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Assessment of the Division 4VsW Skate Fishery

by

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ABSTRACT

In 1994, a combination of closures of traditional groundfish fisheries on the Scotian Shelf and openings in the markets for skate wings resulted in the development of a directed Canadian skate fishery. The 1994 TAC for skates was set at 1,200t with an additional 800t allocated to conduct joint industry science surveys. The TAC was exceeded by 200t. In 1995 a shortfall of 100t occurred in the 1,600t TAC. During the brief history of the experimental fishery for skates much has been learned, both about the fishery and biology of the species involved. The fishery has demonstrated the ability to target adult winter skate on the eastern offshore banks of the Scotian Shelf (individuals > 60 cm constitute greater than 90% of the catch). Because the TAC was based on a 10% harvest rate for all skates combined in Div. 4VsW, the initial derivation is inappropriate. Using the criterion of 10% of the mature biomass of winter skates from spring and summer rv surveys as a basis for setting harvest levels yields a range between 300 and 756t which is low relative to the current TAC. Winter skate are near their northern limit of distribution on the offshore banks of the eastern Scotian Shelf. Length at 50% maturity for female winter skate occurs between 65 and 70cm while thorny skate mature closer to a length of 50cm. Recent preliminary ageing of winter skate suggests that the length at 50% maturity coincides with individual 6-7 years old. Industry has reported spawning in late August in the vicinity west of Sable Island. Current concerns include the localized nature of the fishery with the possible depletion of bank concentrations and the practise of capturing and processing only the largest winter skate when markets for the smaller thorny skate could be established.

RÉSUMÉ

La combinaison de la fermeture de pêches traditionnelles du poisson de fond sur le plateau néo-écossais et de débouchés commerciaux pour les ailes de raie a donné lieu en 1994 au développement d'une pêche canadienne dirigée de la raie. Le TAC de raie pour 1994 a été fixé à 1 200 t, 800 t additionnelles ayant été réservées à des fins de relevés commerciaux-scientifiques conjoints. Le TAC pour 1994 a été dépassé par 200 t, tandis que le TAC de 1 600 t pour 1995 n'a pas été atteint par 100 t. Beaucoup d'information a été recueillie au cours de la brève histoire de la pêche expérimentale de la raie, autant sur la pêche que sur la biologie de l'espèce visée. La pêche s'est révélée capable de cibler la raie tachetée adulte des bancs hauturiers de l'est de le plateau néo-écossais, où les raies > 60 cm constituent plus de 90 % des prises. Le TAC initial n'était pas approprié parce qu'il était basé sur un taux de capture de 10 % de toutes les espèces regroupées de la division 4VsW. L'application du critère à l'effet que 10 % de la biomasse de raies tachetées matures établie d'après des relevés de recherche menés au printemps et à l'été pour établir les niveaux des prises donne une fourchette de 300 t à 756 t, faible par rapport au TAC actuel. La raie tachetée des bancs hauturiers de l'est du plateau néo-écossais est presque à la limite nord de son aire de répartition. La longueur à maturité de 50 % des raies tachetées femelles se situe entre 65 et 70 cm, tandis que la raie épineuse atteint la maturité à environ 50 cm. Des données préliminaires sur l'âge de la raie tachetée indiquent que la longueur à maturité de 50 % des individus correspond à une raie de 6 à 7 ans. L'industrie a signalé que la fraie avait lieu vers la fin d'août aux environs de l'ouest de l'île de Sable. La nature localisée de la pêche, qui pourrait donner lieu à un appauvrissement des bancs, et la pratique de ne capturer et de ne transformer que les grosses raies tachetées même si des marchés pour la raie épineuse, plus petite, pourraient être développés sont des préoccupations courantes.

Introduction

This document contains information and analyses relevant to the experimental skate fishery on the eastern Scotian Shelf. Here we provide a comprehensive assessment of skates based upon a recent fishery, a cooperative industry/science skate survey, research vessel survey data, biological observations from observers, and a preliminary age and growth study for winter skate. There are many limitations to this assessment because of the lack of age- or size-structured data from the fishery, some biological parameters for skates are unknown and because five species of skates regularly co-occur whose exact identity is not reported. Of the five species of skates (winter *Raja ocellata*, thorny *Raja radiata*, smooth *Raja senta*, little *Raja erinacea* and barndoor *Raja laevis*) caught in the management unit the commercial fishery directs for winter skate with a seasonal bycatch of thorny skate. General guidelines for a skate harvesting strategy are provided.

Fishery

Past

There has never been a regulated fishery for skates on the Scotian Shelf. Landings data exist since 1961, however the data only represent a fraction of the actual catches since there was no requirement to report incidental catches. Canadian landings have generally been low with the exception in Divs. 4VWX during the mid-1970s when landings ranged between 60 - 700t (Table 1).

Foreign fleets have reported much greater landings than Canada. Prior to 1977 and the extension of jurisdiction, foreign landings were as high as 6,100t in Div. 4Vs, 16,000t in Div. 4W, and 2,100t in Div. 4X (Table 1). The validity of these high catches have been questioned. After 1977, reported skate landings never exceeded 2,600t and was generally restricted to Div. 4W (Figure 1).

Present

The brief history of the current directed skate fishery on the eastern Scotian Shelf and the rationale for the harvesting plan was reviewed in Simon and Frank (1995). In 1995, the allocation of 1,600t of skates was not reached (Table 1) and two factors contributed to this shortfall: i) a developing skate fishery in Div. 3LNOPs contributed to an oversupply of skate causing a weakening of prices and a suspension of fishing during the months of July and August, and ii) with the resumption of fishing in the fall inclement weather resulted in lower catches. In 1996, the directed fishery was regulated in the same manner as the previous year with a 20% by-catch permitted in the directed flatfish fishery.

Data from the International Observer Program (IOP) was examined to determine the by-catches of skates from other fisheries operating on the Scotian Shelf since 1989. The foreign fisheries in Div. 4W removed as high as 1970t in 1990 and as little as 20t in 1994 (Table 2). The by-catch of skate in the Canadian groundfish fisheries in Div. 4VW ranged between 1 and 3% and recently has sharply fallen to very low levels due to the closure of the cod and haddock fisheries in the region. In the directed flatfish fishery a by-catch estimate of 20% was applied over all years yielding removals ranging from 323 to 849t . Estimates of the total removals by these fisheries peaked in 1990 at 4,418t and in 1995 were at 530t . In 1995, the combination of catches from the directed fishery and by-catch equalled 2,062t (Table 2).

Other recent sources of removals of skates are associated with the Sentinel surveys using longlines conducted in Div. 4Vn (Lambert 1995) and Div. 4VsW (L.P. Fanning, pers comm.) in 1994 and 1995. Skates were a significant by-catch in both surveys. In Div. 4Vn skates made up 5% of the total landings and were the fourth most abundant species caught. In Div. 4VsW skates were the fourth most common species collected (16.6% of the total catch) and a total of 4.8t were caught during the survey (Table 3).

Distribution

Distributional information from the 1995 Sentinel survey in Div. 4VsW s revealed the highest concentrations of skate along the southern edges of Banquereau Bank and eastern Shoal area (Figure 2). Unfortunately the skates were not identified by species during their surveys.

Recent observer data does however provide a breakdown of the catches by species and plots of the observed distribution of winter and thorny skate in 1995 by quarter are shown in Figures 3 and 4(note: only positive sets >10 kg. per tow are shown). During the third quarter observer coverage of the skate fishery was slight. Winter skate catches were concentrated along the slope waters adjacent to Sable Island and Banquereau Banks during the first and second quarter. During the fourth quarter winter skates were distributed in shallower water suggesting a movement from deep water had occurred sometime after the second quarter (Figure 3). Thorny skate were caught along the edges of the outer banks from Div. 4X to 4V during the first and second quarter. During the fourth quarter the highest catches were generally confined to Banquereau Bank (Figure 4).

Commercial Catch at Length for 1995

Commercial sampling of winter skates from Department of Fisheries and Oceans port technicians began in 1995 with the collection of eleven winter skate length frequencies. Only 4 of 11 were used in the reconstruction of the length distribution of landings because the other samples did not include sample weights. Catches peaked at about 70cm and declined monotonically towards fish in excess of 100cm. The smallest sizes landed were near to 60cm (Figure 5). The skewness of the length distribution is probably a result of both discarding and the large mesh gear (255-320mm cod end) used in the fishery. The landings during the year included a varying amount of thorny skate which peaked at 22% of the total landings in the fall of the year (J. Fennell pers. comm.).

Research Vessel (RV) Surveys

Distribution

Spring

Spring research vessel surveys of the eastern Scotian Shelf groundfish community have been conducted since 1979. Simon and Frank (1995) summarized the results of these surveys and the interested reader should consult that document for details. For 1996 the spring survey was not considered comparable to previous spring surveys because coverage was incomplete.

Summer

Summer research vessel surveys of the Scotian Shelf groundfish community have been conducted since 1970. Information on distribution and abundance of the principal skate species has been developed in the past by Simon and Comeau (1994). Here we show distributional information on winter and thorny skate from the two most recent survey in 1995 and 1996.

Winter skate distributions in 1995 were different from the historical patterns reported in Simon and Comeau (1994). The expected concentrations on Banquereau Bank were not evident but there were aggregations on Browns Bank and the inner Bay of Fundy (Figure 6). In 1996 the distributional patterns were near normal with concentrations on Banquereau, Western and Sable Island banks in Div. 4VW and on Browns Bank and the Bay of Fundy in Div. 4X (Figure 6).

Thorny skate were concentrated in two areas at opposite ends of the survey area: on the offshore banks of the eastern Shelf and the Bay of Fundy (Figure 7). These patterns are consistent between years and with the historical distribution reported in Simon and Comeau (1994). The distributional pattern suggests a natural division between the eastern and western Scotian Shelf stocks.

Abundance

Spring

Thorny skate catch rates were higher in Div. 4Vs than in Div. 4W (Figure 8) with no trends in abundance evident in either division in that last 10 years. Winter skate catch rates were similar between Div. 4Vs and 4W except for the 1994 survey when one large set in Div. 4Vs inflated the number and weight (kg.) per tow values, otherwise no trends in abundance were apparent.

Summer

Thorny skate abundance has been declining slowly since the early 1980s in Div. 4Vs. In Div. 4W abundance is much lower than in 4Vs and has changed only slightly since 1980 (Figure 9).

Winter skate catch rates show a variable pattern with no time trends evident in either Div. 4Vs or 4W (Figure 9).

Fall

Thorny skate abundance was generally higher than winter skate during the 1978-1984 survey series in Div. 4VsW (Figure 10).

Minimum Trawlable Biomass

The minimum trawlable biomass of skates (thorny and winter combined) from the summer RV revealed a slow decline since 1982 (Figure 11). Nearly all of the decline in skate biomass was due to the reduction in thorny skates. The average biomass of winter and thorny skate over the past 10 years (1987-1996) was 10,538t. The 10 year average total biomass of winter skates from the summer survey was 3,000t. The spring survey minimum trawlable biomass of winter and thorny skates showed no temporal trends. The recent past 10 year biomass of winter skate, excluding the anomalous 1994, was 7,561t.

Summer Size Frequencies

Size frequency data for winter and thorny skates from 1970-present was examined. Winter skate size frequency distributions exhibited no apparent temporal trend (Table 4) There was an expansion of the size ranges from 1970 to the mid-1980s due to the increasing quantity of smaller sizes observed during that time period. The median lengths were greatest during the early part of the survey series and since that time has varied around 60cm.

Thorny skate showed a decline in larger individuals (>50cm) from 1970 to the early 1980s. Since the early 1980s there has been no systematic change in the length frequency distribution. The median lengths have been stable around 30cm over the entire survey series.

The size frequency data was further evaluated as a possible indicator of incoming recruitment using the abundance of fish less than 30cm. Using this criterion three pulses of small winter skate has occurred since 1979 separated in time by about seven years (Figure 12). The abundance of thorny skate less than 30cm was high in the mid-1980s and has dropped to lower levels since that time (Figure 12).

Spring Size Frequencies

The catch rate at length of thorny and winter skate show similar patterns to the summer RV data. The minimum and maximum size of winter skate has not changed during the survey period (Table 6). The maximum size of thorny skate was larger during 1979-1989 compared to 1990-present.

The minimum size has not changed appreciably during the survey period (Table 7).

Zoogeographic Patterns of Distribution

A recent initiative, the East Coast of North America Strategic Assessment Program (ECNASAP) has resulted in the compilation and display of survey data from several laboratories in the Canada and the United States yielding information on the distribution of groundfish species over large geographic areas. The distributions of winter and thorny skate from survey data from Cape Chidley to Cape Hatteras for 1970-1994 combined were examined (Figure 13). Winter skate concentrations were evident on Georges Bank, upper Bay of Fundy, and southern Gulf of St. Lawrence. Thorny skate showed a pronounced northerly distribution with highest concentrations on the Newfoundland and Labrador shelves, southern Grand Banks, northern Gulf of St. Lawrence. Newfoundland and eastern Scotian Shelf. Lesser concentrations were seen in the Gulf of Maine/Bay of Fundy. The distribution of thorny skate is nearly opposite to that of winter skate with the only area of overlap occurring on the eastern half of the Scotian Shelf.

Industry/Science Skate Directed Survey

Distribution

As part of the domestic harvesting plan established in 1994 industry agreed to conduct two skate surveys per year. Sampling of the catch was to be undertaken by observers from IOP with costs borne by industry. The survey objectives were to map the extent of the resource in Div. 4VsW, estimate by-catch levels of traditional species and to begin to collect detailed biological information on individual skate. Science designated the fishing locations and requested the use of 155mm mesh gear in 1994. Results of these surveys were reviewed in Simon and Frank (1995). In 1995 a stratified random survey design was implemented (Figure 14) with surveys conducted during April and October. Mesh sizes used ranged from 255 to 315mm. In 1996 the same survey design was maintained for both surveys with the use of 155mm mesh in the codend (Table 8). It should be noted that in both 1995 and 1996 in addition to the 12 sets per vessel allocated to the survey design, three directed fishing sets were permitted by each boat (designated as Captain's own or C.O.).

In April 1995 very few thorny skate were captured in either the survey sets or C.O. sets (Figure 15). Winter skate were concentrated in the eastern Shoal area and along the edge of the shelf below Sable Island. One large C.O. set was recorded south of Banquereau Bank along the edge of a deep canyon (Figure 16).

The second annual survey in 1995 was conducted in October. Very few thorny skates were collected either during the survey sets or the C.O. sets (Figure 17). Winter skates were collected throughout the survey area with highest concentrations on the shelf west of Sable Island and the eastern Shoal area. The C.O. sets were generally concentrated on the eastern Shoal where catches were greatest (Figure 18).

The length frequency data from these surveys are shown in Figures 19 and 20. Because so few thorny skate were collected the length frequency data is sparse. Winter skate showed similar size distributions between April and October with sizes ranging from 40 to 110cm. Male winter skate were larger than females and tended to exhibit more than one length mode (Figure 20). Note that in comparison to the RV survey length data (Tables 4 and 6) the winter skate captured during the industry surveys tended to be larger. The reason for this difference may be due to the different gear configurations including footgear (4 to 12 inch rollers) and mesh sizes.

During April 1996 thorny skate were located to the south of the eastern Shoal and very few were encountered during the C.O. sets (Figure 21). Winter skates were abundant throughout the survey area with the highest concentrations along the edges of the offshore banks. Fewer fish were captured during the C.O. sets which were conducted south of Sable Island (Figure 22). Winter skate length frequencies were calculated separately for the survey sets with 155mm codends and the directed fishery which used a range of codend mesh sizes from 300-400mm. The 155mm survey sets caught fish ranging from 30-100cm with peaks around 43 and 75 cm. The directed fishery sets caught winter skate that ranged from 43-105cm, peaking between 60-70cm (Figure 23).

The relative catch rates of winter and thorny skate from the two annual industry surveys in 1995 were similar to the spring survey result where winter skate catches exceeded thorny skate. The catch rate of thorny skate exceeded winter skate during the 1995 summer research vessel survey.

One of the industry survey objectives was to estimate the by-catch of other species, given the concerns about fishing in areas where closures exist for cod and haddock. In general the industry surveys have yielded extremely low levels of by-catch (Table 10). Data from the directed fishery was also available from 1996 to address this question with a result identical to the industry survey, i.e. by-catches were extremely low during the directed fishery (Table 10).

Another one of the industry survey objectives was to make detailed biological measurements of individual winter skate and to compare this to similar observations made from the spring and summer RV surveys in 1995. Individual male and female thorny and winter skate were weighed during sampling. Plots of the relationship between weight and length for each survey are shown in Figures 24-27. Thorny skate show no differences in the slope (b approximately equals 3.0) of the weight vs length relationship between males and females for the spring and summer RV surveys. No comparison could be made with the industry surveys for thorny skates due to low sample sizes. During the 1995 spring RV survey, no difference was observed between the slopes of the weight vs length regression for males and females. Once again, b was close to 3.0. The summer survey yielded fewer winter skate than the spring survey making it difficult to compare differences between males and females. The spring industry survey in 1995 resulted in weight and length measurements of over 400 fish (male and female combined). However, the length range was much narrower and did not overlap when compared to the RV surveys. This resulted in slopes of the relationship between weight and length that deviated greatly from 3.0. The fall industry survey yielded weight and length measurements of several hundred winter skate. Similar to the spring industry survey there was a much narrower and non-overlapping size range of fish in comparison to the survey results.

More Biological Observations

Observer data in 1996 from the directed skate fishery produced information on length at maturity for female winter skate. Percent mature as a function of body size revealed 50% maturity at 68 cm total length (Figure 28). Discussion with industry revealed that peak spawning of winter skate west of Sable Island occurred during late summer with all large females extruding eggs upon capture. This situation was not as prevalent on Banquereau Bank suggesting either a different spawning time or location (W. Grover and J. Baker, pers. comm).These fish were also observed to be in better condition (heavier for a given length) than fish on Banquereau Bank.

Observations of maturities of female thorny skate were made during the 1996 spring RV survey. Twenty-eight fish were measured and surprisingly a very strong pattern was noted. Nearly all individuals less than 50cm were immature and nearly all individuals greater than 50cm were mature (Figure 28). These preliminary results are comparable to maturity studies conducted by Templemen (1982) on the Newfoundland shelf.

In 1995 an honours student from St. Marys University - Mr. Robert Nearing - began a study of the skate fishery on the eastern Scotian Shelf with one objective to conduct a preliminary age and growth study. Ageing was attempted by using cross-sections of vertebrae embedded in resin and subsequently sectioned through the nucleus using an isomet saw. Sections were examined microscopically with the aid of an image analysis system. Rings were evident in most but not all specimens and ages were approximated under the assumption of one ring per year. Age determinations were made by a single reader (R. Nearing) and have yet to be examined by other readers. Consequently, the data are considered preliminary. Nevertheless, the ages ranged from 0-group to 16 years spanning a length range of 12 to 100 cm (Figure 29). No differences in length at age were evident between males and females and the variance in length at age was low within the abundant age groups (age 5-12). These results suggest that mature winter skate (i.e. those at 50% maturity) are about 6-7 years old.

We attempted to estimate the natural mortality rate of winter skate from empirical relationships published in the literature and applied most recently to North Atlantic blue shark (O'Boyle et al. 1996). This first required fitting the vonBertallanffy growth model to the length at age data (Figure 30) developed by R. Nearing. The model equation was:

$$L = 114.01\ [1 - e^{-0.14405(t\ -\ 0.00315)}]$$

According to the model developed by Taylor (1958) for cod, the life span can be estimated from the equation: $t_0 + 2.996/K$. For winter skate the life span = 0.00315 + 2.996/0.14405 or 20.8. Hoenig (1983) developed a relationship between longevity and the observed natural mortality rate from literature data. The equation was $\ln(M) = 1.44 - 0.982 \ln(t_{max})$. Using the predicted maximum age of 20.8 years for winter skate resulted in M=0.214.

Conversion Rates

When the fishery began in 1994 a conversion factor of 1:4 (25%) was used to convert wing weight to round weight. After consultation with industry in August of 1994 this was changed to 37% based on the fact that half the fleet were hand cutting wings resulting in a 42% yield while the other half were using machines to cut wings with a yield of 35%. These rates improved during the year so that by fall hand cutting of wings was resulting in a yield of 44.8% and machine cut fish yields were ranging between 32.8% and 42.1% (Table 11). No further changes in the conversion rate were made. By 1996 one additional vessel had converted to hand cutting. Yields had improved to 45.6%. Machine yields were also reported to have increased. The improvements in yields and the indication that the remaining vessel using a machine will convert to hand cutting may require that the 37% conversion rate be reviewed in 1997.

Discussion

The experimental skate fishery on the eastern Scotian Shelf has evolved as more information has become available. Industry has expanded its area of directed fishing in part based on fishing concentrations discovered during industry/science surveys. Codend mesh sizes have increased to reduce discarding of undersized skates and by other groundfish species. The initial TAC set for this management unit was based on the total biomass of all skate species and is no longer valid given that industry has selectively harvested mature winter skate. Further, the biomass estimates were based on all size categories and industry is selecting through mesh sizes the largest individuals in the population. Using the criterion of 10% of mature biomass during the past decade of winter skates from the summer and spring surveys as a basis for setting harvest levels yields a range between 300 and 756t. This range is low relative to the current TAC.
By contrast no reduction in the length range of winter skates is evident from the commercial fishery. Neither research vessel series indicate any significant temporal trends in biomass since the early 1980s. No loss in areal distribution is evident at this time.

The ECNASAP program has shown that winter skate are at their northern limits of distribution. This suggests that they may be vulnerable to environmental effects. Given the low reproductive rates common to skate, a reduction in the reproductive potential of the stock is of concern. The localized nature of the fishery may result in the rapid depletion of mature winter skate concentrations in these areas. Unless industry is able to diversify their markets to include additional thorny skate and not concentrate only on the largest individuals of the population the sustainability of this fishery as it is currently practised may not be possible.

Acknowledgements

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Table 1. Reported nominal landings of skates (all species combined) in Divisions 4Vn, 4Vs, 4W, 4X.

Year	4Vn				4Vs				4W				4X			
	Canada	USSR	Others	Total	Canada	USSR	Others	Total	Canada	USSR	Others	Total	Canada	USSR	Others	Total
1961	-	-	-	0	-	-	-	0	1	-	-	1	177	-	-	177
1962	-	-	-	0	-	-	-	0	4	-	-	4	104	-	2	106
1963	-	-	-	0	-	-	-	0	-	-	-	0	95	-	2	97
1964	1	-	22	23	-	-	-	0	-	-	1	1	52	-	-	52
1965	-	-	-	0	17	-	4	21	51	-	-	51	94	-	-	94
1966	-	-	9	9	-	-	1	1	14	-	-	14	36	-	-	36
1967	-	-	-	0	-	-	-	0	16	-	-	16	61	-	-	61
1968	-	-	4	4	3	780	4	787	56	5397	-	5453	45	-	-	45
1969	-	-	4	4	4	269	8	281	10	4122	-	4132	9	15	-	24
1970	-	-	10	10	2	60	6	68	24	3802	-	3826	6	-	-	6
1971	2	-	7	9	12	1519	3	1534	1	15970	-	15971	3	149	-	152
1972	-	-	8	8	1	894	10	905	-	4325	5	4330	-	22	-	22
1973	1	-	55	56	3	364	38	405	2	6287	1	6290	-	821	1	822
1974	17	-	41	58	-	-	89	89	61	8323	18	8402	-	553	-	553
1975	-	-	66	66	2	633	81	716	-	15451	5	15456	-	2103	-	2103
1976	72	78	15	165	705	6026	108	6839	57	1738	-	1795	126	253	-	379
1977	101	-	5	106	382	-	-	382	52	489	-	541	48	105	-	153
1978	20	-	9	29	109	-	20	129	26	755	29	810	44	-	-	44
1979	48	-	3	51	52	-	-	52	36	287	5	328	27	-	-	27
1980	92	-	14	106	59	-	-	59	12	756	6	774	15	21	-	36
1981	53	-	10	63	7	5	-	12	2	297	-	299	1	-	-	1
1982	-	-	-	0	-	-	-	0	-	-	-	0	17	-	1	18
1983	-	-	5	5	-	-	-	0	9	130	18	157	1	26	5	32
1984	-	-	4	4	7	-	-	7	9	141	-	150	49	-	9	58
1985	1	-	9	10	7	-	-	7	-	421	5	426	2	-	-	2
1986	-	-	19	19	6	-	-	6	6	1467	-	1473	17	-	-	17
1987	9	-	-	9	17	-	-	17	28	1632	*107	1767	27	4	-	31
1988	1	-	-	1	3	-	-	3	4	2580	*29	2613	14	45	*0	59
1989	1	-	-	1	3	-	-	3	7	1364	*167	1538	17	21	*0	38
1990	0	-	-	0	0	-	-	0	2	1655	*315	1972	15	28	*0	43
1991	3	-	-	3	5	-	-	5	8	1112	*721	1841	5	36	*4	45
1992	0	-	-	0	0	-	-	0	2	279	*158	439	1	11	*13	25
1993	1	-	-	1	66	-	-	66	101	*117	*658	876	27	-	*16	43
1994	2	-	-	2	1971	-	-	1971	181	*0	*20	201	95	-	*1	96
1995	1	-	-	1	1502	-	-	1502	21	*0	*117	138	136	-	*5	141

1961-1988 NAFO data
1989-present ZIF data (Canadian)
* - IOP data

Table 2. Skate by-catch in Canadian and foreign fisheries in Divs. 4VsW as estimated by the International Observer Program.

	Foreign 4W [1]			Canadian Groundfish(4VsW) [2]			Flatfish(4Vs) [3]			Bycatch Total (Cdn.+For.)	Bycatch + Directed Fishery
	USSR	Others	Total	Landings(t)	Bycatch estimate	Est. skate removals	Landings	Bycatch estimate	Est. skate removals		
1989	1364	167	1531	60127	0.03	1744	3424	0.2	685	3960	3970
1990	1655	315	1970	57117	0.03	1599	4246	0.2	849	4418	4420
1991	1112	721	1833	56591	0.03	1471	2506	0.2	501	3805	3818
1992	279	158	437	47698	0.02	1002	3149	0.2	630	2069	2071
1993	117	658	775	8972	0.03	287	2916	0.2	583	1645	1812
1994	0	20	20	8211	0.01	49	2226	0.2	445	514	2666
1995	0	117	117	6449	0.01	90	1613	0.2	323	530	2062

Note: 1. Foreign IOP coverage 100% 1989 -1995
2. Estimated percentage of skate caught in the cod, haddock, pollock, and redfish fisheries.
3. Estimated percentage of skates caught in the flatfish fishery.

Table 3. Summary of species caught during the 1994 4Vn Sentinel Surveys and the 1995 4VsW Sentinel Survey.

4Vn Sentinel Survey-Species Summary				
	Stratum			
Species	<30	30-50fm	>51	Total(kg)
Cod	1662	5098	6874	13634
Dogfish	1935	1061	304	3300
Plaice	36	638	1258	1932
Skate	**71**	**295**	**632**	**998**
White hake	130	15	360	505
Wolffish	135	287	78	500
Shark		155	35	190
Sculpin	34	26	7	67
Pollock			58	58
Hagfish			11	11
Misc.		6	9	15

4VsW Sentinel Survey-Species Summary			
Species	Total measured	Total # caught	Total wt.(kg) caught
Cod	5565	6631	6656
Haddock	4262	7274	6229
Dogfish	11	3134	5813
Skate	**-**	**3399**	**4772**
Hake	1837	2685	2828
Blue Shark	-	31	861
Cusk	156	383	804
Halibut	25	70	702
Monkfish	-	155	653
Am. plaice	-	597	420
Wolffish	-	189	273
Pollock	-	109	170
Redfish	-	228	158
Flounder	-	136	105
Sculpin	1	150	56
Red hake	-	192	52
Silver hake	53	53	40
Turbot	-	5	9

Table 4. Numbers of winter skate caught at length during the summer research vessel groundfish survey in Div. 4VsW.

Length	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0.008	0	0	0	0	0	0	0.029	0	0.008	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0.008	0	0	0	0	0	0	0.016	0.02	0.012	0	0	0	0	0	0.016	0	0.006
22	0	0	0	0	0	0	0	0	0	0.056	0	0	0	0	0	0	0.01	0	0.008	0	0	0	0.003	0	0.008	0.005	0
25	0	0	0	0	0	0	0.007	0	0	0.168	0	0	0	0.011	0	0.01	0	0.01	0	0	0.005	0	0.007	0.034	0.034	0.027	0.01
28	0	0	0	0.01	0	0	0	0	0	0.2	0	0	0	0	0.012	0	0.01	0.022	0.029	0	0	0.013	0.02	0.051	0.033	0	0
31	0	0	0	0	0	0.012	0	0.013	0	0.208	0	0	0	0.01	0.033	0.01	0	0.019	0	0	0.006	0.042	0.022	0.103	0.112	0.031	0.012
34	0	0	0	0.006	0.009	0	0	0.024	0	0.148	0.016	0	0	0.02	0.022	0	0	0	0.057	0	0	0.12	0.042	0.12	0.21	0.022	0
37	0	0	0	0	0	0	0	0.124	0	0.144	0	0.009	0	0.01	0.011	0.01	0.01	0.024	0.019	0.005	0.009	0.105	0.04	0.217	0.214	0.037	0.008
40	0	0	0	0.016	0	0	0.007	0.03	0	0.033	0.012	0.036	0.02	0	0	0.041	0	0.031	0.056	0	0.017	0.132	0.038	0.169	0.193	0	0
43	0	0	0	0.02	0.026	0	0.007	0.105	0	0.076	0.022	0.016	0.014	0.052	0.026	0.041	0.01	0	0.02	0.017	0.012	0.151	0.043	0.165	0.09	0.029	0.036
46	0	0	0.009	0.011	0.007	0.02	0	0.038	0.025	0.073	0.031	0.053	0.041	0.072	0.027	0.021	0.017	0.017	0.081	0.005	0.025	0.091	0.08	0.126	0.04	0.017	0.01
49	0	0.015	0.01	0.011	0.029	0.12	0.013	0.06	0.018	0.16	0.025	0.135	0.046	0.031	0.094	0.031	0.029	0.01	0.112	0.02	0	0.15	0.114	0.108	0.011	0.013	0.05
52	0.01	0.075	0	0.039	0.014	0.058	0.016	0.061	0.034	0.336	0.07	0.107	0.019	0.057	0.161	0.083	0.103	0.028	0.077	0	0.013	0.102	0.029	0.081	0.027	0	0.028
55	0.01	0	0.006	0.053	0.007	0.027	0.013	0.078	0.031	0.308	0.054	0.152	0.032	0.011	0.04	0.097	0.096	0.026	0.097	0.006	0.033	0.071	0.084	0.105	0.013	0.033	0.021
58	0	0	0	0.055	0.02	0.04	0.013	0.083	0.009	0.243	0.028	0.098	0.071	0.014	0.012	0.075	0.042	0.018	0.045	0	0.031	0.083	0.038	0.04	0.016	0	0.024
61	0	0	0	0.072	0.009	0.033	0.013	0.056	0.037	0.118	0	0.097	0.032	0.027	0.043	0.05	0.026	0.018	0.087	0.03	0.031	0.058	0.015	0.03	0	0.026	0.041
64	0	0	0	0.025	0.002	0	0	0.022	0	0.138	0.023	0.111	0.02	0	0	0.008	0	0.015	0.046	0.02	0.059	0.08	0.066	0.014	0.007	0	0.034
67	0	0	0.009	0	0.005	0.038	0.013	0.008	0.019	0.169	0.012	0.054	0.125	0	0.006	0.025	0.02	0	0.059	0.011	0.02	0.027	0.032	0.015	0.023	0.011	0.06
70	0	0.007	0	0	0	0.038	0	0.079	0.037	0.021	0.034	0.079	0.077	0.039	0.006	0.045	0.003	0.005	0.006	0	0.061	0.047	0.058	0.007	0	0.006	0.06
73	0	0	0.006	0	0.01	0.038	0.026	0.045	0	0.012	0.023	0.044	0	0.028	0.006	0.06	0	0	0.117	0	0.019	0.071	0.062	0	0.005	0.031	0.029
76	0	0	0	0.055	0.014	0.038	0.013	0.045	0.018	0.016	0.065	0.018	0.033	0.005	0.006	0.032	0.019	0.012	0.035	0.011	0.032	0.044	0.05	0	0	0	0.038
79	0	0	0.005	0	0.009	0.026	0.019	0.062	0.009	0.005	0.037	0.006	0.014	0.011	0.015	0.053	0	0.023	0.038	0.027	0.053	0.029	0.039	0.007	0.009	0.025	0.036
82	0.009	0	0	0.021	0.017	0.022	0.013	0.033	0.06	0.07	0.053	0.045	0.043	0	0.014	0.009	0.013	0.018	0.05	0	0.018	0.023	0.018	0.011	0.005	0	0.025
85	0.013	0.028	0.009	0.041	0.017	0	0.013	0.022	0.012	0.054	0.02	0.006	0.013	0	0	0.03	0	0.003	0.08	0.009	0.028	0.035	0.023	0.016	0.01	0	0.026
88	0.034	0.074	0.01	0.138	0.039	0.02	0	0.042	0.015	0.062	0.052	0.027	0.062	0	0.013	0.049	0.014	0.006	0.022	0	0.048	0.058	0.059	0	0.005	0	0.012
91	0.015	0.08	0.064	0.101	0.009	0.028	0.013	0	0.031	0.051	0.023	0.024	0.034	0	0.034	0.018	0.014	0.009	0.076	0.01	0.023	0.016	0.053	0	0	0.007	0
94	0.057	0.015	0.066	0.052	0.017	0.032	0	0	0	0.015	0.009	0.027	0.056	0.012	0	0.009	0.046	0.01	0.034	0.003	0.028	0.017	0.026	0	0.006	0.007	0
97	0.021	0	0.098	0.134	0.021	0.08	0.013	0.022	0.009	0	0	0.006	0.027	0.008	0.006	0.035	0.011	0.026	0.036	0	0.023	0.014	0.006	0	0.006	0	0
100	0.049	0.013	0.056	0.068	0.007	0.148	0	0.02	0	0.023	0	0	0.049	0	0	0	0	0	0.029	0.011	0	0.006	0.014	0	0	0	0
103	0.106	0	0.019	0.033	0.01	0.057	0	0	0	0.008	0	0	0.035	0.014	0	0	0	0.008	0.01	0	0	0	0.008	0	0	0.005	0
106	0.095	0.007	0.056	0.028	0.007	0.088	0	0.022	0	0	0.017	0	0.014	0	0	0	0	0.008	0.011	0	0	0	0	0	0	0	0
109	0	0	0.037	0.032	0.015	0.012	0	0	0	0	0	0	0	0	0	0	0	0	0.023	0	0	0	0	0	0	0	0
112	0.011	0	0	0.015	0	0.025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	0.011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5. Numbers of thorny skate caught at length during the summer research vessel groundfish survey in Div. 4VsW.

Length	70	71	72	73	74	75	76	77	78	79	80	81	82
1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0.013	0	0	0
10	0	0	0.013	0	0	0.005	0	0	0	0	0	0	0.016
13	0.132	0.438	0.248	0.068	0.324	0.129	0.036	0.038	0.056	0.261	0.143	0.027	0.669
16	0.276	0.653	0.171	0.319	0.39	0.624	0.141	0.072	0.142	0.392	0.338	0.563	1.312
19	0.333	0.962	0.414	0.864	0.367	1.022	0.614	0.242	0.29	0.307	1.112	0.891	1.242
22	0.336	0.629	0.357	1.34	0.515	1.113	0.81	0.393	0.389	0.296	1.197	1.528	1.573
25	0.224	0.455	0.558	1.162	0.513	1.259	1.161	0.682	0.733	0.524	0.966	1.517	0.937
28	0.229	0.327	0.69	1.28	0.613	1.646	0.784	0.947	0.599	0.647	1.308	1.391	0.844
31	0.273	0.222	0.453	1.289	0.749	1.891	0.92	0.705	0.541	0.717	1.008	0.891	0.664
34	0.156	0.14	0.441	0.854	0.569	1.45	0.484	0.693	0.723	0.532	0.914	1.049	0.807
37	0.213	0.168	0.235	0.515	0.397	0.924	0.37	0.787	0.784	0.852	0.509	0.597	0.608
40	0.193	0.101	0.26	0.485	0.367	0.764	0.491	0.507	0.685	0.433	0.632	0.651	0.584
43	0.129	0.047	0.117	0.346	0.216	0.547	0.509	0.34	0.511	0.279	0.558	0.71	0.422
46	0.135	0.178	0.162	0.247	0.192	0.414	0.367	0.182	0.32	0.164	0.37	0.383	0.422
49	0.085	0.041	0.068	0.317	0.223	0.286	0.216	0.204	0.304	0.194	0.338	0.18	0.198
52	0.142	0.082	0.176	0.203	0.189	0.283	0.091	0.221	0.21	0.259	0.227	0.283	0.176
55	0.213	0.301	0.28	0.325	0.15	0.194	0.15	0.164	0.188	0.116	0.15	0.106	0.072
58	0.111	0.095	0.13	0.237	0.174	0.243	0.146	0.233	0.121	0.129	0.121	0.197	0.165
61	0.218	0.147	0.29	0.297	0.216	0.324	0.26	0.16	0.099	0.106	0.078	0.321	0.093
64	0.395	0.214	0.205	0.474	0.233	0.452	0.187	0.154	0.139	0.101	0.136	0.217	0.06
67	0.262	0.202	0.244	0.335	0.367	0.454	0.316	0.136	0.069	0.171	0.142	0.269	0.083
70	0.37	0.137	0.278	0.399	0.207	0.492	0.126	0.135	0.049	0.124	0.157	0.175	0.02
73	0.184	0.153	0.132	0.493	0.296	0.436	0.266	0.188	0.105	0.104	0.104	0.192	0.018
76	0.065	0.146	0.121	0.291	0.126	0.408	0.134	0.154	0.054	0.083	0.078	0.065	0.013
79	0.107	0.178	0.099	0.194	0.163	0.271	0.104	0.082	0.027	0.088	0.036	0.101	0.086
82	0.052	0.095	0.052	0.136	0.078	0.03	0.059	0.034	0.021	0.021	0.018	0.029	0
85	0.061	0.033	0.085	0.06	0.107	0.069	0.097	0.01	0.016	0.034	0.012	0.02	0.008
88	0.027	0.022	0.067	0.055	0.101	0.032	0.015	0.023	0.011	0.003	0.012	0	0.008
91	0.064	0.036	0.025	0.029	0.138	0.032	0.007	0.042	0	0.041	0.014	0	0
94	0	0.017	0.035	0.026	0.016	0.013	0.025	0.085	0.057	0	0	0.018	0
97	0.028	0.024	0.009	0	0.024	0.024	0.008	0.016	0	0	0	0	0
100	0.01	0.033	0.027	0.029	0.077	0.007	0.014	0.021	0.009	0	0	0.009	0
103	0.005	0	0.004	0.014	0	0	0	0	0	0	0	0	0.008
106	0	0	0	0	0.027	0	0.022	0	0	0	0	0	0
112	0.005	0	0	0	0	0	0	0	0	0	0	0	0.038

Length	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	0	0	0.016	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0.046	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0.005	0	0.042	0.022	0	0.004	0	0	0.006	0.019	0.109	0	0.026	0.005
13	0.103	0.265	0.142	0.115	0.043	0.119	0.008	0.061	0.041	0.034	0.134	0.171	0.064	0.037
16	0.665	0.356	0.646	0.154	0.071	0.461	0.044	0.134	0.096	0.059	0.177	0.172	0.217	0.324
19	1.309	0.36	1.469	0.274	0.099	0.901	0.26	0.305	0.245	0.257	0.21	0.358	0.379	0.355
22	1.256	0.898	1.584	0.296	0.385	0.56	0.398	0.351	0.434	0.464	0.518	0.597	0.481	0.352
25	0.914	0.763	1.301	0.326	0.299	0.747	0.352	0.486	0.342	0.244	0.866	0.444	0.591	0.471
28	1.787	0.583	0.856	0.247	0.325	0.81	0.5	0.522	0.483	0.331	0.915	0.358	0.602	0.227
31	1.561	0.738	0.867	0.434	0.411	0.922	0.668	0.546	0.515	0.26	0.841	0.312	0.564	0.181
34	1.493	0.437	0.823	0.369	0.502	0.723	0.602	0.336	0.326	0.382	0.533	0.25	0.476	0.202
37	1.011	0.577	0.974	0.442	0.322	0.529	0.618	0.408	0.403	0.31	0.397	0.178	0.641	0.066
40	1.105	0.476	0.908	0.423	0.284	0.323	0.474	0.322	0.341	0.344	0.321	0.087	0.386	0.131
43	0.341	0.495	0.747	0.372	0.297	0.32	0.533	0.304	0.335	0.27	0.264	0.07	0.406	0.179
46	0.405	0.269	0.655	0.179	0.148	0.317	0.403	0.271	0.205	0.315	0.192	0.099	0.211	0.12
49	0.193	0.228	0.287	0.087	0.09	0.182	0.352	0.174	0.218	0.25	0.186	0.068	0.244	0.1
52	0.09	0.176	0.494	0.145	0.094	0.212	0.171	0.076	0.079	0.191	0.071	0.042	0.124	0.057
55	0.063	0.107	0.173	0.06	0.032	0.144	0.151	0.043	0.052	0.154	0.059	0.026	0.069	0.045
58	0.061	0.151	0.158	0.037	0	0.124	0.149	0.061	0.032	0.089	0.038	0.014	0.083	0.023
61	0.091	0.103	0.061	0.034	0	0.056	0.11	0.054	0.028	0.07	0.049	0.003	0.029	0.055
64	0.017	0.134	0.059	0.041	0.069	0.063	0.036	0.044	0.003	0.043	0.005	0	0.012	0.002
67	0	0.033	0.034	0.024	0.005	0.027	0.046	0.037	0.009	0.007	0	0.029	0	0
70	0.03	0.072	0.084	0.059	0.006	0.005	0.044	0	0.006	0.004	0.007	0	0.011	0
73	0.028	0.064	0.015	0.028	0.018	0.031	0.025	0.013	0.027	0.006	0.009	0	0.012	0
76	0.026	0.028	0	0	0.01	0.011	0.009	0	0	0.021	0	0	0.015	0
79	0.005	0	0.013	0.027	0.01	0	0.011	0	0.008	0.004	0	0	0	0
82	0	0.044	0.007	0.019	0	0	0	0	0	0	0	0	0	0
85	0	0.012	0	0.006	0.024	0.018	0	0	0	0	0	0	0	0
88	0.02	0.048	0	0.006	0	0.027	0	0.01	0	0	0	0	0	0
91	0.02	0.009	0	0.019	0.008	0	0.016	0	0	0	0	0	0	0
94	0.02	0	0	0	0	0	0	0	0	0	0	0	0.01	0
97	0	0.024	0	0	0.008	0	0.009	0	0	0	0	0	0	0
100	0.012	0	0	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Number of winter skate caught at length during the spring research vessel groundfish survey in Div. 4VsW.

Length	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	0	0	0	0	0	0	0	0.007	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0.003	0	0	0	0	0	0	0
10	0	0	0	0	0.005	0	0	0	0.018	0	0.016	0.003	0	0	0	0	0	0
13	0	0.002	0	0	0	0	0	0	0.036	0	0.009	0.029	0.003	0.005	0	0	0.015	0.012
16	0	0.002	0	0.028	0	0	0	0	0.236	0.039	0.076	0.074	0.055	0.014	0.083	0	0	0.053
19	0.013	0	0	0.075	0	0	0	0.007	0.24	0.107	0.085	0.05	0.114	0	0.081	0.022	0.022	0.011
22	0.013	0.01	0.006	0.051	0.007	0	0	0.035	0.2	0.133	0.11	0.068	0.171	0	0.037	0.01	0.037	0.065
25	0.032	0.085	0.01	0.036	0.01	0	0	0.034	0.138	0.126	0.159	0.074	0.096	0.012	0.107	0.058	0.078	0.06
28	0.009	0.056	0.022	0.091	0.007	0	0	0.056	0.231	0.285	0.1	0.057	0.09	0.011	0.078	0.155	0.134	0.052
31	0.067	0.097	0.03	0.08	0.01	0	0	0.069	0.222	0.259	0.058	0.035	0.071	0.011	0.269	0.362	0.139	0.046
34	0.054	0.094	0.046	0.13	0.009	0.009	0	0.027	0.356	0.287	0.052	0.04	0.092	0.017	0.376	0.316	0.262	0.061
37	0.06	0.084	0.141	0.063	0.026	0.009	0	0.076	0.193	0.153	0.05	0.029	0.115	0.012	0.719	0.221	0.279	0.065
40	0.086	0.147	0.152	0.062	0.023	0	0	0.09	0.243	0.094	0.024	0.028	0.203	0	0.664	0.199	0.373	0.141
43	0.131	0.181	0.329	0.092	0.046	0	0	0.084	0.29	0.085	0.014	0.014	0.214	0.005	0.501	0.089	0.504	0.137
46	0.171	0.33	0.234	0.061	0.075	0.037	0	0.07	0.152	0.086	0.022	0.007	0.184	0.01	0.43	0.038	0.501	0.157
49	0.193	0.302	0.376	0.201	0.055	0.044	0	0.193	0.364	0.12	0.024	0.023	0.103	0	0.22	0.033	0.622	0.162
52	0.178	0.402	0.429	0.069	0.181	0.03	0	0.197	0.395	0.108	0.054	0.013	0.122	0.017	0.172	0.34	0.253	0.04
55	0.142	0.212	0.253	0.075	0.087	0.027	0	0.167	0.27	0.071	0.056	0.035	0.114	0.01	0.026	0.311	0.164	0
58	0.085	0.126	0.109	0.107	0.117	0.023	0	0.064	0.114	0.007	0.035	0.017	0.035	0.005	0.091	0.781	0.123	0.061
61	0.051	0.034	0.129	0.082	0.063	0.003	0	0.13	0.084	0.024	0.017	0.021	0.032	0	0.031	1.087	0.087	0.02
64	0.013	0.053	0.037	0.09	0.01	0.033	0	0.117	0.092	0	0.046	0	0.027	0.036	0.005	1.235	0.057	0.02
67	0.012	0.025	0.038	0.04	0.067	0.022	0	0.179	0.044	0.013	0.045	0	0.057	0.015	0.012	0.927	0.028	0.031
70	0.02	0.068	0.041	0.052	0.029	0.036	0	0.246	0.11	0.01	0.015	0	0.065	0.005	0.002	1.313	0.019	0.02
73	0.05	0.045	0.04	0.069	0.016	0.023	0	0.131	0.049	0.017	0.055	0	0.057	0.012	0.012	1.159	0.027	0.011
76	0.017	0.025	0.05	0.03	0.025	0.04	0	0.158	0.118	0	0.059	0	0.072	0.024	0	1.004	0.007	0
79	0.004	0.004	0.041	0.022	0.04	0.034	0	0.107	0.018	0.03	0.032	0	0.088	0.024	0	0.926	0.007	0.011
82	0.025	0.015	0.179	0.057	0.043	0.018	0	0.073	0.06	0.033	0.063	0	0.113	0	0.007	2.162	0.007	0
85	0.025	0	0.051	0.028	0.047	0.05	0	0.182	0.032	0.007	0.028	0.018	0.078	0.017	0.002	0.773	0.004	0
88	0.028	0.025	0.046	0.042	0.026	0.015	0	0.072	0.033	0.007	0.02	0.037	0.111	0	0.002	0.695	0	0.011
91	0.017	0.014	0.028	0.055	0.059	0.032	0	0.204	0.113	0	0.032	0.006	0.162	0.017	0.019	0.695	0	0.003
94	0.018	0.041	0.051	0.032	0.029	0.048	0	0.2	0.052	0	0.033	0.012	0.157	0.027	0.002	0.232	0	0
97	0.002	0.015	0.014	0.018	0.093	0.011	0	0.076	0.036	0	0.045	0	0.103	0.015	0.015	0.232	0.008	0.027
100	0.02	0.019	0.01	0.057	0.016	0.008	0	0.046	0.025	0	0.013	0.006	0.077	0.012	0.014	0.309	0	0
103	0.024	0.007	0.02	0.021	0	0.007	0	0.04	0.015	0	0.007	0.006	0.031	0.005	0.002	0.309	0	0
106	0.014	0	0.002	0	0.037	0.003	0	0.027	0.024	0	0.007	0	0.007	0	0	0	0	0
109	0.006	0.002	0	0	0.01	0	0	0	0	0	0.01	0	0.01	0	0	0	0	0.002
112	0.006	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0.014	0	0	0	0	0.005	0	0	0	0	0	0	0	0	0
118	0.006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0.014	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7. Numbers of thorny skate caught at length during the spring research vessel groundfish survey in Div. 4VsW.

Length	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0.034	0	0.015	0	0	0	0.014	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0.007	0	0	0
10	0.013	0	0	0.015	0	0.009	0	0.013	0.007	0.009	0.044	0.019	0.038	0.026	0.002	0.01	0	0
13	0.741	0.305	0.405	0.283	0.643	0.511	0	0.182	0.079	0	0.156	0.293	0.24	0.255	0.224	0.318	0.12	0.057
16	0.903	1.906	0.528	0.773	0.672	0.857	0	0.545	0.322	0.151	0.175	0.397	0.406	0.185	0.325	0.586	0.146	0.126
19	0.965	1.393	0.456	0.704	0.646	1.007	0	0.643	0.355	0.383	0.648	0.426	0.68	0.265	0.291	0.306	0.209	0.367
22	2.589	1.409	0.473	1.231	0.554	1.35	0	0.565	0.789	0.501	0.734	0.47	0.739	0.483	0.452	0.237	0.398	0.402
25	3.785	0.812	0.697	1.171	0.359	1.097	0	0.714	1.018	0.389	0.724	0.82	1.259	0.503	0.365	0.138	0.319	0.353
28	3.285	0.689	0.855	1.014	0.663	0.614	0	0.426	0.818	0.631	0.541	0.703	1.785	0.318	0.385	0.147	0.441	0.352
31	2.28	0.789	1.011	1.066	0.551	0.76	0	0.64	0.916	0.38	0.631	0.638	1.561	0.344	0.261	0.311	0.165	0.307
34	1.09	0.513	1.24	1.07	0.459	0.818	0	0.548	0.922	1.205	0.365	0.52	0.987	0.24	0.119	0.349	0.124	0.248
37	0.727	0.457	1.051	1.046	0.593	0.451	0	0.361	0.956	1.018	0.451	0.506	1.037	0.126	0.17	0.36	0.142	0.072
40	0.397	0.475	0.883	0.73	0.51	0.536	0	0.283	0.942	0.736	0.487	0.322	0.841	0.173	0.173	0.299	0.109	0.114
43	0.394	0.237	0.357	0.647	0.348	0.662	0	0.25	1.04	0.919	0.346	0.251	0.512	0.133	0.089	0.699	0.08	0.082
46	0.235	0.161	0.629	0.464	0.224	0.417	0	0.158	0.653	0.572	0.336	0.125	0.26	0.064	0.087	0.489	0.051	0.032
49	0.184	0.075	0.139	0.398	0.124	0.315	0	0.173	0.498	0.359	0.196	0.06	0.329	0.051	0.061	0.523	0.045	0.031
52	0.154	0.08	0.308	0.313	0.103	0.2	0	0.098	0.348	0.302	0.175	0.085	0.195	0.043	0.039	0.56	0.083	0.032
55	0.104	0.045	0.159	0.038	0.067	0.203	0	0.054	0.206	0.174	0.12	0.025	0.103	0.068	0.025	0.135	0.078	0.029
58	0.097	0.029	0.209	0.306	0.106	0.172	0	0.021	0.086	0.161	0.062	0.013	0.131	0.016	0.025	0.202	0.037	0.034
61	0.148	0.088	0.156	0.042	0.01	0.124	0	0.027	0.111	0.019	0.042	0.01	0.078	0.019	0.005	0.178	0.011	0.034
64	0.183	0.011	0.276	0.178	0.034	0.086	0	0.019	0.086	0.048	0.028	0.019	0.052	0.002	0.005	0.066	0.002	0.016
67	0.096	0.055	0.164	0.015	0.051	0.112	0	0	0.064	0.052	0.007	0.004	0.043	0.005	0.002	0	0.001	0.011
70	0.245	0	0.087	0.005	0.041	0.094	0	0	0.038	0.019	0.007	0	0.027	0	0	0.024	0	0.009
73	0.092	0.023	0.097	0.009	0.035	0.037	0	0	0.042	0	0.016	0	0.005	0	0	0	0	0.002
76	0.088	0.016	0.164	0.306	0.005	0.041	0	0.023	0.019	0.008	0	0	0	0	0	0	0	0
79	0.081	0.017	0.102	0.175	0.005	0.031	0	0	0	0	0	0	0	0	0	0	0	0
82	0.033	0	0.011	0.153	0.006	0.01	0	0	0.027	0	0	0	0	0	0	0	0	0
85	0.032	0	0	0	0.018	0	0	0	0.008	0	0.002	0	0	0	0	0	0	0
88	0	0	0	0	0.002	0.006	0	0.007	0	0.019	0.002	0	0	0	0	0	0	0
91	0	0.014	0.017	0	0	0	0	0.007	0.003	0.004	0.002	0	0	0	0	0	0	0
94	0.014	0	0	0	0	0	0	0.007	0	0.004	0.002	0	0	0	0	0	0	0
97	0	0	0	0	0	0.022	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0.068	0	0.006	0	0	0	0	0.014	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0.002	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0.012	0	0	0	0	0	0	0	0	0

Table 8. Summary of gear used by the vessels conducting the directed Div. 4VsW skate fishery.

Vessel	Mesh(mm)	1994 August Survey	1994 August Directed fishing	1994 September Survey	1994 September Directed fishing	1995 April Survey and Directed fishing	1995 October Survey and Directed fishing	1996 April Survey	1996 April Directed fishing
1	codend	153	234	155	254	305	305	155	(355-406)
	belly	140	140	140	140	305	305	305	305
2	codend	155	-	155	263	315	320	155	320
	belly	140	-	140	140	315	320	320	320
3	codend	155	254	155	254	279	300	155	(300-390)
	belly	138	138	155	154	279	300	300	300
4	codend	155	258	155	258	255	300	155	305
	belly	142	142	142	142	255	300	305	305

Note: 155mm= 6"
255mm=10"
279mm=11"
305mm=12"
406mm=16"

In 1994 all nets used square mesh
In 1995 two of the vessels used diamond mesh in the codend
In 1996 the first directed fishing trips of the year used 16" square mesh in the codend.
They were allowed to revert to the 1995 net regulations in April, though 14"square and 16" diamond were tried.

Vessel 1. 65', 300 Balloon Trawl

Vessel 2. 65', 300 Balloon Trawl

Vessel 3. 65' , 300 Balloon Trawl

Vessel 4. 45', 280 Balloon Trawl

Table 9. Comparison of mean weight(kg) per tow of skates from the 1995 research vessel and industry surveys in strata 46-58.

Mean wt(kg.) per Tow	Winter skate	Thorny skate
April(industry)	11.9	0.6
Spring rv survey	5.2	1.7
Summer rv survey	0.7	5.0
October(industry)	17.8	1.0

Table 10. Bycatch estimates from the April/October 1995 , April 1996 experimental survey and the 1996 commercial fishery as observed by IOP.

April 1995 255-315 mm Species	survey + commercial Catch(kg)	Bycatch %
Am. plaice	48	0.05
Angler	48	0.05
Halibut	38	0.04
Haddock	12	0.01
Dogfish	7	0.01
Redfish	5	0.00
Lumpfish	4	0.00
Sea raven	2	0.00
Capelin	2	0.00
Spotted wolffish	1	0.00
Herring	1	0.00
Twohorn sculpin	1	0.00
Total	169	0.16
Barndoor skate	0	
Thorny skate	4907	
Smooth skate	2	
Little skate	8547	
Winter skate	92792	
Sum(skates)	106248	

October 1995 300-320 mm Species	survey + commercial Catch(kg)	Bycatch %
Angler	80	0.09
Twohorn sculpin	70	0.08
Sculpins	27	0.03
Cod	12	0.01
Redfish	6	0.01
Halibut	6	0.01
Y'tail fldr	4	0.00
Fourhorn sculpin	1	0.00
Longhorn sculpin	1	0.00
Total	207	0.24
Barndoor skate	5	
Thorny Skate	441	
Smooth skate	11	
Little skate	1	
Winter skate	85637	
Sum(skates)	86095	

April 1996 155mm Species	survey only Catch(kg)	Bycatch %
Angler	34	0.60
Halibut	23	0.41
Football fish	10	0.18
Pollock	8	0.14
Y'tail fldr	5	0.09
Longhorn sculpin	4	0.07
Dogfish	4	0.07
Sculpin	3	0.05
Capelin	2	0.04
Witch	2	0.04
Cod	2	0.04
Haddock	2	0.04
Lumpfish	1	0.02
Sand lance	1	0.02
Redfish	1	0.02
Red hake	1	0.02
Total	103	1.83
Barndoor skate	0	
Thorny Skate	185	
Smooth skate	18	
Little skate	17	
Winter skate	5409	
Sum(skates)	5629	

1996 Directed fishing sets (300-405mm) Species	Catch(kg)	Bycatch %
Angler	131	0.06
Halibut	72	0.03
Am. plaice	46	0.02
Lumpfish	25	0.01
Redfish	5	0.00
Fourhorn sculpin	2	0.00
Cod	1	0.00
Longhorn sculpin	1	0.00
Total	283	0.13
Barndoor skate	0	
Thorny Skate	18490	8.24
Smooth skate	6	
Little skate	0	
Winter skate	205817	
Sum(skates)	224313	

Table 11. Conversion rates of skates (species unknown) as calculated from the 1994 and 1996 fisheries.

Year	Method	Weight(kg.) Round	Weight(kg.) Wings	Ratio	Data Source	
1994	Hand	184	83	0.448	survey	Individual weights at sea
"	Machine	555349	233890	0.421	Plant 1	Total weight (on land)
"	"	569	210	0.369	Plant 2	"
"	"	2544	835	0.328	survey	" (at sea)
1996	Hand	415293	189210	0.456	Plant 1	Total weight (on land)

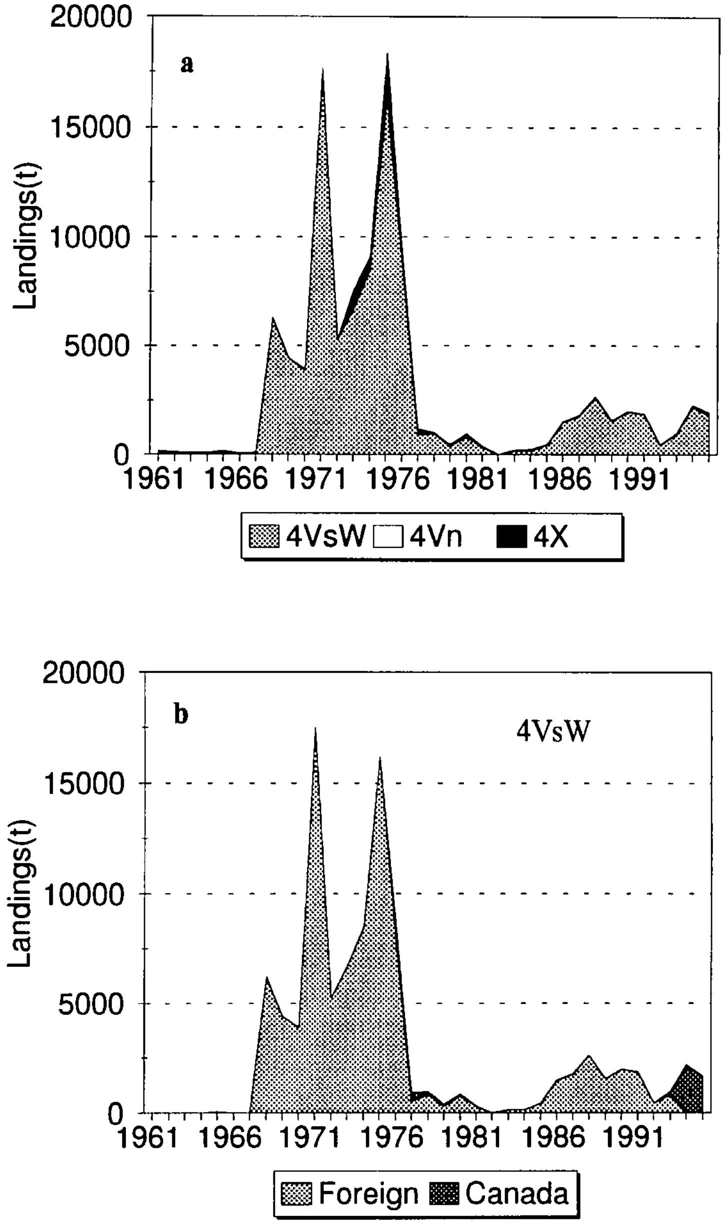


Figure 1. Reported nominal landings of skate (all species combined) by a) division and b) country in Divs. 4VsW.

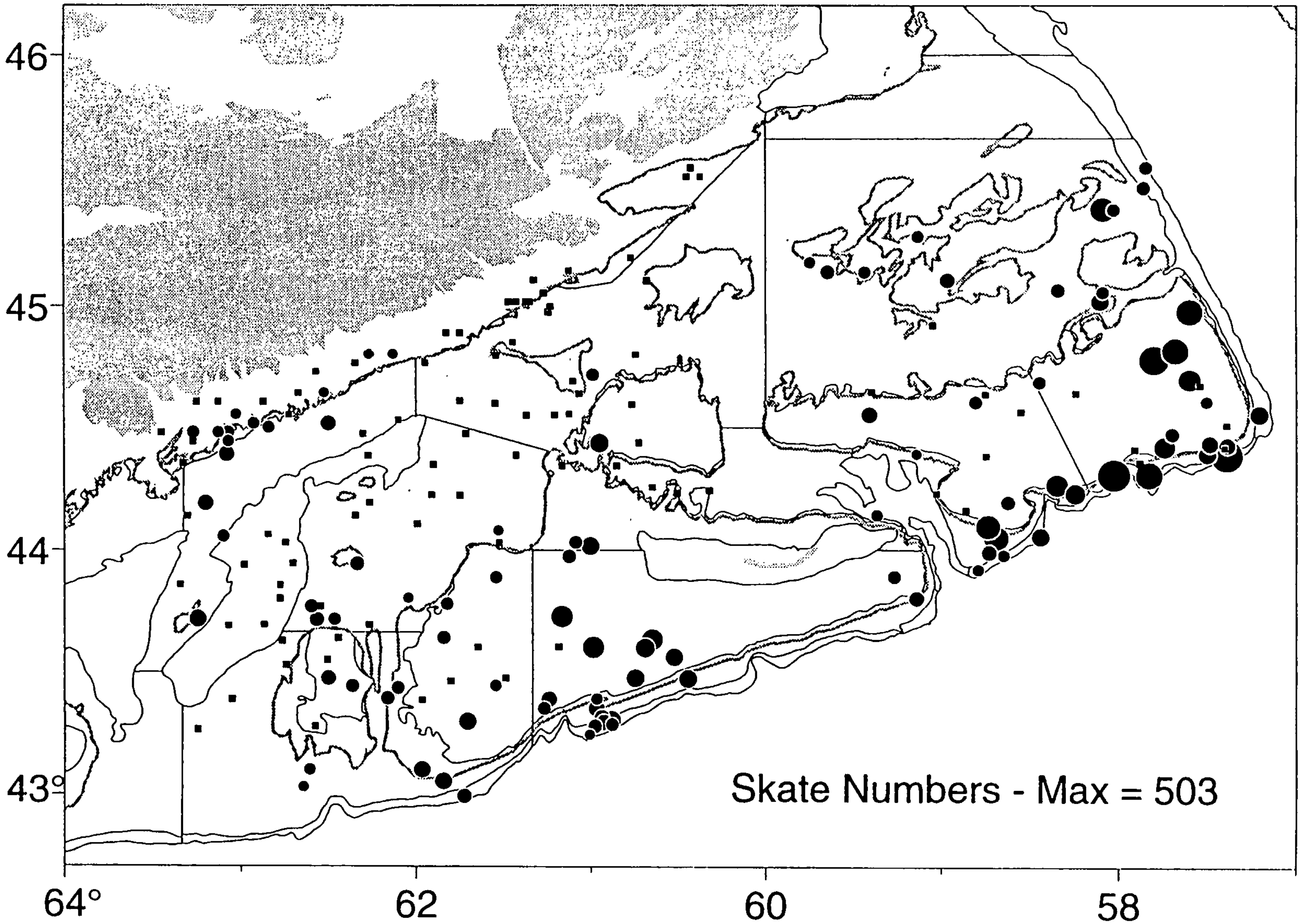


Figure 2. Distribution of skates (all species) caught (#/tow) during the fall 1995 4VsW Sentinel Survey.

Winter skates

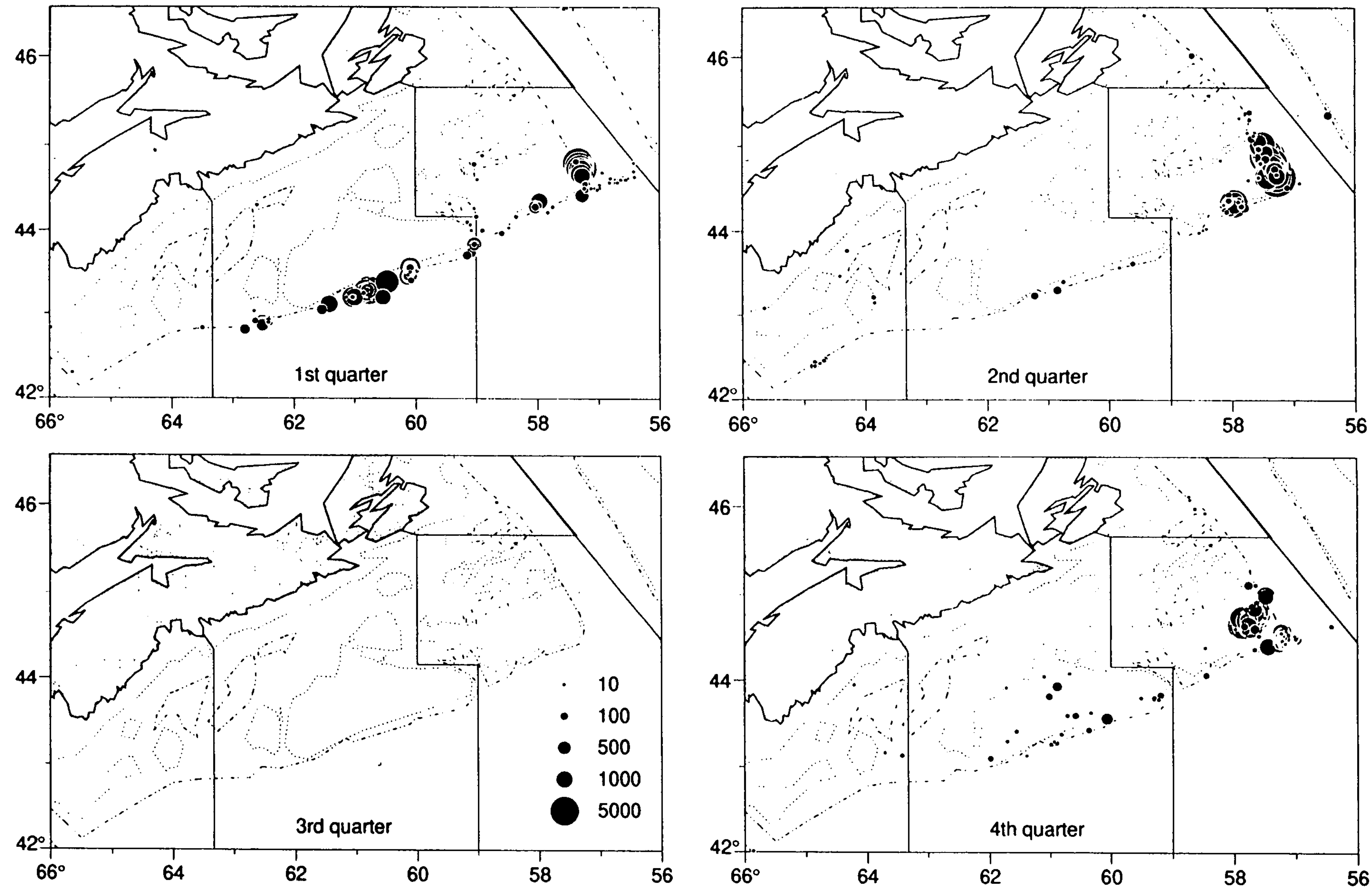


Figure 3. Distribution of winter skate caught by quarter in 1995 by Canadian vessels as reported by I.O.P..
Observations less than 10 kg. are excluded. No directed skate trips were observed in the 3rd. quarter

Thorny skates

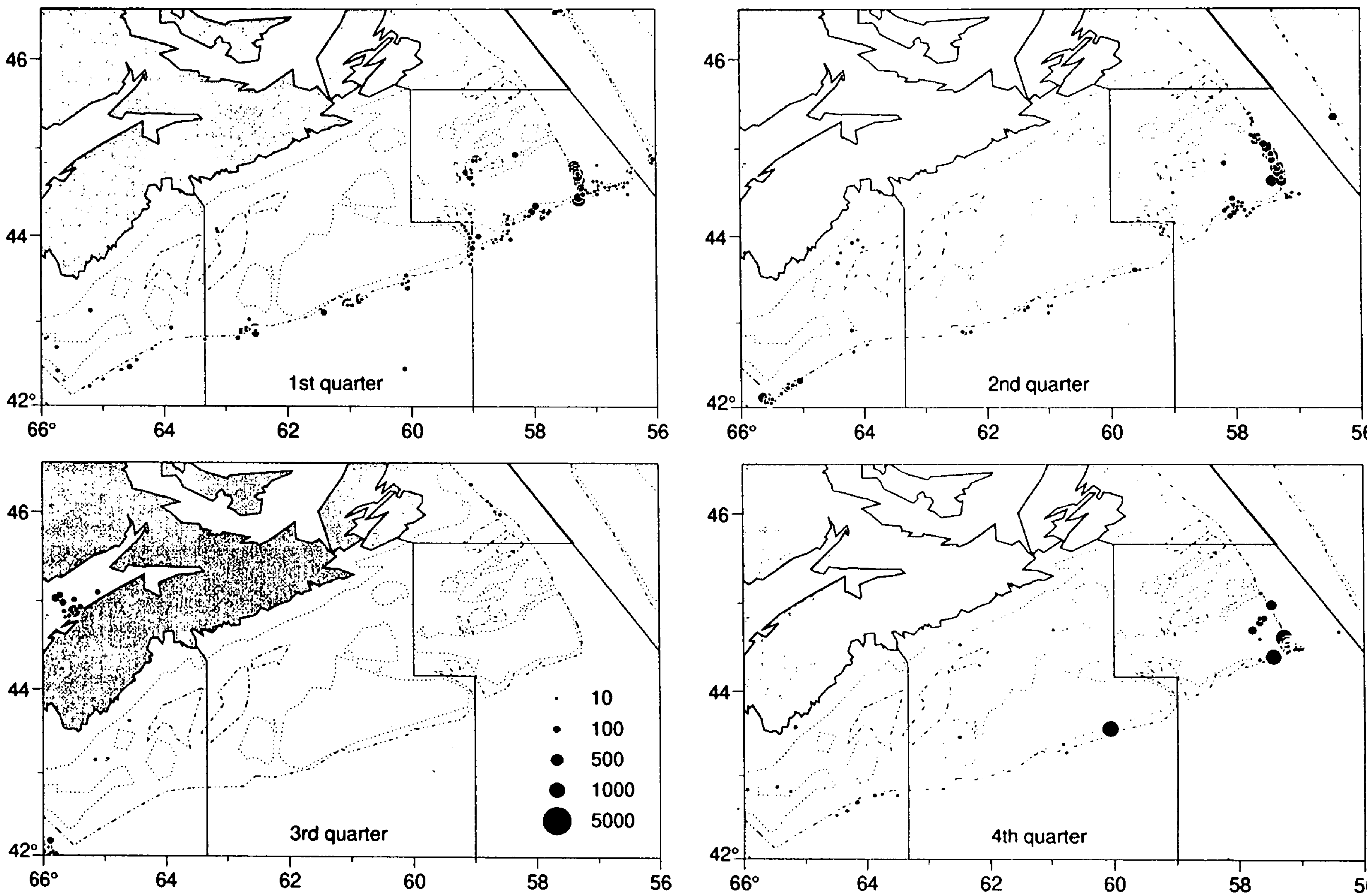


Figure 4. Distribution of thorny skate caught by quarter in 1995 by Canadian vessels as reported by I.O.P.. Observations less than 10 kg. are excluded. No directed skate trips were observed in the 3rd. quarter

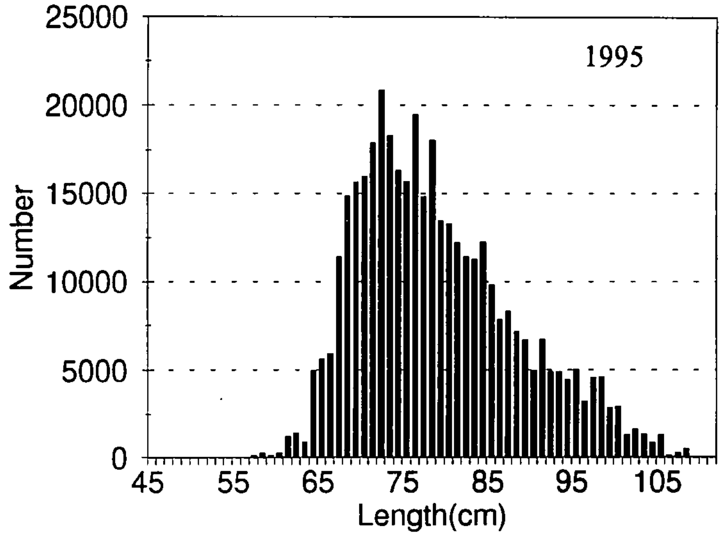


Figure 5. Annual catch numbers at length of Div. 4VsW skate taken during the 1995 commercial fishery.

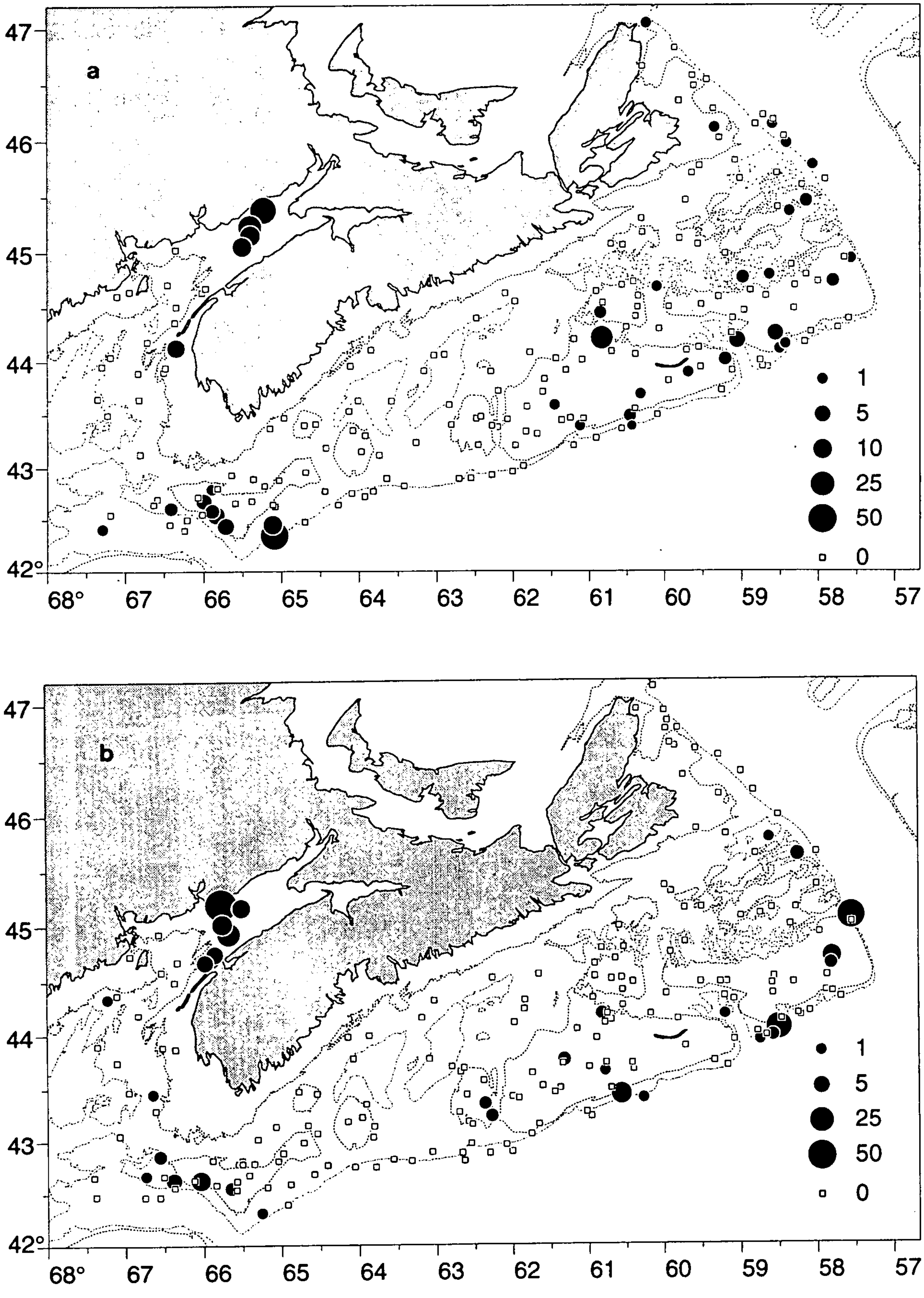


Figure 6. Distribution of winter skate caught (nos./tow) during the a) 1995 and b) 1996 summer groundfish research vessel surveys.

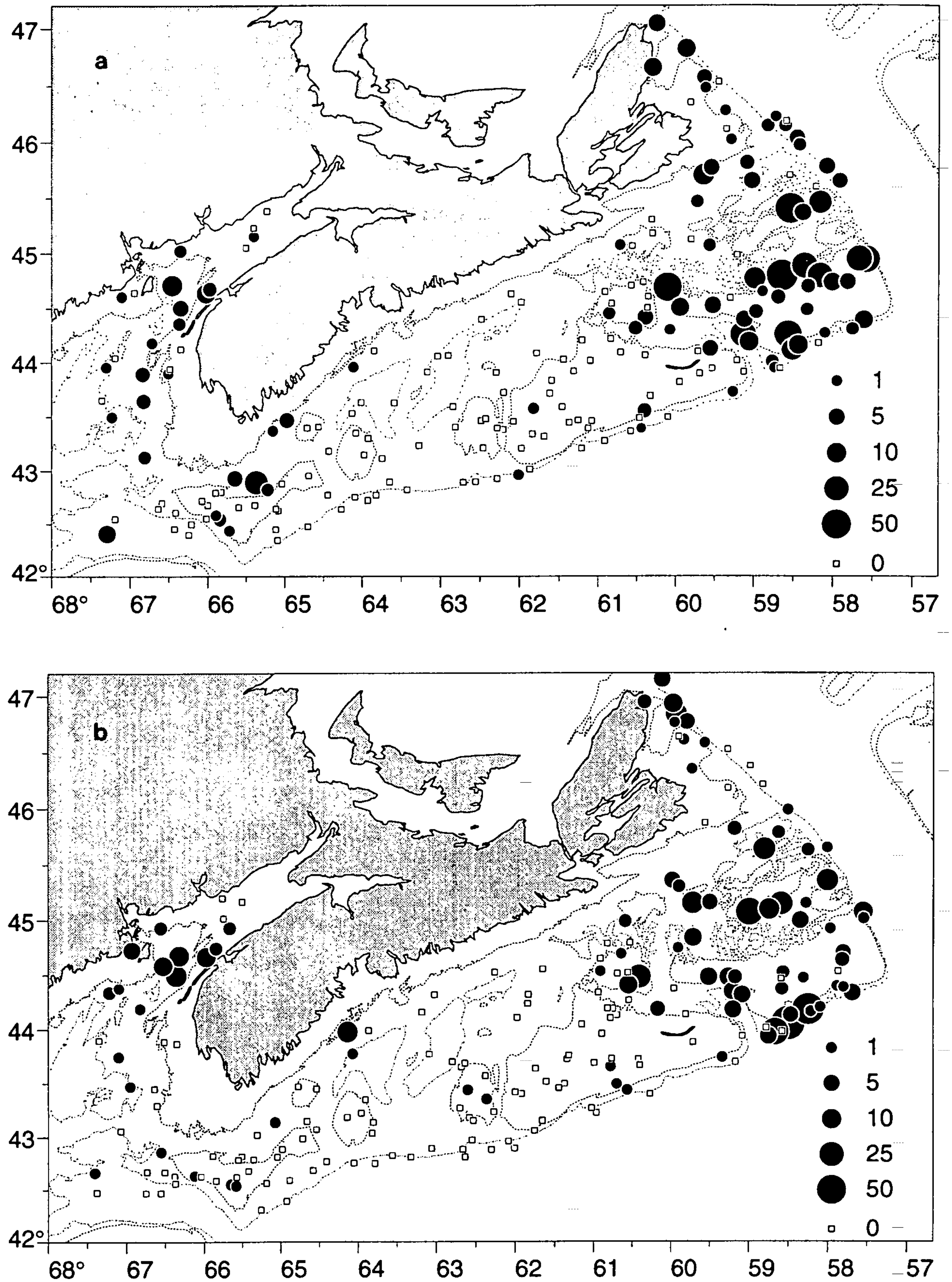


Figure 7. Distribution of thorny skate caught (nos./tow) during the a) 1995 and b) 1996 summer groundfish research vessel surveys.

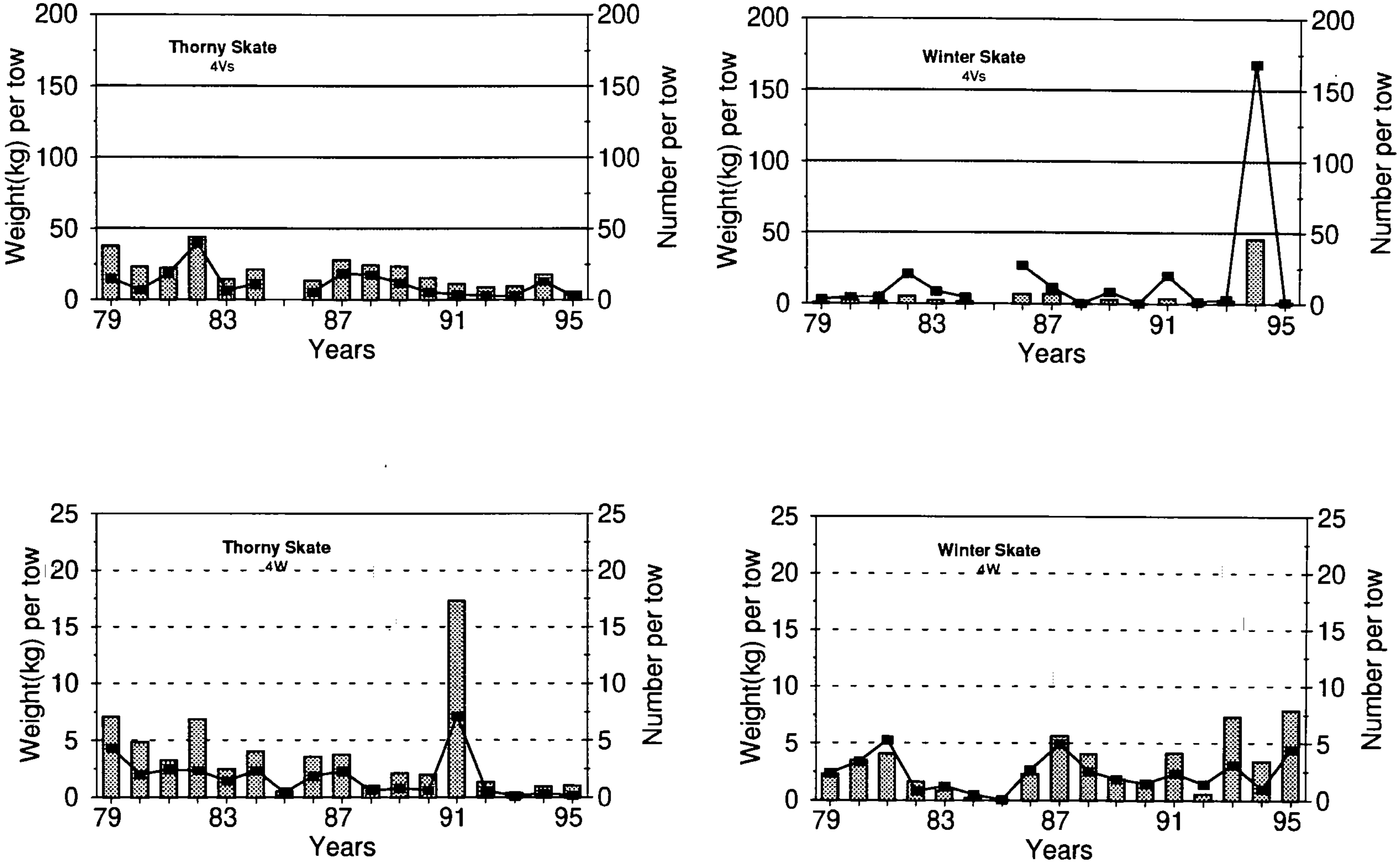


Figure 8. Abundance trends (numbers and weights per tow) of thorny and winter skates in Divs. 4Vs and 4W from the spring RV groundfish survey. The histograms indicate number per tow and the line indicates weight (kg.) per tow.

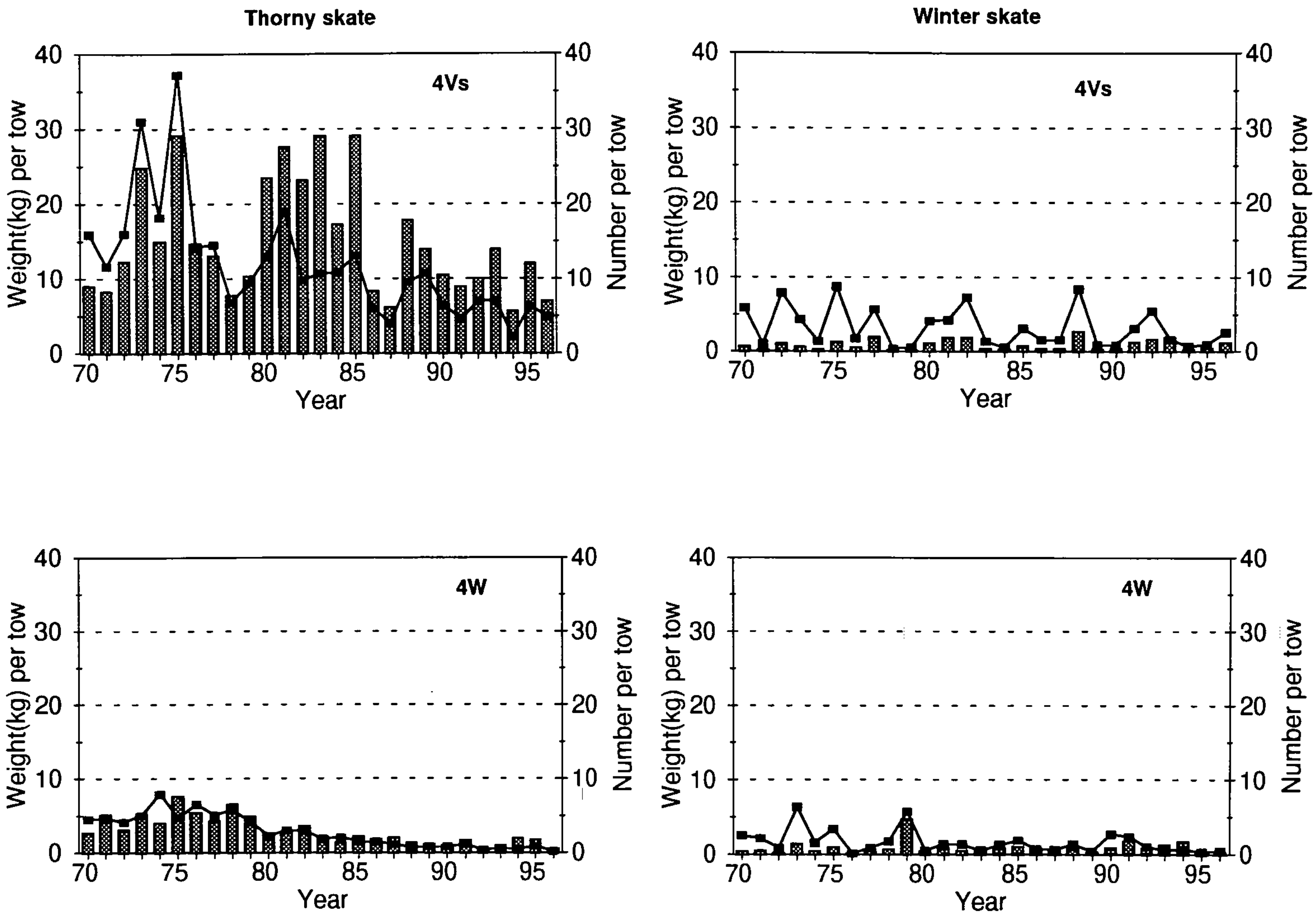


Figure 9. Abundance trends (numbers and weights per tow) of thorny and winter skates in Divs. 4Vs and 4W from the summer RV groundfish survey. The histograms indicate number per tow and the line indicates weight (kg.) per tow.

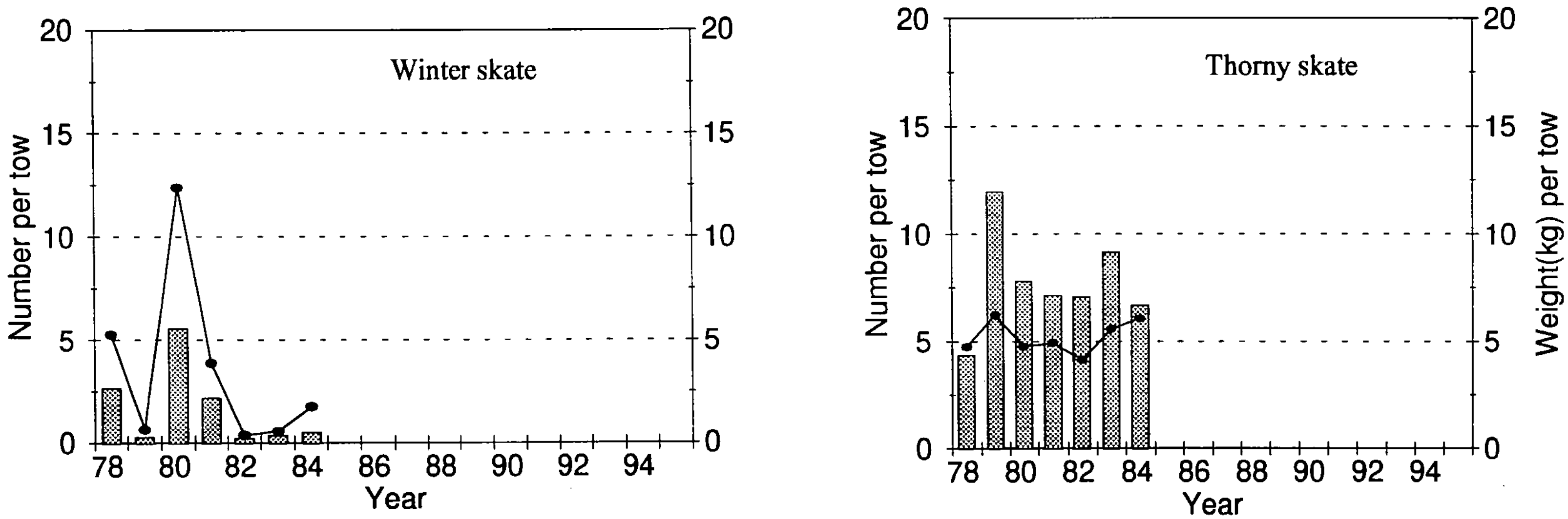
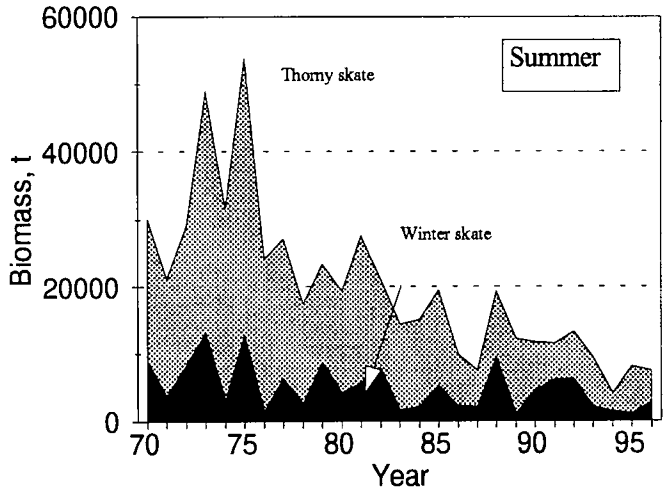


Figure 10. Abundance trends (number and weight per tow) of winter and thorny skate in Div. 4VsW from the fall RV groundfish survey. The histograms indicate number per tow and the line indicates weight (kg) per tow.



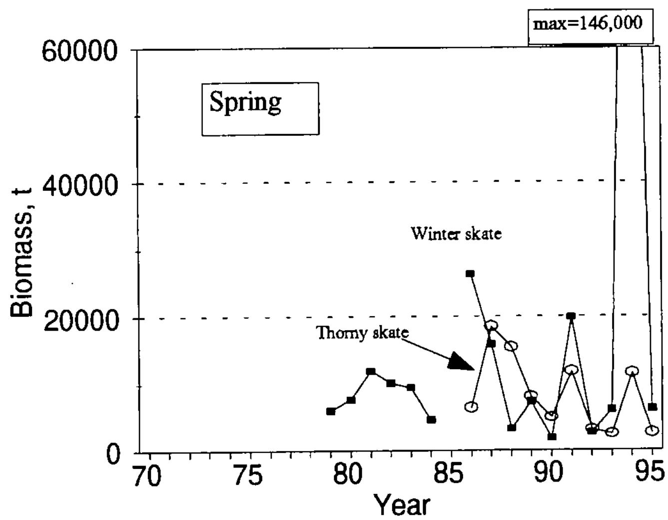
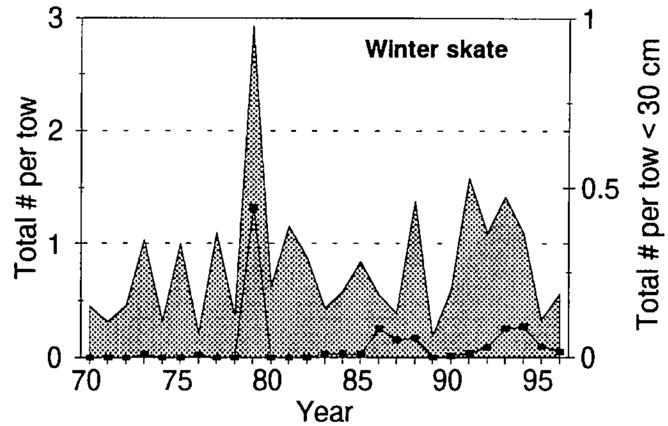


Figure 11. Minimum trawlable biomass of winter and thorny skates in Div. 4VsW as estimated by the spring and summer groundfish surveys.



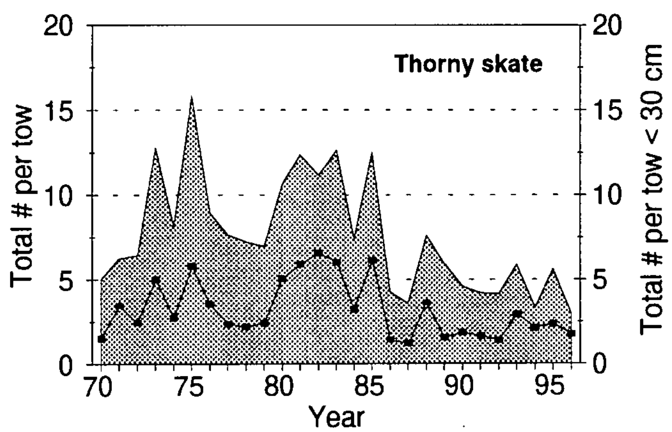
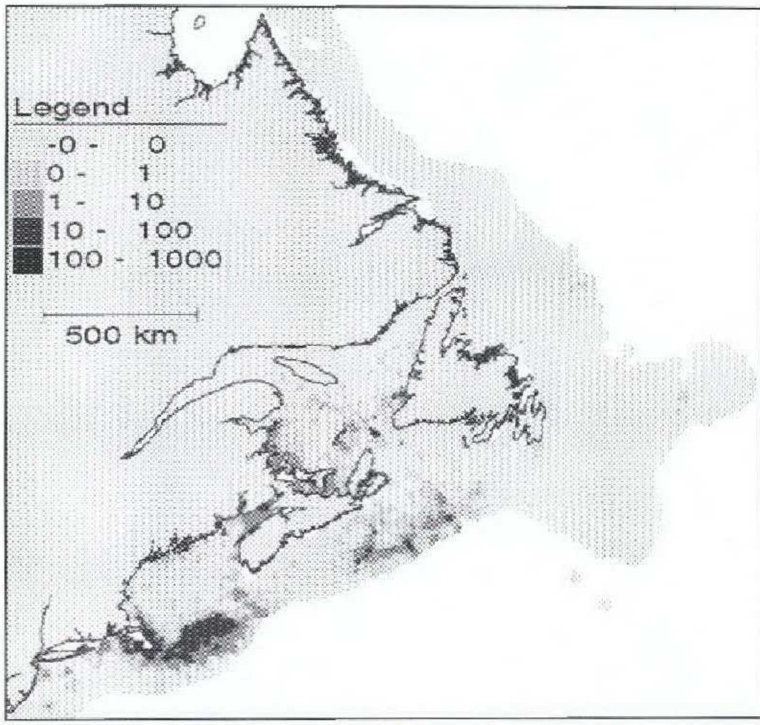
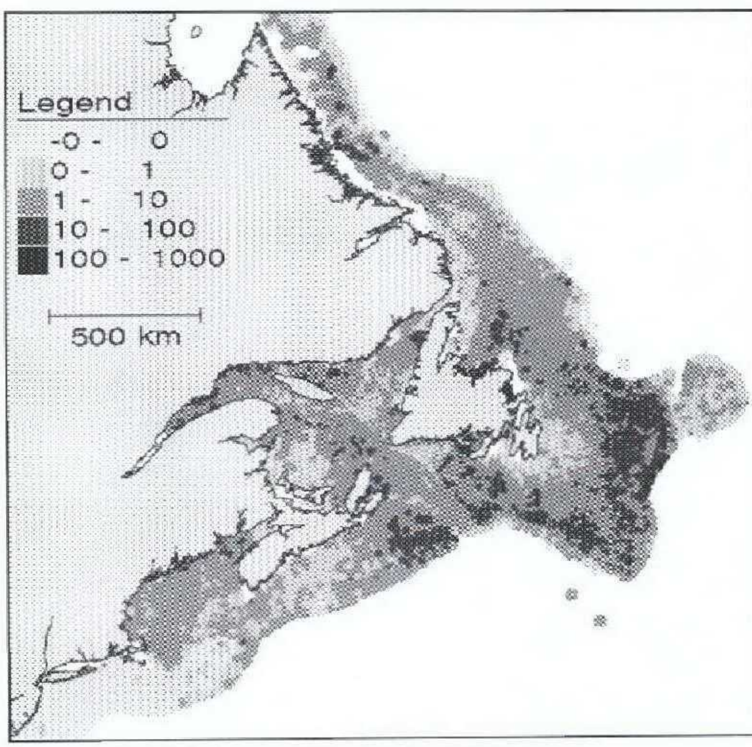


Figure 12. Number at length of winter and thorny skate in Div. 4VsW from the summer groundfish survey. The line indicates the sum of all fish < 30 cm , while the shaded area is the sum of all fish.



Winter skate



Thorny skate

Figue 13. Distribution of winter and thorny skate in the Northwest Atlantic from 1970-94 based on research vessel surveys (from the ECNASAP program).

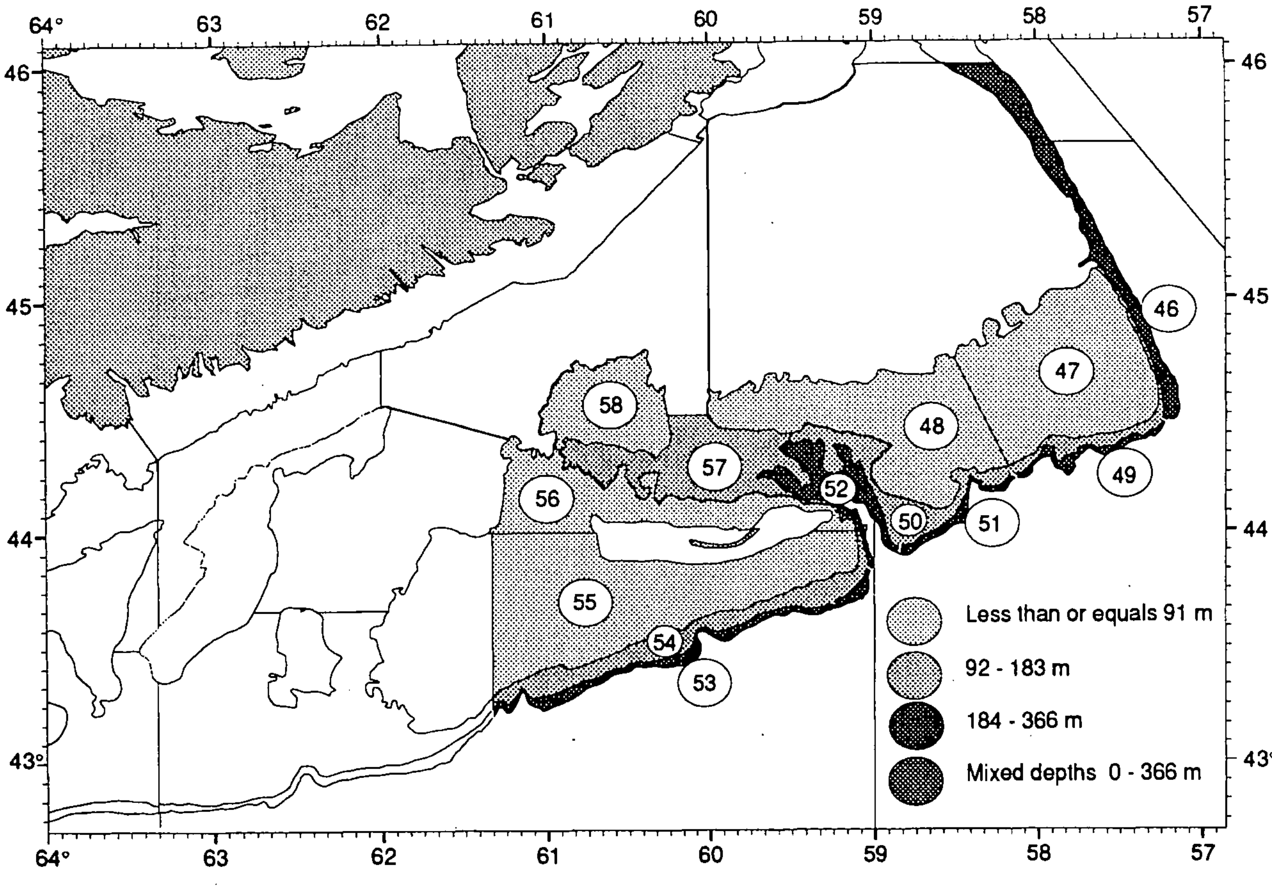
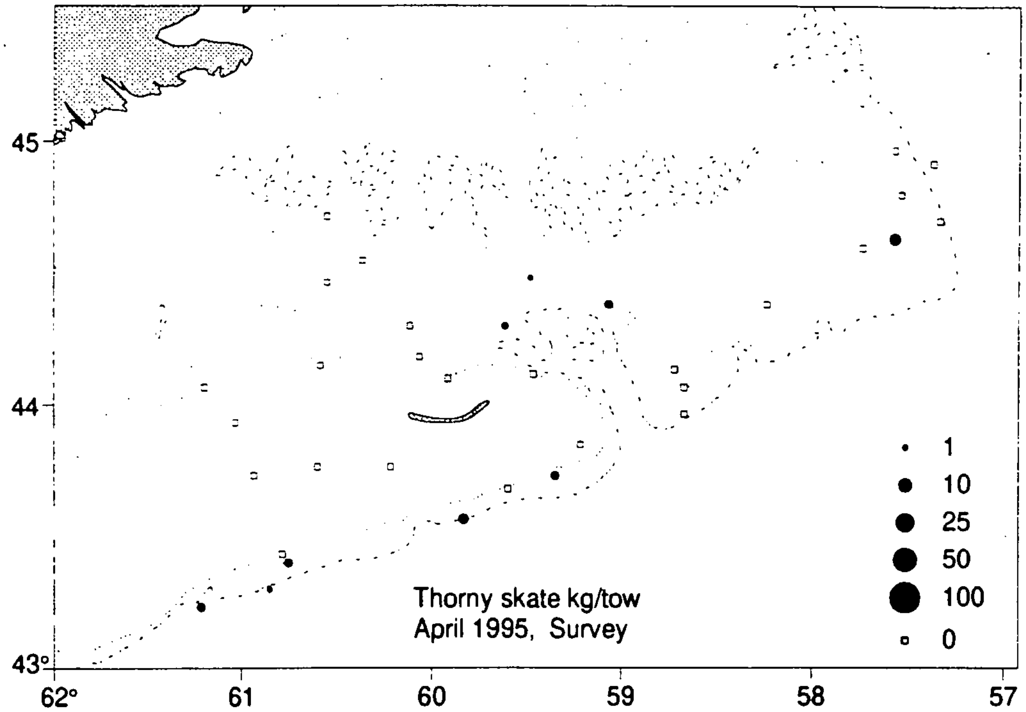


Figure 14. Summer research vessel groundfish strata surveyed during the industry/science skate survey.



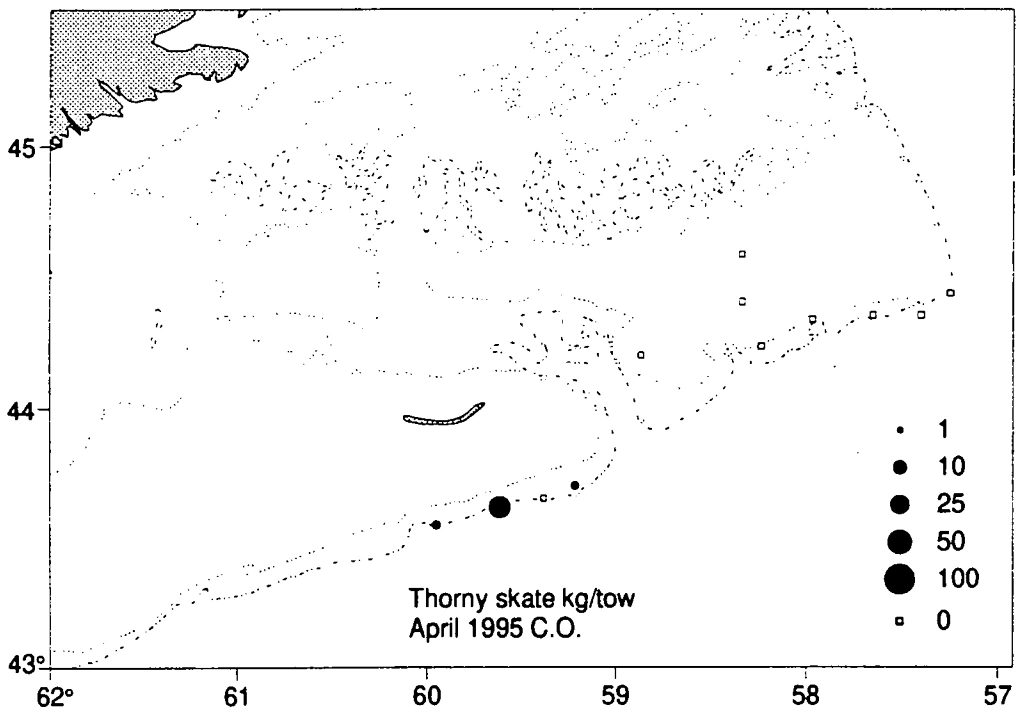
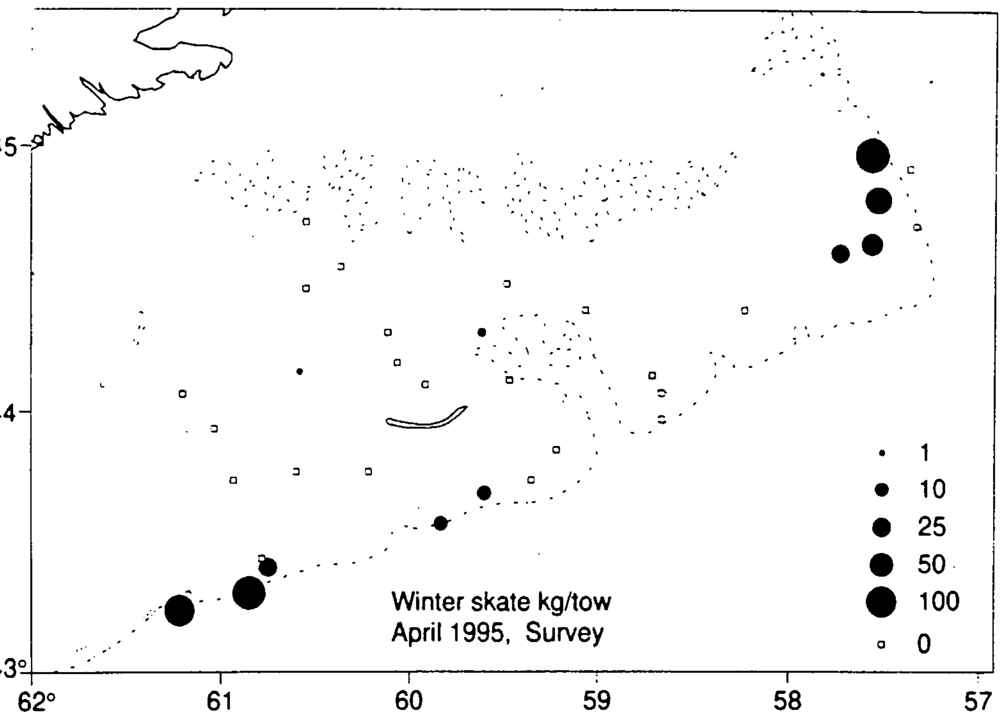


Figure 15. Distribution of thorny skate caught during the April 1995 industry/science skate survey. C.O. are "Captain's Own" sets and are not included in survey estimates.



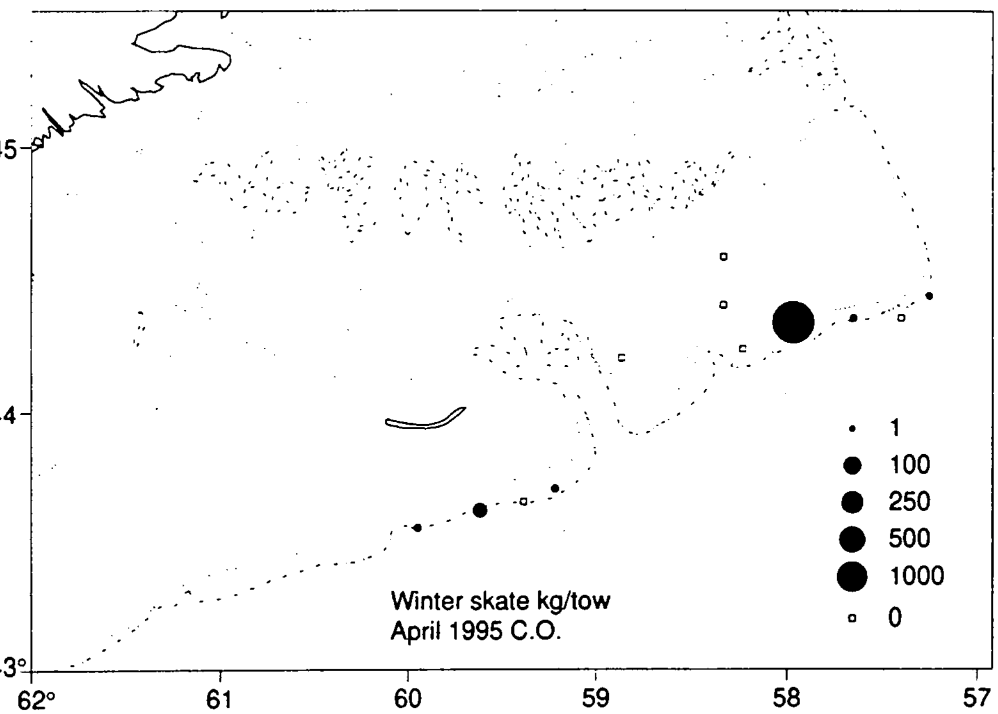
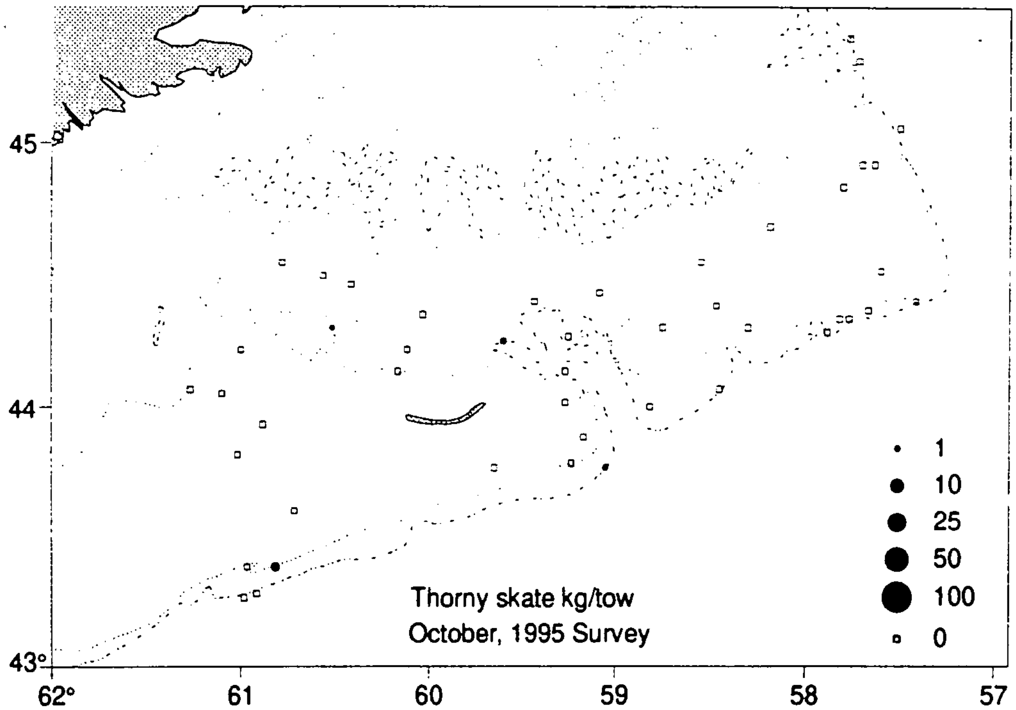


Figure 16. Distribution of winter skate caught during the April 1995 industry/science skate survey. C.O. are "Captain's Own" sets and are not included in survey estimates.



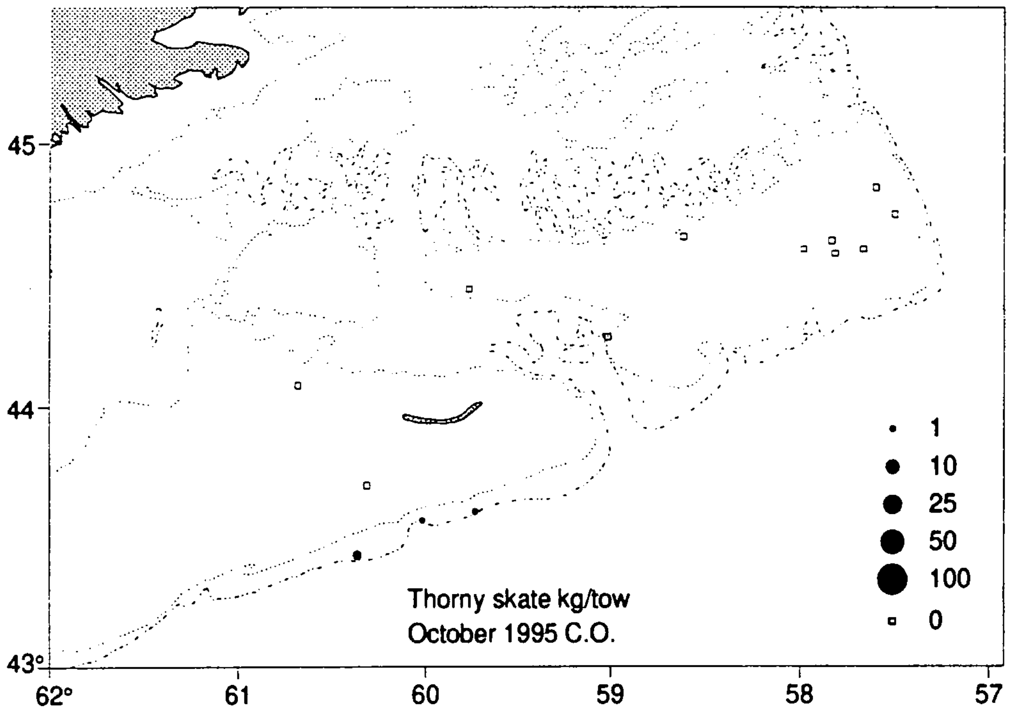


Figure 17. Distribution of thorny skate caught during the October 1995 industry/science skate survey. C.O. are "Captain's Own" sets and are not included in survey estimates.

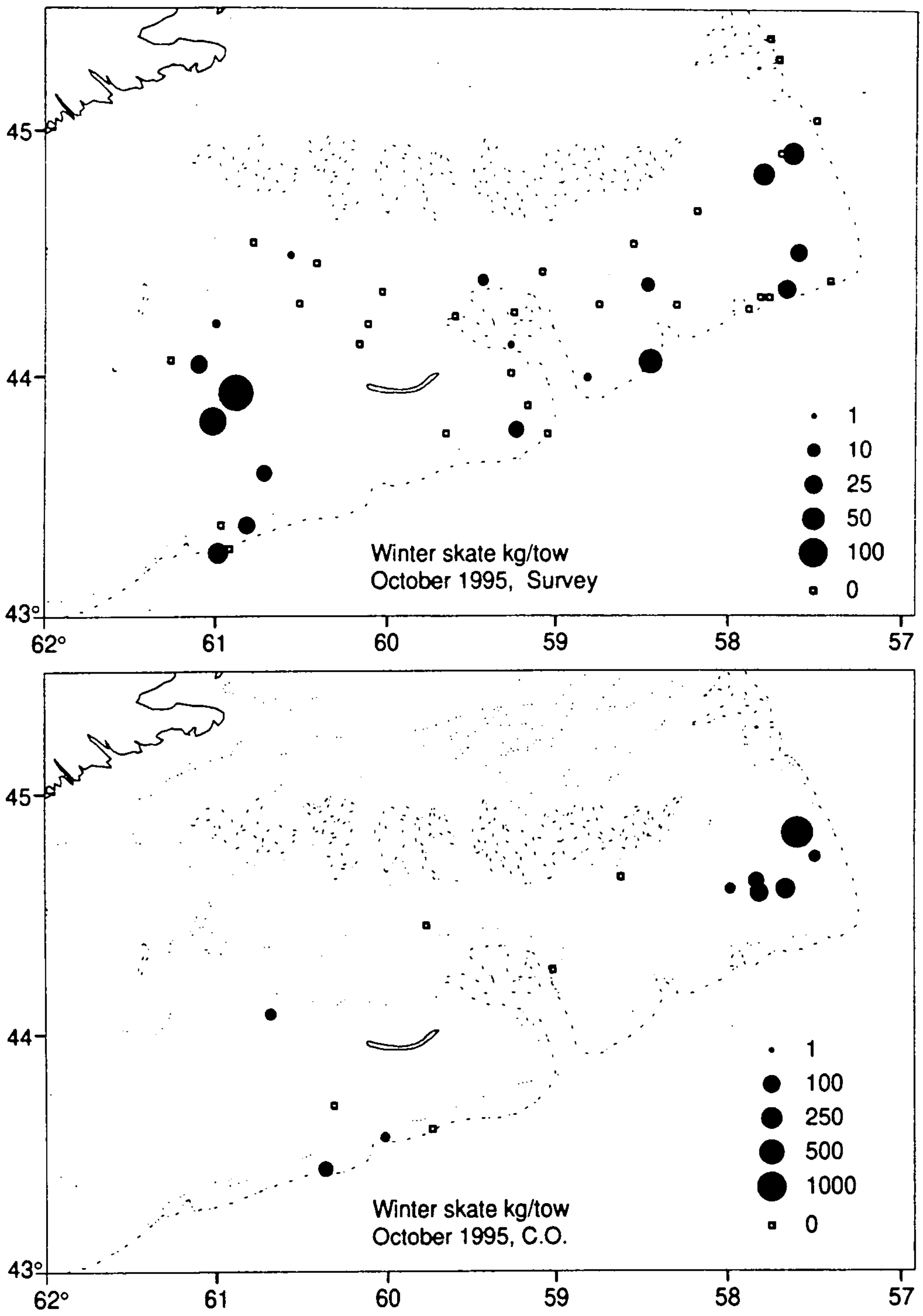


Figure 18. Distribution of winter skate caught during the October 1995 industry/science skate survey. C.O. are "Captain's Own" sets and are not included in survey estimates.

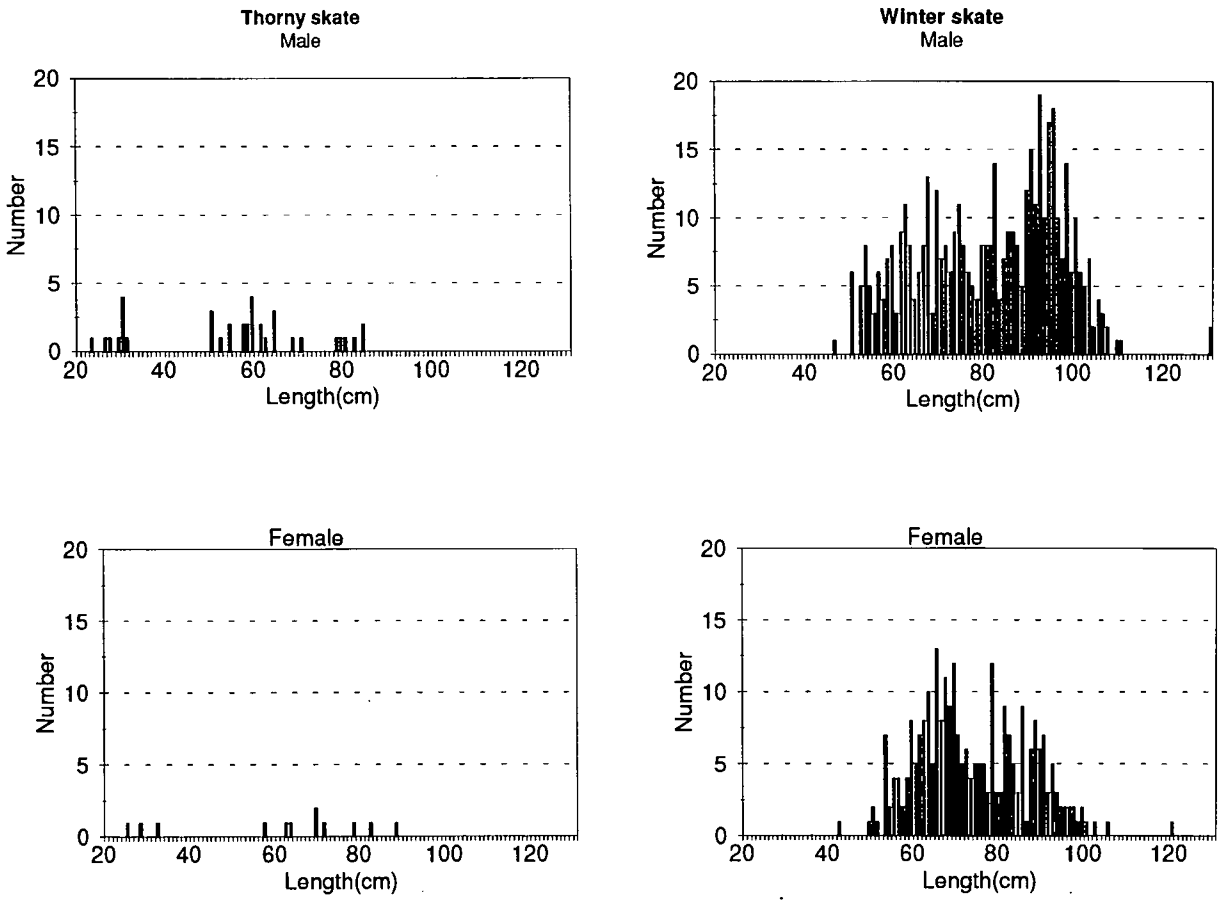


Figure 19. Length frequencies of skates measured during the April, 1995 industry/science survey.
Note: Codend mesh size 255-315mm.

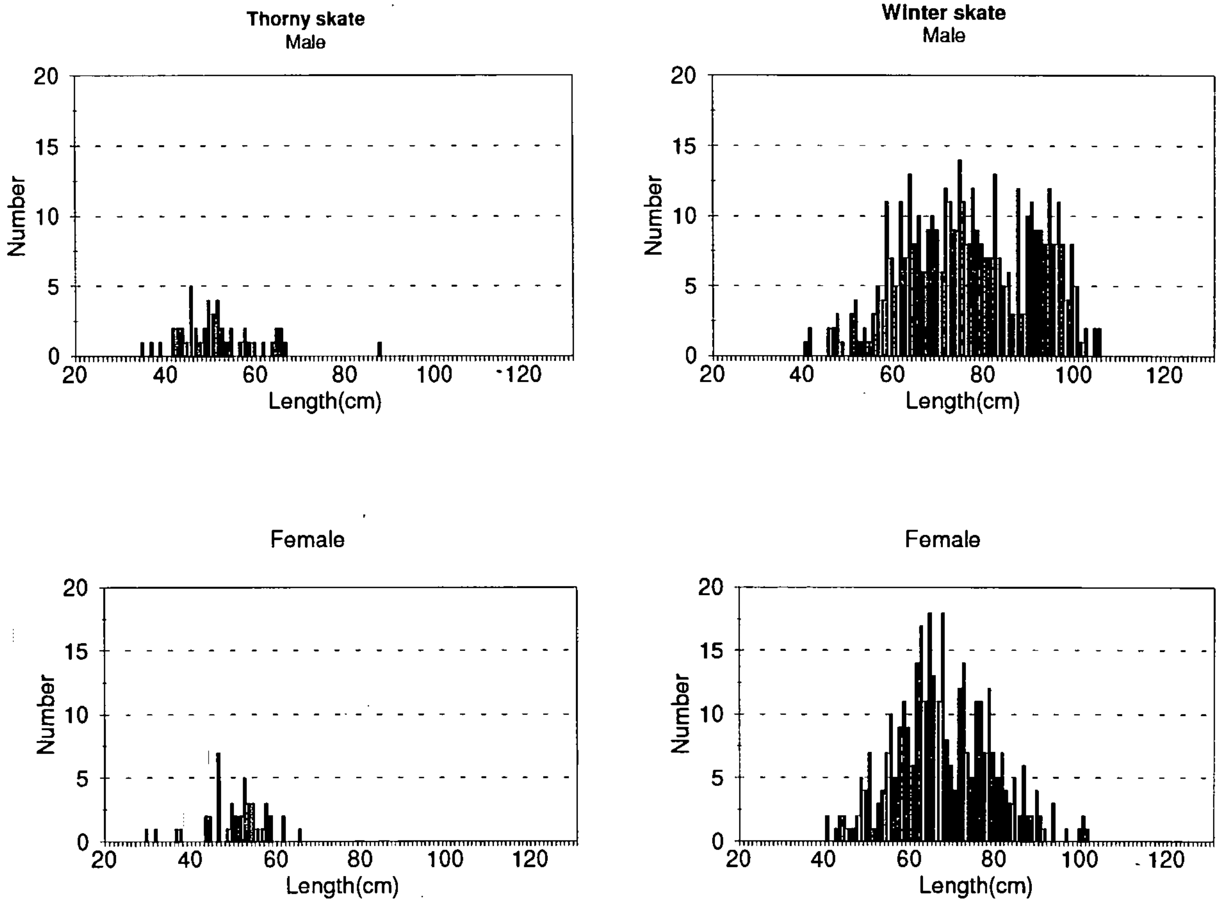


Figure 20. Length frequencies of skates measured during the October, 1995 industry/science survey.
Note: Codend mesh size 300-320mm.

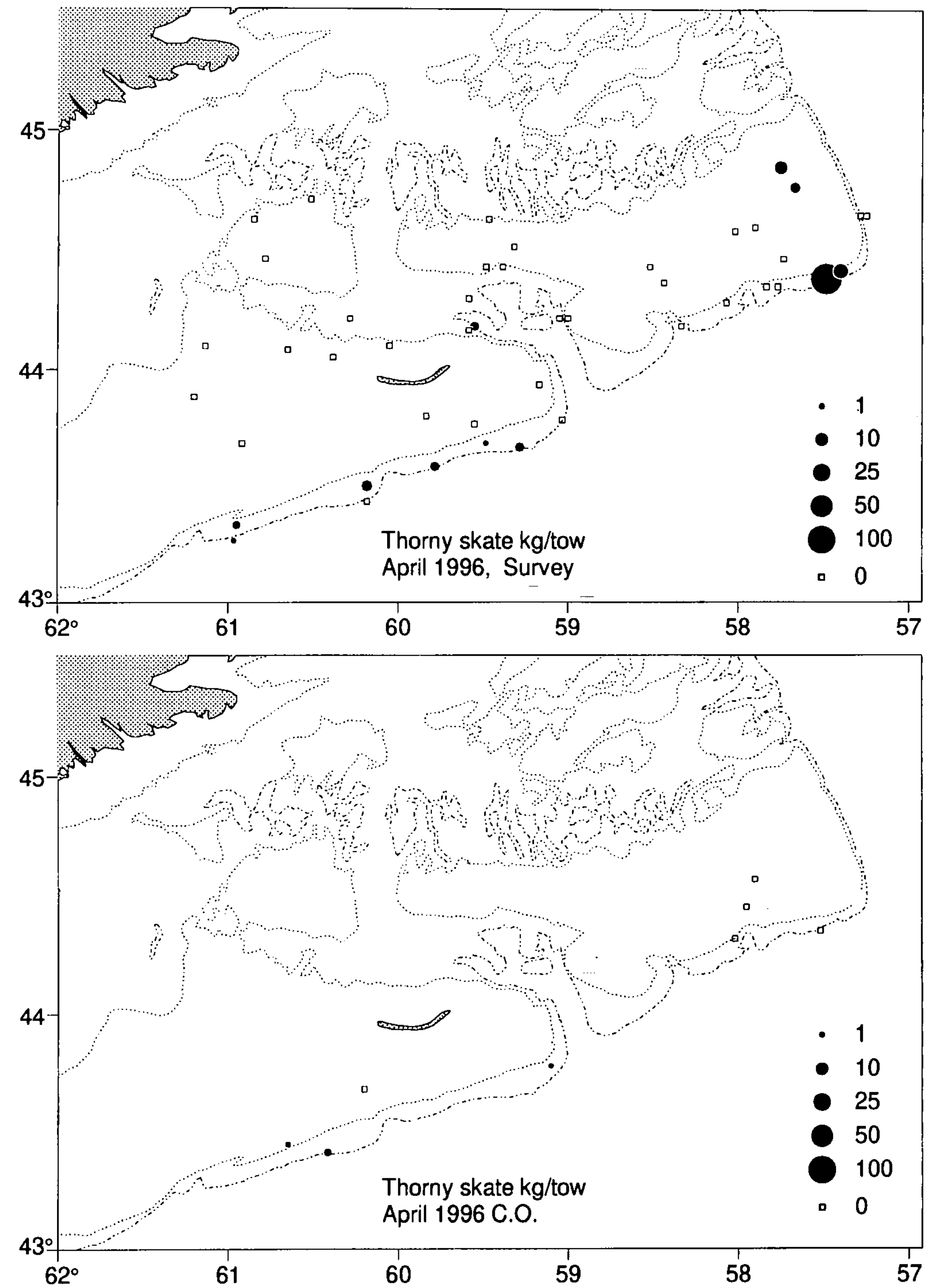


Figure 21. Distribution of thorny skate caught during theApril 1996 industry/science survey. C.O. are "Captain's Own" sets and are not included in any survey estimates.

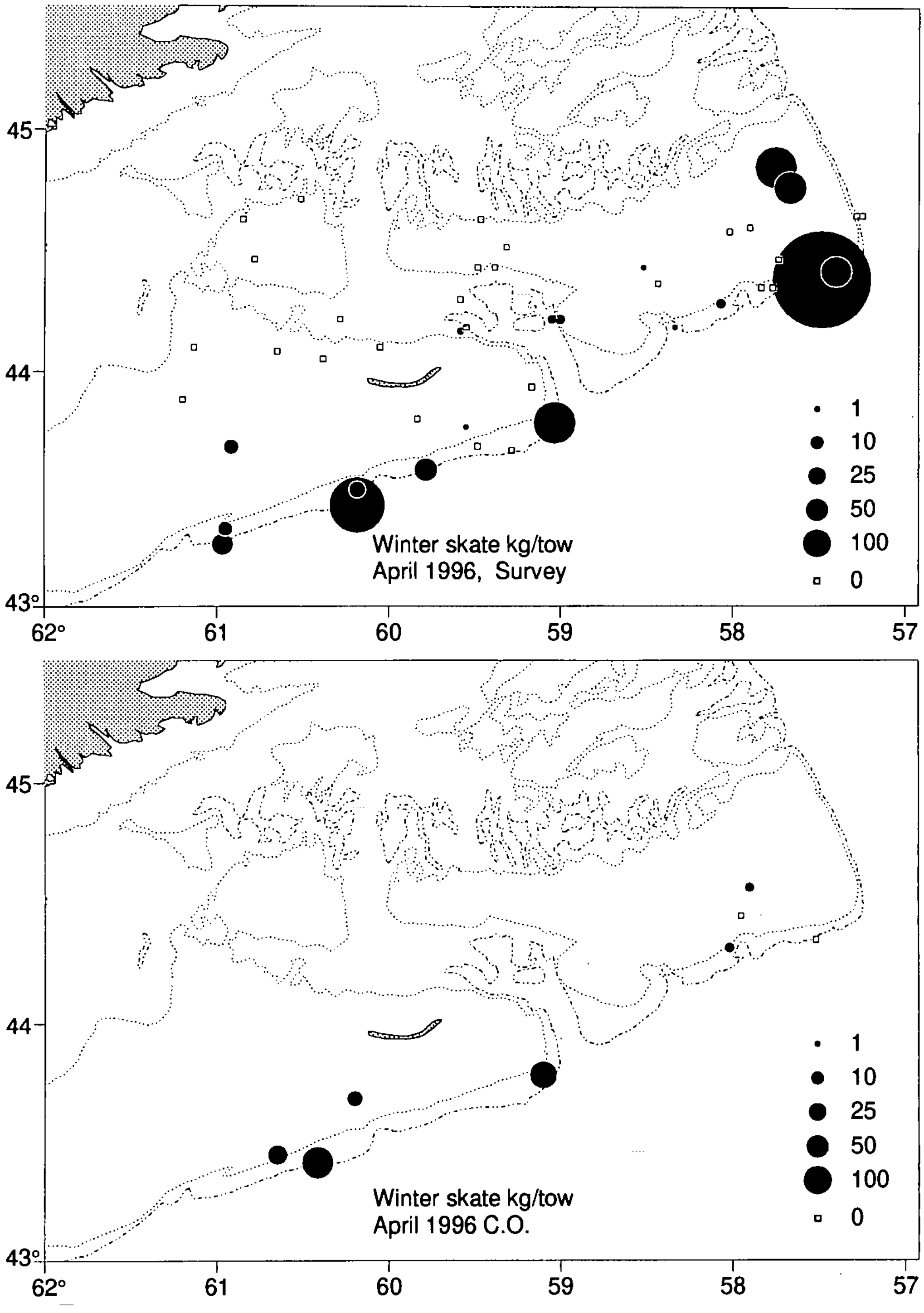


Figure 22. Distribution of winter skate caught during the April 1996 industry/science survey. C.O. are "Captain's Own" sets and are not included in any survey estimate.

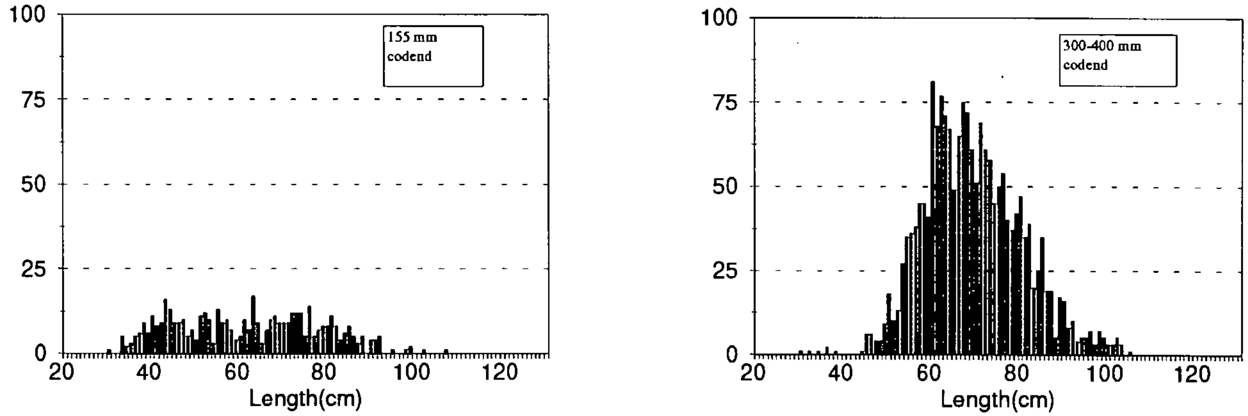


Figure 23. Length frequencies of winter skate measured during the April 1996 industry/science survey.

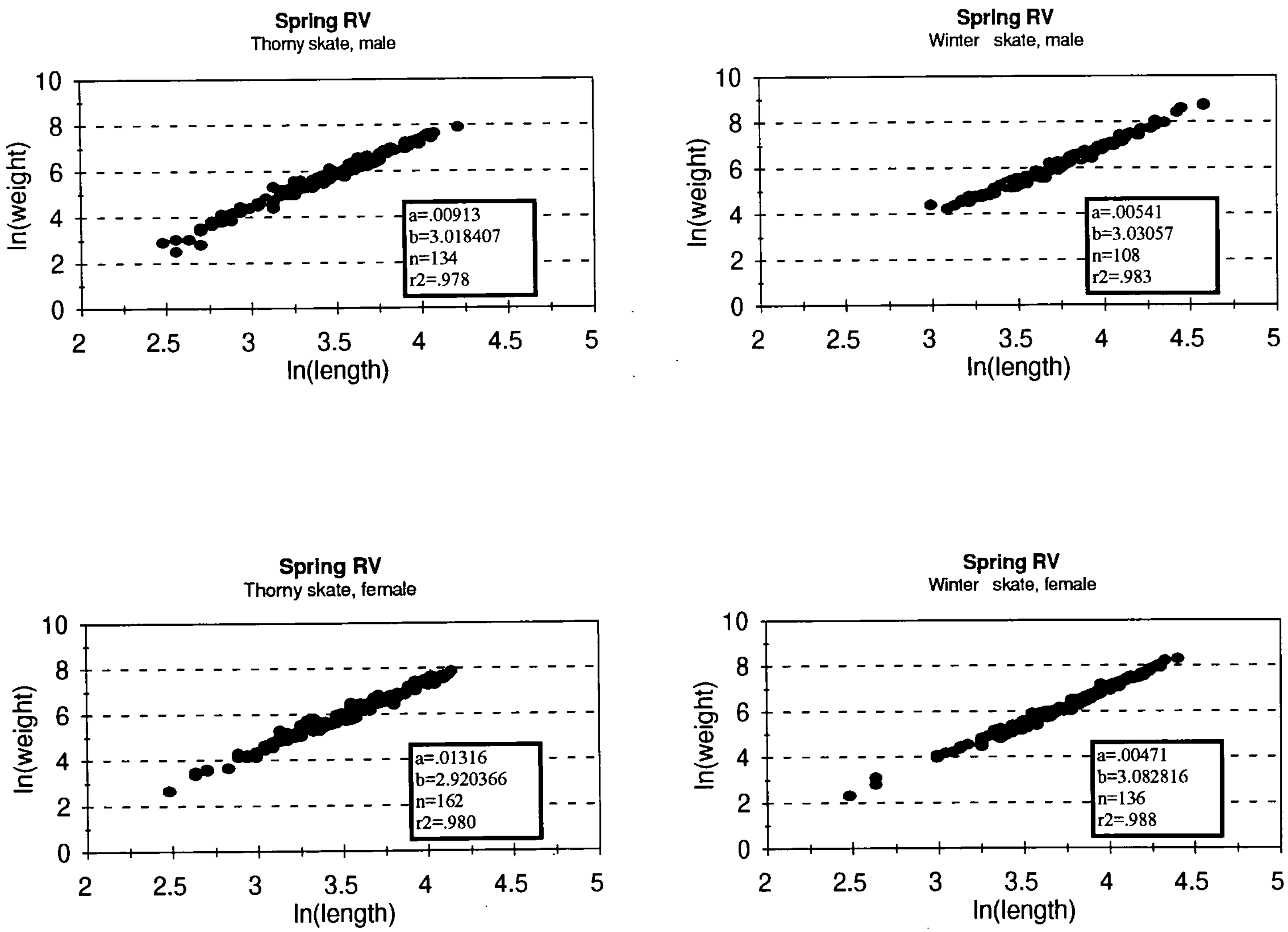


Figure 24. Length weight regression coefficients of skate sampled during the 1995 spring research vessel survey in Div. 4VsW.

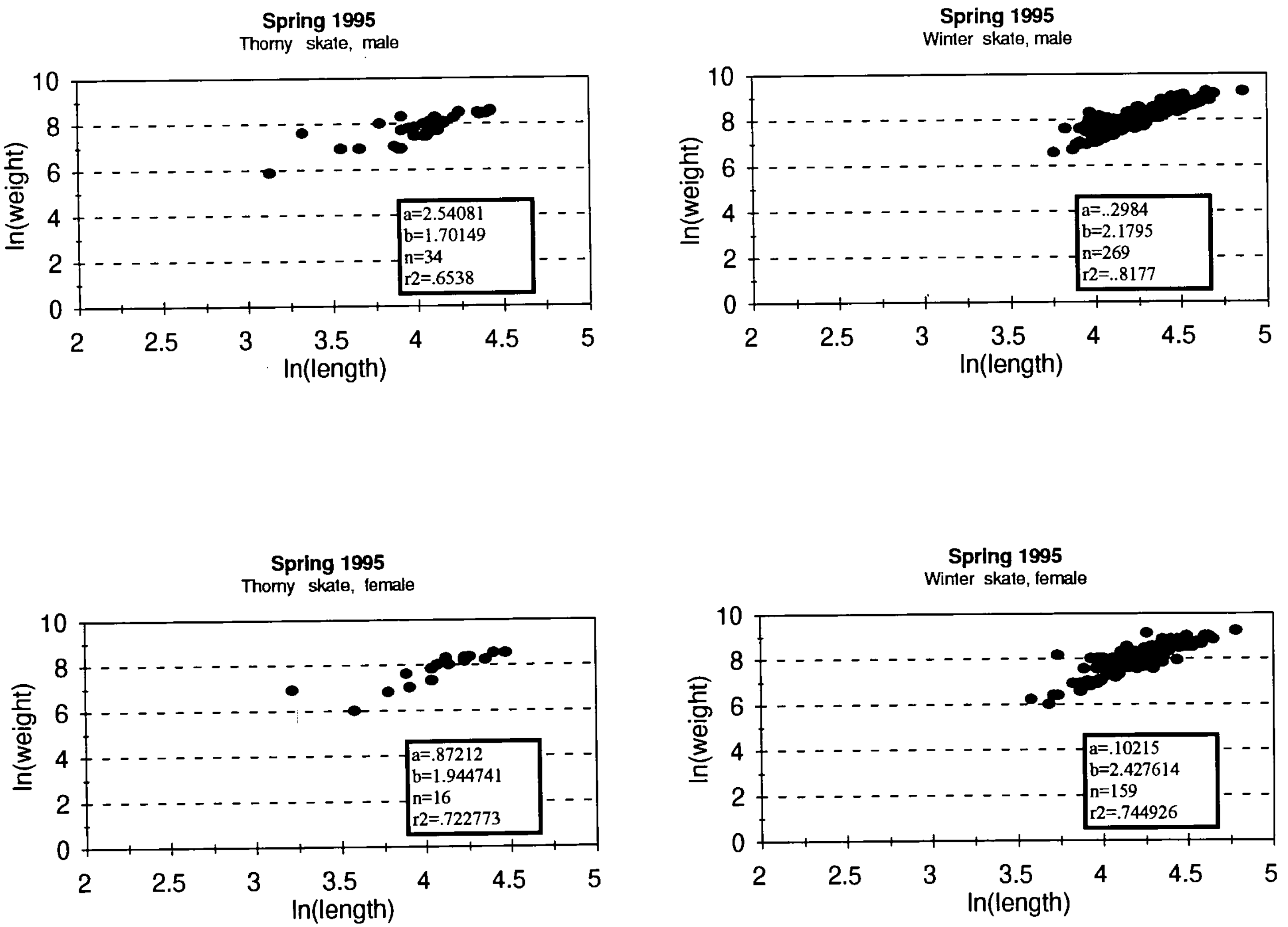


Figure 25. Length weight regression coefficients of skate sampled during the April 1995 science/industry survey.

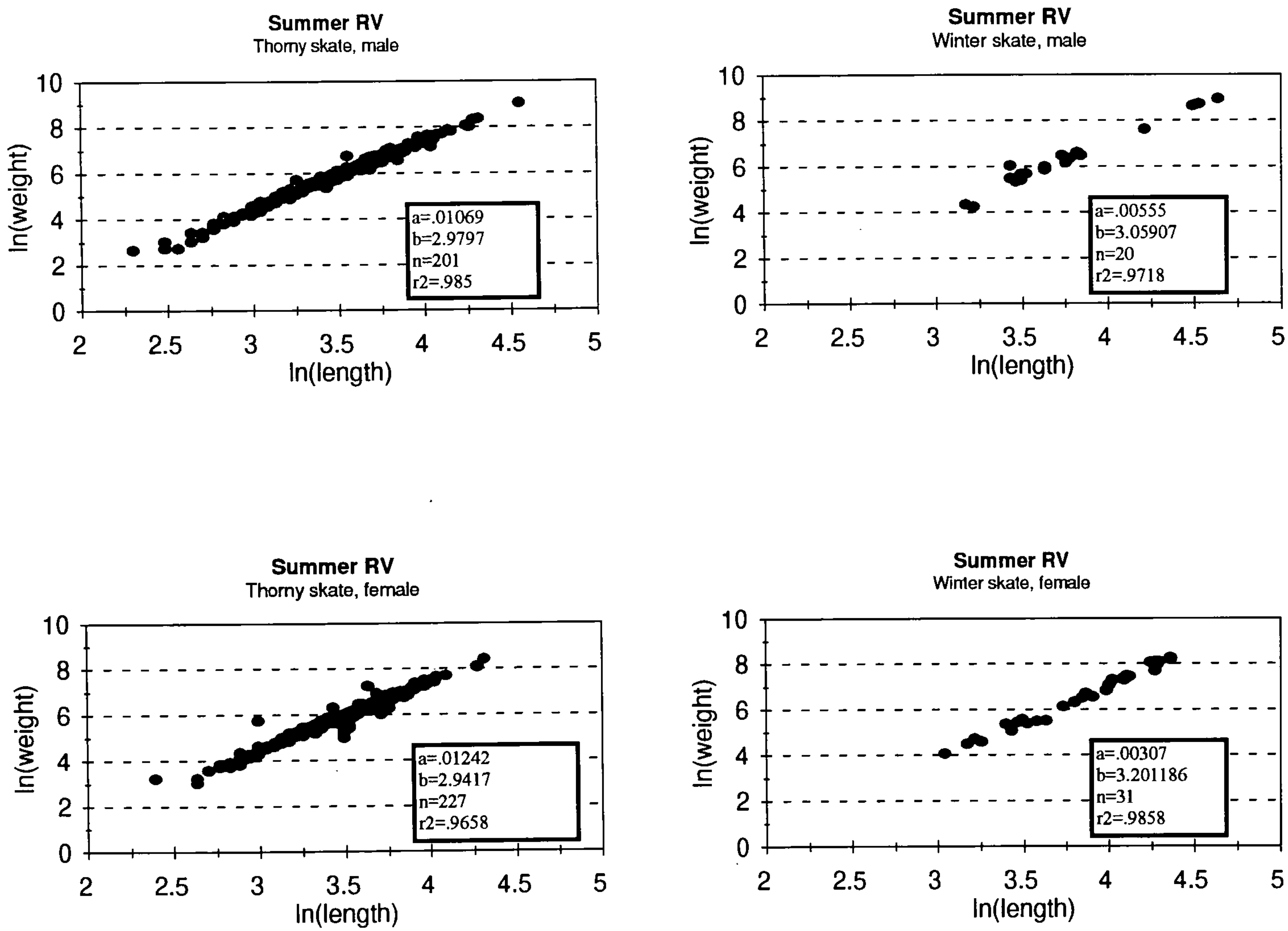


Figure 26. Length weight regression coefficients of skate sampled during the 1995 summer research vessel survey in Div. 4VsW.

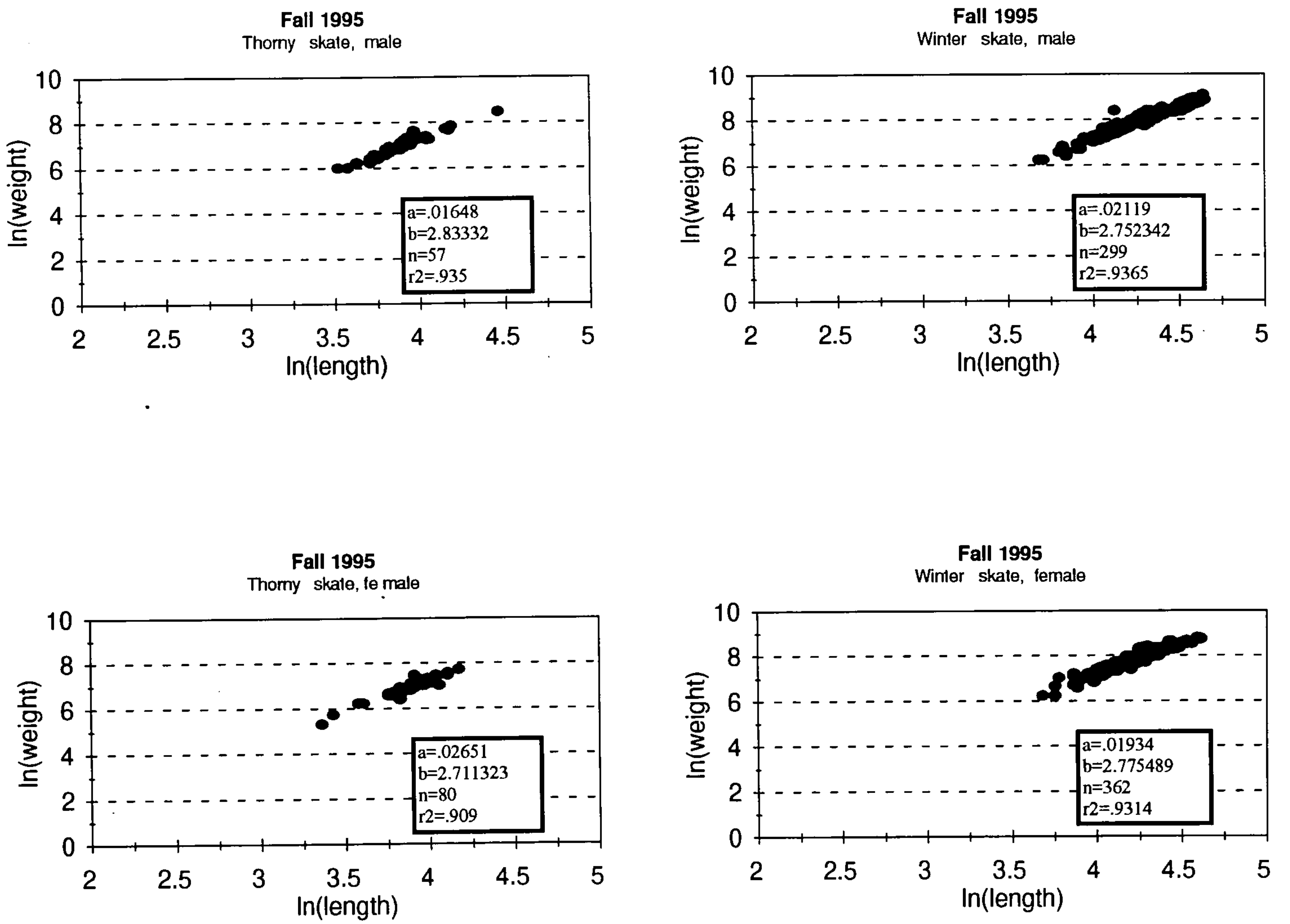


Figure 27. Length weight regression coefficients of skate sampled during the October 1995 science/industry survey.

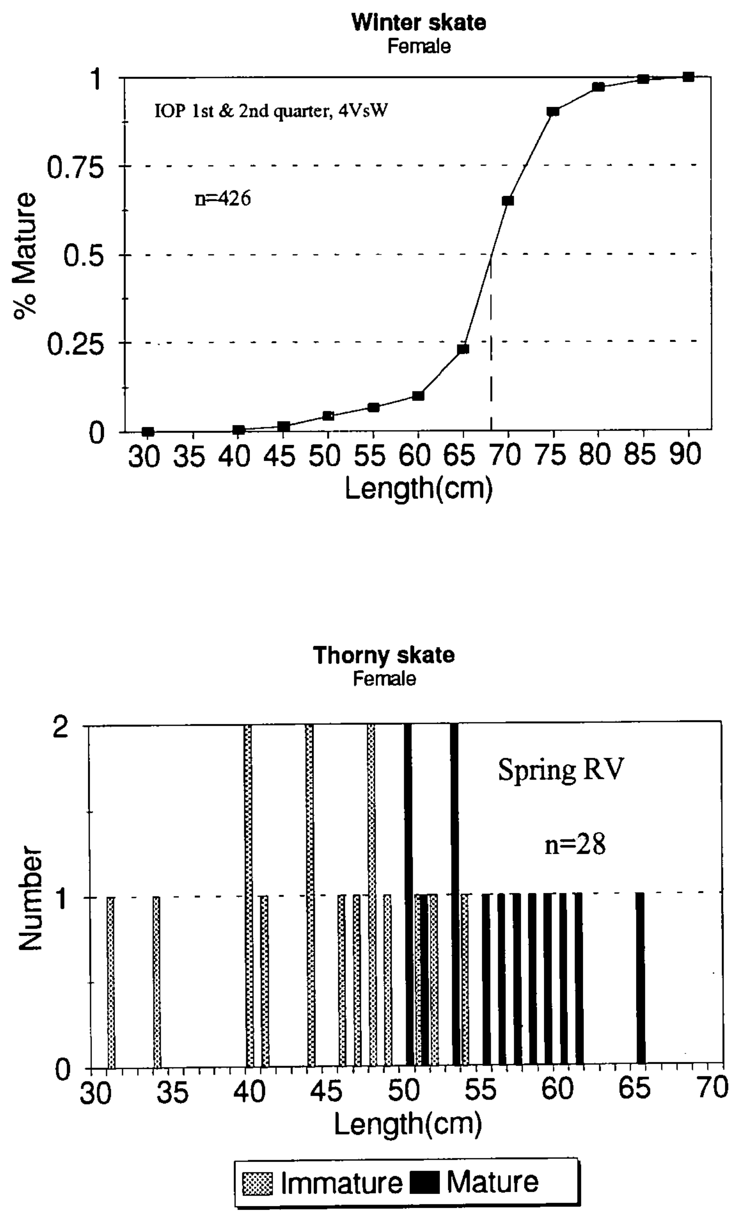


Figure 28. Preliminary estimates of skate maturity in Div.4VsW.

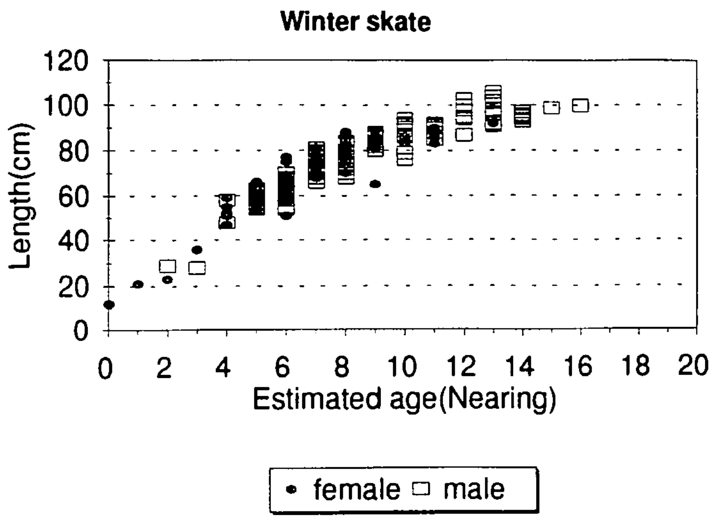


Figure 29. Preliminary growth model of winter skate based on ages provided by R. Nearing (pers. comm.).

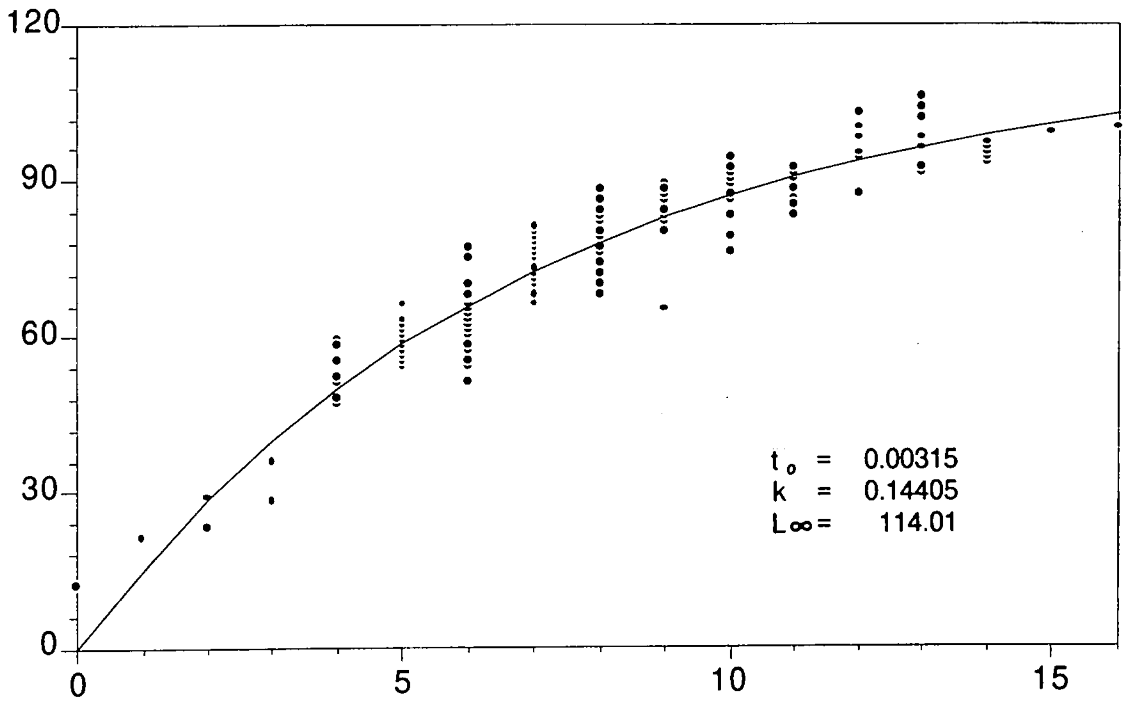


Figure 30. Predicted parameters from the Von Bertallanffy growth model for winter skate.