

Not to be cited without
permission of the authors¹

DFO Atlantic Fisheries
Research Document 95/42

Ne pas citer sans
autorisation des auteurs¹

MPO Pêches de l'Atlantique
Document de recherche 95/42

**The Status of Spiny Dogfish (*Squalus acanthias*, Linnaeus)
in the Southern Gulf of St. Lawrence (NAFO Division 4T)**

by

Tom Hurlbut², Gloria Nielsen², Réjean Hébert³ and Dave Gillis⁴

Department of Fisheries and Oceans
²Science Branch / ³Resource Allocation Branch
Gulf Region
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

⁴Prince Edward Island Department of Agriculture, Fisheries and Forestry
P.O. Box 2000, Charlottetown, Prince Edward Island
C1A 7N8

¹This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

¹La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte Atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

Table of Contents

1 - Summary Sheet	3
2 - Abstract	4
3 - Résumé	4
4 - Introduction	4
5 - Basic Life History Information	5
6 - Description of Fisheries	6
A) <i>Landings and Description of the Fisheries in the NAFO subareas 2-6 Management Unit</i> ..	6
B) <i>Landings and Description of the Fishery in the southern Gulf (NAFO Div. 4T)</i>	7
C) <i>Management Measures Relevant to the Dogfish Fishery in the southern Gulf in 1994</i>	7
D) <i>Descriptions from Industry of the Dogfish Fishery in the southern Gulf in 1994</i>	8
7 - Target	10
8 - Fishery Data	10
A) <i>Commercial Samples</i>	10
9 - Research Data	10
A) <i>Fall Groundfish Surveys of the southern Gulf</i>	10
i) <i>Geographic Distribution</i>	10
ii) <i>Length Frequency Distribution and Sex Ratio of Survey Catches</i>	10
iii) <i>Abundance Indices and Biomass Estimates</i>	11
B) <i>January 1994 and 1995 Surveys of Cabot Strait</i>	11
10 - Assessment Results	12
11 - Ecological Considerations	12
12 - Future Prospects	12
13 - Management Considerations	12
14 - Research Recommendations	13
15 - Acknowledgements	13
16 - References	13
17 - Tables	15
18 - Figures	19
19 - Appendices	37

1 - Summary Sheet

Year	1988	1989	1990	1991	1992	1993	1994	1995	Min.	Med.	Max.
Reported Landings - 000's t	0.0	0.0	0.6	0.1 ¹	0.2 ¹	0.5 ¹	1.0 ¹		0.0 ²	0.1 ²	1.0 ²
Estimated Biomass - 000's t	8.4	21.0	2.4	7.2	7.6	40.7	8.5		0.7 ²	7.4 ²	40.7 ²
¹ Preliminary statistics						² For 1985 - 1994					

Description of Fisheries (Landings): In the southern Gulf of St. Lawrence (NAFO Div. 4T), where the majority (80%) of the landings of spiny dogfish (1989-94) have been taken by gillnets, annual landings did not exceed 15 t until 1990 when 615 t were recorded. The landings dropped to 142 t in 1991 after which they grew steadily to a peak of 970 t in 1994.

Target: The Canadian Atlantic dogfish fishery is not under any management control (no TAC's), as is the case throughout the rest of the management unit for spiny dogfish (NAFO subareas 2-6).

Fishery Data: Examination of length frequencies from the commercial fishery reveals that virtually all of the male dogfish sampled were sexually mature, whereas a significant proportion of the females were probably immature. Generally, the size range of dogfish was limited and may be indicative of the tendency for this species to form schools based on size until they become sexually mature.

Research Data: Spiny dogfish were not captured in the surveys of the southern Gulf conducted from 1971-83. No consistent patterns were apparent in the distribution of dogfish catches in surveys of the southern Gulf except for the occurrence of concentrations off the eastern and western coasts of P.E.I. since 1991 and the occurrence of concentrations off the Acadian Peninsula since 1992. The mean number per tow in the annual research survey rose after 1987 and peaked at 11.8 fish per tow in 1993 but decreased sharply to 2.7 in 1994. With the exception of 1990 and 1992, substantially more males than females have been caught in the surveys since 1985, which may be an indication of size/sex selective fishing mortality. Examination of the survey length frequencies revealed that the majority of male dogfish sampled were sexually mature, whereas most of the females were probably immature.

Assessment Results: Research vessel data from surveys of the southern Gulf (NAFO Div. 4T) suggest an increase in abundance since 1987.

Data and analyses presented during the most recent (1994) assessment of spiny dogfish in the northwest Atlantic (NAFO subareas 2-6) by the U.S. National Marine Fisheries Service indicates that total landings from this resource have increased five-fold since 1987 and that total catches may have been 2/3 or more higher than the reported landings, when recent estimates of discard rates were considered. The results of the latest U.S. assessment also suggest that this stock may be fully utilized with respect to the level of fishing mortality and that the current fishery which mainly targets mature females will result in reduced longterm recruitment.

Ecological Considerations: Predation mortality by spiny dogfish is probably a significant source of mortality for commercially important species. Preliminary analyses conducted by the U.S. National Marine Fisheries Service indicate that the biomass of commercially important species consumed by spiny dogfish may be comparable to the amount harvested by man.

Future Prospects: Spiny dogfish are a transboundary species that are felt to constitute a single unit stock in the northwest Atlantic. Analyses presented during the most recent assessment of this resource by the U.S. National Marine Fisheries Service indicate that given the relatively stable level and distribution of the exploitable stock, and recent increased targeting, landings in 1995 will likely exceed the 1993 landings of 22,000 t.

Management Considerations: Given the evidence for a single unit stock in the northwest Atlantic (NAFO subareas 2-6), joint assessment and management of this resource by Canada and the U.S. should be considered.

2 - Abstract

Although spiny dogfish have historically been regarded as nothing more than a nuisance by many inshore fishers, the relatively recent development of markets for dogfish products from North America has resulted in the establishment of directed fisheries in the northwest Atlantic, including the southern Gulf of St. Lawrence, where landings have increased significantly since 1990.

Research vessel data for surveys of the southern Gulf (NAFO Div. 4T) suggest an increase in the abundance of spiny dogfish since 1987.

Analyses presented during the most recent (1994) assessment of spiny dogfish in the northwest Atlantic (NAFO subareas 2-6) indicate that this stock is stable at best and has possibly begun to decline as a result of recent increases in exploitation (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

3 - Résumé

Même si traditionnellement l'aiguillat commun a été considéré comme une nuisance par de nombreux pêcheurs côtiers, l'émergence, ces derniers temps, de marchés pour les produits de l'aiguillat commun en provenance de l'Amérique du Nord a entraîné l'établissement d'une pêche sélective dans l'Atlantique Nord-Ouest, y compris dans le sud du golfe du Saint-Laurent où les débarquements ont considérablement augmenté depuis 1990.

Les données découlant de relevés effectués par le bateau de recherche dans le sud du golfe (division 4T de l'OPANO) suggèrent une augmentation de l'abondance de l'aiguillat commun depuis 1987.

Les analyses présentées au cours de la plus récente évaluation (1994) de l'aiguillat commun dans l'Atlantique Nord-Ouest (sous-zones 2-6 de l'OPANO) indiquent que ce stock est stable - selon les estimations les plus positives - et qu'il a peut-être commencé à décliner comme suite de l'intensification récente de l'exploitation (U.S.N.M.F.S., N.E.F.S.C. document de référence 1994).

4 - Introduction

The spiny dogfish (*Squalus acanthias*) is a small pelagic shark that has generally been regarded as a "nuisance" by Maritime inshore fishers because of the damage they cause by consuming bait, damaging longlines and gillnets and devouring hooked or netted fish.

Spiny dogfish and the problems related to their occurrence are not a recent phenomenon in the Gulf of St. Lawrence as the following account indicates:

In 1912, Mr. G.M. Cornish wrote about dogfish in the Tignish area of Prince Edward Island: "The picked dogfish is very common and extremely destructive. It appears about the end of July and remains until the end of the fishing season in the autumn. It is noticed in the east a few days before it reaches the west coast (P.E.I.). As a result of its appearance, fishing for cod may often cease entirely early in August; the trawls of hooks are set for cod at night and when raised in the morning sometimes every fish has been devoured by the pest, with only the heads and vertebral column remaining on the hook."

The spiny dogfish has become an increasing menace to fixed gear, inshore fishermen on the Scotian Shelf and in the Gulf of St. Lawrence. Hurley, et al., (1987) concluded that spiny dogfish interfere with fishing operations more than any other species. Furthermore, spiny dogfish predation may be a significant source of mortality for commercially and recreationally important species (Salsbury, 1986).

Opinions about the extent of the "nuisance" caused by spiny dogfish have moderated to a certain extent with the establishment of markets and directed fisheries in certain areas of its range, especially during the recent declines and closures in traditional northwest Atlantic groundfish fisheries. In fact, the spiny dogfish has been described as the largest underutilized finfish resource in the northwest Atlantic (Walsh, 1982).

Historically though, directed fisheries for sharks have tended to be characterized as "boom and bust" enterprises, because populations have been rapidly reduced to levels that will not support the fishery. Populations impacted by shark fisheries are slow to recover, sometimes requiring decades to reach their former levels (Pratt and Casey, 1990). This has been attributed to their slow growth, considerable longevity and low reproductive capacity (ie. long gestation period and low fecundity). Holden (1977) recommended that there is not enough resilience in even the most fecund and abundant elasmobranchs, the skates and spiny dogfish, to maintain intensive fisheries.

In view of these recent developments and because of the potentially significant negative impact of spiny dogfish on other species, particularly the commercially important species that are currently at low levels of abundance, it was decided to review the status of this resource in the southern Gulf of St. Lawrence.

5 - Basic Life History Information

Spiny dogfish occur on both sides of the North Atlantic, chiefly in temperate and subarctic waters (7° to 13°C) and in depths less than 360 m (Jensen, 1966). In the northwest Atlantic, the range of dogfish extends from Labrador to Florida, but they are most abundant between Nova Scotia and Cape Hatteras.

Spiny dogfish in the northwest Atlantic are highly migratory and undertake seasonal migrations northward in the spring and summer and southward in the fall and winter. Migration takes place in schools. Tagging and field observations by Templeman (1944), Bigelow and Schroeder (1953), Holland (1957), Jensen (1961; 1966) and Shafer (1970) indicate that spiny dogfish school by size until they reach sexual maturity after which they form schools based on size and sex.

Dogfish traditionally arrive off Nova Scotia and the Bay of Fundy in June and appear in the Gulf of St. Lawrence in July (Walsh, 1984). By late autumn (mid-October to mid-November) most of the migrants leave Canadian waters on their return migration southward to waters off the Carolinas and Virginia. Templeman (1944), suggested that some immature males and females, as well as some mature males, may over-winter in Newfoundland waters in deep channels and holes on St. Pierre Bank, in the Laurentian Channel, and in some of Newfoundland's south coast bays.

The spiny dogfish is a very long-lived and slow-growing species. Since they lack conventional scales or otoliths, age determinations are made by interpreting growth rings or zones on the second dorsal spine. Female dogfish grow larger and live longer than males. In the western Atlantic spiny dogfish appear to live for approximately 40 years and reach a maximum theoretical length of 120 cm (approx. 7 kg) for females and 96 cm (approx. 3 kg) for males (Nammack et al., 1985). In contrast, ages as old as 70 years have been determined for spiny dogfish off British Columbia (McFarlane and Beamish, 1987).

Sexual maturity occurs at a median length and age of about 60 cm and 6 years for males and 80 cm and 12 years for females (Nammack et al., 1985). As is characteristic of most elasmobranchs, spiny dogfish are characterized by low fecundity and a long gestation period. Reproduction occurs offshore in the winter (Bigelow and Schroeder 1953), and female dogfish give birth to live young. The gestation period ranges from 18 to 22 months with 2 to 15 pups (average of 6) being produced.

Spiny dogfish are opportunistic feeders that consume whatever organisms are most readily available, with small fishes usually predominating (Scott and Scott, 1988). In the Scotian Shelf and Gulf of Maine, some of the species that are commonly consumed include: herring, mackerel, sand lance, cod, silver hake, white hake,

haddock, pollock, Atlantic salmon, menhaden, winter flounder, and longhorn sculpin, as well as squid and several other invertebrate species (Jensen, 1966). Bowman and Eppi (1984) concluded that predation mortality by spiny dogfish is a significant source of mortality for commercially important species.

Tagging studies of spiny dogfish (Jensen, 1961 and Shafer, 1970) suggest that dogfish in the northwest Atlantic comprise one stock. Annand (1986) examined the extent of genetic differentiation between dogfish from the Gulf of Maine and the Scotian Shelf using protein electrophoresis. The results of her study indicated that there is no genetic difference between spiny dogfish from the two areas and supported previous conclusions that there is one stock of dogfish which undergoes large seasonal migrations. Consequently, spiny dogfish in the northwest Atlantic are considered to be a unit stock in NAFO subareas 2-6 (Figure 1).

6 - Description of Fisheries

A) Landings and Description of the Fisheries in the NAFO subareas 2-6 Management Unit

In addition to spiny dogfish, the current (1960-1992) NAFO fishery statistics for subareas 2-6 contain landings for "dogfish unspecified", but the quantity in this category has diminished substantially since 1978 (Figure 2a). Although there are several other species of dogfish that occur in this zone, notably the black dogfish (*Centroscyllium fabricii*) and the smooth dogfish (*Mustelus canis*), it is thought that the majority of the landings in this category are probably spiny dogfish (personal communication Dr. Emory Anderson, Northeast Fisheries Science Center, Woods Hole, Mass.). As a result, the landings for both categories were combined during the most recent assessment of this resource by the U.S. National Marine Fisheries Service (1994) and in the present document.

In the course of compiling the landings of dogfish for this document, it was noted that the final NAFO data files for 1991-1992 do not contain all foreign landings of dogfish, which are substantial and are predominately American since 1979. Provisional landings, including foreign landings, for 1991-1993 were published in the most recent U.S. assessment of this resource (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 94-22) and were therefore used in the present document.

From 1930 to 1950, spiny dogfish were fished mostly for the vitamin A-rich oil contained in their livers. During the second world war, when a restriction was placed on imports of vitamin A from fish liver oil, a dogfish fishery bloomed in both the Atlantic and Pacific oceans, but it declined rapidly after vitamin A was synthesized (Walsh, 1982).

After 1965, total landings within NAFO subareas 2-6 grew rapidly and peaked at about 24,650 t in 1974, after which they declined rapidly until 1978 (Table 1 and Figure 2a). During this time period, the majority of the landings were made by foreign nations, principally the U.S.S.R. (Figure 2b). The landings were stable at about 5,250 t per year from 1979-89, after which they increased to over 16,500 t in 1990 and further to approximately 22,500 t in 1993 (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

Canadian landings in NAFO subareas 2-6 were insignificant before 1979 when about 1,300 t were landed (Figure 2b). Since then landings have been sporadic, reaching about 1,300 t again in 1990. The 1992 Canadian landings were about 800 t, and increased to an estimated 1,000 t in 1993 (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

The principal gear used by U.S. fishers to catch spiny dogfish has been otter trawls and gill nets, whereas dogfish caught by other foreign fleets have almost entirely been taken by otter trawl. Recent Canadian landings have been mainly by gillnets and longlines (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

The vast majority of the dogfish that are caught are discarded, primarily due to lack of markets. Unfortunately, quantitative estimates of the proportion discarded have not been made until recently with

estimates being as high as 97% in some U.S. fisheries in recent years. Including the estimated discard mortalities of at least 13,800 t, the estimated total catch for NAFO subareas 2-6 in 1993 was 36,000 t and suggests that catches in previous years may have been 2/3 or more higher than the reported landings (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

B) Landings and Description of the Fishery in the southern Gulf (NAFO Div. 4T)

The NAFO statistics for NAFO Div. 4T also include landings of "dogfish unspecified" which are assumed to represent spiny dogfish. With the exception of 1975 when 3 t were landed, there were no landings of spiny dogfish in the southern Gulf of St. Lawrence until 1986 when 11 t were recorded (Figure 3). Landings did not exceed 11 t until 1990 when 615 t were landed. The landings dropped to 142 t in 1991 after which they grew steadily to a peak of 970 t in 1994.

The ZIFF (Zonal Interchange File Format) data files which contain individual purchase slip records were examined for the period 1989-94 to assess temporal and spatial variability in the landings in NAFO Div. 4T. In the process, it was discovered that the ZIFF data files do not include landings of "dogfish unspecified" and thus will not agree with the NAFO statistics for all years.

From 1989-1994 almost 50% of the landings of spiny dogfish in NAFO Div. 4T were taken in statistical unit area 4TI and 36% were taken in statistical unit area 4Tg (Table 2, Figure 4). During the same time period, 64% of the landings of spiny dogfish were taken off PEI, with 42% of the total landings taken in two statistical districts in western PEI (statistical districts 382 and 392 - Table 3, Figure 5).

From 1989-1994, 80% of the landings of spiny dogfish in NAFO Div. 4T were taken by gillnets with equal proportions of the remaining landings being taken by longline and otter trawl (Table 4). During this time (1989-94) 72% of the landings of spiny dogfish were taken in the months of September and October (Table 5).

C) Management Measures Relevant to the Dogfish Fishery in the southern Gulf in 1994

Under the continuation of the cod moratorium in 1994, each fleet sector was required to limit their cod by-catch to no more than 10%. In consultation with industry, DFO developed and implemented a cod by-catch protocol that resulted in the closure of fisheries for 10 days when cod by-catches exceeded 10% in an area. The closure was then followed by a test fishery to determine if the cod by-catch level in the area was more or less than 10%.

To further minimize the harvesting of cod, DFO implemented restrictive fishing seasons for both the fixed and mobile gear sectors. The purpose of this management measure was to permit cod migration to be completed before opening the area to any other groundfish fishing activity. As well, the fishing season for mobile gear in the eastern portion of the Northumberland Strait was adjusted to open on July 15 to allow hake to spawn. The fishing seasons that were in effect in NAFO 4T in 1994 were as follows:

<u>DFO Fishing Area</u>	<u>Fixed Gear</u>	<u>Mobile Gear</u>
Gaspé and N.B. (4T3 to 4T6)	May 15 - Oct.15	May 1 - Nov. 1
Magdalen Is. (4T2)	May 15 - Jul. 1	May 1 - Nov. 15
Bay St. Lawrence (4T9)	May 20 - Nov. 1	May 15 - Nov.1
W. Northumberland Strait (4T7)	May 1 - Jul. 20 Sep.15 - Oct. 15	June 1 - Oct. 31
E. Northumberland Strait (4T8)	Jul. 1 - Oct. 20	July 15 - Oct. 31
Cheticamp (4T1)	Jul. 1 - Oct. 30	May 20 - Oct. 1
Northeast P.E.I. (4T2)	Jul. 1 - Oct. 20	May 15 - Oct. 1

(See map of fishing areas - Figure 6)

In 1994, the dogfish fishery, prosecuted predominantly by fixed gear fishers from the western end of P.E.I. was almost constantly closed because of high cod by-catch. Concentrations of cod reported in the inshore zones of the northern side of Prince Edward Island (4T2) and in the Shediac Valley (4T5) were the major factor contributing to the closure of the dogfish fishery. Although the fishery was frequently closed, Prince Edward Island fishers managed to catch 828 t of dogfish, of which 815 t was caught by fixed gear.

The regulated minimum mesh size for gillnets was 140 mm diamond and the regulated hook size was #11 circle, #15 straight shank or equivalent. For mobile gear, the minimum mesh size was 130 mm square in the Northumberland Strait and 145 mm square elsewhere.

Information received by DFO in 1994 indicates that some fishers apparently used sunken mackerel gillnets (mesh size 2.5 to 3 inches (64 to 76 mm)) to target dogfish. Conversations with fishers that used this gear indicated that no cod by-catch occurred when it was used.

At present, the dogfish fishery is not under any management control in terms of setting quotas (TAC's), in Canada or elsewhere throughout the rest of the management unit for spiny dogfish (NAFO subareas 2-6).

D) *Descriptions from Industry of the Dogfish Fishery in the southern Gulf in 1994*

In November 1994, personnel from the Dept. of Fisheries and Oceans, Science Branch, Gulf Region, made presentations at public meetings in Grande-Rivière, Québec, Shippagan, N.B., Charlottetown, P.E.I., Chéticamp, N.S. and Cap-aux-Meules in the Magdalen Islands on the groundfish stocks of the southern Gulf of St. Lawrence. The purpose of the meetings was to obtain views from fishers and fishing industry on the status of the various groundfish stocks in the southern Gulf in 1994. A record of all of the comments and discussions regarding spiny dogfish at these meetings is contained in Appendix 1.

Relative to the comments that were made regarding cod, hake and the flatfishes, there were far fewer opinions expressed at these meetings regarding dogfish. At the meetings in Grande-Rivière, Shippagan and

Charlottetown there seemed to be agreement that dogfish were more abundant in 1994 and a participant at the Grande-Rivière meeting indicated that the abundance has been high since the mid-1980's. At the meeting in Cap-aux-Meules, a fisher suggested that the abundance of dogfish was highest in the Magdalen Islands in the mid-1980's and has declined since 1990. Participants at the meetings in Grande-Rivière and Shippagan recalled that dogfish were abundant in the 1940's and 1950's.

By far the most interest in dogfish was expressed at the meeting in Grande-Rivière, where a participant recommended an agreement with the U.S. for joint management of this migratory stock. The opinion was expressed at the Charlottetown meeting that dogfish have interfered with the fishery for hake and several participants felt that dogfish have driven hake and perhaps American plaice out of the western Gulf.

On P.E.I. where the majority of the fishery for dogfish occurred in 1994, several processors and fishers were contacted for their opinions on the fishery. In general, there was agreement that the dogfish resource seemed to be as abundant as it has been in the last several years and appeared to move into local waters at the same time and in the same fashion as observed previously.

Markets for dogfish products appeared stable and several local processors were buying and processing this species more aggressively during 1994, likely in order to compensate for the decline in the supply of more traditional groundfish species. A major processor from western P.E.I. mentioned that much more dogfish could have been harvested, but there was some uncertainty among fishers about prices due to the relative newness of this fishery that probably detracted from their participation. One buyer reported that the greatest problem that he experienced in 1994 was the disruption caused by the repeated closures of the groundfish fishery.

Landings of dogfish might have been higher had the series of groundfish closures not curtailed the activity of the fixed gear fleet along the north shore. Efforts along the central and eastern north shore of the Island were curtailed by groundfish closures and no significant effort was directed at dogfish in the south-eastern Strait, where this resource may be more prevalent in the late fall months. As mentioned previously, much of the dogfish landed on P.E.I. in 1994 was caught in small mesh pelagic gears (mackerel nets), rigged in a fashion which placed the nets near or at the bottom.

Two processors indicated that the quantity of dogfish discarded in 1994 was insignificant (<5%) and one said that approximately 10% of the dogfish delivered to his facility were less than the preferred minimum commercial size (30"/76 cm).

Field staff from the Gulf Nova Scotia area reported that despite an abundance of dogfish in 1994, participation by fishers was very low because of poor markets and considerable quantities were discarded.

The Gulf Groundfish Index Fisher Program was introduced in 1990, primarily to obtain catch and effort information from inshore groundfish fishers that traditionally have not been required to maintain logbooks. Volunteers in this program maintain a daily logbook of their groundfish catch and effort and are contacted periodically throughout the fishing season, by phone, to obtain their views on the fishery. In 1994, 53 fishers volunteered to participate in this program, of which 40 actually fished for groundfish in 1994. At the end of the fishing season (Nov. 1994), all of the volunteers were contacted by phone and asked for their responses to a questionnaire concerning the 1994 groundfish fishery. When asked to describe the abundance of dogfish in 1994, 5 of the 40 respondents described it as average, 7 described it as higher than average and 11 described it as the highest or maximum. On the same question, 11 respondents described the abundance in 1994 as less than average and 4 described it as the lowest or minimum (the responses of 2 respondents were deemed not applicable because they indicated that dogfish never occurred in their area). When asked if dogfish interfered with their efforts to fish for groundfish in 1994, 28 out of 40 replied no and 12 said yes.

7 - Target

No target has been identified (The Canadian Atlantic dogfish fishery is not under any management control (i.e., no TAC's), as is the case throughout the rest of the management unit for spiny dogfish (NAFO subareas 2-6)).

8 - Fishery Data

A) Commercial Samples

Since directed fishing for spiny dogfish did not really start in the southern Gulf until 1990 and has been sporadic since then, samples from the commercial fishery have only been obtained opportunistically by DFO. More extensive length frequency sampling has been conducted on PEI by staff of the Prince Edward Island Department of Agriculture, Fisheries and Forestry (Figure 7).

Examination of the length frequencies reveals that virtually all of the male dogfish sampled were sexually mature (> 60 cm), but a significant proportion of the females were probably immature (< 80 cm). Generally, the size range of dogfish in these few samples is limited (58 - 88 cm for males and 62 - 96 cm for females) and may be indicative of the tendency for this species to form schools based on size until they become sexually mature.

9 - Research Data

A) Fall Groundfish Surveys

Research vessel surveys have been conducted every autumn since 1971 in the southern Gulf of St. Lawrence to provide an index of groundfish stock abundance. A stratified random survey design was initially adopted and has been maintained, except for the period 1984-1987, when randomly chosen fixed stations were surveyed. The surveys are conducted in the month of September before groundfish commence their migration out of the Gulf. The survey stratification scheme for NAFO Div. 4T is shown in Figure 8.

In the history of these surveys, spiny dogfish were not recorded until 1984 when one specimen was caught.

i) Geographic Distribution

The distribution of dogfish catches in surveys of the southern Gulf has been extremely variable (Figure 9). No consistent patterns are apparent, except for the occurrence of concentrations off the eastern and western coasts of P.E.I. since 1991 and the occurrence of concentrations off the Acadian Peninsula since 1992.

ii) Length Frequency Distribution and Sex Ratio of Survey Catches

Length frequencies were produced for the abundance surveys of the southern Gulf conducted since 1985 (Figure 10). As with the length frequencies from the commercial fishery, the size range was limited and the majority of the male dogfish sampled were sexually mature whereas most of the females were probably immature.

Estimates of the population (NAFO 4T) mean length of male and female spiny dogfish were compared for the years 1985-94 (Table 6, Figure 11). Aside from 1985 when fewer than 10 female dogfish were caught in the whole survey, the mean lengths for the two sexes have been remarkably similar (range 71-79 cm). From 1985-89, the mean length of male dogfish was greater than that of females and the converse was true from 1990-93 (in 1994 the mean lengths for both sexes were about the same (75 cm)).

Length frequency data from both the U.S. commercial landings and research vessel survey catches have indicated a decrease in the mean length of females in recent years that may be indicative of size/sex specific removals by the fishery. Since 1992 more than 95% of the sampled landings of spiny dogfish in the U.S. have been females larger than 84 cm. Males have composed only a small fraction of the landings and their mean length has remained stable (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

With the exception of 1990 and 1992, substantially more males than females have been caught in the surveys since 1985 (Table 6). Although the mean length of females in these surveys has not decreased in the manner described above for the U.S. commercial landings and research survey catches, the disproportionate ratio of male to female dogfish may be an indication of size/sex selective fishing mortality.

iii) Abundance Indices and Biomass Estimates

The research vessel stratified mean catch (numbers and weight) per tow, estimates of population abundance and biomass and associated variances were calculated using the RVAN analysis programs for the surveys of the southern Gulf conducted since 1984 (Table 7). For spiny dogfish, which are predominately pelagic and highly migratory, these estimates from a bottom trawl survey should be regarded as minimum estimates.

As mentioned previously, spiny dogfish were not captured in the surveys of the southern Gulf conducted from 1971 - 83 (only one specimen was caught in 1984). The mean number per tow rose after 1987 and reached 7.4 fish per tow in 1989 and then dropped to 0.6 in 1990 (Figure 12). This index increased again in 1991 and peaked at 11.8 fish per tow in 1993 but decreased sharply to 2.7 in 1994.

The trends in the estimates of research vessel mean catch (numbers and weight) per tow for spiny dogfish were compared with data from research vessel surveys on the Scotian Shelf (Figure 13 - Data from Simon and Comeau (1994)). The survey data for NAFO 4Vn, 4W and 4X all exhibit peaks in abundance in the late 1980's, however the peaks are not in synchrony. The peak occurred in 1987 in NAFO 4X, in 1985 in NAFO 4W and in 1988 in NAFO 4Vn. In contrast, in NAFO 4T the peak occurred in 1993.

Annand (1985) observed that catch per tow indices for spiny dogfish from groundfish surveys on the Scotian Shelf indicated an apparent increase in abundance since 1983 but stressed that it was not apparent whether or not overall stock abundance had increased or moved north as a result of environmental influences such as shifts in water temperature or availability of prey from one area to another. If the prey species such as mackerel also follows a migration route, the dogfish may follow it, depending on the abundance of the prey species at the time. Localized increases in abundance could be due to behavioral and environmental changes rather than increases in biomass. Since the pattern of migration is thought in general to be a northward movement following the summer warming and a southward migration in connection with winter cooling, the time for the appearance of dogfish could vary considerably from year to year. Therefore, temperature shifts, prey availability and timing of the surveys are some of the factors which cause the variability found in dogfish biomass estimates (Annand, 1985).

American bottom trawl surveys conducted off the east coast of the United States documented a steady increase in both abundance and biomass of dogfish since the early 1970's, but total biomass indices in the last several years and abundance indices of large fish (i.e., females > 80 cm - which constitute the bulk of the fishery landings) show no evidence of increase (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

B) January 1994 and 1995 Surveys of Cabot Strait

Groundfish surveys were conducted in the Cabot Strait (NAFO division 4T to 4Vsb) in January of 1994 and 1995 using the Alfred Needler. Station selection for the 1994 survey was random but the 1995 survey used a non-random (grid) design, otherwise standard Gulf survey protocols were followed. The primary objective of

these surveys was to determine the distribution and relative abundance of groundfish species in the Cabot Strait area during winter.

The distribution of spiny dogfish catches in both January surveys are shown in Figure 14. Only one spiny dogfish was caught in the January 1994 survey but concentrations were encountered in 1995 along the slope of the Cabot Strait, in depths greater than 200m (no catches were realized within the Gulf). The occurrence of these fish is interesting and offers support for Templeman's (1944) suggestion that dogfish may overwinter along the edge of the shelf.

10 - Assessment Results

Research vessel data for surveys of the southern Gulf (NAFO Div. 4T) suggest an increase in the abundance of spiny dogfish since 1987.

Data and analyses presented during the most recent (1994) assessment of spiny dogfish in the northwest Atlantic (NAFO subareas 2-6) indicate that total landings from this resource have increased five-fold since 1987 and that total catches may have been 2/3 or more higher than the reported landings, when recent estimates of discard rates in U.S. fisheries are considered. Consequently, they concluded that this stock is stable at best and has possibly begun to decline as a result of the recent increases in exploitation. They suggested that this stock may be fully utilized with respect to the level of fishing mortality and that the current fishery which mainly targets mature females will result in reduced longterm recruitment (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

11 - Ecological Considerations

Jensen (1966) reported that the dominant component of the diet of spiny dogfish on the Scotian Shelf and Gulf of Maine comprised fish including: herring, mackerel, sand lance, cod, silver hake, white hake, haddock, pollock, Atlantic salmon, menhaden, winter flounder, and longhorn sculpin as well as squid and several other invertebrate species.

Bowman and Eppi (1984) concluded that predation mortality by spiny dogfish is a significant source of mortality for commercially important species. Preliminary calculations indicate that the biomass of commercially important species consumed by spiny dogfish is comparable to the amount harvested by man. Therefore, the impact of spiny dogfish predation on other species should be considered in establishing harvesting policies for this species (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

12 - Future Prospects

Analyses presented during the most recent (1994) assessment of spiny dogfish in the northwest Atlantic (NAFO subareas 2-6) indicate that given the relatively stable level and distribution of the exploitable stock, and recent increased targeting, landings in 1995 will likely exceed the 1993 landings of 22,000 t. However, they cautioned that the strategy of the current fishery which mainly targets mature females will result in reduced longterm recruitment (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

13 - Management Considerations

Given the evidence for a single unit stock in the northwest Atlantic (NAFO subareas 2-6), joint assessment and management of this resource by Canada and the U.S. should be considered (U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

14 - Research Recommendations

Work needs to be done to establish the identity of "dogfish unspecified" in the ZIFF and NAFO data files and to avoid the use of this species group if possible

The ecological role of spiny dogfish is important to understand. Estimates of the consumption rate of spiny dogfish on its prey species in the Gulf of St. Lawrence are required.

15 - Acknowledgements

We would like to thank the following industry representatives (processors/buyers) for their responses to questions concerning the spiny dogfish fishery in the southern Gulf:

- Eugene Bernard of the Tignish Fisheries Co-op Ass'n. Ltd. (Tignish, P.E.I.)
- Garth Jenkins and Roger Riggs of Abegweit Seafoods Inc. (Charlottetown, P.E.I.)
- Bernie MacDonald of the Caleigh Co-op (Port Hood, N.S.)

We would also like to express our appreciation to John Hanlon and Phil George (DFO, Antigonish) for their descriptions of the Gulf Nova Scotia fishery in 1994 and to Doug Swain and Mikio Moriyasu (DFO, Moncton) for their constructive reviews of an earlier version of this manuscript.

16 - References

Annand, C. 1985. Status report on 4VWX dogfish (*Squalus acanthias*). CAFSAC Res. Doc., 85/73. 23 p.

Annand, C. and D. Beanlands. 1986. A genetic stock structure study of dogfish in the northwest Atlantic. NAFO Sci. Coun. Studies, SCR Doc., 86/102. 5 p.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Wildl. Serv. Fish. Bull. 53: 47-51.

Bowman, R. and R. Eppi. 1984. The predatory impact of spiny dogfish in the northwest Atlantic. Int. Coun. Explor. Sea. C.M. 1984/G: 27, 16 p.

Cornish, G.M. 1912. Notes on the fishes of Tignish, P.E.I. Contrib. Can. Biol., 1906-1910. p. 79-81.

Holden, M.J. 1966. The food of the spurdog, (*Squalus acanthias*). J. Cons. Int. Explor. Mer. 30: 255-266.

Holden, M.J. 1977. "The fisheries for spiny dogfish" in chapter 9 of Fish Population Dynamics. Gulland, J.A. (ed.). J. Wiley and Sons, London: p. 190-199.

Holland, A.A. 1957. Migration and growth of the dogfish shark (*Squalus acanthias*), of the eastern north Pacific. State of Wash. Dept. of Fish., Fish. Res. Pap. 2(1): 43-59.

Hurley, G.V., H.H. Stone and D.W. Lemon. 1987. The Dogfish Scourge: Protecting Fishing Gear from Shark Attack. Can. Ind. Rep. Fish. Aquat. Sci. 180(8): 34 p.

Jensen, A.C. 1961. Recaptures of tagged spiny dogfish (*Squalus acanthias*). Copeia (2): 228-229.

Jensen, A.C. 1966. Life history of the spiny dogfish. Fishes of the Gulf of Maine. Fish. Wildl. Serv. Fish. Bull. 65(3):527-553.

- McFarlane, G.A. and R.J. Beamish. 1987. Validation of the dorsal spine method of age determination for spiny dogfish. In: R.C. Summerfelt and G.E. Hall, eds., *The Age and Growth of Fish*, p. 287-300. Ames, Iowa: Iowa State Univ. Press.
- Nammack, M.F., J.A. Musick and J.A. Colvocoresses. 1985. Life history and management of spiny dogfish off the northeastern United States. *Trans. Amer. Fish. Soc.* 114: 367-376.
- Pratt, H.L. and J.G. Casey. 1990. Shark reproductive strategies as a limiting factor in directed fisheries, with a review of Holden's method of estimating growth parameters. In "*Elasmobranchs as living resources: Advances in the biology, ecology, systematics and the status of the fisheries*", Pratt, H.L., S.H. Gruber and T. Taniuchi (eds.). NOAA Tech. Rept., NMFS 90 (1990).
- Salsbury, J. 1986. Spiny dogfish in Canada. *Can. Ind. Rep. Fish. Aquat. Sci.* 169: xii + 57 p.
- Scott, W.B. and M.G. Scott. 1988. *Atlantic Fishes of Canada*. Toronto: Univ. of Toronto Press. 731p.
- Shafer, T.C. 1970. Migration and distribution of the spiny dogfish (*Squalus acanthias*) in the western North Atlantic. M.Sc. Thesis, Univ. of Rhode Is. 45 p.
- Simon, J.E. and P.A. Comeau. 1994. Summer distribution and abundance trends of species caught on the Scotian Shelf from 1970-92 by the Research Vessel Groundfish Survey. *Can. Tech. Rep. Fish. Aquat. Sci.* 1953: X + 145p.
- Templeman, W. 1944. The life history of the spiny dogfish, (*Squalus acanthias*), in the northwest Atlantic. *NAFO Sci. Coun. Studies* 3: 46-52.
- United States National Marine Fisheries Service. Northeast Fisheries Science Center. 1994. Report of the 18th Northeast Regional Stock Assessment Workshop - Stock Assessment Review Committee (SARC) Consensus Summary of Assessments: Spiny Dogfish. CRD 94-22: 46p.
- Walsh, S.J. 1982. Atlantic Spiny Dogfish. *Underwater World*, U.W. 81/013E.

Table 1. Total Landings (Canadian and Foreign) of Spiny Dogfish and Dogfish Unspecified in NAFO Subarea 2-6.

(NOTE: Final NAFO statistics including foreign landings are not yet available for 1991-94).

(* - The landings for 1991-93 are provisional landings obtained from the latest U.S. assessment of this stock (N.E.F.S.C. Ref. Doc. 04-22)).

YEAR	2G	2H	2J	2NK	3K	3L	3M	3N	3O	3Pn	3Ps	3NK	4R	4S	4T	4Vn	4Vs	4W	4X	4NK
1960	0	0	43	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	7	8	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	10	0	0	12	0	10	0	0	0	0	0	0	34	0	0
1966	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	79	0	1451	4	0
1967	0	0	0	0	0	7	0	3	15	0	0	0	0	0	0	0	3	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	229	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	686	0	0	0	0	0	12	6	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	258	0	2194	16	0
1973	0	0	5	0	2	0	0	0	0	0	23	0	0	0	0	0	437	2288	746	0
1974	0	0	8	0	5	30	3	0	0	0	88	0	0	0	0	0	0	4324	2504	0
1975	0	0	0	0	0	2	0	0	5	0	109	0	0	0	3	0	146	3529	533	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	1608	954	284	0
1977	0	0	0	0	0	10	0	0	25	0	19	0	0	0	0	8	8	326	92	0
1978	0	0	0	0	0	25	0	0	15	1	81	0	0	0	0	0	0	9	9	0
1979	0	0	0	0	0	18	0	0	0	1	1295	0	0	0	0	1	7	38	2	0
1980	0	0	0	0	0	28	0	0	0	1	612	0	0	0	0	0	0	367	27	0
1981	0	0	0	0	6	2	15	23	0	0	557	0	0	0	0	0	5	467	29	0
1982	0	0	0	0	1	3	0	1	0	0	362	0	0	0	0	0	0	27	25	0
1983	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	334	47	0
1984	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	36	2	286	1	0
1985	0	0	0	0	13	166	0	0	146	0	0	0	0	0	0	2	2	372	11	0
1986	0	0	0	0	0	8	0	0	3	0	0	0	0	0	11	14	2	221	8	0
1987	0	2	1	0	34	1	0	0	0	0	0	0	0	0	11	9	5	85	264	0
1988	0	1	4	0	2	0	0	25	0	0	0	0	0	0	0	1	1	545	0	0
1989	1	3	4	0	4	36	2	17	2	0	0	0	0	0	4	1	3	157	166	0
1990	5	3	0	0	0	0	0	0	0	0	1	0	0	9	615	41	1	329	724	0
1991	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1992	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1993	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1994	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

YEAR																	Totals for
	5Y	5Ze	5Zw	5Zc	5Zu	5ZNK	6A	6B	6C	6D	6E	6F	6G	6H	6NK	NAFO SA's	
1960	455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	519	
1961	438	0	0	0	0	0	0	0	0	0	0	0	0	0	0	438	
1962	296	0	0	0	0	0	0	0	0	0	0	0	0	0	0	296	
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
1964	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	16	
1965	0	0	0	141	0	0	0	0	0	0	0	0	0	0	0	207	
1966	0	0	0	5284	0	0	0	0	0	0	0	0	0	0	2601	9428	
1967	0	0	0	2038	0	0	9	0	0	0	0	0	0	0	634	2729	
1968	0	1801	1630	0	0	0	0	0	0	0	0	0	0	0	677	4108	
1969	78	378	6499	0	0	0	715	790	480	0	0	0	0	0	112	9302	
1970	3	2321	2043	0	0	0	289	231	68	0	0	0	0	0	0	5659	
1971	4	3182	4844	0	0	0	2006	1438	83	0	0	0	0	0	0	11560	
1972	200	8303	4339	0	0	0	6693	1429	562	0	0	0	0	0	0	23994	
1973	4	9109	2796	0	0	0	1940	1428	57	0	0	0	0	0	0	18835	
1974	1	9051	3202	0	0	0	3943	1476	16	0	0	0	0	0	0	24651	
1975	2	11206	5104	0	0	0	1955	96	2	0	0	0	0	0	0	22692	
1976	433	10214	2244	0	0	0	1865	24	1	0	0	0	0	0	0	17340	
1977	829	3223	1729	0	0	0	1256	227	364	0	0	0	0	0	13	8129	
1978	725	90	391	0	0	0	177	31	1	3	0	0	0	0	0	1558	
1979	4089	83	60	0	0	0	253	409	13	0	0	0	0	0	0	6269	
1980	3492	103	30	0	0	0	154	410	205	0	0	0	0	0	0	5429	
1981	5031	145	68	0	0	0	126	1115	812	0	0	0	0	0	0	8401	
1982	3157	58	63	0	0	10	163	2022	1491	0	0	0	0	0	0	7383	
1983	4755	7	0	0	0	0	41	141	14	0	0	0	0	0	0	5370	
1984	4269	19	14	0	0	0	67	136	9	0	0	0	0	0	0	4844	
1985	3872	80	8	0	0	0	137	219	28	0	0	0	0	0	0	5056	
1986	2415	0	7	0	138	0	191	18	18	0	0	0	0	0	0	3054	
1987	2565	0	24	0	44	0	69	36	3	0	0	0	0	0	1	3154	
1988	2784	0	3	0	85	0	148	31	137	0	0	0	0	0	0	3767	
1989	4546	0	3	0	10	0	46	19	0	0	0	0	0	0	0	5024	
1990	9459	0	2196	1	68	0	98	3010	20	0	0	0	0	0	0	16580	
1991	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	15831	
1992	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	19012	
1993	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	22572	
1994	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	N/A	

Table 2. Landings (t) of Spiny Dogfish in NAFO Div. 4T by NAFO unit area.

U-AREA	Year						PERCENT	PERCENT
	1989	1990	1991	1992	1993	1994	1994	1989-94
4TF	0.0	36.6	0.0	0.2	0.0	29.4	3.0	2.9
4TG	4.2	399.6	0.6	190.3	107.9	108.2	11.2	36.0
4TH	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.1
4TJ	0.0	32.1	0.7	1.8	18.7	8.3	0.9	2.7
4TK	0.0	0.2	0.0	0.0	0.0	0.5	0.1	0.0
4TL	0.0	34.1	0.0	0.0	352.3	717.1	73.9	48.9
4TM	0.0	8.6	0.0	0.0	13.6	4.8	0.5	1.2
4TN	0.0	15.7	0.0	0.0	42.8	99.5	10.3	7.0
4TO	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
4TP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4TQ	0.0	0.0	0.0	0.0	0.0	2.1	0.2	0.1
4T?	0.3	22.4	0.0	0.0	0.0	0.0	0.0	1.0
TOTALS	4.4	549.2	1.3	192.3	537.4	970.0	100.0	100.0
TOTAL LANDINGS 1989-94:						2254.7		

Table 3. Landings of Spiny Dogfish (t) in NAFO Div. 4T by Fishery Statistical District:1989-94.

Stat. Dist.	Year						Totals	1994	1989-94
	1989	1990	1991	1992	1993	1994		Percent	Percent
101	0.0	38.7	0.0	0.0	5.5	0.1	44.3	0.0	2.0
102	4.2	186.3	0.5	173.9	0.0	0.0	364.9	0.0	16.2
103	0.0	0.4	0.0	16.6	0.0	5.3	22.3	0.5	1.0
109	0.0	0.0	0.0	0.0	0.0	7.7	7.7	0.8	0.3
112	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
113	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.0	0.0
264	0.0	0.0	0.0	0.0	13.6	0.0	13.6	0.0	0.6
265	0.0	14.0	0.0	0.0	0.0	0.0	14.0	0.0	0.6
266	0.0	12.8	0.0	0.0	38.6	0.0	51.4	0.0	2.3
267	0.0	0.0	0.0	0.0	4.2	0.0	4.2	0.0	0.2
268	0.0	0.0	0.0	0.0	162.0	0.0	162.0	0.0	7.2
382	0.0	5.7	0.0	0.0	72.7	347.2	425.6	35.8	18.9
385	0.0	0.0	0.0	0.0	1.2	0.0	1.2	0.0	0.1
387	0.3	147.8	0.0	0.0	2.6	0.0	150.7	0.0	6.7
388	0.0	69.9	0.1	0.0	106.1	102.6	278.7	10.6	12.4
392	0.0	41.5	0.0	0.0	112.7	370.0	524.2	38.1	23.2
395	0.0	13.6	0.7	1.8	14.4	2.5	33.0	0.3	1.5
396	0.0	18.5	0.0	0.0	3.8	5.8	28.1	0.6	1.2
398	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
403	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
404	0.0	0.0	0.0	0.0	0.0	2.1	2.1	0.2	0.1
405	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
409	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
410	0.0	0.0	0.0	0.0	0.0	56.6	56.6	5.8	2.5
411	0.0	0.0	0.0	0.0	0.0	46.9	46.9	4.8	2.1
413	0.0	0.0	0.0	0.0	0.0	1.3	1.3	0.1	0.1
426	0.0	0.0	0.0	0.0	0.0	2.3	2.3	0.2	0.1
427	0.0	0.0	0.0	0.0	0.0	9.9	9.9	1.0	0.4
428	0.0	0.0	0.0	0.0	0.0	9.3	9.3	1.0	0.4
TOTALS	4.4	549.2	1.3	192.3	537.4	970.0	2254.7	100.0	100.0

NOTE: The ZIFF (Zonal Interchange File Format) landings data on which the table (above) are based do not include landings of Dogfish Unspecified and will not agree with the totals in Table 1 for some years.

Table 4. Landings of Spiny Dogfish (t) in NAFO Div. 4T by Gear:1989-94.

Year	GNS	LLS	OTB	SNU	MISC	TOTALS
1989	4.2		0.3			4.4
1990	321.1	47.1	153.4	6.4	21.2	549.2
1991	0.2	1.1	0.0	0.0	0.0	1.3
1992	126.0	64.0	1.0	1.0	0.4	192.3
1993	482.0	31.8	12.6	1.5	9.5	537.4
1994	869.5	54.3	12.8	8.1	25.4	970.0
TOTALS	1798.8	198.2	179.8	17.0	56.5	2250.3
PERCENT	79.9	8.8	8.0	0.8	2.5	100.0

Table 5. Landings of Spiny Dogfish (t) in NAFO Div. 4T by Month:1989-94.

Year	April	May	June	July	Aug	Sept	Oct	Nov	Totals
1989	0.0	0.0	0.0	0.0	0.0	4.2	0.3	0.0	4.4
1990	0.0	0.0	0.0	0.1	0.0	166.3	242.8	140.0	549.2
1991	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.5	1.3
1992	1.1	0.0	0.0	0.0	0.0	4.2	87.6	99.4	192.3
1993	0.0	0.0	3.5	72.8	130.1	244.6	86.5	0.0	537.4
1994	0.0	0.0	1.5	21.8	157.2	427.5	362.0	0.0	970.0
1994 PERCENT	0.0	0.0	0.2	2.2	16.2	44.1	37.3	0.0	100.0
1989-94 PERCENT	0.0	0.0	0.2	4.2	12.7	37.6	34.6	10.6	100.0

NOTE: The ZIFF landings data on which the two tables (above) are based do not include landings of Dogfish Unspecified and will not agree with the totals in Table 1 for some years.

Table 6. Research vessel estimates of the sex ratio and mean length of male and female Spiny Dogfish in NAFO Div. 4T.

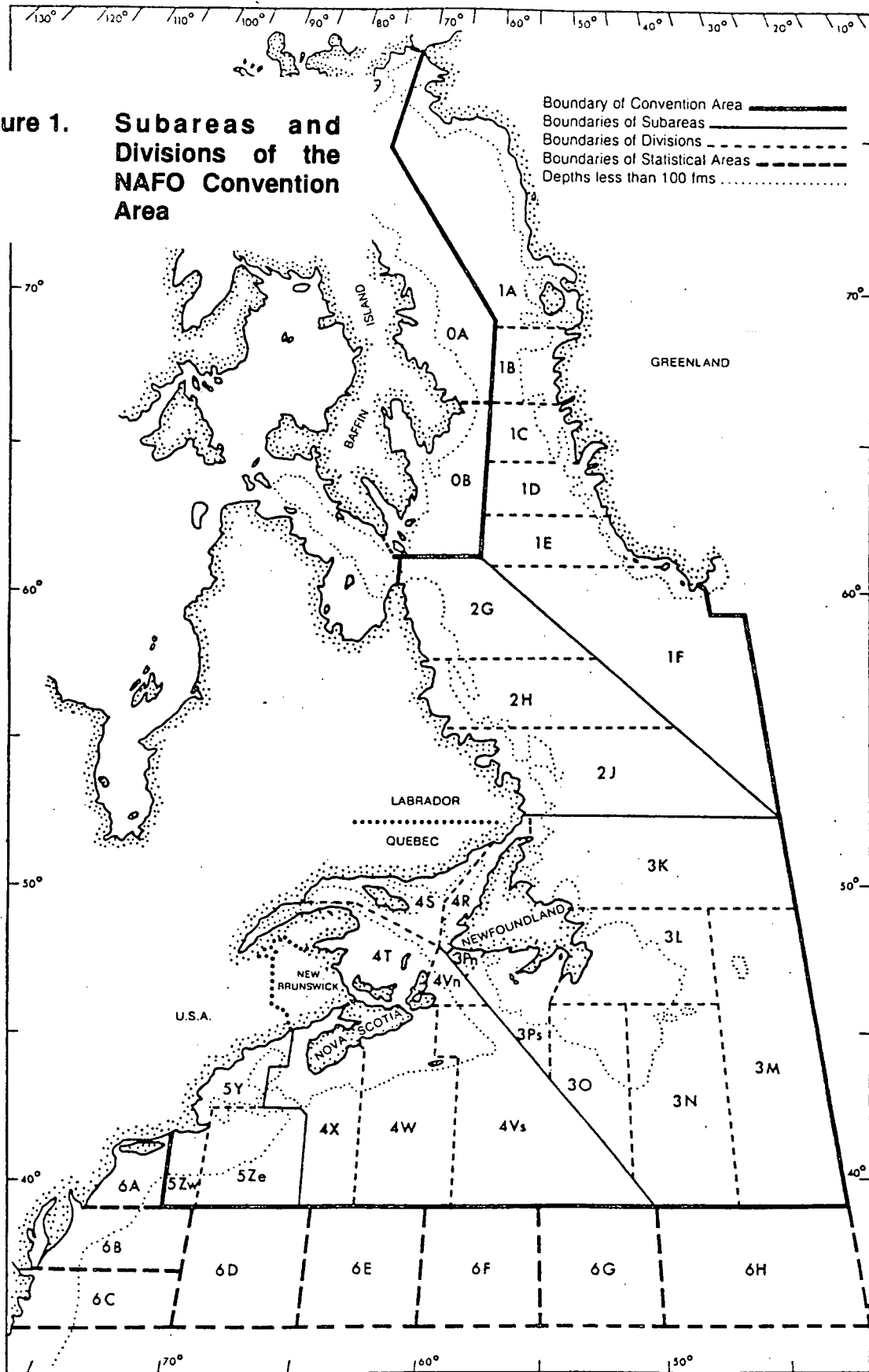
Year	Est. Gulf Popl'n. Sex Ratio	Mean Lt. of Gulf Popl'n.	Mean Lt. of Gulf Popl'n.
	Males:Females	Males	Females
1985	4.5:1	75.5	64.6
1986	1.6:1	75.4	73.4
1987	1.3:1	76.5	73.0
1988	1.6:1	73.5	72.9
1989	2.9:1	73.6	72.7
1990	0.5:1	70.6	76.8
1991	1.1:1	74.2	76.1
1992	0.7:1	75.3	78.8
1993	1.1:1	74.9	76.3
1994	3.0:1	75.3	74.6

Table 7. Research vessel estimates of the mean catch per tow (numbers and weight), population numbers and population biomass for Spiny Dogfish in NAFO Div. 4T.

Year	Stratified Mean Number Per Tow	Variance	Stratified Mean Wt. (kg.) Per Tow	Variance	Population Numbers (000's) in NAFO 4T	Variance	Population Biomass (t) in NAFO 4T	Variance
1984	0.00	0.00	0.02	0.00	7	50	35	1261
1985	0.32	0.02	0.50	0.04	574	53971	899	117568
1986	0.29	0.01	0.59	0.05	532	38691	1064	149802
1987	0.15	0.01	0.39	0.06	275	27882	696	183950
1988	2.90	5.15	4.71	12.30	5158	16278859	8373	38911135
1989	7.36	16.70	11.90	51.14	13010	52203406	21038	159860997
1990	0.58	0.06	1.31	0.44	1042	207661	2358	1434229
1991	2.06	0.84	4.08	2.88	3639	2636334	7221	8994000
1992	1.94	0.36	4.22	1.63	3508	1187446	7626	5322482
1993	11.81	10.21	22.55	34.71	21333	33322932	40738	113262044
1994	2.70	0.69	4.80	1.99	4766	2144372	8490	6220131

Research Vessels: E.E. Prince from 1971-85
 Lady Hammond from 1986-91
 Alfred Needler from 1992-94

Figure 1. Subareas and Divisions of the NAFO Convention Area



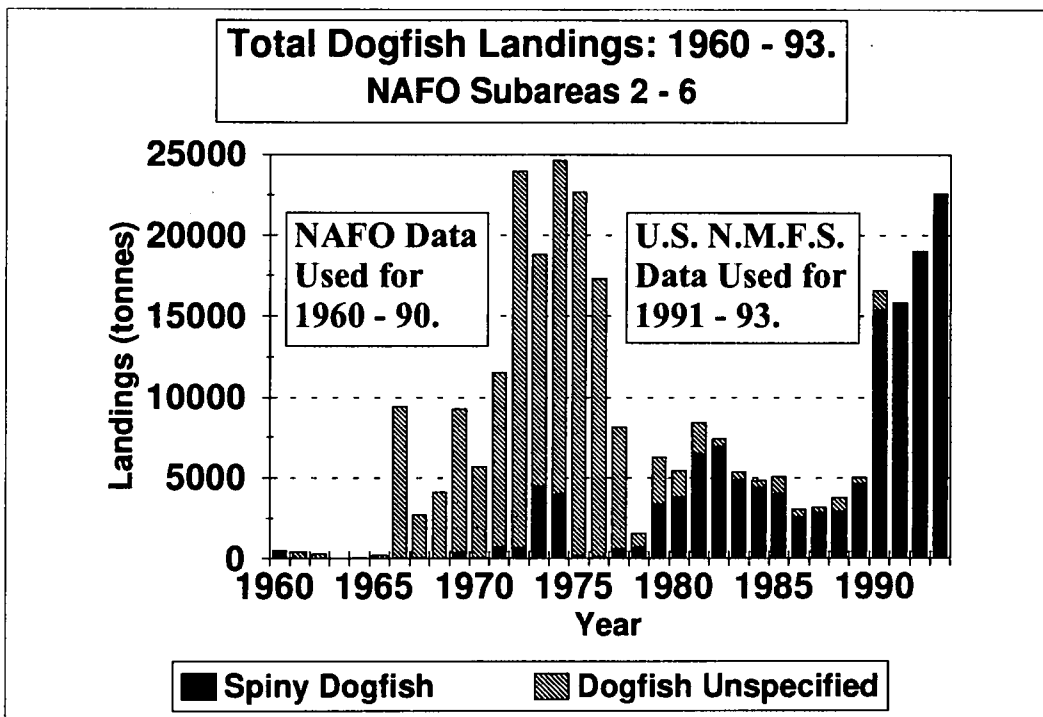


Figure 2a. Landings of all dogfish in NAFO areas 2-6.
(NOTE: Final NAFO landings data are not yet available for 1991-94).

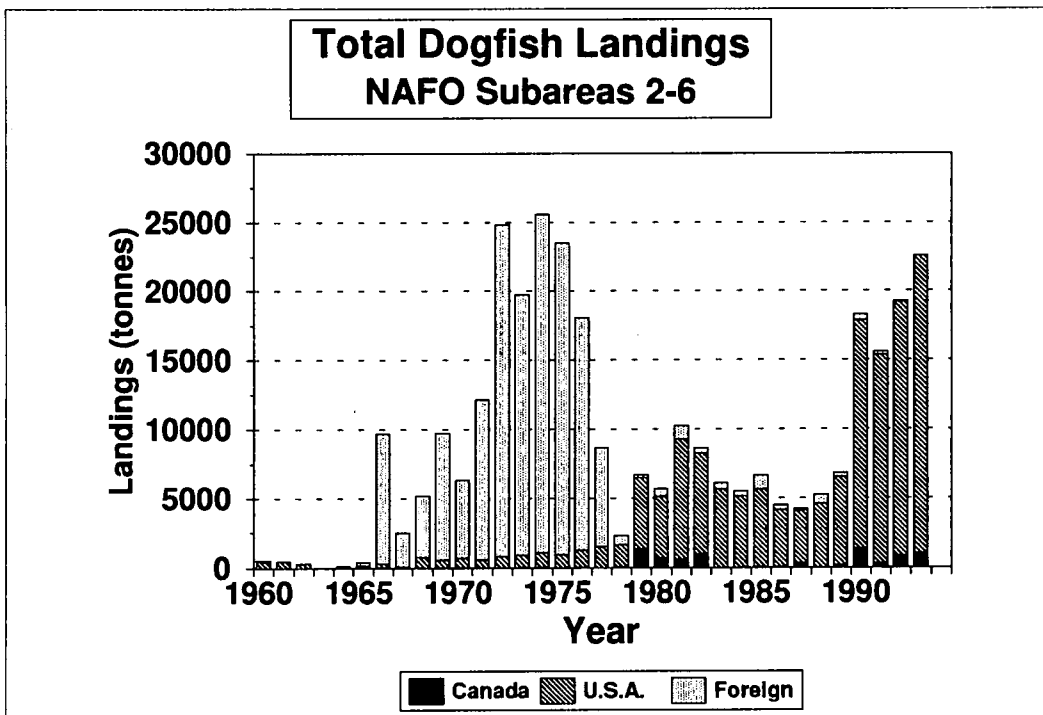


Figure 2b. Landings of all dogfish in NAFO subareas 2-6 from 1960-93. 20
(Data from U.S. N.M.F.S. N.E.F.S.C. Ref. Doc. 1994).

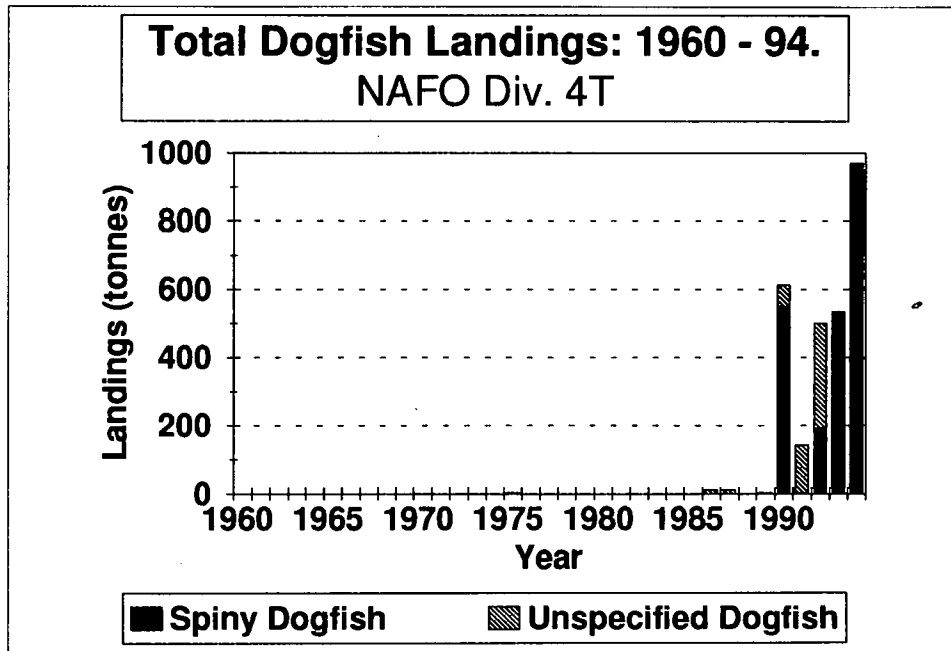


Figure 3. Landings of dogfish in NAFO Div. 4T.
(NOTE: The landings for 1993-94 are provisional ZIFF data and do not include Unspecified Dogfish).

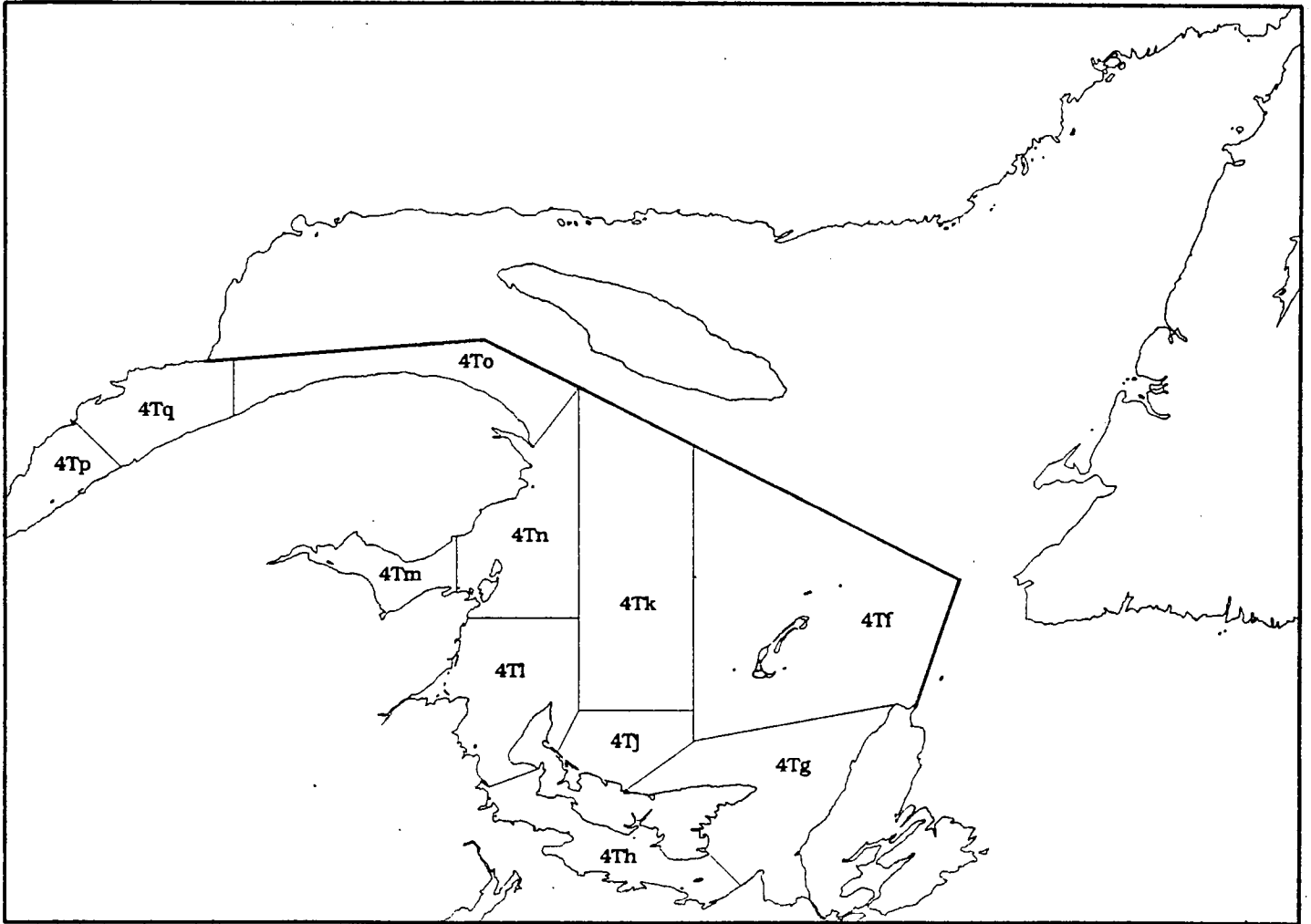


Figure 4. Canadian statistical unit areas within NAFO division 4T.

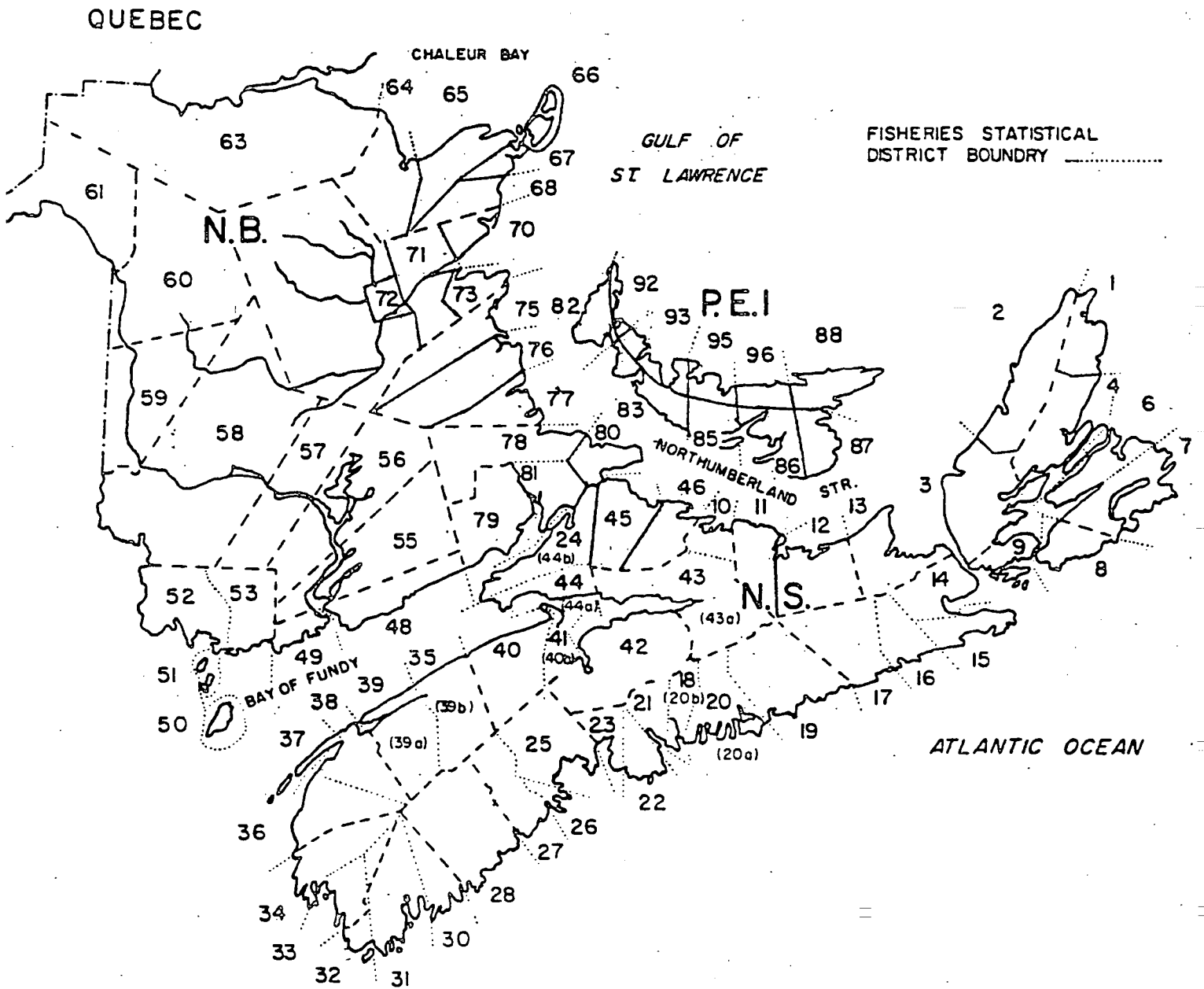


Figure 5. Map showing the DFO fishery statistical districts in NB, NS and PEI.

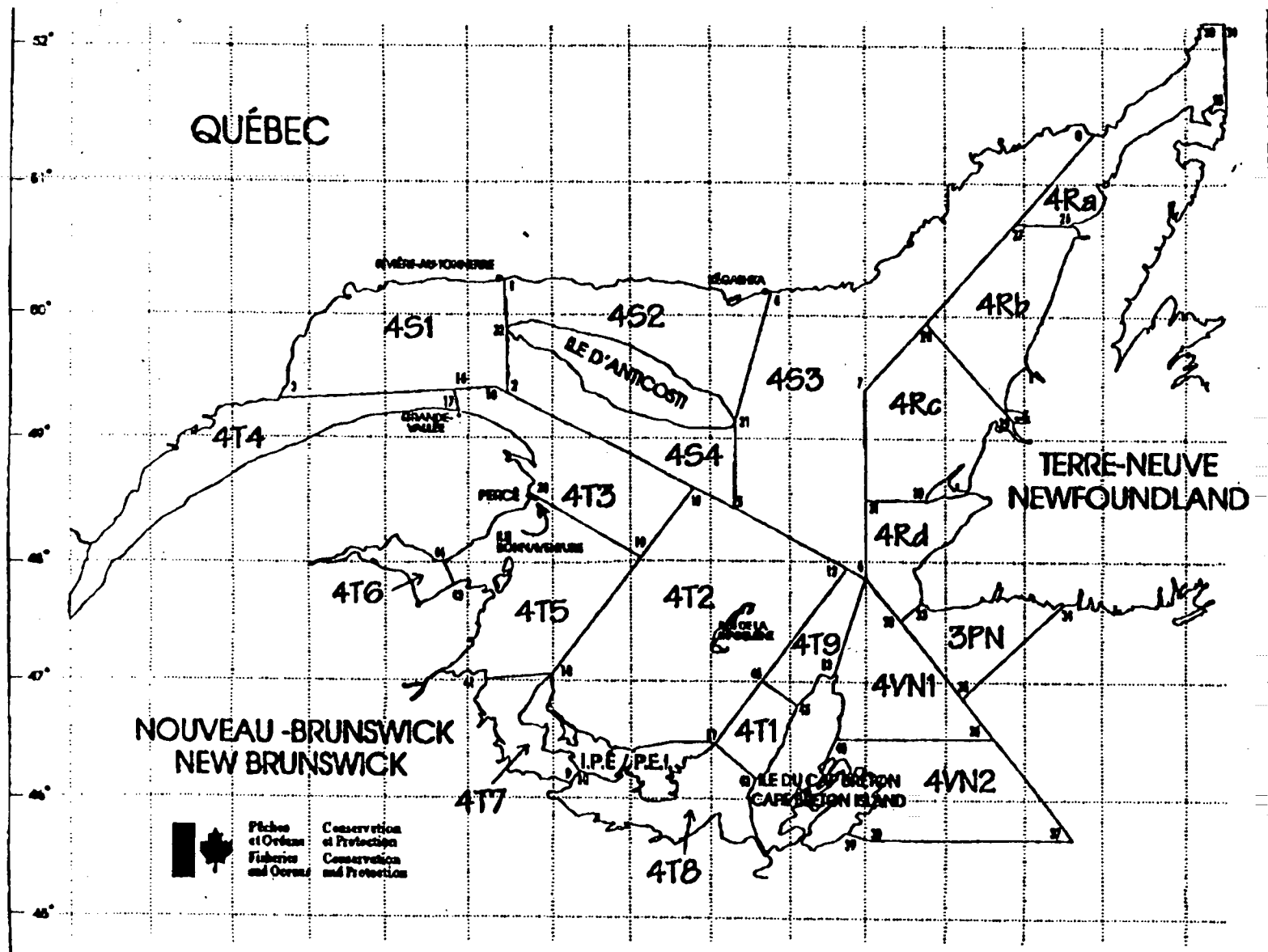


Figure 6. Map of the Gulf of St. Lawrence showing the groundfish fishing areas used by DFO Fisheries Management to manage small fish and by-catch in 1994.

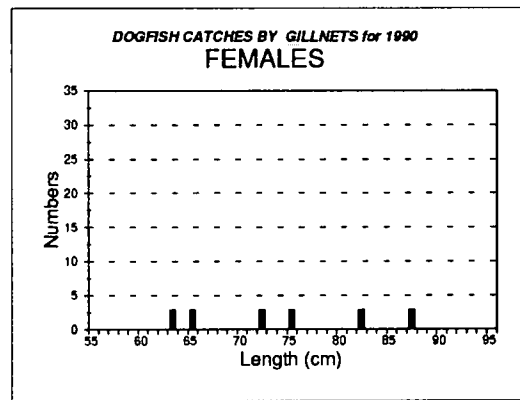
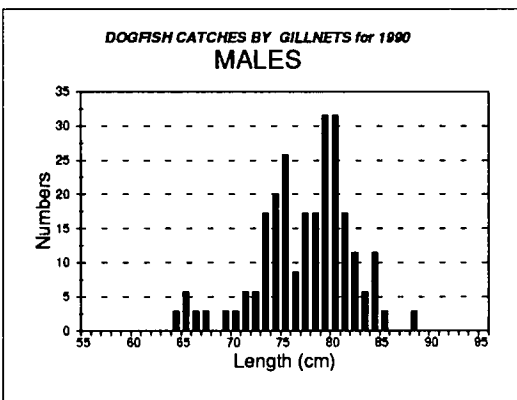
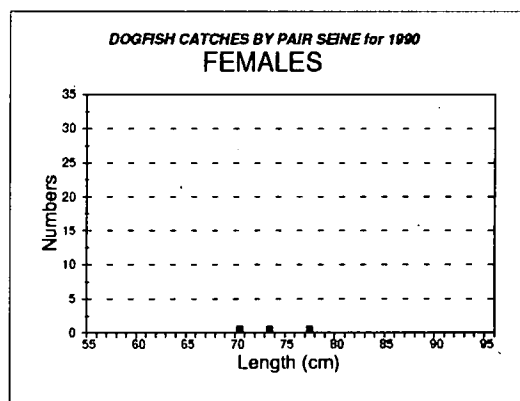
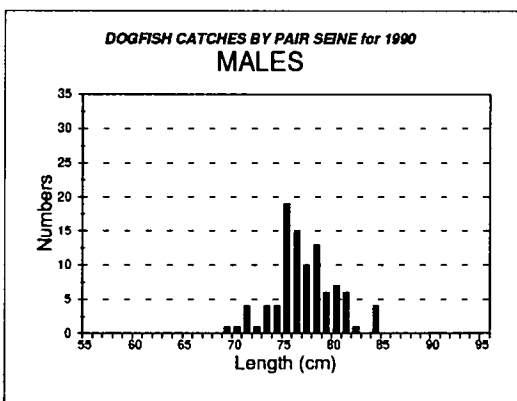
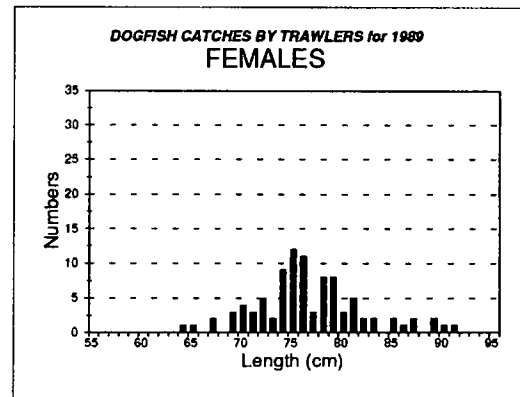
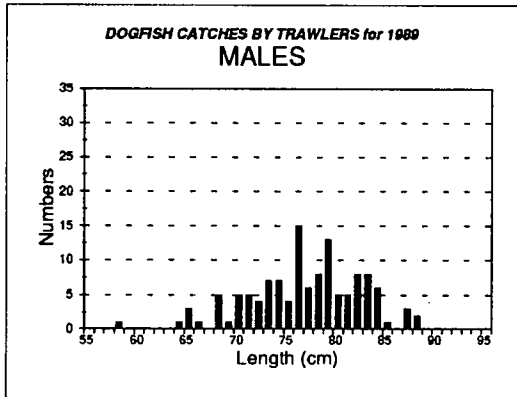


Figure 7. Length frequencies (sexes separated) for Spiny Dogfish sampled from commercial catches on P.E.I.

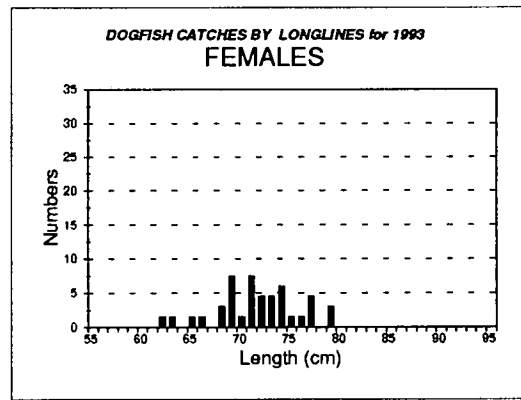
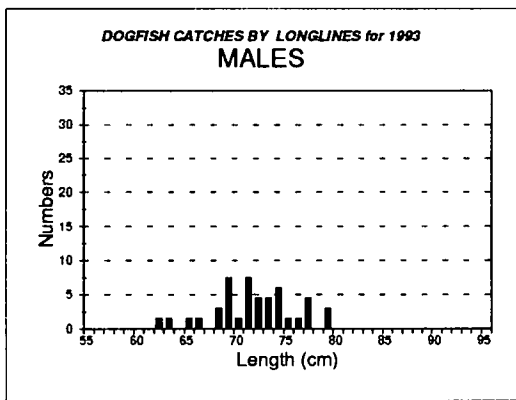
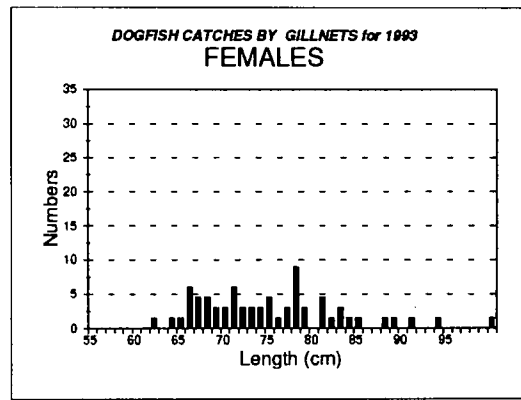
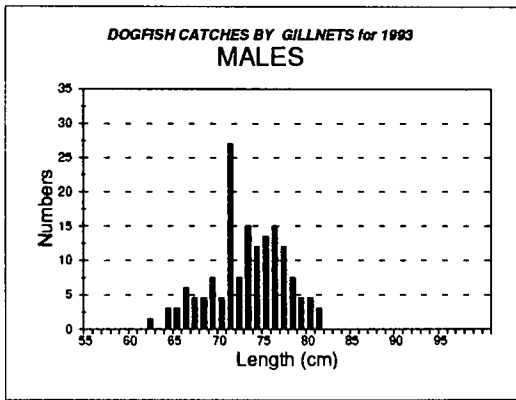
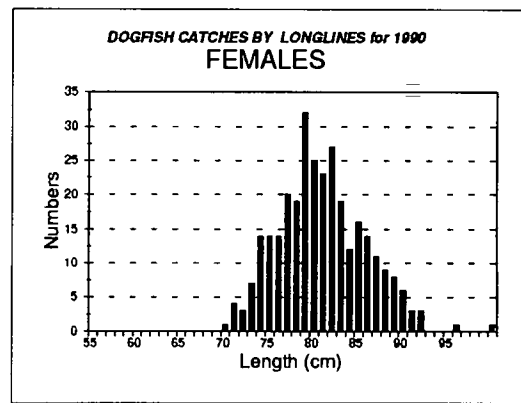
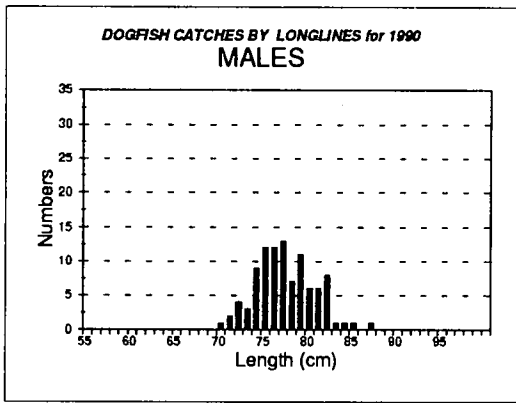


Figure 7. Length frequencies (sexes separated) - Continued.

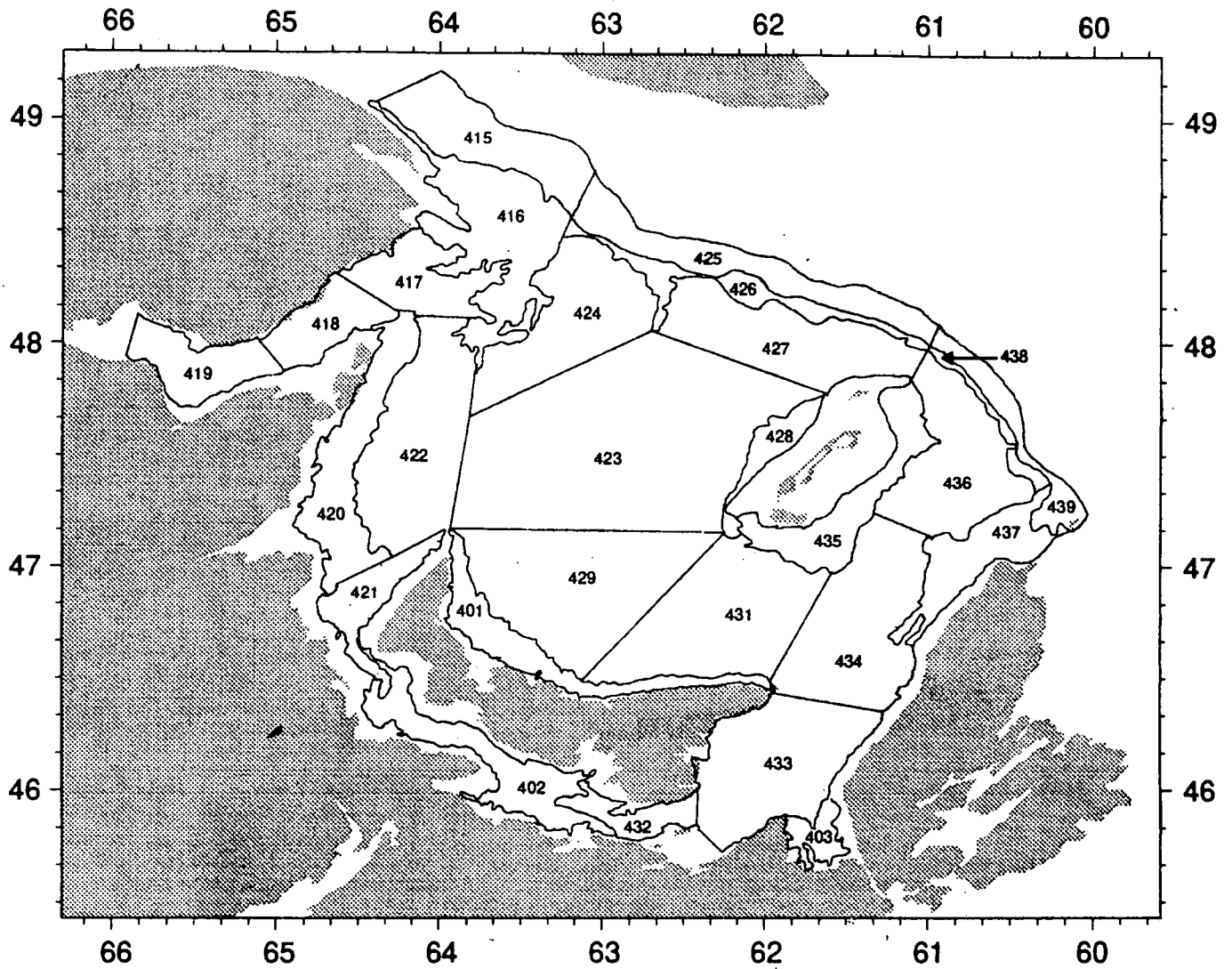


Figure 8. Survey strata for the annual groundfish survey of the southern Gulf of St. Lawrence.

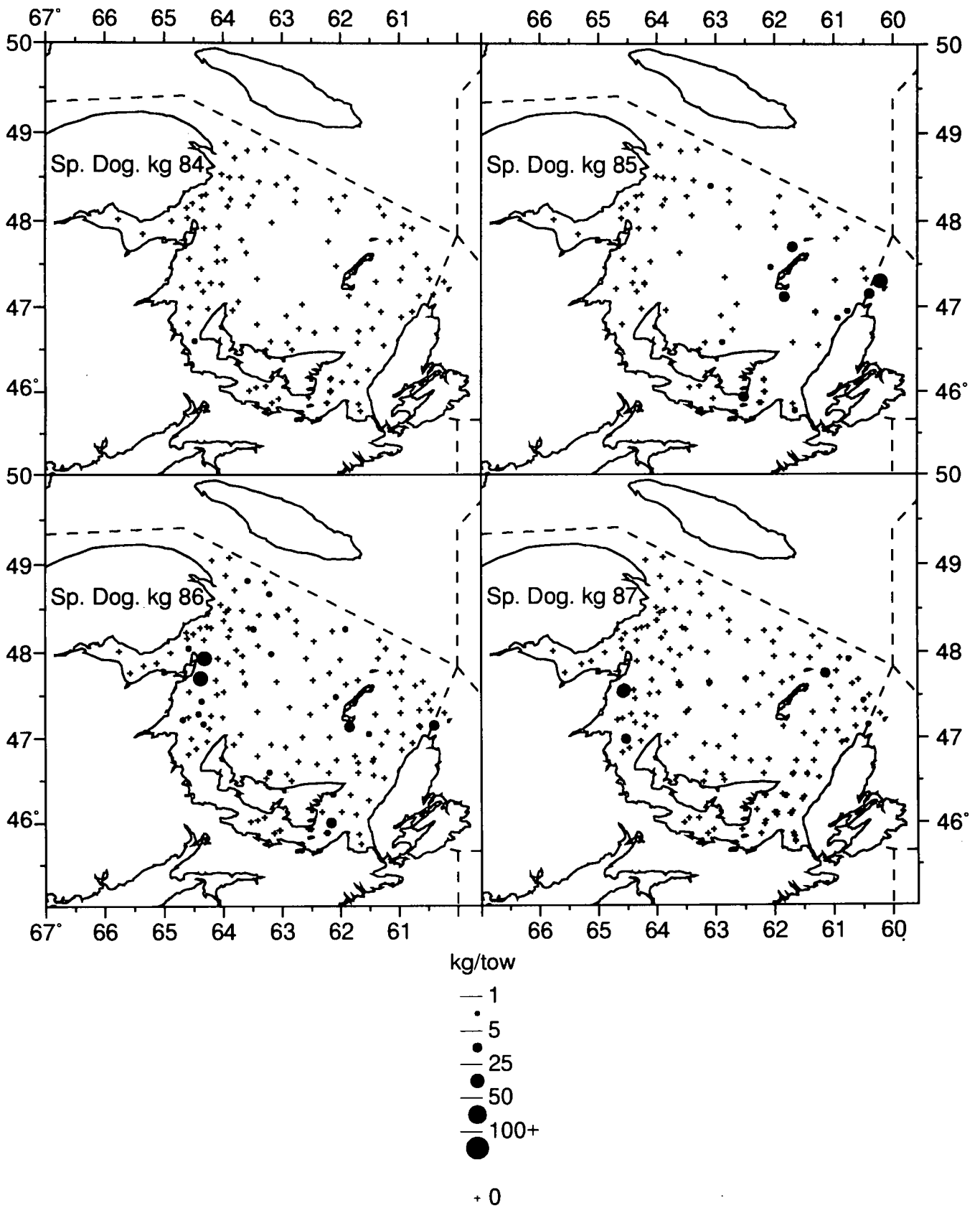


Figure 9. Distribution of catches (kg/standard tow) of spiny dogfish during annual (September) groundfish surveys of the southern Gulf of St. Lawrence (NAFO Div. 4T) from 1984 - 1994.

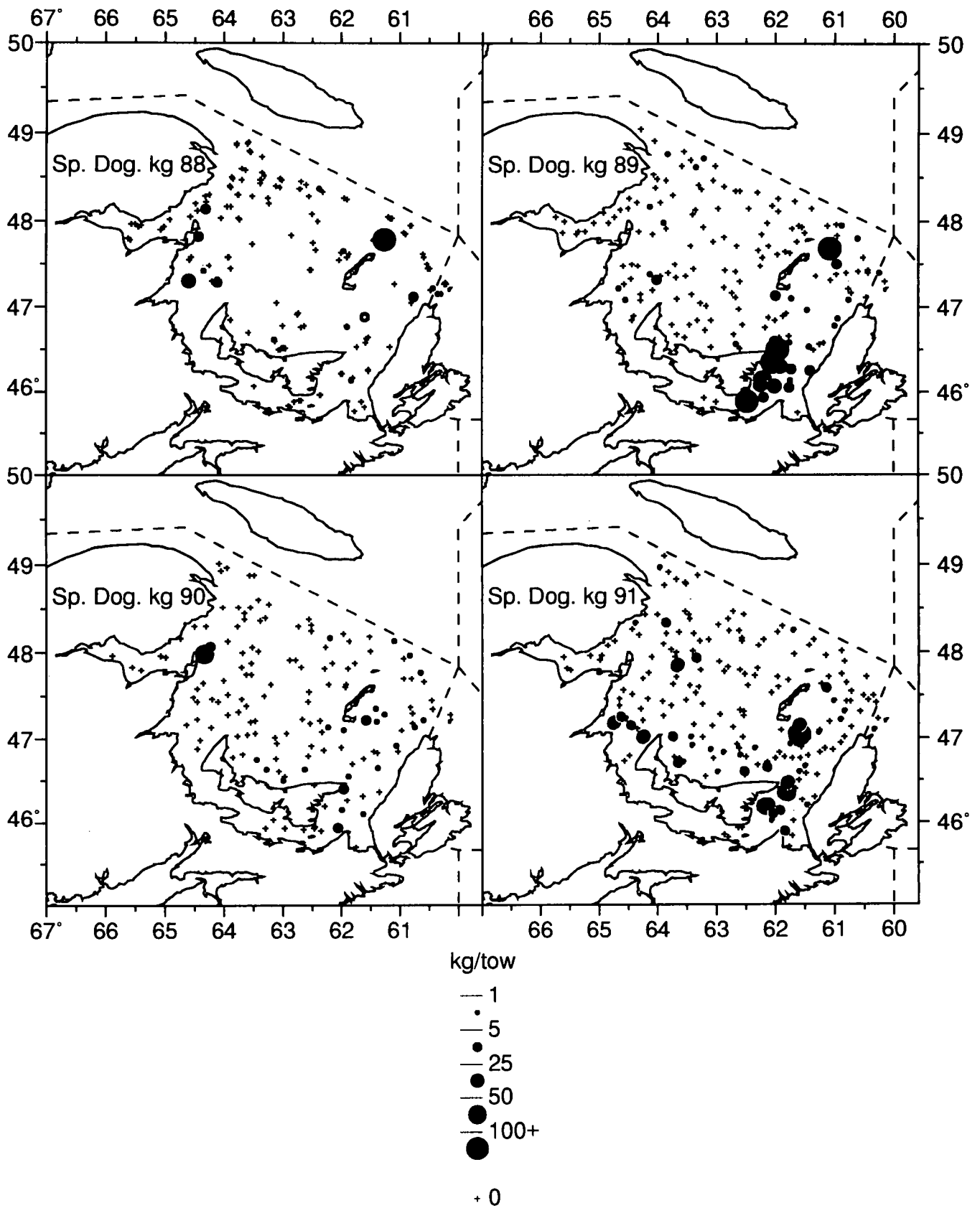


Figure 9. Distribution of catches of spiny dogfish - Continued.

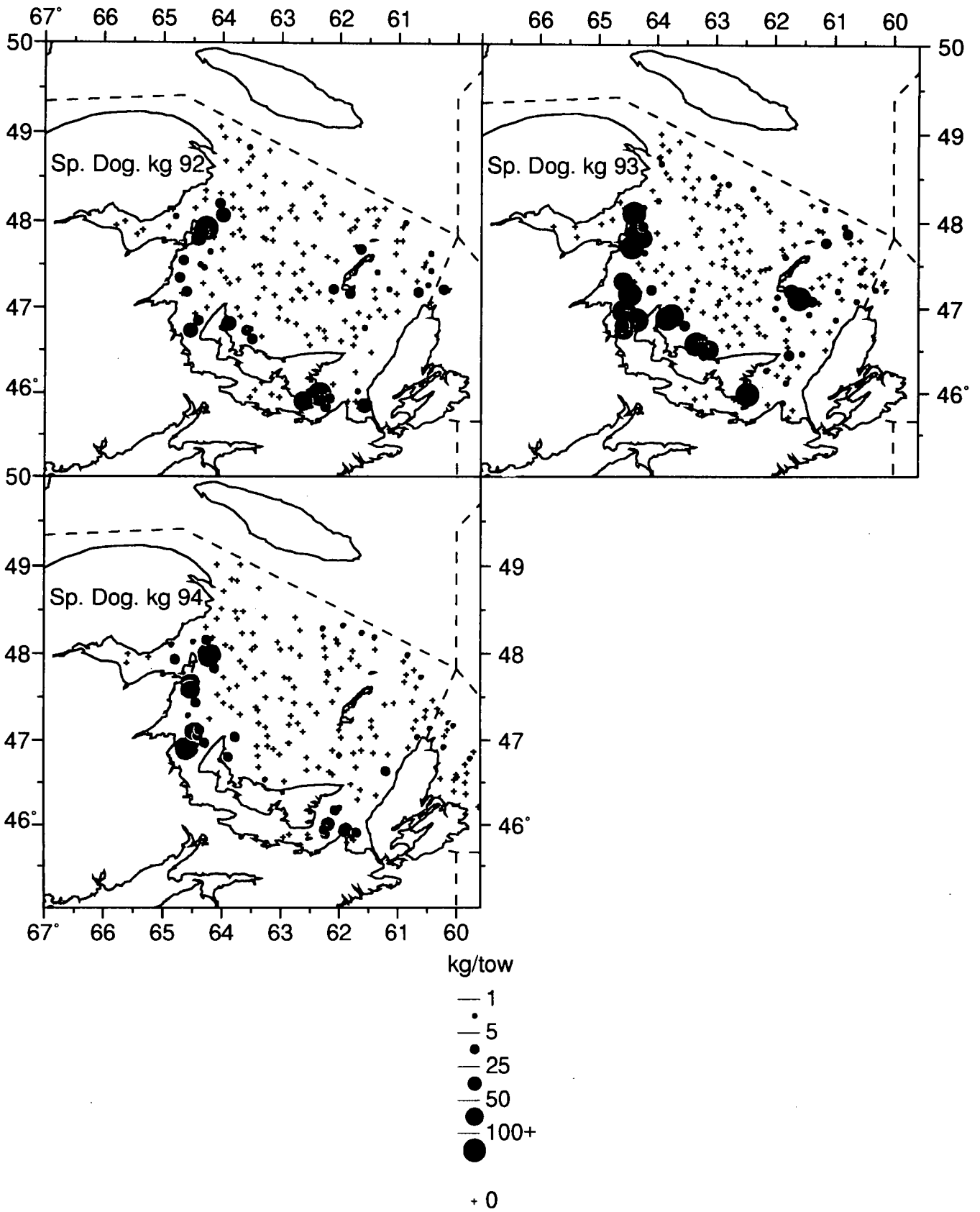


Figure 9. Distribution of catches of spiny dogfish - Continued.

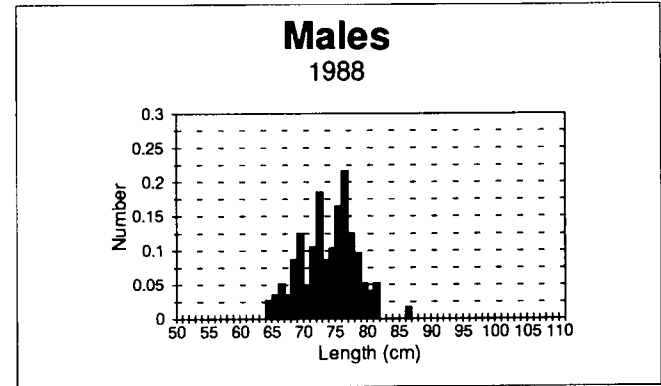
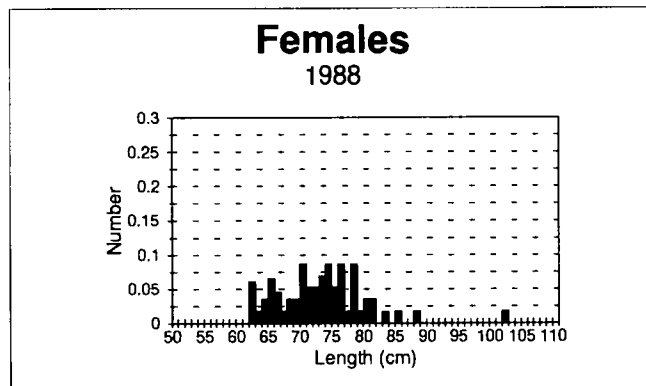
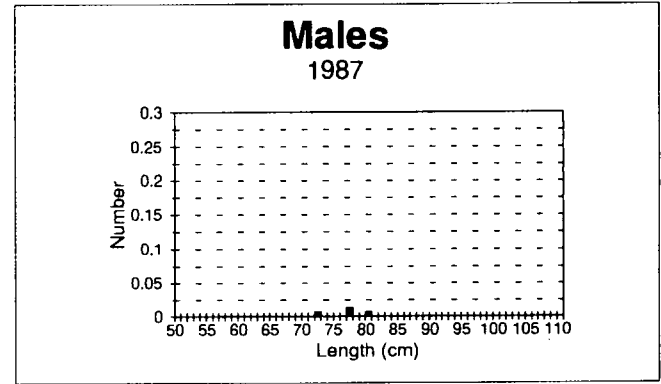
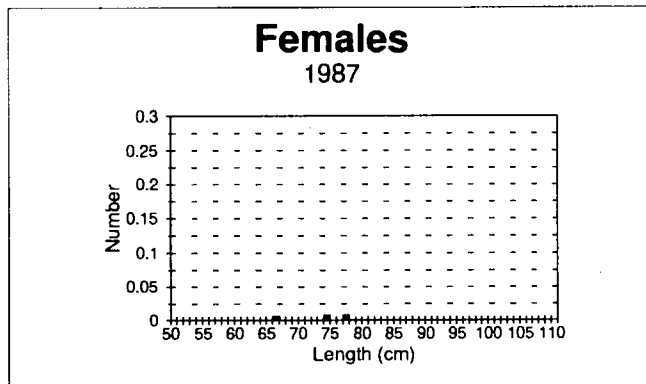
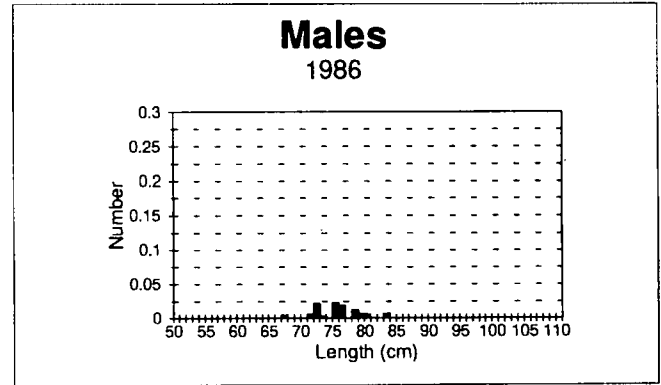
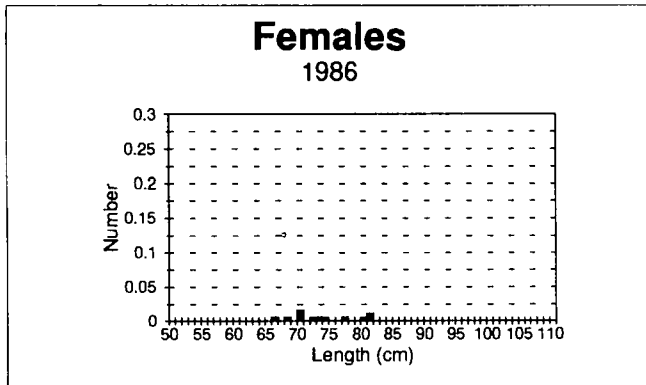
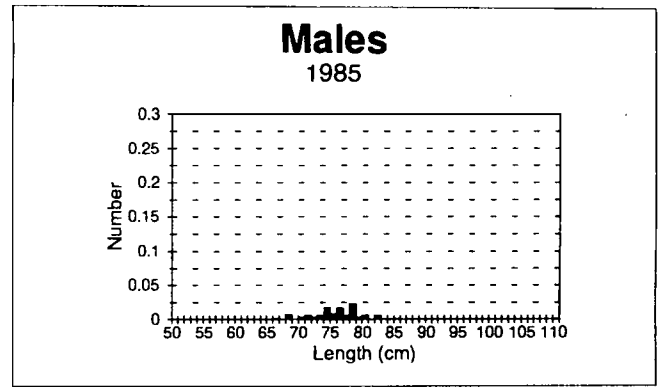
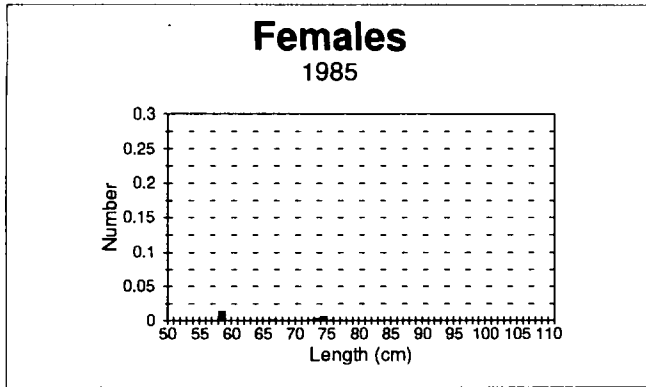


Figure 10. Mean length frequency distributions (sexes separated) for sexed catches of spiny dogfish from September groundfish surveys of the southern Gulf of St. Lawrence (Note: the difference in scaling of the Y-axis for 1989 and 1993).

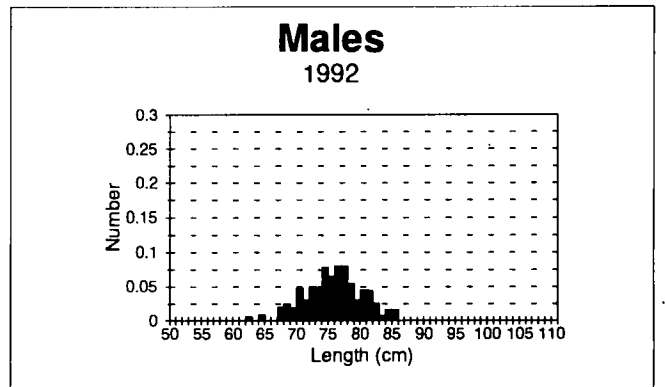
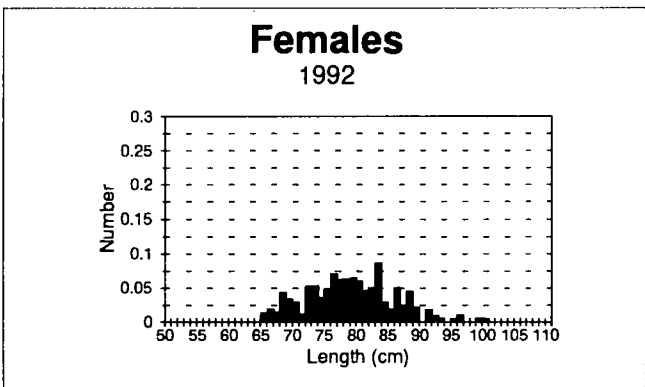
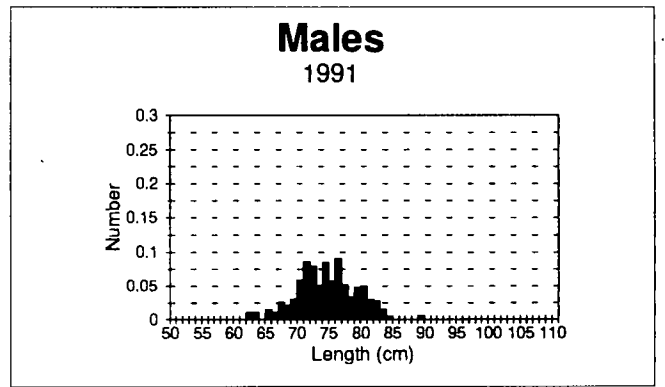
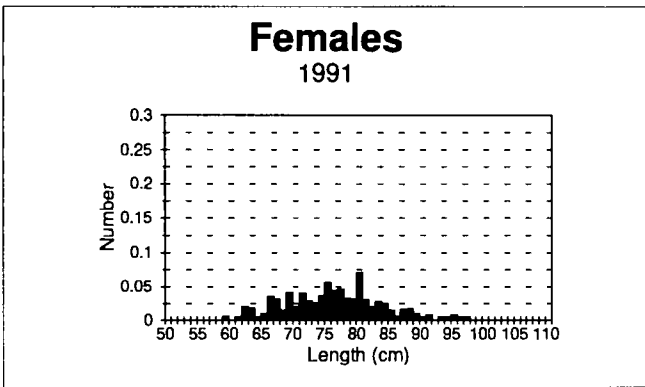
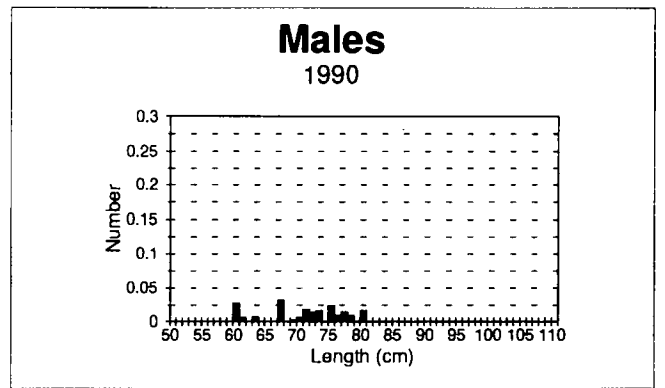
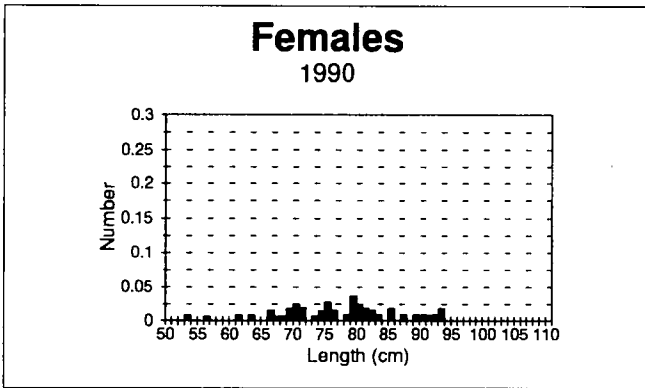
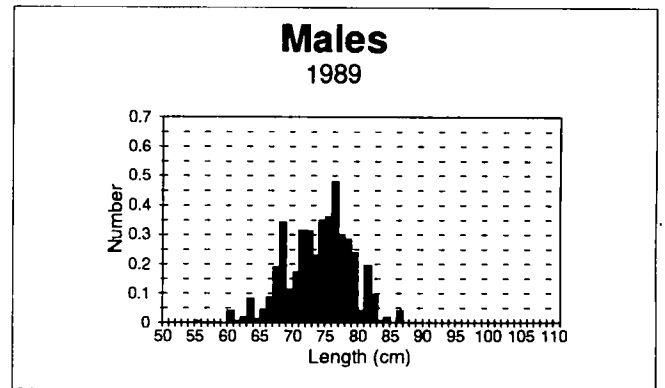
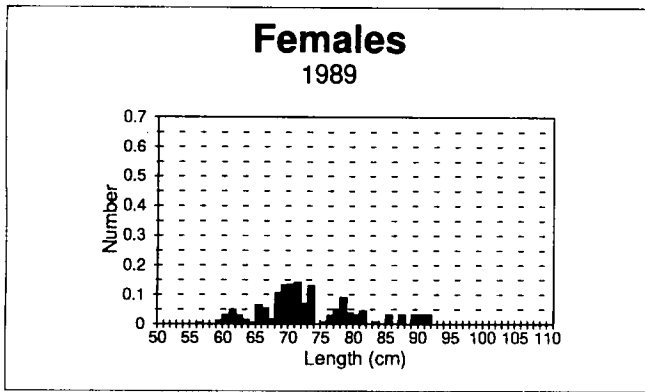


Figure 10. Research vessel length frequency distributions - Continued.
 (Note: the difference in scaling of the Y-axis for 1989 and 1993).

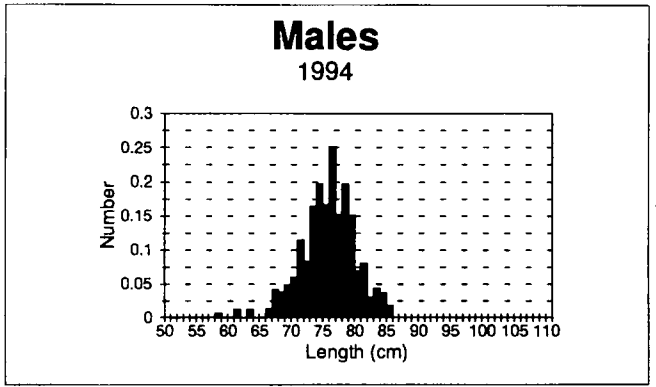
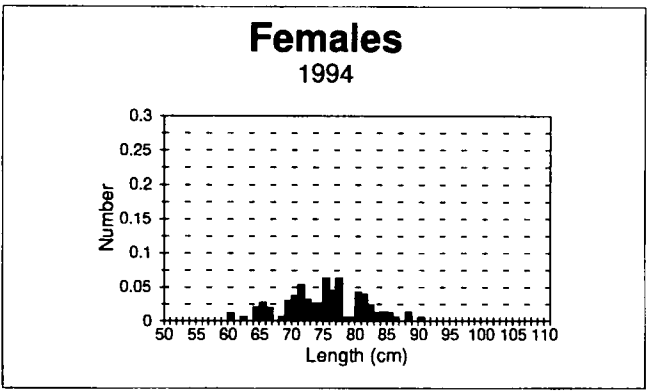
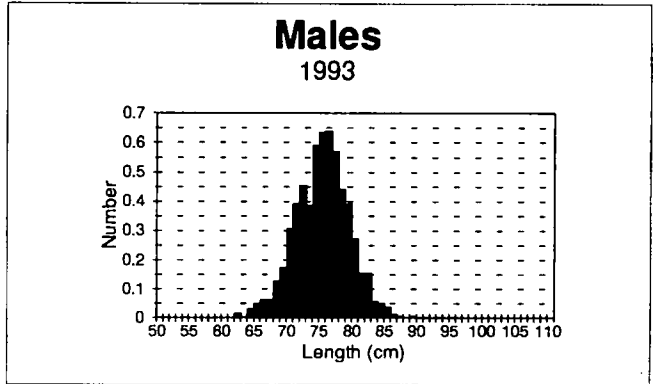
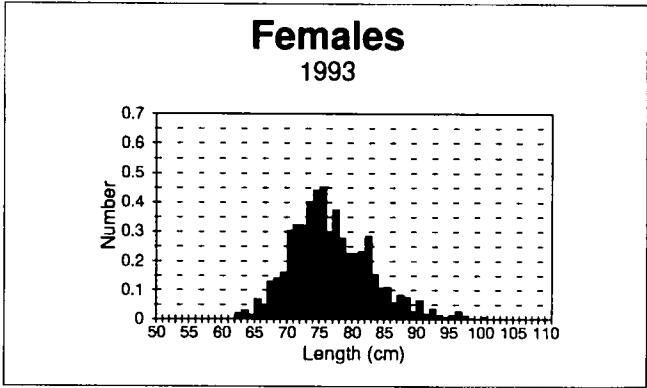


Figure 10. Research vessel length frequency distributions - Continued.
(Note: the difference in scaling of the Y-axis for 1989 and 1993).

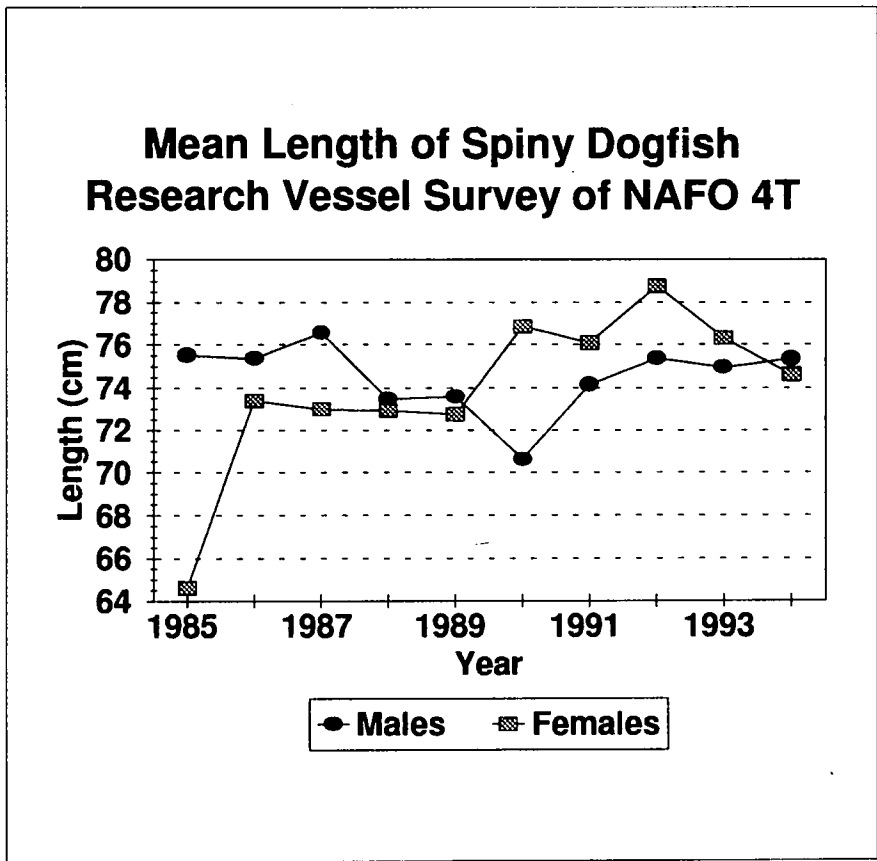


Figure 11. Research Vessel estimates of the population mean length for male and female spiny dogfish in NAFO Div. 4T.

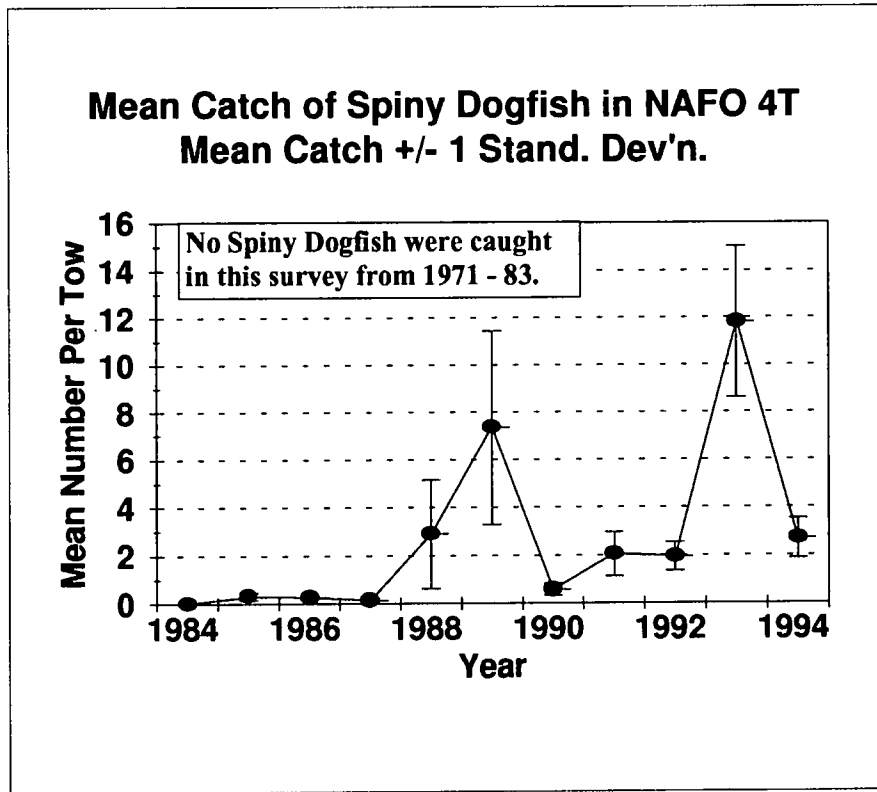


Figure 12. Research vessel mean number per tow for spiny dogfish in NAFO Div. 4T.

Research Vessel Index for S. Dogfish NAFO Div. 4T

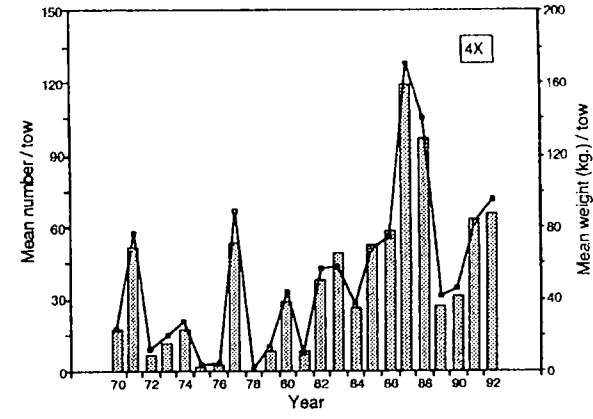
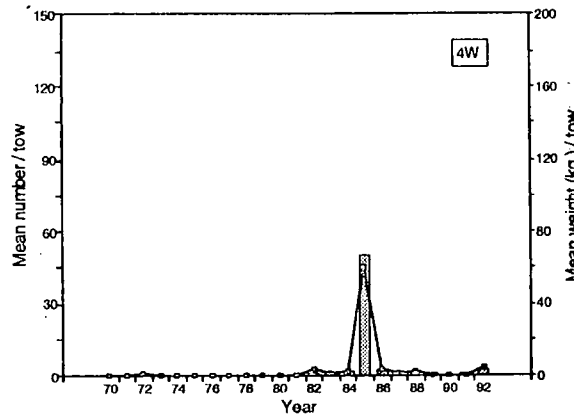
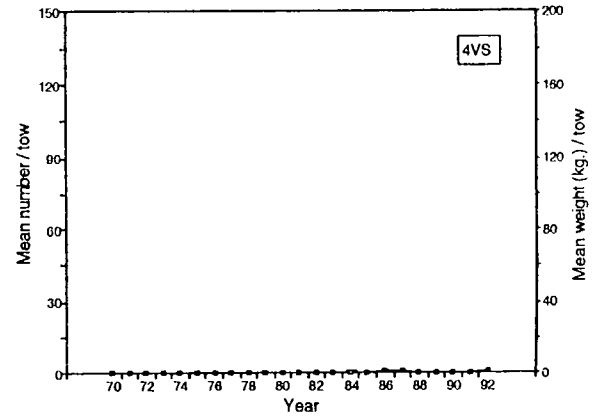
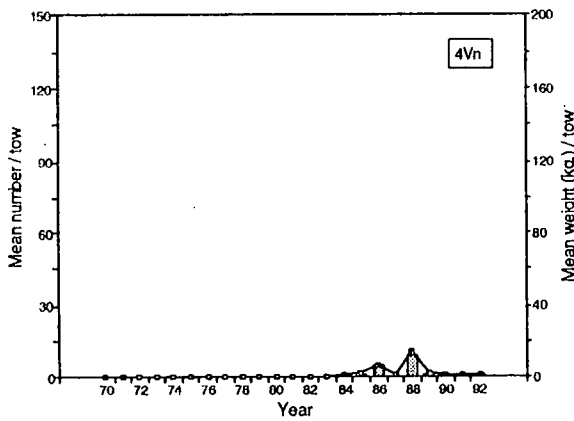
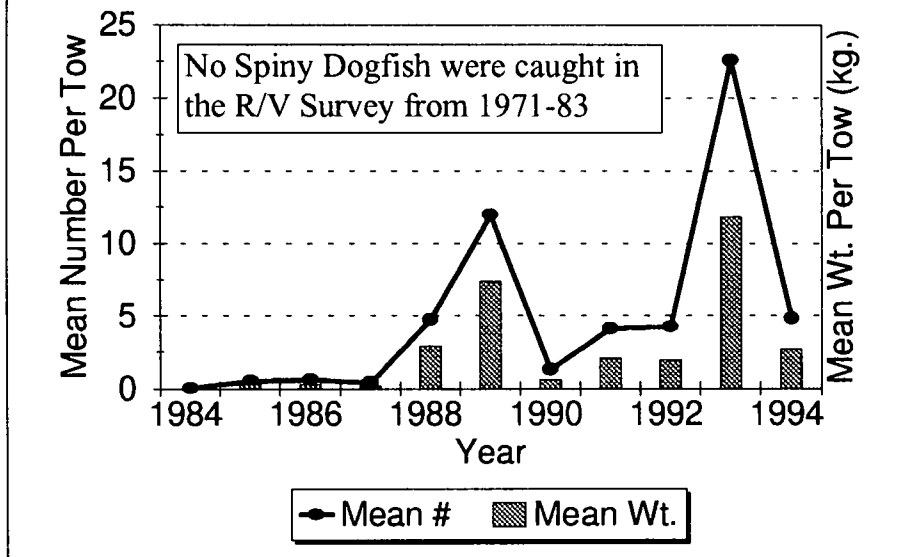


Figure 13. Comparison of the research vessel mean number and mean weight per tow for spiny dogfish in NAFO 4T, 4Vn, 4Vs, 4W and 4X. (Note: Data for research surveys of the Scotian Shelf are from Simon and Comeau (1994)).

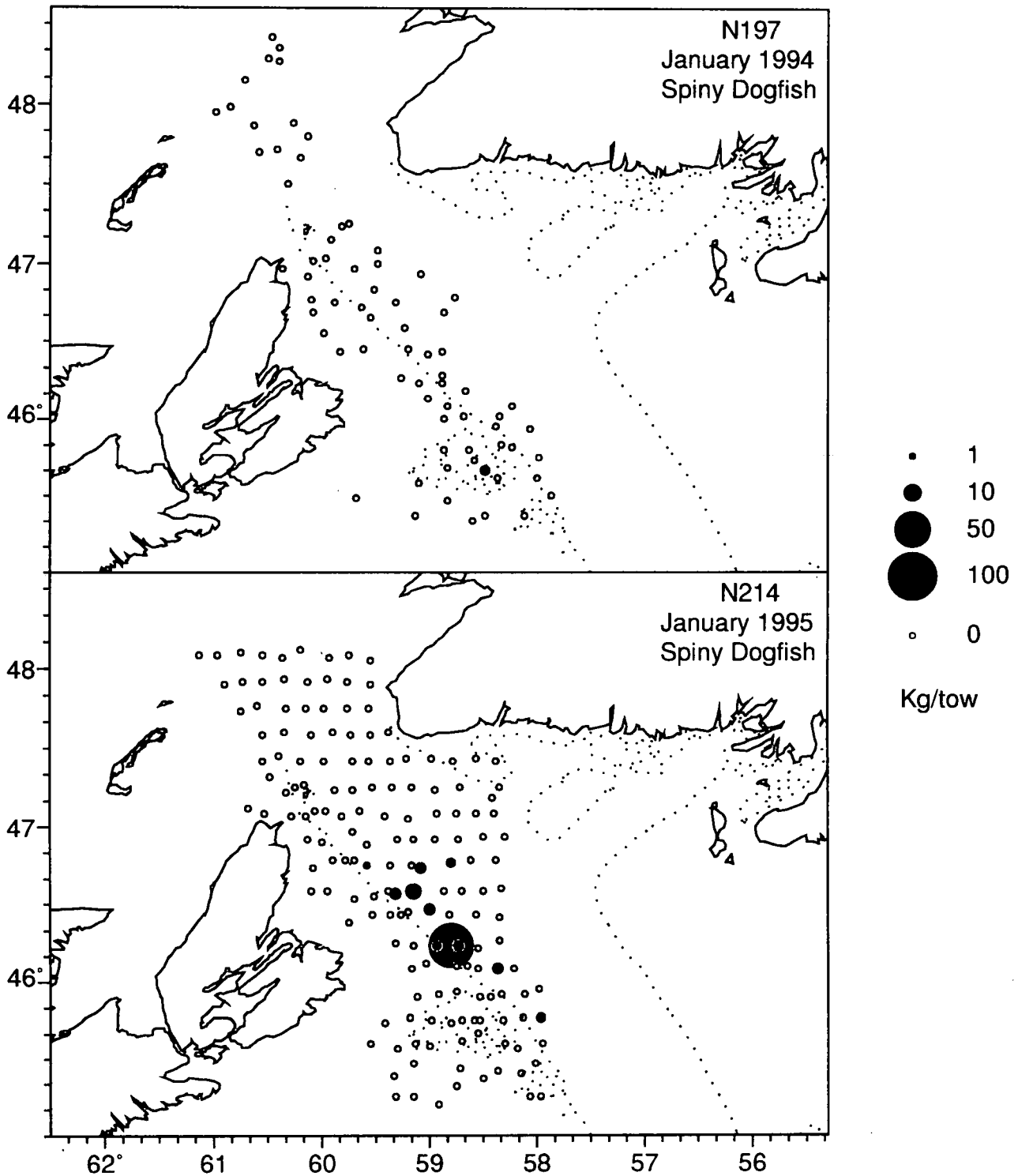


Figure 14. Distribution of catches (kg/standard tow) of spiny dogfish during the January 1994 and 1995 groundfish surveys of the Cabot Strait area (open circles indicate set locations and the dotted lines represent the 200 m depth contour).

19 - Appendices

Appendix 1

Gulf Region Science Workshops

Personnel from the Dept. of Fisheries and Oceans, Science Branch, Gulf Region presented an overview of the data on the groundfish stocks of the southern Gulf of St. Lawrence collected during 1994 including a summary of catches and the preliminary results of the September groundfish survey. The objective of the meetings was to obtain views from fishermen and fishing industry on the status of the various groundfish stocks. The following represents a summary of the main points made during the five workshops regarding spiny dogfish.

Minutes

Science Workshop

Centre Spécialisé des Pêches, Grande-Rivière, Québec
November 15, 1994

Spiny Dogfish

- abundance of dogfish has been high since the mid to late 1980's
- abundance of dogfish was high during the summer but decreased during September
- dogfish are found in shallow waters near herring spawning beds
- a fisher reported that dogfish had been abundant in the late 1940's and early 1950's in the area but then disappeared around 1954/1955. He wondered about the effect of the Canso Causeway
- because dogfish is a migratory stock, an agreement should be worked out with the U.S. for its management
- fishermen request more information on dogfish
- an exploratory fishery took place along the Gaspé coast during 1994
- it was reported that a study of the diet of dogfish had been commissioned by the Regroupement des pêcheurs professionnels du sud de la Gaspésie. About 400 dogfish had been examined. Some of the prey species included squid, crab, lobster, cod and herring. A report is in preparation.

Minutes

Science Workshop

Centre Marin, Shippagan, N.B.
November 16, 1994

Spiny Dogfish

- Some fishermen felt that there were more dogfish than indicated by the research survey.
- It was noted that a large concentration of dogfish occurred in the Bay of Fundy during the 1980's. Has this concentration moved into the Gulf of St. Lawrence?
- One fisherman noted that dogfish were abundant in the Gulf in 1958-1959.

Minutes

Science Workshop

Wandlynn Inn, Charlottetown, P.E.I.
November 23, 1994

Spiny Dogfish

- Dogfish were driving fishermen off of hake grounds
- Some feel dogfish have driven hake and perhaps plaice out of the western Gulf
- Some feel dogfish are being wiped out in N.S. waters - the last time dogfish collapsed was due to the massive fishery in US waters.
- Many dogfish were inshore (herring nets)

- There were lots of dogfish along north coast of P.E.I. (70 to 130 feet deep) during Sept/Oct.

Minutes

Science Workshop

Chéticamp Fire Hall, Chéticamp, N.S.

November 24, 1994

Spiny Dogfish

- Dogfish were late arriving in Gulf and are still present (i.e., Nov. 1994)
- Dogfish appeared in the commercial fishery the same year that they showed up in the groundfish survey (i.e., 1984)

Minutes

Science Workshop

Château Madelinot, Cap-aux-Meules, Magdalen Islands

November 28, 1994

Spiny Dogfish

- There were large concentrations of dogfish around the Magdalens in the mid 1980's. The highest abundance was in 1985-86
- Abundance has declined since 1990
- Dogfish may be found in the area until early November
- Many dogfish caught in gillnets have hook scars in their mouths