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A review of the status of the 4VWX halibut stocks

by

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ABSTRACT

Recent landings and the market value of Atlantic halibut have increased considerably, prompting this first assessment of halibut separate from the rest of the 4VWX flatfish. Due to an absence of commercial fishery samples, it is not yet feasible to undertake a detailed stock assessment. Indices of abundance from the commercial fishery indicate a declining trend in catch-per-unit effort since 1981. Given that the effort expended has increased recently and with the increased hooking efficiency of the new circle hook gear, the decline in the commercial CPUE is worrisome. Indices of abundance from annual research vessel surveys conducted in summer indicate an increasing population, however.

RÉSUMÉ

A cause de l'augmentation considérable des débarquements récents et de la valeur marchande du flétan atlantique, ce poisson a fait l'objet, pour la première fois, d'une évaluation indépendante des autres poissons plats de la division 4VWX. Etant donné l'absence d'échantillons provenant de la pêche commerciale, il n'est pas encore possible d'entreprendre une évaluation détaillée du stock. Les indices d'abondance dérivés de la pêche commerciale laissent entrevoir une tendance à la baisse dans les prises par unité d'effort (PUE) depuis 1981. Etant donné l'accroissement récent de l'effort de pêche et l'efficacité accrue des nouveaux engins à hameçon circulaires, la baisse dans la PUE commerciale est inquiétante. Cependant, les indices d'abondance obtenus à partir des relevés annuels à l'aide de navires de recherche réalisés en été indiquent une augmentation de la population.

"On some parts of the coast of Nova Scotia, this fish is found in such abundance, and so large size, that the localities are avoided (authors' emphasis) by those engaged in cod-fishing, as a boat, or small vessel, becomes soon heavy laden."

Moses Perley
1852

INTRODUCTION

This document presents for the first time assessment of Atlantic halibut (Hippoglossus hippoglossus) separate from the assessment of 4VWX flatfish. This action was a result of the considerable increase in the landings of this highly valued species. However, a detailed analytical assessment of this species is not yet feasible, due largely to an absence of sampling of the commercial fishery. This document does, however, review aspects of halibut biology and their exploitation, which should provide a foundation for the development of a more detailed assessment in the future.

While Greenland halibut (Reinhardtius hippoglossoides) also occur on the Scotian Shelf, there is virtually no fishery for them, with only 4 t landed in 1983. We therefore restrict this report to Atlantic halibut.

ECOLOGY OF ATLANTIC HALIBUT

Habitat and Movements

Atlantic halibut, largest of the flatfishes, range widely over NAFO Divisions 4VWX. It avoids temperatures below about 2.5°C and tends to move from shallow water (<36.6 m) into deeper water in winter, returning to shallow waters in summer. Young halibut appear to be most available in shallow waters, 37-55 m, whereas large mature fish inhabit deeper waters 165-229 m. Although not usually regarded as a highly migratory fish, they may at times move great distances. Tagging studies in Canadian waters indicate that most recaptures take place within about 48 km of the tagging location, but one fish tagged off Anticosti Island in the Gulf of St. Lawrence in 1946 was recaptured off Iceland in 1953, a straight-line distance of about 2572 km. Other recaptures show movements from Browns Bank and southwest Nova Scotia to the Grand Banks and Georges Bank, involving distances of 161-968 km (100-600 mi) (Martin and McCracken 1955; McCracken 1958; Wise and Jensen 1959; Jensen and Wise 1961).

Reproduction

The time and place of spawning for Atlantic halibut are of great interest from a management viewpoint, but those aspects of the reproductive ecology are poorly understood. Halibut are thought to spawn mainly during February, March and April (McCracken 1958; Kohler 1967). However, the spawning grounds are not clearly defined. Available evidence indicates that

spawning occurs at a depth of 183 m or greater. In the northeast Atlantic, halibut spawn at depths of 1000 m or more. A 90.7-kg female may produce over 2 million eggs. The eggs are spherical and are about 3.0 mm in diameter. Previously thought to be neutrally buoyant, more recent evidence suggests that even unfertilized eggs will sink in water of salinity less than 37 o/oo (Lonning et al. 1982). Incubation takes 16 d at a temperature of 6°C, but the length of the pelagic larval stage is unknown.

Trophic Relationships

Atlantic halibut are thought to be voracious feeders. Up to a length of about 30 cm, food consists almost exclusively of invertebrates, mainly marine annelid worms and crustaceans such as crabs, decapod shrimp and euphausiids. From 30-80 cm in length, both invertebrates and other fishes are eaten but halibut over 80 cm feed almost exclusively on other fishes (Kohler 1967).

Larval and juvenile halibut undoubtedly fall prey to other animals but evidence is lacking. The Greenland shark Somniosus microcephalus and seals may be predators (Bigelow and Schroeder 1953). However, in a study of 279 harbor seal stomachs by Boulva and McLaren (1979), no evidence of halibut was found.

Growth

Atlantic halibut have a more rapid rate of growth than any other flatfish, particularly at ages over 10 yr. Females grow faster than males after the first few years and attain a much larger maximum size. Studies by McCracken (1958) indicated that older and larger halibut were taken in the Gulf of St. Lawrence than off western Nova Scotia, although the difference in the growth rate of males from the two regions was greater than for females. McCracken also noted that halibut from the Gulf of St. Lawrence and Scotian Banks grew at about the same rate as those from Greenland, possibly slightly faster than those off northern Norway and more slowly than those from the Faroes. A recent study by Beacham (1982) suggests that there has been a marked decrease in the length at maturity. In the period 1959-69, the length at which 50% of individuals reached maturity was 84 cm for males and 98 cm for females, but in the period 1970-79, the lengths declined significantly to 66 cm for males and 70 cm for females. These data suggest that the population may be heavily exploited.

In anticipation of possible requirements for age-structured data in the future, an attempt was made to gain expertise in the age determination of Atlantic halibut. To accomplish this, age determinations were completed on halibut captured during spring, summer and fall Scotian Shelf groundfish cruises conducted by the Marine Fish Division, Scotia-Fundy Region. To ensure that the ages thus obtained were reliable, we randomly selected 50 pairs of otoliths for corroboration by the age readers at the International Pacific Halibut Commission (IPHC) in Seattle, Washington. The otolith pairs were supplied in coded containers with no information on fish length, sex, time of capture or other such data. Three readers provided independent age determinations. In some instances, the IPHC age readers had previous experience reading otoliths of Atlantic halibut and, in any case, felt that the otoliths of the Atlantic species were comparable to what they observed in Pacific halibut; however, the interpretation of the first annulus caused

some difficulty. The results of the various readings are shown in Table 1. In cases where the IPHC readers did not agree, a consensus was reached after viewing the otolith in doubt with a closed circuit television. In general, our results agreed well with those of IPHC. However, there appeared to be a tendency on our part to count more annuli in the older fish.

We attempted to fit von Bertalanffy growth curves to our data. However, due to the comparatively narrow range of sizes of fish available to us, the von Bertalanffy curve fit program did not converge to an asymptotic value and L_∞ could not be determined.

Distribution

We examined the distribution of adult Atlantic halibut by plotting the distribution of catches in the spring, summer and fall groundfish cruises conducted during 1979-83 (Fig. 1). In March, the fish appear to concentrate along the Shelf edge, in the deeper water in the vicinity of the Gully, along the margin of Western Bank and in the vicinity of Browns Bank. The distribution also extended into the Bay of Fundy. The distribution apparent during the July and October cruises did not differ much, although the concentrations in the Western Bank area and in the Bay of Fundy appeared reduced.

ABUNDANCE INDICES FROM THE RESEARCH VESSEL SURVEYS

Biomass estimates from the research vessel surveys conducted in spring, summer and fall (1979-83) were calculated for each strata (Fig. 2, 3, 4). Greatest spring concentrations of halibut biomass were found in strata 77, 81, and 85 in NAFO Division 4X and in strata 62 and 65 in 4W. In fall, strata 77 and 85 again were associated with high biomass estimates, as was strata 59 in 4W. In summer, no comparable strata with high biomass abundances were found.

The trend in biomass estimates obtained in the summer cruises appears to suggest an increasing population (Tables 2, 3). However, this trend is not supported by the limited series available for the spring and fall cruises. It may be that the biomass estimates have rather wide confidence limits, as typically few fish are caught on a given cruise. Extrapolation of these trends to the fishery is also made more difficult by the fact that the research trawl apparently does not sample the larger, older halibut which appear more frequently in the longline fishery.

THE COMMERCIAL FISHERY

Patterns of Exploitation

Halibut landings have declined from 1574 t in 1965 to 649 t in 1975. However, since 1975, there has been a steady increase in annual landings, with 1938 t reported in 1984 (Table 4; Fig. 5). Recently, almost 50% of total landings have been from NAFO Division 4X with about 20 and 30% from 4V and 4W, respectively (Table 4; Fig. 6). The percentage of all halibut catches taken as main species caught (species comprising the largest fraction at catch weight) has also increased considerably lately (Fig. 7).

Longline gear is the most commonly used gear type in the fishery (Table 5). Until as recently as 2 or 3 yr ago, the traditional U-shaped hooks have been used. However, the new circle hook is quickly gaining favor to the extent that most halibut fishermen are now using it. The circle hook design has the point offset and turned towards the shank, so that the probability of encircling a hard part of the fishes' mouth is increased (Fig. 8). In a recent study by the Fisheries Development Branch (Peeling and Rodgers, 1984) a comparative study of the two hooks was made. The results are summarized below:

		Traditional hooks	Circle hooks
Number of hooks counted		3706	3706
Number of sets made		31	31
Number of days fished		8	8
Number of fish caught:	halibut	70	128
	cusk	186	180
	hake	116	421
	cod	26	19
	other	52	46
	TOTAL	450	794

Bait used for trip: frozen mackerel - 3000 lb
shack fish - 5300 lb

Estimated landed weight for the trip was 10,000 lb of head-on halibut and 15,000 lb of other species. Fishermen also noted that the quality of the landed fish was higher, as they felt no need to gaff fish as they were hauled aboard, a necessity with the older design of hook.

The halibut fishery is based mainly in southwest Nova Scotia, from Port Medway to Cape Sable Island. In that area, there are about 28 halibut longliners ranging from about 12.3-27.7 m, fishing throughout the Scotian Shelf. There also is an inshore fishery based out of Cape Sable Island, involving about 20-30 longliners ranging in size from 9.2-12.3 m. These vessels fish predominately in NAFO Subarea 4XO (D. Lyon, pers. comm.).

At present, the fishery is unregulated.

Commercial CPUE Indices

We obtained a commercial CPUE index series by plotting the catch of halibut per 1000 hooks versus time for NAFO Divisions 4VWX (Table 6, Fig. 9). Catch data from all tonnage classes of longliners were used in developing the series. The trend remained more or less stable from 1968-78. The CPUE index then went up appreciably, coincident with the beginning of the period of increased landings. In 1982, the CPUE began to fall, and has continued to do so until the present. The declining CPUE index is worrisome, as the effort expended on the fishery appears to be increasing, measured in terms of 1000's of hooks set (Table 6). Also, the recent introduction of circle hooks and their apparently increased hooking efficiency should promote an upward trend in recent CPUE values.

CONCLUSIONS AND RECOMMENDATIONS

As this is the first year in which a halibut assessment was attempted, we feel it is premature to draw conclusions regarding stock status. However, questions regarding possible overexploitation were raised here which may be addressed with more certainty as more complete data become available, especially commercial samples.

ACKNOWLEDGMENTS

We wish to thank Dr. W.B. Scott, Huntsman Marine Laboratory, who graciously gave us permission to include excerpts from his species description of Atlantic halibut which will appear in his forthcoming revised version of Fishes of the Atlantic Coast of Canada. Mr. Donald Peeling, Fisheries Development Branch, kindly gave us permission to cite parts of his manuscript report. Marine Fish Division port samplers Bill Smith, Gilbert Donaldson and Daryl Lyon described the fishery in their respective regions. Brenda Fawkes of the Biological Station, St. Andrews, provided the word processing services. Dr. S. Campana and Ms. C. Dale provided useful comments on an earlier draft.

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Table 1. Results of "blind" comparisons of age determinations of Atlantic halibut, St. Andrews and the International Pacific Halibut Commission.

Otolith #	Age 1[a]	Age 2[a]	Age 3[a]	A[b]	F[c]	St.A[d]	Otolith #	Age 1	Age 2	Age 3	A	F	St.A
1	7	7	7	7		7	26	4	4	5		4	4
2	8	7	9		9	8	27	5	5	5	5		5
3	6	7	7		6	8	28	6	6	5		5	6
4	9	11	9		9	10	29	4	4	5		4	4
5	10	10	11		11	11	30	4	4	4	4		5
6	5	4	6		4	6	31	5	5	5	5		5
7	7	6	7		6	7	32	7	6	6		6	4
8	3	3	4		3	4	33	6	7	5		6	4
9	3	3	3	3		3	34	7	7	6		7	7
10	5	5	5	5		5	35	4	3	4		4	3
11	4	4	4	4		4	36	5	4	4		4	3
12	5	5	6		5	5	37	4	4	4	4		3
13	6	6	6	6		6	38	5	4	5		5	5
14	8	9	9		9	8	39	6	4	5		5	5
15	4	4	4	4		5	40	3	3	3	3		3
16	6	5	5		5	5	41	6	5	5		6	5
17	4	4	4	4		5	42	3	3	3	3		3
18	6	5	6		5	5	43	8	7	7		7	7
19	5	5	5	5		5	44	9	5	6		6	5
20	5	5	6		6	6	45	10	9	10		9	8
21	6	5	6		5	5	46	6	4	6		5	4
22	2	2	2	2		2	47	5	5	6		5	5
23	3	3	3	3		3	48	10	8	9		9	10
24	5	5	6		5	5	49	2	2	2	2		2
25	4	3	4		4	3							

[a]Aged by the International Pacific Halibut Commission, by three agers.
[b]Agreed age.
[c]Age determined by using a closed T.V. circuit system, and by consensus with the three age readers.
[d]Ages determined in St. Andrews.

Table 2. Estimates of Atlantic halibut biomass (tons) on the Scotian Shelf, 1970-1984. Data are from otter trawl surveys and population estimates obtained by the method of areal expansion.

Year	Spring	Summer	Fall
1970	-	1,975	-
1971	-	1,258	-
1972	-	1,489	-
1973	-	1,375	-
1974	-	2,037	-
1975	-	1,469	-
1976	-	3,878	-
1977	-	3,933	-
1978	-	5,133	6,792
1979	19,573	5,605	4,424
1980	10,212	7,221	10,281
1981	10,959	5,567	4,304
1982	8,940	6,046	2,025
1983	-	4,170	1,742
1984	-	10,065	-

Table 3. Five-year mean annual biomass (tons) for Atlantic halibut on the Scotian Shelf. Data are from summer otter trawl surveys and the population estimates obtained using the method of areal expansion.

Years	Summer
1970-1974	1,626
1975-1979	4,006
1980-1984	5,781

Spring surveys:

- no 4Vn strata done in 1979, 1980 and 1982
- in 1979 strata 72, 73, 74 and 75 missed in 4X
- in 1981 strata 83, 84, 90, 91, 92, 93, 94 and 95 missed in 4X

Fall surveys:

- in 1978 no 4Vn; strata 47, 49 and 51 missed in 4W; and all of 4X
- in 1979 strata 90, 93, 94, 95 missed in 4X
- in 1982 strata 61, 63, 64, 65 and 66 missed in 4W; all of 4X

Table 4. Total Atlantic halibut catch (t) for NAFO Division 4VWX for 1963-84.

Year	4V	4W	4X	Total	Canadian catch	Foreign catch
1963	214	479	840	1533	1453 (90)[c]	80 (10)
1964	332	358	861	1551	1461 (94)	90 (6)
1965	486	458	665	1609	1574 (98)	35 (2)
1966	532	313	331	1176	1030 (88)	146 (12)
1967	380	322	546	1248	1236 (99)	12 (1)
1968	250	363	604	1217	1175 (97)	42 (3)
1969	192	431	441	1064	1024 (96)	40 (4)
1970	115	349	366	830	818 (99)	12 (1)
1971	231	360	414	1005	946 (94)	59 (6)
1972	178	216	456	850	825 (97)	25 (3)
1973	147	226	401	774	765 (99)	9 (1)
1974	124	127	404	655	641 (98)	14 (2)
1975	114	159	376	649	638 (98)	11 (2)
1976	144	148	422	714	708 (99)	6 (1)
1977	88	177	448	713	705 (99)	8 (1)
1978	244	283	565	1092	1082 (99)	10 (1)
1979	230	358	636	1224	1224 (100)	-
1980	339	371	748	1458	1454 (100)	4 (0)
1981	250	379	766	1395	1389 (100)	6 (0)
1982	342	476	907	1725	1720 (100)	5 (0)
1983[a]	418	546	864	1828	1827 (100)	1 (0)
1984[b]	444	572	922	1938	1938 (100)	- (0)

[a]All countries except USA.
[b]Provisional (Maritime catches only).
[c]Percentage of total catch.

Table 5. Nominal catch (t) of Atlantic halibut by gear in NAFO Division 4VWX for all countries, 1972-84.*

Year	Side otter trawl	Stern otter trawl	Longline	Danish and Scottish seine	Other[a]	Total
1972	60	89	639	1	61	850
1973	45	60	658	3	8	774
1974	12	54	555	1	33	655
1975	42	84	514	3	6	649
1976	74	79	544	1	16	714
1977	40	129	492	1	51	713
1978	56	265	689	5	77	1092
1979	70	219	824	5	106	1223
1980	81	312	1021	2	42	1458
1981	42	268	1049	2	34	1395
1982	61	270	1371	0	23	1725
1983[b]	24	244	1524	0	36	1828
1984[c]	6	165	1754	2	11	1938

[a]Includes NK and MISC gears.
[b]All countries except USA.
[c]Provisional (Maritime catches only).
*No commercial fishery samples were taken for this species.

Table 6. Data used for the development of commercial CPUE, Atlantic halibut, NAFO Divisions 4VWX, 1968-84.

Year	Catch (t)	Effort (1000's hooks)	t/1000 hooks
1968	221	3711	.060
1969	142	2076	.068
1970	132	2328	.057
1971	148	2235	.066
1972	198	2987	.066
1973	211	2476	.061
1974	171	2888	.059
1975	112	2004	.056
1976	110	1818	.061
1977	80	1310	.061
1978	69	1093	.063
1979	179	1963	.091
1980	176	1887	.093
1981	117	1211	.097
1982	219	2768	.079
1983	610	7955	.077
1984	801	11854	.068

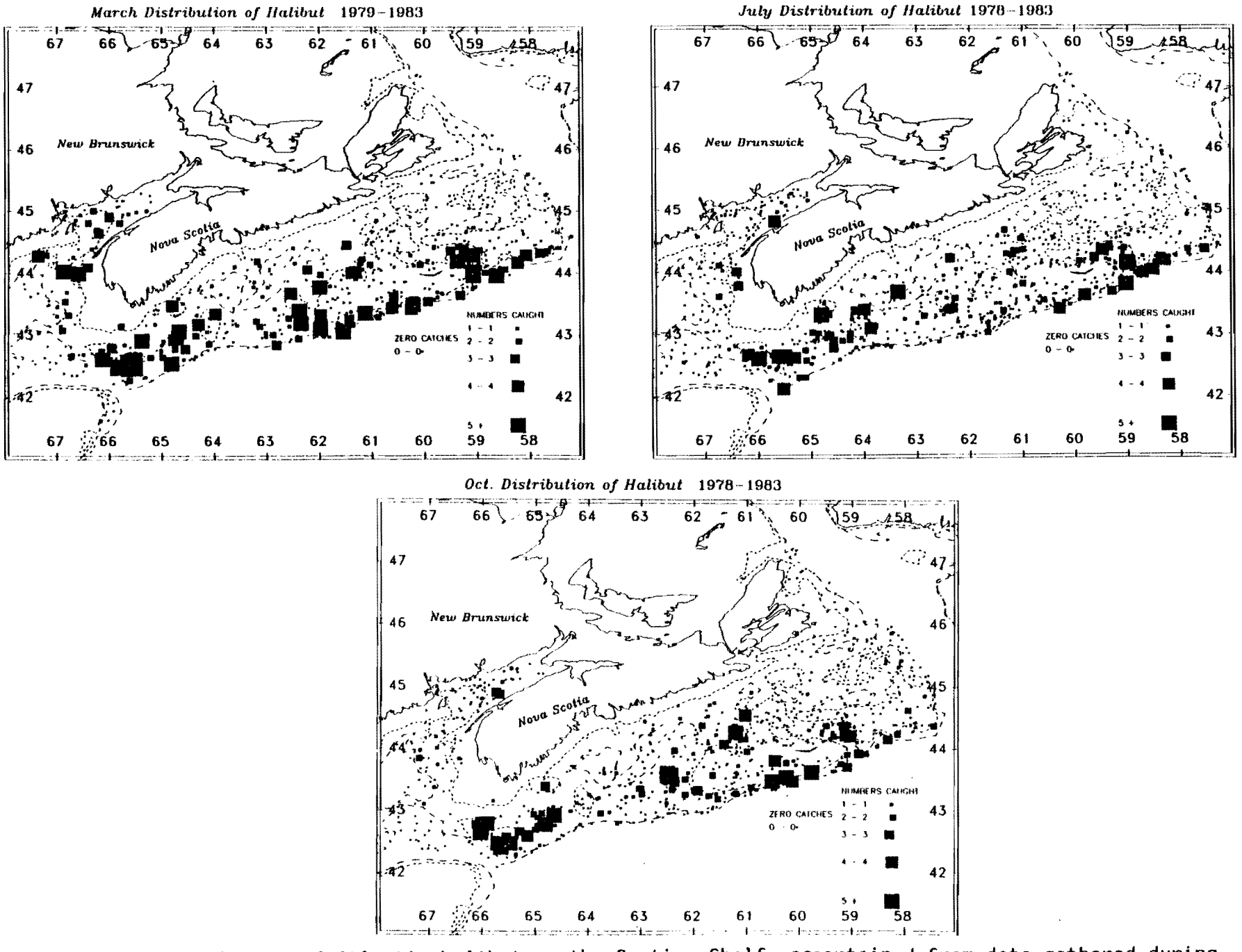

Fig. 1. Distribution of Atlantic halibut on the Scotian Shelf, ascertained from data gathered during the spring, summer and fall groundfish cruises of the Marine Fish Division, Scotia-Fundy Region.

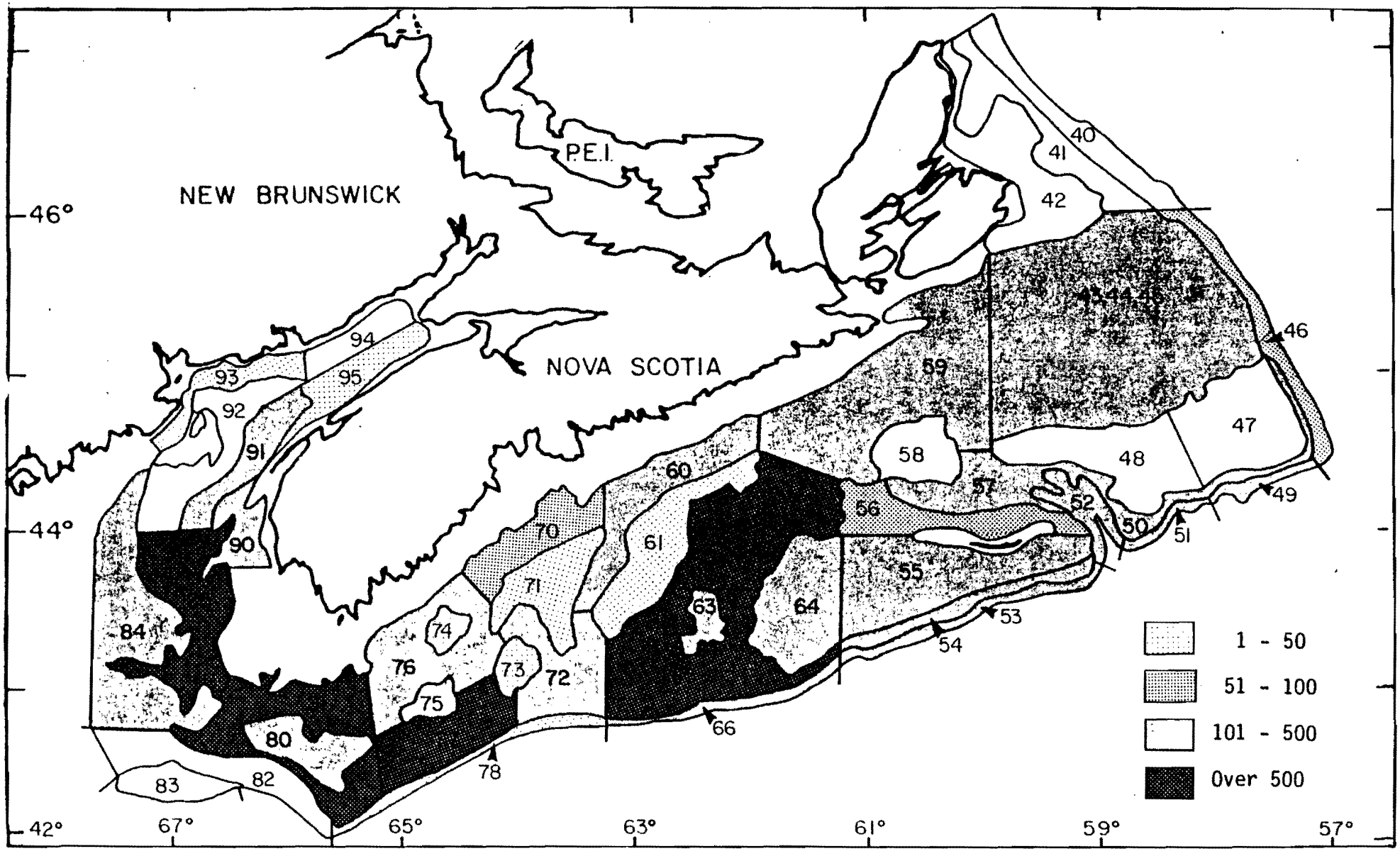

Figure 2 . Halibut biomass estimates; spring surveys. Units are tons.

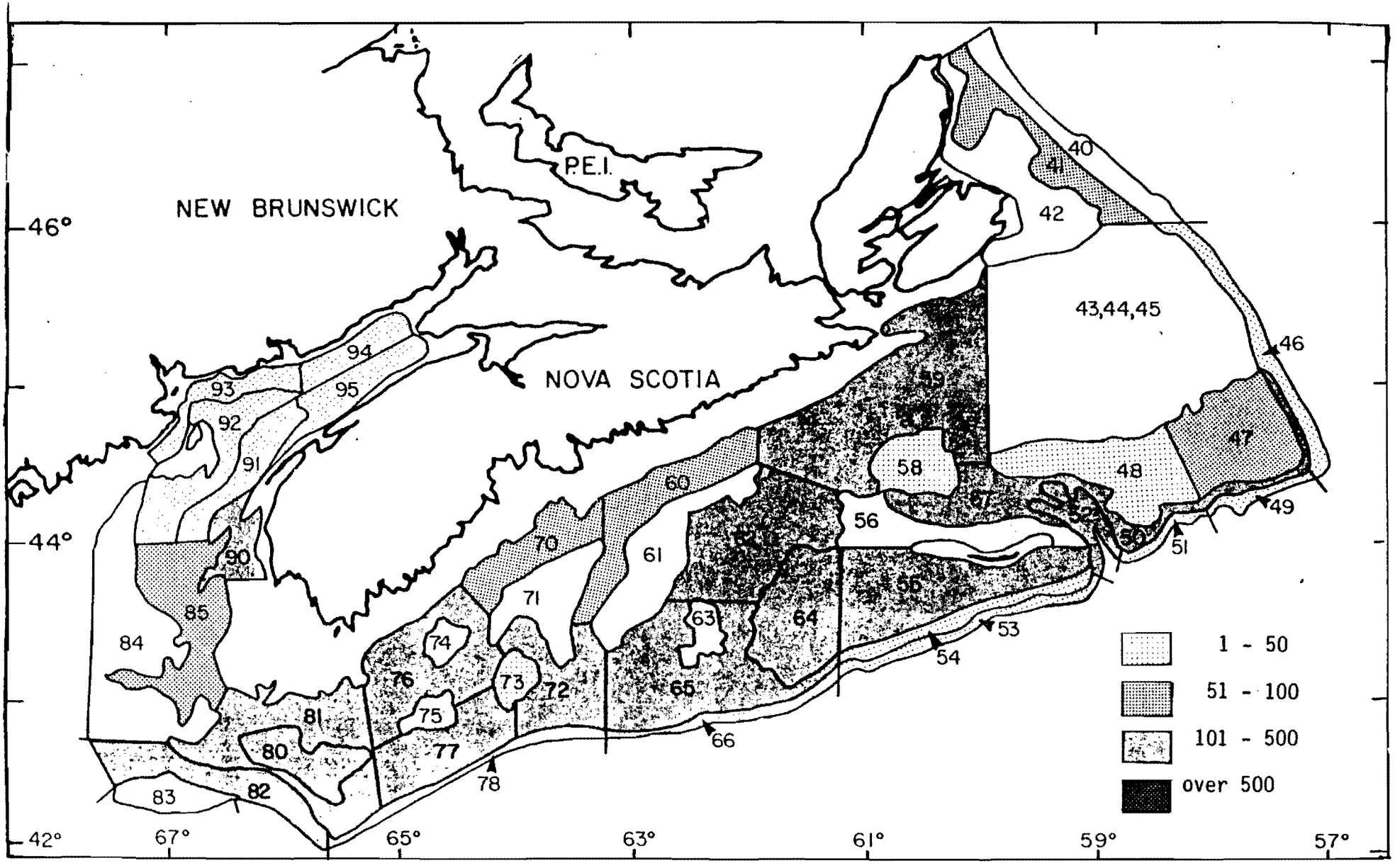

Figure 3. Halibut biomass estimates; summer surveys. Units are tons.

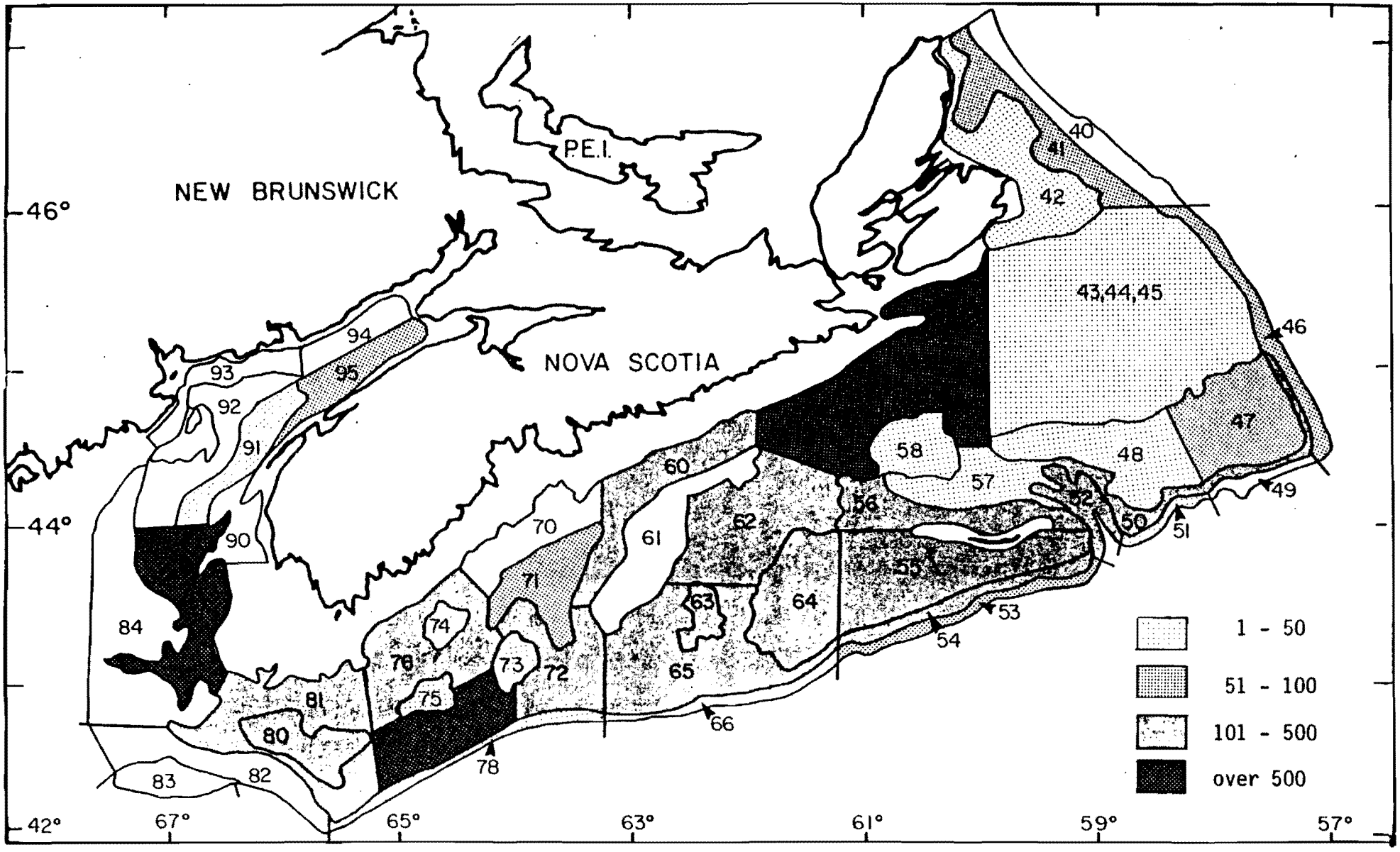

Figure 4 : Halibut biomass estimates; fall surveys. Units are tons.

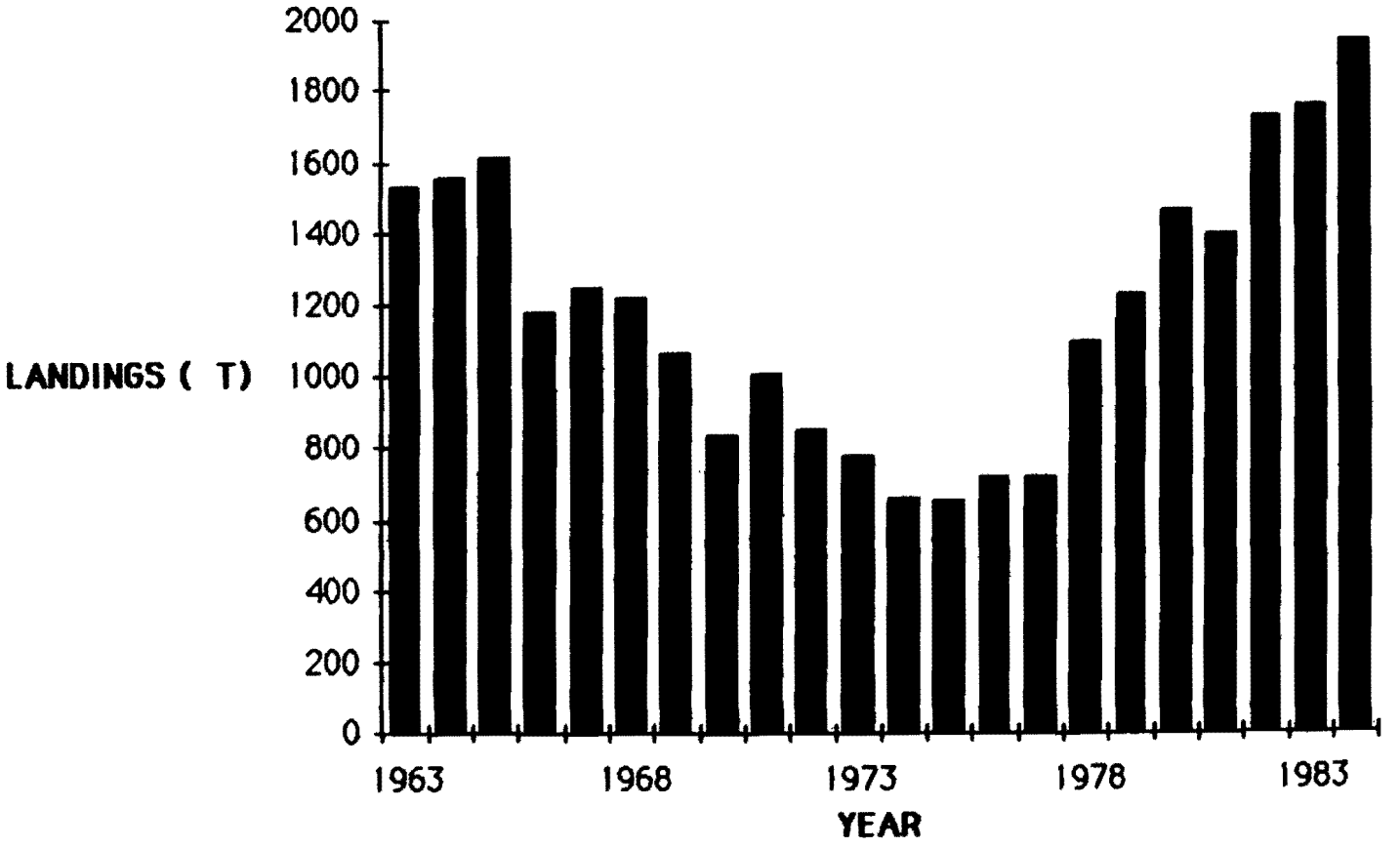

FIG. 5. Atlantic halibut landings in NAFO 4VWX, 1963 - 1984.

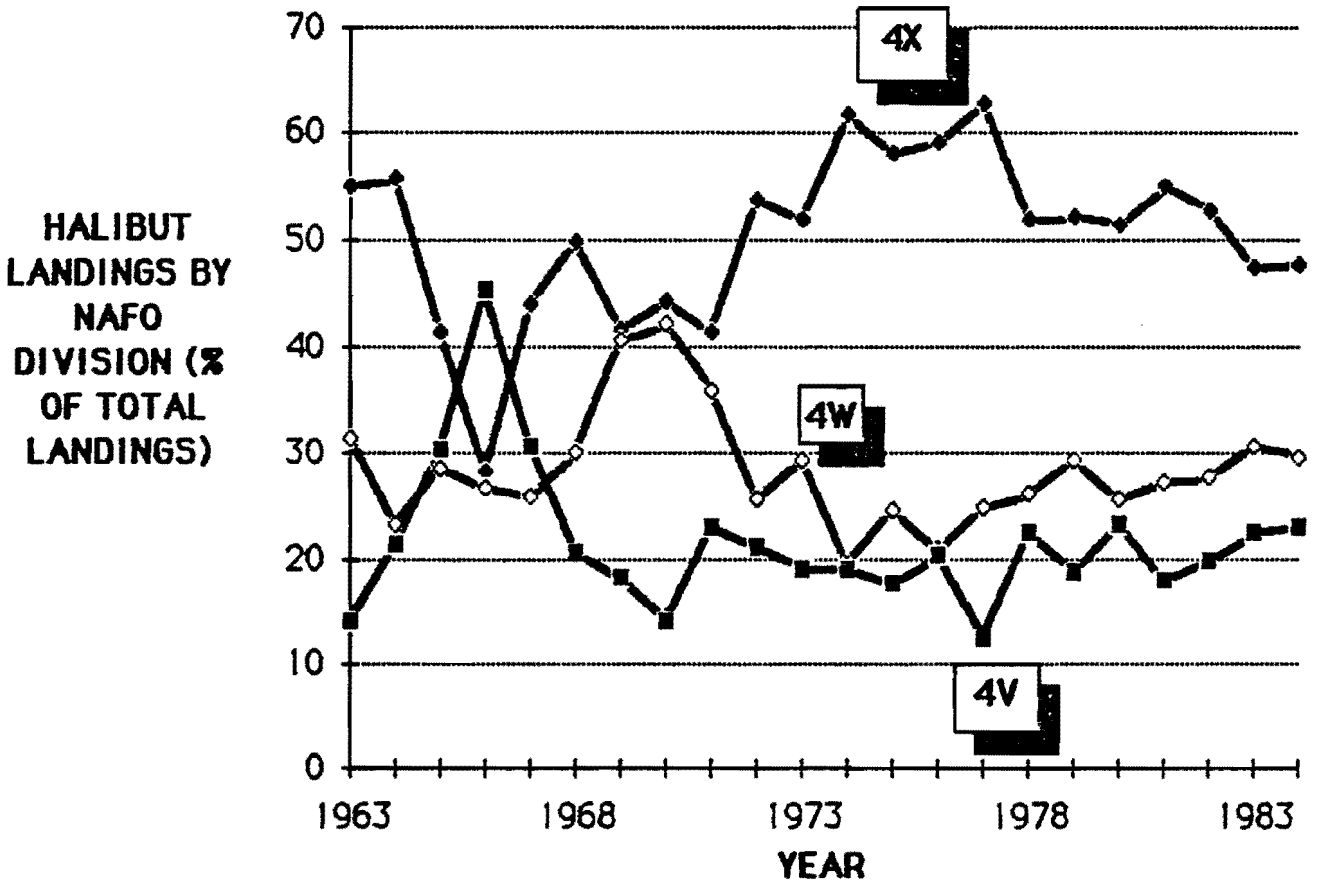

Fig. 6. Annual Scotian Shelf Atlantic halibut landings by NAFO Division, 1963-1968, expressed as percent of total landings.

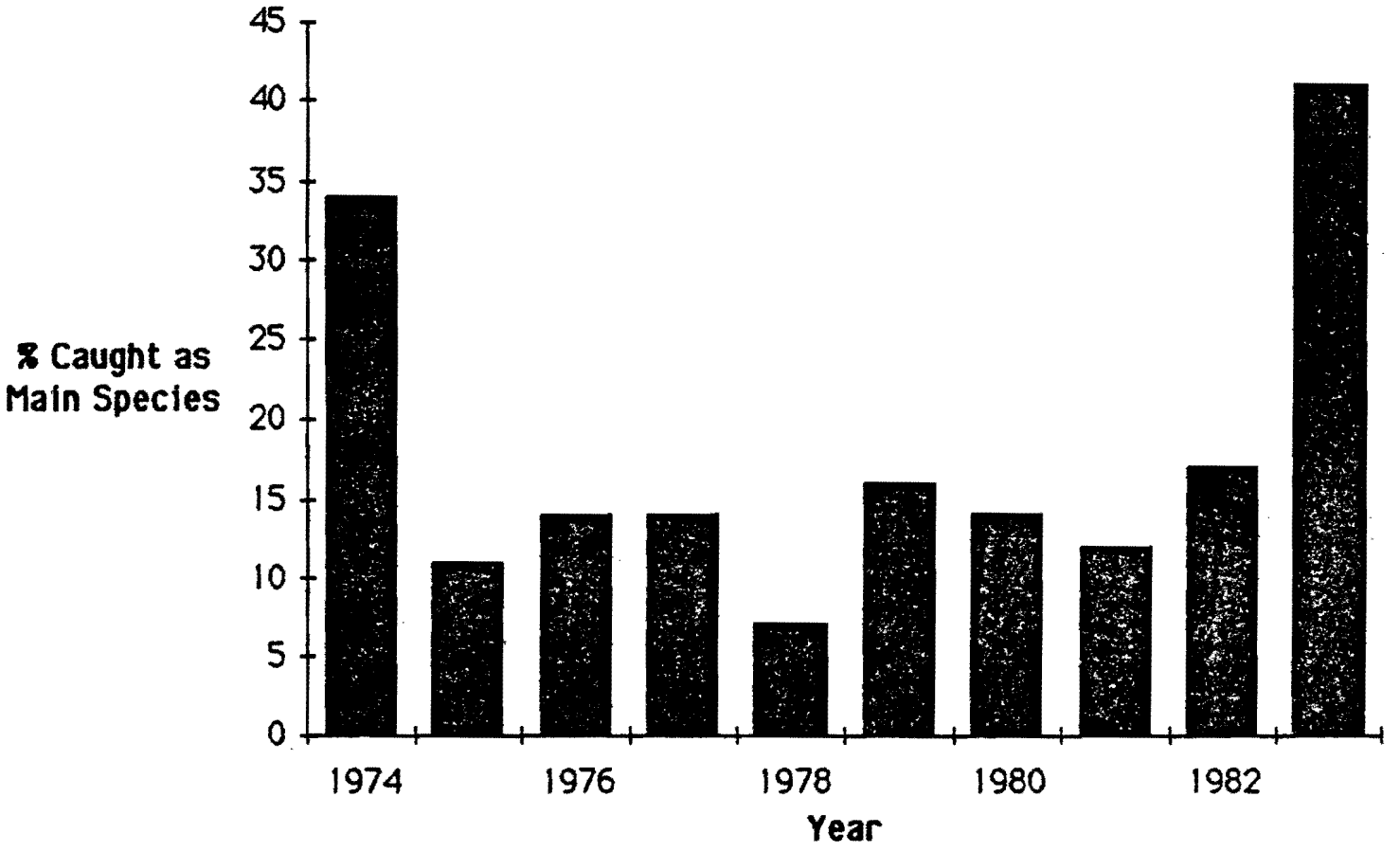

Fig. 7. Percentage of annual Atlantic halibut landings taken as main species caught, Scotian Shelf, 1974-1983.

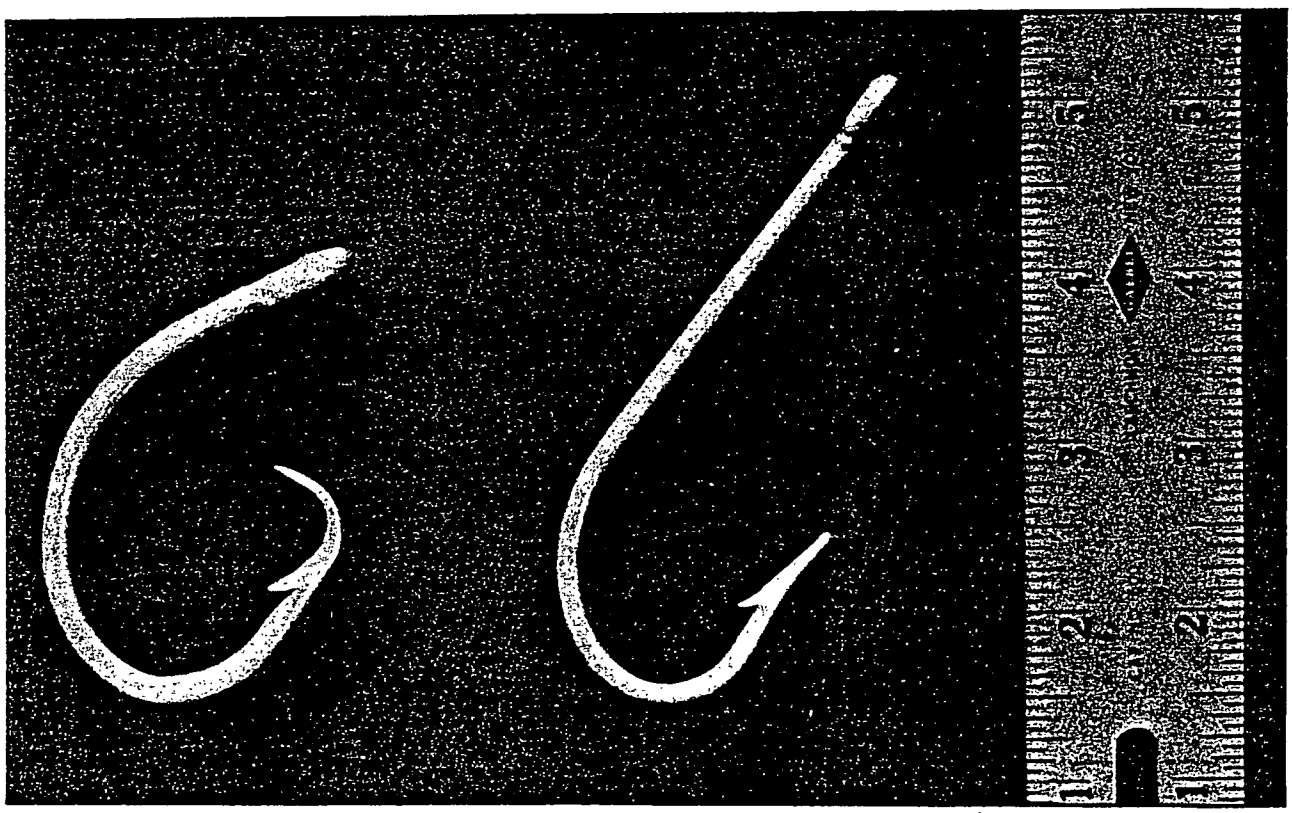

Fig. 8. Comparison of U-shaped hook and circle hook used in halibut long-line fishery. Reproduced with permission from Peeling and Rodgers (1984).

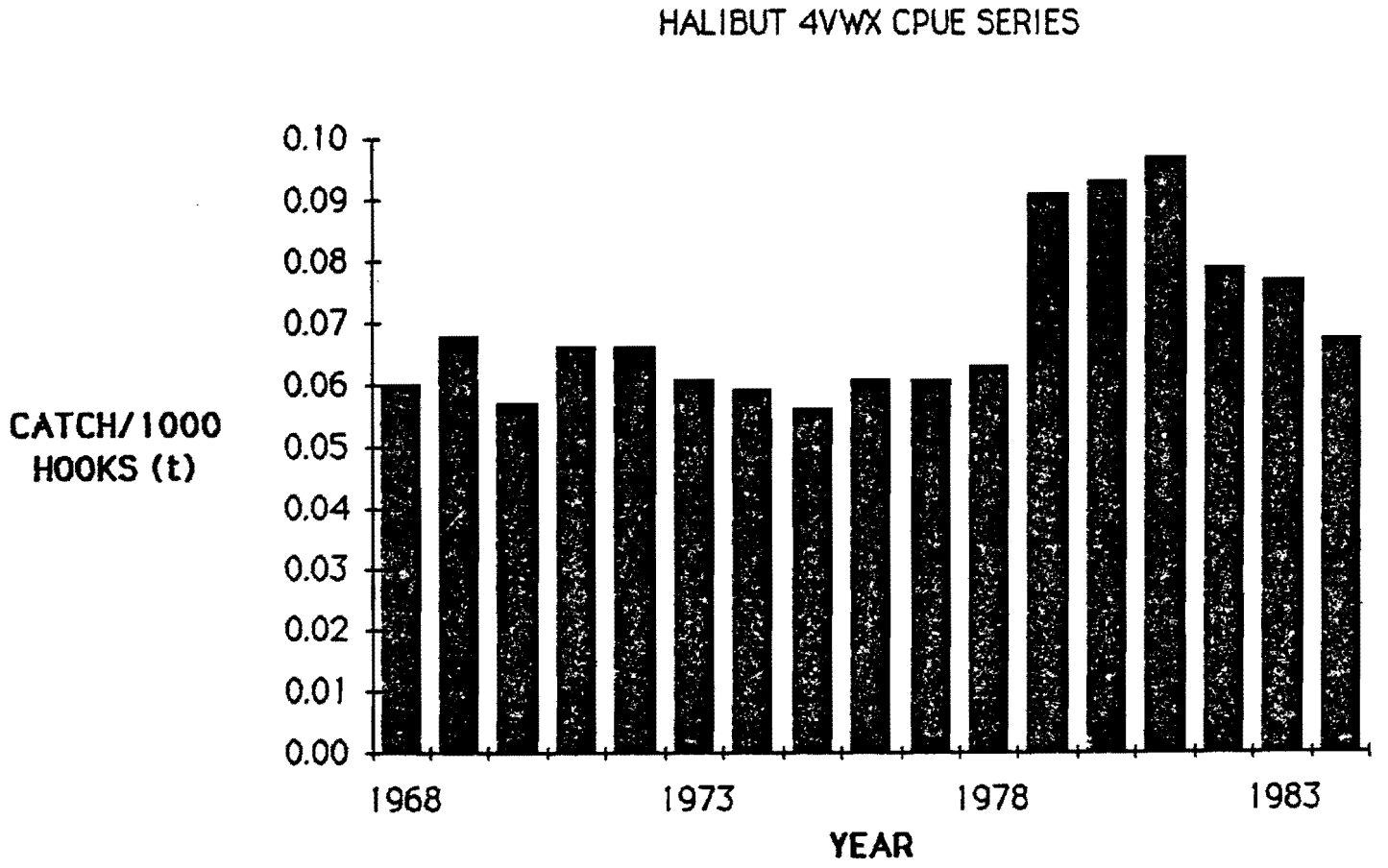

Fig. 9. The trend in Atlantic halibut catch-per-unit effort, Scotian Shelf, 1968-1984. The derivation of the data is shown on Table 6.