

**Effects of Scotian Shelf Small Mesh Gear Fishery Regulations
on the catch rate of silver hake
and bycatch rates of cod, haddock and pollock in the period 1983-98.**

By R. Branton

**Department of Fisheries and Oceans
Maritimes Region, Science Branch
Bedford Institute of Oceanography
1 Challenger Drive, Dartmouth
Nova Scotia, B2Y 4A2
Canada**

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Abstract

Changes to catch and bycatch rates from the Scotia Shelf (Div 4VWX) foreign small mesh otter trawl fishery are examined for the period 1983-98 to determine what affects if any can be attributed to the bycatch reduction measures that were introduced at the start of the 1994 fishing year. The cod, haddock and pollock bycatch reductions after 1994 were the combined result of decreased fishing effort, reduced abundance of bycatch species, mandatory use of separator grates, and restrictions on fishing area. The distribution of fishing effort, however, did not change greatly after the initial introduction of restrictions in 1994 due to subsequent modifications and the granting of exemptions to the new rules. As a result, the expected benefits from the restrictions on area were not realized as predicted by the scientific advice underlying them. It was however still possible to confirm that the original advice was valid by demonstrating that catch rates of silver hake were not affected by the fishing area restrictions and that bycatches would have been reduced even further had there been no modifications and exemptions. The analysis shows that fishing area restrictions effectively reduce the accidental capture of small haddock which are the same size as mature silver hake and hence not released by the separator grates. Given that the 1994 regulatory changes do not reduce silver hake catch rate, yet could reduce bycatch considerably, it was concluded that there appear to be no rationale to the allowing of exemptions.

Résumé

Les variations, de 1983 à 1998, des taux des captures et des prises accidentelles de la pêche étrangère au chalut de petit maillage du plateau néo-écossais (div. 4VWX) sont examinées afin de déterminer les effets attribuables aux mesures de réduction des prises accidentelles imposées au début de l'année de pêche de 1994. Les réductions des prises accidentelles de morue, d'aiglefin et de goberge survenues après 1994 résultaient d'une baisse de l'effort de pêche, d'une abondance réduite des espèces capturées accidentellement, de l'utilisation obligatoire de la grille de sélection et de limitations visant la zone de pêche. La répartition de l'effort de pêche n'a cependant pas été modifiée de façon importante après l'imposition des restrictions en 1994 étant donné les modifications apportées et les exemptions accordées aux nouvelles règles. Les avantages prévus de la limitation de la zone découlant de l'application des avis scientifiques n'ont donc pas été obtenus. Il a cependant été possible de confirmer que les premiers avis étaient valables en démontrant que les taux de capture du merlu argenté n'avaient pas été affectés par les restrictions visant la zone de pêche et que les prises accidentelles auraient été réduites encore plus en l'absence de modifications et d'exemptions. L'analyse montre que les limitations imposées à la zone de pêche réduisent de façon certaine la capture accidentelle des aiglefins de petite taille qui sont de la même taille que les merlus argentés matures et ne sont donc pas rejetés par les grilles de sélection. Comme les modifications apportées à la réglementation de 1994 n'ont pas réduit le taux de capture des merlus argentés, mais qu'elles pouvaient réduire de façon importante les prises accidentelles, il a été conclu que rien ne justifiait les exemptions.

Introduction

The Scotian Shelf (Div. 4VWX) silver hake fishery, developed by the former Soviet Union in the early 1960s, was unrestricted in terms of area and season of fishing up until extension of jurisdiction in 1977. A minimum mesh size of 60 mm was then required and the fishery was restricted to deeper waters (>100-150 m) in a defined area along the edge of the shelf. This area became known as the "Silver Hake Box" and its shoreward boundary as the "Small Mesh Gear Line" (SMGL). Subsequently some fishing was permitted to the east, with this area being called the "Extension". Other changes at this time involved lowering the 4X cod trip bycatch limit to 1 percent, the 4VsW cod bycatch to 5 percent and introducing a 5 percent bycatch limit for pollock. The bycatch limit for haddock remained at 1 percent for all areas.

These measures were considered adequate until 1992-93, when domestic industry representatives expressed concern over bycatches of cod, haddock and pollock from the foreign silver hake fishery and demanded that these bycatches be eliminated. Trip bycatch limits were subsequently reduced to 0.5 percent for cod, haddock and flatfish and 1 percent for pollock as DFO imposed more restrictive management measures to reduce bycatches in this fishery. Separator grates were made mandatory on all vessels fishing for silver hake in August 1993. A revised SMGL approximating the 190m depth contour was implemented and the Extension was eliminated at the start of the 1994 season. Scientific advice at the time (Branton, MS 1994) stated that these changes would greatly reduce bycatches of haddock and pollock, and probably also cod, while still allowing effective prosecution of the silver hake fishery. It was also noted that fishing deeper would be crucial to reducing the accidental capture of small haddock, since the grate used by the fishing industry would not be effective in releasing small immature haddock.

These new restrictions on fishing area were endorsed by the Harris Panel on Foreign Fishing and strictly enforced in 1994. In subsequent years, modifications and exemptions were requested by Cuban authorities to facilitate navigation in and around the canyons on the shelf slope and to generally improve fishing conditions for silver hake. A number of these were granted, thus allowing an evaluation of the area restrictions. At the June 1996, NAFO Scientific Council meeting, concern was expressed that these new SMGL regulations could have an important affect on the catch rate of silver hake, such that they should be taken into account in stock status calculation. A study into the affect of area restrictions on the commercial catch rate of silver hake in 1994-96 (Branton *et al*, 1997) showed that silver hake catch rates were consistently as good as or better seaward of the new 1994 SMGL as landward. The NAFO Scientific Council reviewed this study at their June 1997 meeting and concluded that the new SMGL did not have an affect on the catch rate of silver hake thus confirming an important portion of the original scientific advice.

An evaluation of the separator grates experiments conducted in 1992-93 (Halliday and Cooper, 1997) showed that grates released up to 85-98% by weight of pollock and haddock and 48-70% of other species, while retaining 95% of the silver hake. Commercial catches however were found to contain more small haddock than experimental catches and hence it was projected that commercial use of a grate would release only 75-80% by weight of haddock and 50% by number.

This present document extends the evaluation of the affects of fishing area restrictions on the catch rates of silver hake to include 1997-98 as well as evaluates their affects on the bycatch rates of cod, haddock and pollock for the period 1994-98. In both cases data from the period 1983-93 are used to describe fishing conditions prior to the induction of the new bycatch reduction measures. In addition, the modifications and exemptions granted to the Cuban fleet in 1996 are sequentially examined to study finer scale effects of area restrictions on the catch rate of silver hake and the bycatch rate of haddock. As well, the size composition of haddock in 1996 is also examined to illustrate the numbers of small fish being caught in relation to the 1994 SMGL.

Methods

Data used in this analysis are from the Canadian observer program for the period 1983-98, when the foreign small mesh gear fishery was directed almost entirely towards silver hake. Although observer data exist from 1977, there was a substantial squid fishery until 1982, so 1977-82 data were excluded from the analysis. Data selection was on the basis of fishing sets by all vessels subject to the *SMGL* regulations where the main species sought was silver hake, resulting in data from over 120,000 fishing sets (83,000 for the period 1989-98) being retrieved for analysis. The recording of main species sought by observers makes these data particularly suitable for bycatch analysis, as sets that were unsuccessful in catching a predominance of the target species were also included. Observer coverage was approximately 40% in 1983-86 and 100% in 1987-98. Catch and fishing effort observations for 1983-93 were multiplied by the ratio of annual silver hake landing reports from NAFO by annual observed catches to account for variations in observer coverage. There are as yet no silver hake landing reports from NAFO for 1994-98, therefore catch and fishing effort observations for that period were taken as is without adjustment. The depth and location of each set was determined by averaging start and end depths, and latitudes and longitudes. Size composition data for haddock are taken from observer samples for 1996.

Results

The estimated silver hake catch (Table. 1) derived from observer data is approximately equal to the nominal catch used for assessment purposes (Showell, 1998). The silver hake catch in 1983-93 ranged from 30,000 to 90,000 t and subsequently from 8,000 to 20,000 t. The catch of cod in 1983-93 ranged from 9 to 260 t and subsequently from 1 to 3 t. The catch of haddock in 1983-93 ranged from 140 to 1,000 t and subsequently from 8 to 47 t. The catch of pollock in 1983-93 ranged from 700 to 2,500 t and subsequently from 8 to 134 t. The catch of non-target species combined (including cod, haddock and pollock) in 1983-93 ranged from 4,000 to 11,000 t and subsequently from 1,100 to 2,200 t. Bycatch reductions when viewed as annual tonnages could be the result of several factors, including: decreased fishing effort, reduced abundance of bycatch species, mandatory use of separator grates, and restrictions on fishing area.

Fishing effort changes are expected to have a proportional affect on bycatch quantities and should therefore be removed from the formulation. This is especially important here, as effort in this component of the fishery during the period 1994-98 was only about 40% of that in 1983-1993. Examining bycatch rates, which are calculated as a percentage of the silver hake catch does just this and therefore give a truer perception of the bycatch reductions. Following this approach, the bycatch rates of cod (Fig. 2) prior to 1994 were about 0.3% (except in 1983 and 1985 when it was 0.7% and < 0.1% respectively) and after that was less than 0.1%. Haddock bycatch (Fig. 3) prior to 1994 were around 0.5% (except in 1983-84 when it was about 1.5%) and after that was about 0.2%. Pollock bycatch rates (Fig. 4) prior to 1994 was about 3.0% (except 1992 when it was 6.0%) and after that was about 0.3%. In short, the bycatch rates of cod, haddock and pollock since 1994 have decreased by 95%, 70% and 90% respectively, as compared to the 1983-93 average. The bycatch rates of all non-target species combined generally range from 7 to 22% throughout the entire period 1983-98 and did not decline after 1993.

Viewing the reductions as bycatch rate however still leaves abundance of the bycatch species, mandatory use of the separator grates, and area restrictions as the remaining influential factors. Given the experimental evidence regarding effectiveness of the grates and that they were mandatory throughout the 1994-98 period, can abundance and area restrictions factors be separated from each other? A comparison of the distribution of fishing tows by depth (Table. 2, Fig. 5) for the periods 1989-93 and 1994-98 shows an overall seaward shift of not more than 10 m. The distribution of hours fished in the *Silver Hake Box* relative to 190m (Table. 3) shows 58% of fishing effort was at 190m or deeper in the period 1994-98 as compared to 53% in the period 1994-98. A similar analysis using 185 m (not shown) gave similar results. The distribution of fishing tows relative to the *Extension* boundary (Table. 2, Fig. 6) shows that 1994 and 96 were the only years when there was little or no fishing in the *Extension*. Therefore the distribution of fishing effort is not much different between the two periods and any remaining observed reductions should be the result of changes in the abundance of the bycatch species and not the result of area restrictions. This

situation however does provide ample opportunity to evaluate the effectiveness of area restrictions had they been in place and without confounding effects of effort and abundance changes and the separator grates.

The catch rate (t/hr) of silver hake in the *Silver Hake Box* for the period 1989-98 (Table. 3, Fig. 7) was almost always as high or higher seaward of the 190m contour than landward. As well, the catch rate was only slightly higher in the *Extension* for 4 of the 9 years when there was fishing in the *Extension*. Together these results confirm that the silver hake catch rate was and continues to be unaffected by area restrictions. The bycatch rate of cod (kg/hr) in the *Silver Hake Box* was 50% lower seaward of the 190 m contour while that of haddock and pollock were 80% and 40% lower, respectively. Bycatch rates of other species combined were almost always lower seaward of 190m contour in the *Silver Hake Box*. Fishing in the *Extension* also almost always resulted in higher bycatch rates of haddock than seaward of 190 m in the *Silver Hake Box*, as was the case for cod. This was not observed for pollock and for the other species combined. Here it is important to note that there no great difference in the bycatch rates before or after 1994, therefore indicating that the bycatch reduction benefits resulting from area restrictions would additive to those resulting from mandatory use of the separator grate.

In 1996, although specific modifications and exemptions were granted to the Cuban small mesh gear fleet (Figure. 1, Table. 4-5), most of the fishing was seaward of the 1994 SMGL (75% of the effort). After April 28, fishing was permitted in the *Amendment #1* area (20% of the effort) and after May 26, some fishing (5% of the effort) was also permitted in the *Extension* (May 27-June 4) and in the *Amendment #2* area (June 5-July 9). Silver hake catch rates (Table. 6) in the *Amendment #1* area although at times higher than that seaward of the 1994 SMGL, they were, when taken as an annual rate, lower there than anywhere else in the *Silver Hake Box*. As well, silver hake catch rates in the *Extension* and the *Amendment #2* area were only marginally (5% and 25% respectively) better than those seaward of the 1994 SMGL. On the other hand, haddock bycatch rates (Table. 7) in the *Amendment #1* & 2 areas and the *Extension* were very much higher (3 to 10 times) than those seaward of the 1994 SMGL. Size compositions samples (Fig. 8) for the same period indicate that 5 times more smaller haddock by number were caught landward (195,000 fish) of the 1994 SMGL than seaward (39,000 fish). As well almost all of these haddock were less than 40 cm (i.e. 1-2 years) and most of them were 1 year old (20 cm).

Conclusion

Changes in bycatch levels for the silver hake fishery between 1989-93 and 1994-98, particularly for cod, haddock and pollock, are the result of several factors. Fishing effort in this component of the fishery in 1994-98 was only about 40% of that in the earlier period, reducing the bycatch quantities proportionately. Changes in the abundance of cod, haddock and pollock between periods would affect both the bycatch tonnages and the bycatch rates. The introduction of separator grates was projected to reduce the bycatch rates by weight of these species by 75-95% (depending on species). The present analysis confirms that restriction of fishing to waters of deeper than 190 m and elimination of the *Extension* would reduce bycatch rates by a further 40-80% depending on species.

The most problematic bycatch species is haddock. Most the haddock contained in the bycatch are small haddock, comparable in size to silver hake and hence not released by the separator grate. Restricting the area of fishing to deeper water is the primary measure available to reduce bycatches of small haddock. The present analysis confirms that almost all of the haddock now being caught by this fishery are small and immature, with most of these being taken landward of the 1994 SMGL.

The present analysis shows that the distribution of fishing did not change greatly after the 1994 revisions were introduced, thus, because of further modifications and exemptions, few of the predicted benefits of the revised SMGL have been realized.

A number of factors are relevant to ensuring conditions for effective prosecution of the silver hake fishery. The present analysis shows that restricting the fishery to depths of about 190 m or deeper and

eliminating the Extension has no appreciable deleterious effect on silver hake catch rate. Thus, given that the 1994 regulatory changes do not reduce the silver hake catch rate, yet reduce bycatch considerably, the rationale for allowing these exemptions remains obscure.

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Table 1. Silver hake catch (t) and other species bycatch (t) by year from foreign small mesh gear fleets on the Scotia Shelf in the period 1983-98.

species	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	total
silver hake	35476	74128	75434	82612	61548	74365	87651	68101	62231	39789	27100	6877	16280	22419	12058	6137	752206
spiny dogfish	1217	339	1837	1247	444	1238	2707	1760	1245	797	337	14	30	92	81	9	13394
pollock	727	256	510	1139	676	1172	2161	1290	1480	2539	731	10	56	134	54	8	12943
short-fin squid	61	386	297	83	283	470	977	1171	736	632	1662	1290	715	442	521	710	10436
mackerel (Atlantic)	5	794	995	663	52	735	414	949	187	795	620	39	58	82	109	7	6504
herring (Atlantic)	0	0	40	141	79	857	1408	1732	1055	325	42	0	6	181	227	117	6210
haddock	660	987	532	521	363	487	688	395	321	197	139	8	32	47	24	13	5414
skates (ns)	0	0	0	2	13	472	637	986	1667	613	705	16	19	33	5	11	5179
hake (ns)	1	0	0	24	390	573	600	435	601	585	223	58	11	75	31	24	3631
squirrel or red hake	743	428	496	565	327	144	92	52	57	10	4	1	124	288	195	75	3601
argentine (Atlantic)	622	495	248	177	39	307	76	58	70	34	154	8	92	209	504	5	3098
monkfish, angler	273	309	385	304	246	192	163	181	200	207	108	7	20	89	49	20	2753
redfish (ns)	67	44	327	121	72	87	287	326	389	361	136	19	41	54	66	11	2408
cod (Atlantic)	259	146	9	27	63	127	200	205	203	105	38	2	1	3	1	1	1390
skates & rays (ns)	205	179	166	146	364	52	0	22	94	18	0	0	0	0	0	0	1246
cusk	116	82	139	47	47	104	90	53	64	62	22	0	0	1	1	0	828
basking shark	69	27	46	12	25	76	57	81	132	177	76	9	20	9	3	4	823
American plaice	48	84	72	51	57	86	38	76	70	70	66	13	18	23	11	23	806
white hake	32	69	124	190	98	55	31	24	31	5	3	0	15	34	23	4	738
dogfishes(ns)	0	33	188	47	24	248	26	24	52	91	0	0	0	0	0	0	733
thorny skate	19	36	27	8	89	50	40	60	61	29	59	2	19	42	27	9	577
halibut (Atlantic)	67	16	47	26	52	41	46	59	72	64	37	1	3	5	2	1	539
winter skate	0	0	0	0	12	0	1	86	90	11	0	1	78	122	45	41	487
witch flounder	18	30	26	18	25	39	22	36	49	42	48	2	19	25	19	24	442
American lobster	12	16	15	17	44	25	32	35	42	34	27	4	7	13	8	5	336
yellowtail flounder	5	70	7	23	7	45	9	21	27	19	41	0	9	4	1	2	290
alewife	1	0	2	14	0	1	0	0	35	73	31	0	0	14	11	5	187
black belly rosefish	0	0	0	0	1	1	1	0	3	11	6	0	34	18	96	4	175
herring (ns)	0	0	29	0	0	19	0	67	0	10	0	0	0	0	0	0	125
spiny tail skate	1	0	0	0	0	0	0	1	55	40	3	0	7	0	0	0	107
~300 other species	52	73	60	87	86	65	63	109	129	167	78	9	24	52	55	20	1129
total bycatch	5280	4899	6624	5700	3978	7768	10866	10294	9217	8123	5396	1513	1458	2091	2169	1153	86529
% bycatch	14.9	6.6	8.8	6.9	6.5	10.4	12.4	15.1	14.8	20.4	19.9	22.0	9.0	9.3	18.0	18.8	11.5
grand total	40756	79027	82058	88312	65526	82133	98517	78395	71448	47912	32496	8390	17738	24510	14227	7290	838735

Table 2. Distribution of fishing effort (number of tows) by depth (m) for foreign small mesh gear fleet on the Scotian Shelf in the periods 1989-93 and 1994-98.

period	depth (m)				
	minimum	25 %	50 %	75%	maximum
1989-93	80	165	205	250	625
1994-98	85	166	210	260	625

Table 3. Effort ('000 hrs), silver hake catch rate (mt/hr) and cod, haddock, pollock and other species bycatch rates (kg/hr) by year and season, seaward vs. landward of the 1994 SMGL (≥ 190 m) and in the Extension (East of 60°) from foreign small mesh gear fleets on the Scotian Shelf in the period 1989-98.

			1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Effort ('000 hrs)	all year	seaward	7.5	17.7	23.0	16.7	10.4	4.7	6.2	10.6	7.8	1.9
		landward	12.9	13.0	11.8	4.4	7.0	0.9	5.7	7.5	3.4	2.5
	Jan-May	seaward	6.5	14.7	16.0	13.3	6.4	3.0	4.9	7.4	4.9	1.4
		landward	5.5	6.9	3.7	2.5	1.4	0.2	1.1	2.4	1.4	0.7
	Jun-Dec	seaward	0.9	3.0	6.9	3.5	4.1	1.7	1.3	3.2	3.0	0.5
		landward	7.4	6.1	8.1	1.9	5.6	0.7	4.6	5.1	2.0	1.8
	all year	extension	1.6	5.3	4.8	3.4	2.9	0.0	0.8	0.2	0.9	0.5
silver hake (mt/hr)	all year	seaward	4.5	1.7	1.7	1.2	1.4	1.2	1.3	1.2	1.0	1.2
		landward	3.3	1.8	1.6	1.6	1.3	1.0	1.3	1.2	1.0	1.2
	Jan-May	seaward	4.8	1.7	1.8	1.3	1.2	1.5	1.4	1.2	1.0	1.3
		landward	4.0	1.9	1.8	1.7	1.2	1.6	1.1	1.2	1.1	1.8
	Jun-Dec	seaward	2.9	1.6	1.3	1.2	1.7	0.9	0.7	1.4	0.8	0.9
		landward	2.7	1.7	1.4	1.4	1.3	0.8	1.3	1.2	0.9	1.0
	all year	extension	4.4	2.2	1.9	1.0	1.2	NA	1.1	1.4	1.1	1.5
cod (kg/hr)	all year	seaward	2.7	1.5	2.7	1.9	0.8	0.0	0.1	0.1	0.1	0.2
		landward	9.7	3.4	7.6	9.2	1.6	1.9	0.1	0.2	0.0	0.2
	Jan-May	seaward	2.3	1.8	3.2	2.1	1.0	0.0	0.0	0.0	0.0	0.3
		landward	9.7	4.3	9.1	8.5	2.1	0.1	0.1	0.1	0.0	0.1
	Jun-Dec	seaward	5.6	0.4	1.4	1.2	0.5	0.0	0.1	0.2	0.1	0.0
		landward	9.7	2.4	6.9	10.0	1.5	2.5	0.2	0.2	0.1	0.2
	all year	extension	28.4	22.7	13.1	2.9	6.4	NA	0.0	4.7	0.0	0.0
haddock (kg/hr)	all year	seaward	4.4	2.2	2.2	1.7	2.4	1.0	0.9	0.8	0.9	2.0
		landward	32.1	16.4	18.8	24.7	13.9	3.1	3.9	4.6	4.6	2.9
	Jan-May	seaward	3.3	2.2	2.2	1.1	1.9	0.6	0.6	0.3	0.7	2.4
		landward	41.6	17.1	21.2	16.1	13.0	4.0	5.1	2.8	5.5	1.9
	Jun-Dec	seaward	12.4	2.1	2.2	3.7	3.1	1.6	2.4	2.2	1.3	0.7
		landward	25.2	15.7	17.8	35.8	14.2	2.9	3.7	5.5	4.0	3.3
	all year	extension	128.3	23.6	13.3	4.9	5.8	NA	3.7	15.9	1.0	3.8
pollock (kg/hr)	all year	seaward	57.9	31.1	31.2	68.5	33.4	1.4	4.8	2.6	4.2	0.9
		landward	115.2	37.3	56.2	162.7	45.9	2.8	4.4	13.0	5.9	2.5
	Jan-May	seaward	59.7	32.4	35.0	63.5	31.9	1.3	5.2	2.1	4.1	0.2
		landward	228.6	54.3	122.1	217.0	70.8	7.4	16.7	5.6	8.4	2.9
	Jun-Dec	seaward	45.5	24.4	22.4	87.3	35.7	1.6	3.3	3.7	4.3	2.7
		landward	32.1	18.0	26.6	93.0	39.5	1.5	1.6	16.6	4.2	2.4
	all year	extension	86.0	38.9	32.6	31.8	17.4	NA	0.5	31.8	0.8	0.3
other (kg/hr)	all year	seaward	272.0	164.7	164.0	158.9	253.5	223.8	82.9	102.0	174.6	134.7
		landward	382.4	287.2	226.9	184.9	202.5	443.0	137.8	103.3	184.0	323.5
	Jan-May	seaward	285.3	173.9	206.4	164.0	229.0	54.9	52.9	87.3	170.8	113.5
		landward	526.7	345.9	398.3	221.7	197.0	71.8	77.5	113.3	119.3	303.1
	Jun-Dec	seaward	179.0	119.6	66.2	139.2	291.7	518.1	196.2	136.5	180.7	190.7
		landward	276.6	220.8	149.8	137.7	203.9	554.9	151.8	98.5	228.0	331.7
	all year	extension	265.4	244.7	225.4	195.1	156.2	NA	81.9	107.7	80.4	128.0

Table 4. Start and end dates of amendments to SMGL regulations made for Cuban small mesh gear fleet in 1996.

Period	Start	End
1	-	April 28
2	April 29	May 26
3	May 27	June 4
4	June 5	July 9
5	July 10	-

Table 5. Silver hake directed effort ('000 hr) by regulation area¹ and time period for Cuban small mesh gear fleet on the Scotian Shelf in 1996.

	Period 1	Period 2	Period 3	Period 4	Period 5	Total
Amendment 2				1.09		1.09
Extension			0.15			0.15
Amendment 1		1.05	0.19	1.35	0.55	3.15
1994 SMGL	4.53	3.43	0.32	2.14	2.54	12.96

Table 6. Silver hake catch rate (mt/hr) by regulation area¹ and time period for Cuban small mesh gear fleet on the Scotian Shelf in 1996.

	Period 1	Period 2	Period 3	Period 4	Period 5	Total
Amendment 2				1.54		1.54
Extension			1.30			1.30
Amendment 1		1.06	0.96	1.27	0.75	1.09
1994 SMGL	1.40	0.91	0.77	1.41	1.14	1.21

Table 7. Haddock catch rate (kg/hr) by regulation area¹ and time period for Cuban small mesh gear fleet on the Scotian Shelf in 1996.

	Period 1	Period 2	Period 3	Period 4	Period 5	Total
Amendment 2				8.9		8.9
Extension			15.6			15.6
Amendment 1		2.0	5.5	5.4	3.7	4.0
1994 SMGL	0.3	0.8	4.0	2.3	3.3	1.4

Notes : ¹ Tows were assigned to regulatory areas based on start date and average position. Approximately 1,000 hours of effort (and associated catch) could not be assigned using these criteria and were not used.

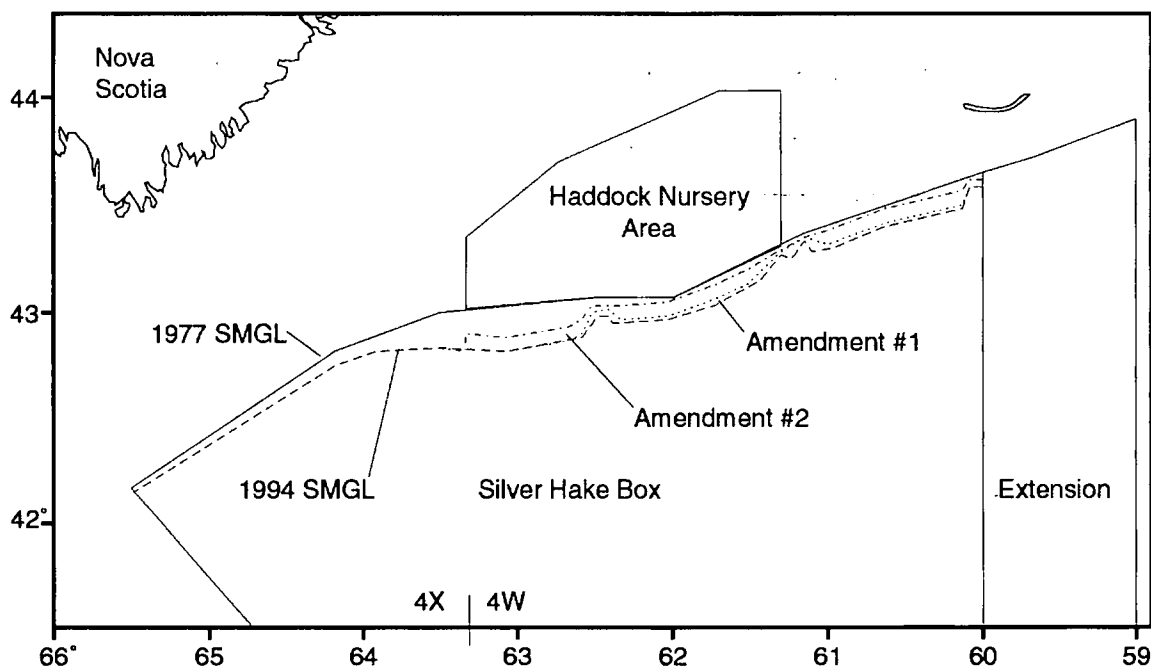


Figure 1. Regulatory areas associated with foreign small mesh gear fleets on the Scotian Shelf plus amendments made for Cuban fleet in 1996.

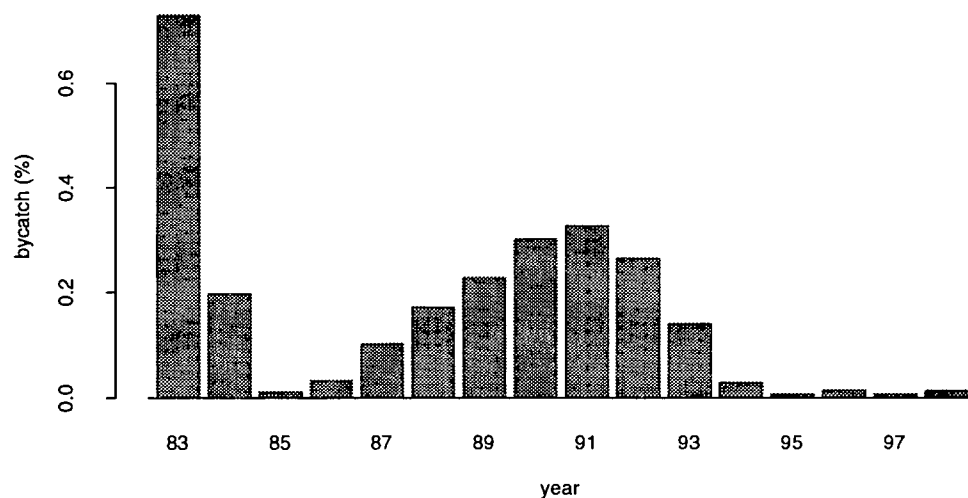


Figure 2. Cod bycatch as a percent of silver hake by year for foreign small mesh gear fleets fishing for silver hake on the Scotian Shelf in the period 1983-98.

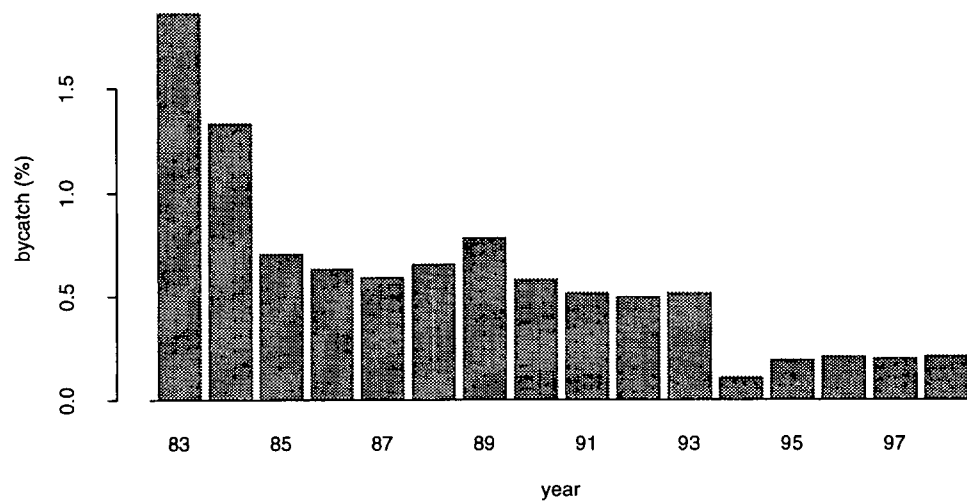


Figure 3. Haddock bycatch as a percent of silver hake by year for foreign small mesh gear fleets fishing for silver hake on the Scotian Shelf in the period 1983-98.

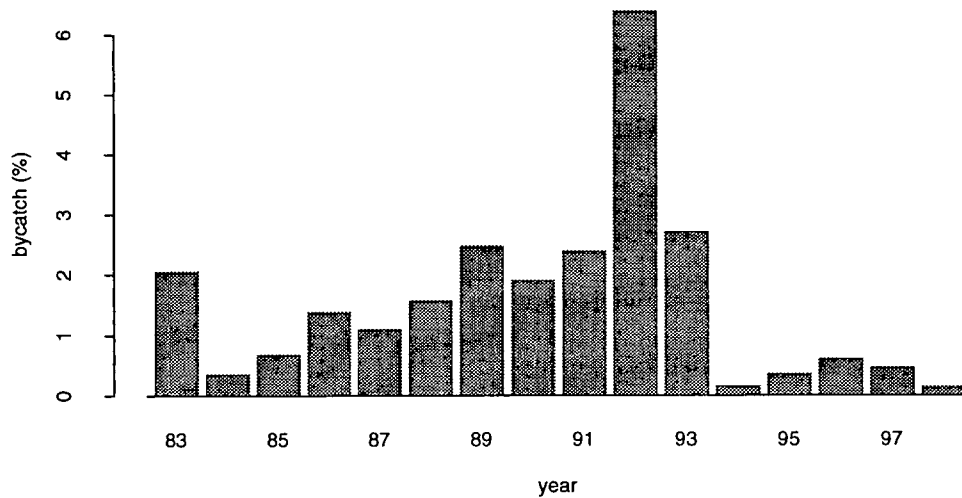


Figure 4. Pollock bycatch as a percent of silver hake by year for foreign small mesh gear fleets fishing for silver hake on the Scotian Shelf in the period 1983-98.

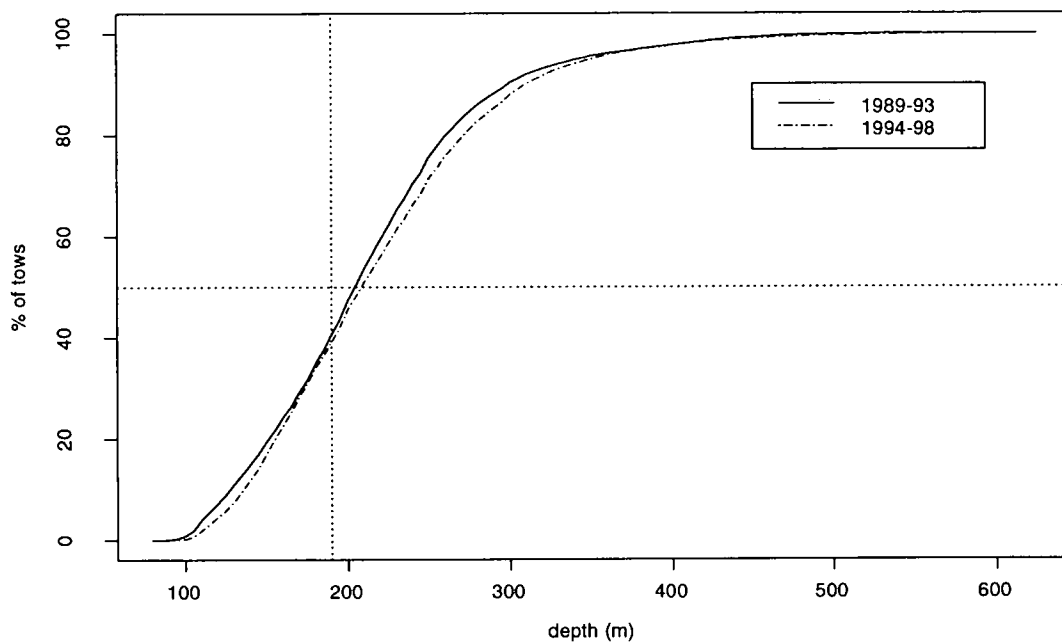


Figure 5. Depth of fishing season for the foreign small mesh gear fishery on the Scotian Shelf for the periods 1989-93 and 1994-98.

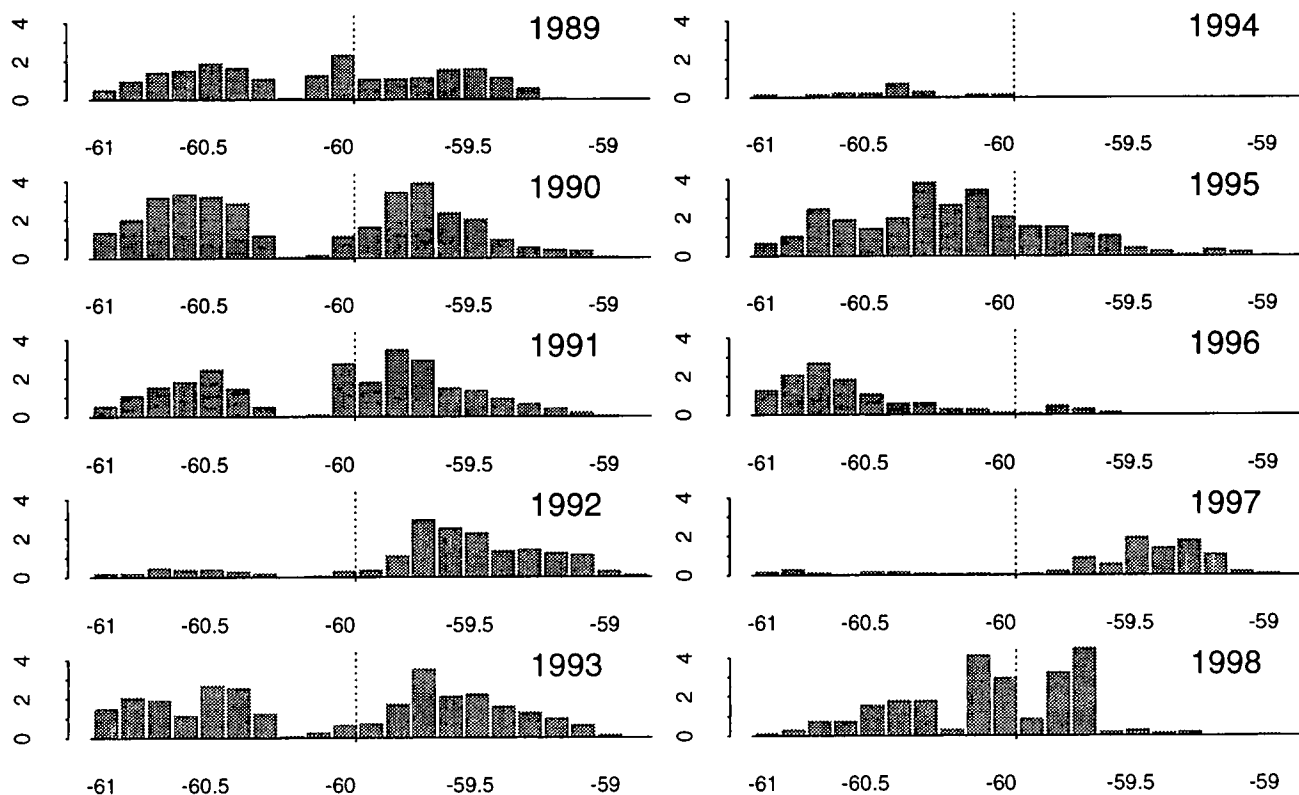


Figure 6. Portion of tows between 59 and 61°W by year for the foreign small mesh gear fishery on the Scotian Shelf in the period 1989-98.

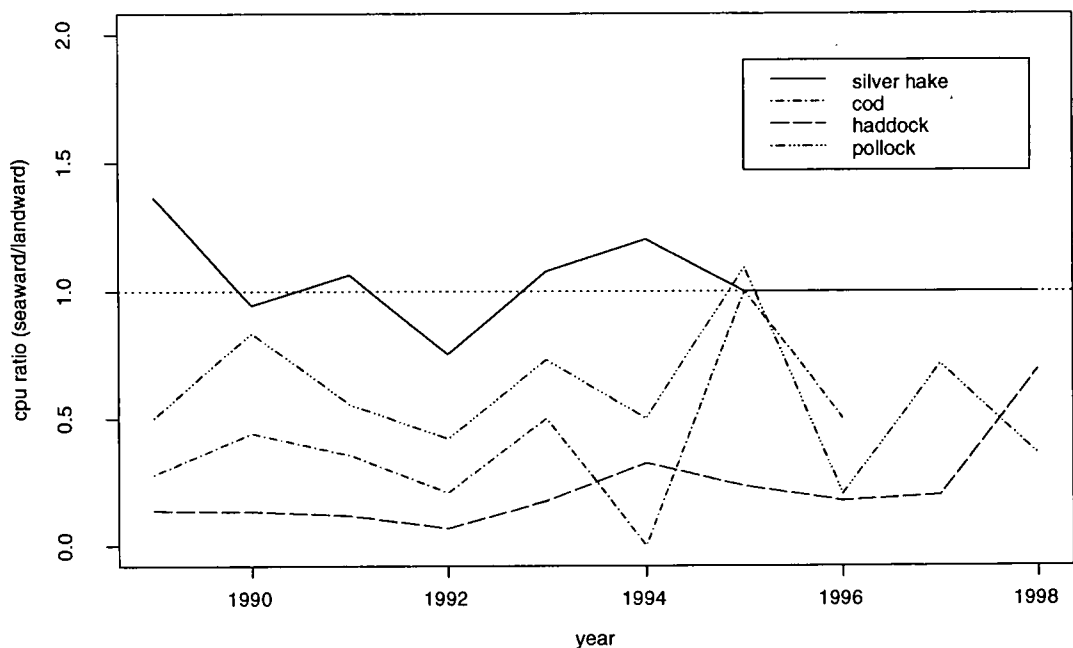


Figure 7. Ratio of silver hake catch rate and cod, haddock and pollock bycatch rates relative to 1994 SMGL (seaward/landward) from foreign small mesh gear fleets in the period 1989-98. (Note: There was no cod caught landward of the 1994 SMGL in 1997 and the seaward/landward ratio in 1998 was one, hence the cod line appears to end in 1996.)

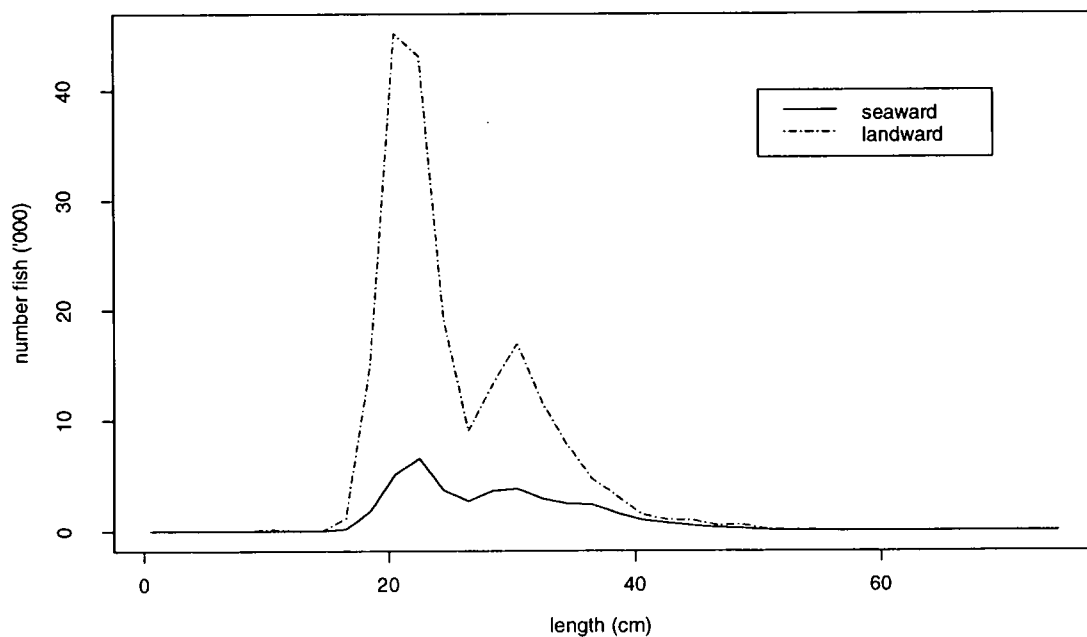


Figure 8. Number ('000) of haddock caught by length class (2 cm intervals) relative to 1994 SMGL (190m) by foreign small mesh gear fleets on the Scotian Shelf in 1996.