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Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2009/051 | **Document de recherche 2009/051**

Review of the St. Mary's Bay Longhorn Sculpin Fishery

Examen de la pêche du chaboisseau à dix-huit épines dans la baie St. Mary's

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ISSN 1499-3848 (Printed / Imprimé)
ISSN 1919-5044 (Online / En ligne)

Canada

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Correct citation for this publication:
La présente publication doit être citée comme suit :

Comeau, P.A., M.J. Tremblay, S. Campana, G. Young, C. Frail, and S. Rowe. Review of the St. Mary's Bay Longhorn Sculpin Fishery. 2009. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/051. vi + 75 p.

ABSTRACT

A directed fishery for longhorn sculpin in St. Mary's Bay (Nova Scotia) began in 1999 and was stopped after the 2006 fishery pending review. The fishery takes place over a 6 week period in April-May, and is limited to 4 license holders. Observer coverage is required and has varied by year from 25% to 100% coverage. While fishing for sculpin, vessels are permitted to use a 90mm diamond mesh codend. Average annual landings in the directed sculpin fishery are 98t, with a high of 152t in 2001 and a low of 52t in 2004. Commercial catch rates showed a decline after the first 2 years, but have remained relatively stable since 2001. Catch rates from the Department Fisheries Oceans (DFO) research vessel (RV) survey increased from the late 1970s to 1993, and have since declined. The industry run Individual Transferable Quota (ITQ) survey shows catch rates consistent with the RV survey. The abundance of mature (>23cm) longhorn sculpin have declined in the directed fishery. The neighbouring RV survey stratum has shown a decline in mean length of sculpin. Exploitation rate estimates were calculated using several estimates of population abundance. Although a precise estimate of the exploitation rate was not available, the within-season exploitation rate of sculpin in St. Mary's Bay is thought to be substantial. There is insufficient information to determine if the high exploitation rate is sustainable. At-sea observers provided estimates of by-catch within the directed sculpin fishery. The most abundant by-catch species caught in the directed sculpin fishery from 1999-2006 were lobster, winter flounder, crabs, and sea raven. Although lobster by-catch is high all animals are released and less than 1% were reported to be damaged or dead. The habitat where the directed sculpin fishery takes place is an area that is highly energetic and of low bottom complexity. As a result, the impact of the sculpin fishery on the sea floor is expected to be low.

RÉSUMÉ

La pêche dirigée du chaboisseau à dix-huit épines dans la baie St. Mary's en Nouvelle-Écosse a commencé en 1999 avant d'être interrompue après la saison de 2006 en attendant la réalisation d'un examen. Cette pêche, qui se déroule sur une période de six semaines en avril et en mai, est limitée à quatre titulaires de permis. La présence d'observateurs est exigée, mais elle varie de 25 % à 100 % des sorties selon les années. Quand les navires pêchent le chaboisseau, ils ont le droit d'utiliser un cul-de-chalut à mailles en losange de 90 mm. Dans le cadre de la pêche dirigée, les débarquements annuels moyens de chaboisseau sont de 98 tonnes, mais ils ont atteint un sommet de 152 tonnes en 2001 et un creux de 52 tonnes en 2004. Même si les taux de prises commerciales ont diminué après les deux premières années, ils sont restés relativement stables depuis 2001. Selon le relevé du navire de recherche du ministère des Pêches et Océans (MPO), les taux de prises ont augmenté de la fin des années 1970 à 1993, puis diminué. Dans le relevé des quotas individuels transférables (QIT) établi par l'industrie, les taux de prises correspondent à ceux qui sont observés par le navire de recherche. L'abondance des chaboisseaux matures (> 23 cm) dans la pêche dirigée a diminué. La strate voisine du relevé exécuté par le navire de recherche a révélé une diminution de la longueur moyenne du chaboisseau. On a calculé le taux d'exploitation à l'aide de plusieurs estimations de l'abondance de la population. Même si on ne dispose pas d'estimations précises de ce taux, il semble que le taux d'exploitation du chaboisseau dans la baie St. Mary's pendant la saison soit substantiel. Faute d'information suffisante, il n'est pas possible de déterminer si ce taux d'exploitation élevé est viable. Les observateurs en mer estiment également les prises accessoires dans la zone de pêche dirigée du chaboisseau. De 1999 à 2006, les espèces les plus abondamment capturées à titre de prises accessoires dans cette zone ont été le homard, la plie rouge, les crabes et l'hémitriptère atlantique. Les prises accessoires de homard sont nombreuses, mais tous les homards sont remis à l'eau et, selon les indications, moins de 1 % subissent des dommages ou meurent. L'habitat où se déroule la pêche dirigée du chaboisseau est un secteur caractérisé par une grande énergie et par un substrat peu complexe. En conséquence, l'incidence de la pêche du chaboisseau sur le plancher océanique devrait être faible.

INTRODUCTION

A directed fishery for longhorn sculpin in St. Mary's Bay (Nova Scotia) began in 1999. The fishery was undertaken by the mobile gear less than 65' (MG<65') Generalist Fleet. These vessels were permitted to direct for longhorn sculpin in St. Mary's Bay using 90mm diamond mesh otter trawls. Vessels were required to carry observers while using the small mesh gear. Observer coverage varied from 100% in the early years to roughly 25-50% coverage through 2003-2006.

Annual sculpin landings have ranged from a low of 50t to a high of just over 150t; sculpin is used as bait in the lobster fishery. The directed fishery is limited to the months of April and May. Vessels are restricted to fishing between 0600h and 1800h. The high level of observer coverage in this fishery is the result of concerns over lobster by-catch.

LONGHORN SCULPIN BIOLOGY

The longhorn sculpin has a broad, blunt head with many spines that tapers posteriorly to a slender caudal peduncle. It is named for its long upper pre-opercular spine. It has 2 dorsal fins, the first comprised of 7-10 spines and the second of 15-17 soft rays. The large pectoral fins have 16-19 soft rays, while the pelvic fins have 1 spine and 3-4 soft rays. The colour of the longhorn sculpin is variable, ranging from pale greenish yellow to dark olive above and white below. The fins and upper parts of the fish are marked with irregular bars or blotches (Scott and Scott, 1988).

Longhorn sculpin is a bottom dwelling fish and, in the western Atlantic, it is distributed from the Strait of Bell Isle off Newfoundland to the coastal waters off Virginia (Figure 1). They are found in shoals and estuaries down to a depth of 192m (Collette and Klein-MacPhee, 2002). On the Scotian Shelf, their preferred depth range is 50-90m (Scott, 1982). Simon and Campana (1987) found a large abundance of longhorn sculpin in St. Mary's Bay while conducting a bottom trawl survey of nearshore waters from Scot's Bay to Lockporte.

Longhorn sculpin can reach a length of 46cm; however, they rarely grow larger than about 35cm (Scott and Scott, 1988). Little work has been conducted on age and growth of this species. However, in southern New England waters, they have been observed to be 5.5cm at age 1, 18cm at age 2, 21cm at age 3, 25cm at age 4, 27cm at age 5, and 30cm at age 6 (Collette and Klein-MacPhee, 2002).

The exact timing of spawning is not well understood. Larval longhorn sculpin were found in plankton collections made on the western Scotian Shelf in March through May during the Fisheries Ecology Program (FEP) which took place 1983-1985 (Figure 2). However, in southern New England, spawning takes place from late November through January (Collette and Klein-MacPhee, 2002). Spawning times are speculated to be similar in the Gulf of Maine and Bay of Fundy. Spawning takes place inshore on rocky bottom (Scott and Scott, 1988) where the average female deposits around 8000 eggs (Collette and Klein-MacPhee, 2002). The eggs are demersal, adhesive, and deposited in clusters on sponges or cavities on hard bottom (Scott and Scott, 1988). On the Scotian Shelf, the larvae are present from March to May and the duration of larval drift is around 30 days. Beacham (1981) reported the size of 50% maturity to be 23cm for females and 24cm for males; all individuals larger than 30cm were mature.

In the Gulf of Maine, longhorn sculpin feed predominantly on crustaceans (82.4% by weight) and to a lesser extent on fish (10.5%) (Bowman et al., 2000). Hacunda (1981) found similar

results along the coast of Maine where the diet consisted of 63 prey taxa with crustaceans making up the most important group with 58.4% of the diet by weight and 95.8% of the diet by number.

Recent diet analysis on the Scotian Shelf shows that longhorn sculpin appear to be opportunistic feeders. Longhorn sculpin stomach contents collected in Stratum 490 (survey stratum adjacent to St. Mary's Bay) indicates that longhorn sculpin near St. Mary's Bay feed primarily on fish. More specifically, 50% of the diet (% weight) was composed of fish, 11% was shrimp, and 9% was crab. Of the fish that were identifiable, haddock (26%) and sand lance (14%) were the most abundant. Lobster were not observed in the stomach contents of longhorn sculpin sampled in Stratum 490; in fact, lobster only occurred in the diets of longhorn sculpin collected in the deep water west of German Bank, where it comprised 8% of the diet. In most other areas of the Gulf of Maine and the Scotian Shelf, sculpin were found to feed more extensively on invertebrates (Adam Cook, pers. comm.).

The opercular and pre-opercular spines of the longhorn sculpin are thought to limit predation on this species (Scott and Scott, 1988). However, longhorn sculpin have been detected as prey items for 10 fish species in the Gulf of Maine. The 8 most common predators are cod, spiny dogfish, winter skate, sea raven, little skate, monkfish, white hake, and other longhorn sculpin (Collette and Klein-MacPhee, 2002). They have also been detected as prey for cormorants (Scott and Scott, 1988).

Description of the Directed Fishery

Sculpin landings began showing up in the catch statistics in the early 1990s (Table 1), likely as a result of the introduction of dockside monitoring. The fishery at that time was a by-catch fishery mainly from the Bay of Fundy, Gulf of Maine, and Browns Bank area (Table 2, Figure 3). Landings were at low levels until the introduction of the directed fishery in St. Mary's Bay in 1999, at which point catches increased to fluctuate between 100t and 200t.

The directed fishery began in 1999 using MG<65' Generalist vessels. These vessels were permitted to direct for longhorn sculpin in St. Mary's Bay using 90mm diamond mesh otter trawls. Vessels were required to carry observers while directing for longhorn sculpin using the small mesh gear. This coverage varied from 100% in the early years to 25% to 50% coverage through 2003 - 2006.

Landings in the directed fishery ranged from 50 - 150t during the course of the fishery (Table 3, Figure 4). Based on reported catches from fishing logs, the fishery was mainly concentrated in the middle of St. Mary's Bay toward the western shore (Figure 5). Observer data shows a similar distribution of longhorn sculpin catches (Figure 6).

Abundance Indices

At present, there are no fishery-independent estimates of abundance for longhorn sculpin in St. Mary's Bay as no research surveys have been conducted in this area. However, there is information on fishery catch rates of longhorn sculpin, and some research survey information is available from the areas just outside of St. Mary's Bay.

Commercial catch rates of longhorn sculpin from the directed fishery peaked in 2000 and have remained relatively stable since 2002 (Figure 7).

The DFO summer research vessel (RV) survey covers NAFO Divisions 4VWX and has been conducted since 1970. The catch rate of longhorn sculpin from the 4X portion of the RV survey has been low but relatively stable since 1970; however, the catch rate from Stratum 490 of the RV survey increased from the late 1970s to 1993, and then subsequently declined (Figure 8).

Since 1996, the Individual Transferable Quota (ITQ) fleet has been conducting a fixed station bottom trawl survey of 4X. The ITQ survey is a much shorter time series, but it extends further inshore towards St. Mary's Bay. Longhorn sculpin catch rates in the ITQ survey (Table 4, Figure 8) are generally consistent with those observed in the RV survey.

Distribution

The longhorn sculpin distribution as indicated by the DFO summer RV survey is presented in Figure 9. The survey shows concentrations of longhorn sculpin in the Bay of Fundy, Gulf of Maine, Browns Bank, and Banquereau Bank areas. In the Bay of Fundy, the RV survey does not cover St. Mary's Bay. Figure 10 shows the longhorn sculpin catches in the survey from the Bay of Fundy and Gulf of Maine areas. The survey shows a reduction in longhorn sculpin catches in the inshore area off southern Nova Scotia.

The distribution of longhorn sculpin as indicated by the ITQ survey is presented in Figure 11. This survey shows a similar distribution to the DFO RV survey with longhorn sculpin mainly being found in the Bay of Fundy, Gulf of Maine, and Browns Bank. This survey has coverage inshore of the area covered by the DFO survey and shows that longhorn sculpin are also found on German Bank. The Trinity/Lurcher area near the mouth of St. Mary's Bay does not appear to be an important area for longhorn sculpin.

Size Composition

During the fishery, at-sea observers collected length frequency data on longhorn sculpin (Table 5) and winter flounder (Table 6). The mean length of sculpin in the directed fishery has declined. The proportion of the longhorn sculpin greater than 23cm (size of 50% maturity) in the commercial catches has declined slightly since 2002 (Figure 12, Figure 13). The length distribution of winter flounder is showing an increase in smaller animals in 2005 and 2006 (Figure 14).

Longhorn sculpin length frequencies from the DFO summer RV survey show little variation through the course of the survey time series (Table 7). The longhorn sculpin length frequencies show that the majority of sculpin captured in the 4X portion of the survey are between 20 and 30cm (Figure 15). Since the mid-1980s, the frequency distribution has remained relatively stable. In Stratum 490 of the summer RV survey, the length frequency distribution shows a similar size range to that of 4X as a whole (Table 8, Figure 16). However, due to smaller numbers of fish being captured, there are some years where there are gaps in the length frequency. For years when the survey caught large numbers of sculpin in this stratum, the length frequency distribution is similar to 4X as a whole, but has a slightly smaller mean length (Figure 17).

Exploitation Rate

Since neither the summer RV survey nor ITQ survey cover the area in St. Mary's Bay, absolute biomass in the fished area of St. Mary's Bay was approximated using the number of trawlable units (10147), a literature based estimate of sculpin catchability (Harley et al., 2001), several

sources of catch rate (mean commercial catch rate, nearshore survey catch rate (Simon and Campana, 1987), and RV survey catch rates in adjacent areas).

The resulting biomass estimates (Table 9) in some cases were less than the annual sculpin catch. This suggests that there has been a change in abundance since the mid 1980s, which makes the use of the Hart survey abundance inappropriate, that the RV survey Stratum 490 is not a good proxy for abundance in St. Mary's Bay, true catchability was less than estimated, or all factors may be contributing to the unrealistic estimates of exploitation rate.

Without a better estimate of absolute biomass, it is not possible to determine an accurate exploitation rate. However, it appears that the exploitation rate in this area is substantial.

By-catch

At-sea observers recorded a total of 63 species of fish and invertebrates caught in the directed fishery. The species by weight are presented in Table 10. Lobster was the most significant by-catch species by weight and was roughly 10% of the longhorn sculpin catch. By-catch of groundfish remained relatively unchanged for the first 6 years of the directed fishery; however, in 2005 and 2006, there was an increase in sea raven and little skate catches (Figure 18).

Table 11 presents the proportion of directed sculpin fishery sets that caught a particular species. Longhorn sculpin, winter flounder, and lobster were caught in the majority of all sets. Since 2003, sea raven and Jonah crab were captured in greater than 90% of all sets.

Table 12 presents the catches by species prorated to the reported landings. Because there was not 100% observer coverage in all years, the longhorn sculpin and by-catch was adjusted to the level of the reported landings.

The 3 main invertebrate species in the longhorn sculpin fishery were lobster, Jonah crab, and rock crab. Lobster was the largest component of this catch (Figure 19). Lobster catches have fluctuated but increased in both 2005 and 2006.

Catch rate in kilograms per hour are presented in Table 13. Longhorn sculpin catch rate was highest in 1999 and 2000, but has remained relatively stable since 2002 (Figure 7). Winter flounder catch rate had a large decline from 2000 to 2001; however, it has increased in recent years (Figure 20). The catch rate of sea raven has increased steadily of the course of the fishery (Figure 21). Ocean pout showed the largest decline in catch rate in the sculpin fishery and has remained at very low levels since the early part of the sculpin fishery (Figure 22). Lobster catch rate showed an increase over the course of the sculpin fishery (Figure 23).

Landings of Lobster in St. Mary's Bay by the Directed Lobster Fishery

Given its relatively small size, St. Mary's Bay is one of the more productive fishing areas for lobster in Atlantic Canada. Lobster landings by the Lobster Fishing Area (LFA) 34 lobster fishery are reported on the basis of 10 minute by 10 minute grids (Figure 24). The grids within St. Mary's Bay number 69 (inner), 81 (middle), and 92 (outer). From 1999 to 2006, landings in these 3 grids comprised an average of 1180t (Table 14 of landings). This is comparable to or greater than several LFAs outside of LFA 34. As a percentage of total lobster landings by the LFA 34 fishery, these 3 grids comprised 6-7%. Grid 81 is where most of the sculpin fishery occurred in St. Mary's Bay. The average annual landings for grid 81 for 1999-2006 was 203t.

The seasonal distribution of landings in St. Mary's Bay is characterized by a peak in the first month of the fishing season (late November-December) (Figure 25). Monthly landings then decrease from January-February, pick up again in March-April, and reach a secondary peak in May. This seasonal pattern in landings is most common throughout LFA 34.

Description of the Area of St. Mary's Bay where the Sculpin Fishery has Occurred

Sculpin fishing occurs primarily at depths of 10 to 35 m (Figure 26).

Underwater video surveys for lobster in late summer-early fall in St. Mary's Bay provide some information on the bottom type and species encountered. The URCHIN underwater video system (Strong and Lawton, 2004; Tremblay et al., 2005) was used to conduct 62 video transects from September 21-October 4, 2006, and 50 video transects from September 10-19, 2007. Many of these transects were within the area where the sculpin fishery has occurred (Figure 27).

During the video transects, the bottom type was noted as mud, sand, gravel, cobble, boulder, or combinations of these sediment types. A summary of the bottom types noted during the transects is shown in Figure 28. Within the area where the sculpin fishery occurred, the bottom can be characterized as primarily sand, mud, gravel, and shell hash. Outside of the area of sculpin fishing, the bottom type was as above, but with the addition of more rough bottom (cobble and boulder with kelp). The distribution of areas with rough bottom is corroborated by an OLEX generated map of bottom bathymetry (Figure 29).

During the video transects, lobsters and crabs were quantified; for other groups, only presence/absence was noted. Within the area of fishing, lobsters (Figure 30) and crabs (Figure 31) (rock and Jonah were not distinguished on the video) were observed in some abundance. Other invertebrate groups seen were bivalves (mainly scallops but also other species including quahogs and razor clams), starfish, and moon snails. Quahogs are known to occur in the area in potentially harvestable quantities (Rowell and Chaisson, 1983). With regard to the fish observed in the video, flatfish and sculpins were observed but many moved quickly, and were largely unidentified.

To summarize, within the area of sculpin fishing, the bottom type is predominantly low complexity. A variety of taxa were found on this bottom type. Video recordings to date cannot be used to evaluate the presence of infauna. In fall, lobsters were fairly abundant (up to 7-8 per 100 m^2) in the area of sculpin fishing. Crabs (rock and Jonah) were also present and abundant at times.

Potential Impacts of Trawling for Sculpins

The potential effects of trawling on a few key species were considered, as well as the effects on bottom structure and biological communities.

Trawling for sculpins occurs in an area where lobsters and crabs can be caught in substantial numbers. Lobsters are caught as a by-catch in the sculpin fishery, are caught by the directed lobster fishery in the area, and are evident in underwater videos in late summer. Of the lobsters that were captured while directing for sculpin, observer reports indicate <1% were damaged or dead. Of those lobsters and other species that are trawled up and then returned to the bottom, it is not known whether any sub-lethal injuries impaired reproduction, growth, or survival. In addition, the level of injuries that may occur to lobsters and other species while the trawl is towed across the bottom is not known.

With regard to the larger question of ecosystem impacts, there are no available studies of the effects of trawling in St. Mary's Bay. A national meeting provided a review and advice on the effects of trawl gears and dredges (DFO, 2006). Experts prepared an overview working paper that reviewed and consolidated the results of 5 major international reviews or symposia, and several additional working papers that considered results of regional studies of these impacts in Canada. These papers were subjected to peer review at a national advisory meeting in March 2006. This peer review included participants from the fishing industry and conservation organizations, as well as experts from the university community.

In all, there were 24 conclusions in the report. The major conclusion was as follows:

1. Mobile bottom-contact fishing gears do have impacts on benthic populations, communities, and habitats. The effects are not uniform, however, but depend on at least:

    a. the specific features of the seafloor habitats, including the natural disturbance regime;

    b. the species present;

    c. the type of gear used, the methods and timing of deployment of the gear, and the frequency with which a site is impacted by specific gears; and

    d. the history of human activities, especially past fishing, in the area of concern. " (DFO, 2006).

Subsequent conclusions were listed under the following headings: Impacts of Bottom-Impacting Gears on Physical Features of the Seafloor; Impacts of Bottom-Impacting Gears on Benthic Populations and Communities; Considerations in the Application or Adoption of Measures to Reduce Impacts; and Management Tools Available for the Reduction of Impacts of Mobile Bottom-Contacting Gears.

The following conclusions are particularly relevant to sculpin fishing in St. Mary's Bay:

2. "The impacts of bottom trawl gears are initially greater on sandy and muddy bottoms than on hard, complex bottoms. However, the duration of impacts is usually greater on hard complex bottoms than on sandy bottoms and probably longer than on muddy bottoms.

    This set of comparative generalisations is for sites of comparable "energy", and may not hold, for example, when comparing potential impacts of a gear on a hard bottom in a high energy area (i.e. with frequent wave or current disturbance) to impacts of the same gear on a low energy sandy bottom (i.e. with extremely infrequent natural disturbances).

3. For a given type of habitat, mobile bottom-contacting gears have greatest impacts on low energy sites and least (often negligible) impact on high-energy sites. " (DFO, 2006)

The above conclusions suggest that where the fishery has occurred on the low complexity bottoms and high energy environments (currents generated by tides, wind and storms) of St. Mary's Bay, the physical effects on the bottom and the effects on communities should be low relative to other areas. Where the sculpin fishery trawls on harder, more complex bottom, a reduction of habitat by structural damage is expected.

Management tools to reduce the impact of bottom impact gear listed in DFO (2006) include (i) reduced effort; (ii) spatial management of effort to avoid vulnerable areas; (iii) closed areas; and (iv) gear modifications.

Sources of Uncertainty

There are a number of sources of uncertainty in the assessment of St. Mary's Bay longhorn sculpin:

- Population structure is unknown, including sources of recruits and the extent of movement among areas.
- There is no directed survey for sculpin and a fishery-independent abundance estimate is lacking.
- A reliable estimate of sculpin catchability is unavailable for use in estimating exploitation.
- Productivity, size at maturity, sustainable exploitation rate, and other reference points are all unknown.
- The by-catch of sculpin in other fisheries in St. Mary's Bay is unknown.
- The consequences of removals on ecosystem structure are unknown.

Conclusions

Based on observer reports, catch rates of longhorn sculpin within St. Mary's Bay declined in the first few years of the directed fishery but appear to have stabilized. The abundance of larger (>23cm) longhorn sculpin in the directed fishery has also declined, as has the mean length of sculpin from the RV survey in Stratum 490. The catch rates from Stratum 490 of the RV survey increased from the late 1970s to 1993, and then subsequently declined. The sculpin catch rates from the ITQ survey are generally consistent with those observed in the RV survey. Estimates of the within-season exploitation rate on sculpin in St. Mary's Bay are substantial (greater than 30%). There was insufficient information to determine if such an exploitation rate is sustainable. While local depletion is probably occurring within St. Mary's Bay and adjacent areas, there is no evidence that sculpin in other areas of 4VWX have been affected.

The most abundant by-catch species caught in the St. Mary's Bay sculpin fishery from 1999-2006 were lobster, winter flounder, crabs, and sea raven. Although lobster by-catch is high, all animals are released, and less than 1% have been reported as damaged or dead. There is poor understanding of any sub-lethal effects on lobsters after they are released.

The habitat over which the directed sculpin fishery takes place is highly energetic and of low bottom complexity. As a result, the impact of the sculpin fishery on the sea floor is expected to be low. Other bottom contacting fisheries occur in St. Mary's Bay, but the impact of those fisheries to benthic habitat has not been assessed.

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Table 1. Reported catch (t) of longhorn sculpin by NAFO Division.

YEAR	4V	4W	4X	5Y	5ZE	Total
1990			0.8			0.8
1991			13.8	0.0		13.8
1992		1.4	38.6			40.0
1993			17.5	0.3		17.8
1994			43.4	0.1		43.5
1995			34.0	0.2	0.0	34.2
1996	0.6	0.1	23.8	0.1	0.1	24.7
1997			18.3	0.0	0.9	19.2
1998		0.0	21.0	0.0		21.0
1999		0.0	82.8	0.0	1.3	84.1
2000			165.5	0.0	0.5	166.0
2001		0.2	172.9	0.1	4.2	177.4
2002		0.1	142.8	0.1	0.2	143.3
2003		0.1	121.5	0.7	0.0	122.3
2004		0.4	106.7	0.4	0.6	108.2
2005		0.1	181.3	0.7	1.6	183.6
2006	8.6	0.6	188.7	0.4	6.1	204.4
2007	3.5	0.1	140.9	0.3	1.5	146.3
2008[1]		0.1	55.2	0.3	1.3	56.9
Total	12.7	3.2	1569.5	3.7	18.3	1607.5

[1]2008 landings to May 21, 2008.

Table 2. Reported catch (t) of longhorn sculpin in NAFO Division 4X by Unit Area.

YEAR	4XM	4XN	4XO	4XP	4XQ	4XR	4XS	4XU	Total
1990								0.8	0.8
1991					0.0	7.6		6.2	13.8
1992		0.2			4.4	30.2	3.9		38.7
1993		0.0	1.0		1.5	14.0	0.8	0.2	17.5
1994			0.3		1.8	29.7	3.1	8.4	43.4
1995	0.0	0.3	2.1	0.1	2.7	24.1	4.6	0.2	34.0
1996	0.0	0.6	1.7	0.1	1.0	16.1	4.3	0.1	23.8
1997	0.4	0.1	0.9	0.1	1.8	12.7	2.2	0.1	18.3
1998	0.3	0.0	1.6	0.4	3.1	9.4	2.8	3.4	21.0
1999	0.3	0.6	3.9	0.1	7.4	55.6	1.0	13.9	82.8
2000	0.1	0.7	3.6	0.1	5.3	150.9	2.2	2.6	165.5
2001	0.3	0.2	3.6	0.4	7.0	157.3	2.1	2.1	172.9
2002	0.3	0.4	2.9	0.1	7.9	124.5	5.0	1.7	142.8
2003	0.7	0.6	4.4	0.1	6.7	95.4	12.7	1.0	121.5
2004	0.5	0.5	5.8	1.0	10.4	69.7	13.5	5.3	106.7
2005	1.2	0.3	15.1	0.4	12.8	125.6	23.8	2.0	181.3
2006	1.9	0.5	20.6	6.7	21.3	114.9	21.5	1.5	188.7
2007	2.0	0.7	31.9	2.4	11.2	71.1	19.4	2.2	140.9
2008	1.5	0.2	13.8	0.4	6.4	27.2	3.3	2.3	55.2
Total	9.5	5.9	113.1	12.5	112.6	1136.0	126.2	54.1	1569.7

Table 3. Reported catch (t) of longhorn sculpin in NAFO Unit Area 4Xr and the directed fishery.

YEAR	4XR	Directed Fishery
1990		
1991	7.6	
1992	30.2	
1993	14.0	
1994	29.7	
1995	24.1	
1996	16.1	
1997	12.7	
1998	9.4	
1999	55.6	61.6
2000	150.9	140.5
2001	157.3	151.5
2002	124.5	105.5
2003	95.4	77.6
2004	69.7	52.0
2005	125.6	94.6
2006	114.9	99.4
2007	71.1	
2008	27.2	
Total	1136.0	782.7

Table 4. Individual Transferable Quota (ITQ) survey mean weight (kg) per tow.

SPECIES	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Longhorn Sculpin	0.93	0.88	0.88	0.75	1.96	1.25	0.48	0.75	1.28	1.26	1.18
Winter Flounder	2.26	1.62	1.99	1.48	4.95	3.72	2.74	3.14	4.41	2.75	2.58
Dogfish	71.92	69.10	11.25	81.90	199.56	44.35	135.65	24.56	57.36	23.57	26.26
Sea Raven	0.55	0.26	0.57	0.29	0.34	0.61	1.03	1.14	1.32	0.81	0.62
Thorny Skate	0.32	0.48	0.32	0.64	0.60	0.69	0.42	0.51	0.79	0.22	0.67
Little Skate									0.02	0.14	0.19
Ocean Pout	0.39	0.14	0.04	0.07	0.09	0.04	0.16	0.22	0.24	0.13	0.14
Jonah Crab	0.00		0.01	0.01	0.04	0.02	0.05	0.02	0.02	0.01	0.01
Rock Crab					0.01		0.01	0.02	0.00	0.01	0.00
Lobster	1.09	0.88	1.22	1.04	4.16	2.65	3.16	5.31	3.42	5.65	4.32

Table 5. Sculpin catch at length ('000s of fish) in the directed fishery.

cm	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	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
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	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
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	0.2	189.4	0.1
12	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3
13	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.7
14	0.0	0.0	0.0	0.5	0.0	0.3	0.1	1.2
15	0.0	0.0	0.0	0.2	0.0	0.7	0.2	2.1
16	0.0	0.1	0.0	0.8	0.9	0.8	0.5	3.5
17	0.0	0.1	0.1	1.3	1.4	1.3	1.1	6.4
18	0.8	0.6	0.0	2.8	5.7	1.8	2.3	13.9
19	1.4	1.2	1.0	5.2	5.3	2.3	3.9	22.0
20	3.9	4.8	3.1	8.3	15.8	3.7	11.4	36.3
21	8.7	13.0	7.9	17.0	36.1	8.7	38.7	49.0
22	28.0	28.3	23.9	41.7	57.0	13.8	57.0	59.1
23	49.1	59.9	63.3	61.0	85.2	26.0	80.8	70.8
24	71.9	121.9	144.8	88.5	97.5	38.4	101.5	85.6
25	75.9	144.2	232.8	102.5	86.0	50.2	107.2	98.7
26	62.1	144.7	202.9	116.3	63.5	47.6	76.9	84.1
27	44.3	128.3	111.4	78.1	33.5	36.8	50.8	60.1
28	22.8	77.8	51.4	49.1	20.3	28.9	26.2	38.4
29	11.4	43.9	27.9	32.1	10.0	17.7	14.1	17.9
30	3.2	16.2	12.9	13.9	6.3	9.6	4.7	8.2
31	1.0	8.9	4.3	4.3	2.9	4.9	3.0	5.9
32	0.4	2.0	2.4	2.1	0.7	2.1	1.2	2.8
33	0.1	0.8	0.7	1.3	0.8	1.4	0.4	1.7
34	0.0	0.5	0.1	0.7	0.3	0.5	0.9	1.0
35	0.0	0.1	0.0	0.0	0.1	0.3	1.5	0.6
36	0.0	0.2	0.0	0.1	0.0	0.1	1.4	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
39	0.0	0.1	0.0	0.0	0.0	0.0	0.9	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Mean Length	24.9	25.7	25.5	25.2	24.1	25.5	21.3	24.1

Table 6. Winter flounder catch at length ('000s of fish) in the directed fishery.

cm	1999	2000	2001	2002	2003	2004	2005	2006
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.075
9	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.100
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.256
11	0.000	0.000	0.000	0.000	0.000	0.000	0.328	0.143
12	0.000	0.000	0.000	0.000	0.000	0.000	0.193	0.185
13	0.000	0.000	0.000	0.000	0.000	0.000	0.423	0.270
14	0.000	0.000	0.000	0.000	0.000	0.000	0.466	0.345
15	0.000	0.000	0.000	0.000	0.000	0.000	0.240	0.416
16	0.000	0.000	0.000	0.000	0.000	0.000	0.724	0.503
17	0.000	0.000	0.007	0.000	0.000	0.000	0.905	0.353
18	0.000	0.018	0.000	0.000	0.000	0.000	1.300	0.304
19	0.000	0.033	0.007	0.000	0.000	0.000	0.857	0.637
20	0.000	0.094	0.007	0.000	0.000	0.000	0.467	0.454
21	0.000	0.166	0.007	0.000	0.000	0.000	0.851	0.464
22	0.016	0.399	0.027	0.000	0.000	0.000	0.565	0.602
23	0.016	0.494	0.020	0.000	0.000	0.000	0.399	0.710
24	0.017	0.511	0.040	0.029	0.014	0.000	0.725	0.689
25	0.005	0.533	0.058	0.000	0.047	0.000	1.070	1.009
26	0.045	0.806	0.155	0.087	0.087	0.002	1.497	0.940
27	0.158	1.418	0.208	0.204	0.120	0.002	1.119	1.300
28	0.578	1.633	0.460	0.087	0.285	0.004	1.341	1.418
29	0.839	2.147	0.788	0.291	0.368	0.004	1.616	1.361
30	1.273	2.005	0.994	0.408	0.548	0.005	1.532	1.551
31	1.083	1.986	1.422	0.204	0.504	0.004	1.612	1.462
32	1.056	1.861	1.098	0.729	0.575	0.006	1.344	1.309
33	0.962	1.153	1.022	0.408	0.502	0.006	1.258	1.307
34	0.708	1.087	0.832	0.583	0.445	0.004	0.914	0.822
35	0.783	0.800	0.444	0.466	0.427	0.005	0.869	0.860
36	0.605	0.656	0.233	0.350	0.291	0.004	0.380	0.578
37	0.784	0.538	0.157	0.379	0.249	0.003	0.606	0.462
38	0.627	0.289	0.145	0.291	0.151	0.003	0.186	0.390
39	0.343	0.253	0.173	0.291	0.108	0.002	0.223	0.274
40	0.465	0.275	0.114	0.204	0.121	0.001	0.210	0.309
41	0.239	0.195	0.060	0.058	0.087	0.001	0.067	0.053
42	0.086	0.105	0.063	0.117	0.025	0.001	0.039	0.148
43	0.080	0.097	0.045	0.058	0.026	0.000	0.140	0.052
44	0.041	0.011	0.014	0.058	0.013	0.000	0.000	0.043
45	0.022	0.008	0.000	0.029	0.020	0.000	0.000	0.032
46	0.016	0.006	0.000	0.000	0.000	0.000	0.000	0.015
Mean Length	33.490	30.475	31.936	34.152	32.826	32.826	26.432	27.319

Table 7. Sculpin mean number per tow at length in the 4X portion of the DFO research vessel (RV) survey.

cm	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.029	0.000
10	0.000	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.049	0.000
11	0.000	0.000	0.029	0.000	0.019	0.000	0.000	0.026	0.029	0.000
12	0.000	0.000	0.000	0.023	0.019	0.000	0.000	0.028	0.029	0.004
13	0.000	0.000	0.000	0.064	0.000	0.000	0.000	0.028	0.000	0.029
14	0.000	0.000	0.000	0.012	0.000	0.006	0.000	0.000	0.000	0.043
15	0.042	0.000	0.032	0.095	0.016	0.000	0.000	0.000	0.000	0.043
16	0.029	0.000	0.072	0.052	0.000	0.000	0.016	0.028	0.000	0.080
17	0.086	0.000	0.057	0.079	0.011	0.006	0.016	0.000	0.011	0.080
18	0.049	0.000	0.043	0.044	0.019	0.013	0.067	0.000	0.069	0.073
19	0.024	0.000	0.000	0.040	0.049	0.097	0.016	0.000	0.091	0.004
20	0.038	0.000	0.056	0.012	0.065	0.029	0.000	0.074	0.145	0.000
21	0.104	0.000	0.043	0.094	0.101	0.022	0.052	0.168	0.097	0.000
22	0.227	0.000	0.068	0.053	0.134	0.229	0.006	0.062	0.091	0.081
23	0.184	0.014	0.067	0.167	0.234	0.268	0.096	0.081	0.168	0.098
24	0.105	0.000	0.068	0.212	0.173	0.213	0.079	0.055	0.324	0.108
25	0.098	0.000	0.057	0.249	0.310	1.118	0.309	0.196	0.288	0.123
26	0.146	0.056	0.069	0.260	0.318	0.527	0.344	0.164	0.152	0.158
27	0.205	0.099	0.134	0.145	0.271	1.163	0.270	0.242	0.259	0.316
28	0.269	0.084	0.157	0.125	0.242	1.067	0.153	0.265	0.112	0.303
29	0.267	0.113	0.169	0.124	0.184	0.727	0.166	0.177	0.153	0.109
30	0.046	0.114	0.157	0.102	0.213	0.723	0.053	0.169	0.100	0.079
31	0.033	0.025	0.095	0.071	0.157	0.399	0.058	0.168	0.077	0.033
32	0.038	0.000	0.014	0.104	0.013	0.257	0.000	0.048	0.013	0.014
33	0.000	0.000	0.000	0.000	0.016	0.062	0.000	0.000	0.036	0.000
34	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	24.755	28.268	24.305	24.130	25.671	27.137	25.752	25.807	24.058	24.487

Table 7 (continued). Sculpin mean number per tow at length in the 4X portion of the DFO research vessel (RV) survey.

cm	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.000	0.000	0.000
7	0.000	0.000	0.000	0.011	0.000	0.000	0.074	0.000	0.000	0.040
8	0.000	0.000	0.000	0.000	0.000	0.021	0.089	0.000	0.000	0.049
9	0.000	0.000	0.035	0.000	0.000	0.042	0.071	0.000	0.019	0.060
10	0.000	0.000	0.009	0.000	0.000	0.052	0.055	0.008	0.058	0.031
11	0.000	0.000	0.056	0.000	0.010	0.038	0.051	0.000	0.000	0.037
12	0.000	0.009	0.000	0.000	0.000	0.000	0.073	0.017	0.000	0.034
13	0.000	0.000	0.146	0.000	0.025	0.029	0.025	0.033	0.015	0.079
14	0.004	0.000	0.084	0.000	0.010	0.010	0.051	0.101	0.023	0.083
15	0.000	0.000	0.096	0.000	0.059	0.021	0.086	0.037	0.010	0.141
16	0.010	0.000	0.062	0.093	0.016	0.173	0.218	0.035	0.092	0.175
17	0.000	0.000	0.110	0.021	0.071	0.041	0.448	0.146	0.151	0.241
18	0.000	0.045	0.176	0.054	0.035	0.106	0.279	0.102	0.116	0.281
19	0.111	0.022	0.162	0.078	0.092	0.161	0.344	0.064	0.228	0.280
20	0.035	0.101	0.077	0.172	0.110	0.261	0.212	0.109	0.190	0.196
21	0.064	0.031	0.104	0.196	0.137	0.262	0.271	0.166	0.363	0.212
22	0.144	0.117	0.249	0.378	0.164	0.245	0.620	0.142	0.562	0.380
23	0.040	0.069	0.132	0.344	0.384	0.145	1.019	0.135	0.777	0.862
24	0.105	0.259	0.378	0.570	0.447	0.152	1.053	0.208	0.663	1.191
25	0.100	0.492	0.472	0.447	0.452	0.530	1.082	0.282	0.984	1.363
26	0.103	0.631	0.622	0.419	0.637	0.652	1.202	0.243	0.894	1.082
27	0.109	0.836	0.562	0.506	0.577	0.713	1.110	0.194	0.681	0.894
28	0.084	0.459	0.273	0.535	0.441	0.643	0.607	0.214	0.458	0.445
29	0.109	0.400	0.262	0.359	0.253	0.548	0.386	0.096	0.379	0.226
30	0.065	0.206	0.056	0.169	0.198	0.455	0.138	0.039	0.150	0.114
31	0.000	0.089	0.081	0.057	0.155	0.156	0.000	0.027	0.066	0.027
32	0.000	0.064	0.113	0.023	0.039	0.080	0.020	0.010	0.000	0.016
33	0.000	0.021	0.000	0.000	0.012	0.043	0.000	0.000	0.023	0.008
34	0.000	0.021	0.008	0.011	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	24.527	26.478	23.678	24.963	25.219	25.063	23.043	22.999	24.179	23.335

Table 7 (continued). Sculpin mean number per tow at length in the 4X portion of the DFO research vessel (RV) survey.

cm	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.019	0.115	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.174	0.116	0.000
7	0.077	0.000	0.000	0.000	0.000	0.004	0.062	0.181	0.117	0.000
8	0.017	0.023	0.014	0.075	0.044	0.040	0.021	0.199	0.023	0.000
9	0.037	0.000	0.000	0.007	0.025	0.033	0.058	0.159	0.115	0.000
10	0.013	0.023	0.004	0.015	0.011	0.052	0.018	0.067	0.046	0.000
11	0.000	0.023	0.025	0.015	0.036	0.048	0.014	0.000	0.040	0.000
12	0.029	0.053	0.033	0.005	0.077	0.005	0.029	0.051	0.000	0.011
13	0.028	0.000	0.091	0.058	0.066	0.056	0.038	0.079	0.005	0.000
14	0.045	0.058	0.149	0.000	0.081	0.024	0.081	0.167	0.080	0.022
15	0.049	0.111	0.140	0.016	0.067	0.076	0.155	0.177	0.047	0.013
16	0.017	0.203	0.417	0.097	0.047	0.064	0.212	0.082	0.140	0.010
17	0.082	0.384	0.351	0.287	0.130	0.283	0.114	0.090	0.060	0.037
18	0.055	0.294	0.218	0.100	0.120	0.223	0.078	0.100	0.116	0.068
19	0.025	0.577	0.236	0.062	0.091	0.260	0.150	0.188	0.076	0.131
20	0.101	0.342	0.225	0.465	0.103	0.398	0.347	0.423	0.101	0.248
21	0.150	0.600	0.572	0.717	0.213	0.524	0.698	0.521	0.181	0.300
22	0.293	1.048	0.729	1.243	0.412	0.783	0.873	0.692	0.227	0.207
23	0.245	1.267	1.136	1.954	0.841	1.174	1.538	0.865	0.329	0.357
24	0.525	1.374	1.562	1.994	1.334	2.357	1.625	1.151	0.479	0.443
25	0.461	1.648	1.581	2.963	1.531	2.165	1.841	1.241	0.406	0.447
26	0.596	1.816	1.722	2.469	1.352	2.246	1.430	1.109	0.530	0.500
27	0.436	1.071	1.524	1.271	0.926	1.831	1.093	1.065	0.427	0.312
28	0.180	0.535	0.735	1.062	0.465	0.797	0.615	0.752	0.328	0.283
29	0.158	0.424	0.320	0.531	0.194	0.442	0.177	0.352	0.454	0.091
30	0.076	0.157	0.079	0.467	0.088	0.228	0.008	0.173	0.156	0.059
31	0.013	0.053	0.050	0.017	0.072	0.052	0.031	0.115	0.123	0.020
32	0.039	0.022	0.034	0.007	0.032	0.068	0.000	0.046	0.019	0.009
33	0.021	0.047	0.035	0.038	0.004	0.009	0.012	0.004	0.010	0.009
34	0.013	0.007	0.004	0.008	0.000	0.007	0.000	0.009	0.009	0.000
35	0.000	0.007	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
36	0.000	0.018	0.000	0.000	0.000	0.014	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
Mean Length	23.712	23.701	23.780	24.460	24.178	24.336	23.648	22.792	22.630	24.018

Table 7 (continued). Sculpin mean number per tow at length in the 4X portion of the DFO research vessel (RV) survey.

cm	2000	2001	2002	2003	2004	2005	2006	2007
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000
5	0.000	0.004	0.000	0.000	0.000	0.015	0.000	0.060
6	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.203
7	0.000	0.000	0.000	0.000	0.014	0.010	0.035	0.468
8	0.000	0.038	0.044	0.000	0.045	0.081	0.015	0.591
9	0.016	0.025	0.021	0.000	0.039	0.020	0.017	0.391
10	0.164	0.004	0.000	0.011	0.022	0.020	0.029	0.226
11	0.234	0.009	0.000	0.005	0.008	0.015	0.000	0.076
12	0.223	0.004	0.022	0.017	0.000	0.036	0.011	0.013
13	0.137	0.000	0.064	0.000	0.000	0.096	0.004	0.072
14	0.027	0.000	0.082	0.020	0.013	0.069	0.114	0.052
15	0.005	0.024	0.145	0.022	0.005	0.031	0.034	0.060
16	0.018	0.026	0.052	0.055	0.015	0.081	0.075	0.323
17	0.064	0.048	0.057	0.017	0.057	0.060	0.156	0.208
18	0.096	0.174	0.056	0.101	0.093	0.050	0.492	0.213
19	0.155	0.185	0.133	0.065	0.077	0.095	0.752	0.313
20	0.221	0.343	0.359	0.068	0.159	0.142	0.799	0.581
21	0.309	0.317	0.348	0.089	0.209	0.278	0.781	0.594
22	0.485	0.734	0.613	0.195	0.330	0.498	0.890	0.928
23	0.974	1.105	0.603	0.280	0.383	0.643	0.682	1.380
24	1.845	1.673	0.885	0.296	0.698	0.538	1.040	0.923
25	2.099	1.727	0.824	0.327	0.418	0.658	1.315	0.783
26	2.081	1.320	0.586	0.373	0.477	0.696	1.050	0.748
27	1.411	1.068	0.490	0.556	0.333	0.316	0.961	0.491
28	0.904	0.593	0.272	0.356	0.231	0.549	0.664	0.367
29	0.232	0.286	0.165	0.355	0.085	0.126	0.657	0.227
30	0.100	0.152	0.036	0.253	0.031	0.027	0.226	0.158
31	0.004	0.019	0.021	0.244	0.017	0.007	0.149	0.086
32	0.000	0.004	0.007	0.039	0.018	0.000	0.004	0.020
33	0.019	0.007	0.000	0.020	0.000	0.000	0.004	0.006
34	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.006
35	0.019	0.000	0.000	0.011	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	24.044	24.363	23.246	25.697	23.541	23.239	23.548	20.192

Table 8. Sculpin mean number per tow at length in the Stratum 490 portion of the DFO research vessel (RV) survey.

cm	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.875	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.437	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.437	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.437	0.583	0.000	0.000	0.000	0.000	0.000	0.547
17	1.750	0.000	1.750	0.000	0.000	0.000	0.000	0.000	0.000	0.547
18	1.167	0.000	1.312	0.000	0.000	0.000	0.000	0.000	0.000	1.094
19	0.000	0.000	0.000	0.583	0.000	2.565	0.000	0.000	0.000	0.000
20	0.000	0.000	1.312	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	1.750	0.000	0.000	0.583	0.795	0.000	0.000	0.000	0.307	0.000
22	4.083	0.000	0.875	0.583	0.398	6.264	0.000	0.000	0.000	1.395
23	4.667	0.000	1.312	0.000	0.000	4.968	0.000	0.389	0.000	1.697
24	1.750	0.000	1.750	0.583	0.000	2.403	0.778	0.000	0.000	0.547
25	1.167	0.000	1.750	1.167	1.591	25.271	0.389	0.389	0.254	0.000
26	2.333	0.000	1.312	2.333	0.795	8.829	0.000	0.919	0.507	1.094
27	4.667	0.000	2.625	0.000	1.193	30.887	0.389	0.654	0.307	1.094
28	5.250	0.000	2.187	0.000	1.193	25.595	0.000	0.389	0.278	2.187
29	3.500	0.000	3.500	0.000	3.182	19.520	0.000	0.265	1.092	1.395
30	1.167	0.000	1.312	0.000	1.591	21.086	0.000	0.265	0.507	1.094
31	0.583	0.000	0.875	0.000	0.398	11.501	0.000	0.000	0.507	0.000
32	0.583	0.000	0.437	0.000	0.398	7.668	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	1.917	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	25.068	0.000	23.857	23.273	27.448	27.507	25.000	26.530	27.840	24.670

Table 8 (continued). Sculpin mean number per tow at length in the Stratum 490 portion of the DFO research vessel (RV) survey.

cm	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.343	0.000	0.000	0.324	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.648	0.667	0.000	0.000	0.461
9	0.000	0.000	0.000	0.000	0.000	1.296	1.010	0.000	0.602	1.842
10	0.000	0.000	0.000	0.000	0.000	1.620	1.315	0.243	1.805	0.691
11	0.000	0.000	0.000	0.000	0.000	0.000	1.315	0.000	0.000	0.866
12	0.000	0.000	0.000	0.000	0.000	0.000	0.324	0.000	0.000	0.758
13	0.000	0.000	0.608	0.000	0.000	0.907	0.000	0.000	0.000	0.292
14	0.000	0.000	0.343	0.000	0.000	0.324	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.648	0.667	0.243	0.000	1.164
16	0.000	0.000	0.000	0.000	0.000	4.116	0.708	0.230	1.805	2.444
17	0.000	0.000	0.000	0.000	0.307	1.264	1.782	0.972	3.609	6.432
18	0.000	0.000	0.951	0.343	0.000	1.264	3.786	0.704	3.008	6.027
19	0.278	0.389	1.638	0.000	0.307	2.819	5.061	0.691	3.609	4.350
20	0.278	0.389	1.295	0.000	0.000	4.926	1.639	1.868	3.008	1.732
21	0.278	0.292	0.608	0.686	0.000	4.569	3.357	1.433	8.422	2.118
22	0.556	0.389	0.343	2.745	0.000	3.306	5.118	1.650	15.296	4.885
23	1.111	0.000	1.295	5.490	0.307	1.458	8.466	1.407	17.101	9.686
24	0.000	2.333	0.951	8.235	0.614	1.231	12.551	2.405	14.264	13.945
25	0.833	3.986	4.383	7.549	0.921	7.418	12.813	1.906	20.450	20.158
26	0.847	5.514	4.227	5.833	1.286	12.509	9.782	0.947	13.662	18.704
27	0.569	7.278	3.088	4.461	0.979	11.764	13.818	1.177	10.484	13.700
28	0.569	6.486	1.373	6.520	1.286	9.430	5.890	0.704	3.091	5.071
29	0.875	3.278	2.059	2.745	0.307	3.986	2.388	0.230	3.008	2.345
30	0.278	2.139	0.343	1.716	0.000	5.963	0.324	0.000	0.859	0.525
31	0.000	0.000	0.000	0.343	0.000	2.106	0.000	0.230	0.000	0.292
32	0.000	0.000	0.000	0.000	0.000	0.000	0.343	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.292	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.343	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.257	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	25.082	26.675	24.295	25.428	25.444	24.024	23.313	22.505	23.355	23.172

Table 8 (continued). Sculpin mean number per tow at length in the Stratum 490 portion of the DFO research vessel (RV) survey.

cm	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.292	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.472	0.254	0.000
8	0.000	0.000	0.000	1.315	0.000	0.000	0.000	5.419	0.000	0.000
9	0.257	0.000	0.000	0.230	0.420	0.390	0.277	4.420	1.648	0.000
10	0.000	0.000	0.000	0.461	0.000	0.194	0.554	1.722	0.763	0.000
11	0.000	0.000	0.000	0.461	0.420	0.510	0.277	0.000	0.509	0.000
12	0.000	1.623	0.000	0.000	0.000	0.000	0.000	0.486	0.000	0.000
13	0.000	0.000	0.000	1.085	0.000	0.000	0.000	1.467	0.000	0.000
14	0.257	0.541	0.000	0.000	0.420	0.459	0.277	3.918	1.524	0.000
15	0.000	0.456	0.000	0.488	0.000	1.240	0.277	3.908	0.889	0.000
16	0.531	4.401	1.973	1.085	0.420	0.850	0.624	1.468	1.919	0.324
17	1.850	3.446	0.729	4.338	1.260	6.274	0.000	1.460	0.763	0.324
18	0.788	4.844	1.716	2.466	2.940	2.337	0.554	1.715	1.145	0.648
19	0.000	10.242	0.987	1.775	0.420	6.168	1.177	1.715	0.000	0.981
20	0.000	4.971	0.729	5.720	0.658	4.106	1.164	3.905	0.380	2.269
21	1.834	9.913	3.946	9.798	2.100	9.337	5.819	5.386	0.630	2.611
22	3.442	19.099	4.782	10.406	1.918	13.574	7.413	5.623	0.504	1.306
23	3.619	19.432	7.892	19.636	13.037	16.616	13.219	4.883	1.770	1.639
24	6.273	20.416	12.739	29.319	18.506	43.655	15.990	6.135	1.509	3.268
25	6.241	25.286	10.637	26.547	18.948	31.888	20.411	5.631	2.792	1.972
26	4.471	27.738	13.232	32.695	10.951	21.197	13.137	4.615	3.046	3.822
27	5.018	16.859	6.541	18.709	7.354	13.323	5.723	0.964	0.901	2.000
28	2.606	8.495	0.879	14.825	3.509	6.365	1.247	0.494	0.260	0.000
29	1.351	4.922	0.729	4.589	0.238	2.142	0.900	0.243	0.515	0.333
30	0.000	1.853	0.257	7.326	0.000	0.705	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	0.624	0.000	0.000	0.000
32	0.000	0.000	0.000	0.230	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.257	0.887	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.257	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	24.079	23.595	23.991	24.401	24.053	23.639	23.917	18.368	19.943	23.184

Table 8 (continued). Sculpin mean number per tow at length in the Stratum 490 portion of the DFO research vessel (RV) survey.

cm	2000	2001	2002	2003	2004	2005	2006	2007
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.474	0.000	0.365
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.167
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.389
8	0.000	0.000	0.000	0.000	1.017	0.000	0.000	2.285
9	0.000	0.000	0.000	0.000	0.509	0.000	0.000	1.556
10	0.601	0.000	0.000	0.000	0.509	0.000	0.328	1.531
11	0.000	0.000	0.000	0.000	0.254	0.000	0.000	0.753
12	0.503	0.000	0.000	0.000	0.000	0.000	0.000	0.389
13	0.256	0.000	0.000	0.000	0.000	0.345	0.000	0.000
14	0.256	0.000	0.000	0.258	0.254	0.000	2.984	0.000
15	0.000	0.233	0.000	0.516	0.000	0.000	0.663	0.365
16	0.251	0.465	0.000	0.333	0.000	1.036	0.663	0.365
17	0.000	0.000	0.000	0.000	1.017	0.690	3.648	0.753
18	1.010	0.000	0.000	0.425	1.526	0.000	10.612	0.000
19	0.507	0.489	0.000	0.000	1.272	0.345	14.592	1.118
20	1.852	0.489	0.244	0.000	2.035	1.381	16.580	0.753
21	2.541	0.489	0.000	0.167	3.045	1.036	17.907	0.729
22	4.725	1.419	0.000	0.424	3.307	1.165	16.084	0.778
23	9.195	2.606	0.000	0.000	3.815	1.855	11.608	4.108
24	17.429	7.097	0.658	0.000	4.070	0.690	18.572	3.014
25	21.965	6.981	0.658	0.167	3.052	0.345	26.531	3.743
26	18.660	5.166	0.987	0.500	4.324	0.345	20.891	3.403
27	7.870	4.979	0.658	0.500	2.035	0.345	22.053	1.847
28	3.405	0.721	0.987	0.000	1.265	0.000	15.419	1.167
29	0.700	0.744	0.000	0.000	0.254	0.000	17.077	0.000
30	0.606	0.000	0.000	0.000	0.000	0.000	6.632	0.000
31	0.000	0.000	0.000	0.000	0.000	0.000	4.476	0.000
32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean Length	24.428	24.682	25.807	20.619	22.120	20.181	23.916	19.503

Table 9. Estimates of exploitation rate using different sources of data to calculate longhorn sculpin biomass.

		Biomass Estimates (000t)			Exploitation Rate		
YEAR	Commercial Catch (000t)	RV Survey Stratum 490	Hart Survey 1985[1]	Hart Survey 1986[1]	RV Survey Stratum 490	Hart Survey 1985	Hart Survey 1986
1999	61.6	124.8	223.7	470.0	49.4	27.5	13.1
2000	140.5	579.3	223.7	470.0	24.3	62.8	29.9
2001	151.5	195.6	223.7	470.0	77.5	67.7	32.2
2002	105.5	28.4	223.7	470.0	371.0	47.2	22.4
2003	77.6	16.0	223.7	470.0	484.4	34.7	16.5
2004	52.0	157.4	223.7	470.0	33.1	23.3	11.1
2005	94.6	44.3	223.7	470.0	213.7	42.3	20.1
2006	99.4	1523.5	223.7	470.0	6.5	44.4	21.1
Mean					157.5	43.7	20.8

[1]Jim Simon, pers. comm.

Table 10. Catch (kg) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Longhorn Sculpin	64285	142936	149884	31005	22768	28986	42435	42067	524366
American Lobster	2874	10094	6534	3813	3929	4719	6393	9546	47902
Winter Flounder	5297	7105	3406	783	645	1411	2911	2747	24305
Jonah Crab	232	802	4470	4996	2590	2588	2334	2318	20330
Sea Raven	704	1207	559	405	942	1242	1787	3514	10360
Rock Crab	77	359	546		1135	1124	3871	3152	10264
Thorny Skate	1183	949	352	782	638	1012	780	723	6419
Ocean Pout	2349	1274	629	185	67	33	113	146	4796
Little Skate	0	0	0	0	0	51	1350	2327	3728
Starfish	90	155	43	307	900	28	103	196	1822
Sea Scallop	5	4	2	26	261	705	358	369	1730
Brittle Star	0	0	0	0	1086	0	0	0	1086
Spiny Dogfish	231	694	115	0	14	0	0	0	1054
Windowpane Flounder	0	0	37	0	2	258	292	290	879
Short-finned Squid	5	749	16	0	0	0	0	8	778
Sturgeon	5	130	193	175	0	30	255	86	729
Winter Skate	0	0	0	0	0	2	445	267	714
Jellyfish	352	0	0	0	0	0	0	4	356
Herring	24	1	8	0	0	8	46	194	281
Lumpfish	64	88	25	0	0	31	8	50	266

Table 10 (continued). Catch (kg) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Haddock	55	200	1	0	0	0	0	2	258
Sea Cucumber	32	32	183	2	0	0	3	6	258
Halibut	0	105	22	11	16	12	6	24	196
Alewife	4	21	122	5	0	4	9	22	187
Skate, Unspec	0	0	0	0	0	5	0	156	161
Grubby Sculpin	0	12	0	0	0	9	40	96	157
Shorthorn Sculpin	0	0	142	0	0	0	0	0	142
Common Mussels	0	0	0	0	102	2	0	0	104
Mussels, Unspec	0	0	0	1	20	1	1	48	71
Rocks	0	0	0	0	0	0	65	0	65
Starfish	0	0	1	2	0	21	29	0	53
White Hake	0	0	1	0	0	0	0	47	48
Scallops, Unspec	0	0	2	0	0	3	0	42	47
Shrimp	0	0	0	0	0	0	40	0	40
Smelt	0	0	0	0	0	6	10	22	38
Yellowtail Flounder	6	14	3	0	0	0	3	11	37
Sea Urchins	1	17	3	0	0	0	0	15	36
Pandulus borealis	0	0	0	0	0	0	30	0	30
Clams	0	0	0	0	0	0	2	22	24
Summer Flounder	0	22	0	0	0	0	0	0	22

Table 10 (continued). Catch (kg) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Wrymouth	0	0	0	0	0	0	1	20	21
Sponges	0	11	0	0	0	0	2	7	20
Mollusca	0	0	0	0	0	0	2	17	19
Cunner	2	5	0	0	0	0	3	7	17
Green Crab	0	0	0	0	0	0	15	0	15
Garbage	0	0	0	0	0	15	0	0	15
Cod	0	0	0	0	0	3	3	7	13
Silver Hake	0	0	0	0	0	0	0	10	10
American Shad	1	0	2	0	0	2	1	3	9
Daubed Shanny	0	0	0	0	0	0	1	8	9
Smooth Skate	0	5	3	0	0	0	0	0	8
Round Skate	0	0	0	7	0	0	0	0	7
Shrimp	0	0	0	0	0	0	0	7	7
Squid, Unspec	0	0	6	0	0	0	0	1	7
American Plaice	5	0	0	0	0	0	0	0	5
Aligatorfish	0	0	0	0	5	0	0	0	5
Monkfish	0	0	2	0	2	0	0	1	5
Crab, Unspec	0	0	4	0	0	0	0	0	4
Whelks	0	0	0	0	0	0	4	0	4
Argentine, Unspec	0	3	0	0	0	0	0	0	3

Table 10 (continued). Catch (kg) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Striped Bass	2	0	0	0	0	0	0	0	2
Capelin	1	0	0	0	0	0	0	1	2
Atlantic Soft Pout	0	0	0	0	2	0	0	0	2
Bregmaceros Sp.	0	0	0	0	0	0	2	0	2
Argentine	0	1	0	0	0	0	0	0	1
American Sand Lance	0	0	0	0	0	0	0	1	1
Butterfish	0	0	0	0	0	0	0	1	1
Sea Bass	1	0	0	0	0	0	0	0	1
Shrimp	0	0	0	0	0	0	0	1	1
Pelagic Sea Snail	0	0	0	0	0	0	0	1	1
Basket Stars	0	0	0	1	0	0	0	0	1
Total	77887	166995	167316	42506	35124	42311	63753	68610	664502

Table 11. Percentage of observed sets containing longhorn sculpin and selected by-catch species.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Number of Sets	193	290	576	152	147	185	273	370
Species								
Longhorn Sculpin	96.9	99.3	99.7	98.7	99.3	99.5	99.6	99.5
American Lobster	94.8	99.3	96.0	98.7	99.3	99.5	99.6	99.5
Winter Flounder	92.7	99.3	93.8	98.7	96.6	99.5	99.3	99.2
Jonah Crab	37.3	45.9	60.9	98.7	97.3	91.4	86.4	84.9
Sea Raven	52.8	83.1	30.7	55.9	91.2	97.3	99.6	99.2
Rock Crab	12.4	39.7	28.3	0.0	46.3	73.0	98.9	97.8
Thorny Skate	55.4	53.4	21.5	68.4	78.2	81.6	37.4	19.7
Ocean Pout	36.3	57.2	41.3	50.7	19.0	11.9	23.4	20.8
Little Skate	0.0	0.0	0.0	0.0	0.0	4.9	45.8	73.5
Starfish	18.7	27.2	6.1	13.2	27.2	8.1	33.0	37.6
Sea Scallop	2.6	1.4	0.3	13.2	44.9	63.2	55.3	31.9
Brittle Star	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0
Spiny Dogfish	10.9	27.6	3.6	0.0	3.4	0.0	0.0	0.0
Windowpane Flounder	0.0	0.0	5.6	0.0	1.4	59.5	78.8	67.8
Short-finned Squid	2.6	24.1	2.4	0.0	0.0	0.0	0.0	1.9
Sturgeon	0.5	1.4	1.6	2.0	0.0	0.5	2.2	0.5
Winter Skate	0.0	0.0	0.0	0.0	0.0	1.1	13.6	15.9
Jellyfish	34.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Herring	12.4	0.3	1.2	0.0	0.0	3.2	14.7	34.1
Lumpfish	9.3	13.1	2.6	0.0	0.0	5.4	1.1	4.6

Table 11 (continued). Percentage of observed sets containing longhorn sculpin and selected by-catch species.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Number of Sets	193	290	576	152	147	185	273	370
Species								
Haddock	6.7	20.0	0.2	0.0	0.0	0.0	0.0	0.3
Sea Cucumber	3.6	9.0	20.8	0.7	0.0	0.0	1.1	1.6
Halibut	0.0	4.5	1.0	1.3	1.4	1.6	1.1	2.2
Alewife	2.1	3.8	13.5	3.3	0.0	1.6	3.3	5.1
Skate, Unspec	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.4
Grubby Sculpin	0.0	0.7	0.0	0.0	0.0	4.9	10.6	11.1
Shorthorn Sculpin	0.0	0.0	10.2	0.0	0.0	0.0	0.0	0.0
Common Mussels	0.0	0.0	0.0	0.0	12.2	1.1	0.0	0.0
Mussels, Unspec	0.0	0.0	0.0	0.7	5.4	0.5	0.4	12.7
Rocks	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
Starfish	18.7	27.2	6.1	13.2	27.2	8.1	33.0	37.6
White Hake	0.0	0.0	0.2	0.0	0.0	0.0	0.0	11.1
Scallops, Unspec	0.0	0.0	0.3	0.0	0.0	1.1	0.0	5.1
Shrimp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Smelt	0.0	0.0	0.0	0.0	0.0	3.2	3.7	5.9
Yellowtail Flounder	2.6	4.1	0.3	0.0	0.0	0.0	1.1	3.0
Sea Urchins	0.5	4.1	0.3	0.0	0.0	0.0	0.0	4.1
Pandulus borealis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clams	0.0	0.0	0.0	0.0	0.0	0.0	0.7	5.9
Summer Flounder	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0

Table 11 (continued). Percentage of observed sets containing longhorn sculpin and selected by-catch species.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Number of Sets	193	290	576	152	147	185	273	370
Species								
Wrymouth	0.0	0.0	0.0	0.0	0.0	0.0	0.4	5.4
Sponges	0.0	2.1	0.0	0.0	0.0	0.0	0.7	1.9
Mollusca	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.6
Cunner	0.5	1.4	0.0	0.0	0.0	0.0	1.1	1.9
Green Crab	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Garbage	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
Cod	0.0	0.0	0.0	0.0	0.0	1.1	1.1	1.9
Silver Hake	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
American Shad	0.5	0.0	0.3	0.0	0.0	1.1	0.4	0.5
Daubed Shanny	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.2
Smooth Skate	0.0	1.0	0.3	0.0	0.0	0.0	0.0	0.0
Round Skate	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Squid, Unspec	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.3
American Plaice	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aligatorfish	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
Monkfish	0.0	0.0	0.3	0.0	0.7	0.0	0.0	0.3
Crab, Unspec	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Whelks	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
Argentine, Unspec	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 11 (continued). Percentage of observed sets containing longhorn sculpin and selected by-catch species.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Number of Sets	193	290	576	152	147	185	273	370
Species								
Striped Bass	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capelin	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Atlantic Soft Pout	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
Bregmaceros Sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Argentine	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
American Sand Lance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Butterfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Sea Bass	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pelagic Sea Snail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Basket Stars	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0

Table 12. Adjusted catch (kg) (adjusted to landings) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Longhorn Sculpin	61610	140492	151512	105519	77592	52025	94560	99354	782664
American Lobster	2754	9921	6605	12977	13390	8470	14246	22546	90909
Winter Flounder	5077	6984	3443	2665	2198	2533	6487	6488	35875
Jonah Crab	222	788	4519	17003	8827	4645	5201	5475	46680
Sea Raven	675	1186	565	1378	3210	2229	3982	8299	21524
Rock Crab	74	353	552	0	3868	2017	8626	7444	22934
Thorny Skate	1134	933	356	2661	2174	1816	1738	1708	12520
Ocean Pout	2251	1252	636	630	228	59	252	345	5653
Little Skate	0	0	0	0	0	92	3008	5496	8596
Starfish	86	152	43	1045	3067	50	230	463	5136
Sea Scallop	5	4	2	88	889	1265	798	872	3923
Brittle Star	0	0	0	0	3701	0	0	0	3701
Spiny Dogfish	221	682	116	0	48	0	0	0	1067
Windowpane Flounder	0	0	37	0	7	463	651	685	1843
Short-finned Squid	5	736	16	0	0	0	0	19	776
Sturgeon	5	128	195	596	0	54	568	203	1749
Winter Skate	0	0	0	0	0	4	992	631	1627
Jellyfish	337	0	0	0	0	0	0	9	346
Herring	23	1	8	0	0	14	103	458	607
Lumpfish	61	86	25	0	0	56	18	118	364

Table 12 (continued). Adjusted catch (kg) (adjusted to landings) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Haddock	53	197	1	0	0	0	0	5	256
Sea Cucumber	31	31	185	7	0	0	7	14	275
Halibut	0	103	22	37	55	22	13	57	309
Alewife	4	21	123	17	0	7	20	52	244
Skate, Unspec	0	0	0	0	0	9	0	368	377
Grubby Sculpin	0	12	0	0	0	16	89	227	344
Shorthorn Sculpin	0	0	144	0	0	0	0	0	144
Common Mussels	0	0	0	0	348	4	0	0	352
Mussels, Unspec	0	0	0	3	68	2	2	113	188
Rocks	0	0	0	0	0	0	145	0	145
Starfish	0	0	1	7	0	38	65	0	111
White Hake	0	0	1	0	0	0	0	111	112
Scallops, Unspec	0	0	2	0	0	5	0	99	106
Shrimp	0	0	0	0	0	0	89	0	89
Smelt	0	0	0	0	0	11	22	52	85
Yellowtail Flounder	6	14	3	0	0	0	7	26	56
Sea Urchins	1	17	3	0	0	0	0	35	56
Pandulus borealis	0	0	0	0	0	0	67	0	67
Clams	0	0	0	0	0	0	4	52	56
Summer Flounder	0	22	0	0	0	0	0	0	22

Table 12 (continued). Adjusted catch (kg) (adjusted to landings) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Wrymouth	0	0	0	0	0	0	2	47	49
Sponges	0	11	0	0	0	0	4	17	32
Mollusca	0	0	0	0	0	0	4	40	44
Cunner	2	5	0	0	0	0	7	17	31
Green Crab	0	0	0	0	0	0	33	0	33
Garbage	0	0	0	0	0	27	0	0	27
Cod	0	0	0	0	0	5	7	17	29
Silver Hake	0	0	0	0	0	0	0	24	24
American Shad	1	0	2	0	0	4	2	7	16
Daubed Shanny	0	0	0	0	0	0	2	19	21
Smooth Skate	0	5	3	0	0	0	0	0	8
Round Skate	0	0	0	24	0	0	0	0	24
Shrimp	0	0	0	0	0	0	0	17	17
Squid, Unspec	0	0	6	0	0	0	0	2	8
American Plaice	5	0	0	0	0	0	0	0	5
Aligatorfish	0	0	0	0	17	0	0	0	17
Monkfish	0	0	2	0	7	0	0	2	11
Crab, Unspec	0	0	4	0	0	0	0	0	4
Whelks	0	0	0	0	0	0	9	0	9
Argentine, Unspec	0	3	0	0	0	0	0	0	3

Table 12 (continued). Adjusted catch (kg) (adjusted to landings) by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***Total***
Number of Sets	193	290	576	152	147	185	273	370	2186
Species									
Striped Bass	2	0	0	0	0	0	0	0	2
Capelin	1	0	0	0	0	0	0	2	3
Atlantic Soft Pout	0	0	0	0	7	0	0	0	7
Bregmaceros Sp.	0	0	0	0	0	0	4	0	4
Argentine	0	1	0	0	0	0	0	0	1
American Sand Lance	0	0	0	0	0	0	0	2	2
Butterfish	0	0	0	0	0	0	0	2	2
Sea Bass	1	0	0	0	0	0	0	0	1
Shrimp	0	0	0	0	0	0	0	2	2
Pelagic Sea Snail	0	0	0	0	0	0	0	2	2
Basket Stars	0	0	0	3	0	0	0	0	3
Total	74647	164140	169132	144660	119701	75942	142064	162043	1052329

Table 13. Catch (kg) per hour by species in observed sets during the directed sculpin fishery.

	1999	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Hours Fished	381	576	1123	290	208	351	343	432
Species								
Longhorn Sculpin	168.7	248.2	133.5	106.9	109.5	82.6	123.7	97.4
Winter Flounder	13.9	12.3	3.0	2.7	3.1	4.0	8.5	6.4
Dogfish	0.6	1.2	0.1	0.0	0.1	0.0	0.0	0.0
Sturgeon	0.0	0.2	0.2	0.6	0.0	0.1	0.7	0.0
Sea Raven	1.8	2.1	0.5	1.4	4.5	3.5	5.2	8.1
Thorny Skate	3.1	1.6	0.3	2.7	3.1	2.9	2.3	1.7
Little Skate	0.0	0.0	0.0	0.0	0.0	0.1	3.9	5.4
Ocean Pout	6.2	2.2	0.6	0.6	0.3	0.1	0.3	0.3
Jonah Crab	0.6	1.4	4.0	17.2	12.5	7.4	6.8	5.4
Rock Crab	0.2	0.6	0.5	0.0	5.5	3.2	11.3	7.3
Lobster	7.5	17.5	5.8	13.1	18.9	13.4	18.6	22.1

Table 14. Lobster landings by the LFA 34 lobster fishery in St. Mary's Bay (reporting grids 69, 81, 92).

	Landings (t)			
Year	**Grid 69**	**Grid 81**	**Grid 92**	**Total**
1999	4	221	781	1,007
2000	7	178	1,057	1,242
2001	-	181	1,163	1,344
2002	0	184	1,119	1,303
2003	7	169	989	1,164
2004	8	154	905	1,067
2005	8	271	955	1,235
2006	24	262	794	1,080
Average	7	203	970	1,180

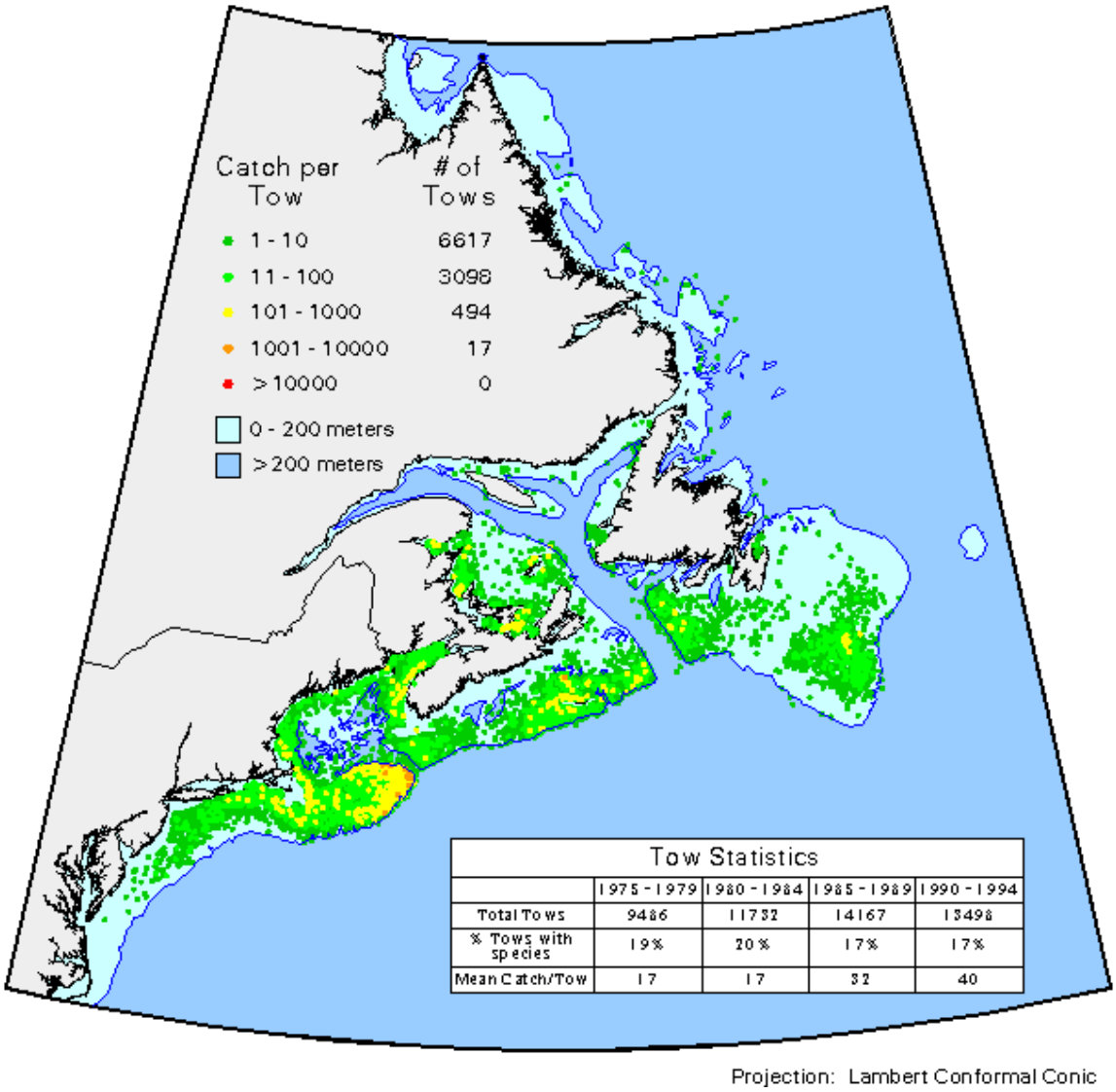

Figure 1. Distribution of longhorn sculpin in the northwest Atlantic based on Canadian and US trawl survey data in the ECNASAP database.

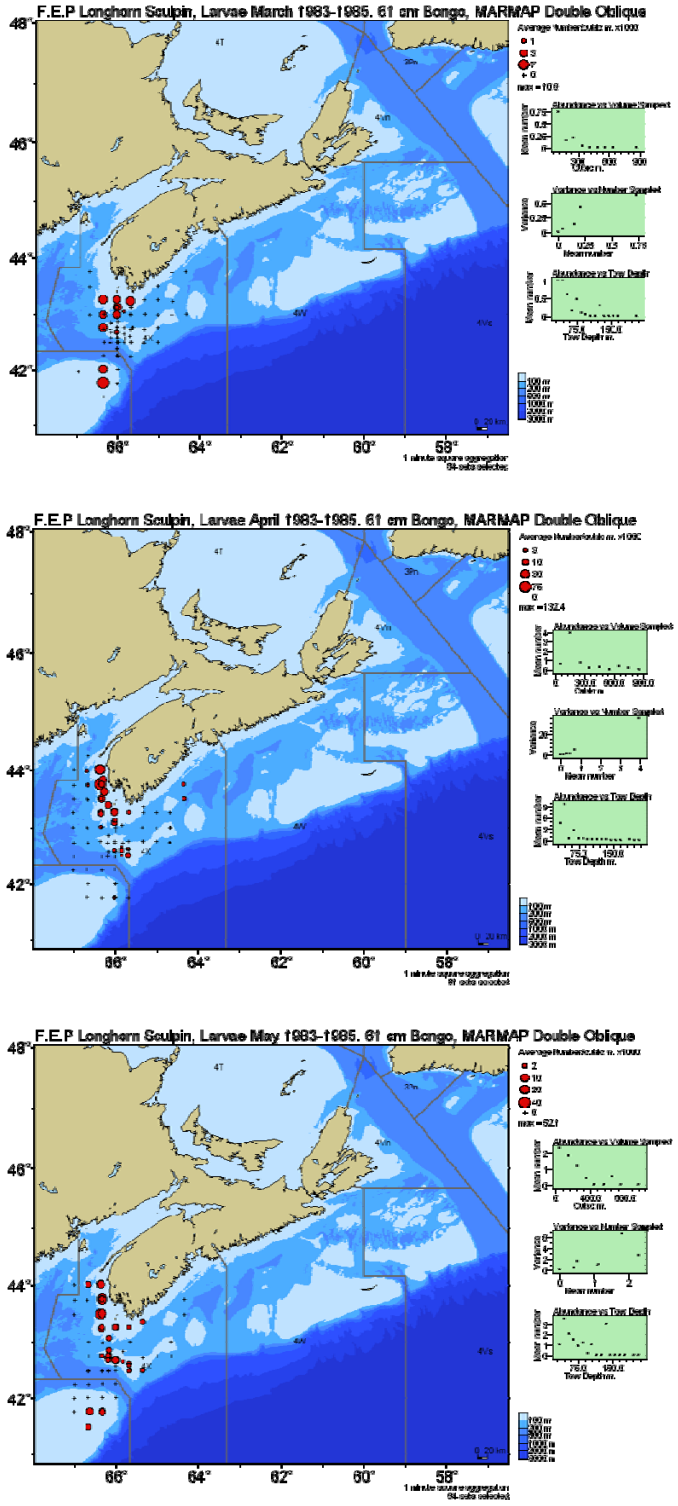

Figure 2. Distribution of longhorn sculpin larvae in the Fisheries Ecology Program (FEP) plankton collections in March, April, and May 1983-1985.

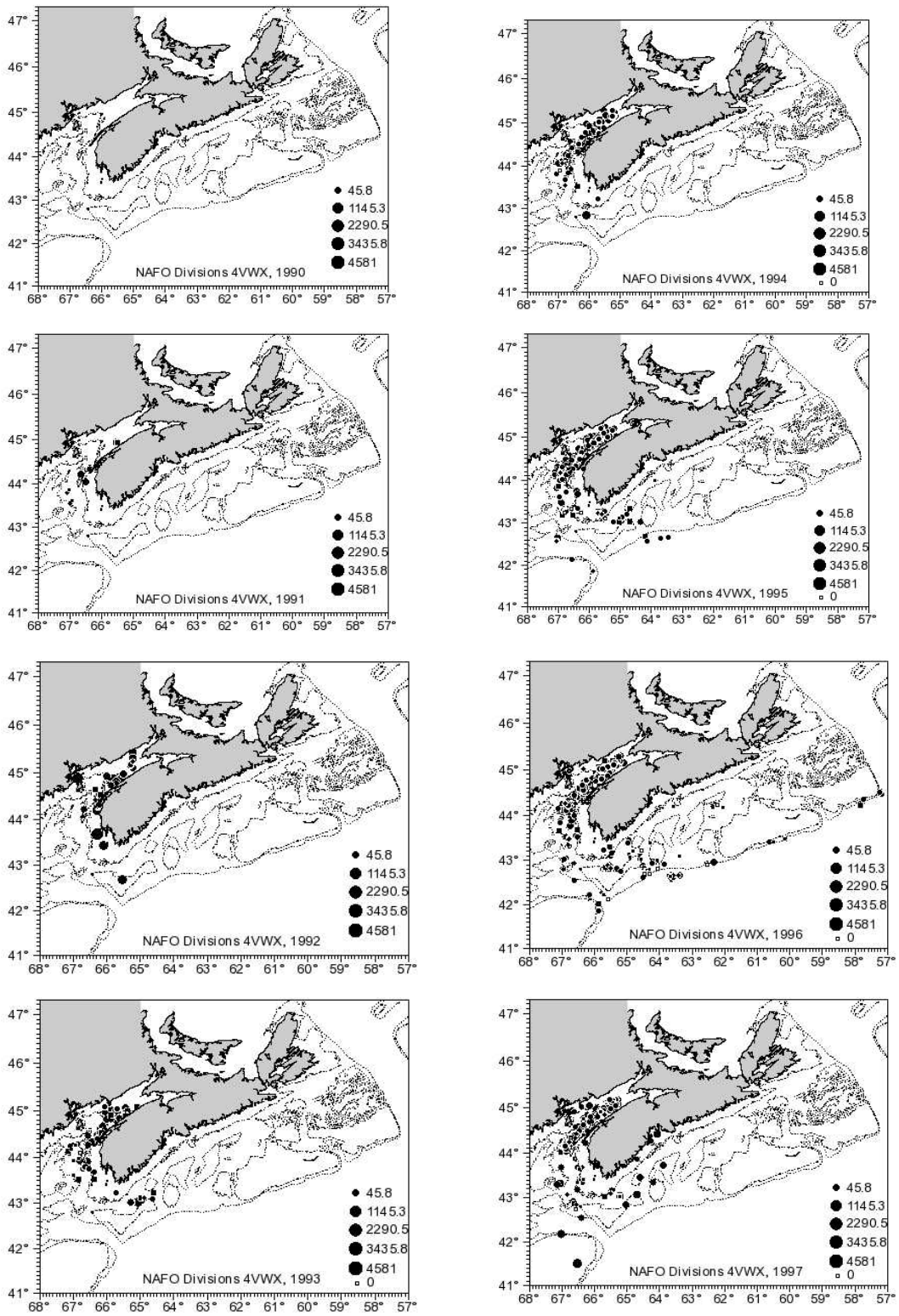

Figure 3. Distribution of reported longhorn sculpin catches (kg) on the Scotian Shelf by year from 1970 - 2007.

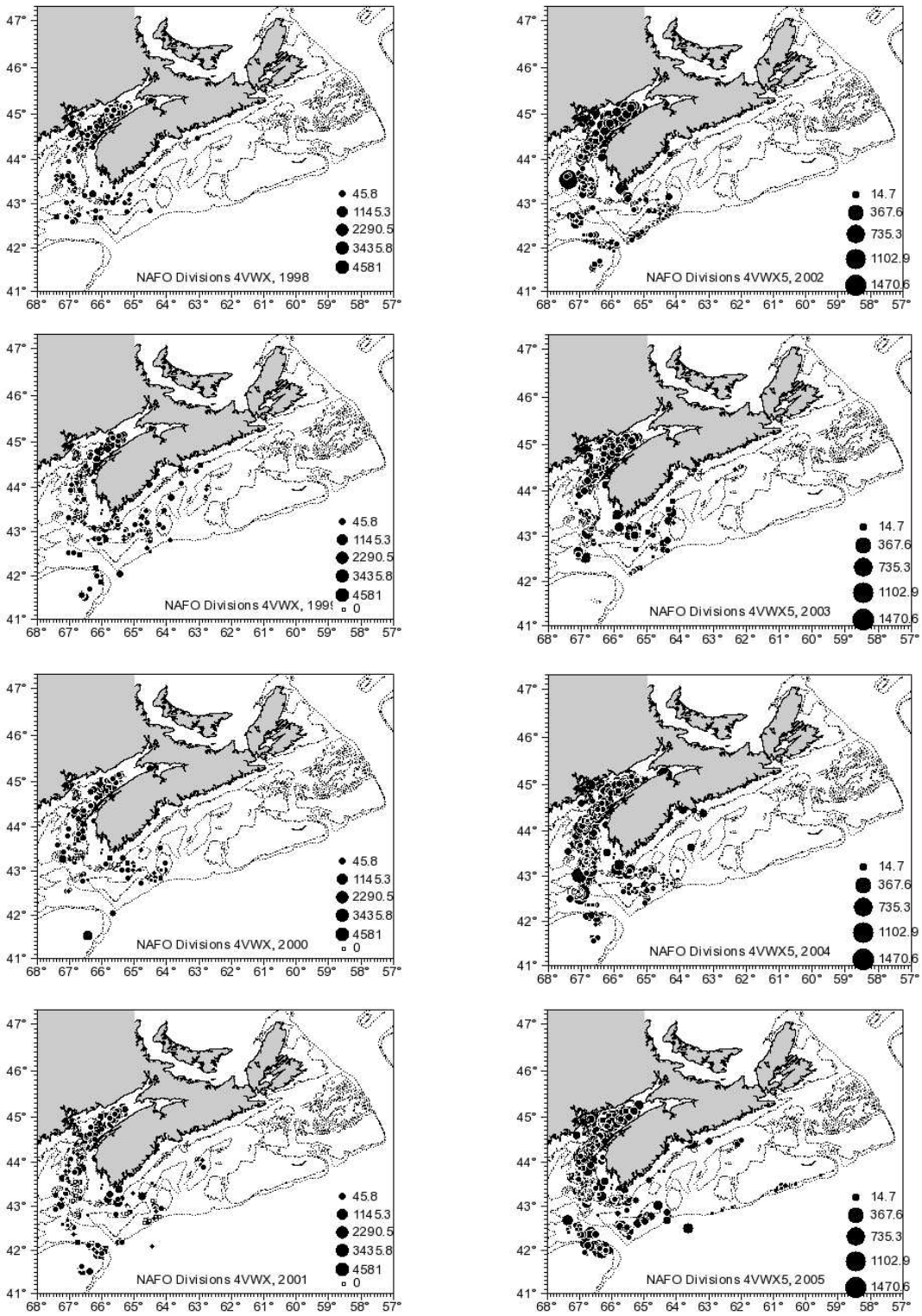

Figure 3 (continued). Distribution of reported longhorn sculpin catches (kg) on the Scotian Shelf by year from 1970 - 2007.

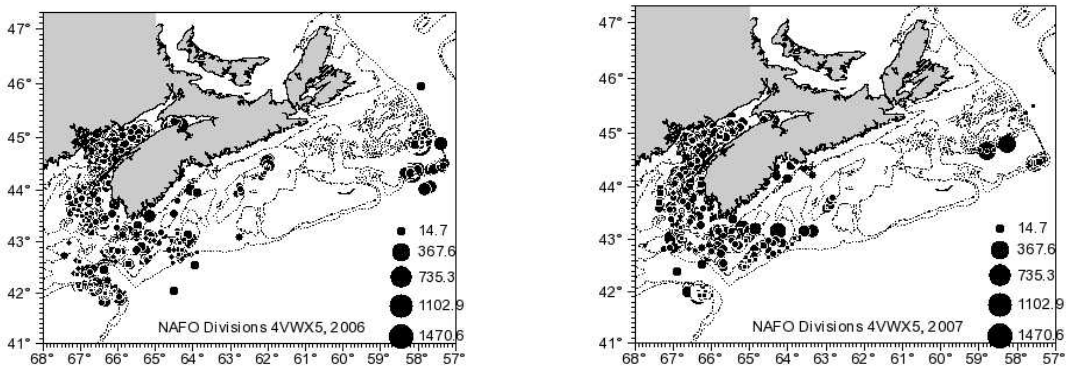

Figure 3 (continued). Distribution of reported longhorn sculpin catches (kg) on the Scotian Shelf by year from 1970 - 2007.

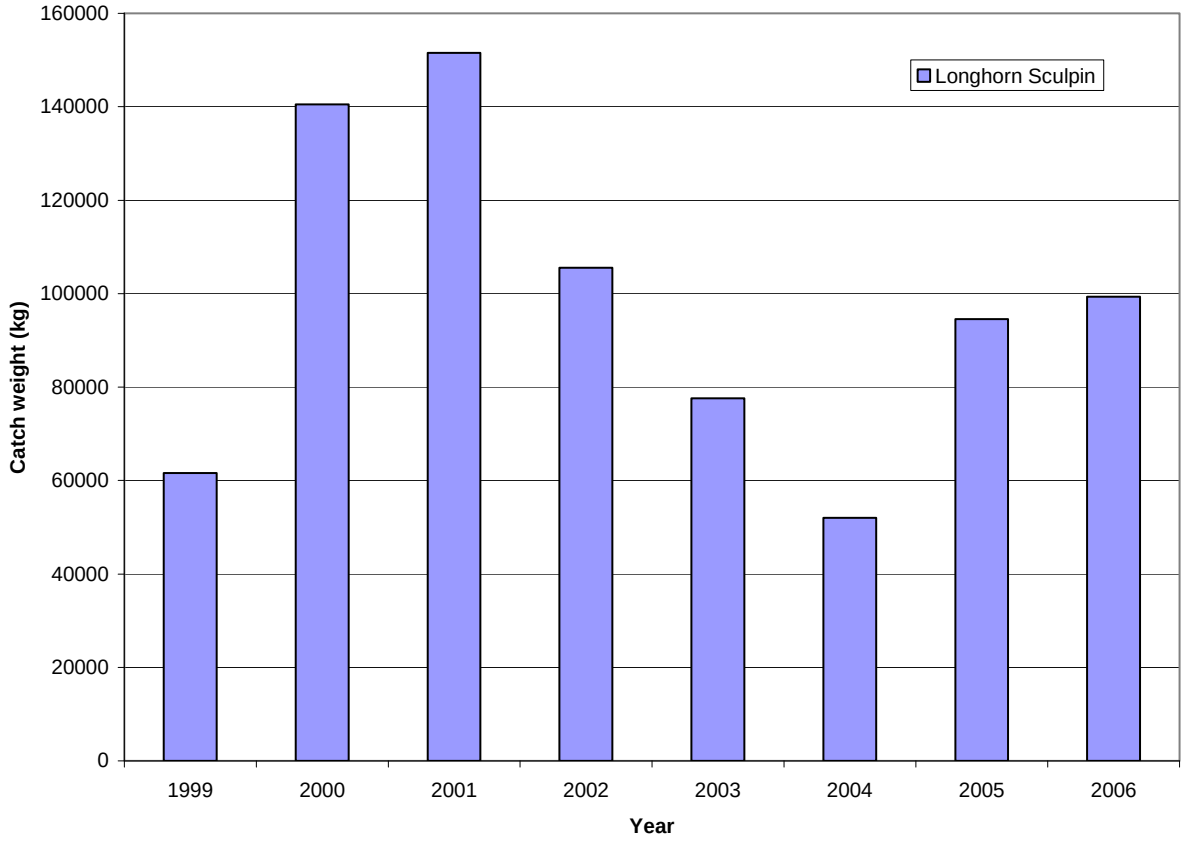

Figure 4. Longhorn sculpin reported catches by year in the directed fishery.

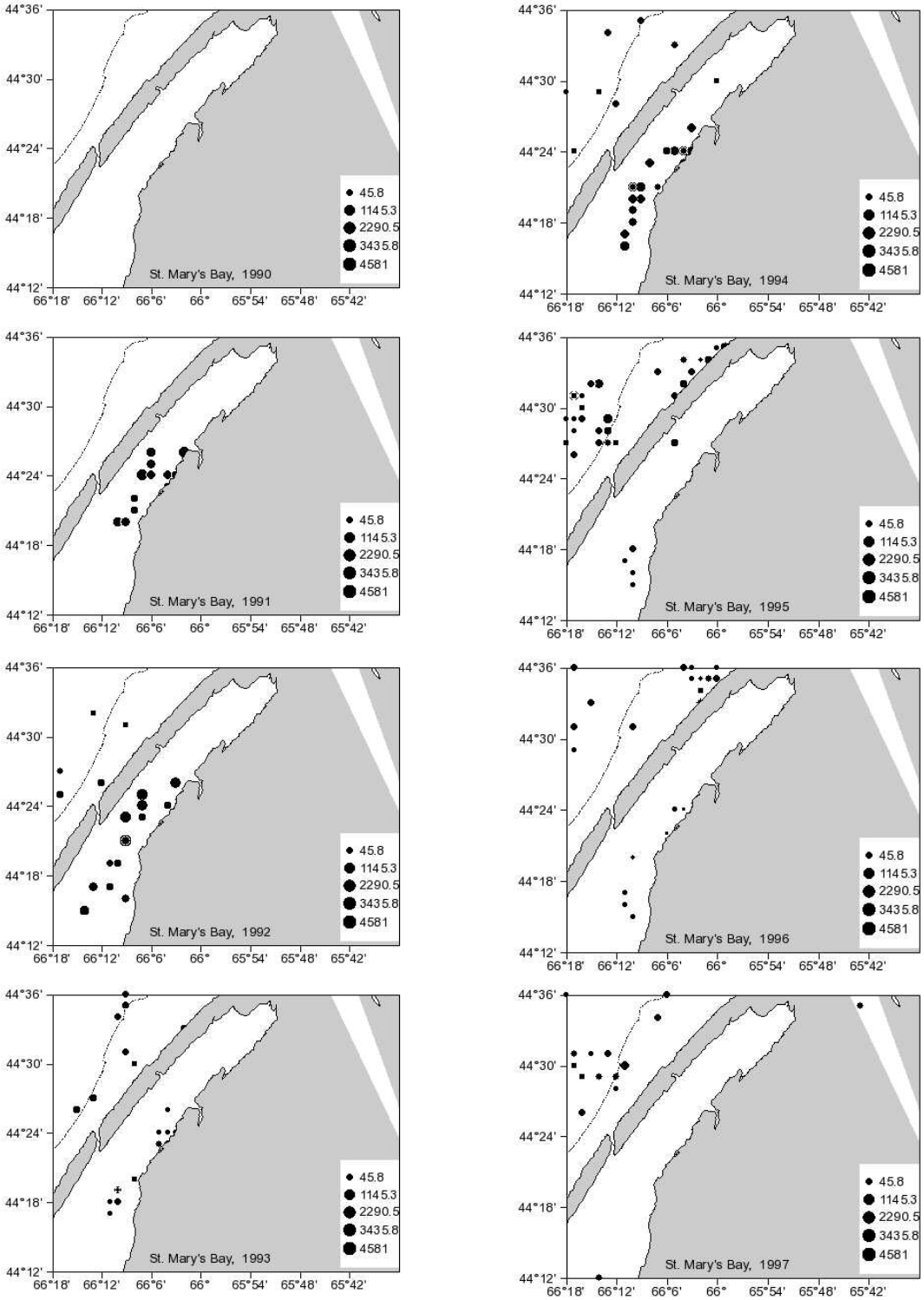

Figure 5. Distribution of reported longhorn sculpin catches (kg) in St. Mary's Bay by year from 1970 - 2007.

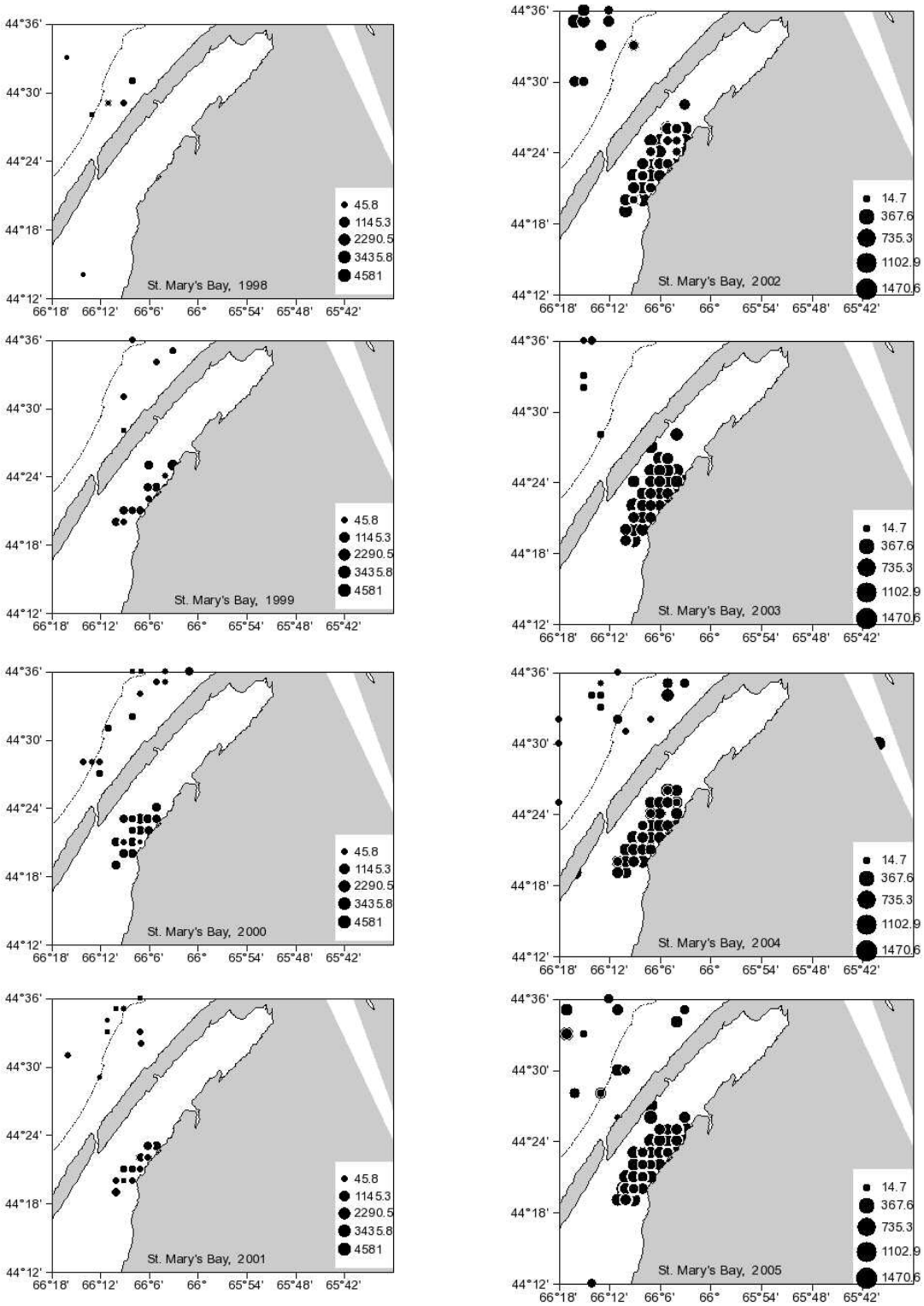

Figure 5 (continued). Distribution of reported longhorn sculpin catches (kg) in St. Mary's Bay by year from 1970 - 2007.

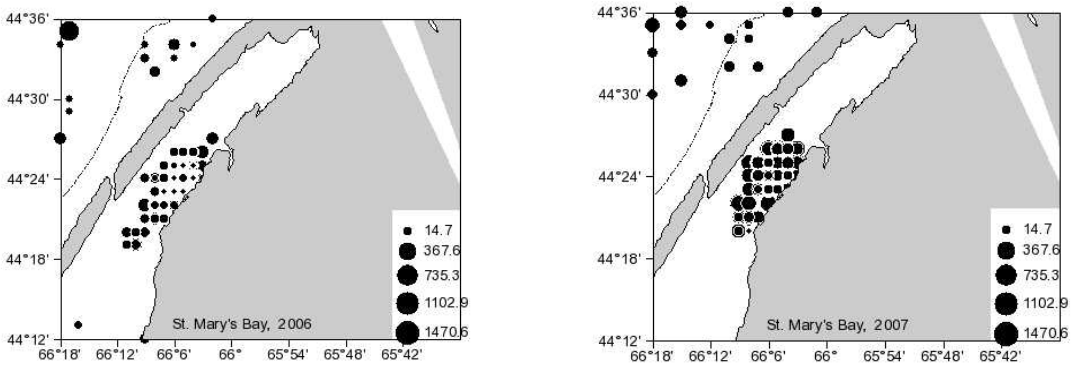

Figure 5 (continued). Distribution of reported longhorn sculpin catches (kg) in St. Mary's Bay by year from 1970 - 2007.

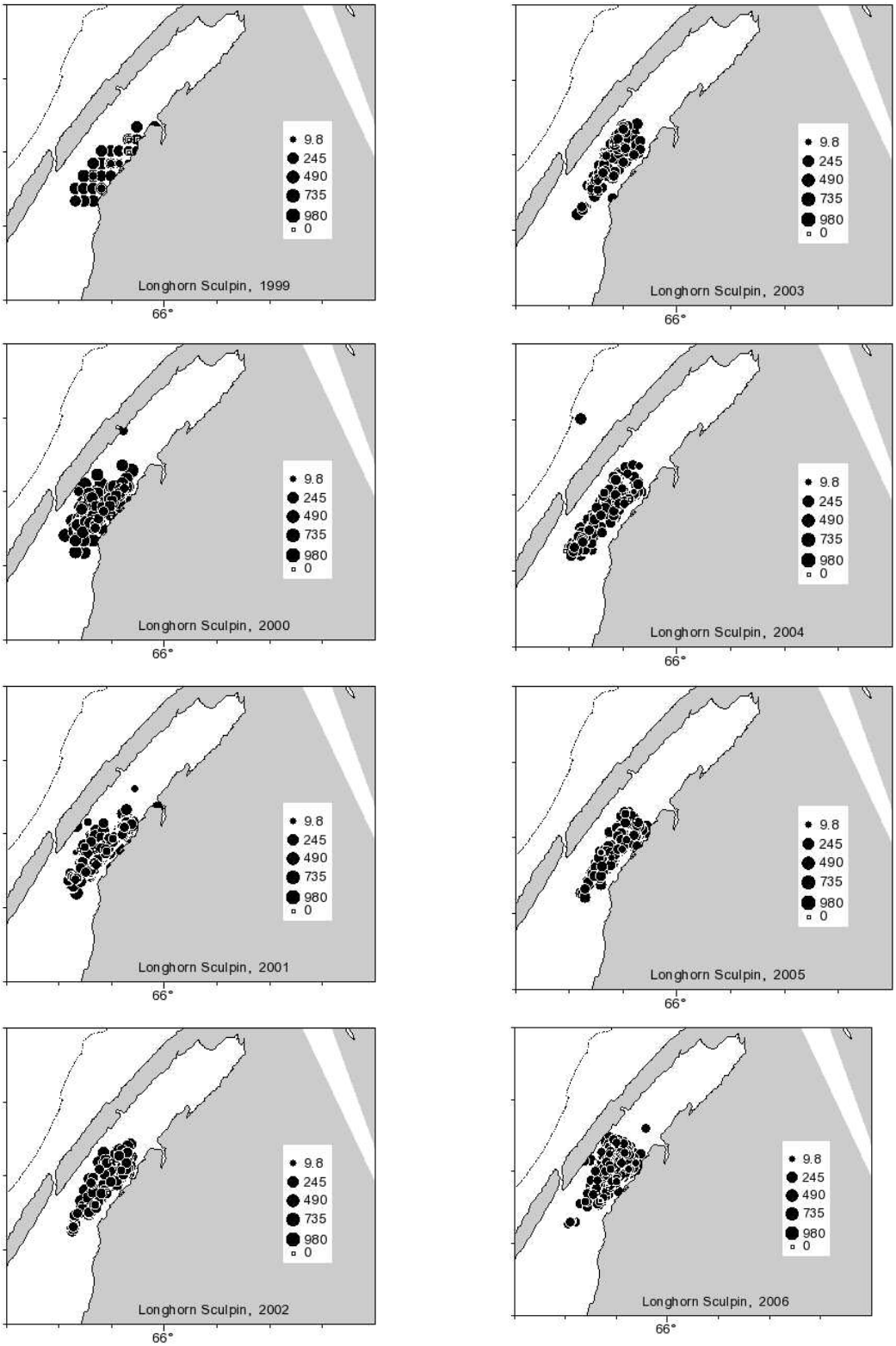

Figure 6. Distribution of observed longhorn sculpin catches (kg) from the directed fishery by year from 1999 - 2006.

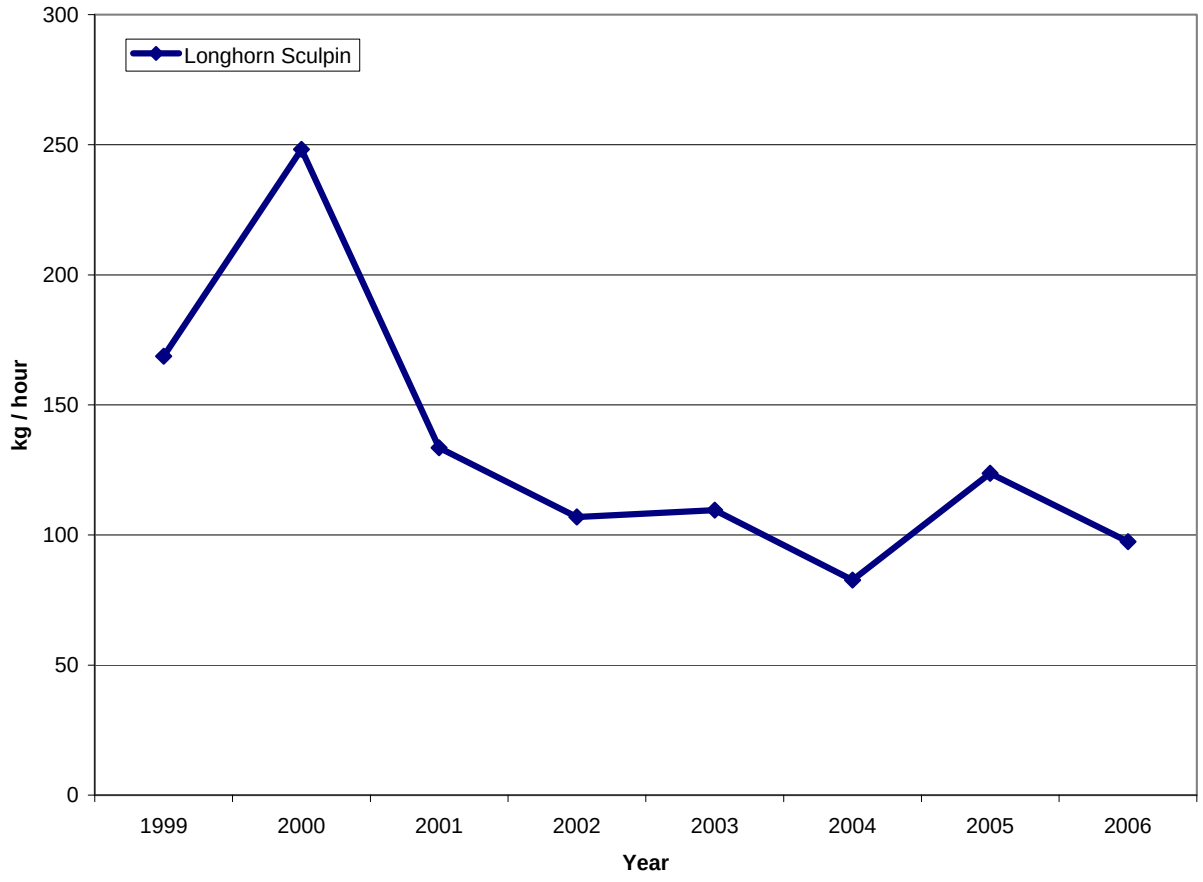

Figure 7. Longhorn sculpin catch rate (kg/hr) by year from the observed directed fishery.

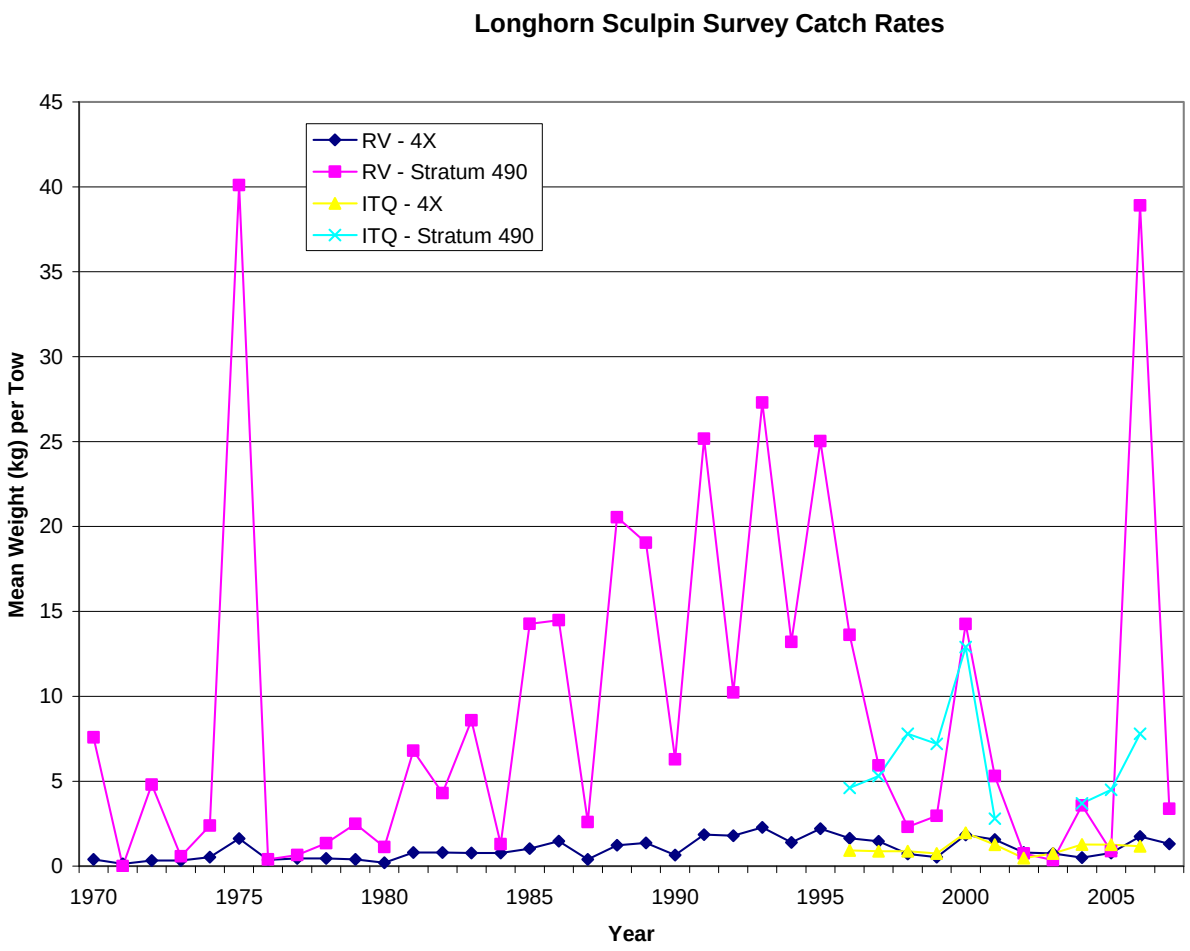

Figure 8. Catch rates (kg per tow) of longhorn sculpin caught in the 4X and Stratum 490 portions of the DFO summer research vessel (RV) survey and the Individual Transferable Quota (ITQ) survey.

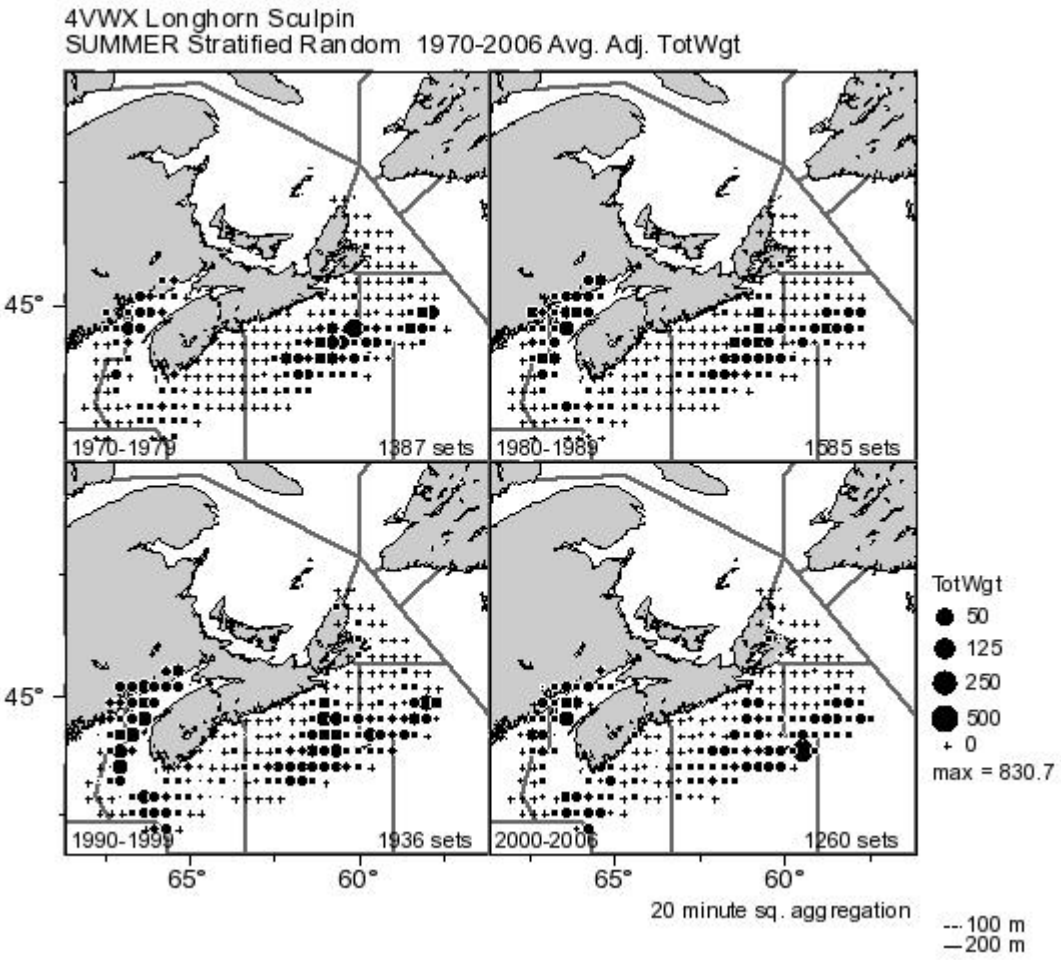

Figure 9. Distribution of longhorn sculpin catches (kg) in 4VWX from the DFO summer research vessel (RV) survey from 1970 - 2006.

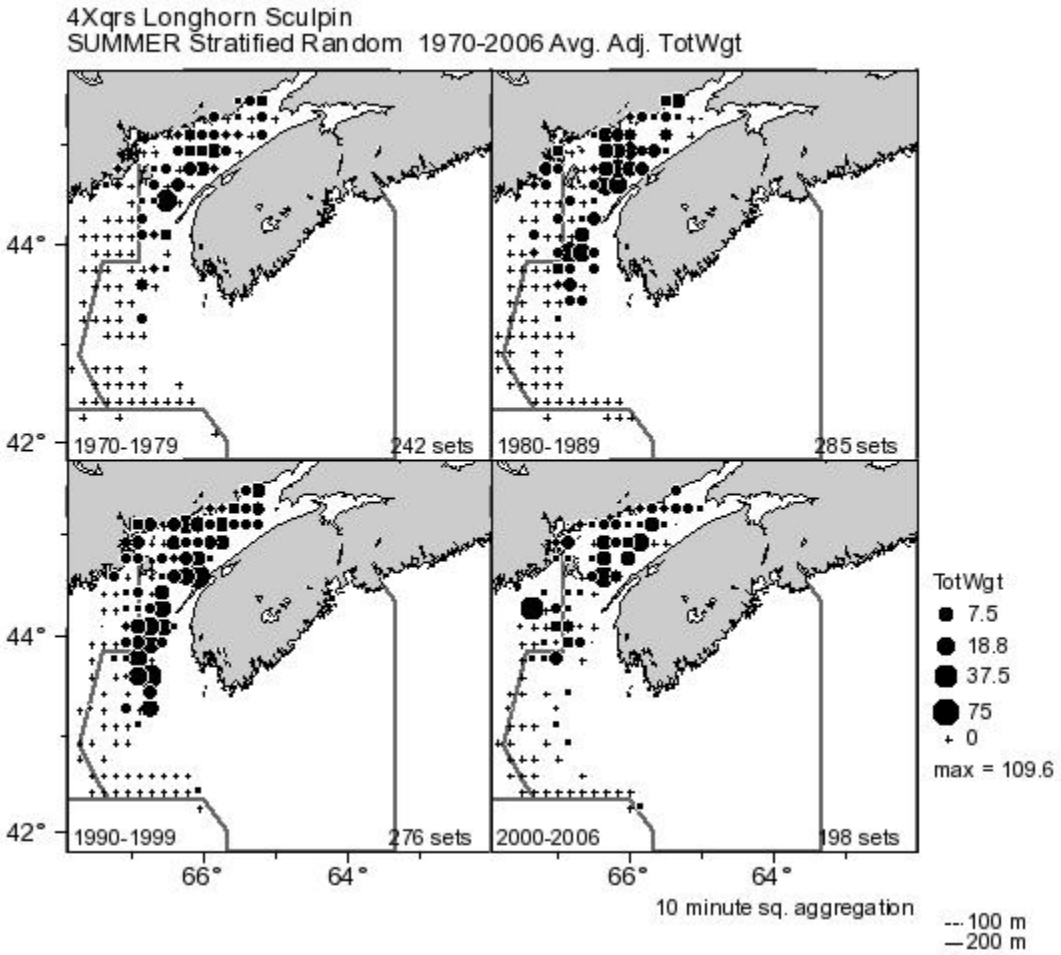

Figure 10. Distribution of longhorn sculpin catches (kg) in 4Xqrs (Bay of Fundy and Gulf of Maine) from the DFO summer research vessel (RV) survey from 1970 - 2006.

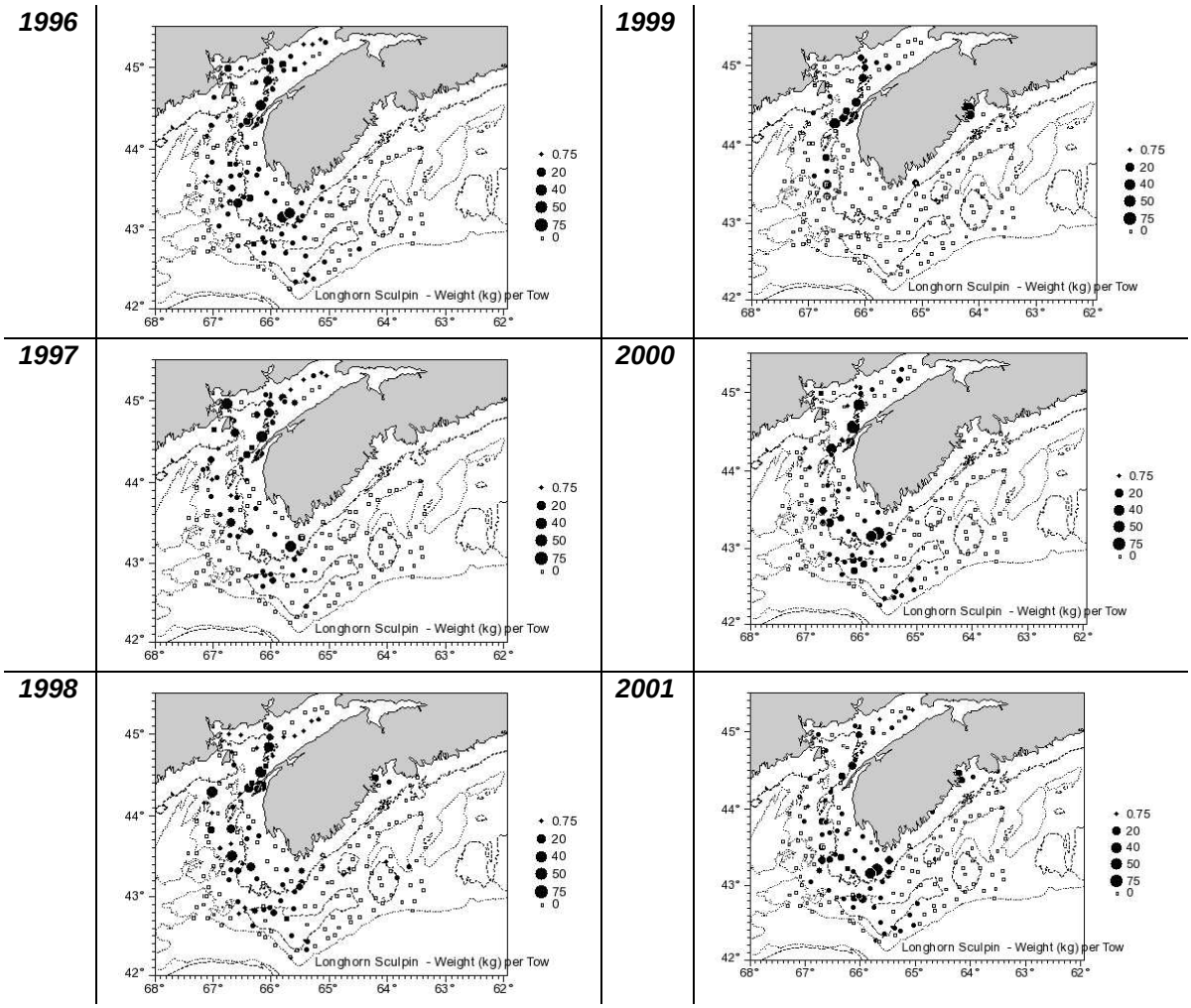

Figure 11. Individual Transferable Quota (ITQ) survey longhorn sculpin catches (kg) by year from 1996 - 2006.

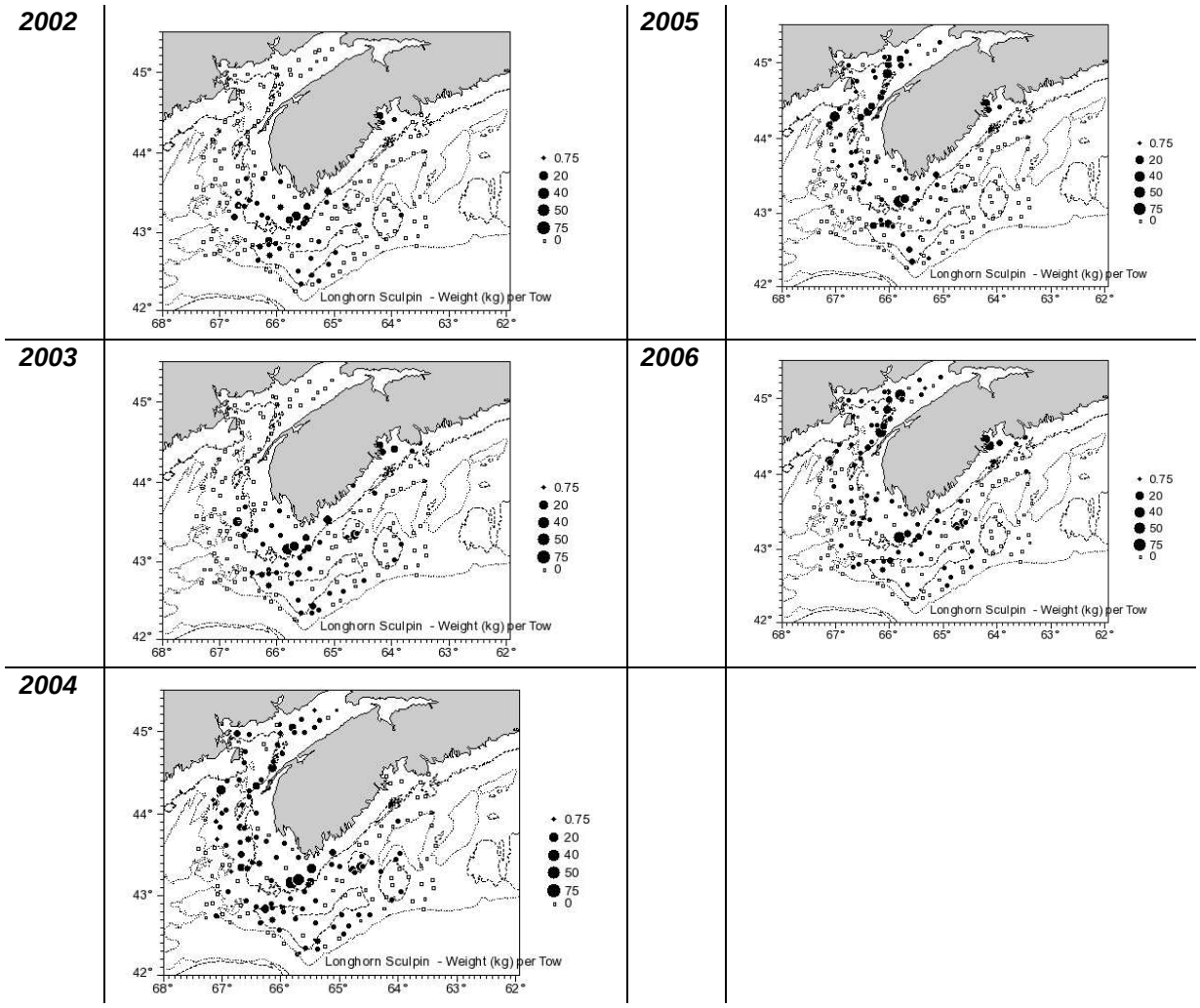

Figure 11 (continued). Individual Transferable Quota (ITQ) survey longhorn sculpin catches (kg) by year from 1996 - 2006.

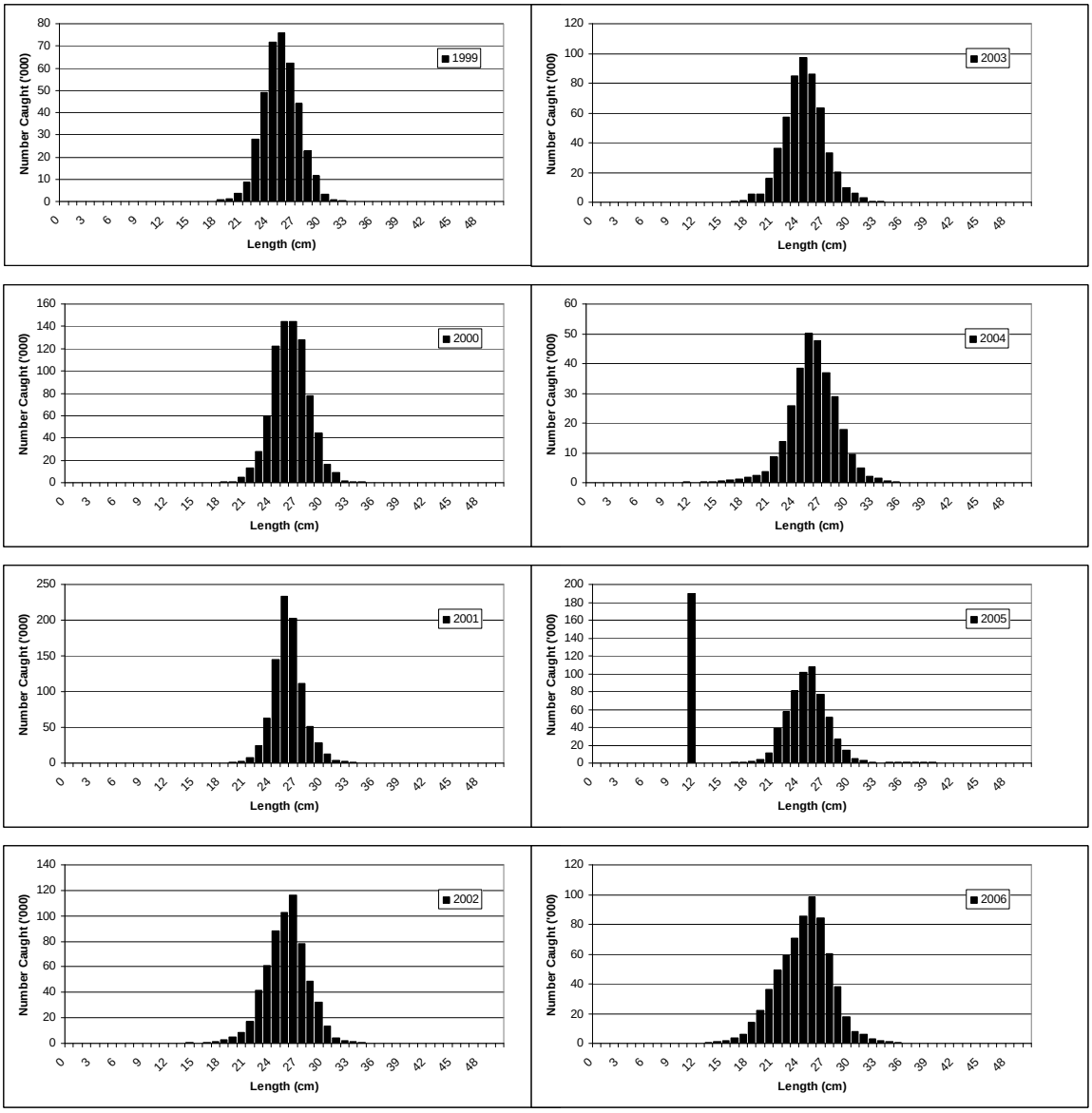

Figure 12. Length composition of longhorn sculpin from the observed catches in the directed longhorn sculpin fishery by year from 1999 - 2006.

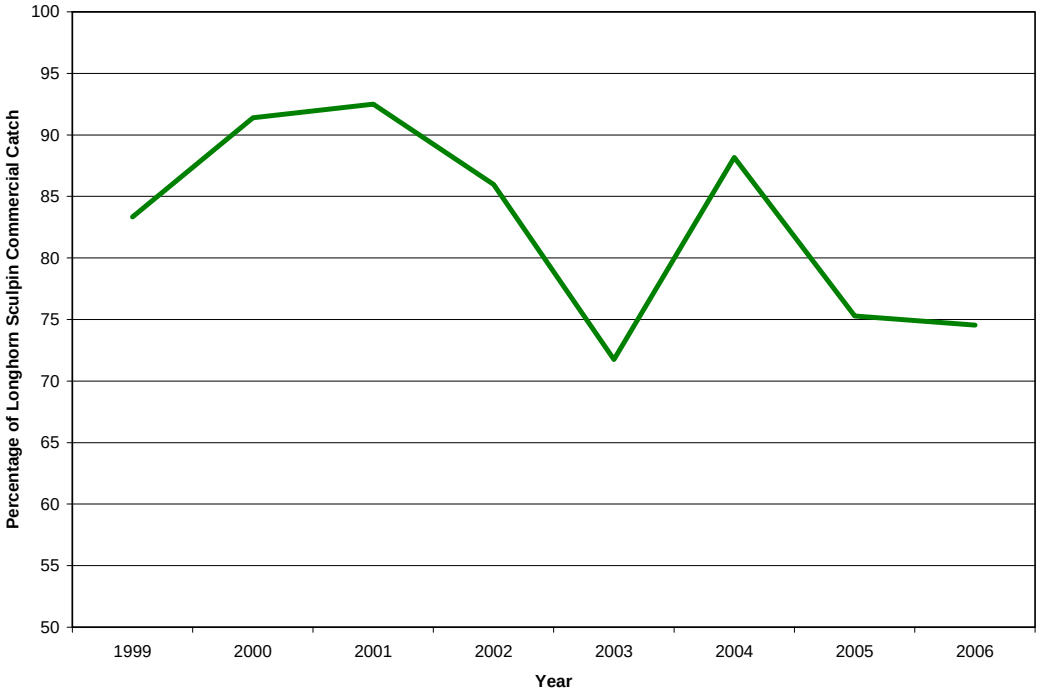

Figure 13. Proportion of commercial longhorn sculpin catch, by year, that is greater than 23cm.

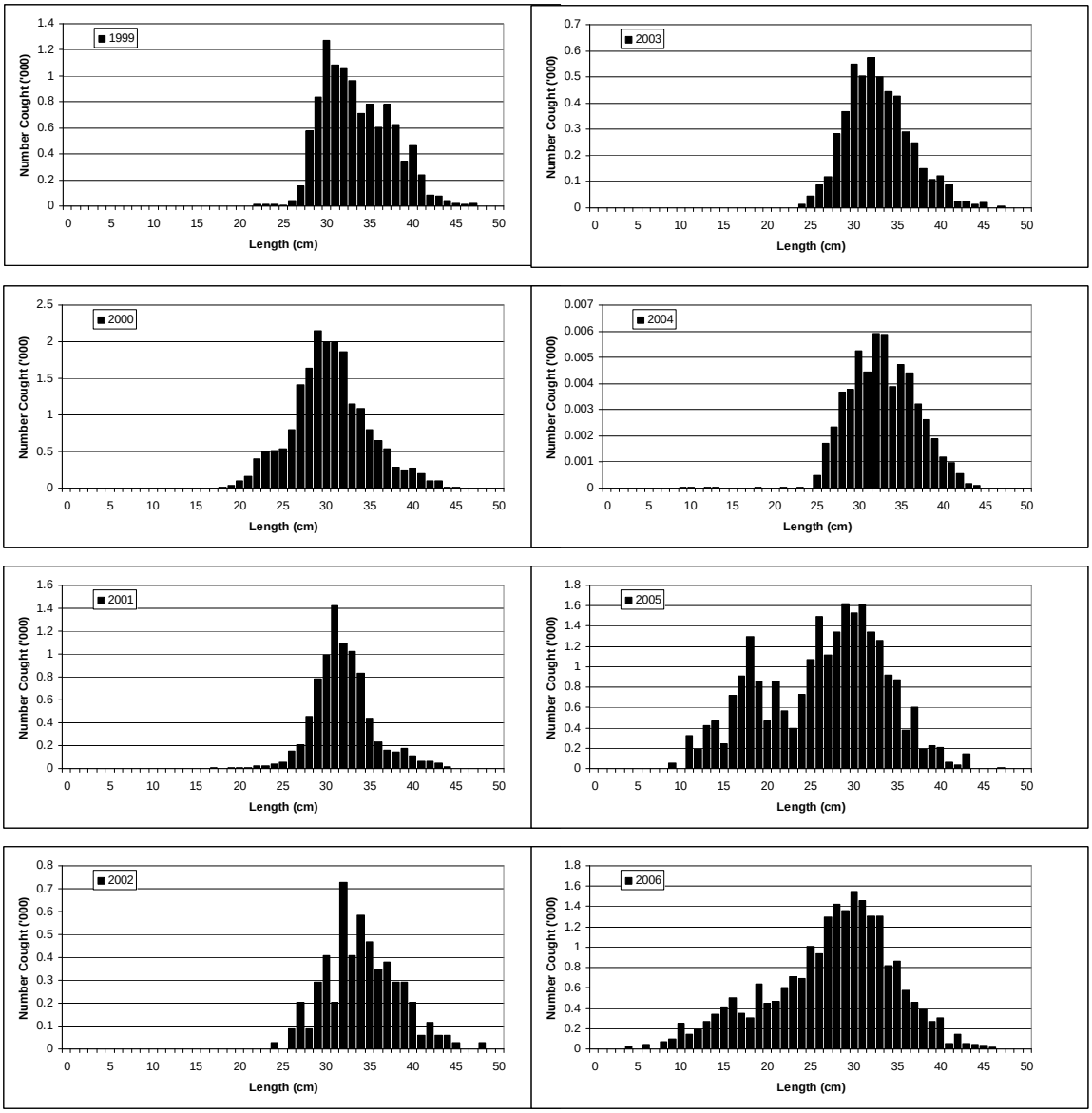

Figure 14. Length composition of winter flounder from the observed catches in the directed longhorn sculpin fishery by year from 1999 - 2006.

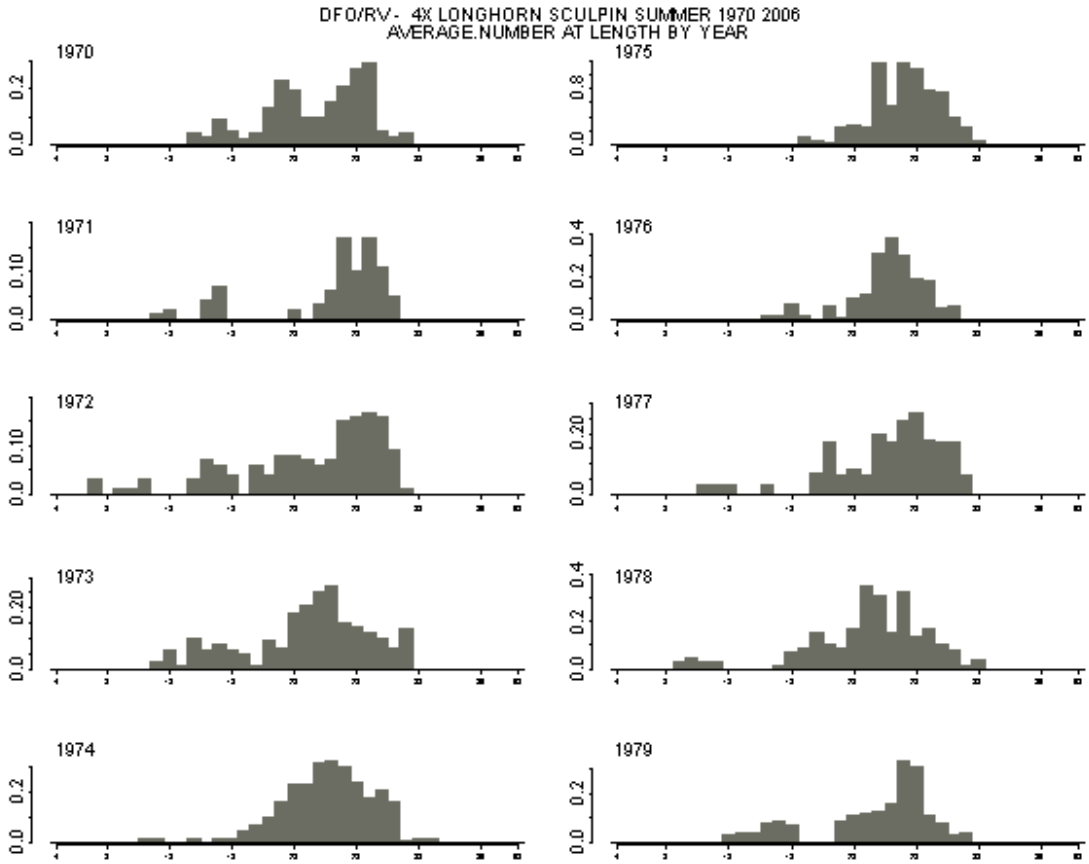

Figure 15. Length composition of longhorn sculpin from the 4X portion of the DFO summer research vessel (RV) survey (1970 – 2006).

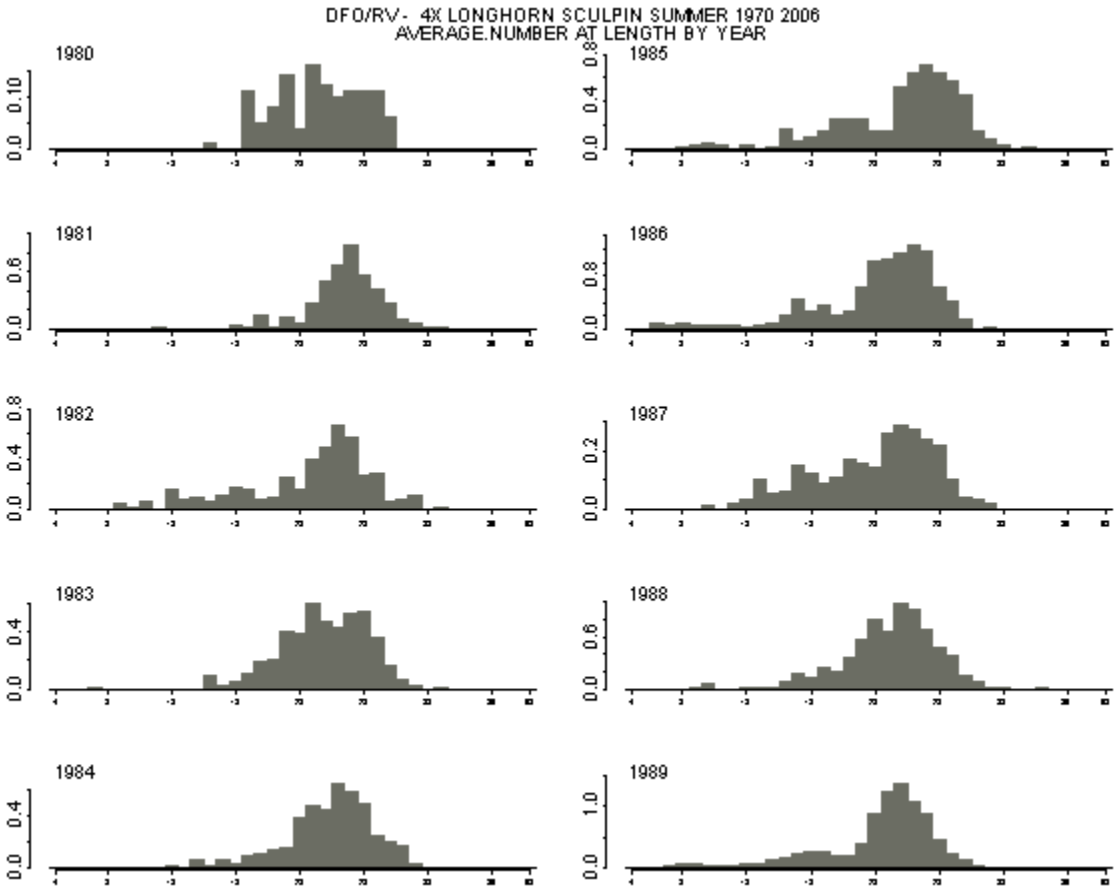

Figure 15 (continued). Length composition of longhorn sculpin from the 4X portion of the DFO summer research vessel (RV) survey (1970 – 2006).

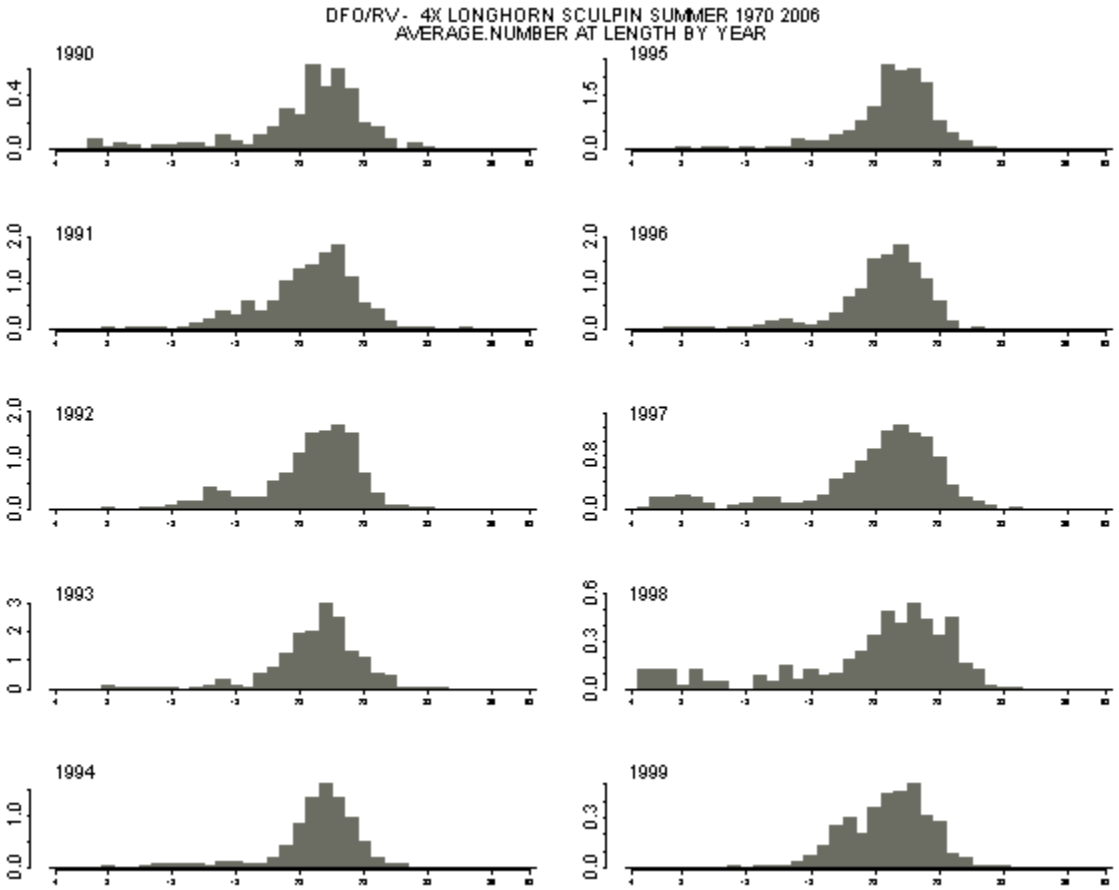

Figure 15 (continued). Length composition of longhorn sculpin from the 4X portion of the DFO summer research vessel (RV) survey (1970 – 2006).

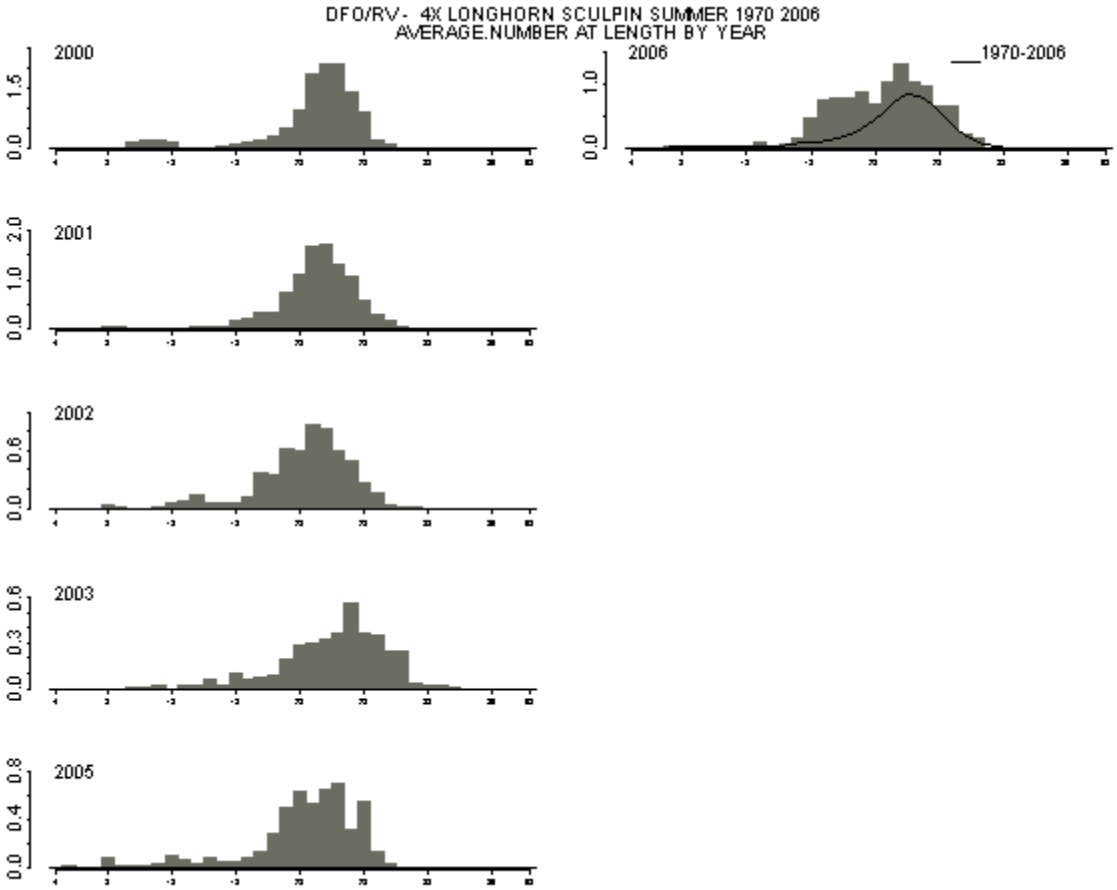

Figure 15 (continued). Length composition of longhorn sculpin from the 4X portion of the DFO summer research vessel (RV) survey (1970 – 2006).

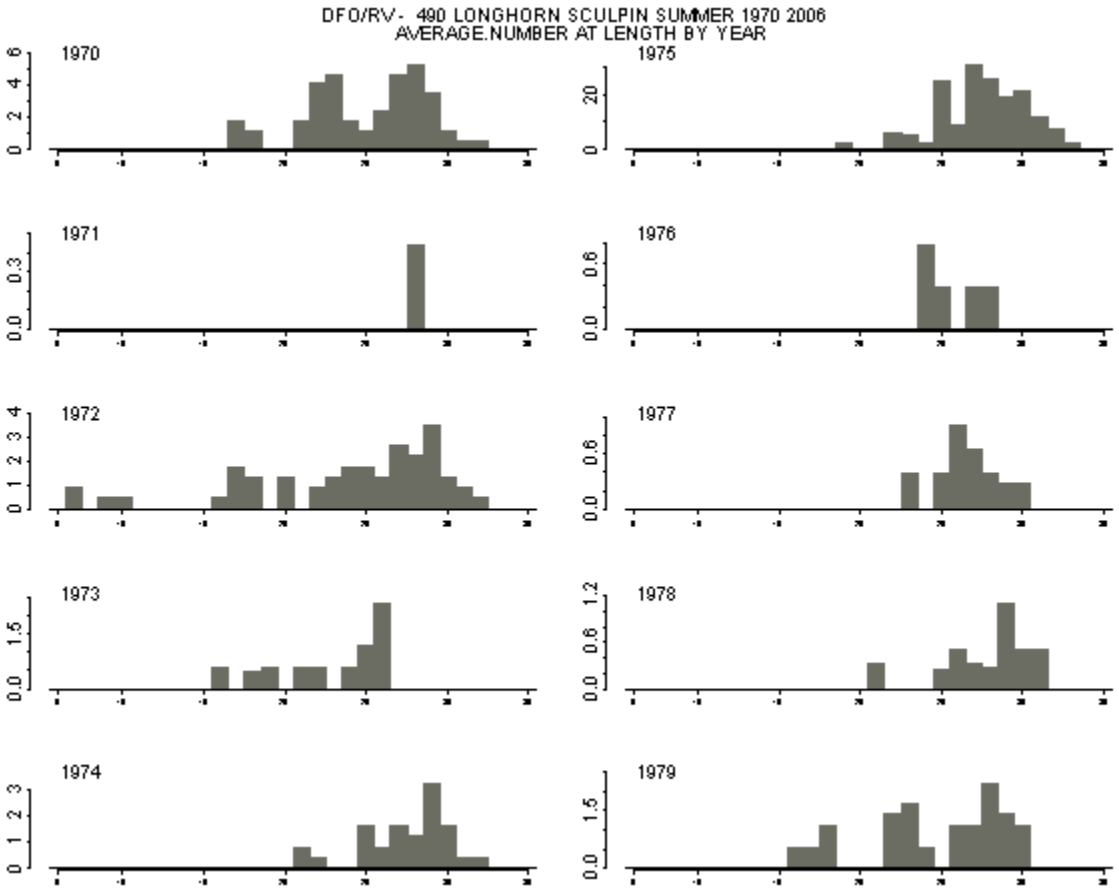

Figure 16. Length composition of longhorn sculpin from Stratum 490 of the DFO summer research vessel (RV) survey (1970 – 2006).

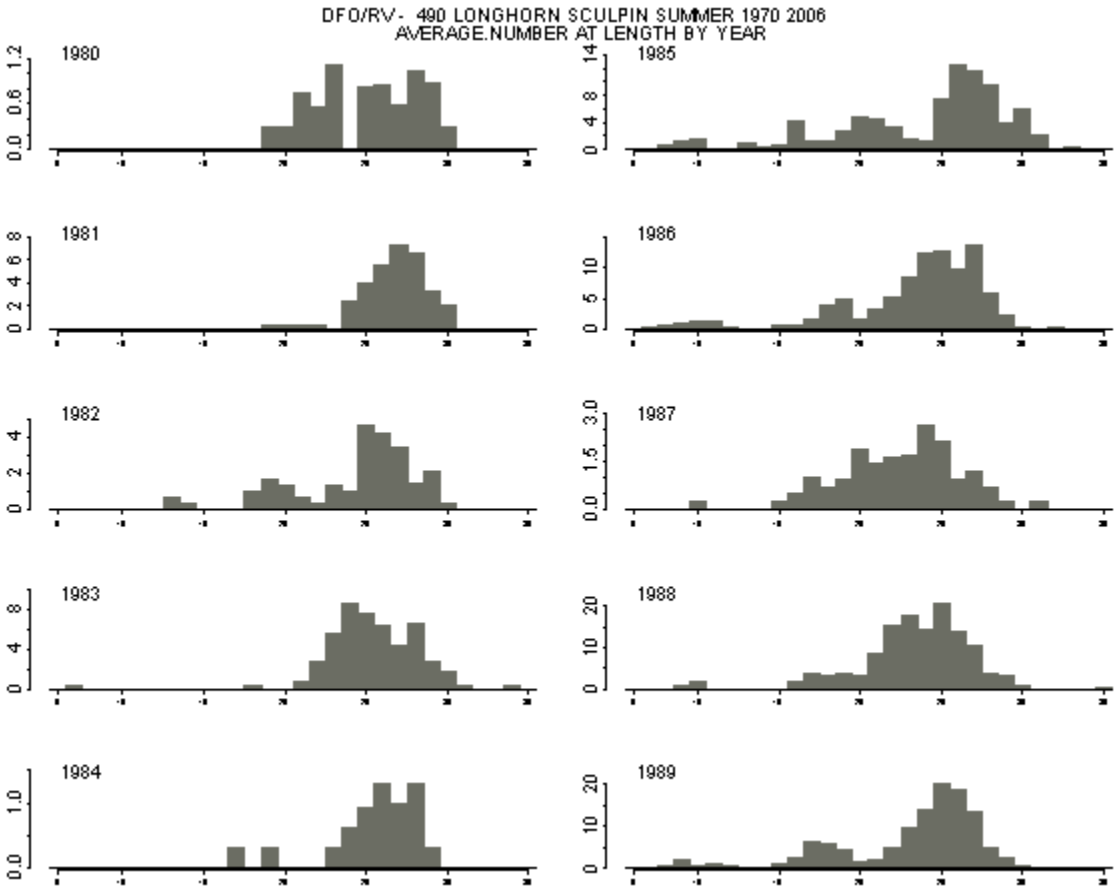

Figure 16 (continued). Length composition of longhorn sculpin from Stratum 490 of the DFO summer research vessel (RV) survey (1970 – 2006).

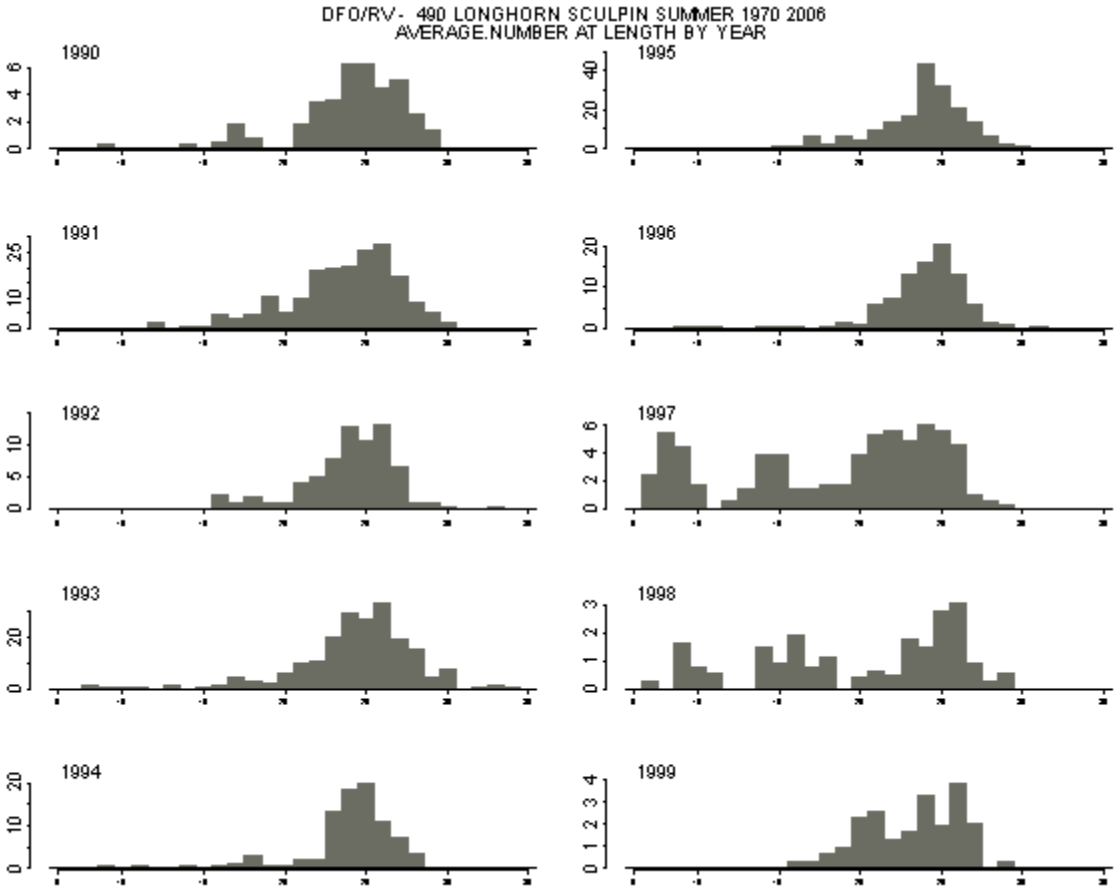

Figure 16 (continued). Length composition of longhorn sculpin from Stratum 490 of the DFO summer research vessel (RV) survey (1970 – 2006).

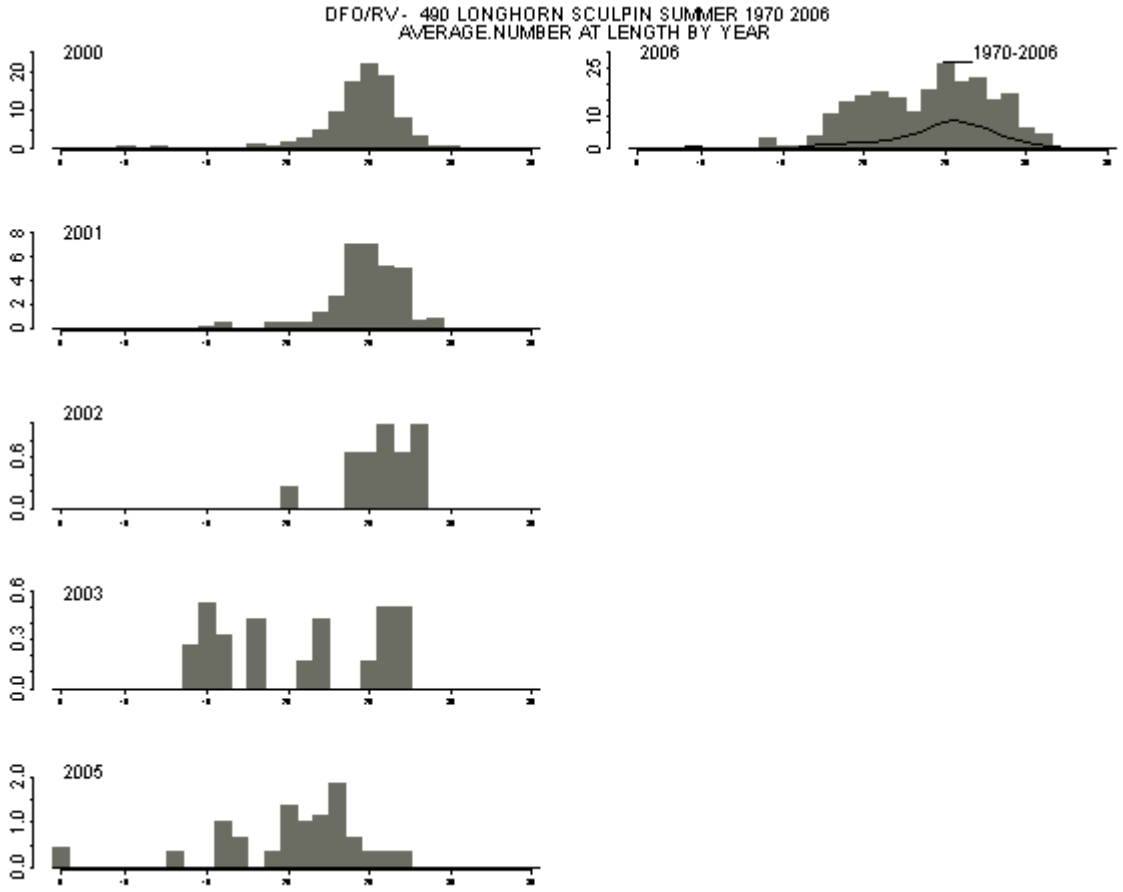

Figure 16 (continued). Length composition of longhorn sculpin from Stratum 490 of the DFO summer research vessel (RV) survey (1970 – 2006).

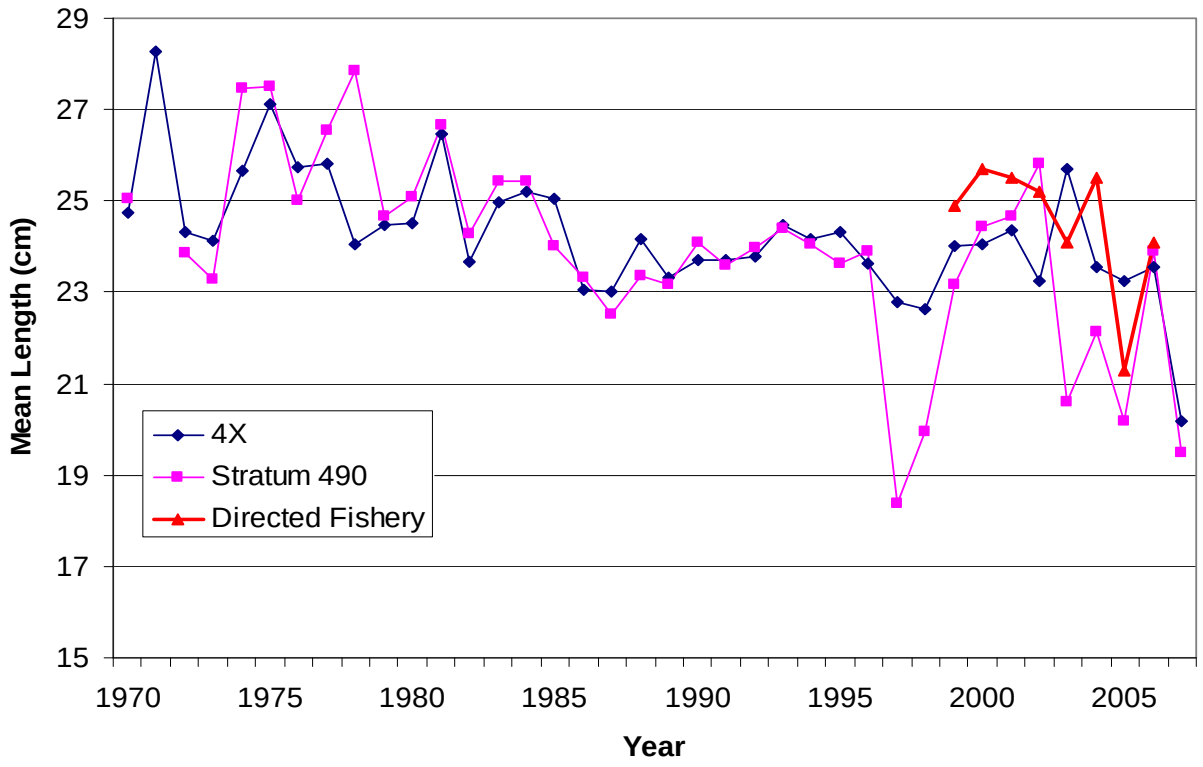

Figure 17. Mean length (cm) of longhorn sculpin caught in the 4X and Stratum 490 portions of the DFO research vessel (RV) survey and in the directed fishery in St. Mary's Bay, by year.

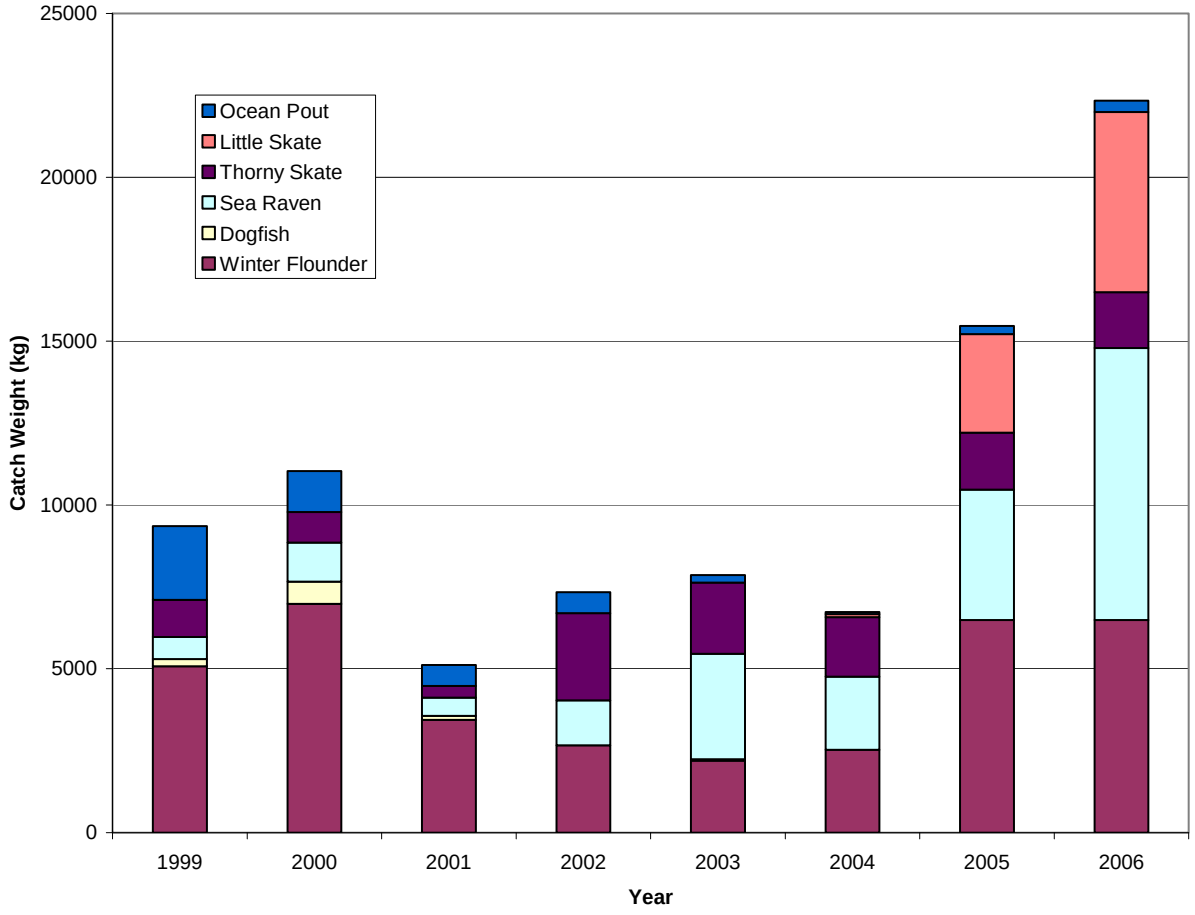

Figure 18. By-catch of selected groundfish species from the directed sculpin fishery, by year. Observer estimates are adjusted to the level of reported sculpin landings.

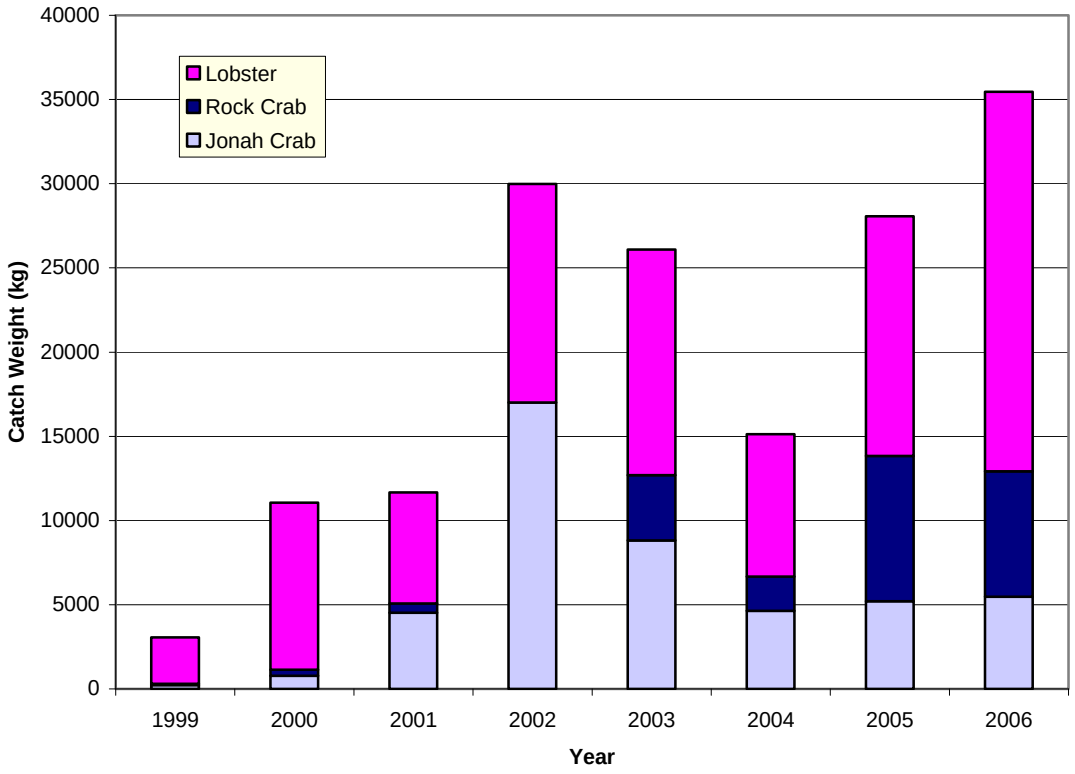

Figure 19. By-catch of selected invertebrate species from the directed sculpin fishery, by year. Observer estimates are adjusted to the level of reported sculpin landings.

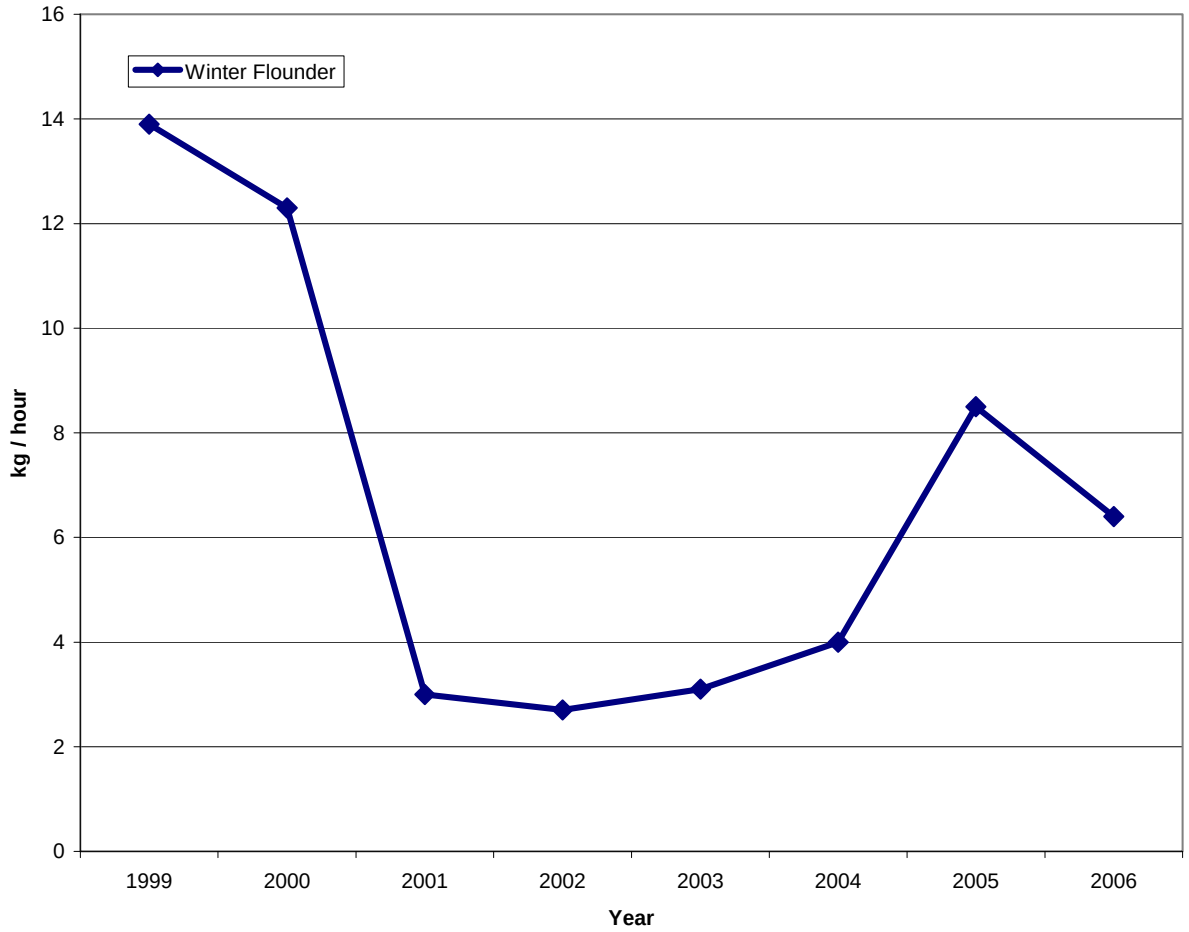

Figure 20. Winter flounder catch rate (kg/hr) by year from the observed directed fishery.

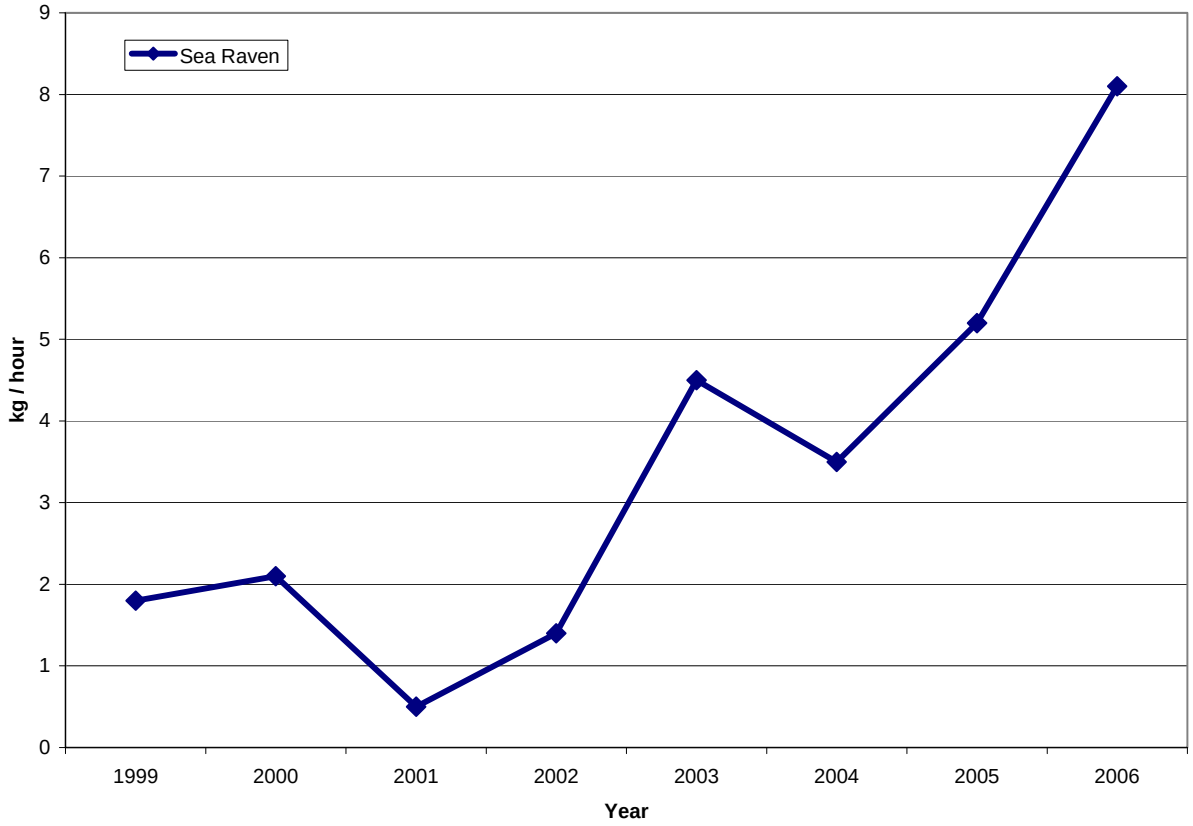

Figure 21. Sea raven catch rate (kg/hr) by year from the observed directed fishery.

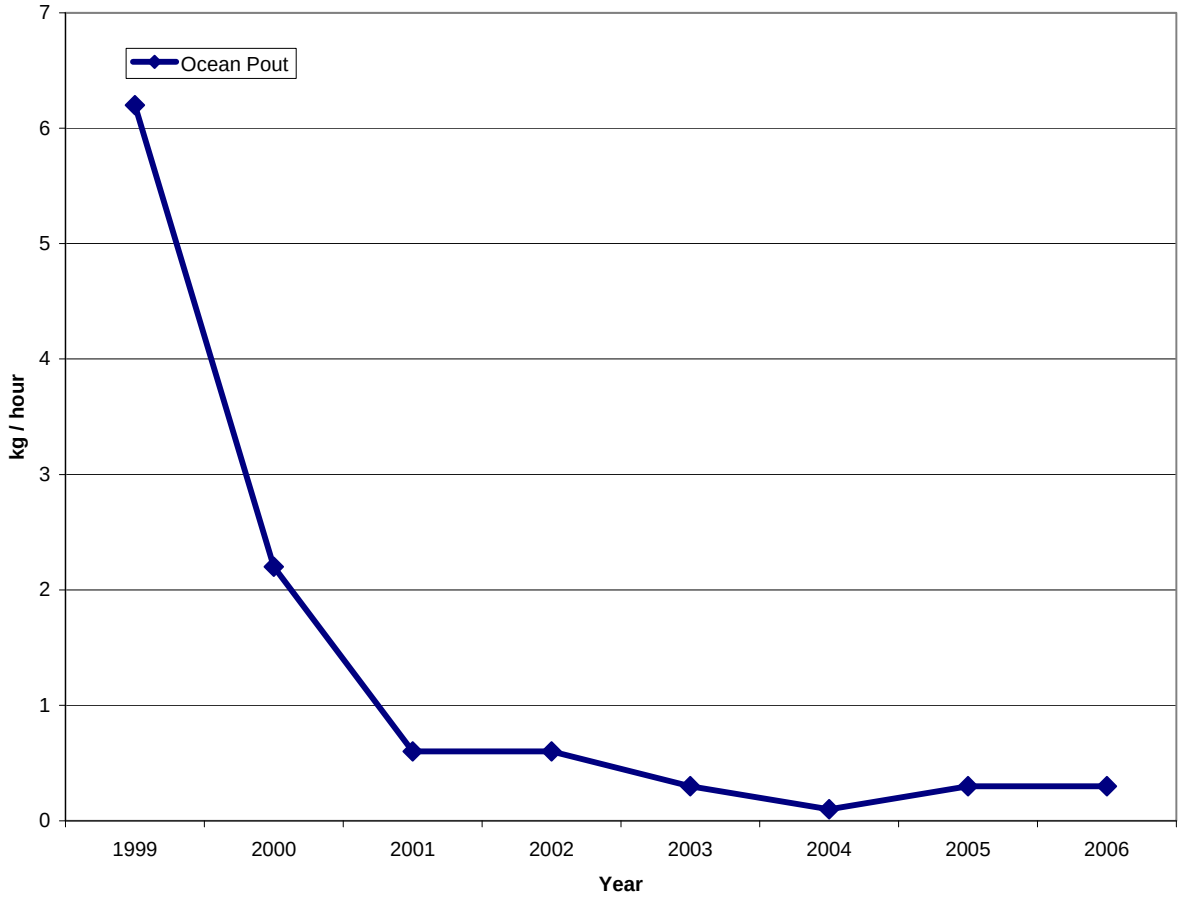

Figure 22. Ocean pout catch rate (kg/hr) by year from the observed directed fishery.

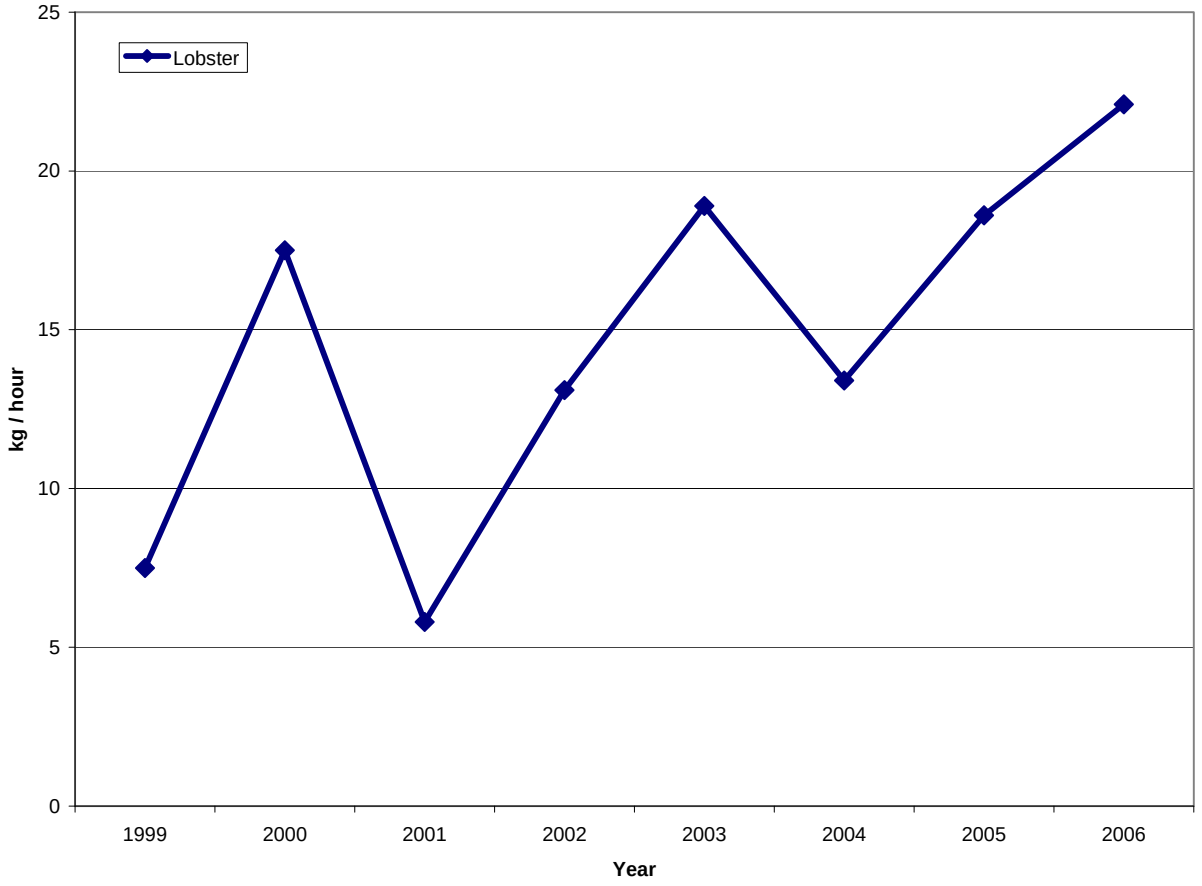

Figure 23. Lobster catch rate (kg/hr) by year from the observed directed fishery.

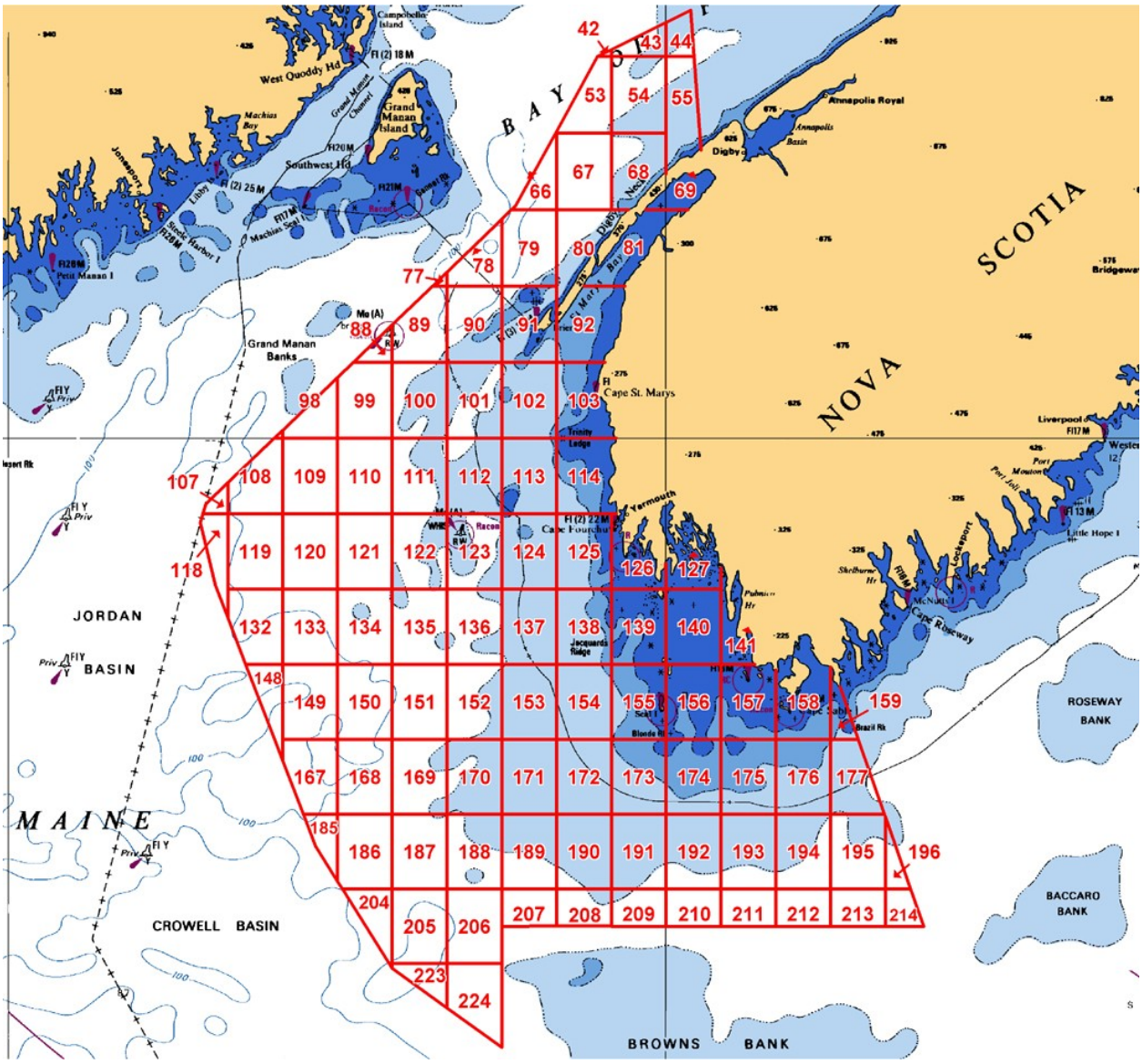

Figure 24. Reporting grids used for Lobster Fishing Area (LFA) 34 lobster fishery.

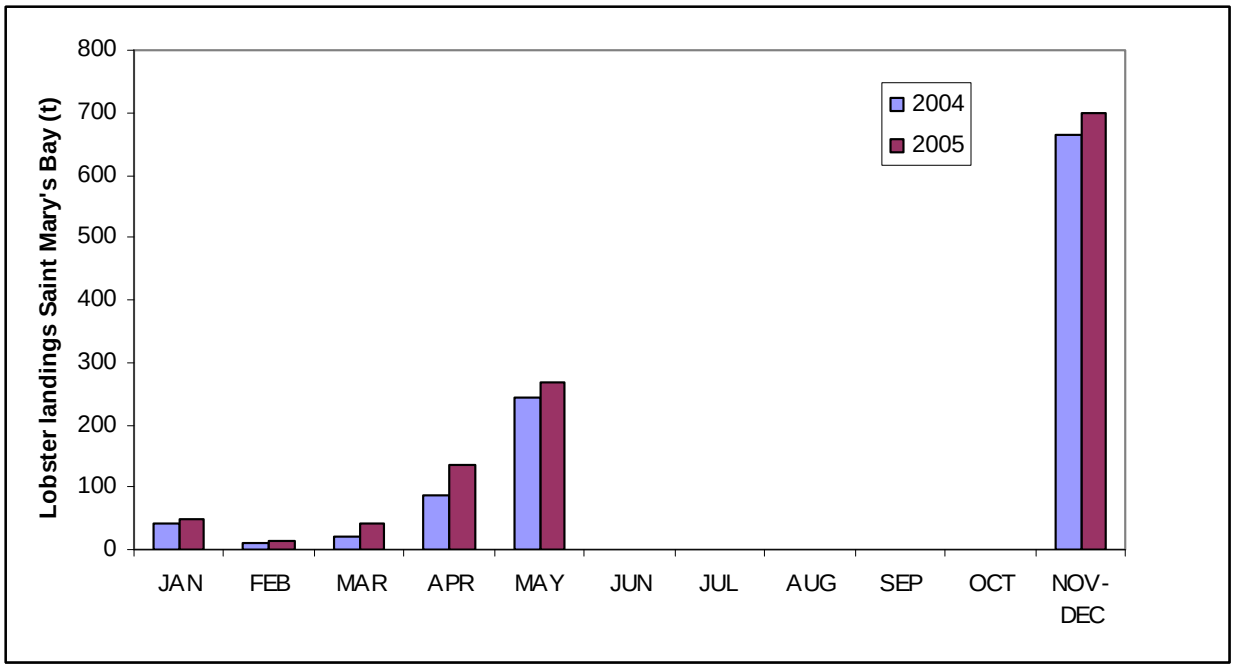

Figure 25. Lobster Fishing Area (LFA) 34 fishery lobster landings by month in St. Mary's Bay (grids 69, 91, 92) in 2004 and 2005.

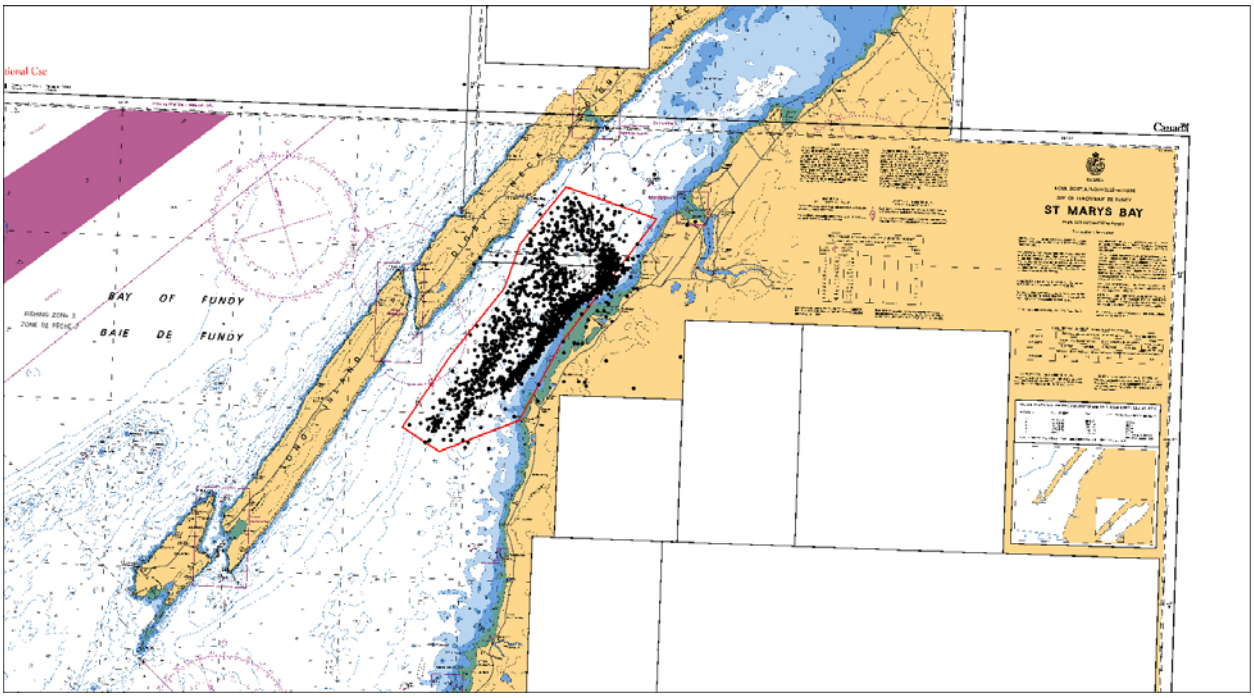

Figure 26. Area of sculpin fishing. Points are from observed sculpin fishing trips, 1999-2006. Polygon outlines sculpin fishing area.

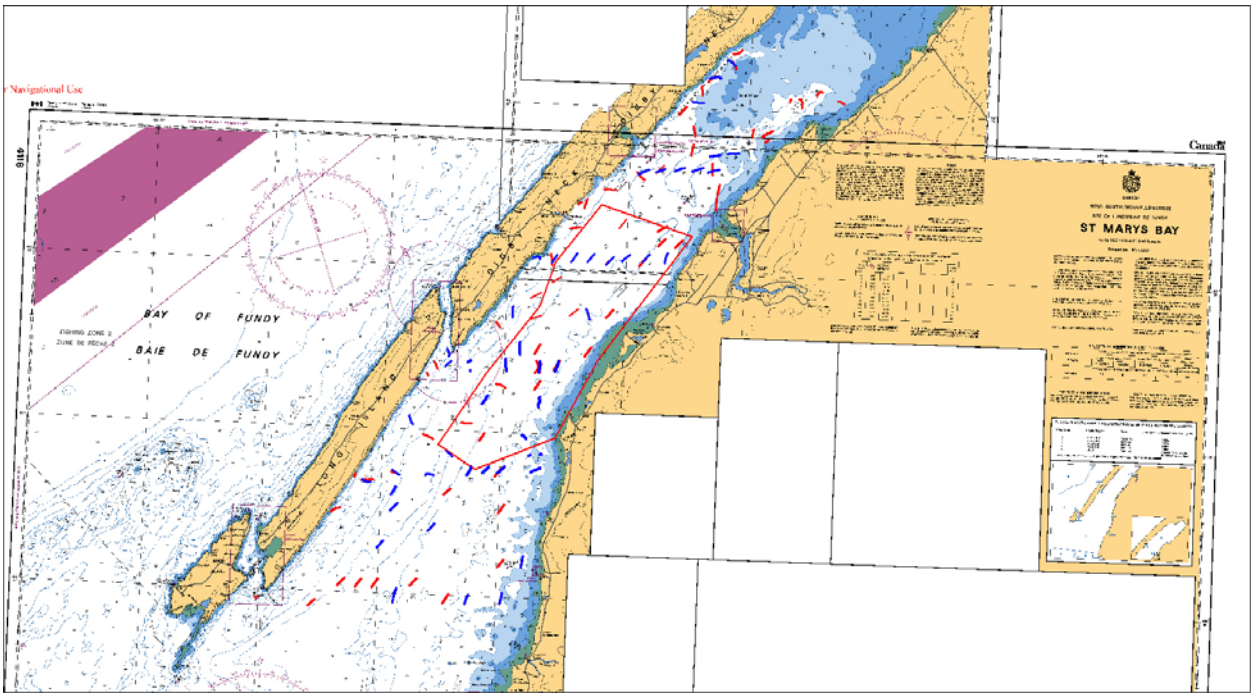

Figure 27. Location of underwater video transects completed with URCHIN. Those in red were completed in 2006; those in blue were completed in 2007.

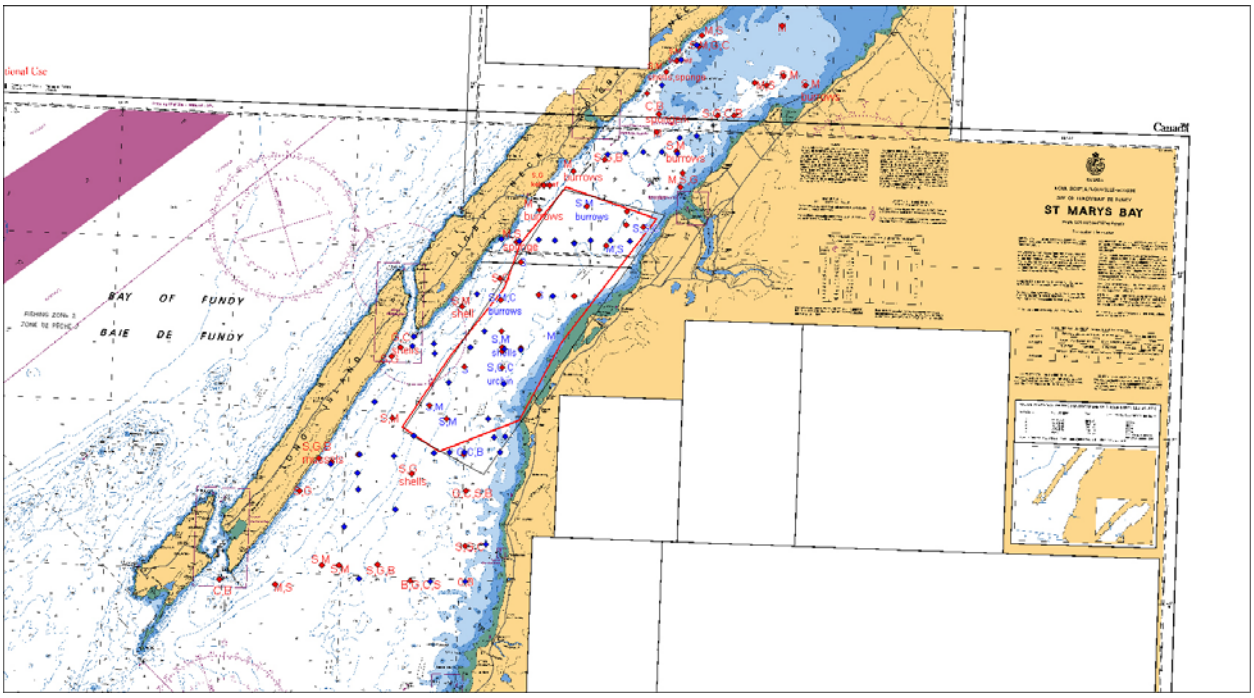

Figure 28. Predominant bottom type for different locations noted during video transects. Points show the central location of each transect. Polygon shows the main area of sculpin fishery.

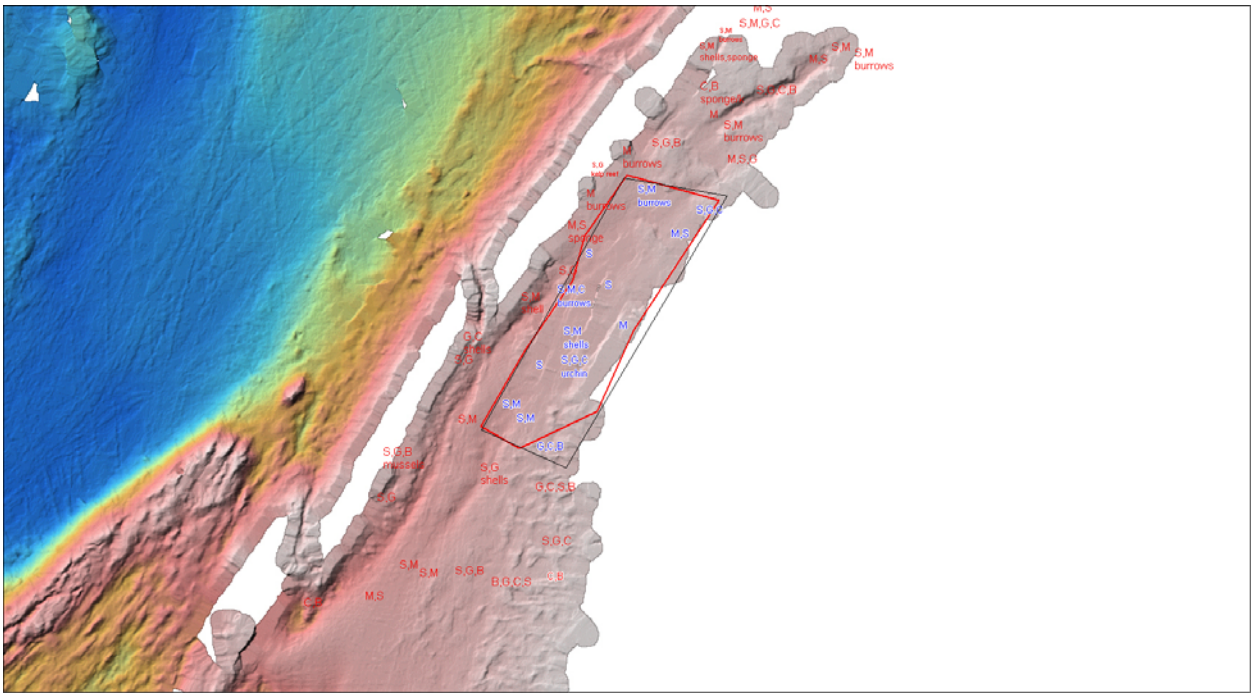

Figure 29. Map of St. Mary's Bay showing predominant bottom type noted during video transects. Polygon shows the main area of sculpin fishery. Base map with colour-coded bathymetry is from OLEX.

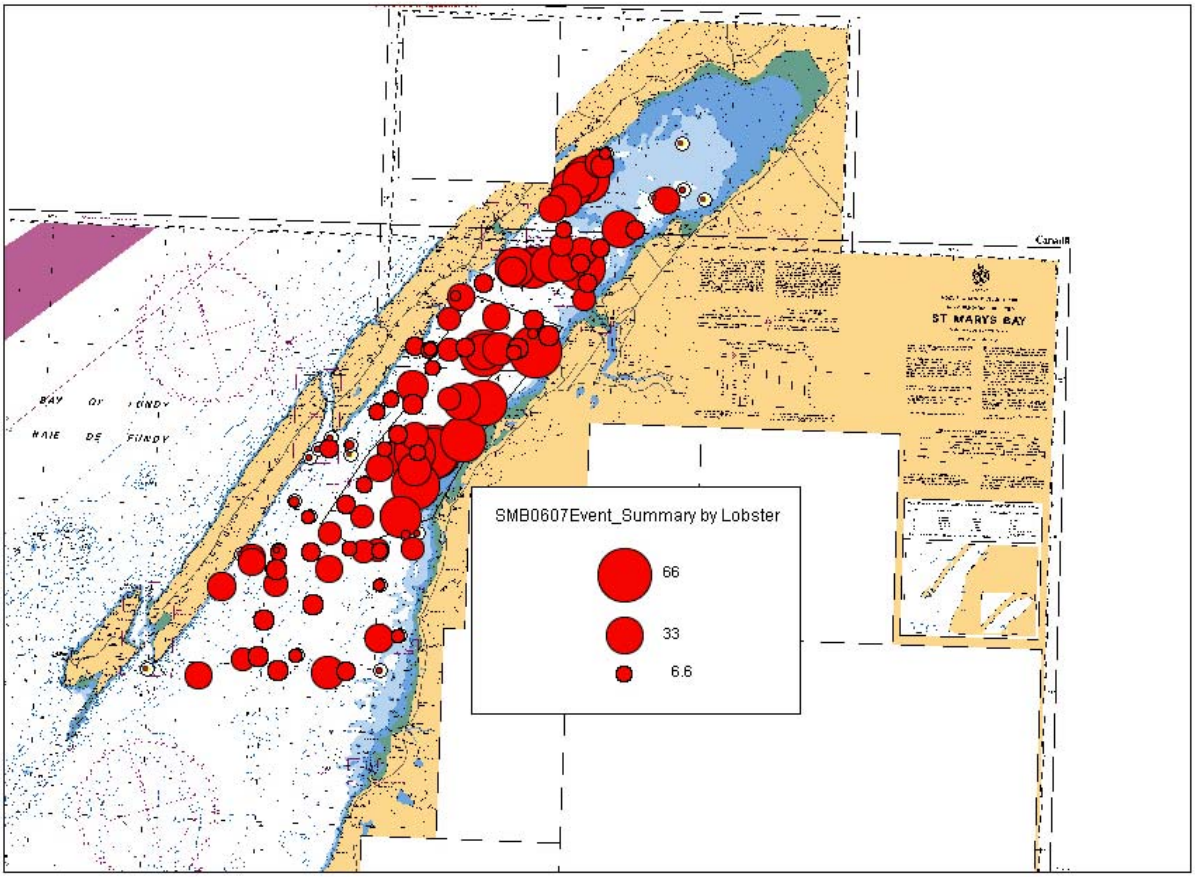

Figure 30. Number of lobster per video transect. Transects were usually 650-750m; numbers still need adjustment for transect length but pattern is not expected to change.

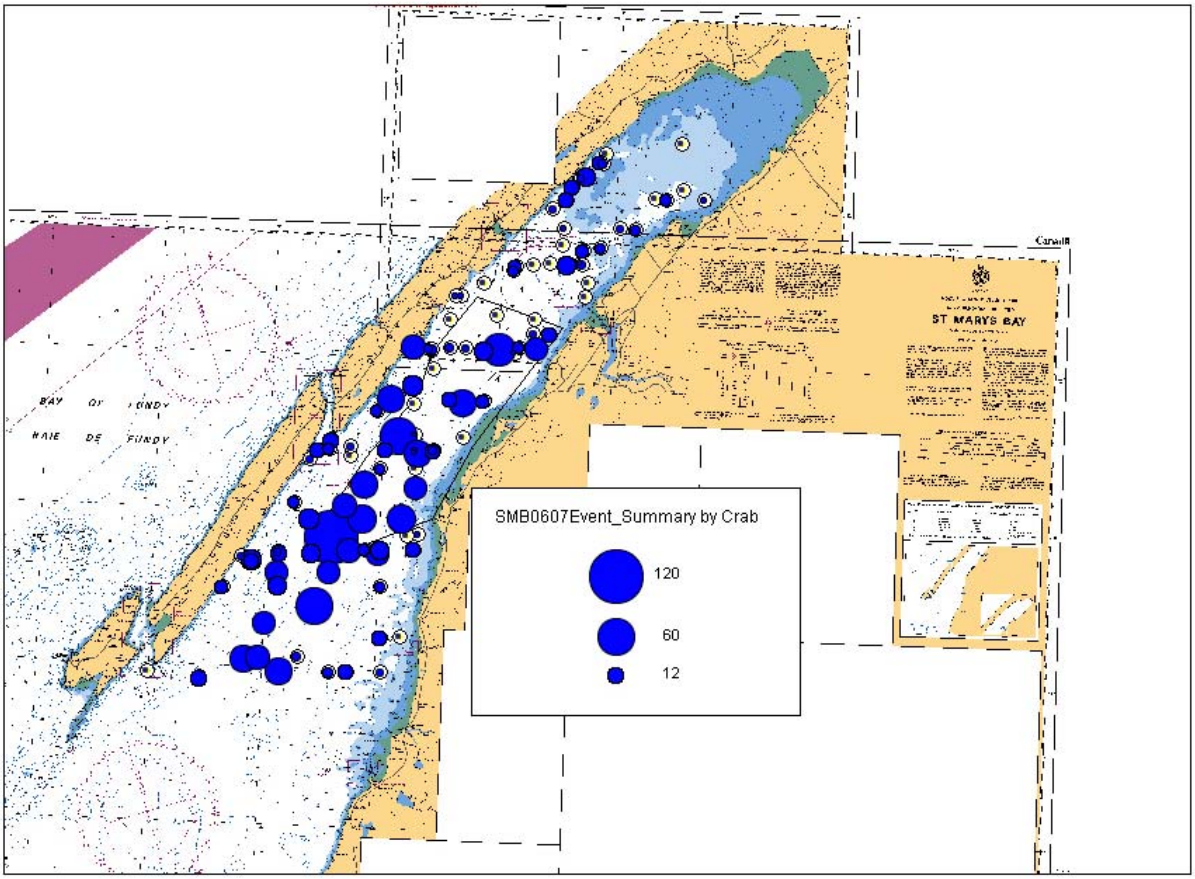

Figure 31. Number of crab (rock and Jonah) per video transect. Transects were usually 650-750m; numbers still need adjustment for transect length but pattern is not expected to change.