56	0.40	114.05	128.20
1972	0	0.52	0.28	2.35	0.30	1.61	1.47	0.39	0.27	0.25	0.19	0	0.37	0.37	8.39	22.12
1973	0	0	2.62	4.48	18.59	0.73	3.06	2.91	0.46	0.22	0	0	0	0.22	35.28	52.58
1974	0	0	0.61	1.36	2.79	3.21	0.40	0.50	0.26	0.22	0.11	0	0	0	9.47	14.44
1975	0	0.61	6.42	8.58	4.65	0.81	1.00	0.58	0.21	0.33	0	0.11	0	0.16	23.47	22.12
1976	0	6.49	2.25	1.48	1.93	1.55	0.73	1.79	1.65	1.41	0.24	0.23	0.47	0	20.21	43.41
1977	0	0.25	6.26	4.01	2.74	1.90	0.72	0.21	0.24	0.14	0.21	0.24	0.15	0.09	17.16	24.58
1978	0	0.66	9.13	19.31	5.54	4.38	1.53	1.17	0.44	0.43	0	0	0.11	0.12	42.84	67.55
1979	0	1.30	0.79	5.15	2.51	0.59	1.72	0.56	0.29	0.15	0	0.17	0.45	0	13.66	27.58
1980	0	1.88	10.52	3.97	23.58	16.40	5.15	1.16	0.45	0.37	0.37	0	0	0	63.84	85.55
1981	0.33	4.36	16.91	36.48	12.02	25.45	11.5	1.26	0.93	0.86	0.24	0.16	0.31	0.17	110.98	161.81
1982	0	2.53	1.74	5.77	10.22	7.61	9.25	3.41	1.32	0.45	0.10	0.23	0	0.10	42.73	74.82
1983	0	4.37	22.11	7.9	10.64	10.04	1.70	3.41	1.52	0.66	0.25	0	0.43	0.27	63.30	78.60
1984	2.83	7.25	10.02	10.48	13.51	8.75	3.58	1.81	1.58	0.85	0.32	0.41	0.46	0.28	62.14	102.30
1985	0	0.48	3.75	19.1	125.95	52.13	22.38	7.26	1.44	0.77	0.67	0	0.37	3.63	237.94	295.97
1986	0	1.33	6.36	11.13	8.11	17.55	6.38	4.92	2.17	1.02	0.55	0.10	0.22	0.09	59.93	83.83
1987	0	0.21	3.70	4.14	5.13	8.89	6.63	2.80	1.18	0.62	0.97	0.31	0	0.08	34.66	49.21
1988	0.61	0.55	2.49	17.05	13.18	31.89	26.45	18.93	6.24	1.70	0.50	0.24	0.32	0.23	120.39	171.24
1989	0	4.60	4.39	11.6	29.76	17.64	32.08	25.53	8.25	1.30	0.33	0	0	0	135.47	177.77
1990	0	0.24	15.07	9.03	3.29	3.87	2.05	2.29	0.73	0.81	0.13	0.09	0.05	0.05	37.68	35.11
1991	.27	1.00	.50	11.10	5.34	3.21	.74	.70	.14	.30	.30	0	.06	0	23.66	25.23

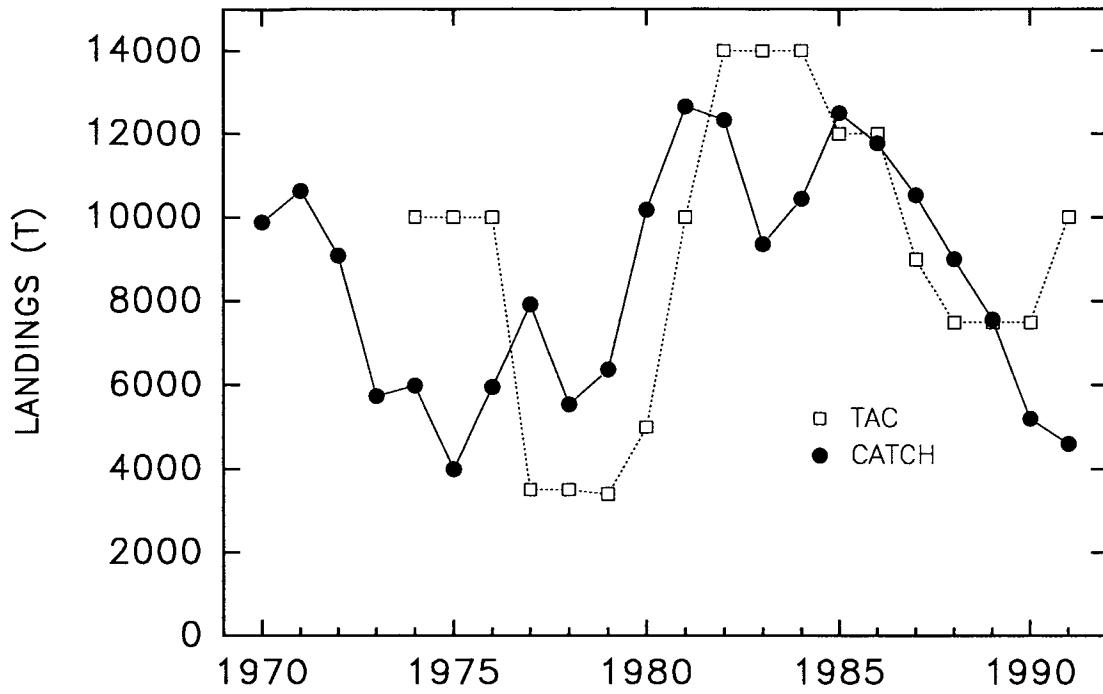


Figure 1. Annual landings and corresponding TAC for 4Vn cod.

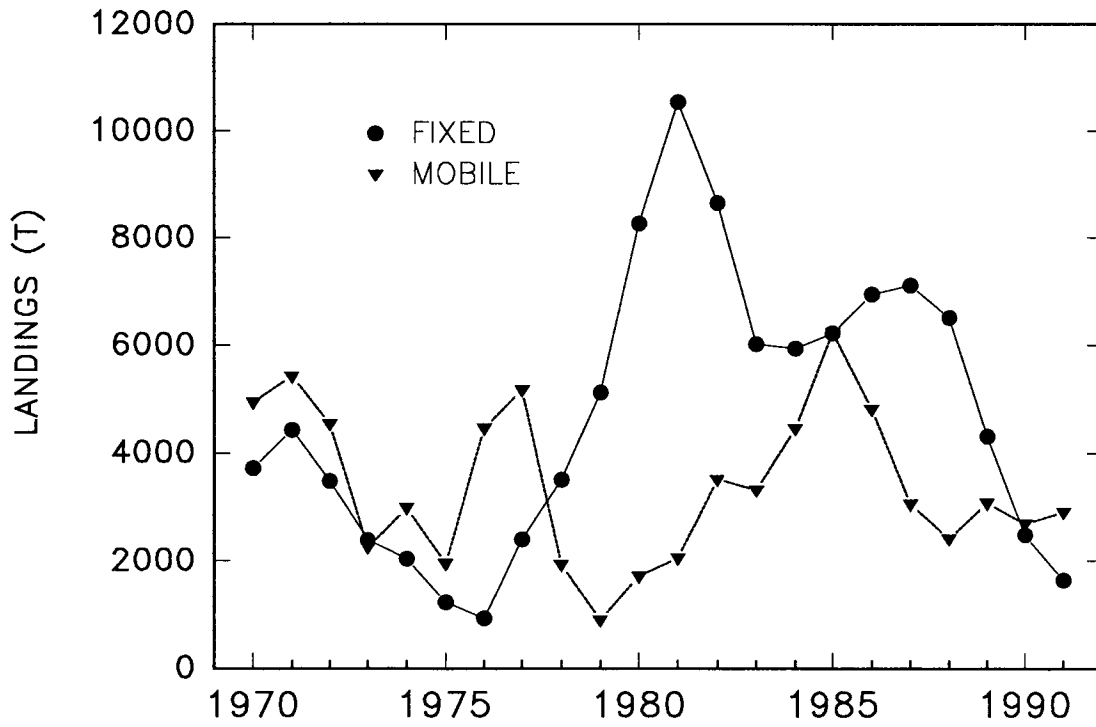


Figure 2. Annual landings by major gear type for 4Vn cod.

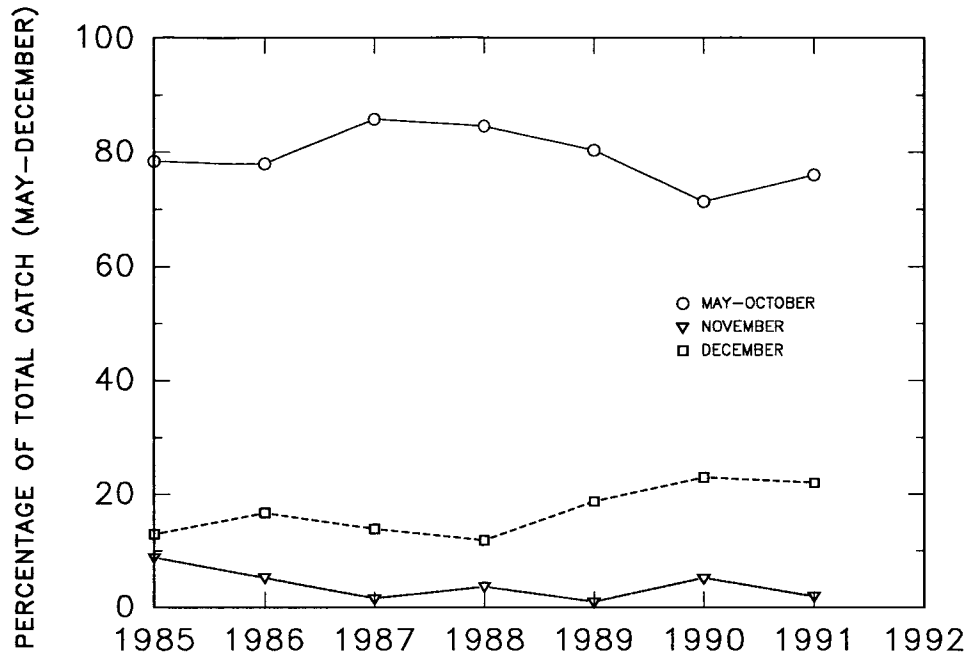


Figure 3. Proportion of annual landings of longliners by specific period for 4Vn cod.

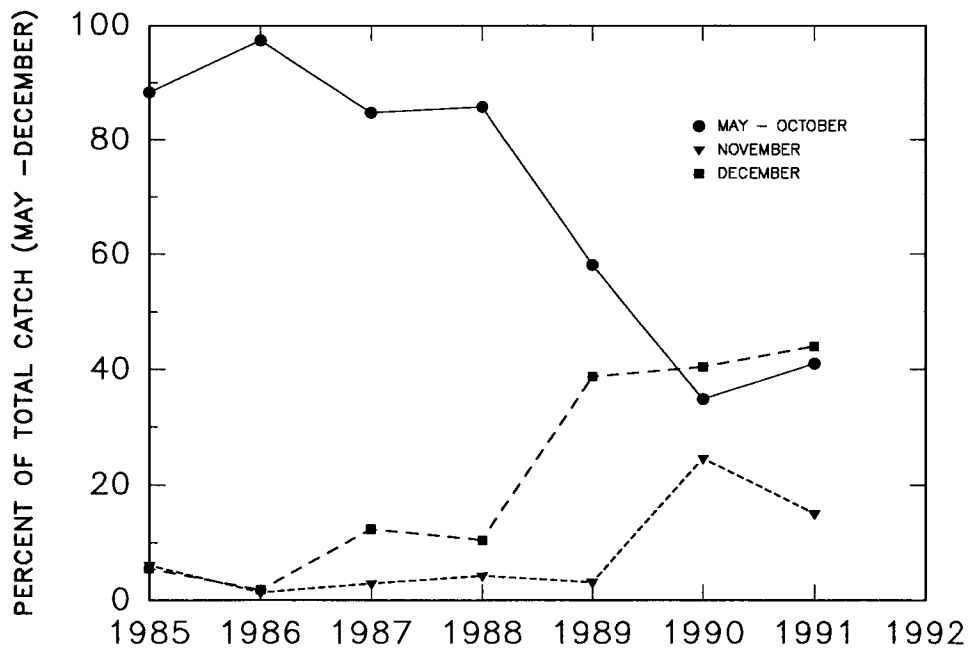


Figure 4. Proportion of annual landings of otter trawlers by specific period for 4Vn cod.

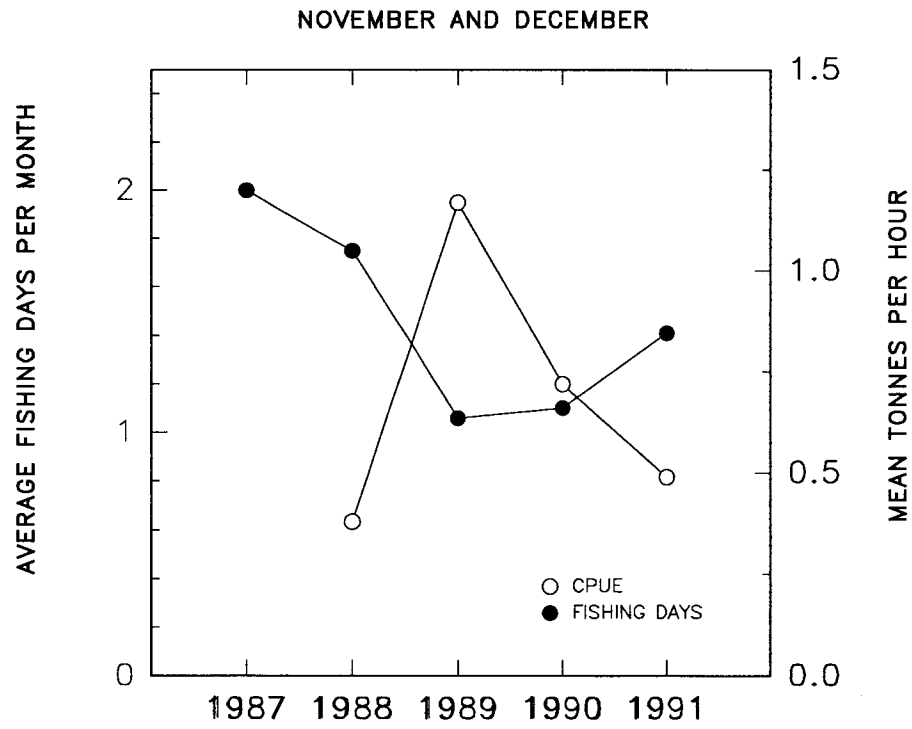
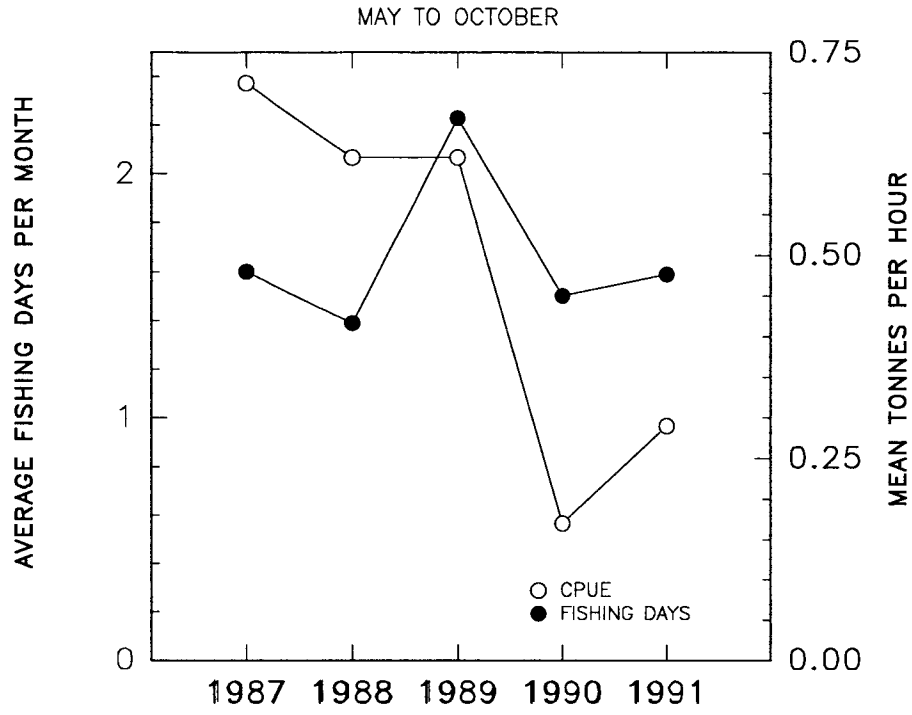


Figure 5. Catch per unit effort for otter trawlers (tonnage class 2) by season for 4Vn cod.

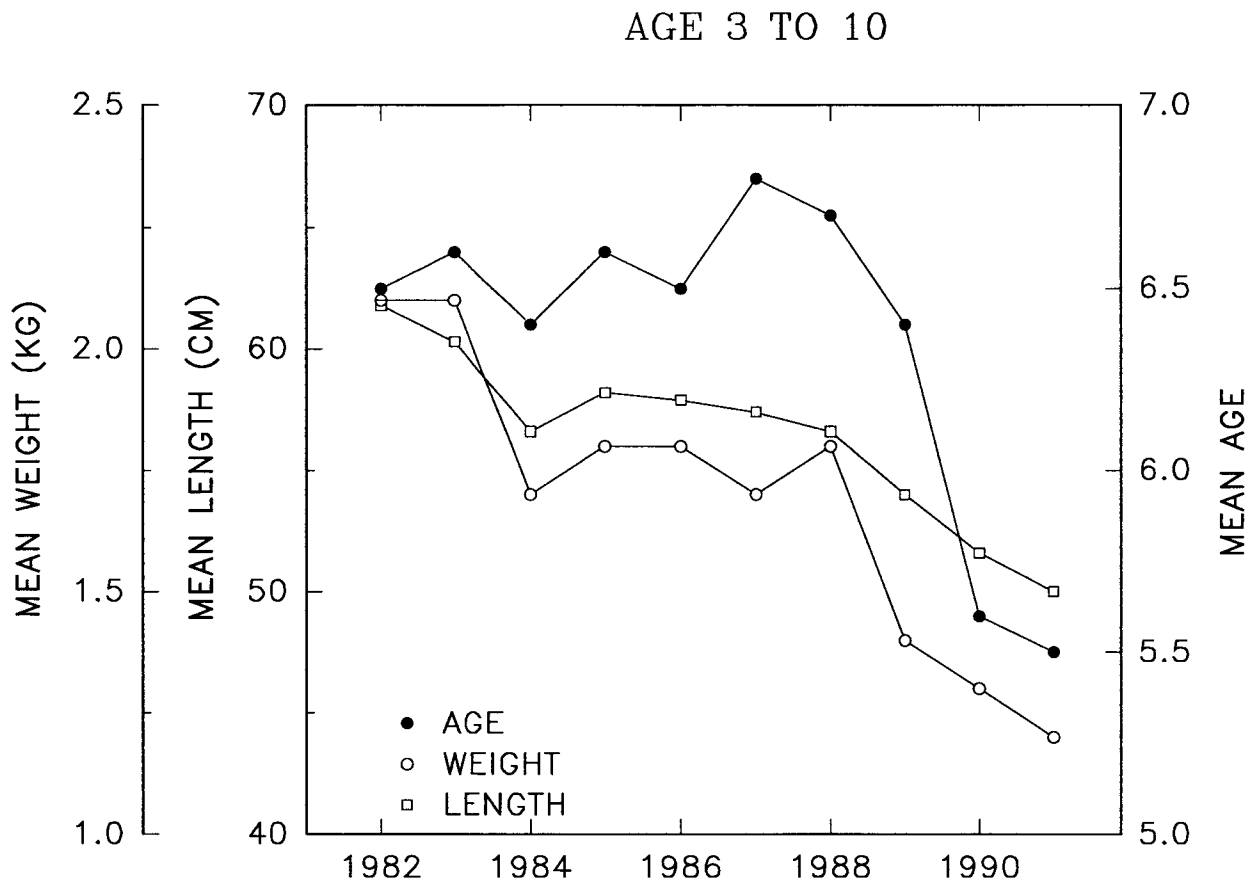


Figure 6. Annual mean values of weight, length and age for cod in commercial catch from 4Vn.

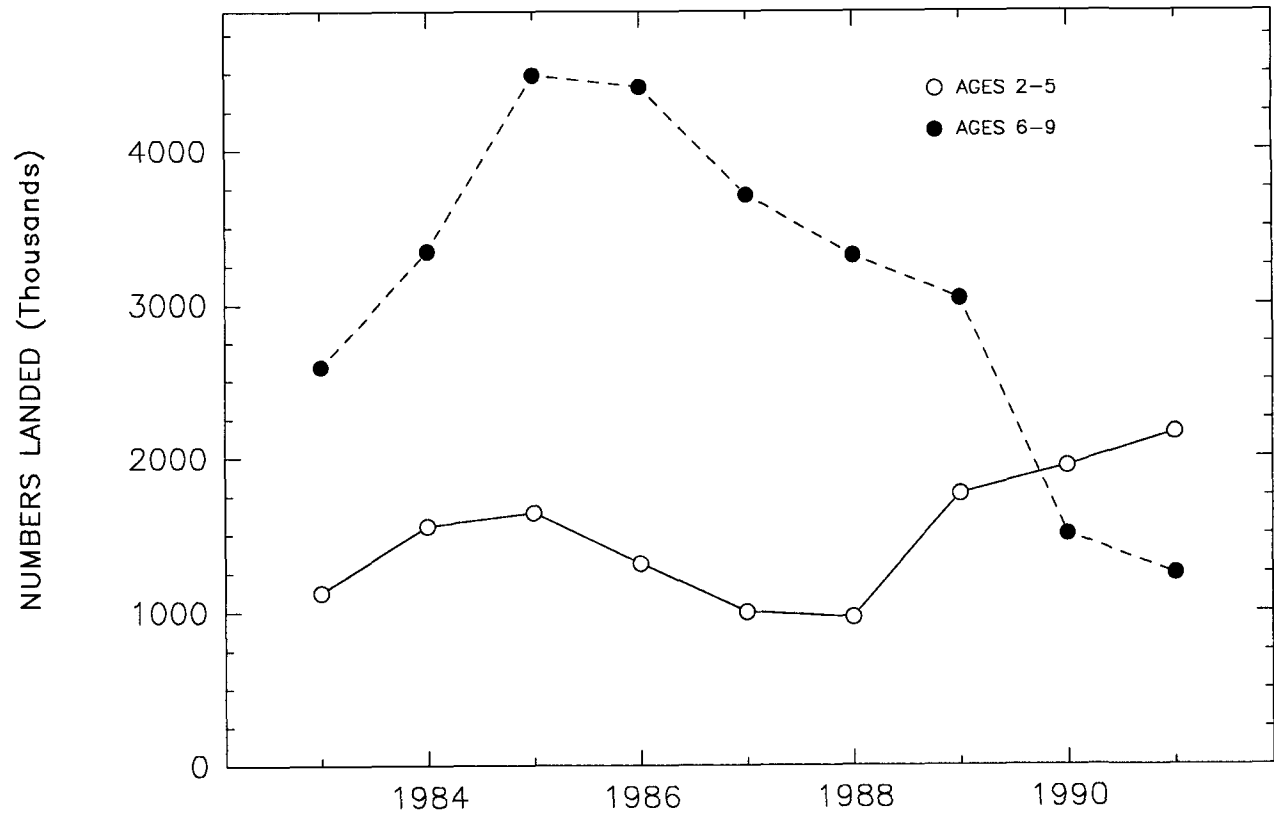


FIGURE 7. Change in abundance of young and old age groups in commercial catch of 4Vn cod.

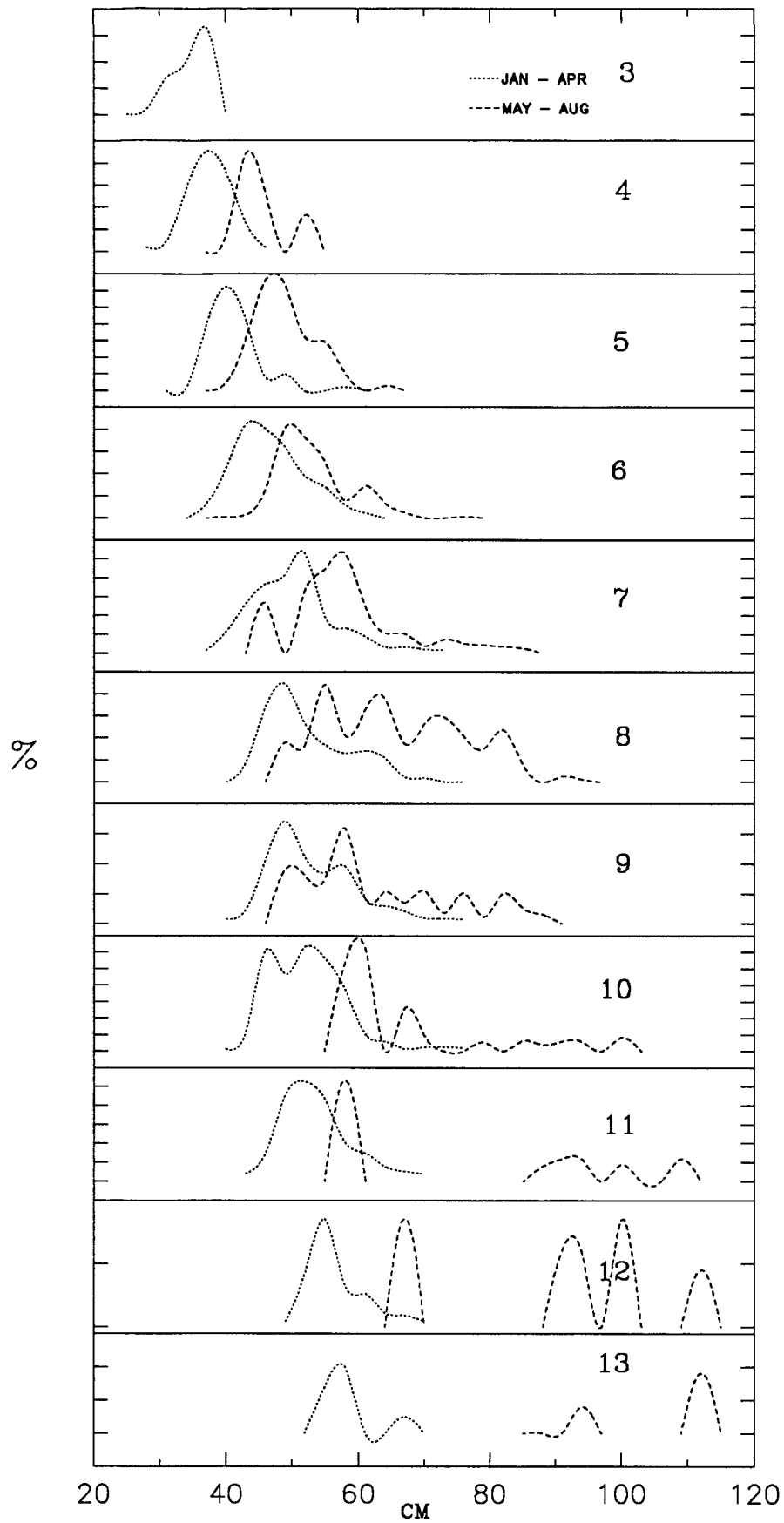


Figure 8. Comparison of length frequency at age of cod landed by otter trawlers in 4Vn between two periods, January to April and May to August, 1990.

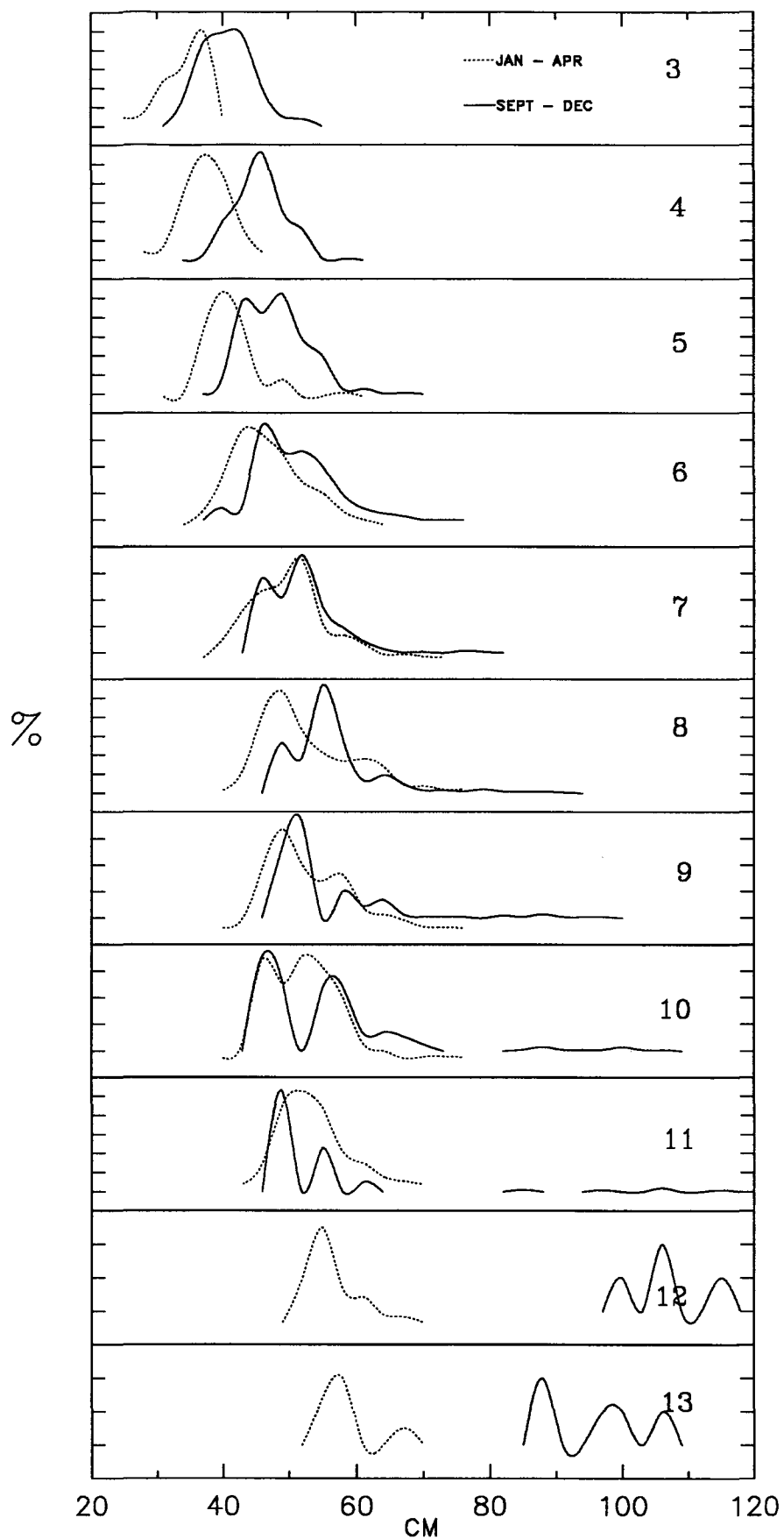


Figure 9. Comparison of length frequency at age of cod landed by otter trawlers in 4Vn between two periods, January to April and September to December, 1990.

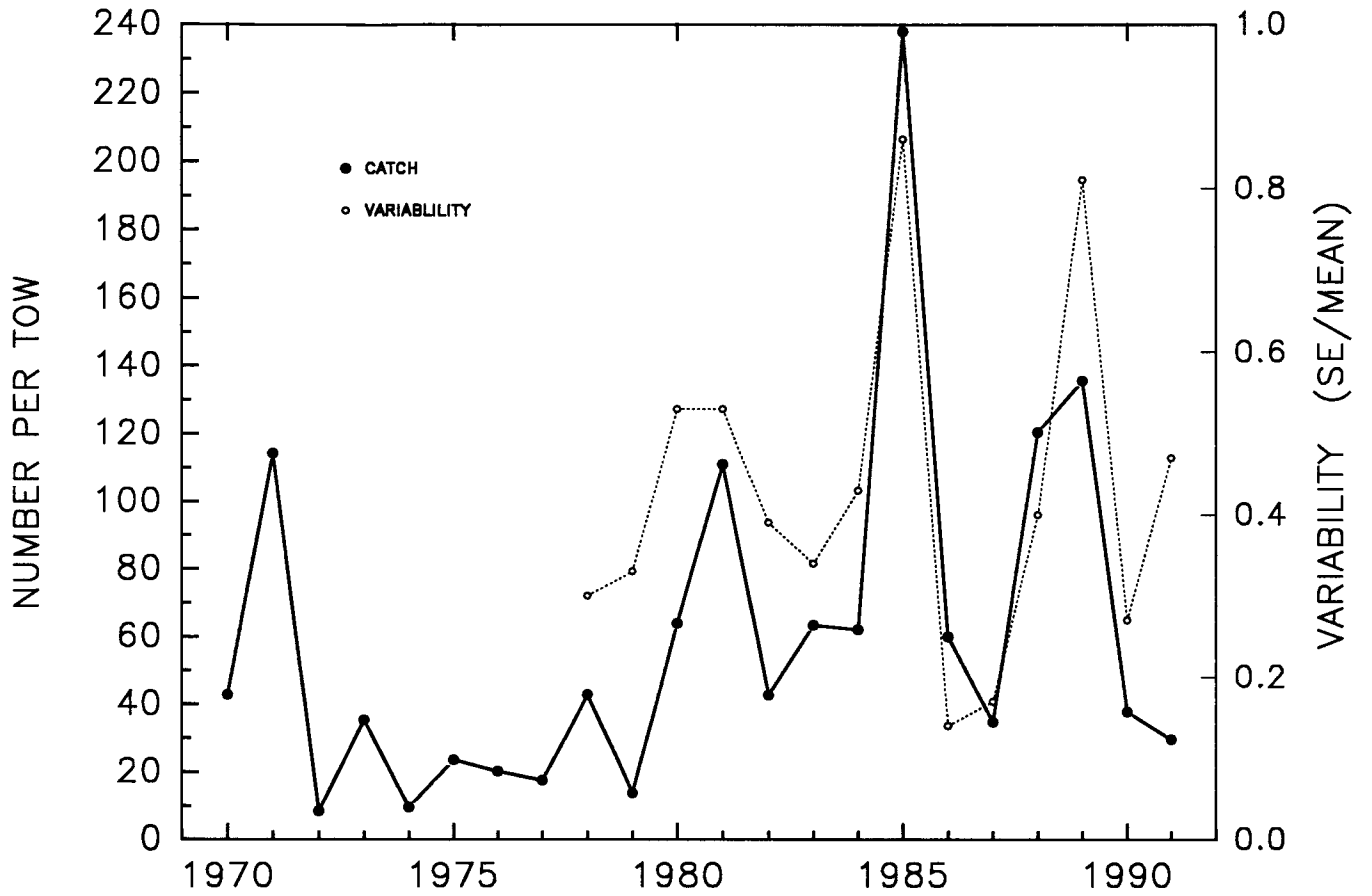


Figure 10. Annual average number per tow of cod from research groundfish survey in 4Vn.

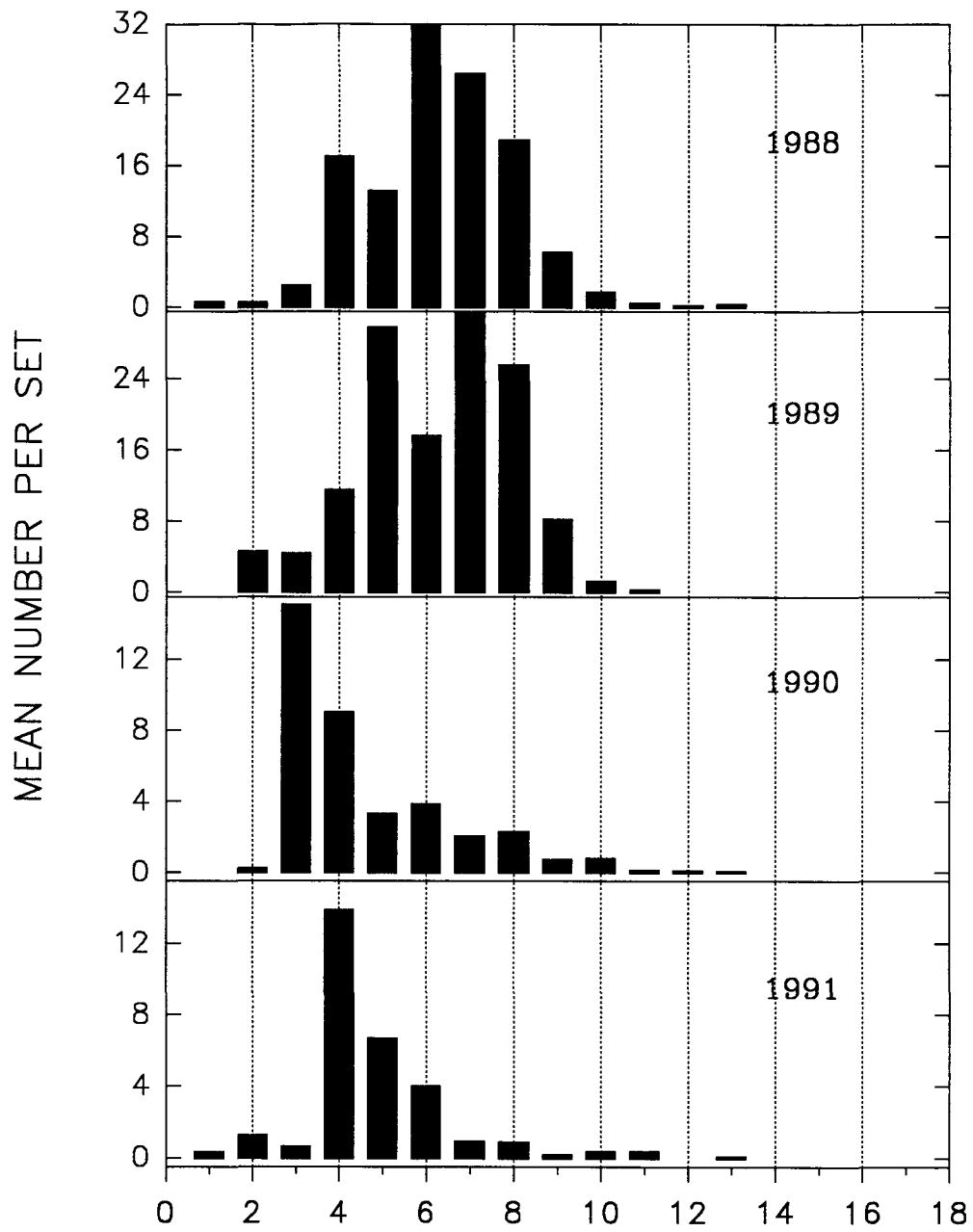


Figure 11. Age frequency of cod from research cruises in 4Vn.

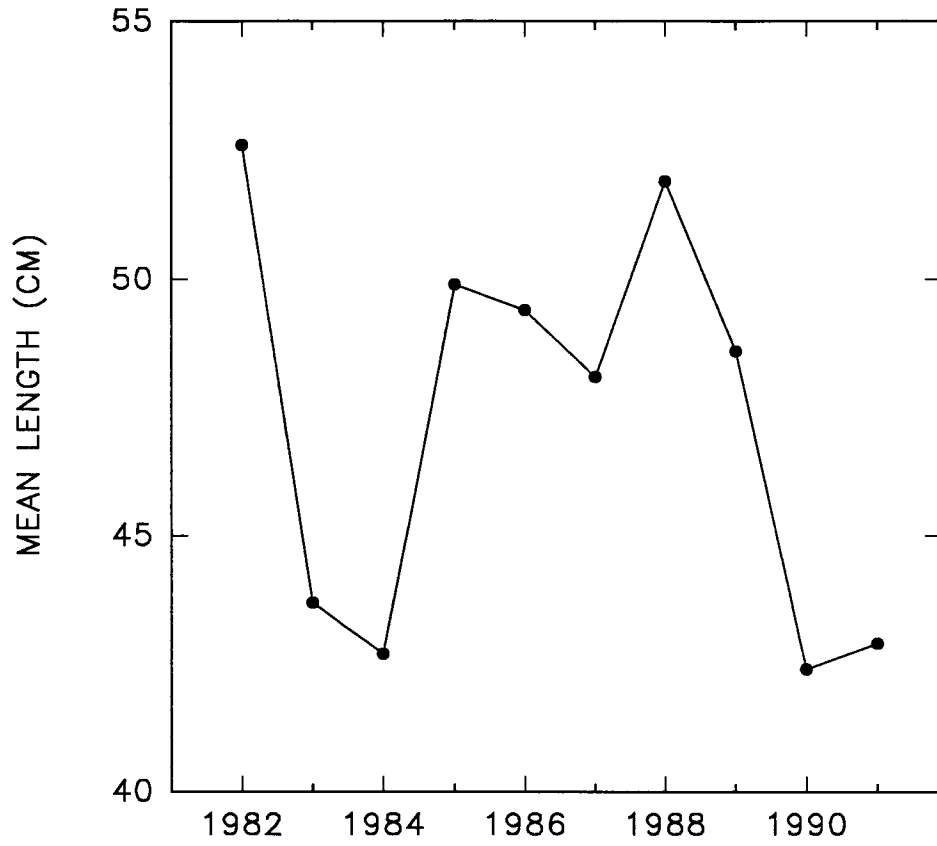


Figure 12. Mean length (ages 3 – 10) of cod from annual groundfish research survey in 4Vn.

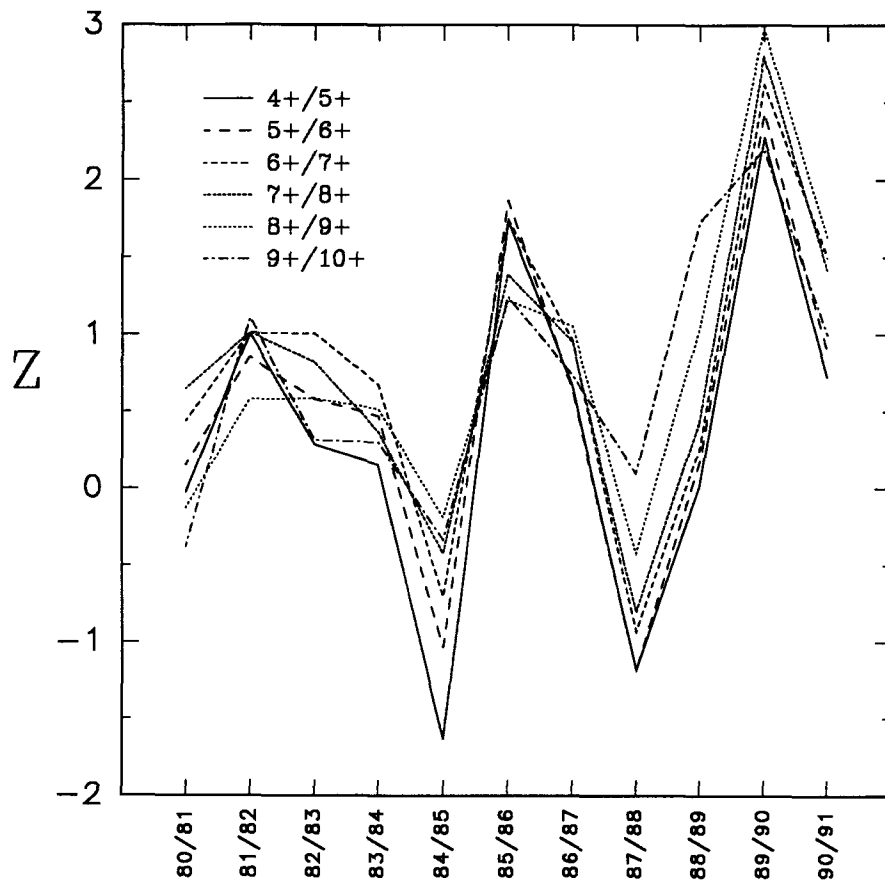


Figure 13. Total mortality estimates (calculated from numbers-at-age) of cod from research survey cruises in 4Vn, 1980-1991.

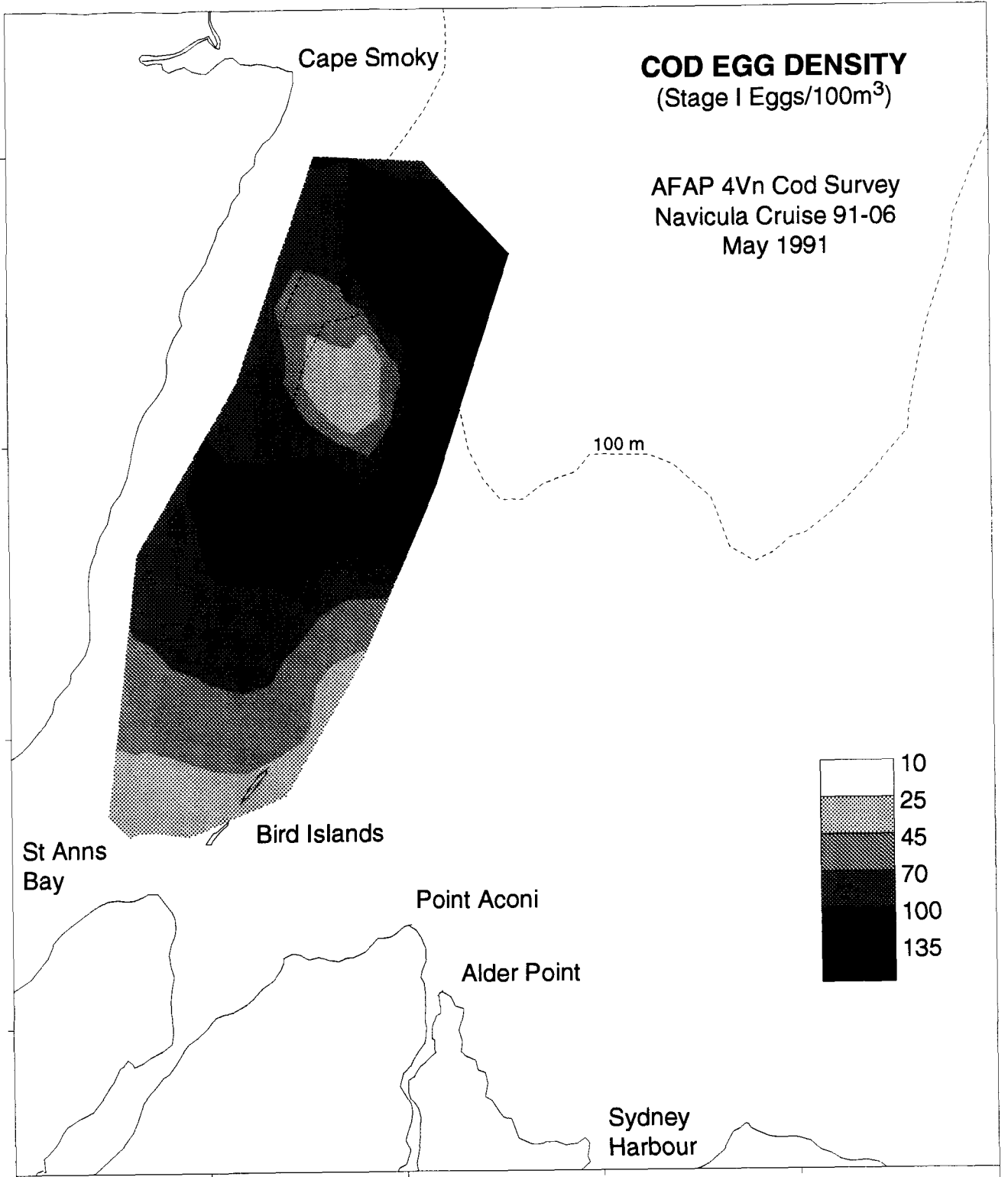


Figure 14

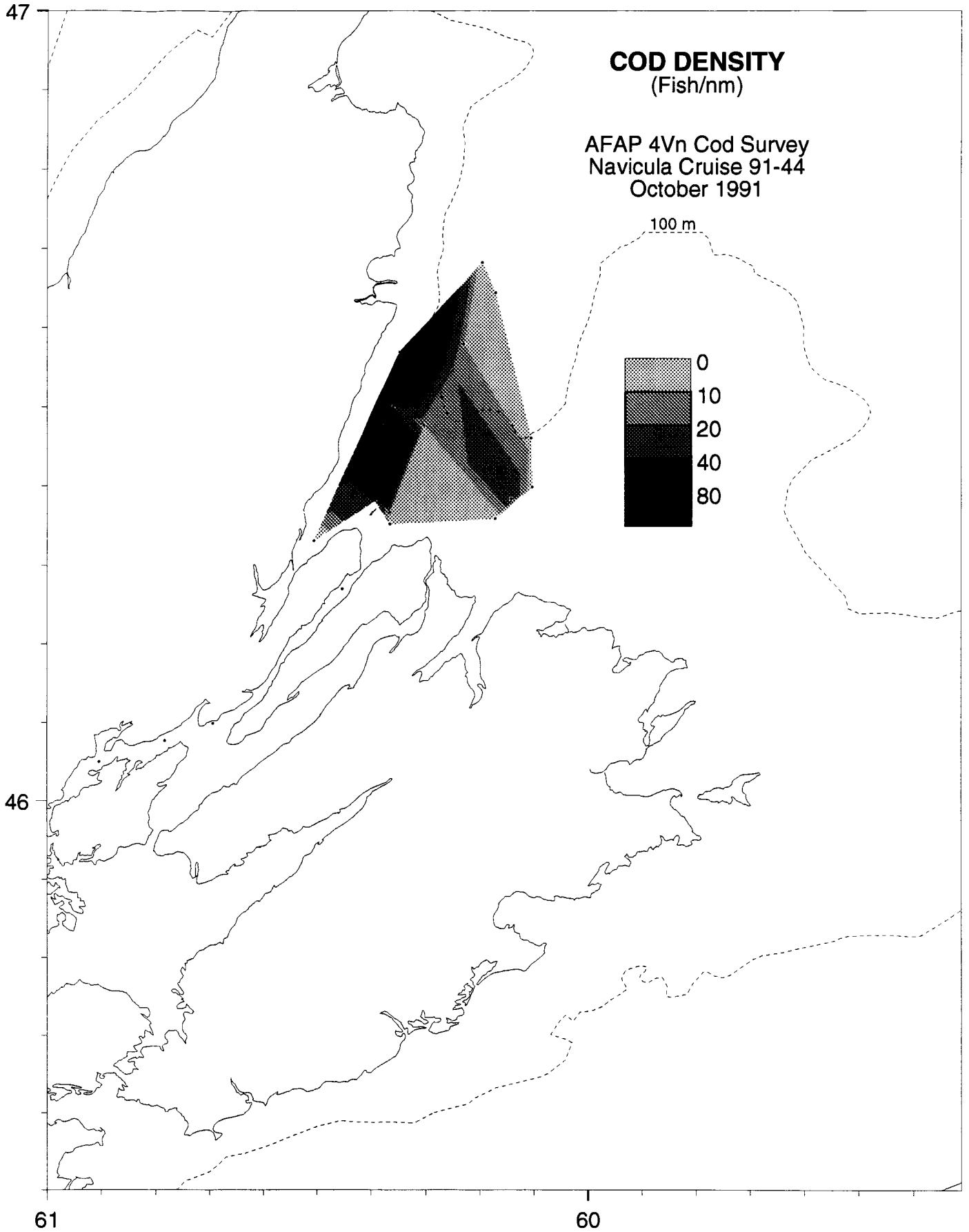


Figure 15

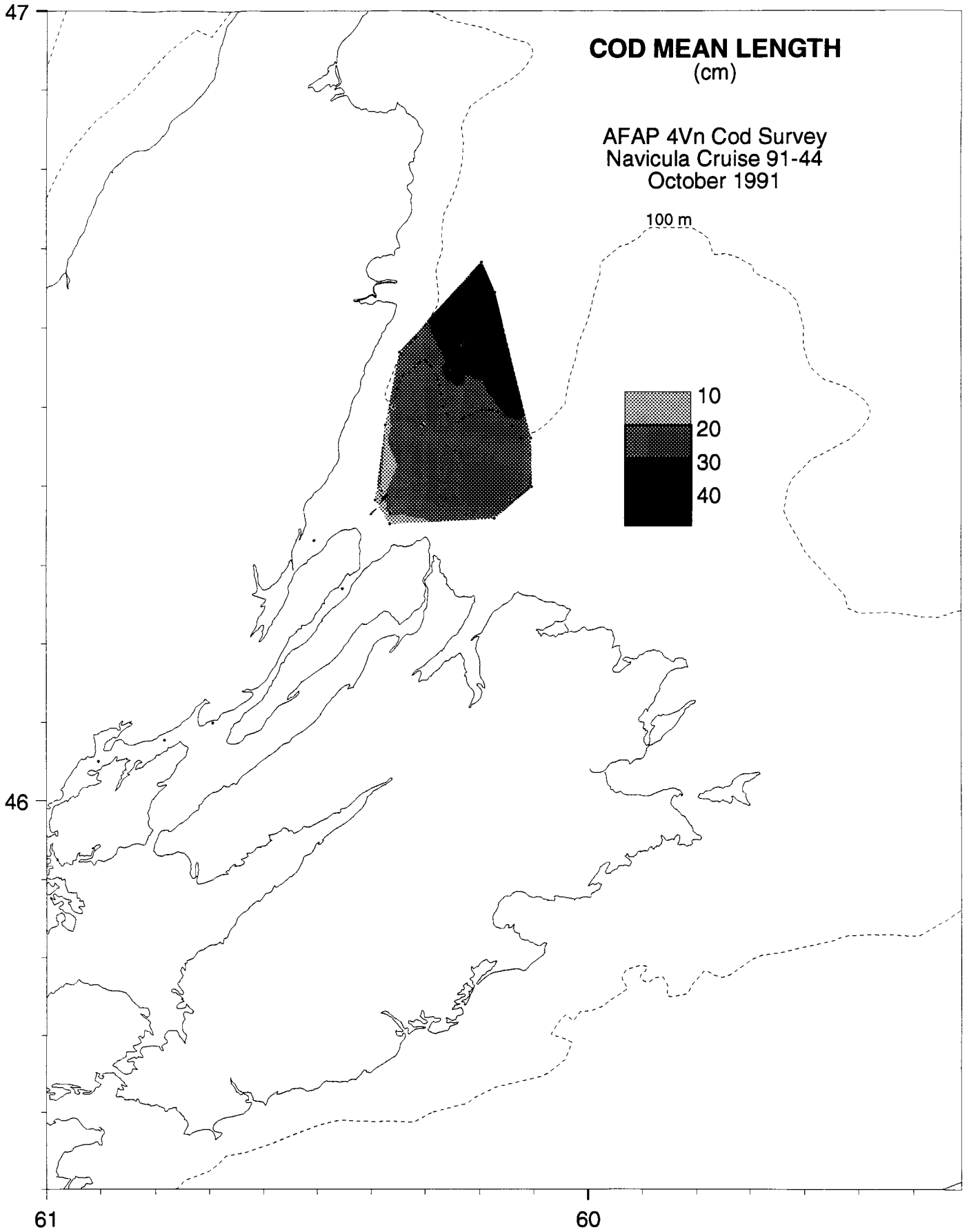


Figure 16

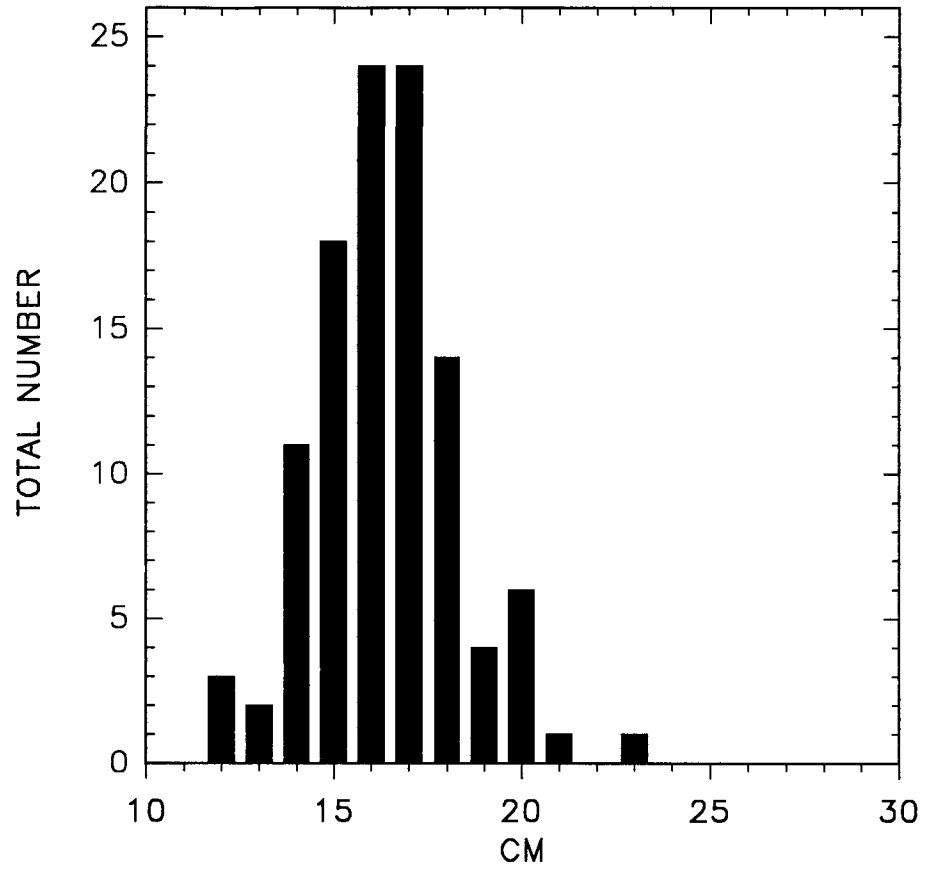


Figure 17. Length frequency of cod from bottom tow adjacent to Bird Islands, Sydney Bight; July 5, 1991.

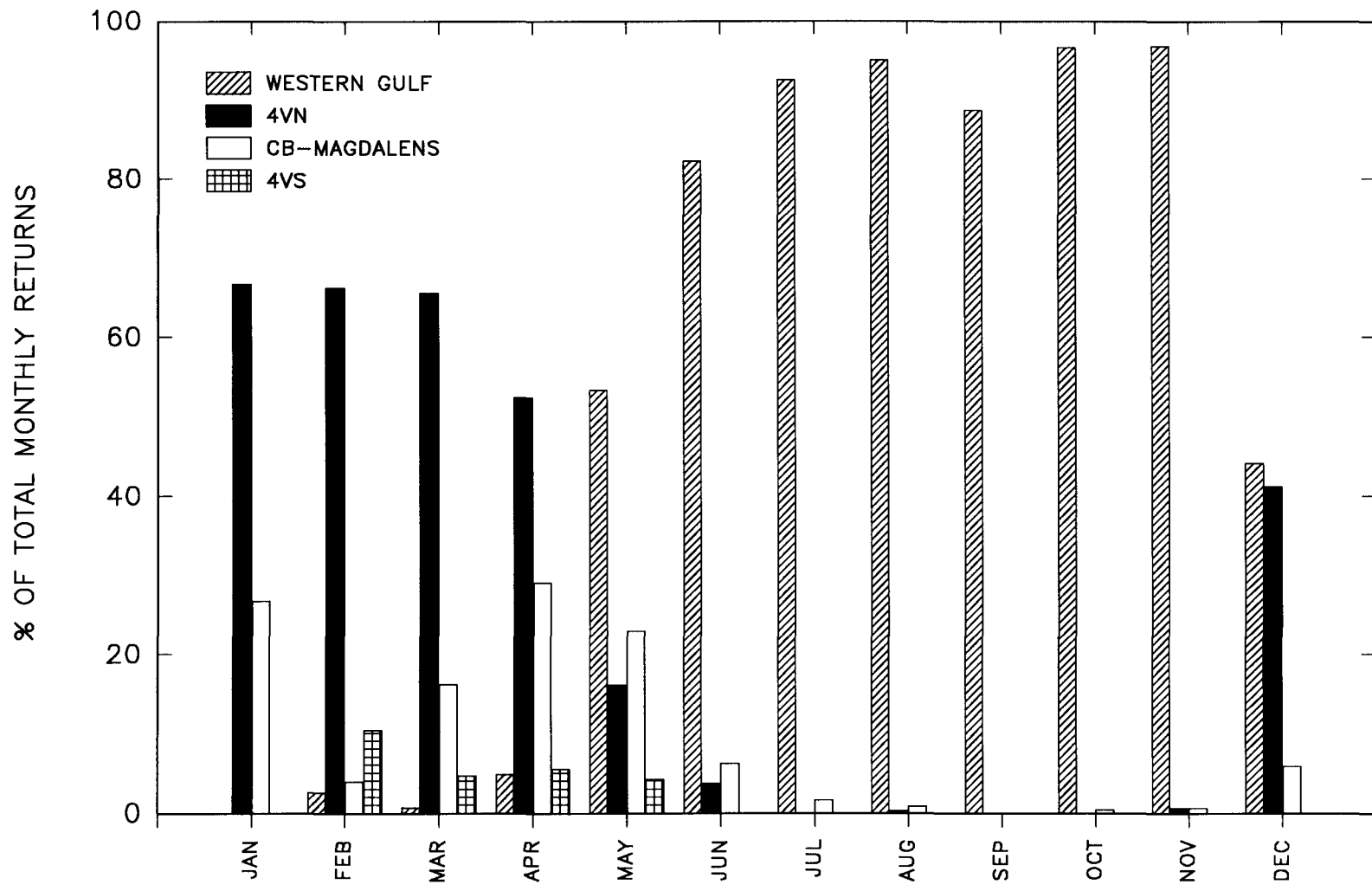


Figure 18. Percent monthly returns by region of cod tagged during the summer in western 4T, in the Chaleur/Gaspé region.

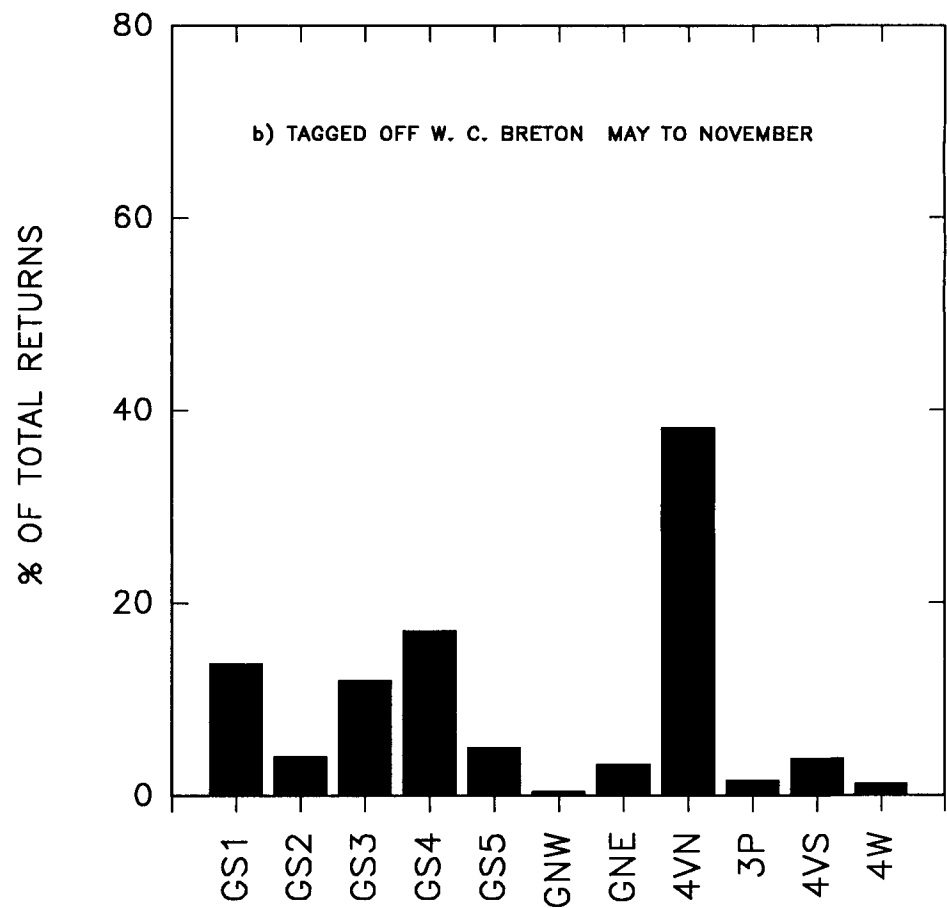
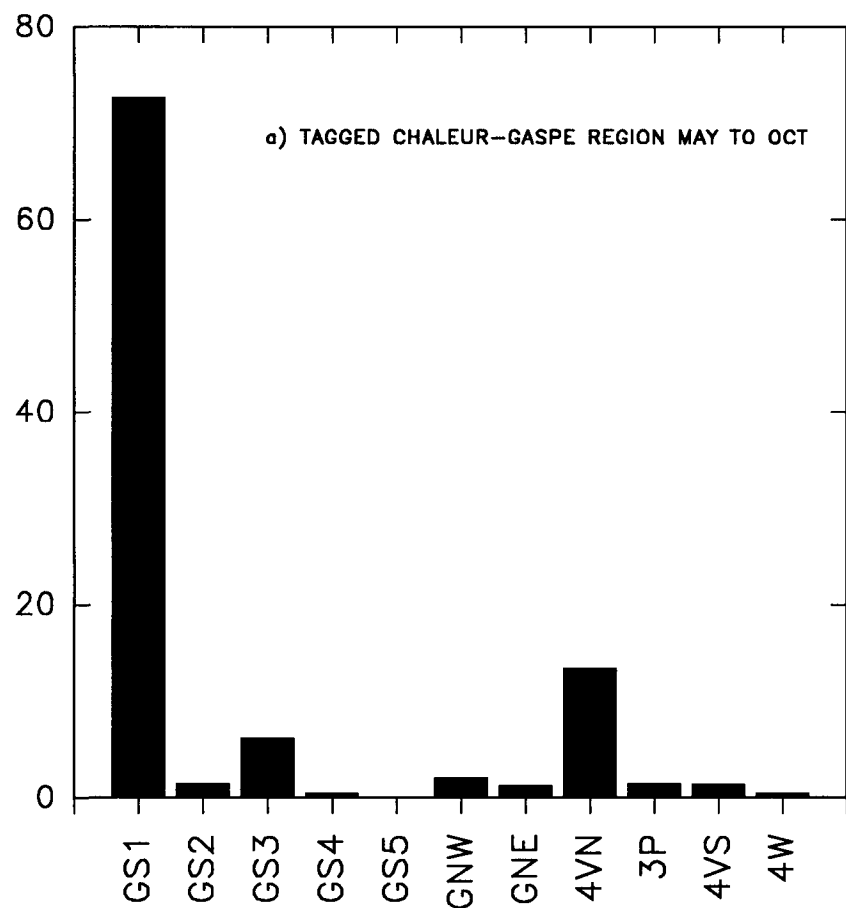


Figure 19. Percent of total returns by region of cod tagged in 4T in a) western Gulf of St. Lawrence and b) SE Gulf of St. Lawrence.

GS - Gulf of St. Lawrence (south)

1. North-west 4T
2. South-west 4T
3. North-east 4T
4. Central-east 4T
5. South-east 4T

GN - Gulf of St. Lawrence (north)

- W. West
- E. East

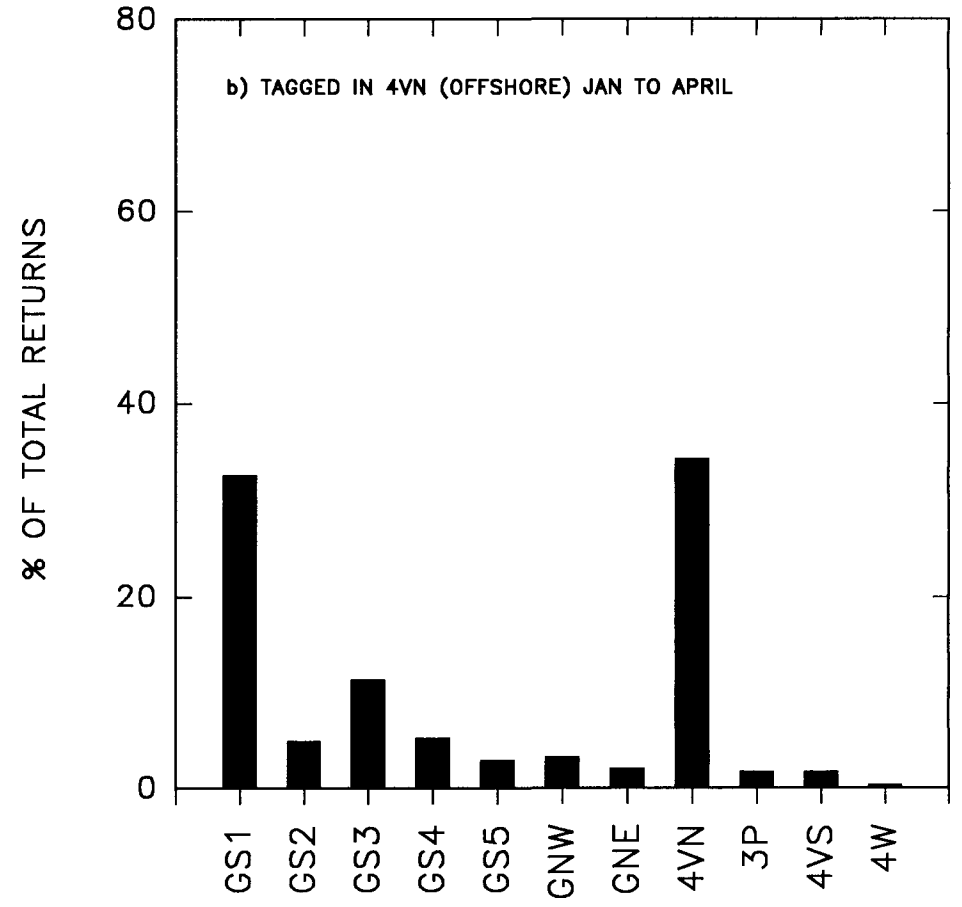
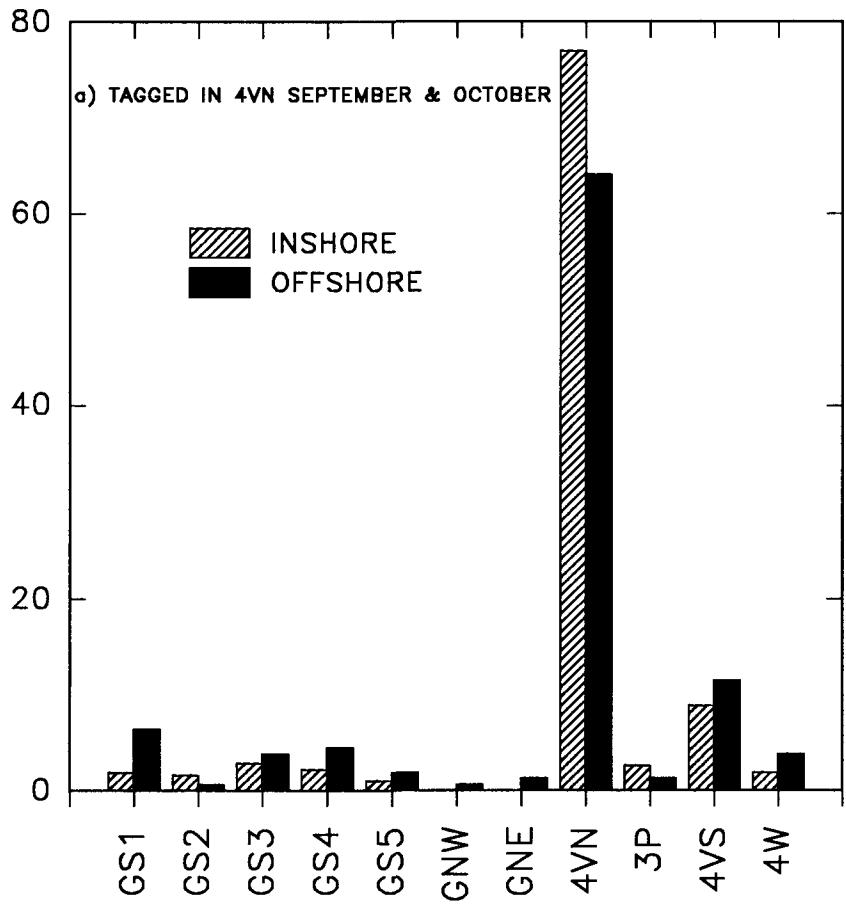


Figure 20. Percent of total returns by region of cod tagged in Sydney Bight, 4Vn in a) Autumn and b) Winter. Notation on abscissa same as Figure 19.

APPENDIX

GEAR	ALLOCATION (tonnes) ¹	MANAGEMENT MEASURE	LANDINGS (tonnes) ²	CLOSURE
<i>FIXED</i>				
<45'	5920	May 1; 13,600 kg trip limit.	1601	May 17
45' - 64'	586	May 1; 15,875 kg trip limit.	26	
65' - 100'	93	May 1; 10% bycatch.	106	
<i>MOBILE</i>				
<45' (C3 - ENS competitive)	6		1	August 8
<45' (Sector overlap 4T)	133	May 1; 6000 kg trip limit.	161	
<65' (ITQ)	2107		2000	
<65' (4T overlap - bycatch)	40	May 1; 1500 kg trip limit.	17	
<65' (Historical overlap - 4Rs, 3Pn)	220	May 1; 20,000 kg trip limit.	161	
65' - 100' (Shrimp)	93	May 1; 1500 kg trip limit.	2	
65' - 100' (EA)	93	May 1; 1500 kg trip limit.	136	
All >100'	700		393	

1. Derived from final allocation schedule as per the 1991 Canadian Atlantic Quota Report (31/12/91)
2. Preliminary statistics only.