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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 87/59

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 87/59

**Haddock Nursery Closed Areas:
Delineation and Impact**

by

P. Fanning, K. Zwanenburg, and M.A. Showell

Biological Sciences Branch
Scotia-Fundy Region
Marine Fish Division
Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia, B2Y 4A2

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Abstract

The available commercial and research vessel datasets were utilized to locate areas of consistent abundance of juvenile haddock in 4VW. The commercial catch and effort data were used to estimate the impact of closures of the identified nursery areas on both the fisheries that traditionally included the closed areas and the juvenile haddock stocks that were to be protected.

It is concluded that the most important nursery areas were on Western, Emerald and Sable Island banks however, the winter distribution was on the slopes surrounding the banks. The impact of closed areas on traditional fisheries would be minimal for cod and redfish and could be minimized for silver hake by keeping the closed areas to the landward of the small mesh gear line. The haddock and pollock fisheries will be unavoidably affected by any closed area to protect juvenile haddock.

Résumé

Les données connues sur les prises commerciales et sur les prises des navires de recherche ont été utilisées pour déterminer les endroits dans la division 4VW où l'aiglefin juvénile présente une abondance uniforme. Les données sur les prises commerciales et sur l'effort de pêche ont été utilisées pour évaluer les répercussions des fermetures des zones d'alevinage identifiées sur les pêches qui couvraient traditionnellement les zones fermées et sur les stocks d'aiglefin juvénile à protéger.

On a conclu que les zones d'alevinage les plus importantes étaient situées sur les bancs Western, Emerald et Sable Island. Cependant, l'hiver les poissons étaient répartis sur les pentes entourant les bancs. Les répercussions des zones fermées sur les pêches traditionnelles à la morue et au sébaste seraient négligeables et elles pourraient être réduites au minimum dans le cas du merlu argenté si on gardait les zones fermées du côté intérieur (vers la terre) de la ligne des engins de pêche à petites mailles. Toute zone fermée visant à protéger l'aiglefin juvénile ne pourra faire autrement que d'influer sur la pêche à l'aiglefin et au goberge.

Introduction

At the November 13, 1986 Scotia-Fundy Groundfish Advisory Committee meeting, industry representatives unanimously recommended closing the Division 4VW haddock nursery areas to all groundfish fishing activity for 1987. At that time an emergency request was made to provide coordinates of all haddock nursery areas in Division 4VW. The short time frame was caused by the decision to incorporate the closed areas as a condition of license on the 1987 groundfish licenses which were being issued within a few weeks.

A set of provisional coordinates were provided at that time with the reservation that not all sources of data had been utilized because of time constraints and that more detailed analysis and review would be necessary to finalize these coordinates.

Initial Analysis

Two separate nursery areas were identified by two separate analyses. The primary data sources were the July groundfish research surveys (1970-1986) and the International Observer Program (IOP) (1981-1986) as well as published reports and personal communication.

The catches of age groups 0-3 haddock in the July research surveys were examined to determine the areas of concentration of each age group on a stratum by stratum basis (Figures 1a-d). Both the relative frequency of sets containing juvenile haddock and the abundance of juveniles in the catches were considered and the result indicated that areas where juvenile haddock were caught frequently also were where the catches were generally largest. The fact that fish become more available to the fishery as they grow implies that age 3 require more protection from fishing than do the younger age groups. The results of this indicated that Strata 63 (Emerald Bank), 64 (Western Bank), and 65 (Western Gully and southwest of Emerald Bank) were the most important nursery areas in July (Figure 2a). Stratum 55 (Sable Island Bank) has had large concentrations in years of high abundance but is hypothesized to be an "overspill" area only. The south-western edge of these 3 strata (Area I, Figure 2b) extends seaward of the Small Mesh Gear Line which has had implications for foreign vessels fishing in that area.

Estimates of the mean length of discarded haddock from 1981 to 1986 were obtained from the IOP for Canadian TC 4-5. The mean length of fish discarded varied from about 35 to 42 cm (Figure 3a) which generally corresponds to the length at about age 3. Maps of sets in which discarding occurred (Figure 3b) showed concentrations of discarding in and around the Western Gully (Strata 65) and on the eastern side of the Gully (Stratum 50) in 1985 and 1986. Western Gully is in the area defined above, based on research vessel surveys as one when age 3 fish are aggregated. While Stratum 50 is above average in terms of the presence of juveniles in the research surveys it is not one of the most important strata; however, the level of fishing activity (and observed discarding) in that area in recent years makes it a potentially critical area within which to protect juveniles for 1987.

From these two analyses the coordinates of 2 areas containing significant concentrations of juvenile haddock were defined based on strata boundaries (Figure 2b). Closed Area I encloses strata 63, 64, and 65 and Closed Area II encloses Stratum 50.

Detailed Analysis

To examine whether the previously described closed areas were adequate to provide protection of juvenile haddock a more detailed set-by-set analysis of the research surveys was undertaken. A series of expanding symbol maps was generated showing set locations and catches. In the July surveys there have been a total of 1561 sets made in Division 4VW from 1970 to 1986. These sets were aggregated by 15 minute squares and the mean, standard deviation, and median of the catches plotted (Figures 3, 4, and 5, respectively). There were high mean catches scattered from Emerald Bank to Banquereau and north to Middle Ground with clusters on and around Emerald Bank, to the west of Sable Island on Sable and Western banks and southeast of Sable Island (Figure 3). The standard deviation (Figure 4) varied generally with the mean and is particularly large southeast of Sable Island. Because of the sensitivity of the mean to large catches, the median was also mapped (Figure 5). Large median catches are much less widely distributed than large mean catches. However, the clusters on Emerald Bank and Sable Island Bank are still present. It is important to note that the cluster of higher means southeast of Sable Island had zero or very small median catches. Detailed examination of each year showed that large catches in that area were made in 1982, 1983, and 1984 only and were associated with the 1981 year-class.

The actual catch in numbers from the fall surveys in 1978 to 1981 are plotted in Figure 6. The largest catches came from Emerald Bank, Western Bank, and Western Gully. Generally the distribution of juveniles in the fall was similar to that in summer.

The catches in numbers from the spring surveys from 1979 to 1981 are plotted in Figure 7. The largest catches were all taken along the edges of the banks (approximately 100 m contour). There was still a cluster of catches along Emerald Bank and another on the southern edge of Sable Island Bank. The spring surveys were the only ones to show large catches of juveniles in the shelf edge.

Closed Area I covers the areas of concentration of the summer and fall distribution of juvenile haddock. However, the southerly edge of the closed area had lower concentrations of juvenile haddock than the northern portions. As well, the eastern edge of Closed Area I did not include a consistent concentration of juvenile haddock on Sable Island Bank. The distribution in the spring surveys is around the edges of the banks, on the slopes, and mostly outside or on the very edge of Area I. Closed Area II had no major concentrations of juvenile haddock in spring, summer, and fall surveys.

Impact on Traditional Fisheries

The question as to the potential impact of the two presently closed areas on traditional fisheries in these areas has several facets only a very few of which will be examined in the following discussion. This is to a large extent due to limitations of available data. The most elementary examination of this question would involve examining the total amounts of each major commercially exploited groundfish species caught in the area, and partitioning between open and closed areas for a number of years to determine the relative distributions of landings between the locations. A somewhat more revealing analysis would also examine the effort expended to realize the catches in each of these areas to determine whether or not the closed areas impact "favoured" fishing grounds, i.e. those that display high catch rates.

Unfortunately fisheries statistics are collected on a spatial scale which is broader than that required for the above analyses. The only information available which approximates those required are from the IOP database. These data are collected by observers at sea and record catch, effort, location, and species composition on a set by set basis for a proportion of domestic vessels fishing in Scotia-Fundy waters. The coverage tends to be restricted to the larger classes of vessel (tonnage class 4 and above) and represents about 10-20% of the effort expended by these vessels annually. Examination of these data will reveal unequivocally where the observed portion of the fleet fished, what it caught and how much effort it expended to catch it. Extrapolating these results to predict what the behaviour of the entire fleet was during that year, and thus what the distribution of catch and effort for all landings involves a number of major assumptions, none of which have as yet been tested. In the absence of a rigorous examination of these assumptions one must be cautious about generalizing the results of an analysis of these data. It should be realized at the outset that any results will apply primarily to vessels in the larger tonnage class categories (TC 4 and above) and precludes conclusions regarding smaller vessels which may show significantly different patterns.

The major domestic groundfish fisheries in Divisions 4VW are those for cod, haddock, pollock, redfish, and flatfish. Catch and effort values for each of these species were extracted summarized by quarter as follows and are given in Appendix I.

International Observer Program data files were analyzed to extract requisite data. This included, for all major fisheries occurring in Divisions 4VW:

1. Directed catch inside and outside of the two presently closed areas. These catches were summed on a quarterly basis from all records (sets) where the species of interest was the main species caught.
2. Effort directed at the species of interest inside and outside of the two presently closed areas. The effort values were summed on a quarterly basis for all records where the species of interest was the main species caught.

3. The total catch directed and non-directed for the species of interest. These catches were summed on a quarterly basis for all records where the species of interest was caught in any quantity.
4. The total effort expended, both directed and non-directed, at the species of interest. These effort values were summed on a quarterly basis for all records where the species of interest was caught in any quantity.

Initial examination of these results indicated that observed redfish and flatfish fisheries were relatively unaffected by the closed areas. The maximum observed catches of redfish in Area I was 11.6 t in 1980 while observed catches in Area II have not exceeded 1.8 t since 1980. Observed catches of flatfish have not exceeded 1 t since 1980. No further analyses of the catch/effort data for redfish and flatfish were conducted. For the remaining three fisheries each will be discussed in more detail below.

Pollock

The percentage of total directed pollock catches (Table 1) inside either Area I or Area II is highly variable between years. For Closed Area I this ranges from less than 1% to 74% while for Area II the value ranges from less than 1% to 22%. The mean percent of directed pollock catches in Area I is 30% from 1980-1986 though in the last three years this has averaged only 9%. In 1986 only 4% of directed pollock catches were taken in Area I. The mean percent of directed pollock catches taken from Area II between 1980 and 1986 was 10% although in the last three years this has risen to an annual average of 15%.

An examination of pollock directed catch rates (Table 2) reveals that catch per unit of effort values inside either Area I or Area II exceed those realized outside in every year except 1985. This would indicate that both of these areas are potentially lucrative pollock fishing grounds.

An examination of the potential impact of the pollock fishery on the juvenile haddock populations in the closed areas was conducted using IOP data. This is provided in Appendix 2. The overall haddock by-catch rate has been lowest in Area I most recently but the fraction of small haddock (≤ 37 cm) was highest. Area II had generally higher overall haddock by-catch rates but a lower percent of small haddock. The data collected by the IOP are essentially limited to TC 4 and 5 trawlers and haddock by-catch length frequencies are relatively infrequent. Because of the large variability in the by-catch rates the possibility of large by-catches of juvenile haddock in the pollock fishery in a given year and area is difficult to evaluate. However, the possibility must be considered greater in Area I than elsewhere given the consistent presence of haddock juveniles in that area.

Cod

In contrast to the results obtained above for pollock, directed cod catches in Area I have not exceeded 2.2% (Table 3) of the total directed cod catches observed over the period 1980-1986. In the last two years less than

0.1% of the observed total directed catch was taken here. The proportion caught in Area II reached a maximum in 1985 of 10.7%. The mean value for 1980-1986 is 3.1%. Although catch rates in the closed areas have exceeded those outside the areas on several occasions over the past few years (Table 4), the low levels of catch probably result in a high degree of variability in these rates. These analyses indicate that the closed areas have not been favoured cod fishing grounds over the past seven years.

Haddock

Since Closed Area I was defined as a haddock nursery area on the basis of a persistent presence of ages 0-3 haddock over the past 17 years it is not surprising that significant proportions of the total directed haddock catches of the past seven years have been taken in that area. The mean percent of directed haddock catch (1980-1986) is 62.4% (Table 5), although in the past three years this has dropped to 38%, consistent with a general shift in the fishery from the 4W to the 4Vs area. This shift is also reflected to some extent by the fact that the fraction of the catch taken in Area II has increased from a 1980-86 mean of 8.8% to a mean value of 28.9% in the past two years.

Haddock catch rates in Area I or II generally equal or exceed those of areas outside (Table 6) indicating that these areas are preferred haddock fishing grounds.

Silver Hake

The impact of the closed areas on the silver hake fishery has been analysed in relation to a set of specific questions. These questions and responses are given in Appendix 3. In summary, the silver hake catches from the portion of Closed Area I seaward of the small mesh gear line (SMGL) accounted for 28% for the USSR and 17% for Cuba of their total catches from Division 4VWX in 1981 to 1985. An extensive analysis of by-catches by the foreign fleet landward and seaward the SMGL (Waldron and Sinclair, 1984) has indicated that by-catch levels of haddock seaward of the SMGL have had no appreciable impact on haddock yields. This conclusion together with the indications from the surveys that few juvenile haddock occur seaward of the SMGL suggest that any closed area to protect juvenile haddock does not need to extend beyond the SMGL.

Conclusions

1. The haddock nursery area in Division 4VW varies with season, from the tops of Emerald, Western, and Sable Island banks in July and October/November to the deeper water on the slopes around the banks in March.
2. As presently defined, Closed Areas I and II may have significant impacts on haddock, pollock, and silver hake fisheries in divisions 4VW by excluding vessels from potentially lucrative fishing grounds.

3. Catches of haddock seaward of the SMGL in the silver hake fishery have been insignificant and so Closed Area I should not extend seaward of the SMGL.
4. Closed Area II does not include any detectable nursery areas. Re-opening Closed Area II would reduce the amount of effort displaced from 13% to 4% based on the last 3 years.

References

Waldron, D.E., and A.F. Sinclair. 1985. Analysis of by-catches observed in the Scotian Shelf foreign fishery and their impact on domestic fisheries. In: R. Mahon [ed] Towards the Inclusion of Fisheries Interactions in Management Advice. Can. Tech. Rep. Fish. Aquat. Sci. No. 1347.

Table 1. Observed percentages of pollock catches inside and outside of Closed Areas I and II (1980-1986).

Year	Observed Directed Catch			Total Observed Catch		
	Area I	Area II	Outside	Area I	Area II	Outside
1980	27.3	0.8	72.0	29.4	2.2	68.4
81	71.4	1.4	27.2	68.7	1.4	29.8
82	74.4	2.7	22.9	70.4	3.2	26.3
83	4.6	22.6	72.8	4.9	20.4	74.6
84	22.7	8.9	68.4	21.3	8.4	70.2
85	0.4	21.5	78.0	0.4	23.3	76.2
86	3.7	13.6	82.7	3.7	14.1	82.1

Table 2. Pollock catch rates inside and outside of Closed Areas I and II.

Year	Area I	Area II	Outside
Directed Catch/Effort			
1980	.75	1.87	1.20
1981	2.30	.74	1.04
1982	1.83	1.18	1.54
1983	1.13	2.69	1.18
1984	2.92	3.36	1.64
1985	.92	2.27	2.39
1986	3.48	2.36	2.97
By-Catch Catch/Effort			
1980	.08	.22	.06
1981	.02	.02	.05
1982	.01	.11	.07
1983	.03	.09	.06
1984	.02	.04	.04
1985	.01	.13	.06
1986	.04	.09	.04

Table 3. Observed percentages of cod catches inside and outside of Closed Areas I and II (1980-1986).

Year	Observed Directed Catch			Total Observed Catch		
	Area I	Area II	Outside	Area I	Area II	Outside
1980	0.6	1.3	98.2	1.1	1.4	97.5
81	2.2	0.7	97.0	3.2	0.9	95.9
82	0.5	2.8	96.7	1.8	2.9	95.3
83	0.3	2.1	97.5	0.7	2.3	97.0
84	0.8	0.7	98.5	0.9	0.8	98.3
85	0.0	10.7	89.3	0.1	11.5	88.4
86	0.0	3.4	96.6	0.4	4.9	94.6

Table 4. Cod catch rates inside and outside of Closed Areas I and II.

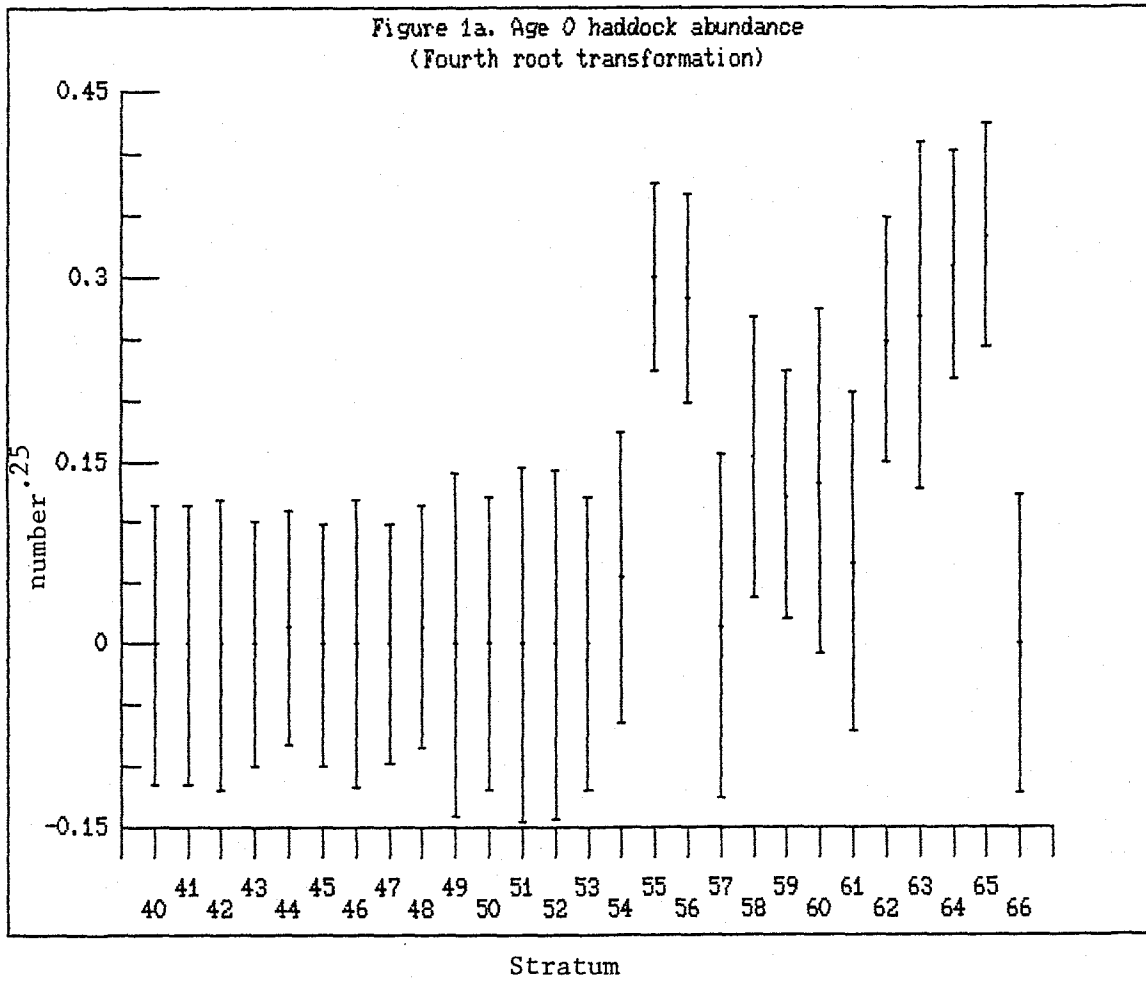
Year	Area I	Area II	Outside
Directed Catch/Effort			
1980	.47	1.92	1.61
1981	.70	.39	.99
1982	.68	.90	1.33
1983	.33	.77	1.21
1984	3.54	.93	1.65
1985	.32	1.91	1.73
1986	.05	1.44	1.50
By-Catch Catch/Effort			
1980	.04	.15	.03
1981	.04	.06	.04
1982	.06	.05	.03
1983	.04	.06	.03
1984	.02	.14	.05
1985	.04	.11	.07
1986	.07	.16	.09

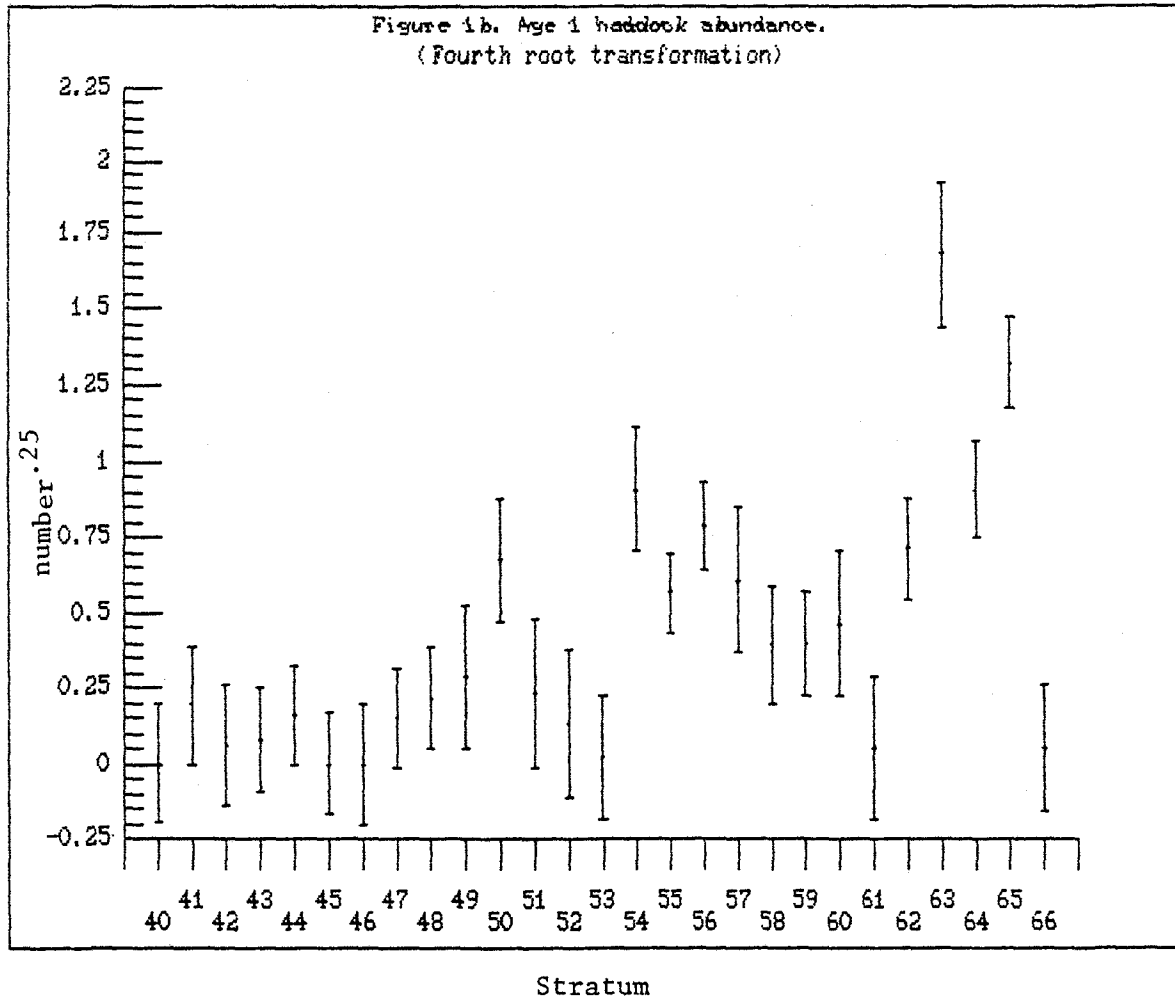
Table 5. Observed percentages of haddock catches inside and outside of Closed Areas I and II (1980-1986).

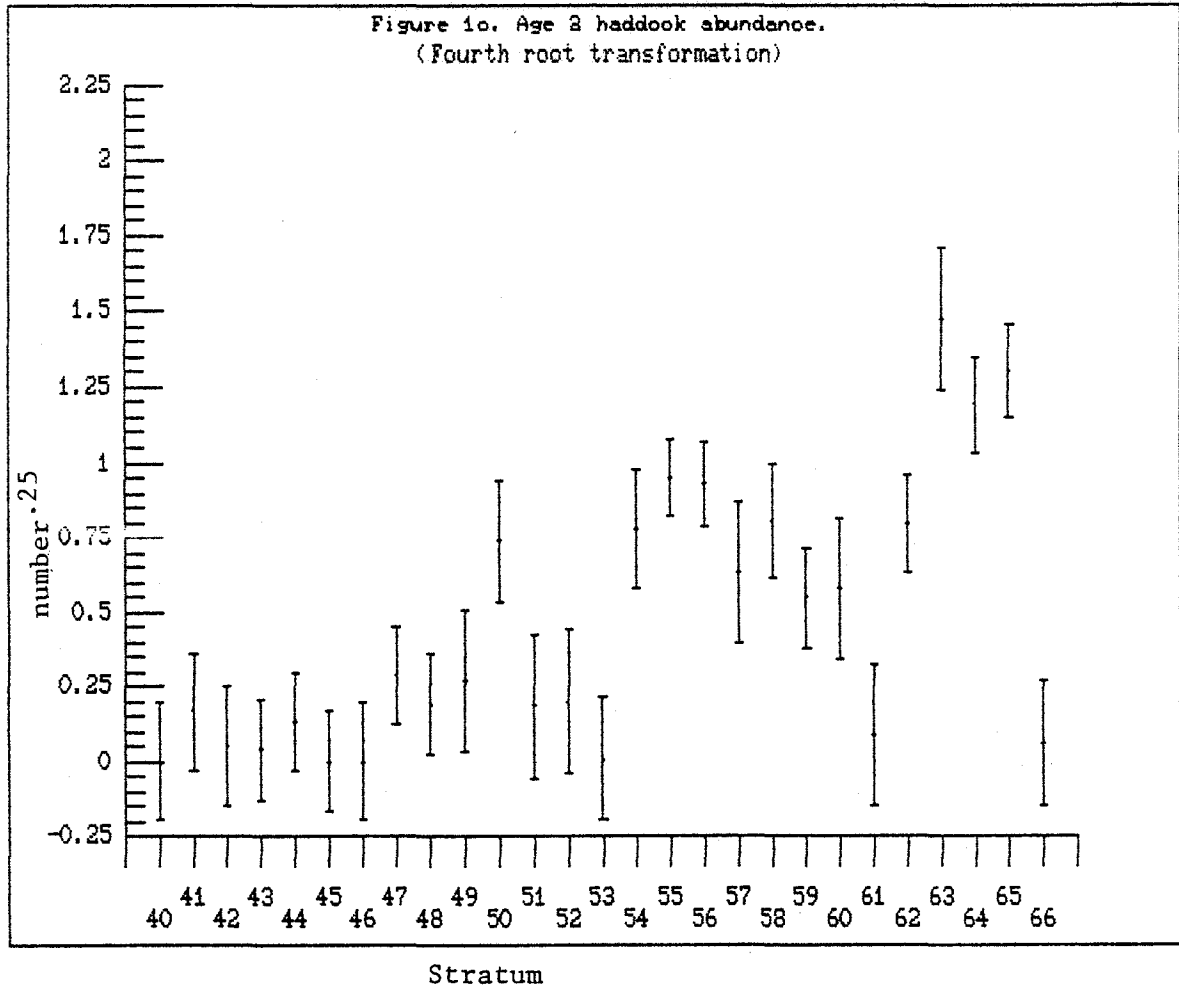
Year	Observed Directed Catch			Total Observed Catch		
	Area I	Area II	Outside	Area I	Area II	Outside
1980	76.9	2.6	20.4	72.7	3.4	23.9
81	82.7	0.3	17.0	75.2	0.8	24.0
82	86.0	0.2	13.8	77.6	1.2	21.2
83	92.6	0.5	6.8	70.8	2.0	27.1
84	46.6	0.4	52.9	30.4	1.1	68.4
85	8.9	43.1	48.0	6.6	39.9	53.5
86	43.0	14.7	42.3	31.7	13.0	55.2

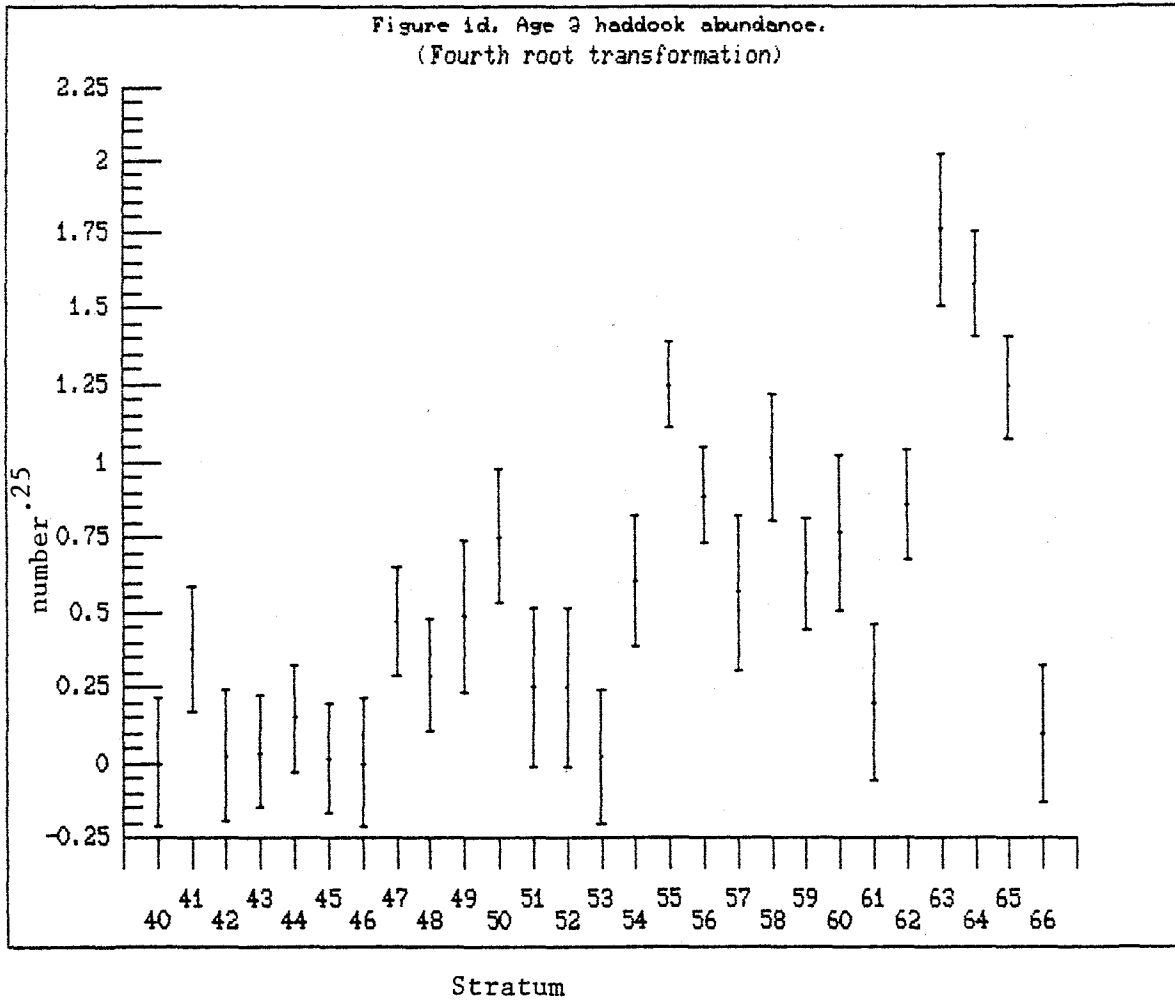
Table 6. Haddock catch rates inside and outside of Closed Areas I and II.

Year	Area I	Area II	Outside
Directed Catch/Effort			
1980	1.00	1.58	.46
1981	.93	.25	.59
1982	1.34	.25	.56
1983	.84	.29	.35
1984	.90	.45	.95
1985	1.09	1.32	1.09
1986	1.98	1.18	.96
By-Catch Catch/Effort			
1980	.04	.31	.04
1981	.02	.09	.07
1982	.03	.09	.07
1983	.01	.06	.06
1984	.02	.08	.08
1985	.02	.16	.11
1986	.005	.08	.12









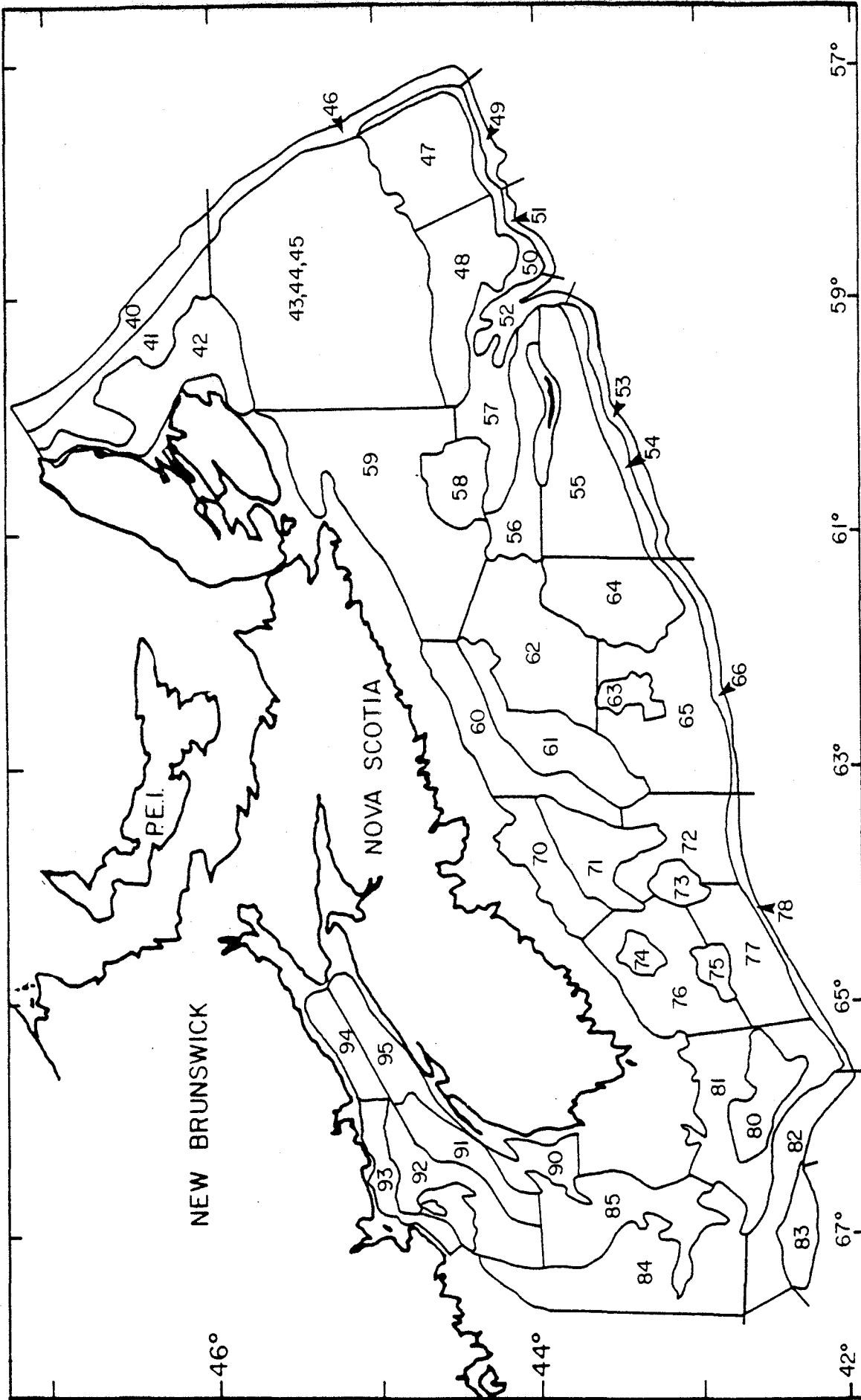


Figure 2a. Stratification scheme used for research trawl survey of the Scotian Shelf from 1970 to the present. Strata boundaries are based on depth.

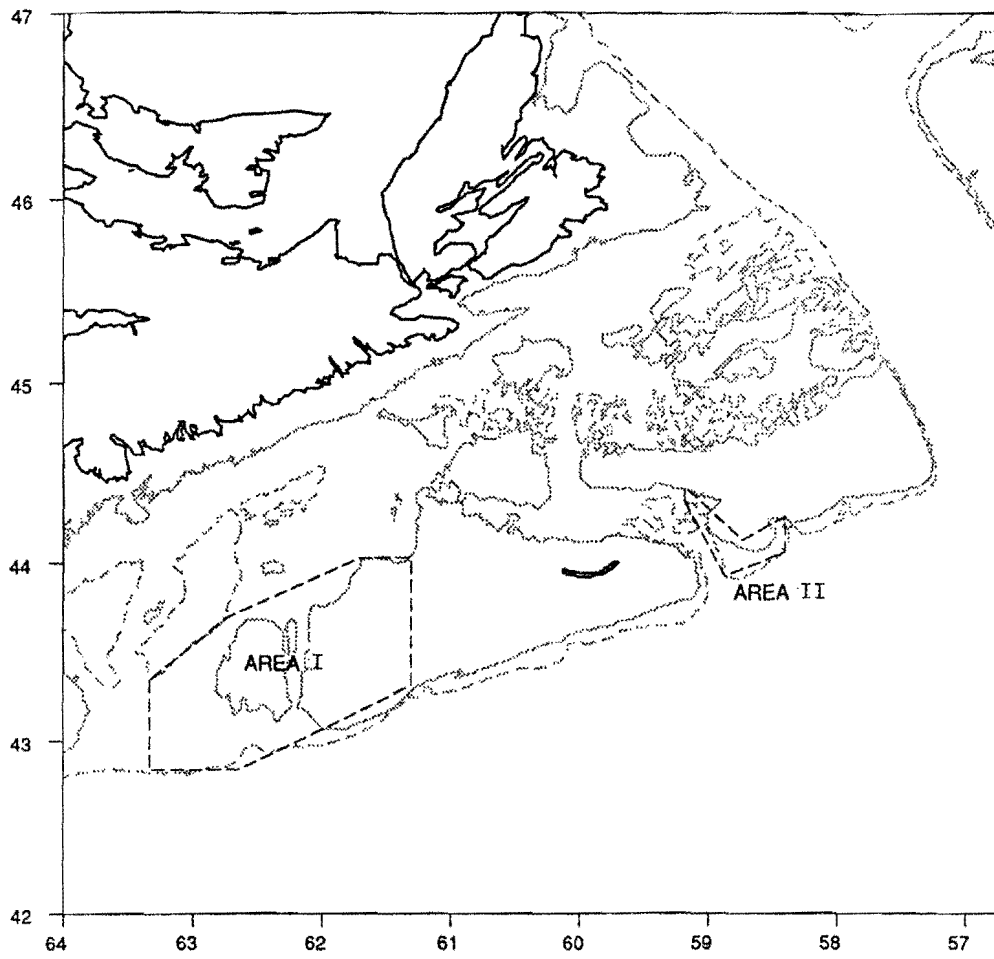


Figure 2b. 1987 Closed Areas in 4VW to protect juvenile haddock.

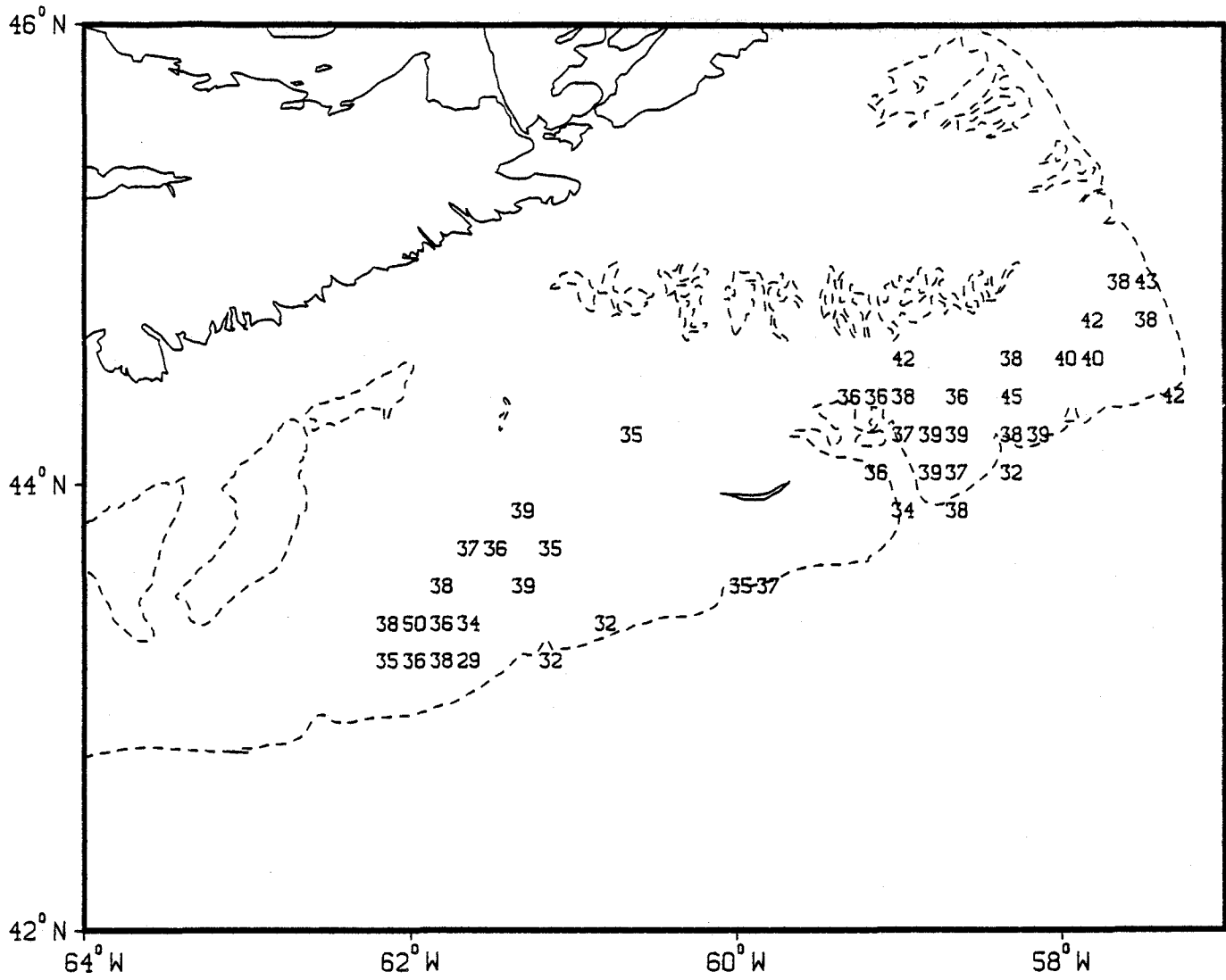


Figure 3a. Mean length of haddock discards observed in the IOP from 1980-1986. Means are aggregated by 10 minute squares.

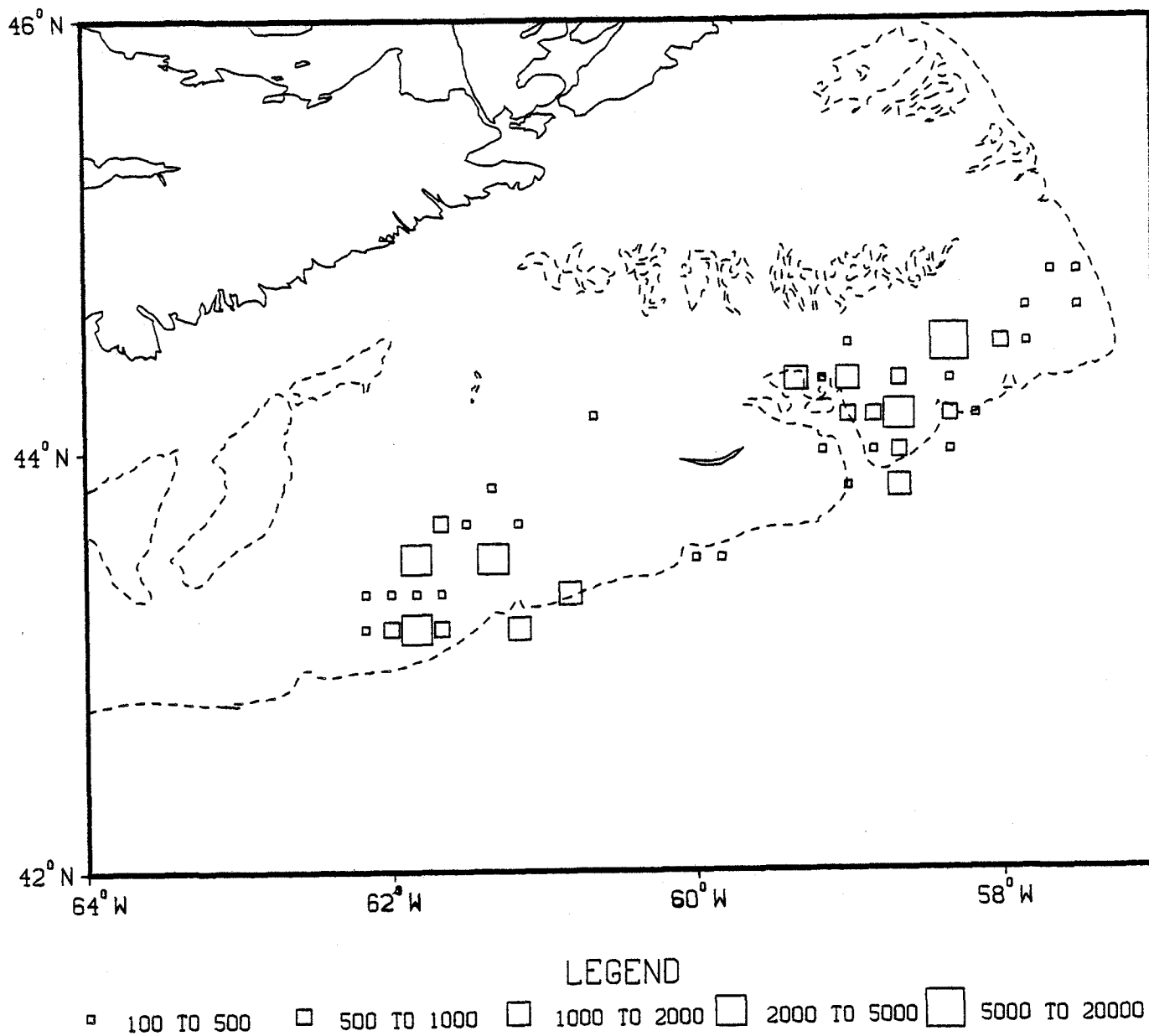


Figure 3b. Estimated weight of discarded haddock observed in the IOP from 1980-1986. Means are aggregated by 10 minute squares.

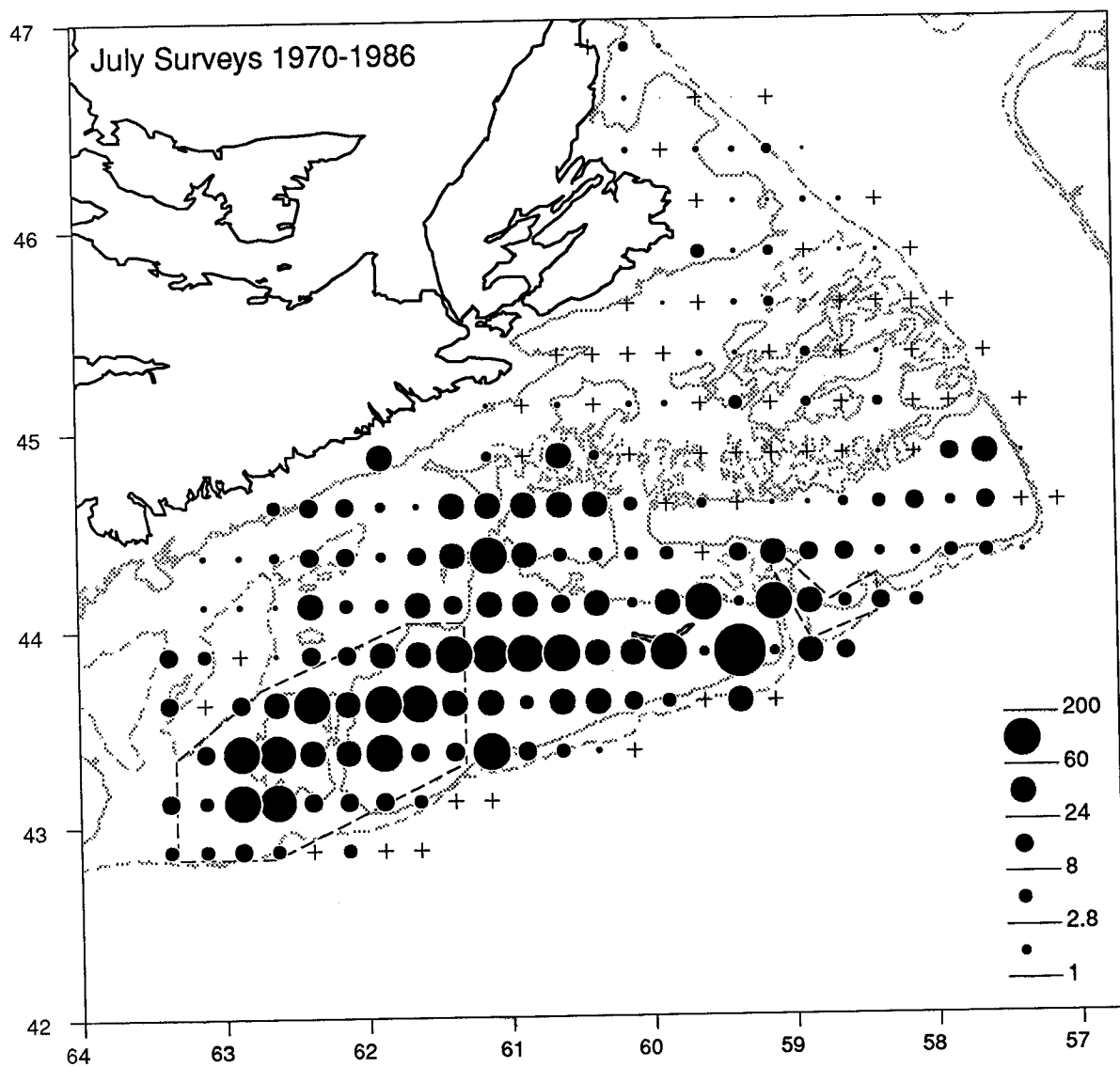


Figure 4 . Mean research survey number of juvenile Haddock (AGES 0-3) caught per tow aggregated by 15 minute squares.

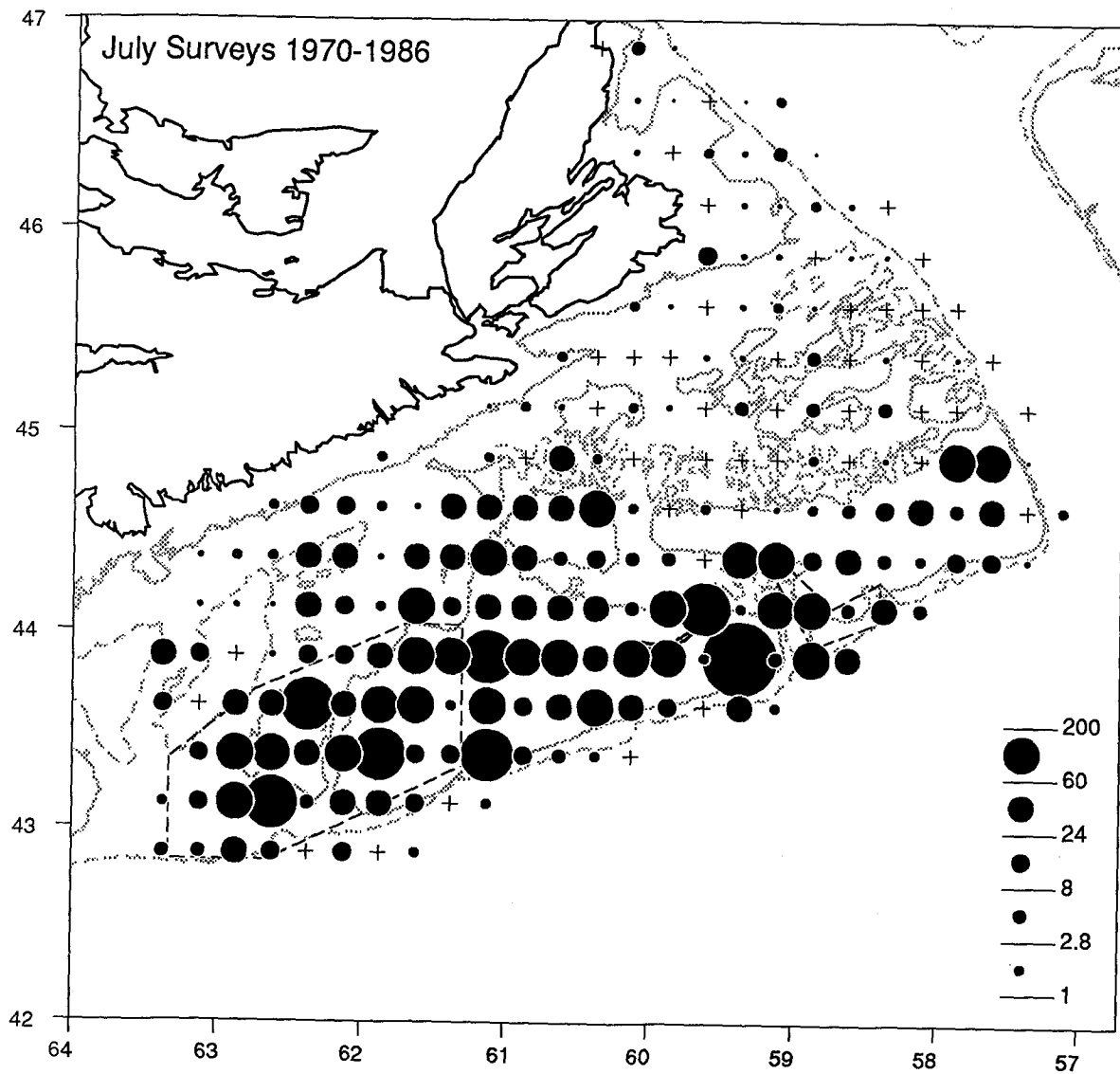


Figure 5 . Standard deviation of research survey number of juvenile Haddock (ages 0-3) caught per tow aggregated by 15 minute squares.

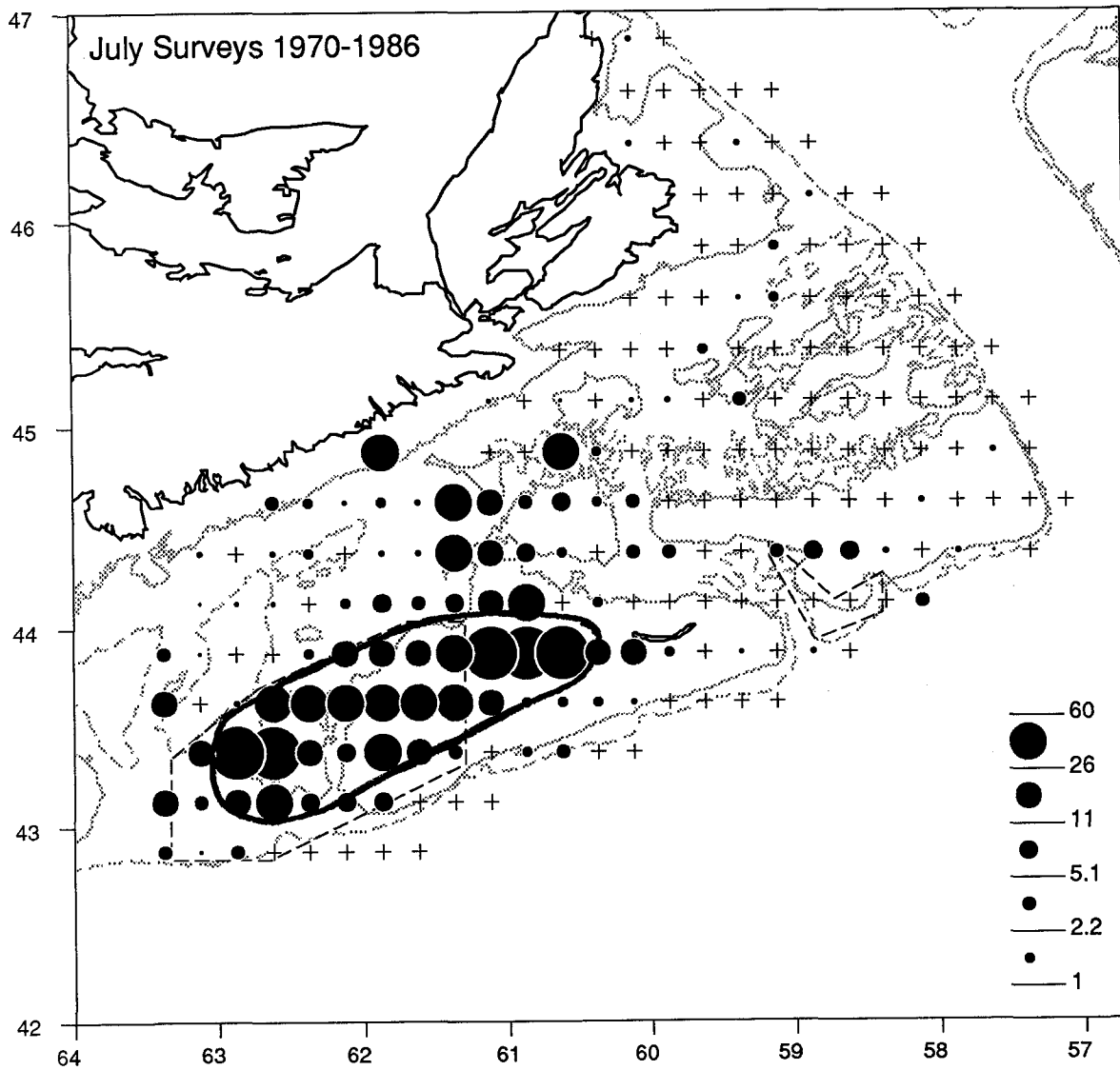


Figure 6 . Median research survey number of juvenile Haddock (ages 0-3) caught per tow aggregated by 15 minute squares.

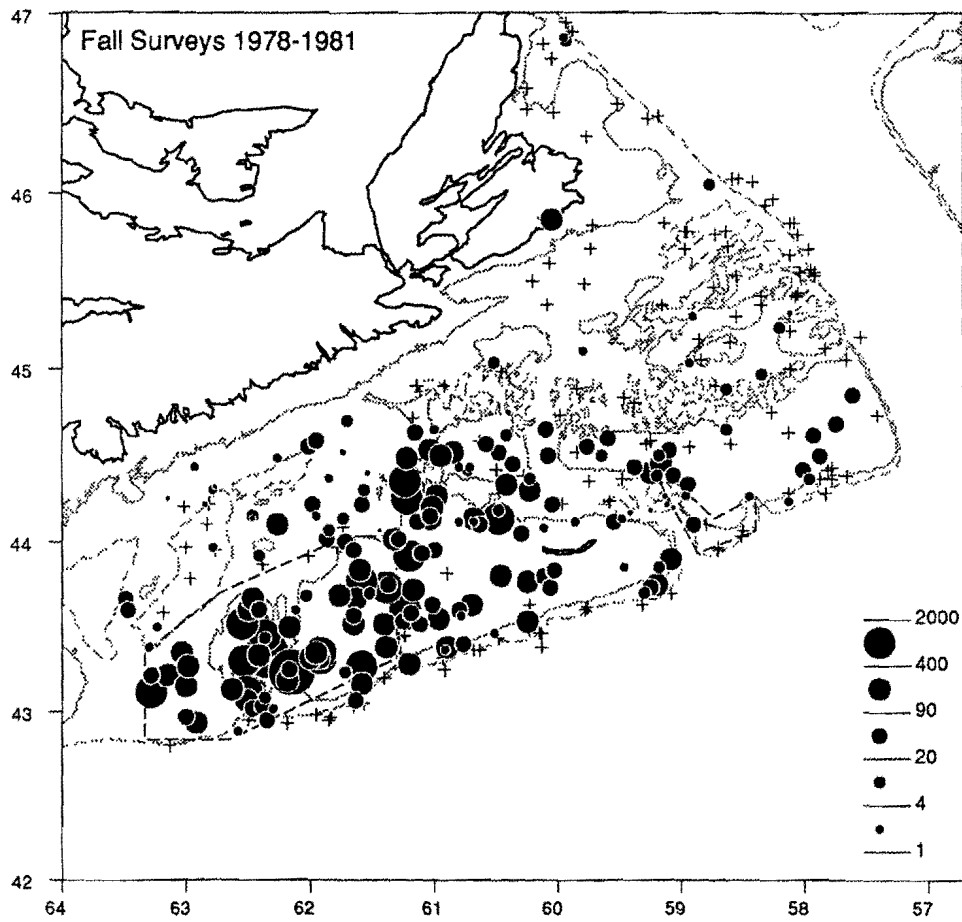


Figure 7 . Research survey number of ages 0-3 Haddock caught per tow.

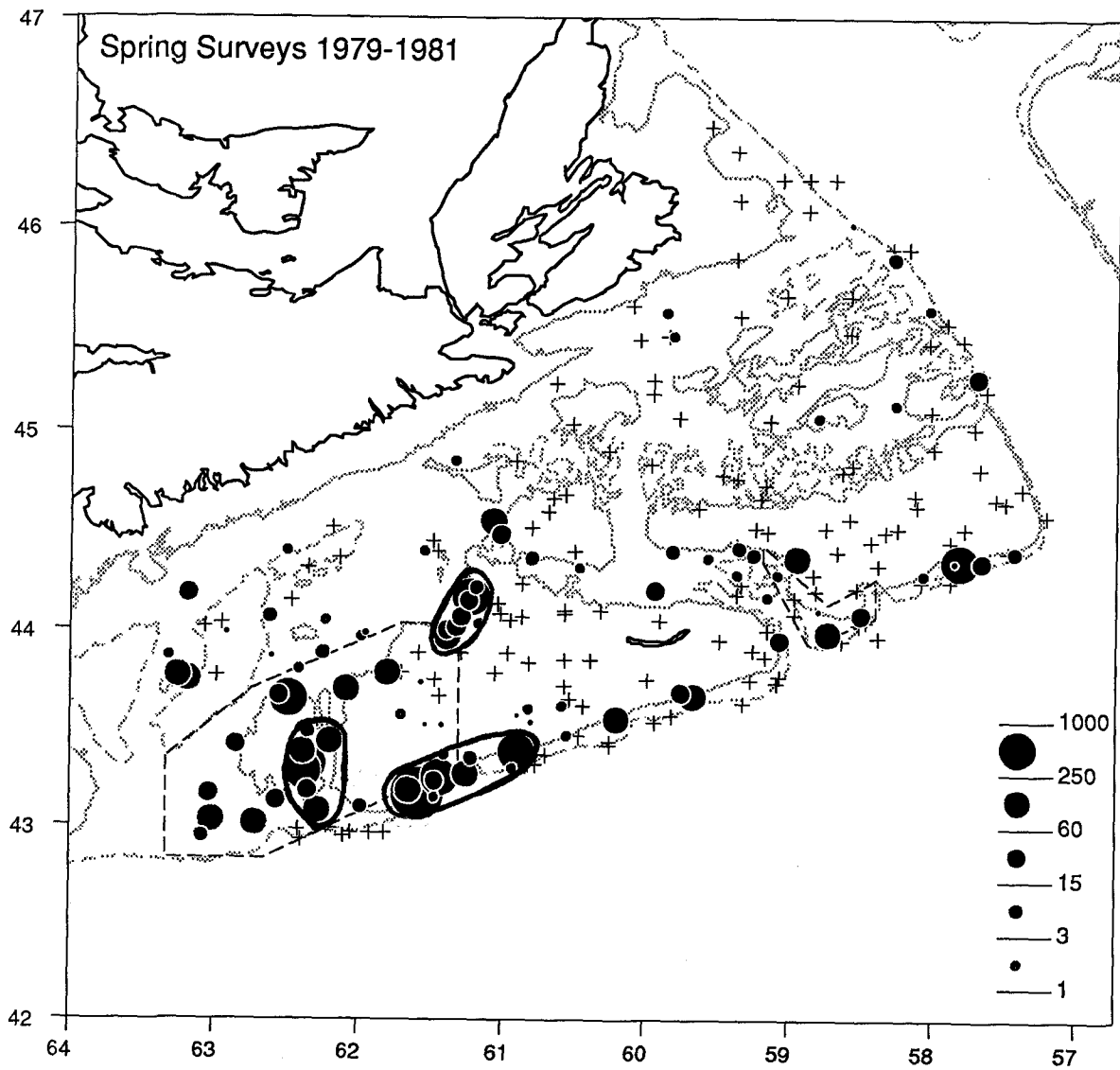


Figure 8. Research survey number of ages 0-3 Haddock caught per tow.

APPENDIX 1

Seasonal catch and effort in Closed Areas I and II and outside the closed areas in Division 4VW for indicated species. Data was obtained from the IOP.

Species: **Pollock**

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1980	Directed Catch	0.2	-	-	97.6	2.8	-	-	-	175.9	0.3	-	81.3
	Directed Effort	2.5	-	-	128.4	1.5	-	-	-	127.1	4.8	-	82.3
	Total Catch	2.6	-	-	136.4	7.3	3.2	-	-	211.8	14.0	0.4	93.0
	Total Effort	52.6	-	-	489.9	26.1	9.3	-	-	749.2	77.4	10.6	272.7
1981	Directed Catch	229.0	-	3.1	1434.3	11.2	20.1	1.5	0.7	206.2	117.7	40.5	270.8
	Directed Effort	162.4	-	5.2	557.2	13.9	22.3	2.3	6.8	215.6	119.5	66.3	208.7
	Total Catch	251.1	0.4	3.1	1436.8	13.0	20.6	1.5	0.7	247.6	153.4	42.3	289.8
	Total Effort	606.5	33.0	5.2	603.2	32.9	51.8	5.7	6.8	584.6	544.1	89.7	592.5
1982	Directed Catch	451.9	43.3	18.2	799.4	-	5.7	38.1	3.3	21.5	74.6	37.1	270.4
	Directed Effort	230.5	53.3	19.8	412.4	-	10.6	23.1	6.2	11.8	72.1	17.3	160.7
	Total Catch	458.6	44.9	18.4	800.2	-	19.3	38.1	3.4	52.0	110.2	37.7	293.9
	Total Effort	310.0	115.7	33.2	453.8	-	86.8	23.1	15.0	378.2	251.4	32.2	666.7
1983	Directed Catch	21.1	0.9	2.0	-	1.0	104.1	14.2	-	40.8	195.5	130.1	17.9
	Directed Effort	11.4	5.0	5.0	-	2.5	27.1	14.8	-	14.9	161.4	119.6	30.3
	Total Catch	26.5	2.8	2.1	0.3	2.3	104.4	24.8	0.1	66.3	227.3	156.4	29.1
	Total Effort	135.6	59.3	10.6	15.1	48.1	31.3	60.0	3.2	282.4	473.4	458.3	398.7
1984	Directed Catch	70.6	73.2	0.2	107.7	43.3	0.08	-	54.9	325.5	19.2	90.7	321.4
	Directed Effort	51.9	14.7	2.9	16.7	7.9	1.7	-	19.7	219.9	16.7	59.2	164.7
	Total Catch	71.9	73.5	3.1	107.7	45.4	0.1	-	55.4	380.8	23.4	93.7	345.8
	Total Effort	107.2	42.7	12.1	18.2	27.5	1.7	-	33.8	984.0	242.6	197.1	586.2

Species: **Pollock**

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1985	Directed Catch	8.3	-	-	3.7	243.4	166.9	63.0	105.0	558.4	207.4	540.9	792.9
	Directed Effort	9.0	-	-	4.0	104.6	95.7	16.8	38.0	232.9	115.7	213.3	317.7
	Total Catch	8.5	0.1	0	3.8	326.9	190.2	64.3	107.3	622.6	260.5	558.8	809.7
	Total Effort	16.5	5.8	3.2	11.7	487.1	241.9	40.3	74.4	804.3	501.3	641.1	604.7
1986	Directed Catch	136.7	-	0.1	2.3	136.1	170.7	204.6	1.2	311.8	1724.3	1005.7	89.1
	Directed Effort	25.1	-	2.5	12.3	80.1	62.8	71.2	3.4	117.4	509.2	357.9	69.3
	Total Catch	137.6	-	0.1	6.7	171.3	170.9	206.9	1.3	349.6	1731.0	1021.9	95.1
	Total Effort	53.8	-	5.5	84.4	234.7	64.3	90.6	12.5	303.1	608.9	588.6	255.7

Species: Cod

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1980	Directed Catch	13.4	-	-	5.3	35.6	6.0	-	-	2646.8	308.5	5.0	38.3
	Directed Effort	15.8	-	-	24.2	15.3	6.4	-	-	1584.8	172.1	3.8	226.8
	Total Catch	22.7	-	0.2	14.4	37.5	9.4	-	-	2688.8	318.9	8.2	260.7
	Total Effort	131.7	-	15.0	344.5	24.6	11.8	-	-	1903.1	462.9	37.2	546.6
1981	Directed Catch	71.0	25.7	-	7.9	10.4	22.4	-	0.5	1188.4	1133.5	8.4	2190.6
	Directed Effort	126.7	19.3	-	4.1	26.6	55.1	-	2.9	1263.7	1403.5	14.3	1872.7
	Total Catch	115.0	32.6	-	12.2	13.6	28.4	0.1	0.6	1276.2	1209.4	45.8	2259.4
	Total Effort	1019.2	216.0	-	248.7	41.9	98.5	3.3	8.3	2052.2	1907.8	430.9	2467.4
1982	Directed Catch	13.6	6.0	-	-	0.8	98.4	-	18.7	1914.5	895.8	0.9	1219.9
	Directed Effort	7.2	21.8	-	-	2.2	113.9	-	14.8	1175.5	725.2	4.8	1135.9
	Total Catch	31.7	40.4	0.2	5.5	0.8	104.3	1.6	19.9	1958.8	925.9	6.2	1256.7
	Total Effort	400.7	317.3	16.6	243.8	2.2	137.4	17.9	22.5	1372.2	1065.0	349.3	1748.6
1983	Directed Catch	8.2	6.7	0	0.5	58.9	1.8	34.8	0.8	1192.5	927.1	398.3	1859.6
	Directed Effort	19.6	19.0	2.0	6.7	69.7	4.0	48.5	3.2	1054.6	894.5	411.8	1268.3
	Total Catch	14.4	14.3	0.4	2.9	59.5	2.6	43.9	0.8	1222.0	980.9	436.8	1874.2
	Total Effort	193.0	170.4	14.6	19.1	80.4	30.6	68.3	4.4	1231.7	1229.9	971.9	1520.9
1984	Directed Catch	55.2	-	-	-	35.8	-	-	8.0	3270.0	543.9	253.8	2397.3
	Directed Effort	15.6	-	-	-	34.4	-	-	12.8	2001.0	567.1	147.3	1194.7
	Total Catch	59.4	1.3	0.2	0.1	36.9	-	-	18.7	3371.0	607.0	287.7	2503.0
	Total Effort	160.5	71.4	9.0	9.3	45.8	-	-	38.4	2751.9	893.3	579.8	1928.4

Species: Cod

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1985	Directed Catch	-	-	-	1.7	566.0	34.2	29.9	4.5	2452.2	815.0	665.7	1378.6
	Directed Effort	-	-	-	5.3	241.2	44.5	38.3	8.2	1123.5	511.8	623.9	812.9
	Total Catch	4.7	0.3	0	1.9	635.9	69.8	32.4	6.9	2523.2	925.0	797.2	1462.0
	Total Effort	84.8	21.5	3.2	16.8	569.4	267.2	70.3	69.8	1661.7	989.8	1927.7	1304.9
1986	Directed Catch	-	-	-	0.4	89.5	-	4.7	0	808.5	326.4	1010.6	517.1
	Directed Effort	-	-	-	7.4	56.4	-	8.2	1.0	252.0	333.9	757.6	434.7
	Total Catch	9.6	-	0.1	4.3	128.7	3.3	24.4	0.9	893.4	408.7	1185.2	541.3
	Total Effort	101.0	-	6.0	102.0	245.1	54.0	83.8	13.4	780.8	904.6	1465.5	710.3

Species: Haddock

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1980	Directed Catch	428.2	-	-	250.9	10.3	12.8	-	-	61.1	8.6	-	110.5
	Directed Effort	228.8	-	-	452.3	9.3	5.3	-	-	78.9	15.4	-	299.4
	Total Catch	431.6	-	0.9	283.0	18.6	14.9	-	-	86.1	19.4	0.3	128.8
	Total Effort	246.3	-	23.8	633.3	24.6	9.3	-	-	596.0	191.0	17.4	512.6
1981	Directed Catch	1239.9	469.2	-	24.2	0.7	4.8	0.3	0.2	149.9	156.8	2.1	46.8
	Directed Effort	1446.9	376.5	-	45.7	1.9	17.8	3.3	1.1	332.2	141.5	8.1	116.7
	Total Catch	1269.6	475.5	0	43.7	4.2	13.2	0.4	0.2	212.7	255.8	3.5	98.4
	Total Effort	1712.3	412.4	1.2	421.3	37.6	79.4	5.7	5.3	1119.1	1216.5	65.7	763.5
1982	Directed Catch	513.6	467.8	1.7	3.8	-	1.6	-	0.1	31.4	107.5	0.2	19.5
	Directed Effort	325.8	360.7	9.2	40.0	-	5.0	-	2.2	31.2	160.5	1.5	90.8
	Total Catch	529.3	473.6	3.3	19.3	0.5	14.1	0.3	0.8	39.0	170.0	0.7	69.9
	Total Effort	535.9	432.7	32.5	286.6	2.2	115.2	11.2	20.8	296.1	577.4	9.8	818.5
1983	Directed Catch	237.9	151.6	0.3	5.4	0.8	0.4	0.9	0.1	6.2	7.5	7.4	7.8
	Directed Effort	299.3	161.1	3.6	5.5	1.5	2.8	2.0	1.3	19.6	27.7	22.2	13.2
	Total Catch	240.8	154.2	0.4	7.0	6.2	0.6	4.5	0.4	29.7	43.2	46.8	34.6
	Total Effort	326.8	195.3	9.6	19.1	71.8	24.8	61.1	4.4	542.8	545.4	496.1	686.3
1984	Directed Catch	135.9	56.3	3.4	0.3	1.5	-	-	0.4	12.8	122.7	56.1	30.7
	Directed Effort	142.4	62.3	6.6	6.0	2.1	-	-	2.2	16.3	121.1	47.0	49.0
	Total Catch	139.4	58.4	3.6	0.6	5.8	-	-	1.6	57.2	175.1	112.1	109.3
	Total Effort	238.3	88.1	14.2	17.2	38.6	-	-	26.9	1099.4	614.2	335.6	977.6

Species: **Haddock**

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1985	Directed Catch	94.6	28.9	0.2	1.2	369.1	203.8	12.9	17.2	69.2	353.3	233.2	16.4
	Directed Effort	83.1	23.1	3.2	5.1	235.7	162.5	22.3	36.8	57.0	232.4	273.1	54.4
	Total Catch	95.8	29.8	0.2	2.0	490.0	234.9	23.4	19.4	118.4	517.2	324.6	69.7
	Total Effort	91.4	29.3	3.2	16.8	549.4	307.8	76.7	84.8	676.5	806.0	1097.5	814.2
1986	Directed Catch	216.3	-	0.8	200.5	134.6	4.7	2.3	0.8	25.3	21.2	265.5	107.9
	Directed Effort	95.6	-	8.8	106.8	103.5	2.4	9.3	5.2	17.6	18.7	267.7	133.9
	Total Catch	217.0	-	0.8	201.0	157.8	5.2	8.5	1.0	61.9	91.0	421.0	156.5
	Total Effort	111.0	-	8.8	120.9	246.8	47.1	82.1	8.4	304.0	591.0	1109.0	499.1

Species: Redfish

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1980	Directed Catch	-	7.4	0.2	4.0	-	-	-	0.2	5.3	79.2	0.8	91.9
	Directed Effort	-	9.0	2.1	8.8	-	-	-	1.2	14.9	210.2	2.1	109.5
	Total Catch	0	7.4	0.4	4.1	1.4	0.5	-	0.2	30.8	87.8	0.9	93.7
	Total Effort	2.3	9.0	4.3	15.7	23.7	5.1	-	1.2	657.3	392.2	6.3	188.2
1981	Directed Catch	-	0.8	-	-	-	3.0	-	-	23.5	128.9	68.7	7.3
	Directed Effort	-	5.5	-	-	-	3.3	-	-	31.2	147.5	135.8	14.3
	Total Catch	0.2	0.8	-	0.1	0	3.0	-	0	38.4	138.0	69.7	15.3
	Total Effort	24.3	20.2	-	2.4	6.7	6.3	-	2.5	415.2	349.4	149.3	256.7
1982	Directed Catch	-	-	0.5	-	-	0.3	-	1.5	-	48.3	148.3	57.7
	Directed Effort	-	-	1.6	-	-	1.3	-	2.2	-	53.2	117.8	39.0
	Total Catch	0	0.2	0.5	0.3	-	0.3	0.1	1.5	6.2	49.4	152.5	70.0
	Total Effort	3.9	10.3	3.2	6.7	-	14.2	4.5	2.2	201.9	129.7	363.8	318.1
1983	Directed Catch	-	-	1.9	3.4	-	0.2	-	-	3.9	46.5	671.9	234.2
	Directed Effort	-	-	4.9	3.5	-	1.8	-	-	2.0	49.8	908.9	284.4
	Total Catch	0.1	-	2.1	3.4	-	0.4	1.8	0	13.6	55.9	684.1	236.2
	Total Effort	19.6	-	9.9	3.5	-	16.2	46.1	1.3	263.5	349.4	1106.7	409.4
1984	Directed Catch	-	-	-	-	-	-	-	0.2	334.2	3.6	68.4	80.8
	Directed Effort	-	-	-	-	-	-	-	0.7	406.4	9.2	76.2	84.4
	Total Catch	0	0.1	0.1	-	0	-	-	0.9	348.3	7.4	70.1	88.1
	Total Effort	4.8	13.7	2.9	-	3.5	-	-	20.4	889.8	77.3	335.5	313.8

Species: **Redfish**

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1985	Directed Catch	-	-	-	-	-	1.3	-	-	188.5	57.8	259.7	28.5
	Directed Effort	-	-	-	-	-	1.3	-	-	307.3	44.3	309.0	70.9
	Total Catch	0.1	-	0	-	11.5	1.8	0.1	2.1	206.1	64.8	271.4	39.9
	Total Effort	1.8	-	3.2	-	54.0	31.7	5.8	37.3	536.3	171.1	620.4	408.9
1986	Directed Catch	-	-	-	-	-	-	-	0.3	16.8	0.9	1.9	10.1
	Directed Effort	-	-	-	-	-	-	-	2.5	27.9	2.3	3.9	60.5
	Total Catch	-	-	-	0.2	4.5	0.4	2.1	0.3	41.3	8.7	9.2	10.6
	Total Effort	-	-	-	9.1	59.0	25.7	43.1	2.5	446.6	293.0	318.5	129.6

Species: **Flatfish**

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1980	Directed Catch	-	-	-	-	-	-	-	-	52.3	51.0	-	68.2
	Directed Effort	-	-	-	-	-	-	-	-	159.2	218.4	-	208.9
	Total Catch	0.2	-	-	1.9	1.6	0.4	-	0	100.5	98.2	0.2	110.3
	Total Effort	35.2	-	-	333.4	44.0	10.2	-	1.2	1285.9	788.4	19.3	727.6
1981	Directed Catch	0.1	0	-	0.1	-	0.1	-	-	90.6	33.3	4.0	101.8
	Directed Effort	8.8	0.4	-	9.5	-	3.0	-	-	291.3	149.7	19.0	378.7
	Total Catch	4.3	4.7	-	0.4	0.4	0.9	-	0	163.8	127.4	269.1	264.5
	Total Effort	513.7	149.0	-	129.5	34.7	68.5	-	2.8	1681.7	2015.7	922.6	2992.2
1982	Directed Catch	-	0.2	-	-	-	-	-	-	104.4	5.9	28.5	78.0
	Directed Effort	-	5.6	-	-	-	-	-	-	188.4	28.2	102.5	392.9
	Total Catch	1.3	1.0	-	0.4	-	0.8	-	0.1	131.3	33.9	109.9	176.1
	Total Effort	184.4	94.7	-	58.0	-	64.2	-	8.0	836.8	855.0	553.5	2167.2
1983	Directed Catch	-	-	-	-	0.2	-	-	-	1.7	23.0	6.9	17.0
	Directed Effort	-	-	-	-	2.2	-	-	-	20.7	99.8	50.0	68.6
	Total Catch	0.3	1.2	-	0.2	0.5	0.1	0.8	0	30.9	94.9	45.3	50.4
	Total Effort	60.6	198.9	-	10.3	60.7	13.7	14.8	1.2	818.6	1372.7	989.6	1343.8
1984	Directed Catch	-	-	-	-	-	-	-	0.3	142.5	6.7	13.3	343.5
	Directed Effort	-	-	-	-	-	-	-	3.5	326.1	46.0	35.6	750.2
	Total Catch	0.5	0.6	0	0	0.5	-	-	0.5	337.6	124.3	29.7	412.3
	Total Effort	87.7	33.5	4.8	3.0	37.2	-	-	10.1	2977.0	1629.6	906.1	2308.1

Species: Flatfish

Year		Area I				Area II				Outside			
		Season				Season				Season			
		1	2	3	4	1	2	3	4	1	2	3	4
1985	Directed Catch	-	-	-	-	-	-	-	-	30.0	6.6	303.5	53.2
	Directed Effort	-	-	-	-	-	-	-	-	150.4	70.5	1080.1	165.4
	Total Catch	0.1	0.2	0.1	0.2	1.8	1.9	0.8	0.1	86.7	79.7	461.2	91.7
	Total Effort	29.6	32.5	6.3	22.3	154.0	133.4	91.2	59.3	1354.2	1176.3	3191.5	1333.9
1986	Directed Catch	-	-	-	-	-	-	-	-	300.8	21.6	0.3	7.3
	Directed Effort	-	-	-	-	-	-	-	-	695.0	117.8	8.6	21.6
	Total Catch	0	-	0	0.1	4.4	0	0.7	0	346.9	52.3	28.6	48.1
	Total Effort	3.8	-	5.8	49.7	194.5	19.0	31.8	5.0	1060.2	1003.8	1378.3	875.0

APPENDIX 2

**Potential Impact of the Pollock Fishery on the
Capture of Small Haddock in Current Closed Areas**

Data was extracted from the International Observer Program (IOP) database for all records in which pollock was either the main species caught or sought. These records were sorted and grouped according to location as indicated in Figure 1, namely: (1) inside Closed Area I, (2) inside Closed Area II, and (3) all areas in Division 4VW not in either Area I or Area II. For each of these areas the total observed pollock catch was summed by year. Haddock by-catch was calculated as the proportion (by weight) of haddock caught in the directed pollock fishery in each area:

$$\frac{\text{Haddock catch}}{\text{Haddock catch} + \text{Pollock catch}}$$

Haddock by-catch in Area I ranged from 16% in 1980 to less than 1% in 1986 with a mean of 4% over the seven year period (Table A2.1). Since 1984 the by-catch in this area has averaged less than 1% of observed total (ie. pollock and haddock) catches in the pollock directed fishery. Haddock by-catches in Area II ranged from 14% to 0% between 1980 and 1986 with a seven year average of 4%. Since 1984 the haddock by-catch has averaged 6% of the observed total catches in the pollock directed fishery in Area II. In Division 4VW, exclusive of the closed areas, haddock by-catches have ranged from 8% to less than 1% with an average of 4%. Since 1984 the by-catch has averaged 2%.

In general terms the data for all three areas show a significant positive correlation between total pollock catches and the total haddock by-catch. Close examination of this relationship however, reveals a high degree of variability. The slope of the relationship between haddock by-catch rates (i.e. proportion of haddock caught in a pollock directed catch) and total pollock catch is not significantly different from zero. This means that the available data indicate that the haddock by-catch rate is relatively constant over the range of pollock catches observed.

In light of these results, the decreased haddock by-catches observed in Area I may be explained by the decreased pollock catches observed there in recent years. Haddock by-catches in Area II have increased in recent years concurrent with a increase in pollock catches.

For present purposes haddock less than 37 cm were assumed to correspond to fish aged 0-3 years. Estimates of haddock by-catch length frequencies are unfortunately not available for each year/area combination used in this study since not all observed haddock by-catches were measured for lengths. This lack of information precludes drawing conclusion regarding trends in catches of small fish in either of the closed areas. Available data suggest that in Area I the proportion of young haddock in haddock by-catches has ranged from approximately 2 to 24%, while in Area II the three available estimates range

from 0 to 11% (Table A2.2). The proportion of small haddock in haddock by-catches outside the closed areas are somewhat more consistently estimated and indicate a range of 1 to 10%.

These data, sparse as they are, do not contradict the assumption that Area I is a major nursery area given the relatively high proportion of small fish usually present in the haddock by-catch. The reduction of haddock by-catch as a result of a reduction in pollock directed fisheries in this area in recent years, will have resulted in a decreased by-catch of small haddock. Increased haddock by-catches in Area II are, in general, less likely to result in large catches of small haddock since available evidence suggests that this is an overspill area only frequented by significant numbers of young fish following the production of relatively large year-classes in Area I. The high proportion of young fish in Area II in 1985 was probably the result of an overspill of the abundant 1980-81 year-classes from Area I.

These analyses show that haddock by-catches in observed pollock directed fisheries have been highest in Area II in recent years. This is probably the result of increases in observed directed pollock catches in Area II relative to Area I. Haddock by-catches in Area I will likely have a larger impact on the overall mortality of small haddock than those in Area II, since small haddock are more consistently prevalent in Area I. Significant by-catches of small haddock in pollock directed fisheries conducted in Area II may result following the production of large year-classes of haddock which spill over from Area I into Area II.

It must be understood that these conclusions are based on the analysis of data collected by the IOP from vessels generally in excess of 500 gross tons fishing with mobile gear. It does not allow for conclusions regarding haddock by-catches realized by smaller vessels using either fixed or mobile gear since these are not covered by the IOP. They also assume that the fishing practices of the vessels observed are not affected by the presence of an observer who has as part of his or her mandate the enforcement of Departmental regulations. Furthermore, the relative paucity of haddock by catch length frequency estimates, should temper ones acceptance of the conclusions regarding the relative impacts of the pollock fishery on the mortality of young haddock in each area.

Table A2.1. Pollock catches and haddock by-catches (t) in Closed Areas I and II as derived from International Observer Program data. (Haddock by-catch percentage is calculated on the basis of total (pollock and haddock) catch.)

Year	A R E A I			A R E A I I			O U T S I D E		
	Pollock Catch (t)	Haddock By-Catch (t)	Haddock By-Catch (%)	Pollock Catch (t)	Haddock By-Catch (t)	Haddock By-Catch (%)	Pollock Catch (t)	Haddock By-Catch (t)	Haddock By-Catch (%)
1980	98.64	18.23	15.60	2.75	0	0	260.65	23.12	8.14
81	1673.32	59.84	3.45	33.98	2.36	6.49	646.58	59.92	8.48
82	1316.32	35.61	2.63	47.11	1.22	2.52	405.74	8.30	2.00
83	24.07	0.92	3.68	119.28	1.10	0.91	388.44	5.34	1.36
84	255.27	1.75	0.68	99.69	1.95	1.92	775.47	15.39	1.95
85	12.14	0.22	1.78	595.80	99.01	14.25	2110.42	54.56	2.52
86	139.24	0.68	0.49	518.26	16.85	3.15	3136.72	28.33	0.90

Table A2.2. Percent of haddock by-catch at lengths ≤ 37 cm in the pollock directed fishery.

Year	Area I	Area II	Outside
1980	-	-	0
1981	2.48	-	9.81
1982	9.60	-	4.00
1983	-	0	-
1984	9.64	-	4.25
1985	22.79	10.71	2.08
1986	-	1.84	1.07

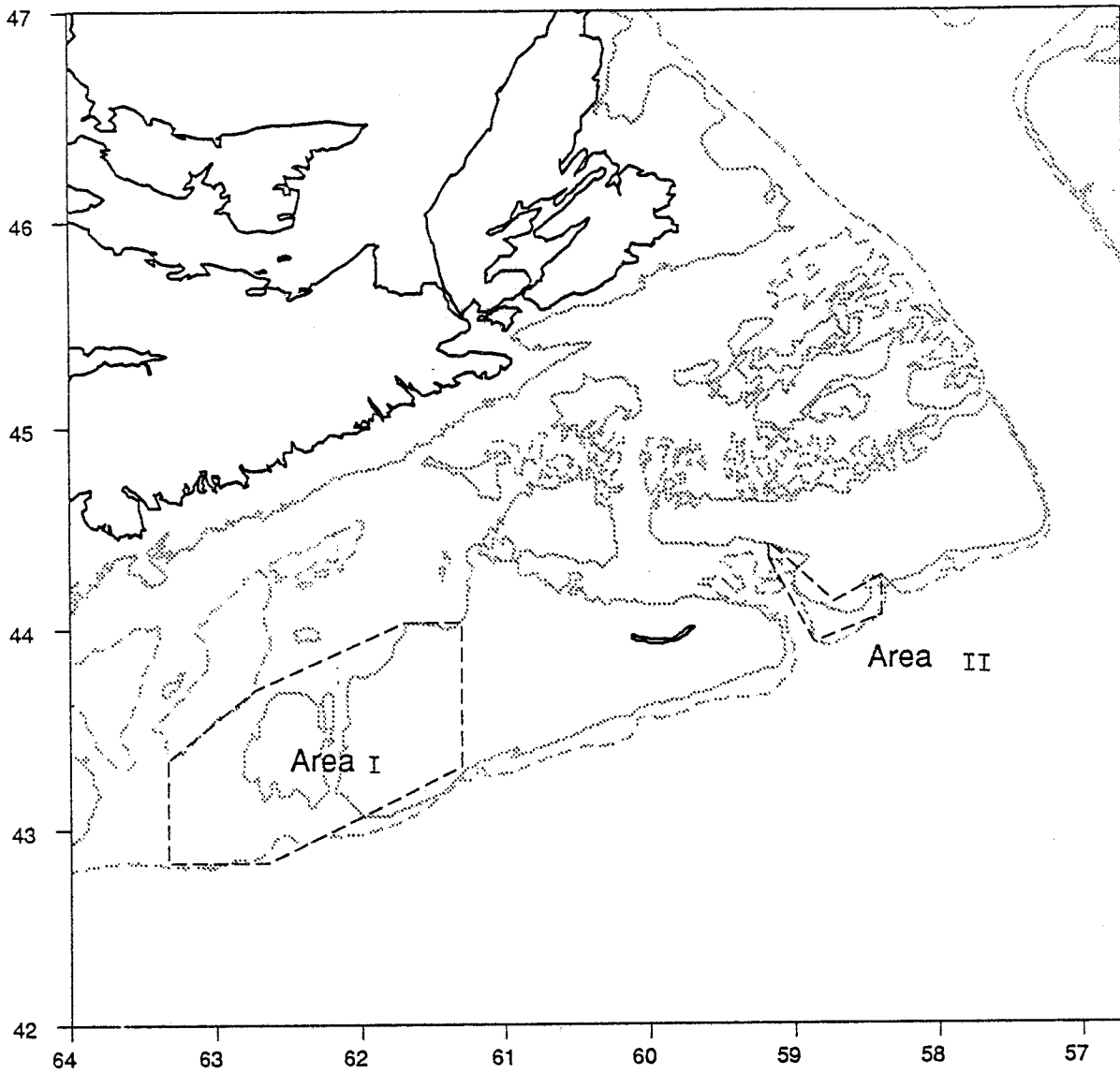


Figure 1. Location of groundfish closed areas in 4VW.

APPENDIX 3

Silver Hake Fishery

Question: What is relative level of dependence foreign vessels have on the portion of the silver hake box closed by the haddock nursery area closure?

This question is best addressed by defining dependence both in terms of the total amount of silver hake caught inside and outside of Closed Area I, and the relative rates at which these catches are realized. It must be understood at the outset that the following analyses are based on observed catches through IOP only. Extrapolation to the total catch requires one to assume that the observed portion of the catch represents a random subsample of the entire catch. This assumption depends on, among other things, whether or not vessel operators modify their fishing tactics in response to the presence of an observer.

The major prosecutors of the foreign silver hake fishery are Cuba and the Soviet Union. Therefore, the following analyses were done for each of these nations separately. If we examine the total observed catch of silver hake taken by the USSR between 1981 and 1986 (Table A3.1), we see that 28% was taken inside Area I with a range of 12-36% on a yearly basis. For the Cuban fleet only 17% was taken inside the closed area with a yearly range of 7-26% (Table A3.2).

Catch rates of silver hake for the USSR inside the closed area range from 1.62 to 4.49 $t \cdot hr^{-1}$ with a six year average of 3.06 $t \cdot hr^{-1}$ (Table A3.1). Outside the closed area catch rates ranged from 1.64 to 3.69 $t \cdot hr^{-1}$ with an average of 2.59 $t \cdot hr^{-1}$. Silver hake catch rates realized by the Cuban fleet inside the closed area ranged from 0.45 to 2.70 $t \cdot hr^{-1}$ with an average catch rate of 1.92 $t \cdot hr^{-1}$ between 1981 and 1986 (Table A3.2). Outside the closed area catch rates ranged from 0.39 to 2.52 $t \cdot hr^{-1}$ for an average of 1.98 $t \cdot hr^{-1}$.

These analyses show that on average the Soviet fleet experienced catch rates which were 18% higher inside the closed area over the years examined, while the Cuban fleet caught silver hake at a rate which was 3% lower inside the closed area. The Cuban fleet experienced catch rates in all years which were significantly lower than those of the Soviet Union.

In summary, these analyses indicate that the foreign fleets have caught between 7 and 36% of their silver hake within the closed area on a yearly basis. It also shows that the Soviet fleet caught silver hake at higher rates inside the closed area than elsewhere while for the Cuban fleet catch rates were about the same inside and out.

Question: What level of haddock by-catch occurs in the closed area during the foreign silver hake fishery?

As was the case with the answer to the above Question, only a proportion of the silver hake fishery was observed in each year between 1981 and 1986, therefore the amounts of haddock listed as by-catch will be some proportion

of the total actually caught. Total amounts of haddock observed to be caught by the USSR inside the closed area ranged from 8 to 89 tonnes. This represents by-catch rates (calculated as haddock caught divided by the total of all species caught) of between 0.21 and 1.42% (Table A3.1). The six year average haddock by-catch rate was 0.60%. Outside of the closed area, where the majority of the silver hake were caught, observed haddock catches ranged from 46 to 240 tonnes representing by-catch rates of between 0.32 and 1.35%. The six year average haddock by-catch rate was 0.81% or about 35% higher than that observed inside the closed area.

For the Cuban fleet fishing inside the closed area observed haddock catches ranged from 4 to 16 tonnes for by-catch rates of between 0.54 and 2.23% (Table A3.2). The overall average was 0.87%. Outside the closed area observed haddock catches by this fleet ranged from 12 to 65 tonnes for by-catch rates of between 0.44 and 1.62%. The overall average for the six year period was 0.85%.

These analyses indicate that on average haddock by-catch rates in the observed foreign silver hake fisheries are usually less than 1.5% annually, although in particular years this level was exceeded. Haddock by-catch rates in the Cuban fisheries are higher both inside and outside of the closed area than those experienced by the Soviet fleet.

Question: What scientific considerations should be addressed if a small mesh gear bottom trawl fishery for silver hake is to proceed in the haddock nursery closed area?

The small mesh gear line was established in 1977 primarily to reduce the capture of cod and haddock in the small mesh fishery. Since then total haddock catches have been below 600 t annually and the 1% haddock by-catch limit has generally been respected. A detailed analysis of the 1977-1982 small mesh fishery was reviewed by CAFSAC (CAFSAC Res. Doc. 84/101) and it was concluded that the management regime had been successful in minimizing the impact of haddock by-catch on the Canadian haddock fishery while permitting access to the silver hake stock by other nations. However, given the current low abundance of haddock, especially young haddock, and the higher TACs for silver hake, it has become important to consider the total catch of haddock and the size composition of the catch rather than just the by-catch limits.

The relative sizes of haddock caught inside and outside Closed Area I has varied from 1981 to 1986 (Table A3.3). For the first three years the fish caught outside the area were smaller, on average, than those taken inside. From 1984 to 1986 this pattern was reversed. These results are not entirely consistent with the establishment of the closed area as a nursery area. However, it must be noted that the small mesh fishery operates only in the southern most part of the closed area, in waters deeper than those normally inhabited by young haddock. There has also been considerable variation in the percent, by numbers, of haddock caught inside and outside the area (Table A3.3). In 1981, 51% of the observed numbers caught were taken inside the closed area. Since then the percentage has varied from 7%

to 26%. Thus it is clear that more haddock have been taken outside the closed area than inside.

It is possible to consider the age groups being caught by examining the length frequencies from inside and outside the closed area. The length distributions of numbers caught are presented on a yearly basis for 1981-1986 in Figure A3.1. The peak in numbers at approximately 20 cm corresponds to age 1 fish, at 30 cm to age 2 fish, and at age 3 the fish are generally over 35 cm in length and their length frequency often blends in with older fish. These graphs indicate that the catch of age 1 and 2 fish has consistently been higher outside the closed area than inside. The same may be said for the older fish (over 40 cm) in 1984-1986. This is mainly due to the higher catch weights taken outside. However, as noted above, in the last three years the fish were smaller on average inside the closed area. If more of the fishing effort was expended in this area, then proportionally more younger fish would be taken.

In summary, it is clear that younger fish have not consistently been taken in the closed area in the small mesh fishery. The main consideration for future fisheries is to minimize the catch of haddock, especially young haddock, throughout the entire fishery. With a higher silver hake TAC this could lead to higher haddock catches. It will be important to steer the fleet away from areas of high haddock by-catch or areas of high abundance of small haddock. Control of this situation will be enhanced with 100% observer coverage.

Table A3.1. Summary of the observed Soviet silver hake fisheries inside and outside of Closed Area I for 1981 to 1986.

Year	INSIDE						OUTSIDE					
	Silver Hake (t)	Haddock (t)	All Species (t)	Effort (hrs)	Haddock By-Catch (%)	Silver Hake Catch Rate (t·hr ⁻¹)	Silver Hake (t)	Haddock (t)	All Species (t)	Effort (hrs)	Haddock By-Catch (%)	Silver Hake Catch Rate (t·hr ⁻¹)
1981	5678	89	6604	3500	1.35	1.62	14010	78	16408	8555	0.48	1.64
1982	5567	8	5799	1240	0.66	4.49	13995	46	14463	3788	0.32	3.69
1983	2320	37	2600	1215	1.42	1.91	6646	103	7640	3833	1.35	1.73
1984	2620	16	2720	816	0.59	3.21	18456	240	19623	6240	1.22	2.96
1985	7888	45	8217	2027	0.55	3.89	14397	130	15538	5350	0.84	2.69
1986	10013	22	10425	2345	0.21	4.27	17989	155	19217	5176	0.81	3.48
Σ	34086	217	36365	11143	0.60	3.06	85493	752	92889	32942	0.81	2.59

Total silver hake caught 1981-1986 = 119,579 t

inside = 28%
outside = 72%

Table A3.2. Summary of the observed Cuban silver hake fisheries inside and outside of Closed Area I for 1981 to 1986.

Year	INSIDE						OUTSIDE					
	Silver Hake (t)	Haddock (t)	All Species (t)	Effort (hrs)	Haddock By-Catch (%)	Silver Hake Catch Rate ($t \cdot hr^{-1}$)	Silver Hake (t)	Haddock (t)	All Species (t)	Effort (hrs)	Haddock By-Catch (%)	Silver Hake Catch Rate ($t \cdot hr^{-1}$)
1981	91	4	179	204	2.23	0.45	480	12	2101	1240	0.57	0.39
1982	1833	11	2034	974	0.54	1.88	5225	43	5538	2726	0.78	1.92
1983	1155	16	1311	716	1.22	1.61	3311	65	4002	2271	1.62	1.46
1984	819	9	886	345	1.02	2.37	5599	84	6022	2225	1.39	2.52
1985	1362	13	1494	505	0.87	2.70	7312	37	8310	3336	0.44	2.19
1986	514	4	643	259	0.62	1.98	6857	44	7528	2718	0.58	2.52
Σ	5774	57	6547	3003	0.87	1.92	28784	285	33501	14516	0.85	1.98

Total silver hake caught 1981-1986 = 34,558 t inside = 17%
 outside = 83%

Table A3.3. Mean weight of haddock caught inside and outside of Closed Area I in the USSR and Cuban silver hake fisheries from 1981-1986.

Year	Mean Weight (gm)		Percent (Numbers) Observed Catch Inside
	Inside	Outside	
1981	467	139	51
1982	269	123	18
1983	512	356	24
1984	448	844	7
1985	516	697	26
1986	607	725	11