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2009 Evaluation of 4VWX Herring

Évaluation des stocks de hareng de 4VWX en 2009

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ABSTRACT

Quota landings in 2007-2008 were 54,560t against a TAC of 55,000t for the SW Nova Scotia / Bay of Fundy component. Acoustic biomass estimates decreased and are near the lowest in the time series for each of the major survey areas in Scots Bay and on German Bank. The overall biomass estimate in 2008 was the lowest in the time series. This assessment indicates little improvement from the low level of the resource noted in recent assessments. A harvest strategy that exercises continued caution to facilitate further rebuilding is strongly recommended.

There was a decrease in landings from 5,400t to 920t from the offshore Scotian Shelf banks mainly due to weather conditions, fish not being available to the purse seine gear and high fuel prices. There was no midwater trawl activity in the offshore area in 2008 and only limited by-catch of herring from bottom trawl gear. Herring abundance in the summer bottom trawl research survey is at a low level after a decade of high values but is not considered indicative of overall abundance. There is no acoustic survey information for the offshore area although industry has been encouraged to explore and undertake structured surveys.

The recorded landings in the 2008 gillnet and trap net fisheries along the coast of Nova Scotia showed a 30% decline from 2007. There were reductions in surveyed acoustic biomass in the Halifax/Eastern Shore and Little Hope areas from the previous year. Surveys were also completed near Glace Bay but there were few spawning herring documented or catch reported. No herring surveys took place in the Bras d'Or Lakes. Given the current situation of reduced or below average biomass in all areas the "survey, assess, then fish" protocol should be applied.

The latest landings for the 2008 New Brunswick weir and shutoff fishery were 6,400t and are the lowest recorded catch since 1963. The success of this passive fishery is historically unpredictable, and catches are inherently susceptible to many natural variables in addition to abundance. These fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and are therefore excluded from the SW Nova Scotia / Bay of Fundy component assessment and quota.

RÉSUMÉ

En 2007-2008, les débarquements assujettis à quota se sont chiffrés à 54 560 t, par rapport à un TAC de 55 000 t, pour ce qui est de la composante du sud-ouest de la Nouvelle-Écosse et de la baie de Fundy. Les estimations de la biomasse dans les relevés acoustiques ont diminué et approchent de leur plus bas niveau de la série chronologique dans chaque grande zone de relevé de la baie Scots et du banc German. L'estimation de la biomasse globale en 2008 était la plus basse de la série chronologique. La présente évaluation reflète peu d'amélioration par rapport au bas niveau de la ressource observé dans les évaluations récentes. Une stratégie de capture restant axée sur la prudence pour faciliter la poursuite du rétablissement est fortement recommandée.

Sur les bancs du large du plateau néo-écossais, les débarquements sont tombés de 5 400 t à 920 t, en raison des conditions météorologiques, de la non-disponibilité du poisson à la capture à la senne coulissante et des prix élevés du carburant. Il n'y a pas eu de pêche au chalut pélagique dans ces eaux. L'abondance du hareng dans le relevé d'été au chalut de fond est basse après une décennie de valeurs élevées, mais elle n'est pas considérée comme révélatrice de l'abondance générale. Il n'y a pas de données de relevé acoustique portant sur les bancs du large, bien qu'on ait encouragé l'industrie à entreprendre des relevés structurés.

Les débarquements enregistrés dans la pêche au filet maillant et au parc en filet en 2008 le long de la côte de la Nouvelle-Écosse reflétaient un déclin de 30 % par rapport à 2007. Comparativement à l'année précédente, la biomasse selon le relevé acoustique avait diminué dans les secteurs d'Halifax et de la côte est ainsi que de Little Hope. Des relevés ont aussi été effectués près de Glace Bay, mais peu de hareng en frai y ont été observés et peu de captures signalées. Il n'y a pas eu de relevé sur le hareng dans le lav Bras d'Or. Dans les conditions actuelles de biomasse réduite ou inférieure à la moyenne dans tous les secteurs, il conviendrait d'appliquer le protocole « relevé, évaluation, puis pêche ».

Les chiffres les plus récents en provenance de la pêche au parc à hareng et à la senne de plage pratiquée au Nouveau-Brunswick en 2008 chiffraient les débarquements à 6 400 t, leur plus bas niveau depuis 1963. Le succès de cette pêche passive a toujours été imprévisible et les captures dépendent intrinsèquement de nombreuses variables naturelles, outre l'abondance. Les poissons de cette pêche sont considérés comme étant un mélange de juvéniles, dominés par ceux qui émanent des composantes de reproducteurs de la sous-zone 5 de l'OPANO, et ils sont par conséquent exclus du quota et de l'évaluation de la composante du sud-ouest de la Nouvelle-Écosse et de la baie de Fundy.

INTRODUCTION

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they are presumed to home. Herring first mature and spawn at three or four years of age (23 to 28cm or 9 to 11in), then begin a predictable annual pattern of spawning, overwintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, overwintering, and spawning aggregations.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same component. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localized, sometimes very near shore or in small embayments. The situation is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same component and with members of other components. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components (Figure 1):

1. SW Nova Scotia/Bay of Fundy spawning component
2. Offshore Scotian Shelf banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component; and
4. SW New Brunswick migrant juveniles.

Each component has several spawning areas, and there is mixing of fish among spawning components. Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and of taking appropriate account of interaction among components (such as fishing restrictions on some areas of mixing). Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff, trap and midwater trawl.

The Georges Bank spawning component is not included in this evaluation except to document Canadian fishing activity. As in 2005, 2006 and 2007, there were no herring landings in 2008 from the Canadian portion of Georges Bank (Table 1). This fishery is included in the Gulf of Maine stock complex (DFO 2003a) and was last evaluated in 2006 (TRAC 2006).

1) OBJECTIVES AND MANAGEMENT

The 2003-2006 Scotia-Fundy Herring Integrated Fisheries Management Plan (DFO 2003b) sets out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan is “the conservation of the herring resource and the preservation of all of its spawning components”. The background for the conservation objectives was first developed and reviewed by Sinclair (1997).

Three conservation objectives appear in the plan:

1) To maintain the reproductive capacity of herring in each management unit through:

- persistence of all spawning components in the management unit;
- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth overfishing:

- continue to strive for fishing mortality at or below F0.1

3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").

- maintain spatial and temporal diversity of spawning
- maintain herring biomass at moderate to high levels

There is evidence that most of these objectives are not being met despite the efforts that have been made in recent years including a reduced TAC. There is also a need to better define these objectives in terms of minimum thresholds and to explicitly list the spawning components in terms of spatial and temporal expectations.

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continues to be used widely within the 4VWX management area (DFO 1997, Stephenson *et al.* 1996, 1999). The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

Collaborative research efforts with the fishing industry have been important in for over a decade. A major portion of the herring industry (including the purse seine sector and major processors) make up the Herring Science Council (HSC), and some members of the fixed gear sector have undertaken a separate Joint Project Agreement with DFO to undertake significant collaborative scientific projects. The herring processing industry has continued to provide biological sampling and samples while the purse seine and gillnet sectors undertook key acoustic surveys with the provision of vessel time. In 2008 field activities were managed by the HSC with assistance from St. Andrews Biological Station staff, individual survey vessel captains and plant owners. In addition downloading and data editing services were contracted by the HSC through A. Clay from FEMTO Electronics.

2) SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

2.1 The Fishery

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff and trap. Herring fishing locations, NAFO unit

areas for catch and sample aggregation, and fishing ground areas are used to describe fishing activities and group the data for analysis (Figures 2-4).

Quota landings in 2007-2008 were 54,560t against a TAC of 55,000t for the SW Nova Scotia / Bay of Fundy component (Table 1). There were additional landings of 11,060t in the non-stock components with 3,700t for 'Coastal Nova Scotia', 920t for the 'Offshore Scotian Shelf' and 6,450t for the 'SW New Brunswick Migrant Juveniles' for an overall 4VWX area total of 65,630t. There was decreased proportion of catches from the New Brunswick weirs in 2008 after above average landings in the previous year.

The current quota year, for the 2008-2009 season, began on Oct. 15, 2008 and had reported landings in the fall and winter purse seine fisheries of 2,760t as of March 1, 2009 (Table 2).

For the SW Nova Scotia / Bay of Fundy stock component, the only component under TAC control, landings have recently tracked the TAC with most of the total quota being taken each year since 2002 (Figure 5). As a result of the reduced quota since 2005, total landings from this component are near the lowest on record since 1963 (Table 3). Most of the catch over the history of this fishery has been caught by purse seine gear with the 4X summer purse seine fishery being the most important (Table 3, Figure 6, 7). In 2008, landings by the purse seine sector accounted for 95% of the component catch with minimal landings by the gillnet sector (15t) and near average landings from the Nova Scotia weirs (2,500t). According to the management plan, eighty percent of the catch limit was initially allocated to the mobile gear sector and 20% to the fixed gear sector and as in past years transfer of unused quota to the mobile fleet occurred near the end of the fishing season.

Purse seine catches are summarized by fishing grounds using definitions of the various grounds based on groupings of 10 minute boxes of latitude and longitude (Table 4, Figure 4). Catches by fishing grounds were compared to recent years with the largest proportions coming from the German Bank (22,440t), Gannet Dry Ledge (10,000t) and Grand Manan (10,490t) areas (Table 4, Figure 8). Landings from the German Bank grounds alone made up about 40% of the purse seine catch. There was an increase in catch from German Bank and the fishing grounds in the New Brunswick coastal area. Catches of non-stock component herring by purse seine came mainly from the Offshore Banks area on the Scotian Shelf with 830t landed in 2008 (Table 5).

There were again, as in recent years, below average catches from Scots Bay and the Long Island shore area. The lower catches off Long Island are attributed to extensive aggregations on Grand Manan Banks and German Bank areas that were more accessible and closer to market for the New Brunswick and SW Nova fleets. The Long Island shore area is also generally a more difficult fishing area, with the boats only able to get fish at dusk or at dawn as the fish go on or off the shore. The reduction in Scots Bay is attributed to the distance to travel to the area and fuel costs. The 5,000t allocation for the Scots area did not limit the fishery in 2008.

Purse seine landings of 1,540t were reported in Oct.-Nov. 2007 fall fishery and 460t in the January 2008 winter fishery (Table 1, Figure 9). These fisheries which take place at the beginning of each quota year are usually concentrated on the New Brunswick side of the Bay of Fundy.

The largest single fishery component of the SW Nova Scotia / Bay of Fundy stock component is the summer purse seine fishery which occurs from May to October in the Bay of Fundy area. In 2008 this fishery took place in similar areas and months as in previous years with total landings of 50,020t (Table 1, Figure 10). A large part of this fishery is directed toward pre-spawning, feeding aggregations in May and June. Catches from the major spawning grounds during the

spawning in Scots Bay and on German Bank are primarily within the pre-defined acoustic survey catch areas but there are some pre-spawning catches for German Bank (Melvin and Power 1999).

During the 1970s and 1980s, a large purse seine fishery took place on over-wintering aggregations in Chedabucto Bay with total landings as high as 17,800t as recently as 1991 (Table 3, 4). There has been no fishing effort in this area since 1999 as traditional vessels have been successfully fishing elsewhere and because the reduced TAC has resulted in conserving of quota for later in the season. In some years (2000 and 2002) there has been a small fishery on over-wintering herring in January off Halifax Harbour (4W Chebucto Head), but the majority of the fall and winter herring landings for the past several years have come from the New Brunswick side of the Bay of Fundy.

Scots Bay

The Scots Bay herring purse seine fishery has been an important component of the summer fishery with catches since 1987 ranging from 1,000 to 24,400t during the period of early July to late August-early September (Table 6, Figure 11). The peak year of 2004 was unusual in several aspects, with the highest recorded catch of 24,400t, the longest season extending to Sept. 16 and the most days with catch recorded (Table 6, Figure 12). In 2004, the distribution of catches was also more widespread extending both north and east of the innermost strata survey area (Figure 11). The overall catch in the following year, 2005, with area restrictions was reduced to 5,870t and included catches to the north and east of the main survey area. The fishing season in 2005 also started later and was of shorter duration than in previous years.

The 2006 fishery had catches scattered mainly within the defined spawning area but there was a further reduction in overall fishing activity with 3,350t landed and less than half of the number of landings (slips) than in the previous year. Several external factors contributed to a decrease in fishing activity and survey effort including a reduced roe market, lack of access to the Digby wharf to offload herring, the distance to market and the re-introduction of Herring Fishing Area 22 (HFA-22) line. The duration of the spawning fishery period in Scots Bay was the same as in 2005 but there was no observed spawning or catches of spawners in the spawning box in the middle of the period during early August (Figure 13). The combination of these factors resulted in fewer vessels fishing in Scots Bay and participating in the surveys with less survey and catch information collected on spawning activity in 2006.

In 2007 catches of 4,100t in Scots Bay were reduced due to the continued restrictions placed on this area including an overall cap of 5,000t with weekly trip limits to distribute effort over the season. The lack of availability of the Digby wharf and the distance to travel to Scots Bay also tended to reduce effort in that area. The total duration of the fishery was extended due to the weekly restrictions, lasting from July 16 to Aug 31 with a total of 21 days with catch.

The 2008 fishery again had a 5,000t cap due to the continued poor performance of the spawning component since 2005. There were also internal arrangements by industry to limit nightly and weekly catches in order to spread the effort over the season and to allow surveys to take place with the possibility of landing fish without being impeded by the cap. Landings in 2008 were substantially reduced from 2007 with only 2,370t caught from July 14 to Aug. 27. There was a gap in landings similar to that seen in 2006 from July 22 to August 8 which was attributed to steaming distance and fuel costs as well as better fish availability off Long Island shore and Grand Manan which were closer to markets (Figure 13).

German Bank

German Bank is one of the primary herring fishing grounds in the Bay of Fundy area. Since 1985, catches from this area have ranged from 9,000 to 36,000t during the main fishery period from early May to late October (Table 7). Catches in the pre-spawning period (defined as prior to August 14) have been increasing since 2004 reflecting a higher reliance on this area and perhaps on the availability of fish closer to markets. Catches during the spawning period (defined as after August 15) have declined to about 12,000t per year since the quota reduction in 2003. The proportion of total German Bank catch taken during the spawning period has declined in recent years due to the higher amounts of pre-spawning catch. The contribution of German Bank catch however has been increasing and is now close to 60% of the overall TAC (Table 7) (Figure 14).

Catches during the pre-spawning period for German Bank from May 1 to Aug. 14 on pre-spawning, feeding aggregations are usually widespread and not just confined to the spawning ground area (as defined by the innermost strata box) (Figure 15). In 2006 the pre-spawning period was unusual with catches concentrated mostly in the northwest corner of the survey box area. This differed from previous years when catches were more widely scattered over a larger area (Figure 15). In 2007 catches were more widely distributed with locations northwest of the strata area as well as within the spawning area box but these catch distributions seemed more concentrated than in the past. In 2008 catches during the pre-spawning period increased to 16,845t, the highest since 1999. They were very widely distributed in comparison to recent years and more similar to patterns seen in the past. This distribution pattern was attributed to the fish moving around in small groups or schools which were widely spaced. Fuel costs were not a major issue within the German Bank area itself, which is fairly close to the home ports.

Catches on German Bank during the spawning period within the spawning box area are primarily of spawning “roe” fish (Figure 16). However, not all catches are spawners, with juvenile sized non-spawning groups often located to the north of the spawning box. In 2007, catches within the survey strata area were similar to those of 2005 and 2006 with two separate localized groups of spawning herring which were also documented during surveys. Catches for 2008 were unusual with an absence of catches of spawning fish in the southern part of the spawning box as seen in previous years. Acoustic surveys did however document some fish in the southern central part of the survey box (Power and Melvin 2010). In 2008 very little herring was caught north of the spawning area box during the spawning period as seen in previous years (Figure 16).

Daily catches in recent years have been spread evenly through the spawning season but have been reduced in total daily amount reflecting markets and the reduced TAC (Figure 17). The daily landings in 2008 were unusual with sporadic catches until mid-September due to fish availability and problems with setting seines. The issues with poor catches were attributed to the fish being hard to catch and the seines not sinking well below 20-25ftm. The poor sinking was partially due to tides and currents but the primary blame was due to a layer of plankton in the water column which interfered with the nets ability to sink. A sample of these ‘eyeballs’ or ‘jellies’ have been identified as the common Salp species, *Thalia democratica*. Blooms of this plankton species have previously been reported in the Gulf of Maine causing fishing nets to become clogged (COOC 2006). After the bloom cleared in mid-September, catches increased to more than 1,200t per day for about one week as plants ran at full capacity in order to ‘catch up’. Catches then declined as individual boat quotas were taken, fewer boats were active and the TAC neared the overall limit.

Trinity Ledge

The Trinity Ledge spawning ground is currently considered to be in a depleted state and still recovering. The area is closed to purse seine gear from Aug. 15 to Sept. 15 although catches have occurred in previous years in the nearby defined area (Table 4). There were no catches from the area by purse seine gear in 2008. Gillnet catches on the spawning grounds are permitted under the 'survey-assess-then fish' protocol with catches of 1,110t in 2007 (Table 8). In 2008 only 7t was landed from a single fishing night on Sept. 23, while three acoustic surveys were undertaken on Aug. 28, Sept. 22 and Sept. 24 with a total estimated SSB of only 270t (Power and Melvin, 2010). There was some additional searching/scouting on six separate nights from Aug. 21 to Sept. 23 by one or more vessels to check for fish in the area but there were no reports of major aggregations (Figure 18).

Spectacle Buoy

A spring gillnet fishery for roe has occurred in recent years for a short period in June in the vicinity of Spectacle Buoy, southwest of Yarmouth, N.S. This fishery is dependent upon the availability of roe herring and to some extent market conditions and thus fishing may or may not occur in any given year. Catches since 1998 have been 0 to 700t and acoustic surveys have documented up to 1,420t (Table 8). In the previous year 2007, the herring gillnet fishery in the Spectacle Buoy fishing area occurred from May 27 to June 22 with total landings of 240t. Three acoustic surveys were completed which documented a total survey biomass of 310t which was only equivalent to the amount landed.

In 2008, there was virtually no fishery with only one landing of 6t (Figure 18). Two acoustic surveys were undertaken, one on June 9 with one boat over 3.5 hours/45km of searching and one on June 16 with two boats including one with a recorder (4.5hrs/45km) but very little fish were found. The data was not edited and analyzed but visual inspection of the echogram showed only small amounts of fish on bottom in a very small localized area (Power and Melvin 2010).

Nova Scotia Weirs

The 2008 catches of 2,520t in the Nova Scotia weirs were below average despite an increase of 1,400t over 2007 (Table 9; Figure 19). The annual variation in catch has been mainly attributed to problems in availability of fish to this fixed gear as there are often substantial purse seine catches in the nearby Long Island area on the Bay of Fundy side of Digby Neck (Table 4). In 2008, there was a reduction in the amount and proportion of purse seine catch in the Long Island ground area and recent catches (since 2006) have been below average for this gear type. The seasonal timing of the Nova Scotia weir landings, which have shifted to the later months of the season in recent years, had the most catch in June in 2008 (Table 9). Catches for the Nova Scotia weirs have been highly variable in recent years and not as consistent in their amount or timing as in the previous decade. There has been a decline in the total number of herring weirs with only 6-14 active weirs in the last decade (Table 10).

Catch and Effort

Catch and effort for gillnet data in the SW Nova Scotia/Bay of Fundy spawning component were examined in previous assessments. They showed little trend and were considered unrepresentative due to the small amounts and variable timing and location of catch and effort (Power *et al*., 2004). This trend of very limited catch and effort continues, with only 15t of gillnet catch attributed to the overall stock in 2008 and so this data was not reexamined.

Purse seine landings make up most of the overall catch and are allocated 80% of the TAC for the SW Nova Scotia/Bay of Fundy component under the current management plan. The purse seine catch has fluctuated between 45,000t and 100,000t since 1989 primarily reflecting changes in the TAC (Table 11, Figure 20). The overall number of boats fishing and days fished has been dropping since 1990 due to fleet rationalization. This has resulted in increases in catch per boat and catch per day in recent years but is also affected by the reduced TAC. In general, purse seine catch rates are not considered to reflect trends in population abundance due to the nature of herring schooling behavior and the acoustic technology used to find these concentrated schools. Catch rates can remain high or stable even at low stock levels. These data are simply reported to document the overall effort by the purse seine fleet.

2.2 Resource Status

Acoustic Surveys

Automated acoustic recording systems deployed on commercial fishing vessels have been used since 1997 to document the distribution and abundance of herring. Scheduled surveys are now conducted each year with surveys every two weeks on each of the main spawning components. An index of spawning stock biomass is estimated by summing these results (Melvin and Power 1999). In 2008 a total of 13 individual surveys were completed within the Bay of Fundy/SW Nova Scotia stock component (Power and Melvin 2010).

A major source of uncertainty continues to be the assumption that the results of the surveys are additive. If herring do not move completely on and off the spawning grounds in waves, the estimate of total SSB will be significantly biased upward due to double counting or biased downward due to missing waves of fish. As well, herring have been observed close to bottom, which can lead to an under-estimation of biomass from acoustic surveys since data very close to bottom are removed from the analysis. Other significant issues relate to the survey area coverage, the acoustic dead zone at both surface and bottom and factors that influence the target strength and acoustic backscatter (DFO 2007).

In 2003, an option to account for the non-square waveform observed in a ball calibration was incorporated into the HDPS software (Melvin *et al.* 2004). Given that the inclusion of the integration calibration factor (ICF or CIF) is deemed to provide a more accurate estimate of biomass, it was recommended that all future analyses utilize the CIF to calculate absolute biomass. However, when comparing observations from year to year it was recommended that the comparisons be made between biomass estimates that exclude the adjustment until a time series for all years has been established with the CIF included. This revision to the acoustic data for the earlier years from 1999-2002 was initiated in 2008 with the new calibration parameters provided for the analysis. The work is ongoing for 1999-2000 but preliminary results are available for the surveys from 2001 and 2002 (Power and Melvin 2010)

Similar to most previous years, four surveys were conducted in Scots Bay in 2008. The duration of surveys throughout the spawning fishery period in Scots Bay was again extended through the entire spawning season as a result of in-season weekly catch limits for the area. Four surveys were also completed on German Bank with a fifth excursion on Oct. 22 after the end of the fishing season. This final survey was not included in the overall estimate due to the lack of sampling to confirm spawning condition. The duration of the spawning fishery on German Bank was similar to previous years but had breaks within the season due to the lack of fish availability. Additional acoustic data from fishing nights on German Bank were examined but are not included in the overall biomass estimate because these estimates were less than the

nearest surveys (within 10-14 day window) which they could have replaced. Individual survey area coverage was more than satisfactory with multiple transects completed which were consistent with established protocols for surveying.

In 2008, the amount of spawning fish documented on Trinity Ledge was extremely low, in fact the lowest recorded. There were no surveys and no reports of spawning herring in other areas around Seal Island and Browns Bank which have seen spawning in the past. The spring gillnet fishery near Spectacle Buoy in June 2008 had little catch with limited survey effort.

In 2008 biomass estimates decreased for each of the primary survey areas in Scots Bay, Trinity Ledge and German Bank for an overall SSB of 223,100t (Table 12, Figure 21). This estimate is a 42% decrease from 2007 and is also the lowest recorded since acoustic surveys began in 1997. The 2008 estimate for the overall area also remains below the long term average.

Spawning Ground Turnover Rates

The current acoustic survey method on spawning grounds is dependent on periodic turnover of spawning fish on the grounds. Acoustic surveys are required to be separated by at least 10 to 14 days to allow for turnover and to prevent double counting (Power *et al.* 2002). This aspect of the assessment method was the subject of investigation in 2001 and of intensive sampling for maturity stage since that time. The results are summarized by Melvin *et al.* (2003, 2004) and Power *et al.* (2005a) and were used to assist in the evaluation of turnover timing and as a rationale for the inclusion or exclusion of specific acoustic surveys.

In 1998 and 2001 spawning herring were tagged on German Bank as part of a cooperative project between the Pelagic Research Council/Herring Science Council and Fisheries and Oceans, Canada. After the 1998 tagging event, 29% of the tag returns were caught on the spawning grounds more than ten days after tagging and 21% were caught more than fourteen days after (Paul 1999). In contrast all tag returns in 2001 were from within 8 days of tagging although these results were complicated by a large decrease in fishing effort in the second week after tag application (Power *et al.* 2002, Waters and Clark 2005).

In response to a recommendation from the 2005 RAP, tags were applied to herring on the spawning grounds of Scots Bay and German Bank (Clark 2006). The results from the tag returns indicated that some tagged herring remained on the spawning grounds for at least 3 weeks after tagging, and in some cases, up to five to six weeks. As a result, acoustic surveys that were spaced at 2 week intervals were surveying some of the same fish twice and possibly three times. These results also indicated a possible affinity between some of the fish tagged in Scots Bay and the New Brunswick weirs.

These results have serious implications for how the acoustic surveys are evaluated and used to determine stock status. Some preliminary analysis has been completed comparing three different approaches for the interpretation of the acoustic biomass estimates in an absolute sense (Power *et al.* 2006b). The results showed that caution is warranted when employing the cumulative biomass estimates as absolute in any of the survey areas. The results also indicated that some proportion of herring remain in the survey area three weeks or longer.

A framework assessment meeting in January 2007 determined that double counting does occur but the extent has not been well determined (DFO 2007). However, it was recommended that surveys continue to be conducted at 10-14 day intervals. The timing/turnover issue was considered to be of highest importance for further study, including work on the duration of the maturation process, further tagging with shorter intervals to estimate turnover rates and

increased survey frequency to reflect maturity stage duration. No additional experiments on turnover rates were completed in 2007 or 2008 due to a lack of funding.

Exploitation Rates on Spawning Grounds

The acoustic survey estimates and catches from individual spawning areas were examined to estimate simple relative exploitation rates on the different spawning groups and for the overall complex. In this analysis exploitation is calculated as the simple ratio of catch divided by acoustic survey biomass. These estimates can be used to assess the impact of fishing and also to estimate the relative size of individual spawning units within the complex (Table 13). These rates are dependent on the assumptions that the acoustic survey SSB is complete, that catches have been properly allocated and most critically, that the acoustic SSB provides an absolute measure of biomass. As a result of these uncertainties the absolute fishing mortalities cannot be determined or inferred but instead the trends over time may be used in a relative sense from year to year.

For this analysis the three main spawning components for Scots Bay, German Bank and Trinity Ledge which have received relatively consistent survey effort since 1999 are used. The acoustic SSB for nearby Seal Island and Spectacle Buoy areas were allocated to the German Bank spawning area. All catches throughout the year from each spawning ground were assumed to be site specific (Table 13-C1), while catches from other areas were allocated based on the relative spawning ground SSB proportions from annual acoustic surveys (Table 13-A2, C2). The adjusted total catch was thus made equal to the reported stock catch. Exploitation rates were then calculated from both the actual catch on the spawning grounds and the overall adjusted catch as proportions (Catch / SSB) (Table13-E1, E2).

The trends in spawning area proportions (Table 13-A2) has been stable since 2005 with about 90% of survey SSB found in the German Bank area and 10% in the Scots Bay area. The increase in 2005 for German Bank corresponds with a dramatic decline seen in Scots Bay since 2004 before which the area made up as much as 36% of the overall SSB.

Calculation of exploitation rates since 1999 by component (Table 13-E2) shows that the larger grounds (Scots Bay and German Bank) have an average exploitation of 23% and 16% respectively, while Trinity Ledge is very high at 52%. Individual values for specific years and areas are highly variable (from 12 to 146%) and this is attributed to inconsistent survey effort, especially for the Trinity Ledge area. The overall adjusted exploitation rate show a stable trend from 14-21% between 1999 and 2006, which has been at or below the $F_{0.1}$ level of 19% for most years. The overall adjusted estimate declined to a low of 13% in 2007 but then increased to 24% in the current assessment year as the TAC remained stable and the survey SSB declined. Fishing mortality cannot be specifically determined because of uncertainties in using acoustic survey estimates as absolute biomass but appears to have increased substantially in 2008 based on these trends (Figure 22).

Biological Sampling

Comprehensive biological sampling continued for this fishery with substantial involvement of the fishing industry which supplied data in the form of length frequencies and maturity reports and saved frozen fish samples for analysis by SABS personnel. In 2008 a total of 944 samples (100,800 fish) were measured for length while 4,480 fish were sampled for sex, weight, maturity and age (Table 14). The sources of the samples are shown in Table 15, with the bulk coming from the processing industry, as has been the case since 1996. Additional samples were collected by DFO personnel, observers deployed on fishing vessels and from DFO research

surveys. Sampling from the commercial fishery were well matched to the spatial and temporal distribution of the fishery and additional sampling from research vessel surveys during the spring and summer resulted in widespread geographic coverage as in the past (Figure 23).

Ageing Review

Since the April 2006 herring RAP, inconsistencies in ageing have been identified that may have an impact on the age based assessment results (DFO 2006). In the interim, any analysis using age data is considered unreliable and other approaches will be applied (Melvin and Power 2007). The implication, or impact, of under ageing on a virtual population analysis (VPA) has been examined by several investigations over the past couple of years (DFO 2006, Melvin and Power 2007). The results from these studies indicated that under ageing leads to an over-estimate of fishing mortality and an under estimate of biomass, the amount depending upon the severity of the under ageing.

A number of recommendations that will improve the ageing of herring were made at the 2008 ageing workshop. These included using a new mounting media for the otoliths, a new variable zoom microscope, and absence of length data during the reading process, a reference collection for quality control, and some new ageing protocols to ensure reader consistency and quality control protocols (e.g., preproduction testing, and random comparisons with a second reader). Once the otoliths have been re-read a new catch at age and age-disaggregated index of abundance will be constructed for input into a VPA. Tentatively, the readings were to be completed by December 2008 as part of the current Framework Review (DFO 2007) but as of April 2009 the work is incomplete and ongoing while awaiting the revised age data.

Catch at Age

Consistent with previous assessments, the catch at length and age was constructed using the 'Catch at Age' application (version 11.5) which is a Population Ecology Section program for computing catch at age statistics as part of the stock assessment process. Data files used by 'Catch at Age' were selected directly from biological sample data in the Pelagic Samples Database. These data included a 2% adjustment for the shrinkage due to freezing on the length measurements for frozen samples (Hunt *et al.* 1986). The length-weight relationships, which are also required as input to the 'Catch at Age' application, were calculated using an Oracle SQL*Plus script.

Due to a lack of ageing data in 2008 the final catch at age was not available. In order to develop catch at length reports for interim analysis age data from a previous year was used. The resulting catch at length is completely independent of any age length keys used since all numbers for a particular length are summed across ages. The catch at length/age statistics were then calculated from length frequency and age-length key samples expanded to total catch using appropriate monthly length-weight relationships. The data were grouped using monthly age-length keys applied to length frequencies to produce catch at length statistics by NAFO unit area, fishing ground, gear-type and month.

Historical Age Composition

The historical time series of catch at age for the period 1965-2005 shows very few fish older than age 7 since 1995 and has been dominated by ages 2 through 4 since 1998 (Table 16a, Figure 24). Since 1995 the series was primarily made up of fish age 6 and younger but older ages were a feature when strong year-classes (i.e. 1976 and 1983) were progressing through the fishery (Table 16b). While the rapid decline of year-classes (including the presumed

moderately strong 1998 year-class) implies a high total mortality (Power *et al.* 2006a) the 1999 to 2005 age data are still under review.

The trend toward catches at younger ages has resulted in reduced yield and is reflected as a decrease in the average weight of fish in the overall catch at age (Figure 25). This indicator has declined from an average fish weight of over 120g in the 1980s and early 1990s to an average fish weight below 100g in 2003-2004. These levels had not been observed since 1975, just prior to the closure of the meal fishery, the implementation of individual boat quotas and the conversion to a food fishery by the herring industry (Iles 1993). However, the most recent years have seen an increasing trend toward a larger average fish size with the 2006-2008 average size near the long term average of 125g. This trend would also translate into a reduction in the total removals of fish by numbers which have been reduced substantially since 2005, remembering that this reduction is also partially due to the reduced TAC (Table 17).

Size Composition of Catch

The size composition of the catch was determined from the length sampling data and was calculated for the stock component using the appropriate catches and monthly length weight relationships. The 1992 catch at length was also determined for comparison with the current data. The time around 1992 is considered to be a period when the stock was known to have a broad size and age distribution but was also in a state of decline (Power *et al.* 2006a). The catch at length for 1992 had a broad distribution of sizes from less than 10cm to 38cm with a substantial proportion (21%) greater than 30cm (approximate mean size for a 5-6 year old herring) (Table 17).

In 2008, the catch at length was composed of 37% small fish <23cm (size at 50% mature) with 167 million removals (Table 17, Figure 26). The proportion of small fish decreased by 9% from 2007 and the overall numbers of removals for this size group has remained below 190 million since 2005.

In 2008 the catch at length of medium sized recruiting fish (23 to 30cm) increased from 49 to 57% with about 260 million removals (an increase of 8% or 60 million) (Table 17, Figure 26). The proportion of the catch greater than 30cm increased from 5% in 2007 to 6% in 2008 with 28 million fish removed. This increase may indicate targeting of larger fish for specific markets or could imply improved survival in the population. It is important to note that these data reflect the composition of the catch and not the population and so must be used with caution when considering population trends.

There has been an increase of older/larger fish in the catch in 2007 and 2008 but the percentage is still well below pre-1999 levels (Figure 27). The number of smaller fish in the catch (less than 23cm) was similar to other years. Small fish presumed to be from the 2005 year-class had been seen in abundance during the previous two years in New Brunswick weir fishery and in the 2007 stock fishery suggesting a possible strong year-class. There was an increase in medium sized (23-30cm) adult fish in the catch for most areas in 2008 but the abundance was not overwhelming and did not indicate an exceptional year-class entering the fishery. Evidence for a strong incoming year-class is considered weak.

Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and taking appropriate account of the interaction among components (such as fishing restrictions on some areas of mixing). Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in lost potential yield. In 2005/2006 industry

made a concerted effort to re-direct to larger fish which resulted in a significant decrease in the proportion of fish less than 23cm in the catch. This, combined with the reduced TAC, appears to have allowed the proportion of adult fish larger than 30cm to increase (Figure 27).

The total catch numbers by length group were determined for the major fishing grounds including Grand Manan, Gannet/Dry Ledge plus Lurcher, Long Island, German Bank plus SW Grounds and Scots Bay, as well as the overall the stock area (Table 18, Figure 28, see also Figure 4 for the map of fishing ground areas). There was a predominance of smaller fish from the Grand Manan and Long Island areas, while most of the larger fish came from the spawning ground areas from the German Bank area (Table 18).

For illustrative purposes, catch at age was estimated by applying 1997 ages to the 2008 fishery catches and samples. The 2008 SW Nova Scotia / Bay of Fundy herring spawning component is summarized by % number and % weight by age for the major fishing grounds as well as for the overall component (Table 19, Figure 29). Younger immature fish predominated in the Grand Manan and Long Island areas at ages 2-3, while older mostly mature spawning fish were found on the spawning ground areas in Scots Bay and German Bank with ages 3-5 predominating. The proportions of 6+ fish were less abundant in all areas but were as high as 11% by number and 16% by weight for the German Bank area. While these estimates by age, using the 1997 data to apportion size to age, may not reflect the current exact growth characteristics of the stock they provide a reasonable estimate of the age distribution for the younger and older age groups in general.

Stock Trends

The 2005 assessment compared a population model, (VPA) calibrated with the relative abundance from the acoustic surveys, with the overall absolute abundance estimated from these same acoustic surveys (Power *et al.* 2006a). While the trends in modelled abundance followed those in the survey, there was an inconsistency with a lower estimate of biomass determined by the VPA compared with the absolute estimate provided by the acoustic surveys. This inconsistency has not been resolved but may be due to issues with the survey (e.g. double counting, target strength) and/or the VPA (e.g. ageing, unaccounted mortality). The 2007 Framework (DFO 2007) concluded that while the current acoustic survey can only provide a relative index of abundance, efforts should continue towards developing them as an absolute estimator.

In April 2006, ageing inconsistencies were identified that may have an impact on the age based assessment results (DFO 2006). To test the sensitivity of the VPA to changes in the age input, several growth models using age-length keys from selected years were applied to the catch at age and the indices of abundance from 1999 to 2006 and input into the 2005 VPA formulation (Melvin and Power 2007). The estimated fishing mortalities for 1995-2006 from these simulations were variable and consistent with the previous investigation, and no scenario produced fishing mortalities at or below $F_{0.1}$ (where $F_{0.1}$ is F=0.23).

The January 2008 herring ageing workshop concluded that there were major inconsistencies with herring ageing amongst the readers and with the historical database. The degree of difference varied depending upon the reader. The current 4VWX otoliths have been consistently under-aged relative to the other readers and the database. The implication, or impact, of under-ageing on a VPA has been examined by several investigations (Melvin and Power 2007). The results from these studies indicated that under-ageing leads to an over-estimate of fishing mortality and an under-estimate of biomass; the amount dependent upon the severity of the

under ageing. As a result, an age based analytical assessment with estimates of fishing mortality cannot be undertaken until these ageing issues are resolved. This work is still ongoing.

Between 1999 and 2003 acoustic survey results were used as minimum estimates of absolute SSB abundance and the population was considered to be approximately 500,000t. An SSB of that size would have been expected to result in substantial growth of the population, improved age composition and low fishing mortality, given reasonable recruitment and the landings over that period.

In the previous assessment, of the 2007 fishery, it appeared that the expected increase in the SSB due to the reduced quota since 2005 was being observed in the acoustic surveys which showed an increase over two consecutive years (Power and Melvin, 2008). Fishing mortality was not determined but appeared to be decreasing based on the trends from relative exploitation rates from acoustic surveys. There were also indications that a strong year-class was entering the fishery with a large number of smaller fish in the catch (less than 23cm) seen in both the stock fishery and in non-stock NB weirs. Despite the increase in acoustic survey biomass in 2006 and 2007 the estimated stock biomass at 384,400t remained below historical levels (average of 427,600t since 1999).

In the current assessment, the 2008 acoustic biomass estimates decreased for all survey areas in Scots Bay, Trinity Ledge and German Bank to an overall amount of 223,100t. This is a 42% decrease from the previous year and is the lowest recorded since acoustic surveys began in 1997. The 2008 SSB estimate for the overall area remains well below the long term average as it has since 2005.

In 2007 there were signs of a strong incoming year-class with substantial numbers of smaller fish (between18-23cm), while in 2008 there was a small increase in the proportion of medium sized fish but the strength of the 2005 year-class (at age 3 in 2008) is still unknown. The proportion of the catch greater than 30cm increased slightly in 2008 which may indicate improved survival but it is important to note that these catch data may not reflect the overall population composition and so must be used with caution when considering population trends.

2.3 Sources of Uncertainty

There are several sources of uncertainty in this assessment that need to be considered, many of which were evaluated in the Framework Review (DFO 2007). The use of the acoustic survey results as a measure of absolute abundance has a number of unknowns including residence time on the spawning grounds and estimation of biomass in the acoustic dead zones at the surface and close to bottom.

The acoustic survey index provides fisheries independent information on the spawning stock biomass but does not provide data on younger age classes. The size of recruiting herring year-classes is known to be highly variable and with no index of recruitment there is a large fraction of the catch dependent on recruiting year classes with uncertain abundances.

There is also uncertainty in the ageing of age 4+ herring for this stock. This is currently under review.

2.4 Ecosystem Considerations

Herring is a keystone forage species prominent in the diet of many fish, seabirds and marine mammals, and therefore should be managed with these interactions in mind. At present, use of

a natural mortality rate of 0.2 in the assessment model and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

The by-catch of other species besides herring in herring directed fishing is summarized in Appendix A for the years 2004-2008. Previous analysis has found no major concerns for these fisheries with very low by-catch reported (DFO 2007). There were a total of 11 trips or 30 sets monitored in 2008 with only herring and mackerel recorded. The lack of observer recording of other incidental species was noted as a possible protocol error by the monitors. The protocols are to be checked and observers will be monitoring catch more closely in 2009 with more trips planned.

Management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning. Increased fishing on juveniles, which are of mixed or unknown stock affinity, is inconsistent with this objective.

2.5 Management Considerations

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the conservation objectives. The "survey, assess, and then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and is considered an important safeguard. Acoustic surveys have become critical to stock status evaluation. It is important that there be continued attention to coverage and survey design in order to assure year-to-year consistency in all spawning areas.

2006 Fishery Evaluation

In the assessment of the 2006 fishery an evaluation of progress in recent years against biological objectives in the management plan indicated that most objectives were not being met (Table 20) (Power *et al.* 2007). The biomass estimates for all spawning areas increased slightly from 2005 but were still at historically low levels with a substantial decline from 2004. The Scots Bay, Trinity Ledge, Lurcher Shoal and Seal Island spawning grounds remained at very low biomass. In 2006 the beginning and duration of spawning in Scots Bay and German Bank occurred as typical of other years, unlike 2005, but there was a mid-season gap in spawning in Scots Bay. Fishing mortality from the VPA was considered high and well above $F_{0.1}$ and the SSB near the lowest recorded level since 1999 from acoustic surveys.

2007 Fishery Evaluation

Evaluation of objectives for the 2007 fishing season showed that some conservation objectives were being met but there were concerns with most spawning areas except German Bank which was considered at or above average biomass (Table 21). The potential benefits of the reduced quota and other rebuilding measures from 2005 through to 2007 were thought to be reflected in the improved biological characteristics of the population (catch size composition).

2008 Fishery Evaluation

In the current assessment of the 2008 fishery, evaluation of objectives indicates little improvement from the low level of the resource noted in recent assessments (Table 22). Acoustic biomass estimates have decreased and are near the lowest level in the time series for all major survey areas in Scots Bay, Trinity Ledge and German Bank. This has resulted in an overall 42% decrease from the previous year and is the lowest recorded since acoustic surveys

began in 1997. There are now concerns for spawning in all areas including German Bank. The 2008 SSB estimate for the overall area remains well below the long term average or at very low biomass (Trinity Ledge) for all areas surveyed.

Spawning activity persisted for the main spawning grounds and was observed in Scots Bay and German Bank but both the spawning area and biomass were reduced. There was minimal spawning activity recorded for Trinity Ledge. There were no surveys or reports of spawning from Seal Island or any other areas such as Lurcher Shoal and Browns Bank which have known spawning activity in the past. In regard to the spawning period for each area, the start of spawning in 2008 for German Bank and Scots Bay was typical but not for Trinity Ledge where spawning was almost non-existent. The duration was shorter for Scots Bay and appeared to be missing waves in mid-Sept on German Bank. There appears to be insufficient spawning in all areas and reduction of diversity of spawning in both time and space.

Overall length composition in the catch has improved. Proportion of larger (30cm+) sizes continues to increase. There is an increase in medium sized (23-30cm) fish but strength of the incoming year-class is unknown. Without a population model, catch is used as the best available proxy of the population.

There were few positive signs from this fishery in 2008 and few of the conservation objectives appear to have been met (Table 22). Fishing mortality was not determined but appears to have increased based on the trends from relative exploitation rates from acoustic surveys. The benefits of the reduced quota and other rebuilding measures which were starting to be reflected in the improved biological characteristics of the population now appear to be limited. This assessment indicates a low level of the resource and is cause for concern. A harvest strategy that exercises caution to facilitate further rebuilding is strongly recommended. Catch levels should remain near the current status quo due to uncertainties in estimating SSB, recruitment and the exploitation rate for this stock.

3) OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

3.1 The Fishery

A foreign fishery during 1963-1973 is estimated to have removed an average of 28,000t per year and as much as 121,000t in 1969 from the offshore Scotian Shelf banks (Stephenson *et al.* 1987). Few herring were caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the Scotia-Fundy purse seine fleet and 11,700t were taken (Table 3). Since this time, a fishery has taken place on feeding aggregations on the offshore banks, primarily in May and June, with catches ranging from 1,000 to 20,000t (Figure 30). The variability in catch levels is often due to problems of fish being too deep, weather and market conditions rather than in the abundance of herring in these areas.

In 2007 total landings were down to 5,400t from 9,800t in 2006 with most landings by purse seine and midwater trawl in May and June, in the vicinity of the Patch, Emerald and Western banks. There was also effort near the shelf edge, west of Sable Island, by midwater trawlers. The reduction in landings was attributed to extremely poor weather and to fish remaining deep and hard to catch. Herring were reported as abundant but there were no surveys or acoustic effort on the aggregations encountered.

In 2008, total catches for the area were 920t, down from 5,400t in 2007 and 9,800t in 2006 with most landings (880t) by purse seine in May and June, in the vicinity of the Patch, Emerald and Western banks (Figure 31). The weather and lack of fish available to the gear remained a

problem with catching fish. There was only 1 trip with records from observers for the 4W Patch area with no by-catch recorded (Appendix A).

The size composition of the catch in 2008 was very similar to previous years: mostly adult fish >23cm (50% maturity at length) with a substantial proportion (36%) larger than 30cm (Figure 32). Biological sampling from the catches showed fish in the early ripening maturation stages (stage 3 and 4) with good fat content reported by herring processing plants.

3.2 Research and Industry Surveys

Industry Surveys

There have been no industry surveys of the offshore Scotian Shelf area since 2001. Acoustic recorders were activated on a few occasions but insufficient quantities of fish were observed to warrant analysis or the information was of poor quality with excessive interference from other electronics. Consequently, no acoustic biomass estimates were available from the Scotian Shelf in 2008.

July Bottom Trawl Survey

Previous results from the summer research bottom trawl survey showed few herring on the Scotian Shelf during the 1970s, increasing amounts during the 1980s and a relatively widespread distribution in recent years (Harris and Stephenson 1999, Power *et al.* 2004, Stephenson *et al.* 2001).

In 2005, offshore herring catches from this survey for strata from The Gully, east of Sable Island, to the Baccaro Line (strata 55-78) showed a substantial decline from the series high in the previous year (Table 23, Figure 33). In 2006 the index increased slightly but then declined in 2007 to the lowest value since 1993. In 2008 the index remained at a low level. The strata areas used for selection of trawling stations in the various indices are shown in Figure 34 (Doubleday 1981). Herring catches from the 2008 summer survey were again widely distributed on banks west of Sable Island but were less abundant compared to the last seven years (Figure 35, 36). Size distribution of catches from the research trawl survey showed a distribution similar to that seen in the catch with a large proportion greater than 30cm (Figure 37-41).

The summer bottom trawl research survey which previously demonstrated considerable abundance and distribution of herring widely spread over the Scotian Shelf, showed a substantial decline from the high of 2004. There are several shortcomings to this data series which preclude its use as an indicator of overall abundance for a schooling pelagic species like herring. These include variable behavior and availability to the gear from year to year and the lack of year-class tracking when this was explored previously (Power *et al.* 2005b) The bottom trawl data, while useful for documenting size, maturity and distribution, are not considered indicative of overall herring abundance.

Fall Herring Research Survey

There has been no fall herring research survey on the Scotian Shelf since 2002 when the research vessel *Alfred Needler* was last used to explore the various inshore and offshore areas where herring were known to aggregate and spawn.

3.3 Outlook and Management Considerations

There continues to be insufficient documentation of stock size, distribution and spawning behavior for this component. The industry has been encouraged to explore and undertake structured surveys of the offshore area but this has not occurred since 2001. Industry, DFO Science and Management are encouraged to continue to work together to improve the biological basis for management. The industry should be encouraged to explore and undertake surveys of the offshore area. There is little new information to add and no reason to change the previous recommendation that the initial catch allocation for 2009 should not exceed the 12,000t as described in the fishing plan.

4) COASTAL (SOUTH SHORE, EASTERN SHORE AND CAPE BRETON) NOVA SCOTIA SPAWNING COMPONENT

4.1 The Fishery and Resource Status

There is no quota for the coastal Nova Scotia spawning component and, apart from four areas, the size and historical performance of spawning groups are poorly documented. In addition to the traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds in recent years (Clark *et al.* 1999). As the inshore roe fisheries off Glace Bay, East of Halifax and Little Hope have developed (since 1996), participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol.

The landings of 3,500t in 2008 in the gillnet fisheries along the coast of Nova Scotia declined from 2007 (Table 24). Landings were slightly lower for Little Hope/Port Mouton area, had a large decrease for the Eastern Shore area, and were minimal for Glace Bay with only 12t recorded. The Bras d'Or Lakes area remained closed. There was an additional 200t landed from trap nets located in Cape Breton and St. Margaret's Bay.

Little Hope/Port Mouton

The 2008 herring gillnet fishery in the Little Hope/Port Mouton fishing area had total landings of 1,108t (Table 24, Figure 42). This is primarily a roe fishery with catches from two main areas, near Little Hope Island and east of Liverpool.

In 2008 acoustic surveys were completed on Sept. 25, Oct. 6, Oct. 8 and Oct. 30 with both the schools and the area between schools surveyed (Power and Melvin 2010). The standard protocol for surveys of spawning herring is to allow 10 to 14 days between surveys in order to avoid double counting of fish that still remain from previous surveys. Summing the biomass estimates for the 2008 season resulted in a total estimate of 14,500t when using the calibration integration factor (CIF) or 11,800t without the CIF (Table 25-26, Figure 43).

East of Halifax (4W Eastern Shore)

The 2008 herring gillnet fishery in the Eastern Shore fishing area began on Sept. 21 and ended on Nov. 2 with total landings of 2,380t, a reduction of 1,350t from the previous year (Table 24). The reduction was due in part to a quota allocation limit for the area of 2,500t which was put in place due to the reduced biomass seen in 2007. Once again, this was primarily a herring roe fishery with catches reported from three main areas; near Halifax Harbour approaches, southwest of Jeddore Head and south of Ship Harbour, N.S. The fishery duration was similar to 2006-2007 with most catches occurring between Sept. 20 and Oct. 20 but the daily amounts

were much more variable. Catches were low in early Oct. and didn't reach a peak until the end of the season for a one week period from Oct 12 to 18. Catches were well distributed in the area but were less concentrated in the area south of Jeddore Harbour (Figure 44).

In 2006 the total SSB estimated from the three surveys was 51,100t which was a substantial increase since 2005. In 2007 multiple surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, N.S. with an overall SSB of 24,000t estimated. This was a reduction in surveyed acoustic biomass of about 50% from the previous year. This reduction was attributed by industry representatives to a lack of survey effort in the Eastern Passage area and high (rapid) turnover rates on the spawning grounds.

In 2008 surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, N.S. on Sept. 23, Oct. 1, 7, 8, 16 and Nov. 26 (Power and Melvin 2010). The total spawning biomass for the Eastern Shore area for 2008 was taken as the sum of the Sept. 23, Oct. 1, Oct. 7, Oct. 16 and Nov. 6 surveys (Table 25-26, Figure 45). The overall estimates are 30,330t with the CIF and 25,250t without the CIF. A multi-panel gillnet was used to collect a representative sample of herring being surveyed on each of the survey nights and was used to estimate TS.

Glace Bay

In 2006 there was minimal catch of 85t in the Glace Bay area due to the poor price for herring roe. In 2007 there was virtually no herring roe fishery with only 5t reported and thus no fishery information for defining possible surveying search areas. Three herring acoustic surveys were conducted in 2007 near Glace Bay, N.S. by a single survey vessel (*Natasha Lee)* equipped with an acoustic recording system. The overall biomass estimate (taken as the sum of the surveys) was 240t with the CIF.

In 2008 catches were very limited with only 11t landed (Table 24, Figure 46). Acoustic data were recorded on four separate nights from Sept. 21 to Oct. 29 but only small portions of the survey box area was surveyed by the single acoustic vessel (Power and Melvin 2010). The overall biomass was estimated as less than 500t (Table 25-26, Figure 47).

Bras d'Or Lakes

The fishery remained closed. No sampling or acoustic surveys were undertaken in the Bras d'Or lakes to document the size distribution or abundance of herring. It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. With no sampling or acoustic surveys in recent years, there is no evidence of any change. It is therefore appropriate to reiterate from a biological perspective, that no fishing take place on this spawning component.

4.2 Outlook and Management Considerations

In the previous assessment (for 2007 fishing year) there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50%, while the Little Hope area saw an even larger decline of almost 90%. In 2008, there was an increase in surveyed acoustic biomass in the Little Hope/Port Mouton area from the low of the previous year, but biomass is still below average (Table 25, 26). The surveyed biomass in the Halifax/Eastern shore area saw a slight increase and is close to the long term average SSB observed for this area. Surveys were also completed near Glace Bay but there were very little spawning herring documented

and only 12t of catch reported. No herring surveys have been conducted in the Bras d'Or Lakes since 2000.

As indicated for the SW Nova Scotia/Bay of Fundy component, summing of multiple surveys may result in overestimates of SSB due to double counting. However, the majority of surveys of the Coastal Nova Scotia spawning component were undertaken on spatially separated aggregations of fish.

Management approaches and recent research efforts have improved knowledge in the three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge in adjacent areas. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. It is again recommended that no coastal spawning area undergo a large effort increase in new areas until enough information is available to evaluate the state of that spawning group. There should be no large increases in effort in coastal spawning areas and no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern, but there has been no research or surveys in recent years. It is therefore again appropriate to reiterate that no fishing should take place on this spawning component.

Harvest levels from the main areas of areas for Little Hope/Port Mouton, Halifax/Eastern Shore use a five-year average of recent catches and/or surveyed acoustic biomass as calculated with the CIF to set annual removals. The provision to document sufficient quantities of fish each year before the fishery begins had been waived in some recent years due to substantial abundances. It is recommended that given the current situation of reduced or below average biomass in all areas, the "survey, assess, and then fish" protocol should be applied.

5) SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy. These fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota.

The success of this passive fishery is historically unpredictable, and catches are inherently susceptible to many natural variables in addition to abundance. The number and distribution of active weirs have decreased over the past decade, due in part to the conversion of sites to aquaculture, as well as the reduction in landings in the past 30 years in the Passamaquoddy Bay area (Stephenson 1990) (Table 10).

In 2003 there was a drop in landings in the traditional New Brunswick weir and shutoff fishery to 9,000t - the lowest since 1983 – and there was concern expressed for this fishery. In 2004 weir landings increased to 20,600t with concerns abating but in the following year landings again decreased to 13,055t. In 2006 landings remained low with about 14,100t recorded while the size of herring caught was abnormally small throughout the season impeding markets. The landings for 2007 of 30,921t were the highest catch for this component since 1993. Catches also confirmed the presence of the 2005 year-class which was observed in high numbers in the previous season as small and mostly unmarketable fish. The number of active weirs with catch increased to 98 in the 2007 season from a low of 76 in 2005.

The landings in the 2008 New Brunswick weir and shutoff fishery were only 6,400t which is the lowest catch recorded (since 1963) and is well below the long term average (Table 3, Figure 48-49). The previous year's fishery had landed 30,900t, the highest amount for this component since 1993. In 2008, weir fishermen in most areas reported good abundance close to their weirs, but catches remained low throughout the season with the fish not moving into the weirs.

The size distribution of fish caught in the 2008 New Brunswick weir and shutoff fishery was primarily juvenile size fish with 98.7% less than 23cm (Figure 50). The number of active weirs with catch decreased from 97 to 76 in the 2008 season although there were more weirs actually constructed but did not catch fish (J. Cline pers. comm.) (Table 10).

Preliminary results from tagging studies conducted on weir fish since August 2002 have indicated a link between the fish caught in the weir fishery and those caught in the fall and winter purse seine fishery off Grand Manan (Waters and Clark 2005). The juvenile fish caught in the purse seine fishery are counted against the 4VWX quota, whilst those caught in the weirs are considered to be of Subarea 5 origin. The recent US management plans (NEFSC 1998, 2004) assumes that all of the juvenile herring from this fishery originate from the US "coastal complex" (5Y + 5Z) which is reported to be at reduced levels of abundance.

The New Brunswick weir fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and are therefore excluded from the 4WX quota.

6) 5Z Georges Bank

The activities of midwater trawlers and herring purse seiners on the Canadian portion of Georges Bank (area 5Z) were monitored and there were no reported landings or effort (Table 1).

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Table 1. 4VWX herring fishery landings (t) by month, gear sector and management unit for 2007-2008 quota year.

	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
S.W. Nova Scotia	4X	Fall P. Seine (2007)										1,009	534		1,543
	4X	Winter P. Seine (2008)	457												457
	4X	Summer P. Seine (2008)					1,012	8,213	12,349	8,997	11,891	7,561			50,022
	4X	Gillnet "Stock" (2008)					0	2			13				15
	4X	N.S. Weirs (2008)						1,136	381	836	171				2,524
S.W. Nova Scotia Total			457	-			1,012	9,351	12,730	9,833	12,075	8,570	534	-	54,561
Coastal Nova Scotia	4Vn, 4X	Trap						168	7	7			21		204
(South Shore,	4Vn	Glace Bay Gillnet					1	1	0		7	3			12
Eastern Shore,	4W	Eastern Shore Gillnet					0	-			473	1,837	71		2,381
Cape Breton)	4X	Little Hope Gillnet					0	0		0	171	935	1		1,108
Coastal Nova Scotia Total								170	7	7	650	2,775	93		3,704
Offshore Scotian Shelf	4WX	Offshore P. Seine					143	738							881
	4WX	Midwater Trawl													-
	4WX	Bottom Trawl + Misc.	1	1	3	4	4	2	4	7	3	5	5	0	37
Offshore Scotian Shelf Total			1	1	3	4	147	740	4	7	3	5	5	0	918
S.W. New Brunswick	4X	N.B. Weirs						81	1,502	2,479	1,507	389	49	32	6,041
Migrant Juveniles	4X	N.B. Shutoff							304	40	25		38		407
S.W. New Brunswick Migrant Juveniles Total							-	81	1,806	2,519	1,532	389			6,447
Georges Bank	5ZE	5Z Purse Seine													-
	5ZE	Midwater Trawl													-
Georges Bank Total										-	-				-

Total 2007-2008	65,631

Table 2. 4WX herring fishery landings (t) by month and gear sector for 2008-2009 quota year (as of March 1, 2009).

	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
2008-09 quota year	4X	Fall 2008 P. Seine										1,314	556		1,870
		Winter 2009 P. Seine	891												891
2009 Calendar year	4WX	Bottom Trawl	0	0											0
2008-09 Total			891	0	-							1,314	556		2,762

Table 3. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2008 (the 1963-73 Offshore Scotian Shelf landings are from Stephenson *et al*. (1987)).

Year^	4W Winter Purse Seine	4Xs Fall&Winter Purse Seine	4Xqr Summer Purse Seine	4X Summer Gillnet	4Xr Nova Scotia Weir	4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs N.B. Weir & Shutoff	4VWX Coastal Nova Scotia	Offshore Scotian Shelf Banks	Total 4VWX Adjusted Landings
1963		6,871	15,093	2,955	5,345	30,264	30,264		29,366		3,000	62,630
1964		15991	24,894	4,053	12,458	57,396	57,396		29,432		2,000	88,828
1965		15,755	54,527	4,091	12,021	86,394	86,394		33,346		6,000	125,740
1966		25,645	112,457	4,413	7,711	150,226	150,226		35,805		2,000	188,031
1967		20,888	117,382	5,398	12,475	156,143	156,741		30,032		1,000	187,773
1968		42,223	133,267	5,884	12,571	193,945	196,362		33,145		18,000	247,507
1969	25,112	13,202	84,525	3,474	10,744	137,057	150,462		26,539		121,000	298,001
1970	27,107	14,749	74,849	5,019	11,706	133,430	190,382		15,840		87,000	293,222
1971	52,535	4,868	35,071	4,607	8,081	105,162	129,101		12,660		28,000	169,761
1972	25,656	32,174	61,158	3,789	6,766	129,543	153,449		32,699		21,000	207,148
1973	8,348	27,322	36,618	5,205	12,492	89,985	122,687		19,935		14,000	156,622
1974	27,044	10,563	76,859	4,285	6,436	125,187	149,670		20,602			170,272
1975	27,030	1,152	79,605	4,995	7,404	120,186	143,897		30,819			174,716
1976	37,196	746	58,395	8,322	5,959	110,618	115,178		29,206			144,384
1977	23,251	1,236	68,538	18,523	5,213	116,761	117,171	109,000	23,487			140,658
1978	17,274	6,519	57,973	6,059	8,057	95,882	114,000	110,000	38,842			152,842
1979	14,073	3,839	25,265	4,363	9,307	56,847	77,500	99,000	37,828			115,328
1980	8,958	1,443	44,986	19,804	2,383	77,574	107,000	65,000	13,525			120,525
1981	18,588	1,368	53,799	11,985	1,966	87,706	137,000	100,000	19,080			156,080
1982	12,275	103	64,344	6,799	1,212	84,733	105,800	80,200	25,963			131,763
1983	8,226	2,157	63,379	8,762	918	83,442	117,400	82,000	11,383			128,783
1984	6,336	5,683	58,354	4,490	2,684	77,547	135,900	80,000	8,698			144,598
1985	8,751	5,419	87,167	5,584	4,062	110,983	165,000	125,000	27,863			192,863
1986	8,414	3,365	56,139	3,533	1,958	73,409	100,000	97,600	27,883			127,883
1987	8,780	5,139	77,706	2,289	6,786	100,700	147,100	126,500	27,320			174,420
1988	8,503	7,876	98,371	695	7,518	124,653	199,600	151,200	33,421			233,021
1989	6,169	5,896	68,089	95	3,308	83,557	97,500	151,200	44,112			141,612
1990	8,316	10,705	77,545	243	4,049	102,627	172,900	151,200	38,778			211,678
1991	17,878	2,024	73,619	538	1,498	97,010	130,800	151,200	24,576			155,376
1992	14,310	1,298	80,807	395	2,227	100,227	136,000	125,000	31,967			167,967
1993	10,731	2,376	81,478	556	2,662	98,464	105,089	151,200	31,573			136,662
1994	9,872	3,174	64,509	339	2,045	80,099	80,099	151,200	22,241			102,340
1995	3,191	7,235	48,481	302	3,049	62,499	62,499	80,000	18,248			80,747
1996	2,049	3,305	42,708	6,340	3,476	58,068	58,068	57,000	15,913	1,450	11,745	87,176
1997	1,759	2,926	40,357	6,816	4,019	56,117	56,117	57,000	20,552	2,340	20,261	99,270
1998	1,405	1,494	67,433	2,231	4,464	77,027	77,027	90,000	20,091	4,120	5,591	106,829
1999	1,235	4,764	64,432	1,660	5,461	77,552	77,552	105,000	18,644	5,618	12,646	114,460
2000	1,012	4,738	78,010	823	701	85,284	85,284	100,000	16,829	4,283	2,182	108,578
2001	0	4,001	62,004	1,857	3,708	71,570	71,570	78,000	20,209	6,006	12,503	110,288
2002	367	5,257	69,894	393	1,143	77,054	77,054	78,000	11,874	10,375	7,039	106,342
2003	0	8,860	79,140	439	921	89,360	89,360	93,000	9,003	9,162	998	108,523
2004	0	5,659	69,015	225	3,130	78,029	78,029	83,000	20,686	6,924	4,165	109,804
2005	0	2,601	43,487	566	2,245	48,899	48,899	50,000	13,055	6,311	5,263	73,528
2006	0	930	45,002	719	2,508	49,159	49,159	50,000	12,863	6,566	9,809	78,397
2007	0	1,847	46,045	1,334	1,130	50,356	50,356	50,000	30,944	5,240	5,385	91,925
2008	0	2,000	50,022	15	2,524	54,561	54,561	55,000	6,447	3,704	918	65,631

^Annual landings by purse seiners are defined for the period from October 15 of the preceding year to October 14 of the current year.

*Adjusted totals includes misreporting adjustments for 1978-84 (Mace 1985) and for 1985-93 (Stephenson 1993, Stephenson et al 1994)

All landings by other gear types are for the calendar year.

Table 4a. Herring purse seine catches (t) by fishing ground areas from 1985 to 2008 for the 4WX stock component.

Stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Browns Bank		732						86		1,903	1,554	40
Chedabucto Bay	4,216	7,498	6,374	7,523	8,325	12,470	12,596	3,084	1,378	1,407	2,049	1,759
Gannet,Dry Ledge	5,675	2,187	1,474	14,901	2,010	4,213	6,294	18,527	2,935	2,588	2,693	1,963
German Bank	15,522	13,346	16,547	18,392	8,087	11,744	23,193	3,235	4,045	9,662	19,549	15,898
Grand Manan	4,989	5,823	4,298	4,440	4,300	5,442	4,225	2,722	783	6,846	5,297	6,005
Long Island	974	3,365	7,499	10,722	21,719	18,484	9,470	3,213	2,814	7,666	7,906	4,385
Lurcher	476	132		2,928	18	65	151	2,141	1,560	530	382	243
N.B. Coastal	188	621	960	1,031	3,033	2,347	488	992	598	99	1,502	271
Pollock Point												
S.W. Grounds	558	1,108	184	181	276	56	521	225	2,961	3,444	6,205	3,035
Scots Bay		36	3,822	4,145	6,583	9,003	7,982	7,987	5,258	10,840	980	8,984
Seal Island	13,818	8,894	11,560	19,019	23,420	25,344	12,740	10,455	3,874	2,820	465	1,567
Trinity	35,860	13,505	18,744	18,539	266	1,113	3,259	4,612	1,348	2,366	370	3,448
Yankee Bank				194	250	3,647	817	119	10	175	323	9
Unknown	184	500	200			200	579	494	140		73	
4WX Stock Total	82,458	57,745	71,661	102,015	78,287	94,127	82,314	57,888	27,703	50,345	49,348	47,606

Stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Recent Decade Average 99-08	2008 vs Avg 99-08	All Series Avg 85-07
Browns Bank	14	3,139	2,197	1,137	486			45		88	34		664		818
Chedabucto Bay		1,583	1,151	10									581		4,762
Gannet,Dry Ledge	4,590	4,156	10,296	12,674	3,877	9,047	6,965	4,456	3,117	6,764	11,344	10,006	7,855	2,151	6,365
German Bank	13,576	20,556	24,660	25,631	24,139	22,355	21,573	14,175	14,171	16,522	15,085	22,437	20,075	2,363	16,421
Grand Manan	5,312	15,983	7,912	18,185	10,545	17,753	17,258	7,542	5,740	7,716	10,011	10,493	11,315	-823	7,901
Long Island	3,557	12,360	18,286	11,199	12,904	6,642	12,639	13,115	8,037	1,884	4,604	3,207	9,252	-6,045	8,610
Lurcher	599	57		715	227	7,683	1,872	7,268	1,692	2,809	2,305	684	2,806	-2,122	1,570
N.B. Coastal	1,176	782	1,867	361	1,250	3,113	3,914	2,707	787	1,889	851	2,205	1,894	311	1,376
Pollock Point					1,563								1,563		1,563
S.W. Grounds	797	1,239	3,241	1,879	53	791	73		1,228	1,206	30	752	1,028	-276	1,306
Scots Bay	4,894	8,210	1,789	10,926	10,739	8,202	19,196	24,869	6,239	3,352	4,116	2,373	9,180	-6,807	7,414
Seal Island	492	617	567	206	101	238	1,096		1,358	209		15	474	-459	6,313
Trinity	5,308	2,825	1,220	103	113	1,609		370	1,448	3,725	112		1,087		5,466
Yankee Bank	4	159	82	133	8	78			528	2	62	178	134	44	357
Unknown		62	84	27			1,103	127	181	396	39		280		274
4WX Stock Total	40,319	71,727	73,350	83,186	66,005	77,511	85,689	74,674	44,526	46,561	48,594	52,350	65,245	-12,895	65,250

Table 4b. Herring purse seine catches (%) by fishing ground areas from 1985 to 2008 for the 4WX stock component.

Stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Browns Bank		1%						0%		4%	3%	0%
Chedabucto Bay	5%	13%	9%	7%	11%	13%	15%	5%	5%	3%	4%	4%
Gannet,Dry Ledge	7%	4%	2%	15%	3%	4%	8%	32%	11%	5%	5%	4%
German Bank	19%	23%	23%	18%	10%	12%	28%	6%	15%	19%	40%	33%
Grand Manan	6%	10%	6%	4%	5%	6%	5%	5%	3%	14%	11%	13%
Long Island	1%	6%	10%	11%	28%	20%	12%	6%	10%	15%	16%	9%
Lurcher	1%	0%		3%	0%	0%	0%	4%	6%	1%	1%	1%
N.B. Coastal	0%	1%	1%	1%	4%	2%	1%	2%	2%	0%	3%	1%
Pollock Point												
S.W. Grounds	1%	2%	0%	0%	0%	0%	1%	0%	11%	7%	13%	6%
Scots Bay		0%	5%	4%	8%	10%	10%	14%	19%	22%	2%	19%
Seal Island	17%	15%	16%	19%	30%	27%	15%	18%	14%	6%	1%	3%
Trinity	43%	23%	26%	18%	0%	1%	4%	8%	5%	5%	1%	7%
Yankee Bank				0%	0%	4%	1%	0%	0%	0%	1%	0%
Unknown	0%	1%	0%			0%	1%	1%	1%		0%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Recent Decade Average 99-08	2008 vs Avg 99-08	All Series Avg 85-08
Browns Bank	0%	4%	3%	1%	1%			0%		0%	0%		1%		1%
Chedabucto Bay		2%	2%	0%									0%		4%
Gannet,Dry Ledge	11%	6%	14%	15%	6%	12%	8%	6%	7%	15%	23%	19%	12%	7%	10%
German Bank	34%	29%	34%	31%	37%	29%	25%	19%	32%	35%	31%	43%	32%	11%	26%
Grand Manan	13%	22%	11%	22%	16%	23%	20%	10%	13%	17%	21%	20%	17%	3%	12%
Long Island	9%	17%	25%	13%	20%	9%	15%	18%	18%	4%	9%	6%	14%	-8%	13%
Lurcher	1%	0%		1%	0%	10%	2%	10%	4%	6%	5%	1%	4%	-3%	2%
N.B. Coastal	3%	1%	3%	0%	2%	4%	5%	4%	2%	4%	2%	4%	3%	1%	2%
Pollock Point					2%								0%		0%
S.W. Grounds	2%	2%	4%	2%	0%	1%	0%		3%	3%	0%	1%	1%	0%	2%
Scots Bay	12%	11%	2%	13%	16%	11%	22%	33%	14%	7%	8%	5%	13%	-9%	11%
Seal Island	1%	1%	1%	0%	0%	0%	1%		3%	0%		0%	1%	-1%	8%
Trinity	13%	4%	2%	0%	0%	2%		0%	3%	8%	0%		2%		7%
Yankee Bank	0%	0%	0%	0%	0%	0%			1%	0%	0%	0%	0%	0%	0%
Unknown		0%	0%	0%			1%	0%	0%	1%	0%		0%		0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%		100%

Table 5. Herring purse seine catches (t) and percentage by fishing ground for 1985 to 2008 from non-stock areas.

a) Herring purse seine catches (t) by grounds for non-stock areas from 1985-2008.

Non-stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Georges Bank						91	64			266		2,491
Liverpool							13		4,067	4,177		
Shelburne			59				64		526	161		56
Halifax									652	1,945		585
Offshore Banks												11,800
Western Hole		41	154				213	3,451	2,255	1,495	108	127
Nonstock Total		41	213			91	353	3,451	7,500	8,044	108	15,058

Non-stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 99-08	Avg 85-08
Georges Bank	79			265									265	542
Liverpool														2,752
Shelburne									29				29	128
Halifax	455			1,002	472	367							460	685
Offshore Banks	18,770	4,284	8,669	1,645	3,977	5,078	722	4,054	4,115	4,846	2,515	829	3,645	5,093
Western Hole	691	1,012	1,057	47	7,712	1,884	156		214	192	220	52	1,282	1,110
Nonstock Total	19,995	5,296	9,726	2,958	12,161	7,329	878	4,054	4,358	5,038	2,735	881	5,680	10,310

b) Herring purse seine catches as percentage by grounds for non-stock areas from 1985-2008.

Non-stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Georges Bank						100%	18%			3%		17%
Liverpool							4%		54%	52%		
Shelburne			28%				18%		7%	2%		0%
Halifax									9%	24%		4%
Offshore Banks												78%
Western Hole		100%	72%				60%	100%	30%	19%	100%	1%
Non-stock Total		100%	100%			100%	100%	100%	100%	100%	100%	100%

Non-stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 99-08	Avg 85-08
Georges Bank	0%			9%									1%	7%
Liverpool														5%
Shelburne									1%				0%	3%
Halifax	2%			34%	4%	5%							4%	4%
Offshore Banks	94%	81%	89%	56%	33%	69%	82%	100%	94%	96%	92%	94%	81%	52%
Western Hole	3%	19%	11%	2%	63%	26%	18%		5%	4%	8%	6%	15%	30%
Non-stock Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

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Table 6. Summary of 1987 to 2008 Scots Bay herring purse seine catches.

Year	Min. Date	Max. Date	Duration in Days	Days with Catch	Catch t	No. Slips	Catch/Day with Catch	Catch/Slip
1987	08-Jul-87	06-Aug-87	30	20	3,398	91	169.88	37.34
1988	20-Jul-88	29-Jul-88	10	9	3,780	65	419.99	58.15
1989	19-Jul-89	13-Sep-89	57	35	6,021	164	172.04	36.72
1990	22-Jul-90	14-Aug-90	24	11	8,088	108	735.24	74.89
1991	05-Jul-91	14-Aug-91	41	16	7,365	163	460.30	45.18
1992	25-Jul-92	11-Aug-92	18	18	7,960	189	442.22	42.12
1993	25-Jul-93	01-Sep-93	39	32	5,228	100	163.36	52.28
1994	10-Jul-94	25-Aug-94	47	36	10,610	286	294.72	37.10
1995	24-Jul-95	26-Jul-95	3	3	907	33	302.33	27.48
1996	25-Jul-96	20-Aug-96	27	13	8,939	151	687.58	59.20
1997	30-Jul-97	27-Aug-97	29	19	4,847	91	255.11	53.26
1998	20-Jul-98	10-Sep-98	53	29	7,880	163	271.72	48.34
1999	19-Jul-99	17-Aug-99	30	16	1,789	40	111.81	44.73
2000	25-Jul-00	30-Aug-00	37	26	10,853	171	417.44	63.47
2001	10-Jul-01	21-Aug-01	43	30	10,739	176	357.97	61.02
2002	22-Jul-02	09-Sep-02	50	36	7,994	160	222.06	49.96
2003	21-Jul-03	05-Sep-03	47	34	19,196	237	564.59	81.00
2004	19-Jul-04	16-Sep-04	60	42	24,388	330	580.67	73.90
2005	26-Jul-05	09-Sep-05	46	27	5,872	96	217.48	61.17
2006	24-Jul-06	04-Sep-06	43	16	3,352	43	209.50	77.95
2007	16-Jul-07	31-Aug-07	47	21	4,116	79	196.00	52.10
2008	14-Jul-08	27-Aug-08	45	14	2,373	43	169.50	55.19

Table 7. Summary of 1985 to 2008 German Bank herring purse seine catches with start and end dates, catches before Aug.15 (pre-spawning period), catches after Aug. 14 (defined spawning period) and proportion of TAC.

Year	Start Date	End Date	Duration No. Days	Total No. Slips	Catch before Aug. 15 (prespawn)	Catch on/after Aug. 15 (spawning)	Total Catch t	% Catch on/after Aug-14	TAC	German as % TAC
1985	22-Jun-85	08-Oct-85	109	428	8,856	14,228	23,084	62%	125,000	18%
1986	18-Jun-86	01-Oct-86	106	349	2,349	13,542	15,892	85%	97,600	16%
1987	26-May-87	14-Oct-87	142	403	5,138	13,218	18,357	72%	126,500	15%
1988	29-May-88	06-Oct-88	131	610	14,776	18,348	33,125	55%	151,200	22%
1989	28-May-89	15-Oct-89	141	313	2,061	12,087	14,148	85%	151,200	9%
1990	23-May-90	23-Oct-90	154	428	1,220	23,647	24,867	95%	151,200	16%
1991	02-Jun-91	15-Oct-91	136	621	11,800	18,328	30,127	61%	151,200	20%
1992	31-May-92	04-Oct-92	127	556	13,175	10,985	24,160	45%	125,000	19%
1993	24-May-93	29-Sep-93	129	192	7,912	1,092	9,003	12%	151,200	6%
1994	05-May-94	28-Sep-94	147	252	1,186	11,454	12,641	91%	151,200	8%
1995	05-Jun-95	06-Oct-95	124	301	434	21,339	21,773	98%	80,000	27%
1996	20-Jun-96	27-Oct-96	130	260	2,229	16,091	18,320	88%	57,000	32%
1997	11-Jul-97	14-Oct-97	96	327	2,009	17,110	19,119	89%	57,000	34%
1998	10-Jun-98	14-Oct-98	127	516	3,231	21,489	24,720	87%	90,000	27%
1999	20-Apr-99	20-Oct-99	184	666	18,508	16,401	34,909	47%	105,000	33%
2000	18-Apr-00	26-Oct-00	192	598	9,806	26,171	35,977	73%	100,000	36%
2001	22-May-01	20-Oct-01	152	521	5,312	22,156	27,468	81%	78,000	35%
2002	18-Apr-02	12-Oct-02	178	643	10,871	19,935	30,806	65%	78,000	39%
2003	05-May-03	15-Oct-03	164	392	8,900	20,070	28,970	69%	93,000	31%
2004	10-May-04	15-Oct-04	159	238	5,680	12,345	18,025	68%	83,000	22%
2005	16-May-05	13-Oct-05	151	364	8,069	12,039	20,107	60%	50,000	40%
2006	27-Jun-06	16-Oct-06	112	475	12,227	12,504	24,731	51%	50,000	49%
2007	15-May-07	05-Oct-07	144	540	13,948	13,307	27,255	49%	50,000	55%
2008	03-May-08	16-Oct-08	167	590	16,845	14,447	31,291	46%	55,000	57%

Table 8. Summary of 1998 to 2008 Spectacle Buoy and Trinity Ledge herring gillnet catches with start and end dates, catches and overall amounts.

Year	Spec. Buoy catches and surveys				Trinity Ledge catches and surveys				Overall
	Min. Day	Max.Day	Catch t	Survey SSB t	Min. Day	Max.Day	Catch t	Survey SSB t	Gillnet catch
1998	10-May-98	30-Jun-98	484		24-Aug-98	21-Sep-98	1,668		2,153
1999	10-May-99	16-Jul-99	355	n/s	12-Aug-99	15-Sep-99	1,257	3,885	1,612
2000	11-Jun-00	14-Jun-00	80	n/s	30-Aug-00	12-Sep-00	734	621	814
2001	11-Jun-01	10-Jul-01	699	1,110	21-Aug-01	26-Sep-01	1,012	14,797	1,711
2002	15-May-02	01-Jul-02	137	n/s	02-Sep-02	30-Sep-02	256	8,096	393
2003	04-Jun-03	06-Jun-03	69	1,420	21-Aug-03	18-Sep-03	369	14,512	439
2004	17-Jun-04	15-Jul-04	5	n/s	02-Sep-04	15-Sep-04	225	6,511	229
2005	09-Jun-05	11-Jul-05	124	290	05-Sep-05	20-Sep-05	447	5,071	570
2006	03-Jun-06	22-Jun-06	2	n/s	23-Aug-06	21-Sep-06	717	8,486	719
2007	07-May-07	22-Jun-07	243	310	27-Aug-07	20-Sep-07	1,091	1,357	1,334
2008	29-May-08	19-Jun-08	6	0	21-Aug-08	25-Sep-08	7	273	13
Avg.			200	626			707	6,361	908

Table 9. Monthly weir landings (t) for weirs located in Nova Scotia; 1978 to 2008.

		MONTH												
PROVINCE	YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Total
N.S.	1978				1	490	3,704	2,990	239	46	111	198	79	7,858
	1979					811	3,458	1,418	420	39	136	57		6,339
	1980					69	647	1,271	395					2,383
	1981					50	437	983	276	37		41		1,824
	1982					16	267	468	195	172	12			1,130
	1983				2	286	141	188	208	53		18		896
	1984					113	1,032	736	602	220				2,702
	1985					378	1,799	1,378	489			11		4,055
	1986					385	403	71	704	390	5			1,957
	1987					1,503	2,526	1,215	1,166	367				6,776
	1988					1,217	2,976	1,696	1,204	386				7,480
	1989					340	1,018	870	843	226				3,296
	1990					208	973	1,482	879	538	52			4,132
	1991				3	23	149	719	342	262				1,498
	1992					35	659	405	754	371				2,224
	1993					226	908	608	867	53				2,662
	1994					111	736	499	519	180				2,045
	1995					236	1,255	1,059	470	29				3,049
	1996					430	1,267	1,232	358	188				3,476
	1997					70	1,874	1,739	271	65				4,019
	1998					1,304	1,677	390	359	317				4,048
	1999					1,958	1,513	547	488	31				4,537
	2000						16	151	326	191				683
	2001					105	1,439	1,565	391	207				3,708
	2002					23	95	240	558	228				1,143
	2003					98	126	68	344	284				921
	2004						667	873	1,370	219				3,130
	2005				11	84	731	472	828	118				2,245
	2006					195	138	414	1,447	182	115			2,491
	2007					26	11	290	579	224				1,130
	2008						1,136	381	836	171				2,524
NS Average Catch (t)					5	385	1,090	852	604	200	72	65	79	3,108

Table 10. Overall effort from New Brunswick and Nova Scotia weirs for catch (t), number of active weirs and the catch per weir (t) for the period 1978 to 2008.

	Annual Catch (t)			No. Active Weirs			Catch per weir (t)		
Year	NB	NS	Total Catch	NB	NS	Total No.	NB	NS	Average
1978	33,599	7,858	41,458	208	31	239	162	253	173
1979	32,579	6,339	38,918	210	27	237	155	235	164
1980	11,066	2,383	13,449	120	29	149	92	82	90
1981	14,968	1,824	16,793	147	28	175	102	65	96
1982	22,181	1,130	23,311	159	19	178	140	59	131
1983	12,568	896	13,464	143	23	166	88	39	81
1984	8,353	2,702	11,056	116	13	129	72	208	86
1985	26,718	4,055	30,774	156	14	170	171	290	181
1986	27,516	1,957	29,473	105	18	123	262	109	240
1987	26,621	6,776	33,397	123	21	144	216	323	232
1988	38,235	7,480	45,715	191	21	212	200	356	216
1989	43,520	3,296	46,817	171	20	191	255	165	245
1990	39,808	4,132	43,940	154	22	176	258	188	250
1991	23,717	1,498	25,216	143	20	163	166	75	155
1992	31,981	2,224	34,206	151	12	163	212	185	210
1993	31,328	2,662	33,990	145	10	155	216	266	219
1994	20,618	2,045	22,662	129	11	140	160	186	162
1995	18,228	3,049	21,277	106	10	116	172	305	183
1996	15,781	3,476	19,257	101	12	113	156	290	170
1997	20,396	4,019	24,415	102	15	117	200	268	209
1998	19,529	4,048	23,577	108	15	123	181	270	192
1999	19,063	4,537	23,600	100	14	114	191	324	207
2000	16,376	683	17,058	77	3	80	213	228	213
2001	20,064	3,708	23,772	101	14	115	199	265	207
2002	11,807	1,143	12,950	83	9	92	142	127	141
2003	9,003	921	9,924	78	8	86	115	115	115
2004	20,620	3,130	23,750	84	8	92	245	391	258
2005	12,639	2,245	14,884	76	10	86	166	225	173
2006	11,641	2,491	14,132	89	6	95	131	415	149
2007	30,145	1,130	31,275	97	8	105	311	141	298
2008	6,041	2,524	8,565	76	8	84	79	315	102
Average	21,829	3,108	24,938	124	15	140	175	218	179

Table 11. Purse seine effort, catch and CPUE levels for 1989 to 2008.

Year	No. Days Fished	No. of Boats Fishing	Total Catch t	CPUE (catch/day)	CPUE (catch/boat)
1989	2198	40	87,383	40	2185
1990	2390	42	103,537	43	2465
1991	2333	40	88,830	38	2221
1992	2431	39	95,072	39	2438
1993	2542	36	92,828	37	2579
1994	2227	36	75,652	34	2101
1995	1682	32	56,441	34	1764
1996	1781	32	60,038	34	1876
1997	1731	30	61,769	36	2059
1998	2290	28	70,931	31	2533
1999	1775	28	78,574	44	2806
2000	1572	28	78,727	50	2812
2001	1826	21	75,343	41	3588
2002	1838	19	76,210	41	4011
2003	1652	18	85,499	52	4750
2004	1358	18	76,361	56	4242
2005	945	16	48,517	51	3032
2006	789	16	44,476	56	2780
2007	914	16	50,667	55	3167
2008	923	16	53,019	57	3314

Table 12. Summary of the minimum observed spawning stock biomass for each of the surveyed spawning grounds in the Bay of Fundy/SW Nova component of the 4WX stock complex. Total SSB is rounded to nearest 100t and all data was calculated without the use of the calibration integration factor (CIF). (Power and Melvin, 2010)

Location/Year	1997*	1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average 1999-2007
Scots Bay	160,200	72,500	41,000	106,300	163,900	141,000	133,900	107,600	16,800	28,600	45,700	19,400	87,200
Trinity Ledge	23,000	6,800	3,900	600	14,800	8,100	14,500	6,500	5,100	8,500	1,400	300	7,044
German Bank (inbox)	370,400	440,700	460,800	356,400	190,500	393,100	343,500	367,600	211,000	245,500	337,200	201,700	322,844
- German (outbox)										4,100	2,820	1,700	3,460
Spectacle Buoy													
- Spring	15,000	1,300	0	0	1,100		1,400	n/s	300	n/s	100	0	483
- Fall					87,500								87,500
Sub-Total	568,600	521,300	505,700	463,300	457,800	542,200	493,300	481,700	233,200	286,700	387,220	223,100	427,902
Seal Island					3,300	1,200	12,200			8,100			6,200
Browns Bank					45,800					6,100			25,950
Total	568,600	521,300	505,700	463,300	506,900	543,400	505,400	481,700	233,200	300,900	387,220	223,100	436,413
Overall SE t	n/a	n/a	94,600	64,900	50,800	49,500	86,100	74,200	64,900	47,251	94,255	94,255	69,612
Overall SE %	n/a	n/a	19	14	10	9	17	15	28	16	25	25	17

*Biomass estimates for 1997 and 1998 are not considered comparable due to variation in the coverage area.

Table 13. Relative exploitation rates (%) by major spawning grounds and for the overall Bay of Fundy/SW Nova component with (A1) acoustic survey SSB, (A2) acoustic survey proportion of total SSB, (C1) catch by spawning component areas, (C2) adjusted catch including non-spawning area catches, (E1) exploitation rate as percentage of acoustic SSB for spawning area catch and (E2) adjusted catch.

A1) Acoustic Survey SSB (t)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	40,972	106,316	163,900	141,000	133,900	107,600	16,800	28,600	45,700	19,400	80,419
Trinity	3,885	621	14,800	8,100	14,500	6,500	5,100	8,500	1,400	300	6,371
German Bank	460,823	356,372	282,400	394,357	357,100	367,600	211,000	249,600	337,300	203,400	321,995
Total SSB	505,680	463,309	461,100	543,457	505,500	481,700	232,900	286,700	384,400	223,100	408,785

A2) Acoustic Survey Proportions	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	8%	23%	36%	26%	26%	22%	7%	10%	12%	9%	18%
Trinity	1%	0%	3%	1%	3%	1%	2%	3%	0%	0%	2%
German Bank	91%	77%	61%	73%	71%	76%	91%	87%	88%	91%	81%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

C1) Catch by Spawn Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	1,789	10,926	10,739	8,202	19,196	24,869	6,239	3,352	4,116	2,373	9,180
Trinity (purse seine+gillnet)	2,526	843	1,271	1,865	369	595	2,014	4,444	1,203	15	1,514
German Bank	24,660	25,631	24,139	22,355	21,573	14,175	14,171	16,522	15,085	22,437	20,075
Spawn Area Total	28,974	37,400	36,149	32,422	41,138	39,639	22,424	24,318	20,404	24,825	30,769
Overall SW Nova Catch	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	50,529	54,561	68,218
Non-spawning area catch remaining	48,578	47,884	35,421	44,632	48,323	38,390	26,557	24,841	30,125	29,736	37,449

C2) Adjusted Catch by Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	5,725	21,914	23,330	19,782	31,996	33,444	8,155	5,830	7,697	4,959	16,283
Trinity	2,899	907	2,408	2,530	1,755	1,113	2,596	5,181	1,313	55	2,076
German Bank	68,929	62,462	45,832	54,742	55,710	43,472	38,231	38,148	41,519	49,547	49,859
Adjusted Catch Total	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	50,529	54,561	68,218

E1) Percentage (C1/SSB)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	4%	10%	7%	6%	14%	23%	37%	12%	9%	12%	13%
Trinity	65%	136%	9%	23%	3%	9%	39%	52%	86%	5%	43%
German Bank	5%	7%	9%	6%	6%	4%	7%	7%	4%	11%	7%
Overall (C1/SSB)	6%	8%	8%	6%	8%	8%	10%	8%	5%	11%	8%

E2) Percentage adjusted (C2/SSB)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg 99-08
Scots Bay	14%	21%	14%	14%	24%	31%	49%	20%	17%	26%	23%
Trinity	75%	146%	16%	31%	12%	17%	51%	61%	94%	18%	52%
German Bank	15%	18%	16%	14%	16%	12%	18%	15%	12%	24%	16%
Overall Adjusted (Catch/Acoustic SSB)	15%	18%	16%	14%	18%	16%	21%	17%	13%	24%	17%

Table 14. Summary of biological samples by gear and month as collected during the 2008 4VWX herring fisheries. 'No. LF Samples' is the number of length frequency samples collected, 'No. Measured' is the number of length frequency fish measured and 'No. Processed' is the number of detail fish with sex and maturity determined.

		Month										
Gearname	Data	Jan.	Feb.	Mar.	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
4Vn Trap	No. LF Samples					2						2
	No. Measured					430						430
	No Processed					64						64
4W Purse Seine	No. LF Samples				1	3						4
	No. Measured				92	443						535
	No Processed				0	0						0
5Y CAN P.Seine	No. LF Samples				1	19	45	12	15	2		94
	No. Measured				220	2,482	5,259	1,447	1,810	225		11,443
	No Processed				27	45	160	31	48	27		338
5Y USA P.Seine/MWT	No. LF Samples							1		6	12	19
	No. Measured							120		721	1504	2345
	No Processed							0		0	0	0
5Z USA P.Seine/MWT	No. LF Samples	12	19							5		36
	No. Measured	1,417	2,197							615		4,229
	No Processed	0	0							0		0
Gillnet	No. LF Samples								4	14	1	19
	No. Measured								309	1,434	75	1,818
	No Processed								74	209	19	302
N.B. Purse Seine	No. LF Samples								15	65	14	94
	No. Measured								1748	7701	1484	10933
	No Processed								74	105	209	388
N.B. Shut-off	No. LF Samples						3	2				5
	No. Measured						348	251				599
	No Processed						0	11				11
N.B. Weirs	No. LF Samples					1	57	78	70	13	3	222
	No. Measured					121	6,799	9,519	8,335	1,536	354	26,664
	No Processed					0	90	65	114	166	0	435
N.S. Purse Seine	No. LF Samples				3	59	89	68	44	12		275
	No. Measured				662	7,544	11,540	9,076	5,755	1,465		36,042
	No Processed				64	282	420	369	336	142		1613
N.S. Weirs	No. LF Samples					21	7	11	4			43
	No. Measured					2,777	957	1,474	465			5,673
	No Processed					24	29	88	57			198
Resrch. Otter Trawl	No. LF Samples			51			79					130
	No. Measured											
	No Processed			372			758					1130
USA Weirs	No. LF Samples						1					1
	No. Measured						134					134
	No Processed						0					0
Total No. LF Samples		12	19	51	5	105	281	172	152	117	30	944
Total of No. Measured		1,417	2,197		974	13,797	25,037	21,887	18,422	13,697	3,417	100,845
Total of No Processed		0	0	372	91	415	1457	564	703	649	228	4479

Table 15. Number of herring samples collected by DFO personnel from commercial fisheries (Commercial), by members of the fishing industry (Industry), observer program (Observer), independent observers on foreign vessels (OSS) and DFO research surveys (Research).

	Sample Source					
Year	**Commercial**	**Industry**	**Observer**	**OSS**	**Research**	**Total**
1990	422			185		607
1991	448			167	1	616
1992	330			205	1	536
1993	183			421		604
1994	223			228	14	465
1995	138			244	108	490
1996	127	868	49		69	1,113
1997	78	1,443			114	1,635
1998	225	1,376			98	1,699
1999	49	1,388	89		198	1,724
2000	34	1,387	108		177	1,706
2001	47	1,455	96		190	1,788
2002	17	1,339	84		181	1,621
2003	58	1,292	56		199	1,605
2004	50	1,270	60		105	1,485
2005	48	1,017	23		152	1,240
2006	33	1,049	70		99	1,251
2007	10	1,139	29		137	1,315
2008	16	781	17		130	944
Average	**133**	**1,216**	**62**	**242**	**116**	**1,183**

Table 16a. Catch at age (thousands) for the SW Nova Scotia / Bay of Fundy herring spawning component, 1965-2005 (from Power *et al*, 2006a).

	Age											
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**	**Total**
1965	270,378	1,084,719	34,835	234,383	49,925	10,592	1,693	561	54	37	1	1,687,178
1966	154,323	914,093	448,940	73,382	321,857	45,916	13,970	7,722	1,690	215	1	1,982,109
1967	722,208	613,970	153,626	266,454	110,051	159,203	57,948	4,497	409	296	148	2,088,810
1968	164,703	2,389,061	224,956	83,109	290,285	73,087	90,617	31,977	15,441	5,668	1,175	3,370,079
1969	108,875	290,329	531,812	132,319	162,439	112,631	62,506	22,595	6,345	2,693	722	1,433,266
1970	699,720	576,896	76,532	286,278	201,215	120,280	111,937	41,257	21,271	7,039	2,674	2,145,099
1971	87,570	404,224	183,896	106,630	113,566	75,593	93,620	50,022	36,618	7,536	5,695	1,164,970
1972		649,254	71,984	148,516	77,207	75,384	49,065	48,700	26,055	13,792	11,679	1,171,636
1973	1,018	167,454	781,061	130,851	40,128	30,334	22,046	20,249	23,871	11,630	13,386	1,242,028
1974	18,411	766,064	93,606	803,651	68,276	19,093	10,232	6,565	12,786	7,102	9,031	1,814,817
1975	3,199	317,641	239,827	124,599	514,605	66,302	12,298	4,409	4,778	3,847	6,225	1,297,730
1976	240	55,596	206,535	153,782	68,804	268,839	21,460	5,571	3,951	2,059	3,446	790,283
1977	1,170	153,921	31,572	218,478	119,234	51,173	177,247	13,977	3,170	1,415	3,894	775,251
1978	35,381	383,611	40,887	12,906	122,108	68,410	31,088	108,975	11,082	2,425	1,676	818,549
1979	342	183,982	250,393	54,620	5,430	23,142	18,255	11,836	41,389	4,527	2,411	596,327
1980	2,339	12,503	80,518	474,091	27,930	4,373	4,692	6,560	2,985	10,641	2,739	629,371
1981		103,051	50,883	102,743	451,482	32,978	2,418	2,767	1,917	538	2,149	750,926
1982	3,589	102,133	150,764	22,640	98,206	211,043	14,627	2,080	1,354	1,250	1,014	608,700
1983	5,488	191,682	150,328	244,007	24,483	60,678	89,982	10,352	1,728	642	1,324	780,694
1984		88,433	243,542	224,354	146,096	22,716	21,654	28,299	9,515	2,183	9,000	795,792
1985	9,022	216,740	337,591	302,782	147,670	42,404	14,075	18,178	7,997	1,201	470	1,098,130
1986	63	125,300	275,903	292,792	56,937	31,599	10,770	4,320	2,942	1,356	349	802,331
1987	2,300	82,940	126,436	527,443	242,597	45,933	19,481	7,292	3,361	3,120	650	1,061,553
1988	151	148,399	113,208	195,096	434,192	236,089	42,533	21,208	4,186	3,797	2,845	1,201,704
1989	8	101,788	114,095	61,842	79,451	169,023	76,684	18,303	8,270	3,814	3,057	636,335
1990		178,532	130,176	171,560	89,922	101,066	201,901	116,788	31,466	10,572	6,848	1,038,831
1991		96,960	179,463	183,647	88,431	41,352	50,380	80,732	45,516	18,291	13,524	798,296
1992	9	168,561	132,642	286,923	126,510	75,473	34,458	35,369	59,136	34,558	20,653	974,292
1993	166	76,405	43,766	194,198	130,713	67,708	33,820	21,481	21,893	20,684	11,175	622,009
1994	151	103,885	142,260	53,700	118,015	72,512	36,059	14,889	8,706	10,447	15,533	576,157
1995	1,831	113,457	219,777	112,245	36,784	36,402	22,127	6,474	4,217	2,957	3,566	559,837
1996		37,496	37,715	256,063	54,534	16,862	9,151	3,300	1,782	1,310	1,605	419,818
1997	356	56,561	87,395	78,098	131,062	18,917	5,131	3,636	894	620	874	383,544
1998	137	264,901	62,322	138,751	97,065	97,464	20,679	3,856	1,730	1,288	398	688,591
1999	2,694	112,893	223,283	147,840	131,463	57,291	10,044	613	212	70	13	686,415
2000	841	364,078	75,330	108,560	124,083	60,754	25,829	4,454	251	33	23	764,236
2001	51	73,368	325,273	57,175	60,409	31,891	15,509	2,203	304	8	4	566,193
2002	15,500	303,723	98,597	210,620	75,258	27,973	12,846	1,577	70	23	3	746,188
2003	459	486,345	342,592	114,850	96,847	13,111	7,136	435	23			1,061,798
2004	3,142	320,628	347,693	132,570	79,884	9,351	3,226	339	36	1		896,870
2005	135	72,039	171,155	180,893	28,030	4,286	1,050	49	2	2		457,640

Table 16b. Catch at age (percent numbers) for the SW Nova Scotia / Bay of Fundy herring spawning component, 1965-2005 (from Power *et al*, 2006a). Proportions for some relatively strong year-classes that persisted in the fishery catch have been highlighted.

	Age											
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**	**Total**
1965	16	64	2	14	3	1	0	0	0	0	0	100
1966	8	46	23	4	16	2	1	0	0	0	0	100
1967	35	29	7	13	5	8	3	0	0	0	0	100
1968	5	71	7	2	9	2	3	1	0	0	0	100
1969	8	20	37	9	11	8	4	2	0	0	0	100
1970	33	27	4	13	9	6	5	2	1	0	0	100
1971	8	35	16	9	10	6	8	4	3	1	0	100
1972	-	55	6	13	7	6	4	4	2	1	1	100
1973	0	13	63	11	3	2	2	2	2	1	1	100
1974	1	42	5	44	4	1	1	0	1	0	0	100
1975	0	24	18	10	40	5	1	0	0	0	0	100
1976	0	7	26	19	9	34	3	1	0	0	0	100
1977	0	20	4	28	15	7	23	2	0	0	1	100
1978	4	47	5	2	15	8	4	13	1	0	0	100
1979	0	31	42	9	1	4	3	2	7	1	0	100
1980	0	2	13	75	4	1	1	1	0	2	0	100
1981	-	14	7	14	60	4	0	0	0	0	0	100
1982	1	17	25	4	16	35	2	0	0	0	0	100
1983	1	25	19	31	3	8	12	1	0	0	0	100
1984	-	11	31	28	18	3	3	4	1	0	1	100
1985	1	20	31	28	13	4	1	2	1	0	0	100
1986	0	16	34	36	7	4	1	1	0	0	0	100
1987	0	8	12	50	23	4	2	1	0	0	0	100
1988	0	12	9	16	36	20	4	2	0	0	0	100
1989	0	16	18	10	12	27	12	3	1	1	0	100
1990	-	17	13	17	9	10	19	11	3	1	1	100
1991	-	12	22	23	11	5	6	10	6	2	2	100
1992	0	17	14	29	13	8	4	4	6	4	2	100
1993	0	12	7	31	21	11	5	3	4	3	2	100
1994	0	18	25	9	20	13	6	3	2	2	3	100
1995	0	20	39	20	7	7	4	1	1	1	1	100
1996	-	9	9	61	13	4	2	1	0	0	0	100
1997	0	15	23	20	34	5	1	1	0	0	0	100
1998	0	38	9	20	14	14	3	1	0	0	0	100
1999	0	16	33	22	19	8	1	0	0	0	0	100
2000	0	48	10	14	16	8	3	1	0	0	0	100
2001	0	13	57	10	11	6	3	0	0	0	0	100
2002	2	41	13	28	10	4	2	0	0	0	0	100
2003	0	46	32	11	9	1	1	0	0	-	-	100
2004	0	36	39	15	9	1	0	0	0	0	-	100
2005	0	16	37	40	6	1	0	0	0	0	-	100
Average	3	26	21	21	14	8	4	2	1	1	0	100

Table 17. Catch at length by size groups in total numbers and percent numbers for the SW Nova Scotia / Bay of Fundy herring spawning component for selected years 1992 and 1999-2008.

a) Catch at length (thousands) by size group category for SW Nova Scotia/Bay of Fundy spawning component.

Size Group	1992	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<23cm	266,144	319,407	372,207	133,417	339,682	581,722	416,121	126,463	144,277	189,119	167,279
23-30cm	499,792	349,668	353,900	402,081	382,383	372,009	390,573	290,904	262,070	199,684	258,950
>30cm	208,357	28,958	49,661	33,039	31,466	16,622	14,770	7,032	7,175	22,014	28,151
Total	974,292	698,033	775,768	568,536	753,532	970,353	821,464	424,399	413,522	410,816	454,380

b) Catch at length (percent numbers) by size group category for SW Nova Scotia/Bay of Fundy spawning component.

Size Group	1992	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<23cm	27%	46%	48%	23%	45%	60%	51%	30%	35%	46%	37%
23-30cm	51%	50%	46%	71%	51%	38%	48%	69%	63%	49%	57%
>30cm	21%	4%	6%	6%	4%	2%	2%	2%	2%	5%	6%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 18. Catch at length by fishing ground by size groups in total numbers and percent numbers for the SW Nova Scotia / Bay of Fundy herring spawning component.

2008 SWNS stock catch by area	Numbers x 1000			Total	Percent nos.			Total
	<23cm	23-30cm	>30cm	Numbers	<23cm	23-30cm	>30cm	Percent
Grand Manan purse seine	83,393	43,422	1,149	127,965	65%	34%	1%	100%
Long Island purse seine	29,781	11,111	508	41,400	72%	27%	1%	100%
Gannet-Dry Ledge + Lurcher purse seine	8,376	58,257	4,741	71,374	12%	82%	7%	100%
German Bank + SW Grounds purse seine	2,812	112,170	19,493	134,475	2%	83%	14%	100%
Scots Bay purse seine	561	12,757	1,497	14,815	4%	86%	10%	100%
SW Nova summer purse seine total	124,925	237,716	27,388	390,028	32%	61%	7%	100%
Remainder of stock catch numbers	42,354	21,234	763	64,351	66%	33%	1%	100%
SW Nova Scotia Stock 2008 (includes fall 2007)	167,279	258,950	28,151	454,380	37%	57%	6%	100%

Table 19. Illustrative catch at age using 1997 age data for major fishing ground by size groups in total numbers and percent numbers for the SW Nova Scotia / Bay of Fundy herring spawning component.

a) 2008 Grand Manan purse seine catch at age (using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	309	53,397	54,681	11,327	7,196	854	185	15	-	-	-	127,965
% numbers	0%	42%	43%	9%	6%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	6	2,924	4,713	1,535	1,276	200	48	4	-	-	-	10,708
% catch wt.	0%	27%	44%	14%	12%	2%	0%	0%	0%	0%	0%	100%
Avg. len (cm)	14.9	19.8	22.4	25.7	27.7	30.2	31.1	32.0	-	-		22.0
Avg. wt. (g)	2.0	54.8	86.2	135.5	177.3	234.5	260.6	286.1	-	-		83.7

b) 2008 Long Island purse seine catch at age (using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	24	18,295	19,624	1,637	1,386	215	119	16	-	-	-	41,316
% numbers	0%	44%	47%	4%	3%	1%	0%	0%	0%	0%	0%	100%
Catch wt. (t)	0	971	1,645	231	262	49	30	4	-	-	-	3,192
% catch wt.	0%	30%	52%	7%	8%	2%	1%	0%	0%	0%	0%	100%
Avg. len (cm)	14.8	19.4	22.3	26.0	28.3	30.0	31.1	31.8	-	-		21.4
Avg. wt. (g)	2.0	53.1	83.8	140.9	188.7	226.5	251.9	270.7	-	-		77.3

c) 2008 Scots Bay purse seine catch at age (using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	40	4,034	4,148	5,144	1,070	328	51	-	-	-	14,815
% numbers	0%	0%	27%	28%	35%	7%	2%	0%	0%	0%	0%	100%
Catch wt. (t)	-	3	433	609	965	259	88	15	-	-	-	2,373
% catch wt.	0%	0%	18%	26%	41%	11%	4%	1%	0%	0%	0%	100%
Avg. len (cm)	-	21.7	23.9	26.2	28.2	30.4	31.4	32.3	-	-		26.7
Avg. wt. (g)	2.0	77.8	107.4	146.9	187.6	242.1	269.6	293.8	-	-		160.2

d) 2008 Gannet/Dry Ledge + Lurcher purse seine catch at age (using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	153	3,394	18,354	21,266	23,259	3,750	1,101	95	2	-	-	71,374
% numbers	0%	5%	26%	30%	33%	5%	2%	0%	0%	0%	0%	100%
Catch wt. (t)	3	88	1,798	3,107	4,338	861	280	27	0	-	-	10,504
% catch wt.	0%	1%	17%	30%	41%	8%	3%	0%	0%	0%	0%	100%
Avg. len (cm)	14.9	15.8	23.3	26.2	28.2	30.0	31.0	32.2	30.9	-		25.9
Avg. wt. (g)	2.0	26.0	98.0	146.1	186.5	229.7	254.6	287.7	223.2	-		147.2

e) 2008 German Bank + SW Grounds purse seine catch at age (using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	-	1,097	36,950	38,163	48,229	11,415	2,740	736	11	3	3	139,348
% numbers	0%	1%	27%	27%	35%	8%	2%	1%	0%	0%	0%	100%
Catch wt. (t)	-	112	4,059	5,800	9,552	2,786	728	202	4	1	1	23,246
% catch wt.	0%	0%	17%	25%	41%	12%	3%	1%	0%	0%	0%	100%
Avg. len (cm)	-	23.7	24.2	26.6	28.7	30.7	31.5	31.8	34.4	34.5		27.1
Avg. wt. (g)	2.0	102.0	109.9	152.0	198.1	244.1	265.8	274.6	352.7	354.8		166.8

f) 2008 SW Nova Scotia Stock overall catch at age (includes fall 2007 purse seine and using 1997 age data)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
Numbers (x1,000)	1,156	103,840	155,991	81,628	88,404	17,769	4,635	936	15	3	3	454,380
% numbers	0%	23%	34%	18%	19%	4%	1%	0%	0%	0%	0%	100%
Catch wt. (t)	38	5,430	14,428	11,963	16,954	4,265	1,218	260	5	1	1	54,562
% catch wt.	0%	10%	26%	22%	31%	8%	2%	0%	0%	0%	0%	100%
Avg. len (cm)	16.8	19.4	22.9	26.3	28.4	30.5	31.3	31.9	33.7	34.5		24.2
Avg. wt. (g)	2.0	52.3	92.5	146.6	191.8	240.0	262.7	277.5	325.5	354.8		120.1

Table 20. An evaluation of 2006 fishery observations for the SW Nova Scotia/Bay of Fundy spawning component progress against biological objectives in the management plan for the fishery.

Objective	**2006: Observations**
Persistence of all spawning components	Spawning not observed on Lurcher. Biomass increases in Scots and Trinity still low. Some spawning near Seal Island.
Maintain biomass of each component	All spawning areas had slightly increased biomass estimates from 2005 but are still at historically low levels. Substantial decline from 2004. Scots, Trinity, Lurcher and Seal are at very low biomass.
Maintain broad age composition	Proportion of larger (30 cm+) sizes has contracted and is very low. Age composition is assumed to be truncated with an absence of larger fish in the population. Recent increase in abundance of herring in the 23-30cm size range is a positive signal for potential future population growth.
Maintain long spawning period	Start and duration of spawning in 2006 for German Bank appeared normal but Scots Bay displayed a midseason gap.
Fishing mortality at or below F0.1	Fishing mortality is likely high and well above F0.1.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in some areas.
Maintain biomass at moderate to high levels	SSB remains near the lowest recorded level since 1999 from the acoustic surveys.

Table 21. An evaluation of 2007 fishery observations for the SW Nova Scotia/Bay of Fundy spawning component progress against biological objectives in the management plan for the fishery.

Objective	**2007: Observations**
Persistence of all spawning components	Biomass increases in Scots Bay and German Bank. Spawning not observed on Seal Island. Trinity Ledge is at the lowest level recorded.
Maintain biomass of each component	German Bank biomass estimate is now at or above average. Scots Bay, Trinity Ledge and Seal Island remain well below average or at very low biomass.
Maintain broad age composition	Proportion of larger (30 cm+) sizes has increased consistent with average growth rates. Age composition is still assumed to be truncated with few larger fish in the population. Possible strong year-class with 18-23cm size range abundant in both the New Brunswick weir and purse seine fisheries.
Maintain long spawning period	Start and duration of spawning in 2007 for German Bank and Scots Bay was typical but not for Trinity Ledge.
Fishing mortality at or below F0.1	Fishing mortality was not determined but appears to be decreasing based on the trends from relative exploitation rates from acoustic surveys.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in all areas except for German Bank and Scots Bay.
Maintain biomass at moderate to high levels	SSB index from the acoustic surveys has increased by 64% over the last two years, is at a moderate level, 12% below the nine year average.

Table 22. An evaluation of 2008 fishery observations for the SW Nova Scotia/Bay of Fundy spawning component progress against biological objectives in the management plan for the fishery.

Objective	**2008: Observations**
Persistence of all spawning components	Spawning observed in Scots Bay and German Bank. Spawning activity could not be determined on Seal Island or Browns due to a lack of fishing or survey effort. Trinity Ledge with minimal spawning.
Maintain biomass of each component	Acoustic biomass estimates decreased and are near the lowest in the time series for each of the major survey areas. Taking into consideration confidence intervals, overall SSB for the past 4 years has been steady, at a lower level than in the 1999-2004 period. SSB in 2008 is the lowest in the time series.
Maintain broad age composition	Overall length composition in the catch has improved. Proportion of larger (30 cm+) sizes continues to increase. Increase in medium sized (23-30cm) fish but strength of incoming year-class is unknown. Without a population model catch is the best available proxy of the population.
Maintain long spawning period	Start of spawning in 2008 for German Bank and Scots Bay was typical. Virtually no spawning on Trinity Ledge. The duration appeared shorter for Scots Bay.
Fishing mortality at or below F0.1	Fishing mortality could not be determined. Relative exploitation rates based on acoustic surveys increased in 2008.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in all areas except for German Bank. Scots Bay area appeared less diverse.
Maintain biomass at moderate to high levels	Herring are a key component in the ecosystem. SSB continues to be at a low level. Recently observed changes in environment may have an impact on spawning type prevalence and abundance.

Table 23. Herring abundance indices from the July bottom trawl survey (stratified numbers per tow): 1970-2008.

	4WX area combined strata 453/495				4W Only strata 453/466		4X Only strata 470/495		4X BOF strata 480/495		4V only strata 442/452		Offshore Banks strata 455/478	
Year	Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE
1970	A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6	1.0	0.6	12.8	9.8	5.7	2.4
1971	A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6	1.4	1.0	4.4	4.4	5.3	2.8
1972	A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1	0.3	0.1	4.5	3.7	2.0	1.0
1973	A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4	1.0	0.4	19.2	19.2	0.9	0.4
1974	A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4	1.4	0.6	0.0	0.0	0.5	0.2
1975	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4	1.3	0.7	2.2	2.2	0.7	0.4
1976	A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3	0.9	0.6	0.0	0.0	0.1	0.1
1977	A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5	1.5	0.9	1.6	1.4	0.1	0.1
1978	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.5	0.5
1979	A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7	1.5	1.3	0.0	0.0	0.2	0.2
1980	A306/307	0.5	0.5	105	0.0	0.0	0.8	0.8	1.6	1.6	0.0	0.0	0.0	0.0
1981	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1	4.6	4.1	0.0	0.0	0.0	0.0
1982	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4	0.8	0.3	0.0	0.0	2.5	1.7
1983	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	3.1	1.6	0.1	0.0	2.1	1.0
1984	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	4.6	2.5	4.0	2.9	8.5	5.4
1985	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	0.4	0.2	0.0	0.0	5.0	2.9
1986	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	24.9	22.3	0.5	0.4	23.4	20.3
1987	N85/86/87	10.4	5.6	135	17.0	11.3	4.0	1.8	6.3	2.8	117.4	90.5	12.9	8.6
1988	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	2.3	0.8	0.3	0.2	2.0	0.9
1989	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	4.9	1.4	3.6	3.1	9.8	2.7
1990	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	3.4	0.8	0.3	0.2	6.5	2.9
1991	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	4.9	2.3	10.2	9.9	14.3	9.0
1992	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	41.8	22.2	0.2	0.1	23.6	7.4
1993	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	27.6	10.3	1.0	0.6	15.0	4.7
1994	N221/222	76.4	30.2	140	108.4	58.9	45.9	18.4	51.1	26.0	25.7	22.0	91.1	45.1
1995	N226/227	63.5	24.2	140	100.5	47.9	28.4	12.8	11.4	5.4	7.9	6.1	92.7	37.6
1996	N246/247	40.2	14.2	135	53.2	24.5	27.1	14.1	32.1	20.8	0.2	0.1	46.5	19.5
1997	N726/734	31.8	15.3	137	34.6	10.1	51.3	39.3	72.8	60.9	0.2	0.1	29.3	7.7
1998	N827/832	99.52	20.65	131	147.6	39.92	54.76	14.5	45.6	19.4	0.8	0.3	130.3	30.3
1999	N925/929	229.8	83.8	133	264.2	101.0	199.4	130.2	251.4	203.6	24.9	15.2	226.2	74.4
2000	N426/431	90.6	20.0	146	146.3	40.6	38.7	7.4	29.5	9.1	2.0	0.6	124.7	30.5
2001	N2001-032/037	145.9	47.7	139	152.7	81.3	139.5	52.5	181.3	80.9	53.9	49.2	132.4	60.9
2002	N2002-037/040	161.9	48.6	147	172.7	81.3	151.9	55.6	170.9	85.3	4.9	2.6	162.6	61.1
2003	N2003-036/042	130.6	70.5	153	207.8	145.4	58.7	14.5	50.3	14.0	4.9	2.0	175.8	108.6
2004t	TEL2004-529/530	295.9	100.2	205	307.6	134.5	285.0	147.4	198.0	170.9	1.4	0.4	355.6	127.6
2005t	TEL2005-605/633	74.1	13.7	118	13.7	8.7	130.5	23.1	51.8	34.4	7.4	2.2	88.0	6.6
2005n	NED2005-027/034	63.1	20.9	150	36.0	13.1	88.2	38.5	61.0	30.2	13.6	5.4	66.2	28.4
2006	NED2006-030/036	85.7	29.7	150	133.3	59.2	40.7	15.5	26.7	9.8	15.2	11.0	118.6	45.6
2007	TEL2007-745	40.7	9.8	121	20.0	8.0	59.9	17.3	85.8	26.9	0.9	0.5	19.0	6.2
2008	TEM2008-830	43.7	12.9	118	46.8	24.7	40.9	10.1	50.8	14.3	2.0	0.8	40.2	18.1

Table 24. Recorded herring landings (t) from gillnet fisheries in the coastal N.S. spawning component, 1996-2008.

Landings (t)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average Catch Last 5 yr.	Average Catch All Years
Little Hope/Port Mouton		490	1,170	2,919	2,043	2,904	3,982	4,526	1,267	2,239	3,133	1,506	1,108	2,296	2,274
Halifax/Eastern Shore	1,280	1,520	1,100	1,628	1,350	1,898	3,334	2,727	4,176	3,446	3,348	3,727	2,381	3,301	2,455
Glace Bay		170	1,730	1,040	834	1,204	3,058	1,905	1,481	626	85	45	12	692	1,016
Bras d'Or Lakes	170	160	120	31	56	0	1	4	0	0	0	0	0	1	42
Total	1,450	2,340	4,120	5,618	4,283	6,006	10,375	9,162	6,924	6,311	6,566	5,278	3,500	6,290	5,533

Table 25. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2008 as calculated without the calibration integration factor (CIF). Total SSB is rounded to nearest 100t.

Survey SSB (t) w/o CIF	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	10% SSB Average Last 5 yr	10% SSB Average All years
Little Hope/Port Mouton	14,100	15,800	5,200	21,300	56,000	**62,500**	15,600	39,500	21,700	2,400	11,800	2,558	2,417
Halifax/Eastern Shore	8,300	20,200	**10,900**	16,700	**41,500**	67,602	18,200	28,100	51,100	24,000	25,250	3,571	2,835
Glace Bay		2,000		21,200	7,700	31,500		2,200	n/s	100	500	858	931
Bras d'Or Lakes		530	70	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	30

Note: shaded cells include mapping surveys; bold cells include mapping and acoustic surveys.

Table 26. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2008 as calculated with the calibration integration factor (CIF). Total SSB is rounded to nearest 100t.

Survey SSB (t) with CIF	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	10% SSB Average Last 5 yr	10% SSB Average All years
Little Hope/Port Mouton						**53,100**	22,500	44,700	24,100	2,800	14,500	2,695	2,695
Halifax/Eastern Shore						92,600	28,400	36,950	68,900	28,300	30,300	4,758	4,758
Glace Bay						31,500		3,180	n/s	240	500	886	886
Bras d'Or Lakes						n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/a

Note 1: shaded cells include mapping surveys; bold cells include mapping and acoustic surveys.
Note 2: data prior to 2003 calculated with the Calibration Integration Factor (CIF) are not available.

Table 27. Monthly weir landings (t) for weirs located in New Brunswick; 1978 to 2008.

PROVINCE	YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Total
N.B.	1978	3				512	802	5,499	10,275	10,877	4,972	528	132	33,599
	1979	535	96			25	1,120	7,321	9,846	4,939	5,985	2,638	74	32,579
	1980					36	119	1,755	5,572	2,352	1,016	216		11,066
	1981					70	199	4,431	3,911	2,044	2,435	1,686	192	14,968
	1982		17			132	30	2,871	7,311	7,681	3,204	849	87	22,181
	1983					65	29	299	2,474	5,382	3,945	375		12,568
	1984					6	3	230	2,344	2,581	3,045	145		8,353
	1985					22	89	4,217	8,450	6,910	4,814	2,078	138	26,718
	1986	43				17		2,480	10,114	5,997	6,233	2,564	67	27,516
	1987	39	21	6	12	10	168	2,575	10,893	6,711	5,362	703	122	26,621
	1988		12	1	90	657	287	5,993	11,975	8,375	8,457	2,343	43	38,235
	1989		24		95	37	385	8,315	15,093	10,156	7,258	2,158		43,520
	1990					93	20	4,915	14,664	12,207	7,741	168		39,808
	1991					57	180	4,649	10,319	6,392	2,028	93		23,717
	1992				15	50	774	5,477	10,989	9,597	4,395	684		31,981
	1993					14	168	5,561	14,085	8,614	2,406	470	10	31,328
	1994				18		55	4,529	10,592	3,805	1,589	30		20,618
	1995					15	244	4,517	8,590	3,956	896	10		18,228
	1996					19	676	4,819	7,767	1,917	518	65		15,781
	1997				8	153	1,017	6,506	7,396	5,316				20,396
	1998					560	713	3,832	8,295	5,604	525			19,529
	1999					690	805	5,155	9,895	2,469	48			19,063
	2000					10	7	2,105	7,533	4,940	1,713	69		16,376
	2001					35	478	3,931	8,627	5,514	1,479			20,064
	2002					84	20	1,099	6,446	2,878	1,260	20		11,807
	2003					257	250	1,423	3,554	3,166	344	10		9,003
	2004					21	336	2,694	8,354	8,298	913	3		20,620
	2005						213	802	7,145	3,729	740	11		12,639
	2006					8	43	1,112	3,731	3,832	2,328	125	462	11,641
	2007	182		20	30	84	633	3,241	11,363	7,637	6,567	314	73	30,145
	2008						81	1,502	2,479	1,507	389	49	32	6,041
NB Average Catch (t)		160	34	9	38	134	331	3,673	8,390	5,657	3,087	682	119	21,829

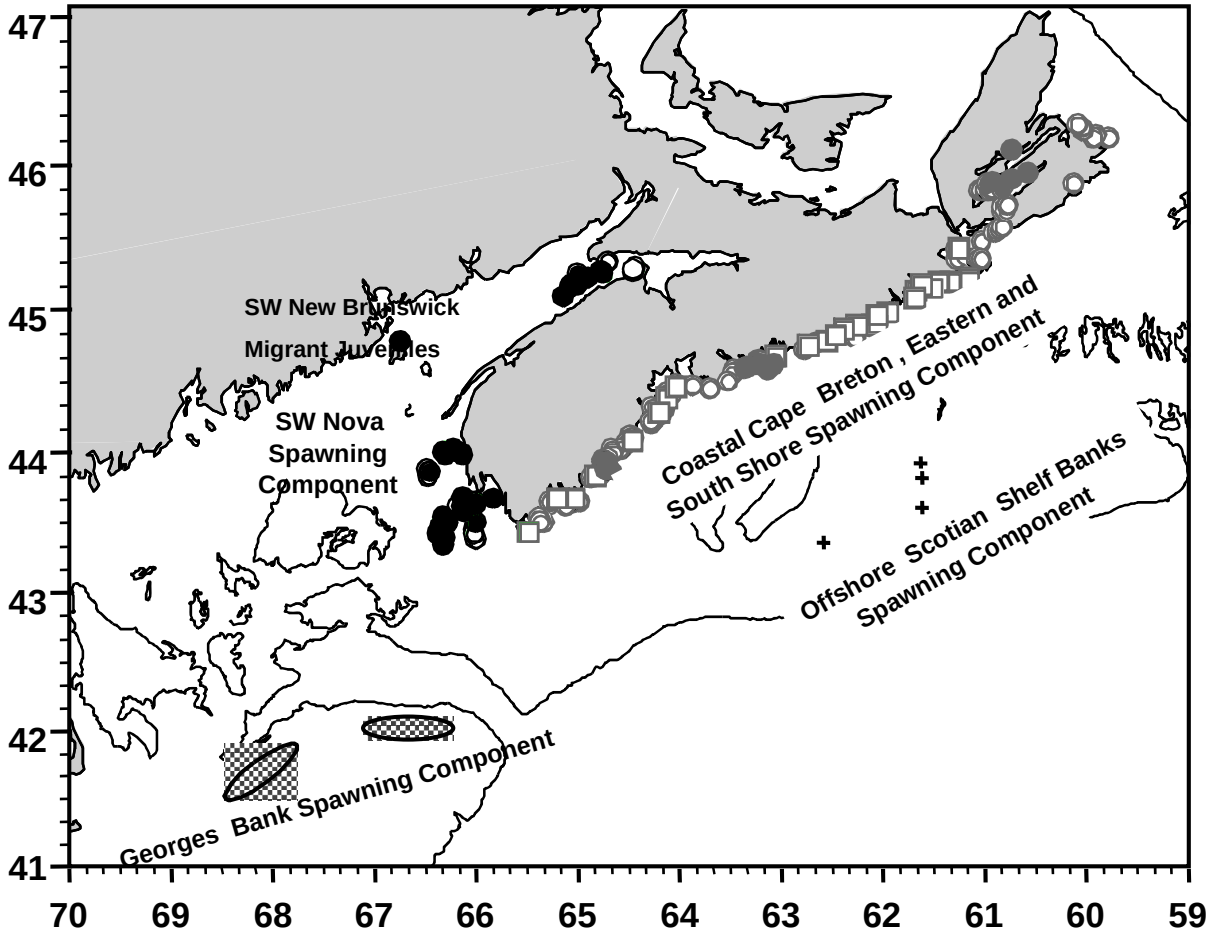


Figure 1. Management units for herring in areas 4VWX and 5YZ showing locations of known current (solid) and historical (open) spawning locations.

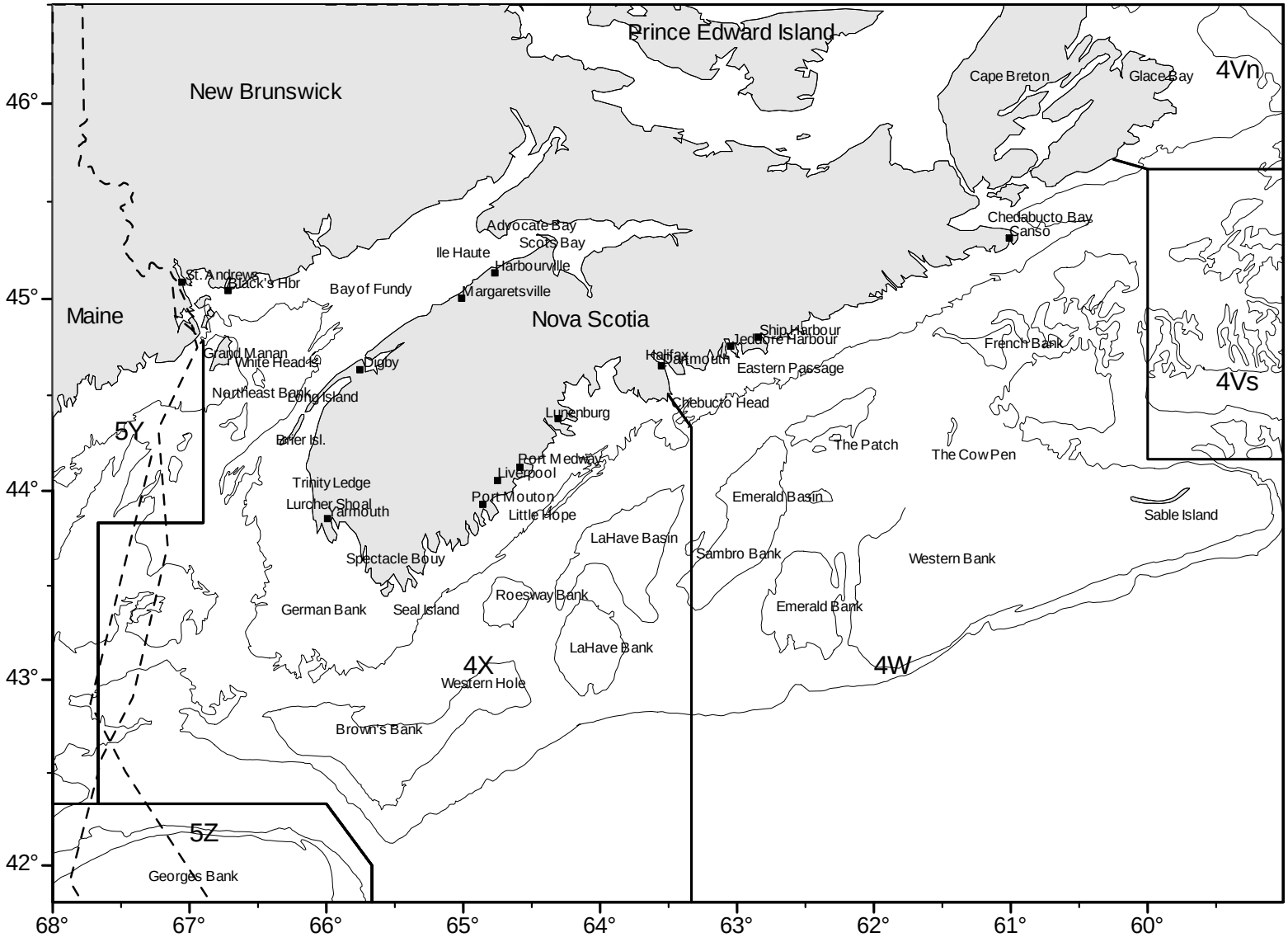


Figure 2. Place names and fishing locations for southwest New Brunswick, coastal Nova Scotia and Scotian Shelf.

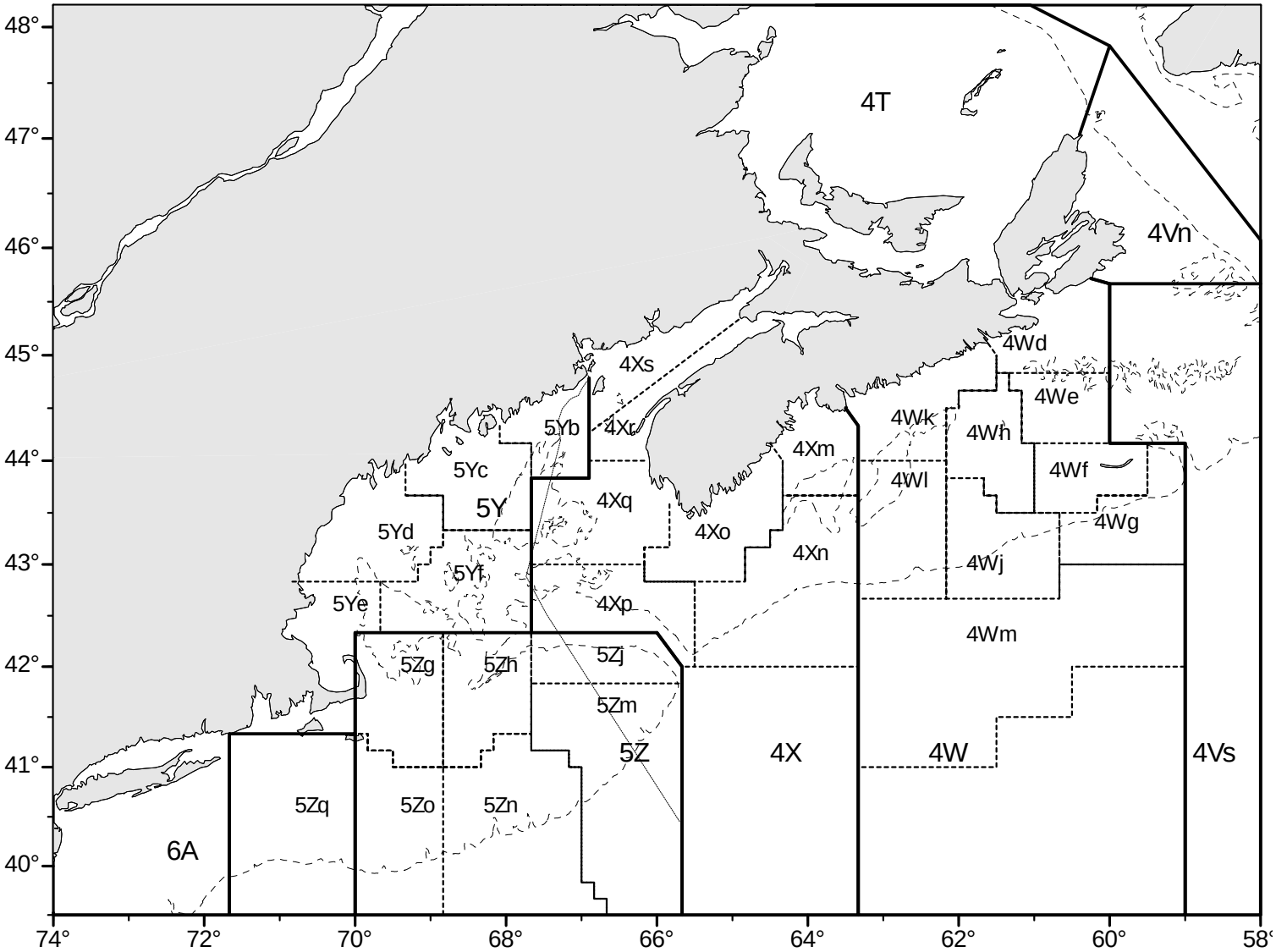


Figure 3. Major and minor NAFO unit areas used for sample and catch data aggregation.

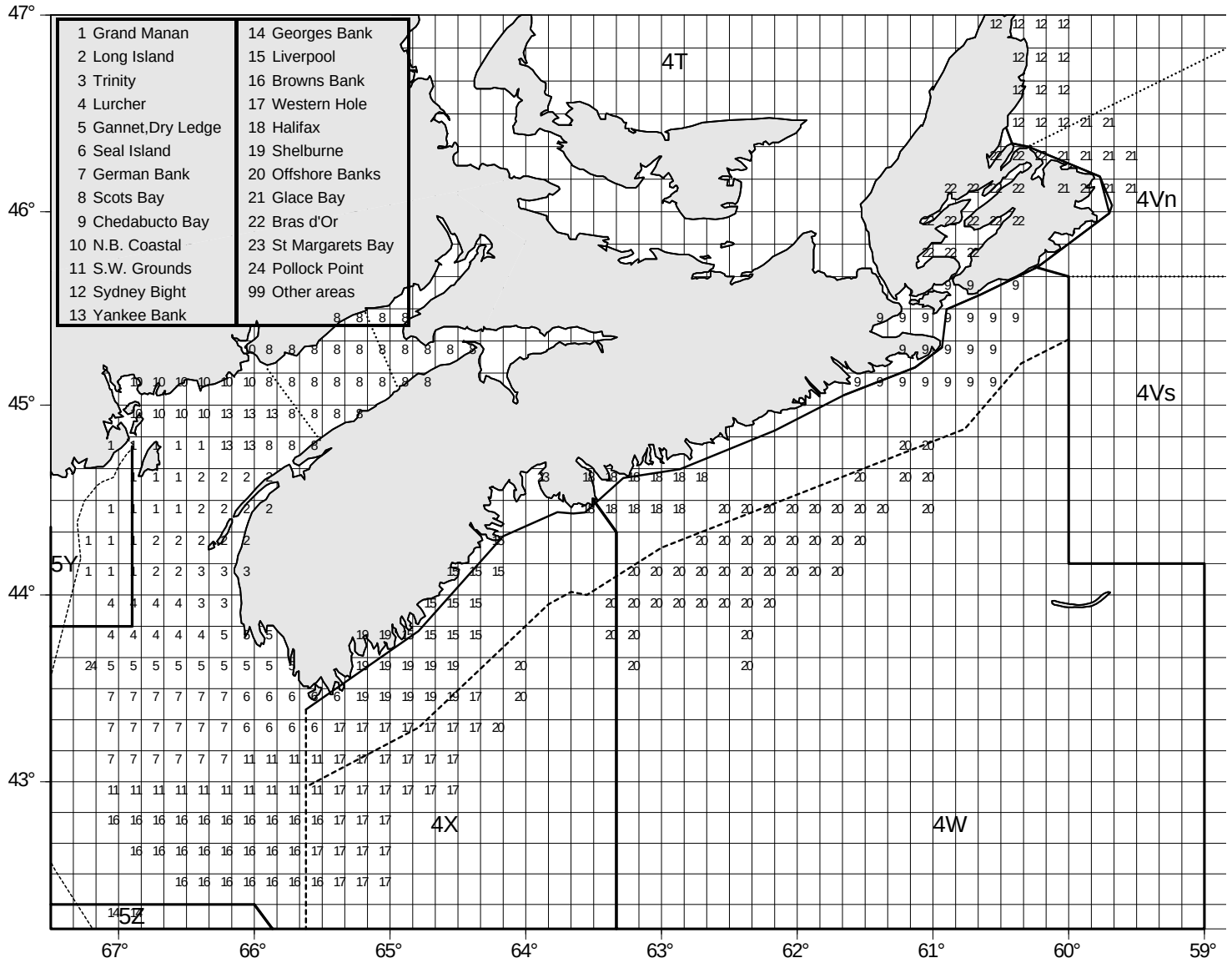


Figure 4. Herring fishing ground areas by 10 mile boxes and management lines for NAFO areas, 25 mile offshore line, coastal embayment line and herring area lines.

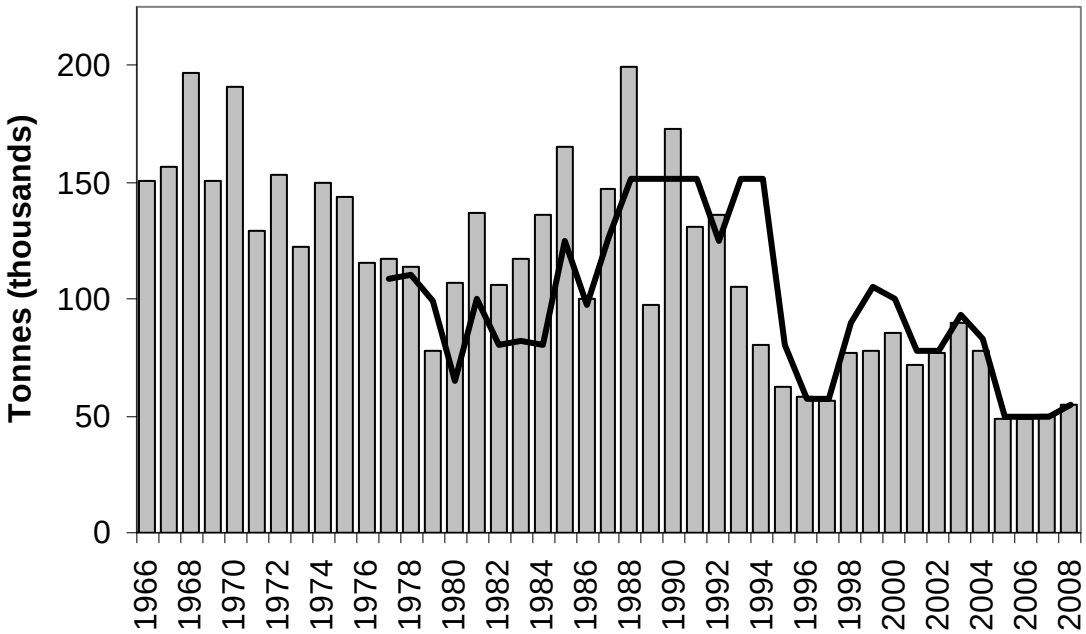


Figure 5. Annual herring landings [bars] and TAC [solid line] (quota) for the southwest Nova Scotia spawning component (4WX stock).

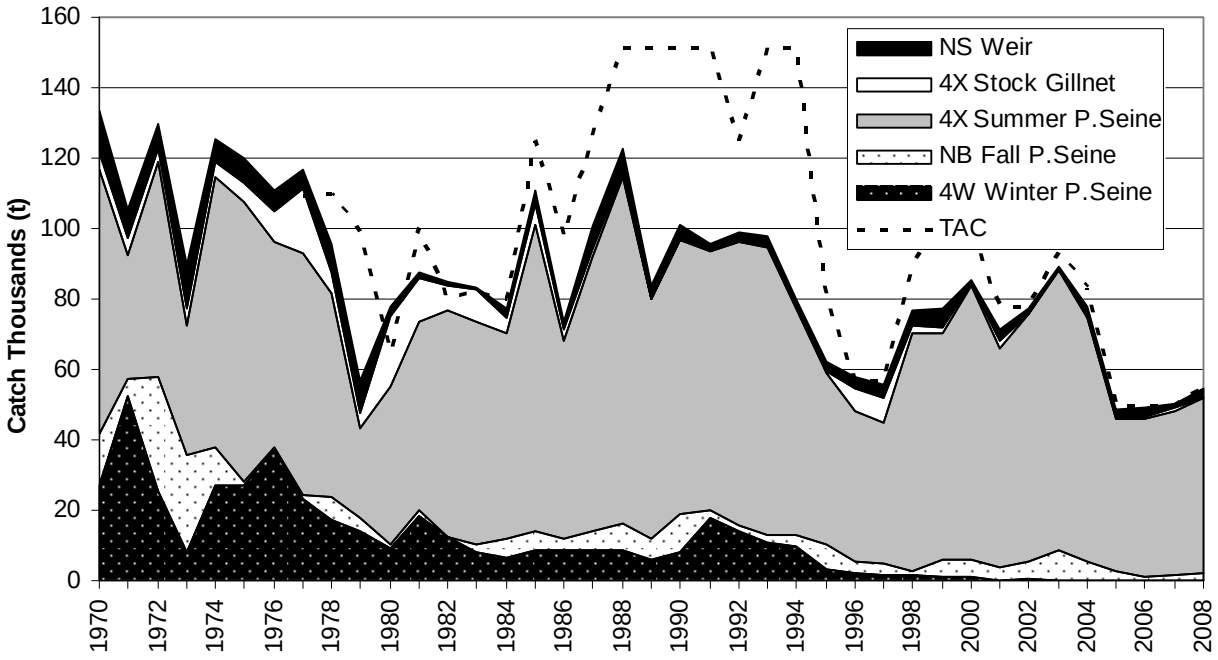


Figure 6. Annual herring landings by gear component for the southwest Nova Scotia spawning component (4WX stock).

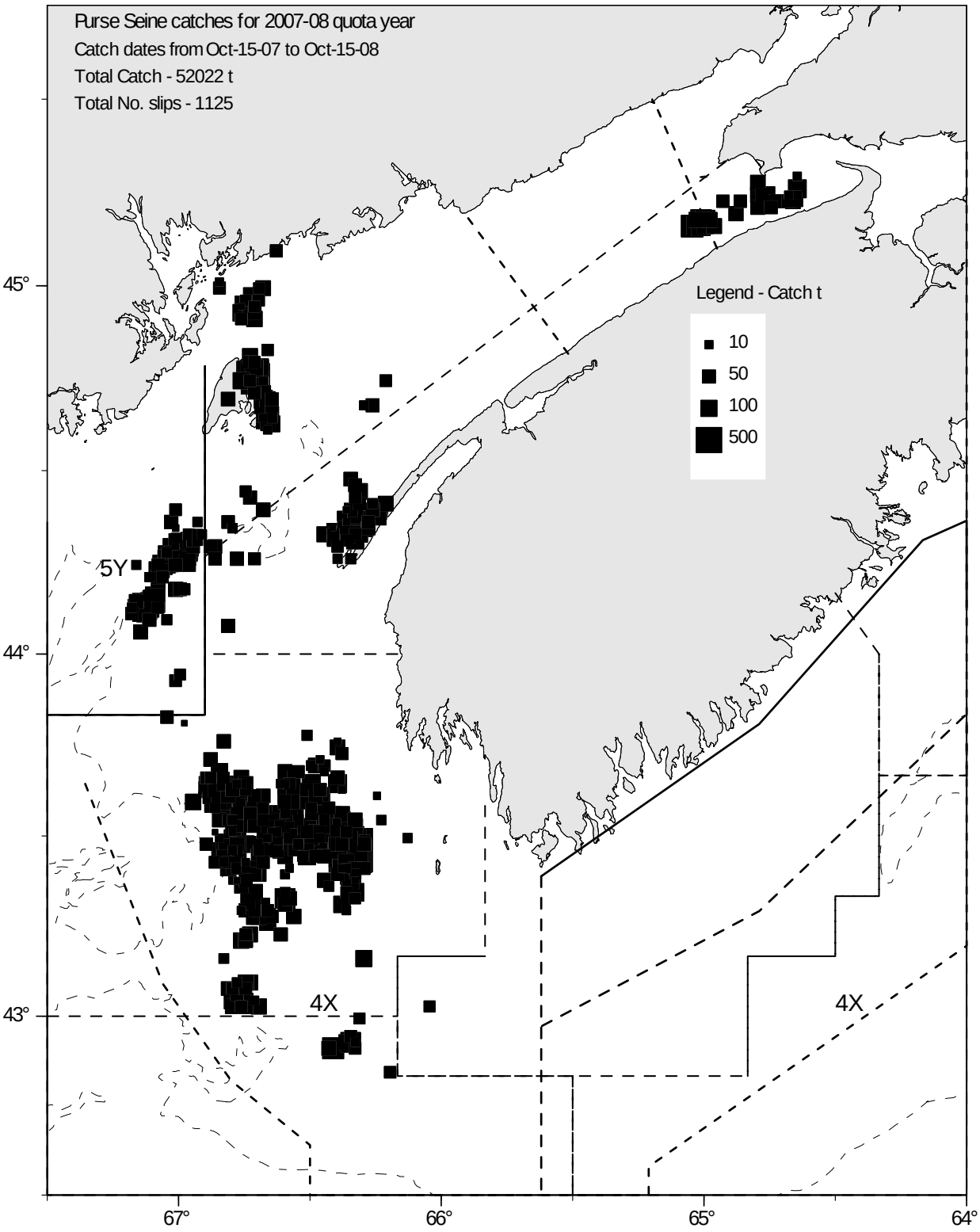


Figure 7. Overall 2007-2008 quota year herring purse seine catches (t) for NAFO areas 4WX (from Statistics Division MARFIS database).

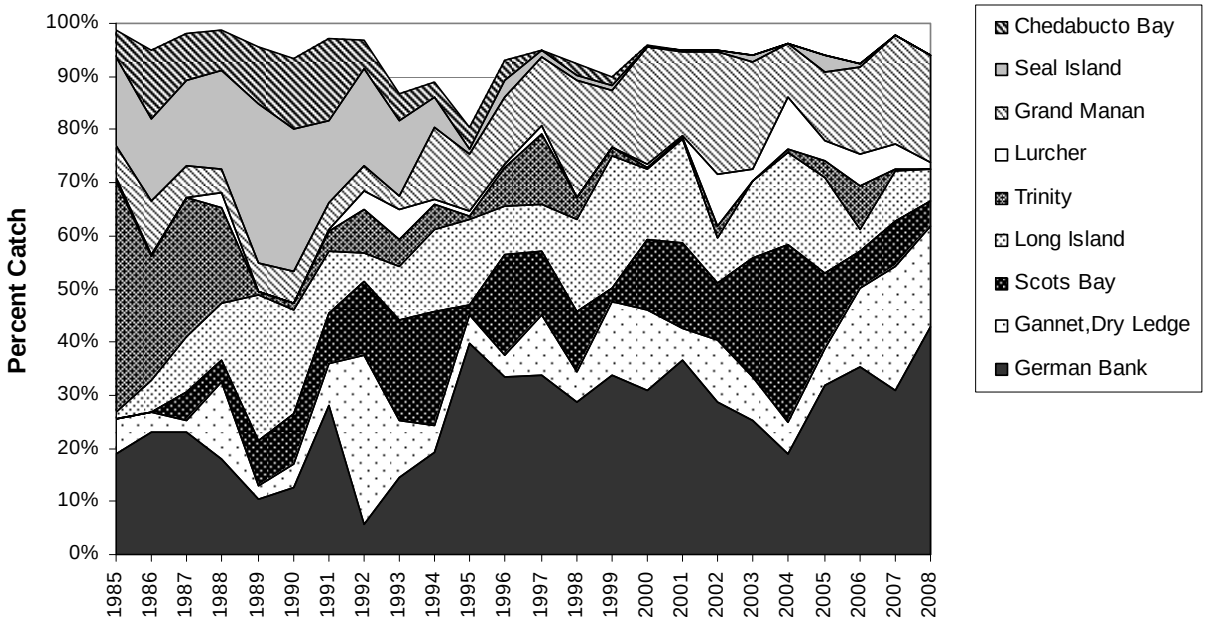


Figure 8. Herring purse seine catches as a proportion of overall landings for selected fishing grounds in the southwest Nova Scotia spawning component from 1997-2008.

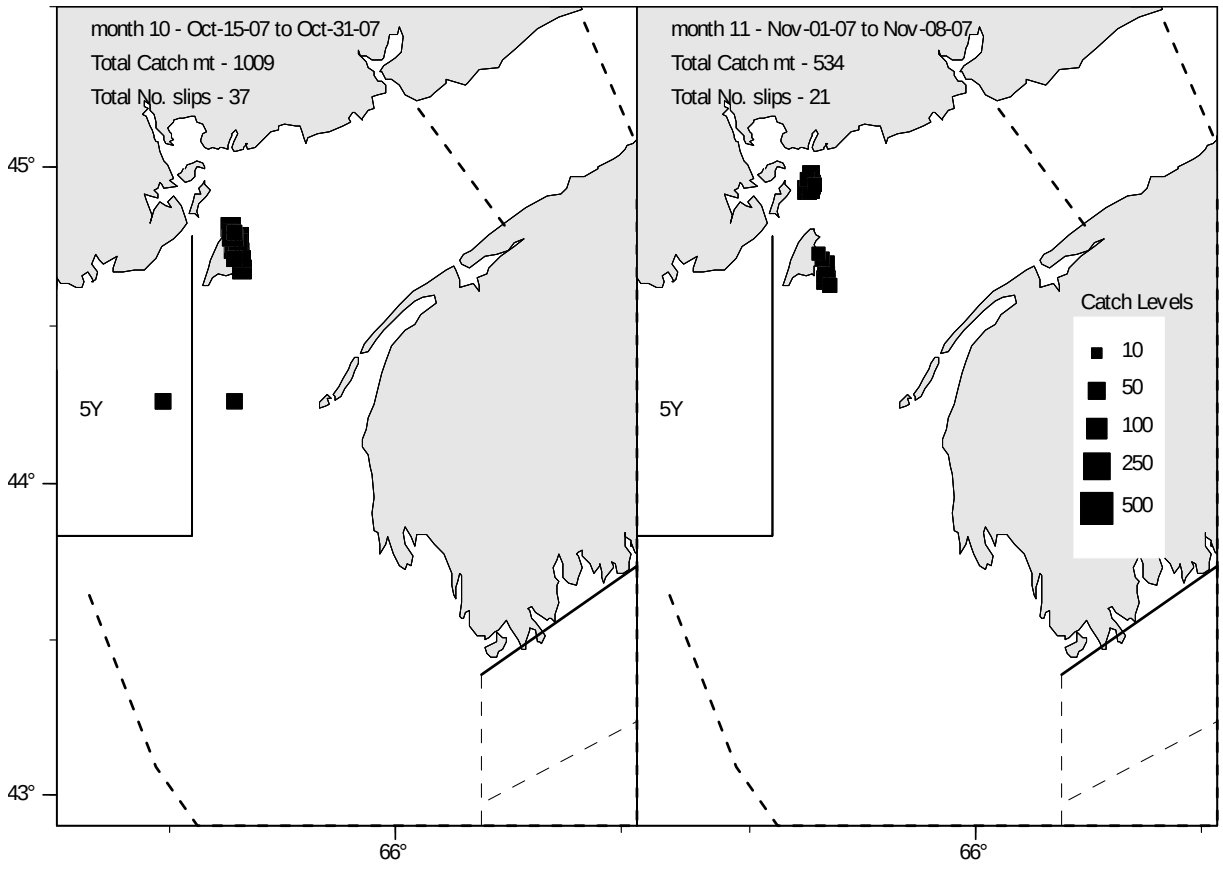


Figure 9. 2007 fall fishery herring purse seine catches (t) by month in NAFO areas 4WX from 2007-2008 quota year (from Statistics Division MARFIS database).

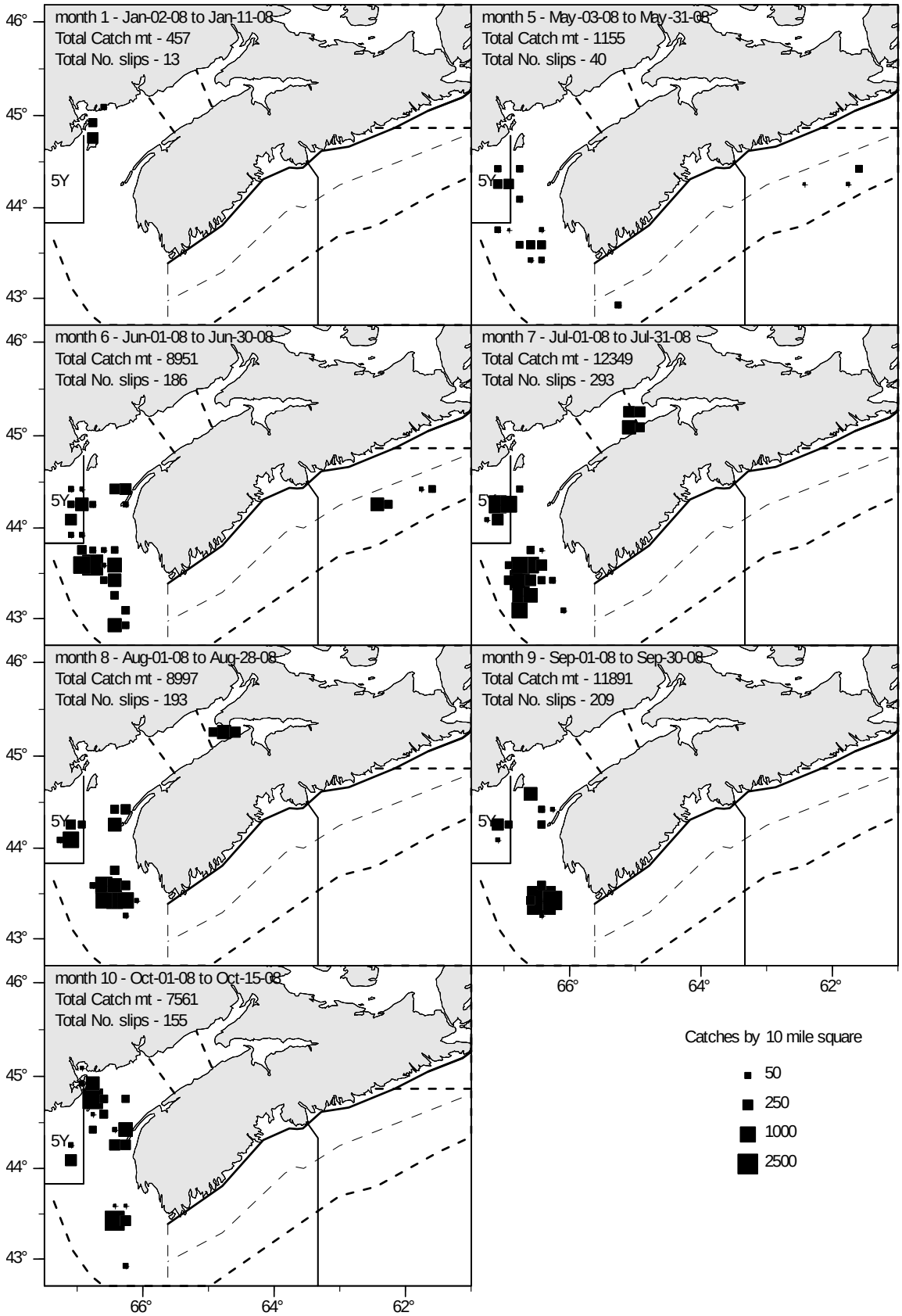


Figure 10. 2008 herring purse seine catches by month in NAFO areas 4WX (Up to the end of the 2007-08 quota year from Statistics Division MARFIS database).

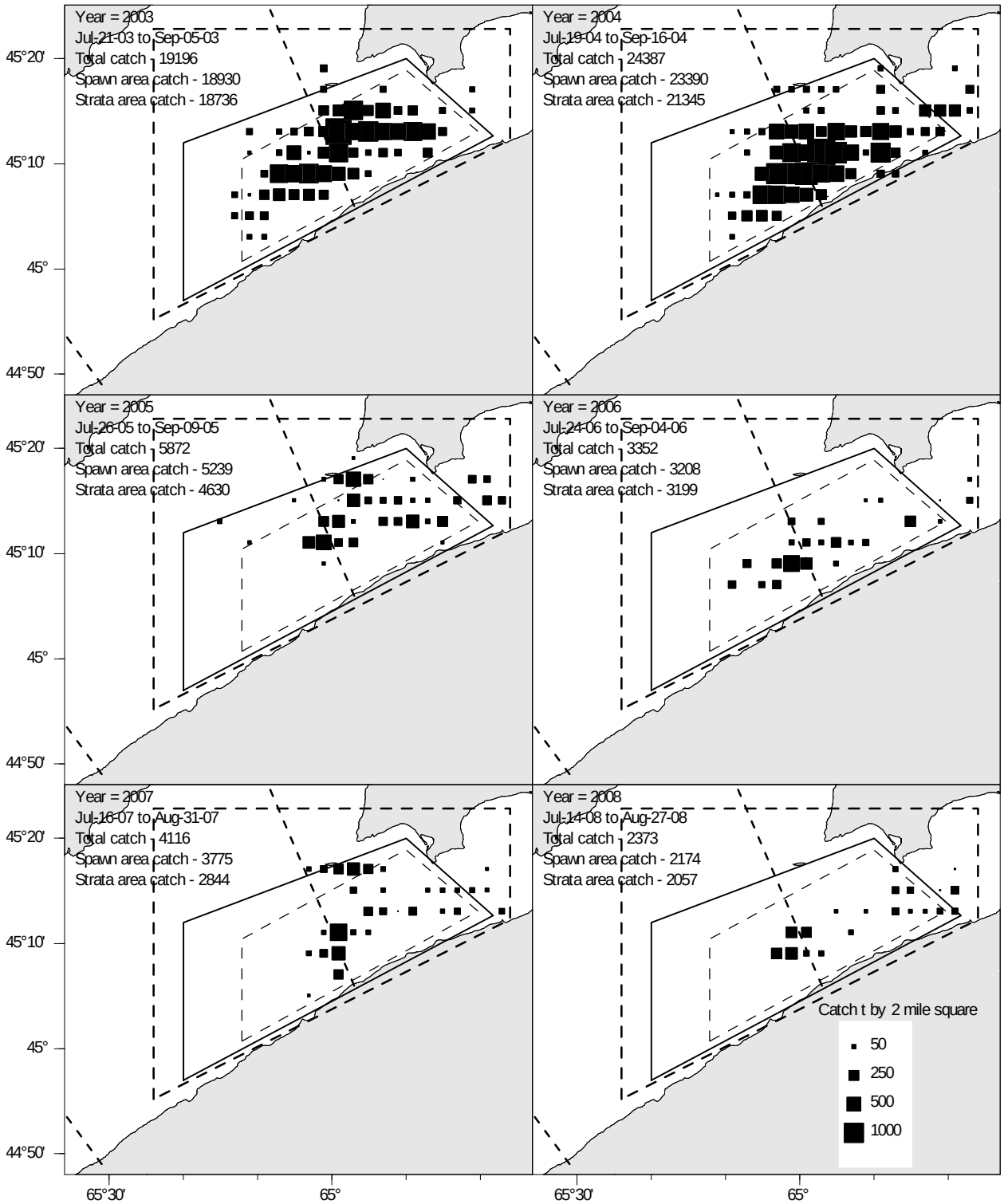


Figure 11. Herring purse seine catches for the Scots Bay area from 2003-2008 with catch totals for the overall area, the middle 'Spawning' area and the inner 'Strata' area which is used as the primary search area in acoustic surveys.

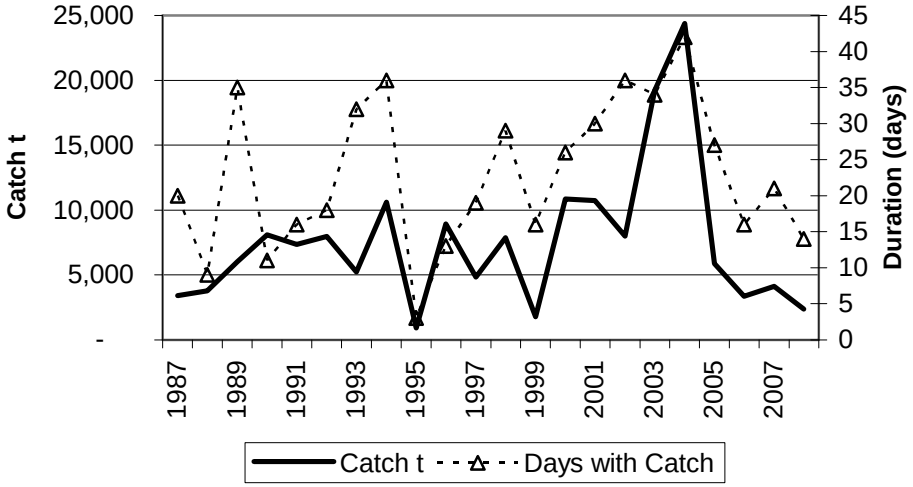


Figure 12. Annual herring purse seine catches for the Scots Bay area from 1987-2008 with duration of fishery in days (start date to end date).

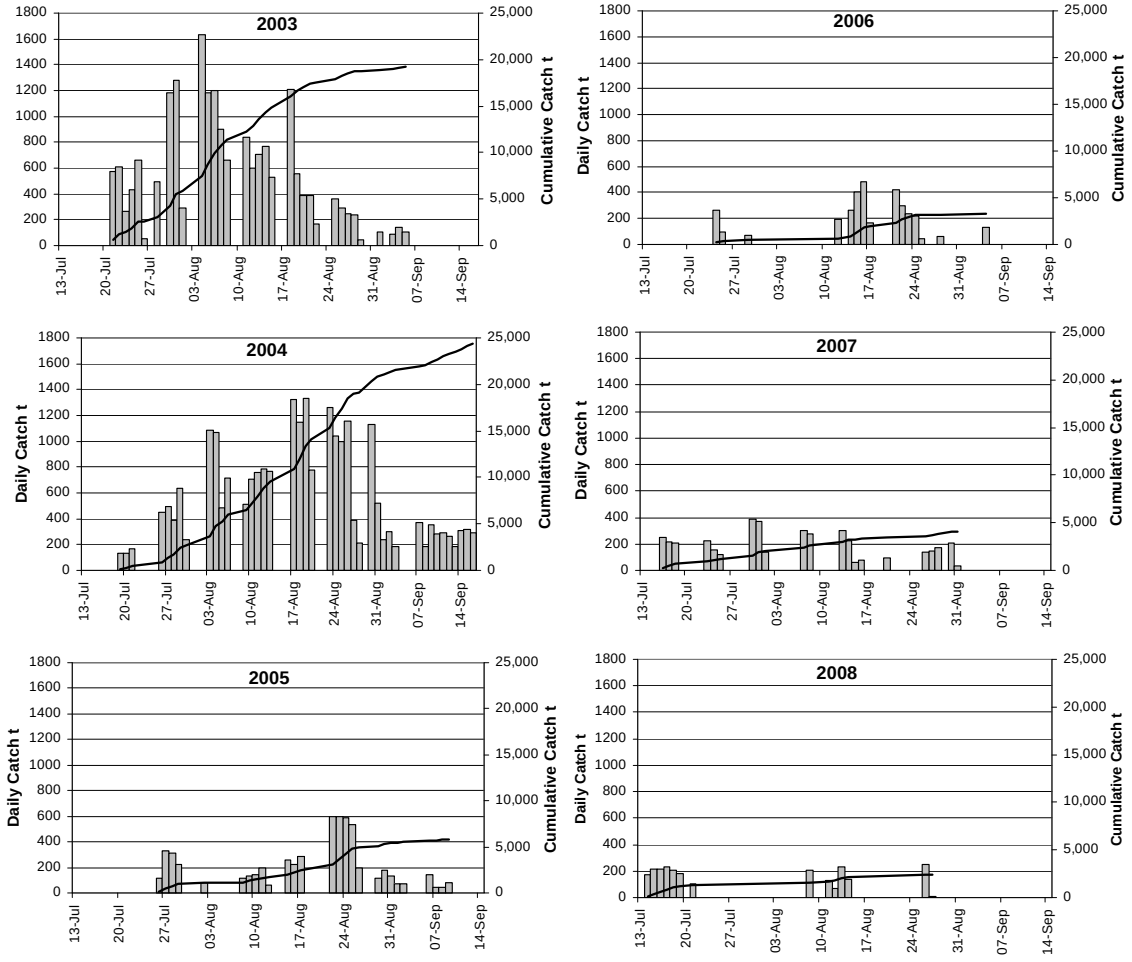


Figure 13. 2003 to 2008 Scots Bay daily purse seine herring catches in tonnes (bars) for Scots Bay with the cumulative total catch (solid line) over the entire fishing season.

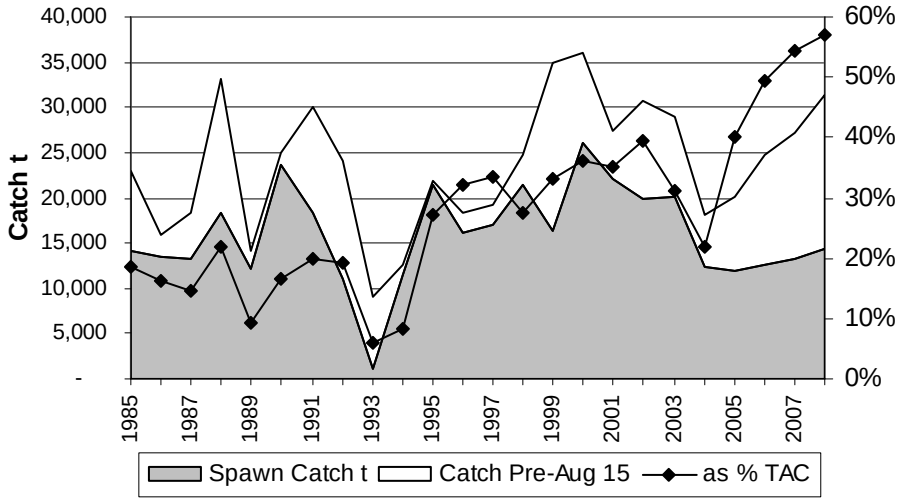


Figure 14. Annual herring purse seine catches for the German Bank area from 1985-2008 with pre-spawning and spawning period catches based on an Aug. 15 start date for the defined spawning period and overall German Bank catches as a proportion of the TAC.

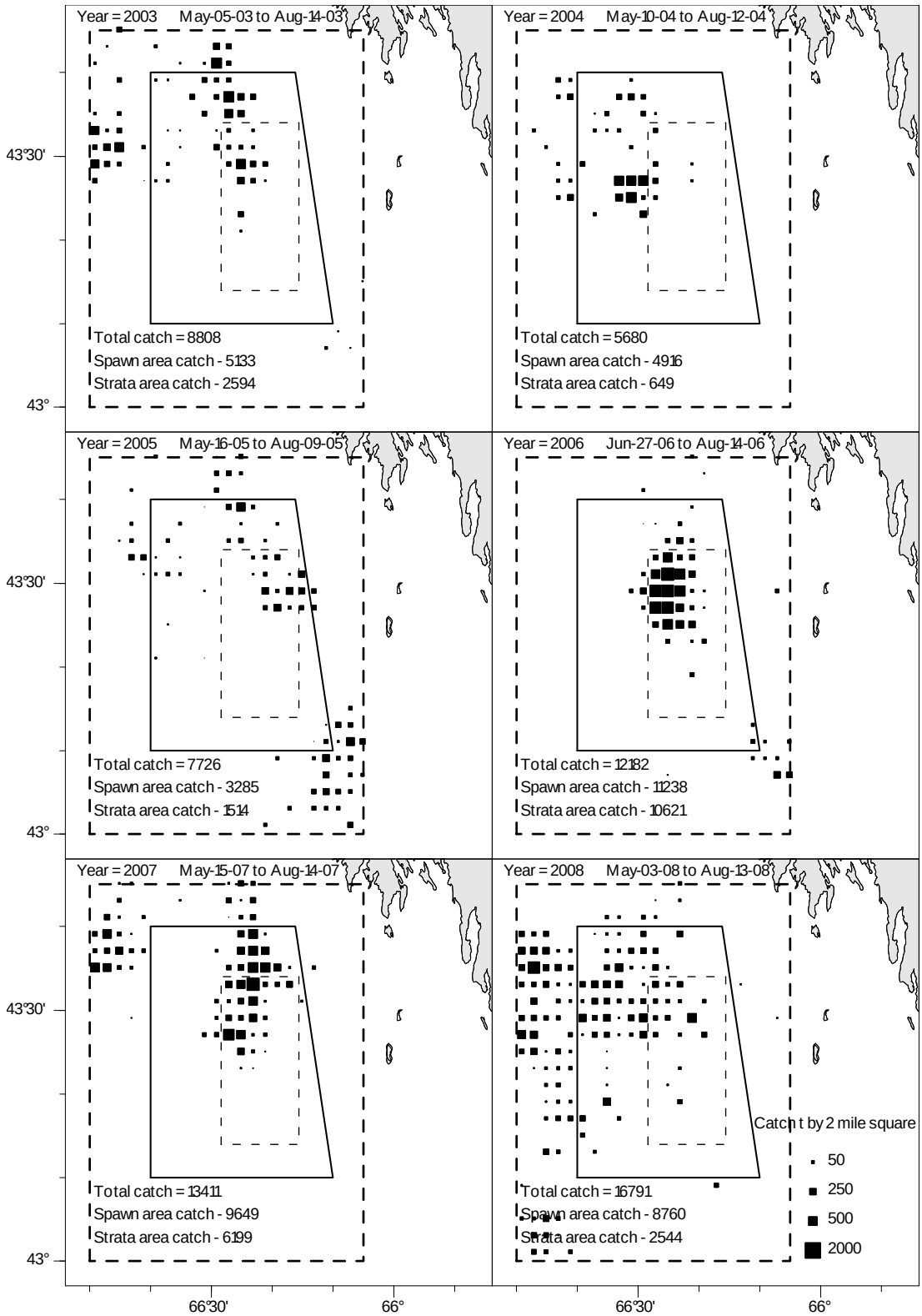


Figure 15. Herring purse seine pre-spawning period catches (May 1 to Aug. 14) for German Bank from 2003-2008 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

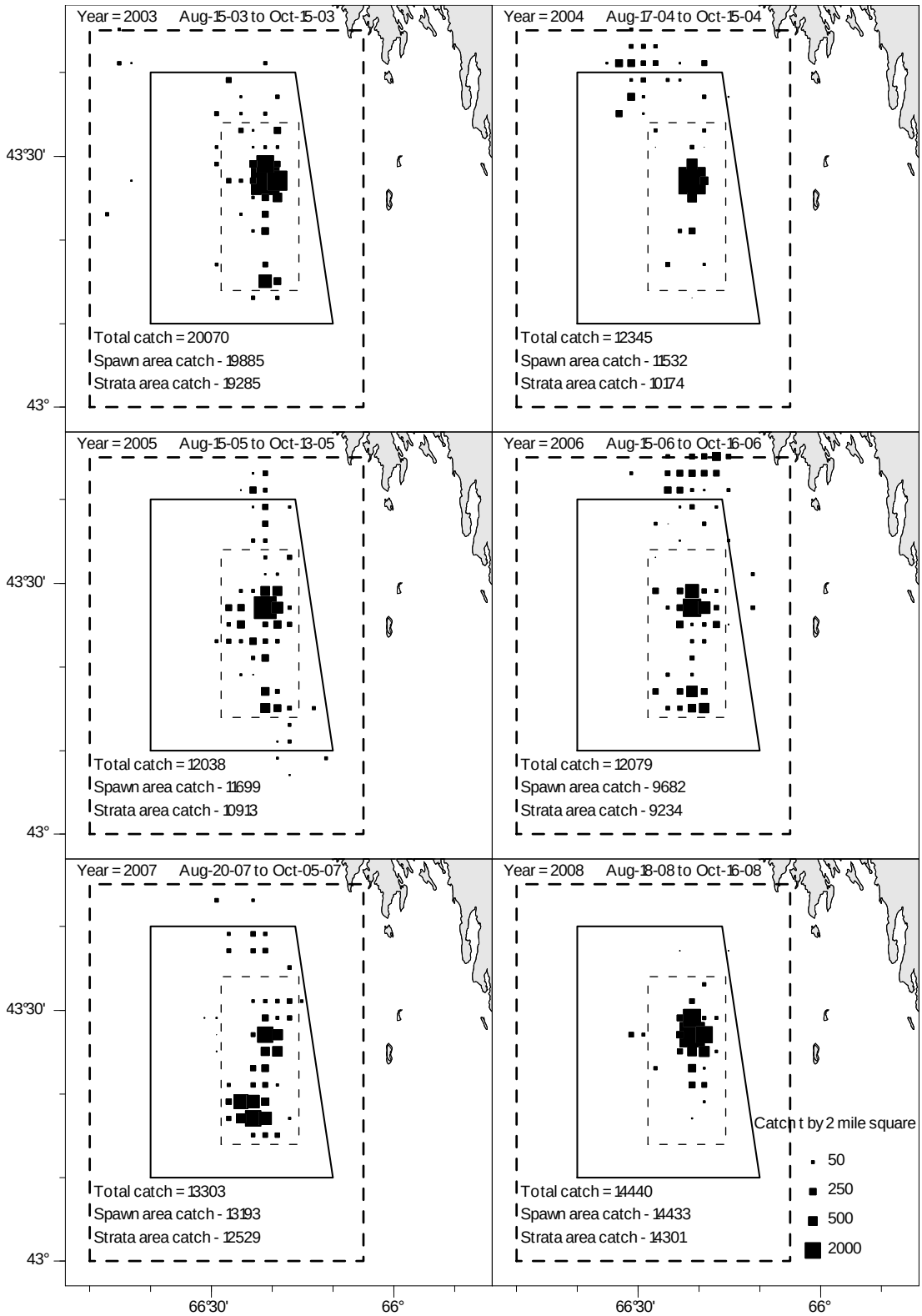


Figure 16. Herring purse seine spawning period catches (Aug. 15 to Oct. 31) for German Bank from 2003-2008 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

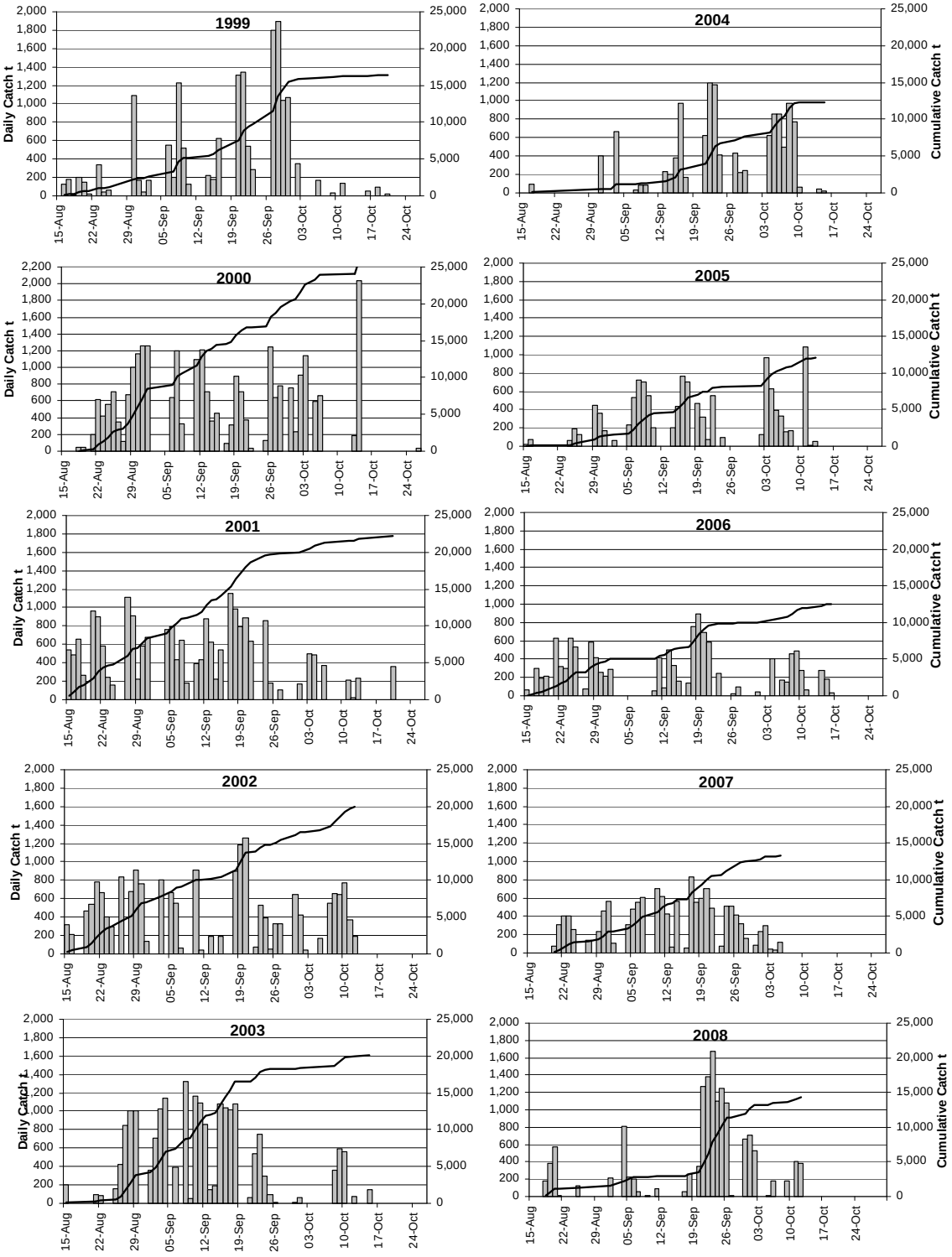


Figure 17. 1999 to 2008 daily purse seine herring catches in tonnes (bars) for German Bank with the cumulative total catch (solid line) over the defined spawning season from Aug. 15 to Oct. 30.

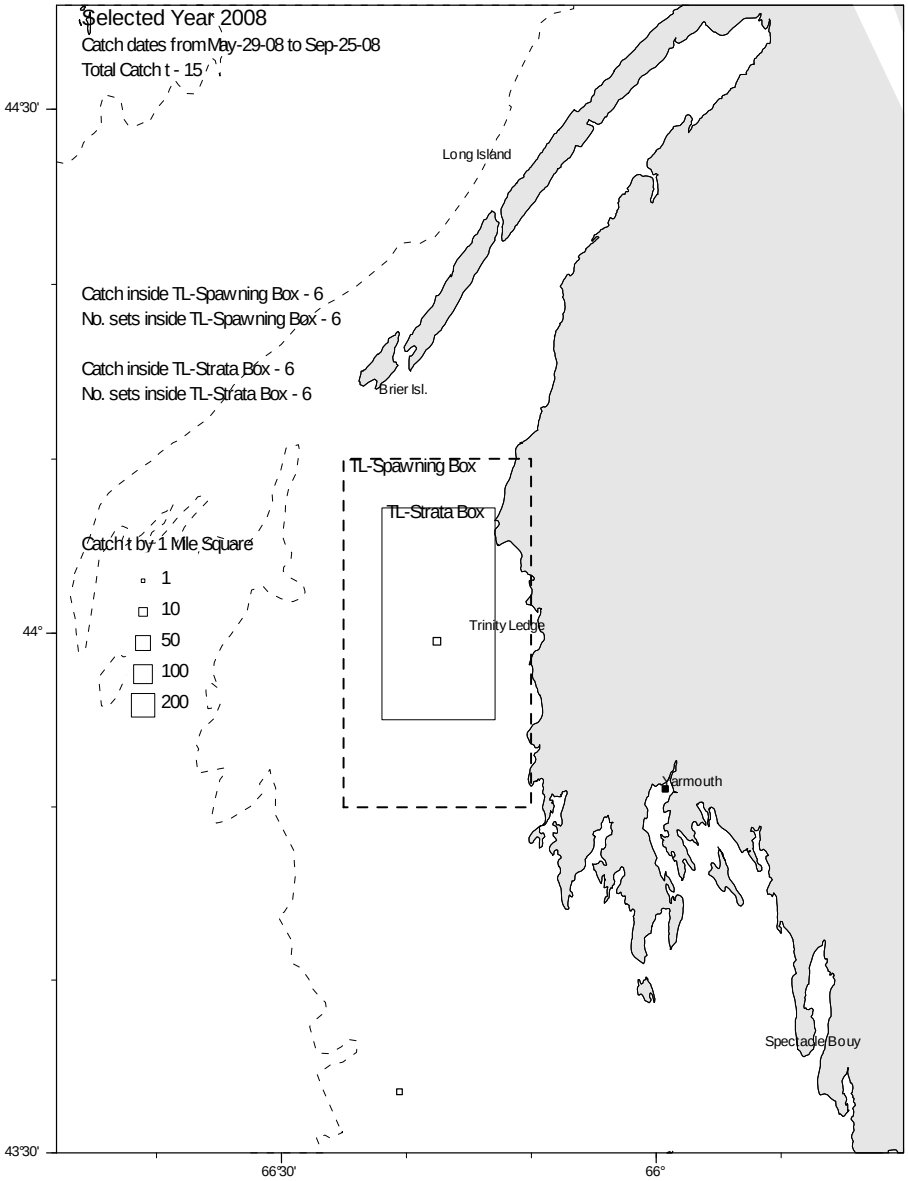


Figure 18. Trinity Ledge/Spectacle Buoy herring catches for 2008 with overall catch amounts and catch portions within the defined spawning area (TL-Spawning Box) and survey areas (TL-Strata Box).

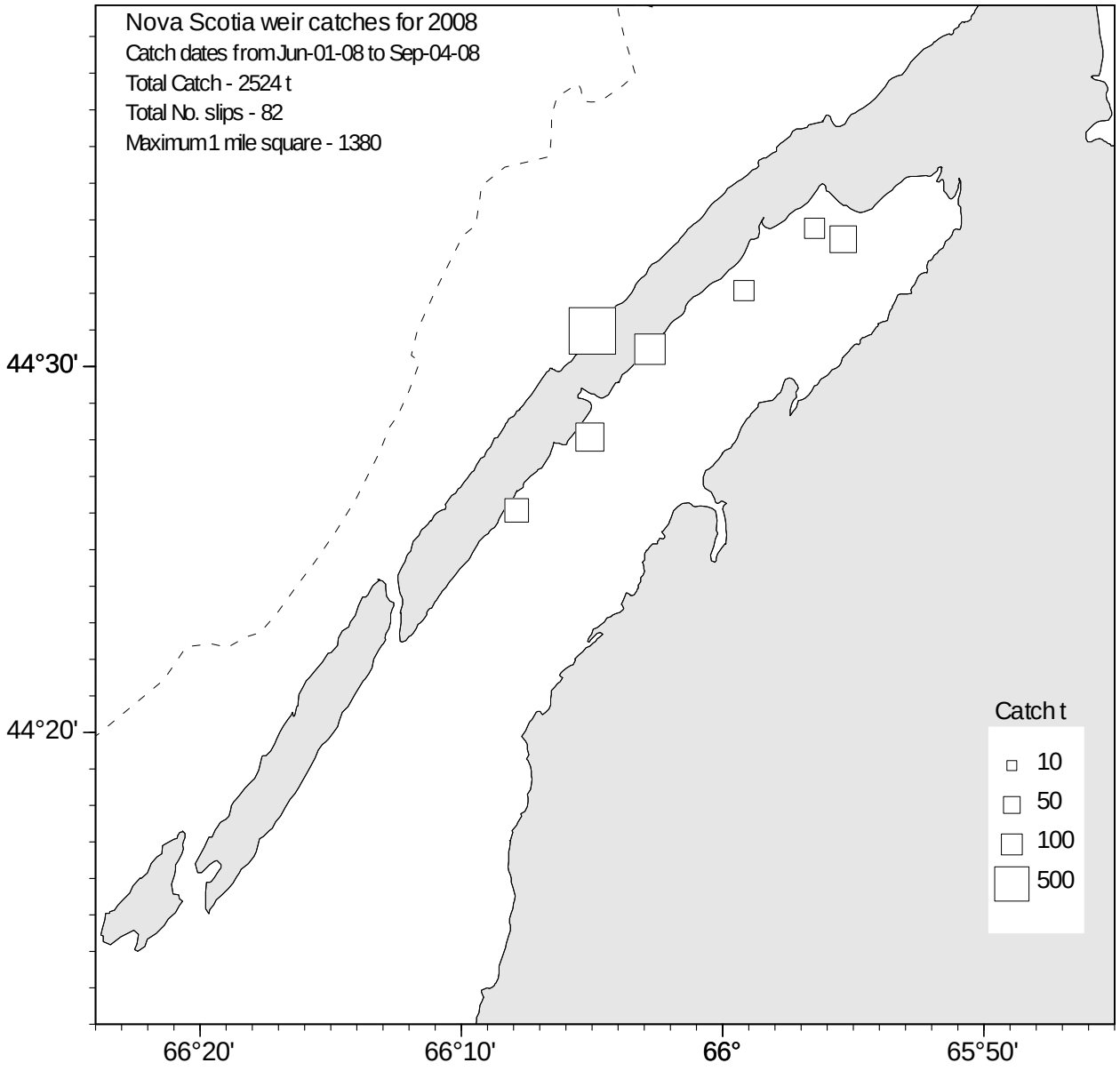


Figure 19. Nova Scotia herring weir catches for the 2008 calendar year.

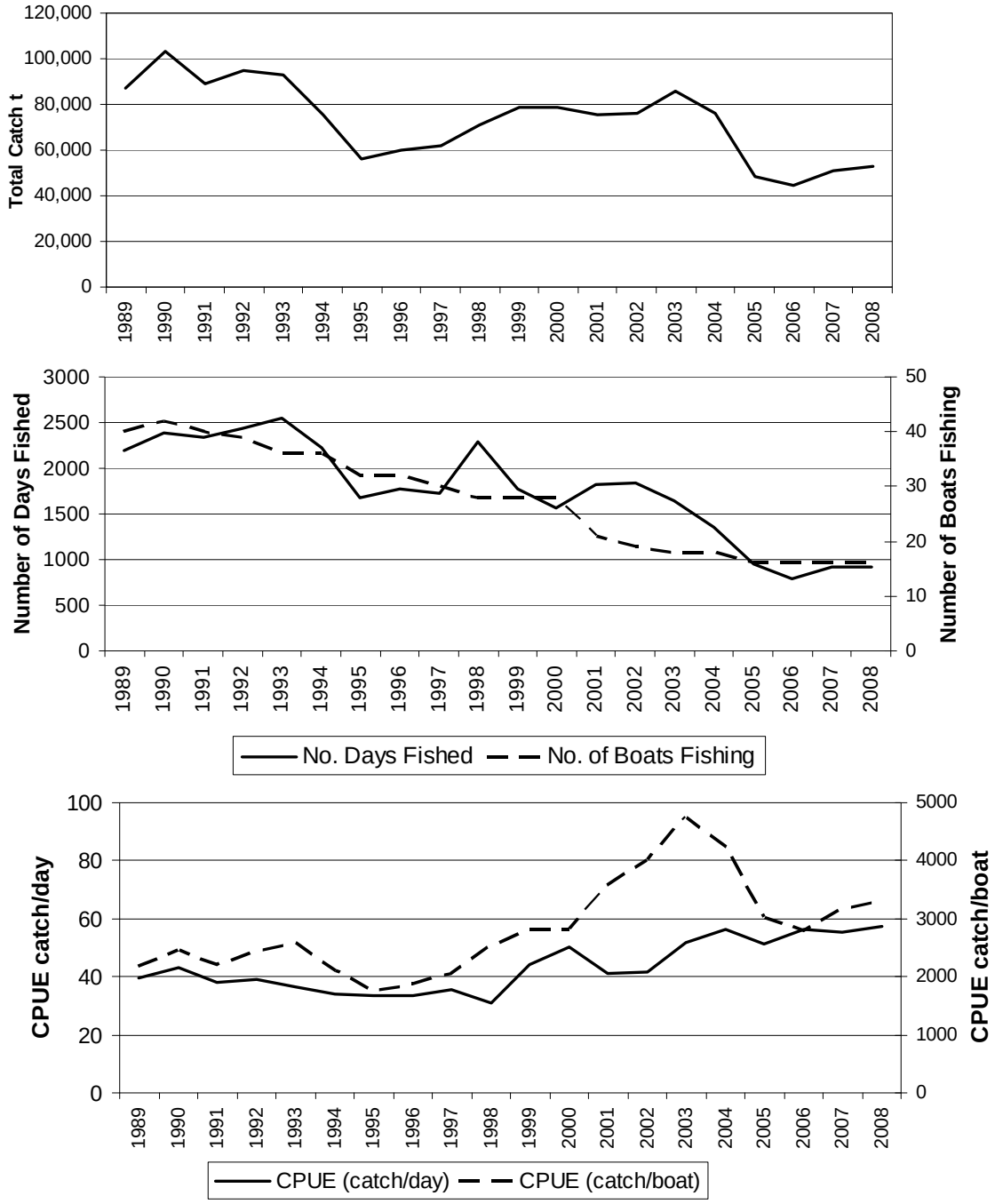


Figure 20. Purse seine catch (top panel), effort (middle panel) and CPUE (bottom) from 1989 to 2008 annual 4WX herring landings data for the SW Nova Scotia/Bay of Fundy spawning component.

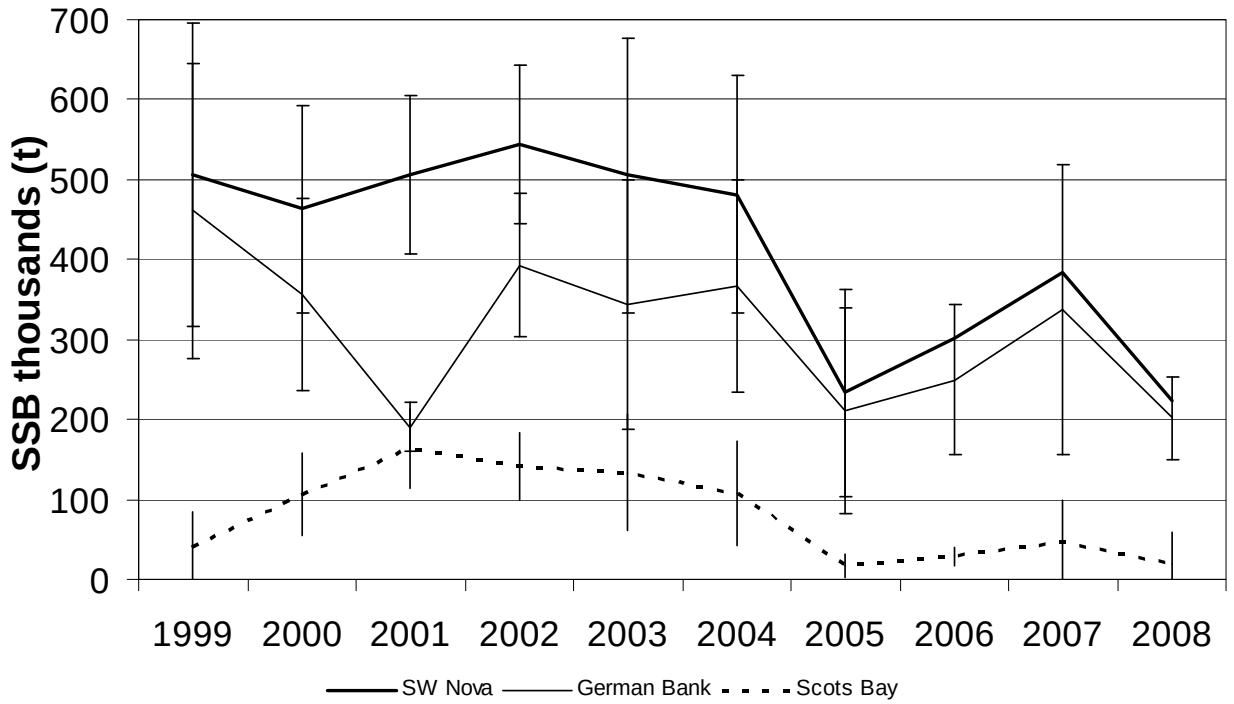


Figure 21. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component overall area and for the German Bank and Scots Bay areas.

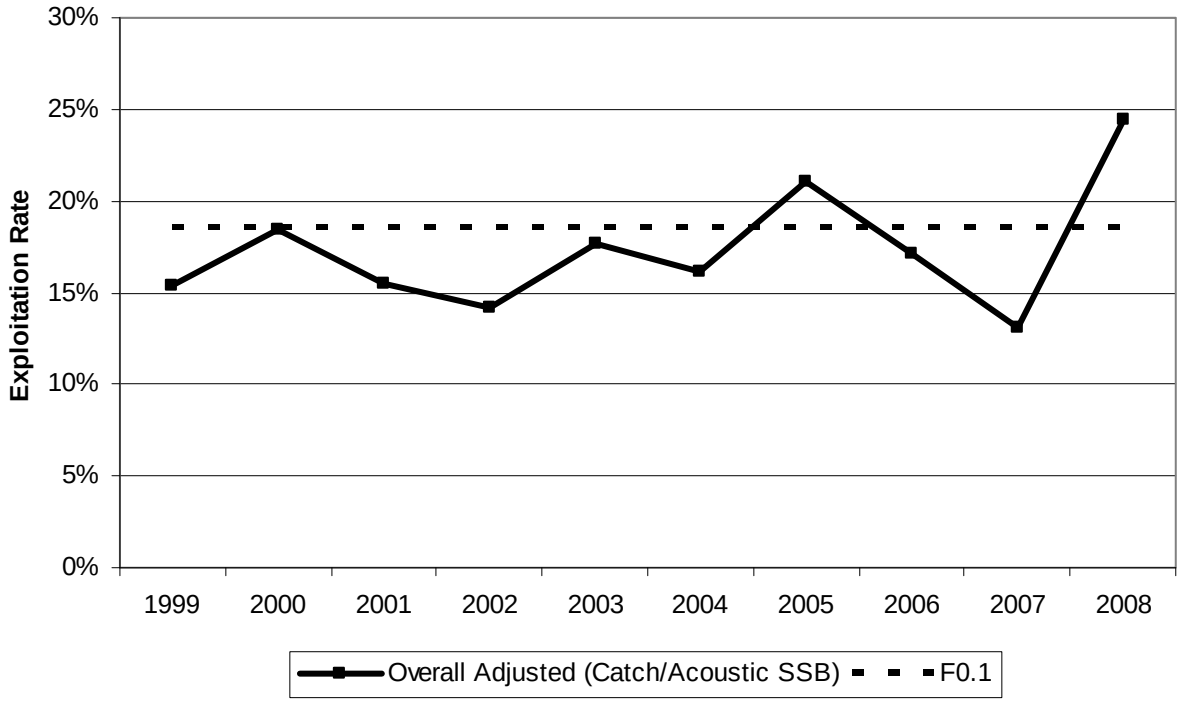


Figure 22. Relative exploitation rate for the SW Nova Scotia / Bay of Fundy spawning component using overall catch as a proportion of the overall acoustic SSB.

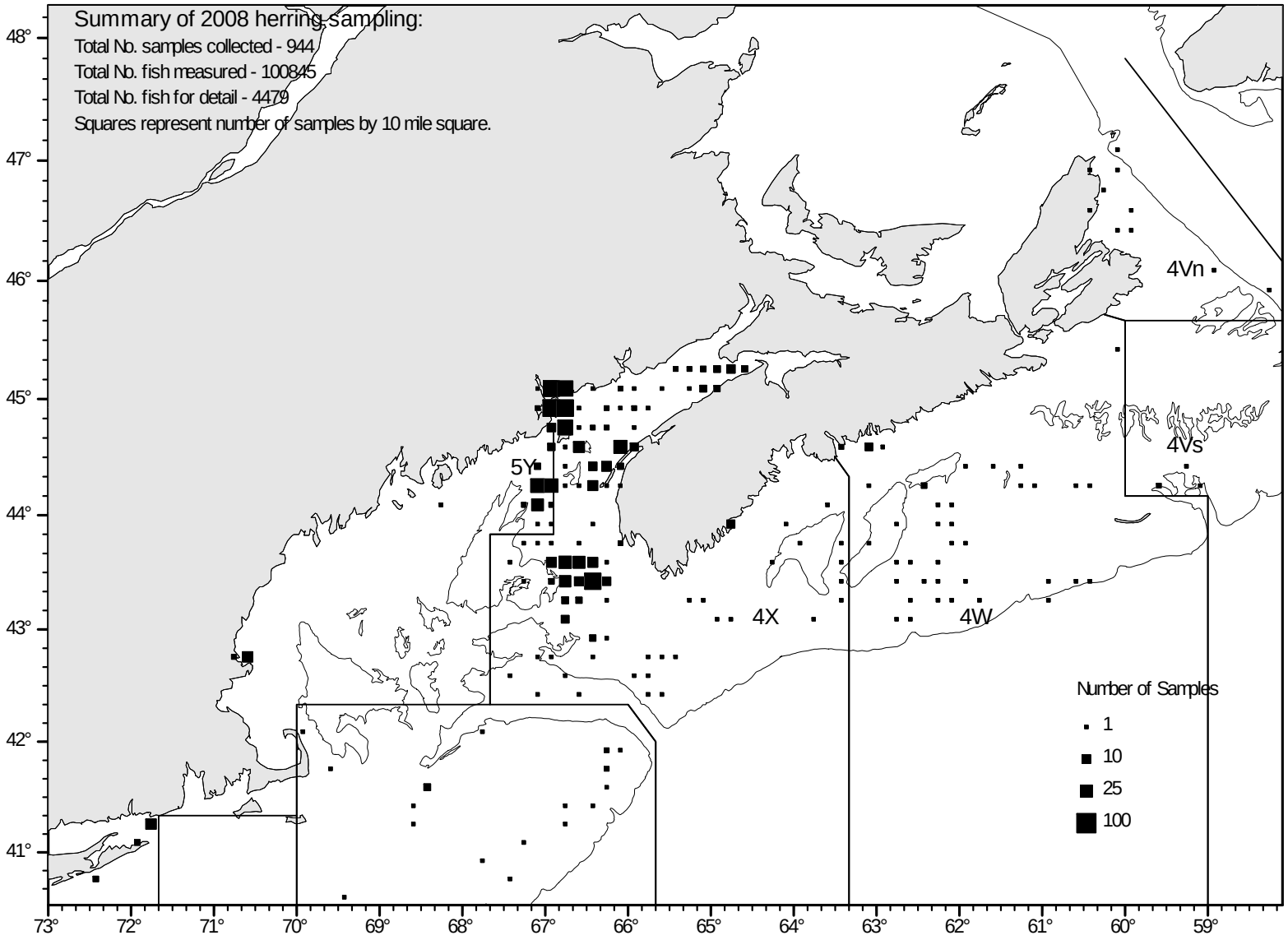


Figure 23. 2008 herring sampling coverage from all sources (number of length frequency samples by 10 mile square).

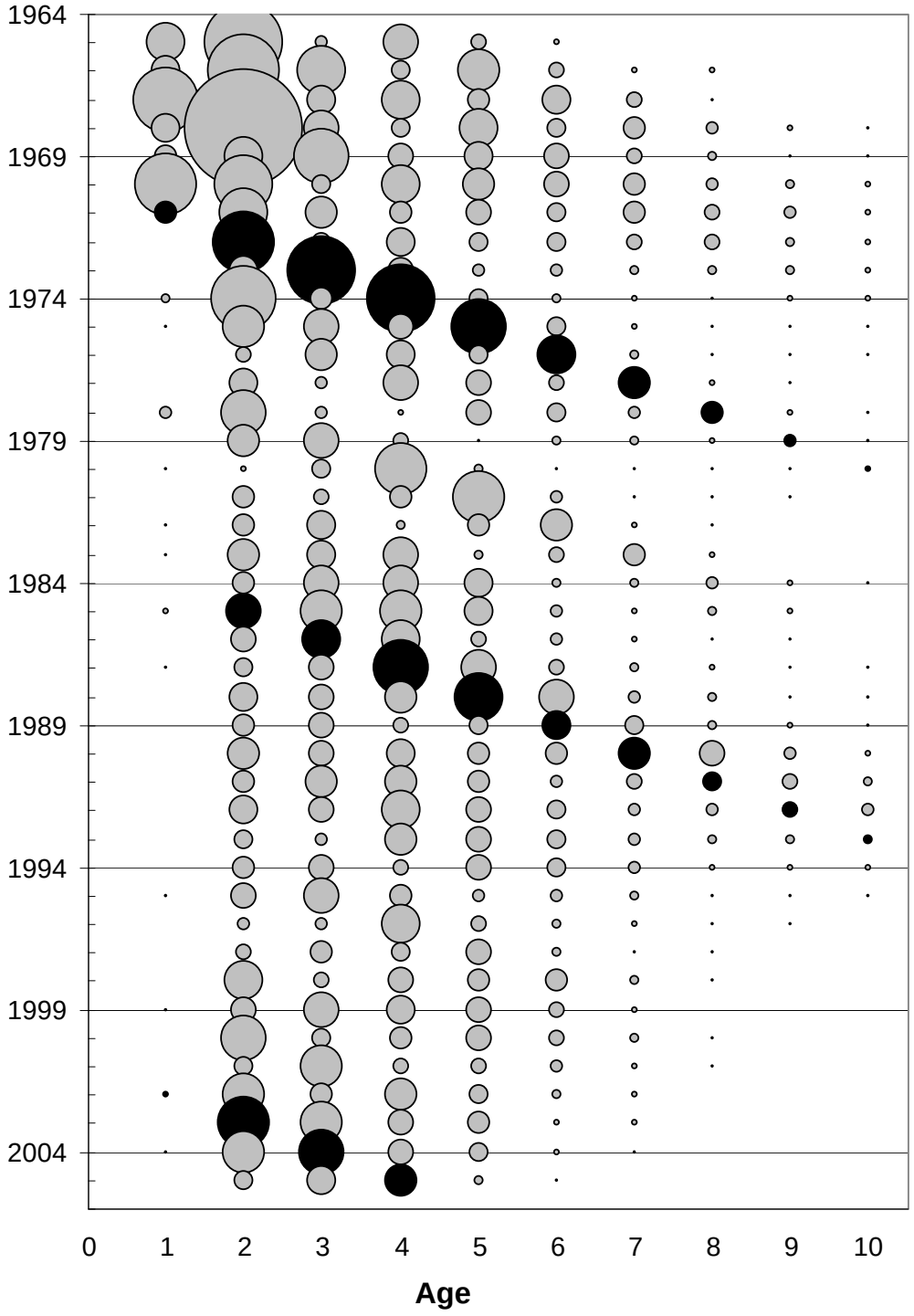


Figure 24. Historical catch at age (numbers) for the SW Nova Scotia / Bay of Fundy spawning component. Refer to Table 15 for actual numbers represented by symbol size. The value for 1968 at age 2 represents the maximum in the series of 2.389 billion. Several of the stronger year-classes are highlighted including the 1970, 1983 and 2001 year-classes (from Power *et al*, 2006a).

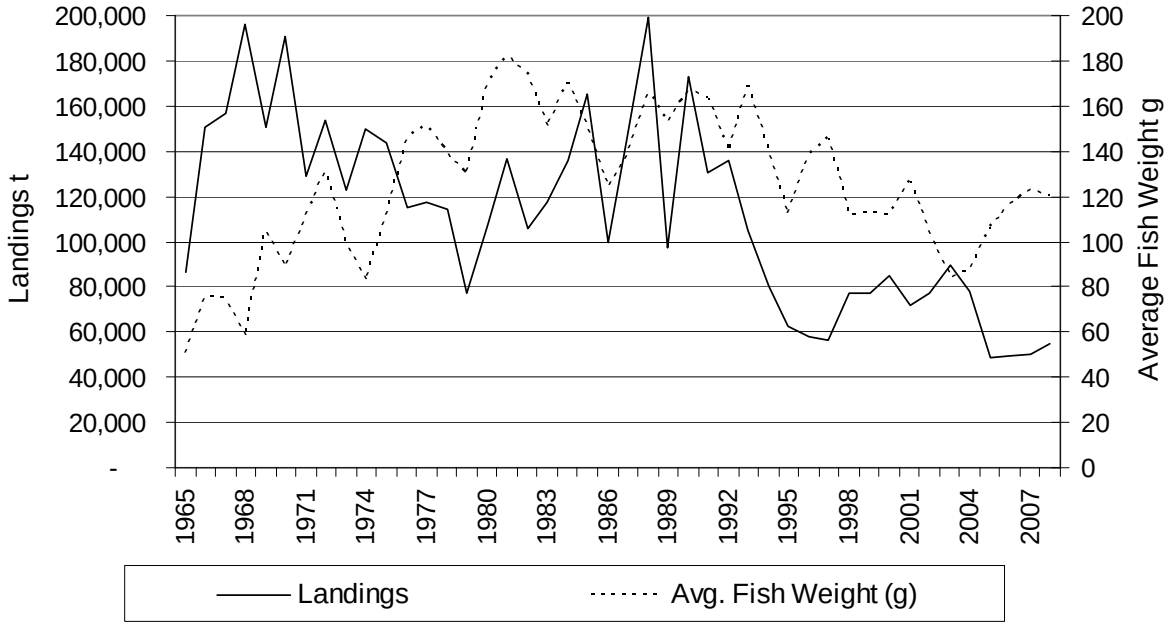


Figure 25. SW Nova Scotia spawning component total catch numbers (millions) and average fish weight (g) for the period 1965-2008.

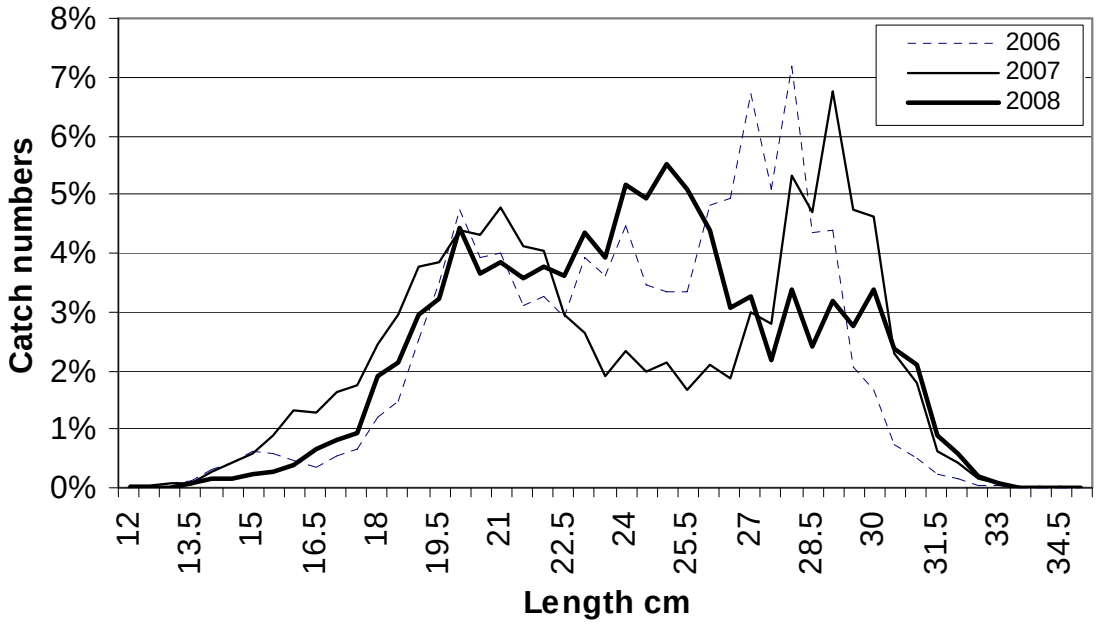


Figure 26. Catch at length (% number) for the 2006, 2007 and 2008 overall SW Nova Scotia / Bay of Fundy herring spawning component.

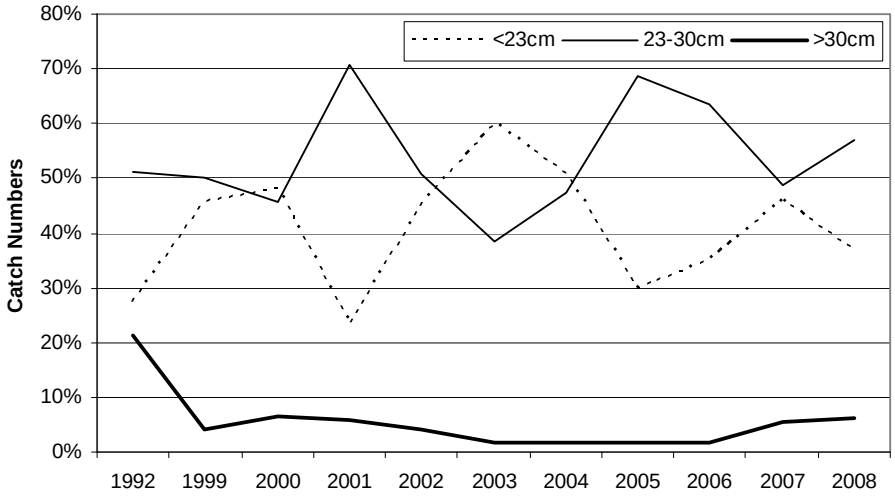


Figure 27. Proportions of size groups (% number) <23cm, 23-30cm and >30cm herring in the catch from the SW Nova Scotia / Bay of Fundy spawning component for 1992 and 1999-2008.

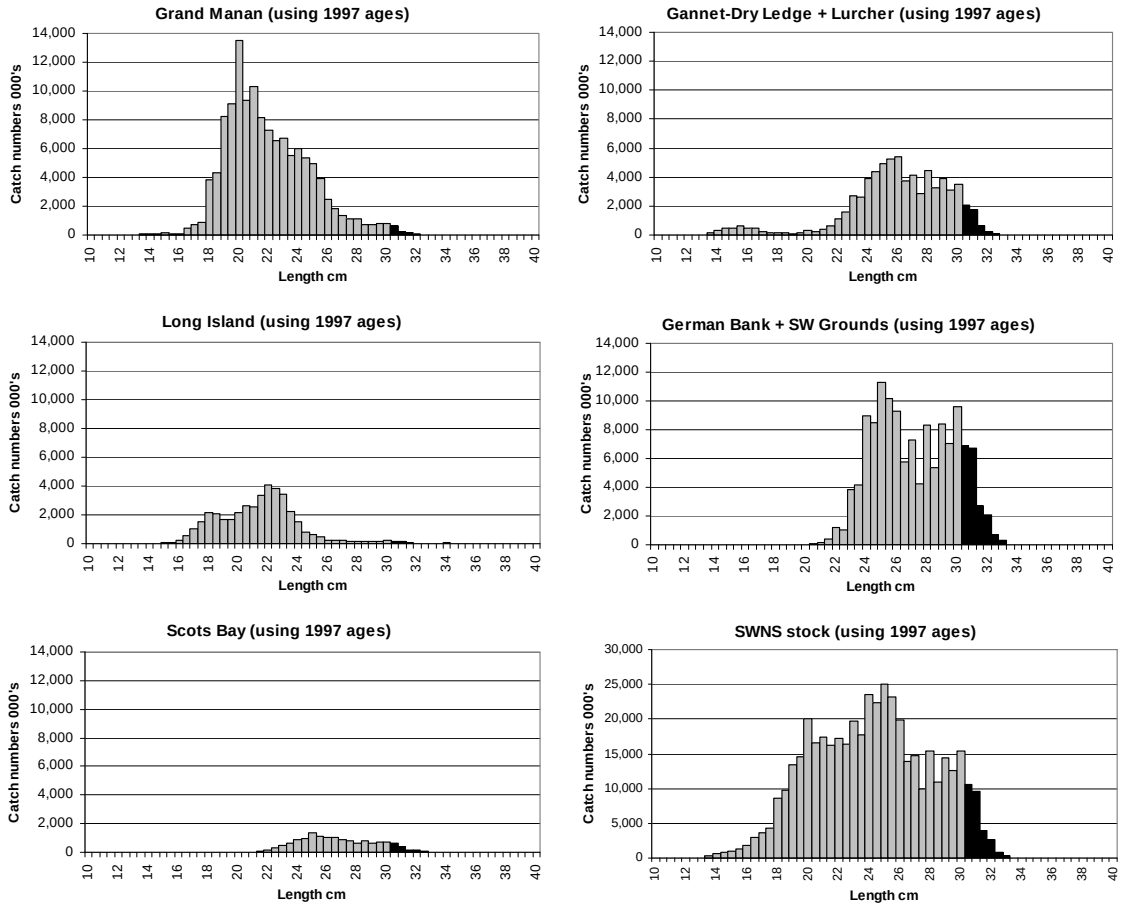


Figure 28. Catch at length with numbers of removals (in thousands) for selected 2008 fishing grounds and the overall SW Nova Scotia / Bay of Fundy herring spawning component.

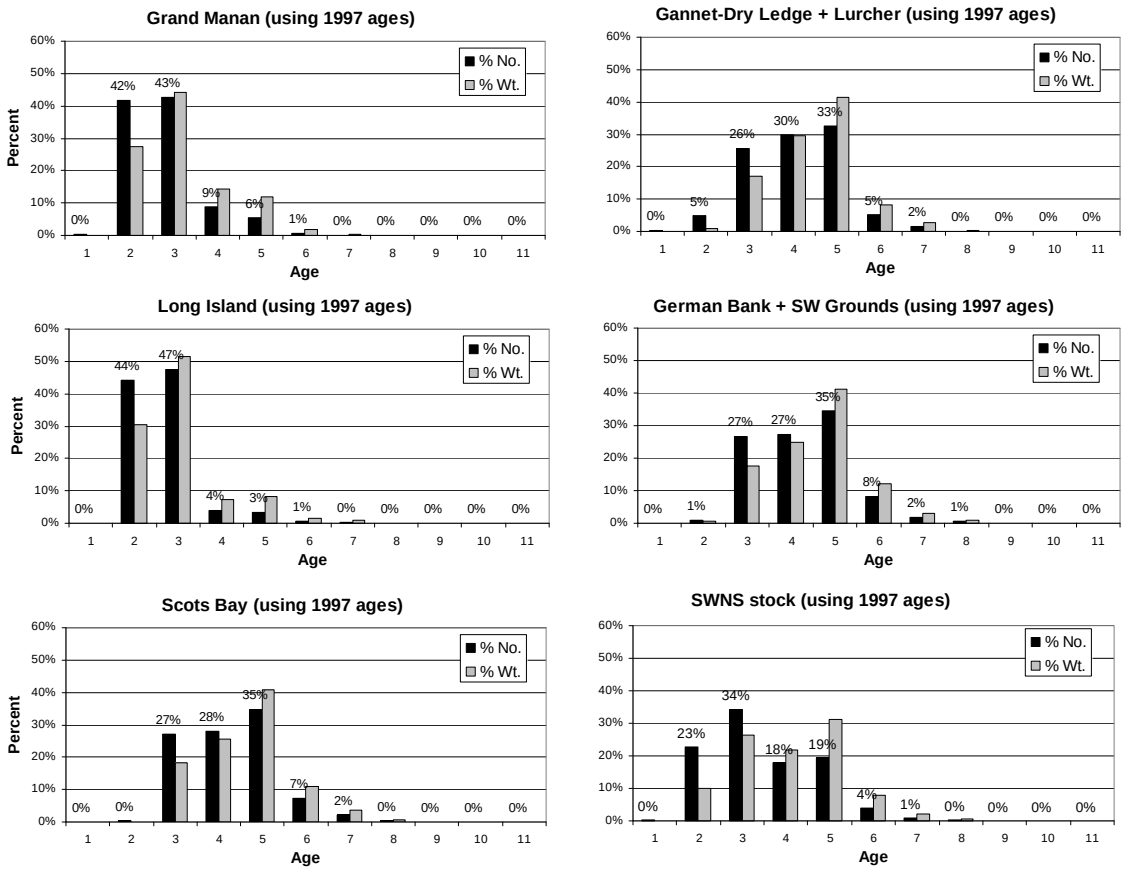


Figure 29. Estimation of catch at age using 1997 ages by fishing ground and overall (% number) for the 2008 overall SW Nova Scotia / Bay of Fundy herring spawning component.

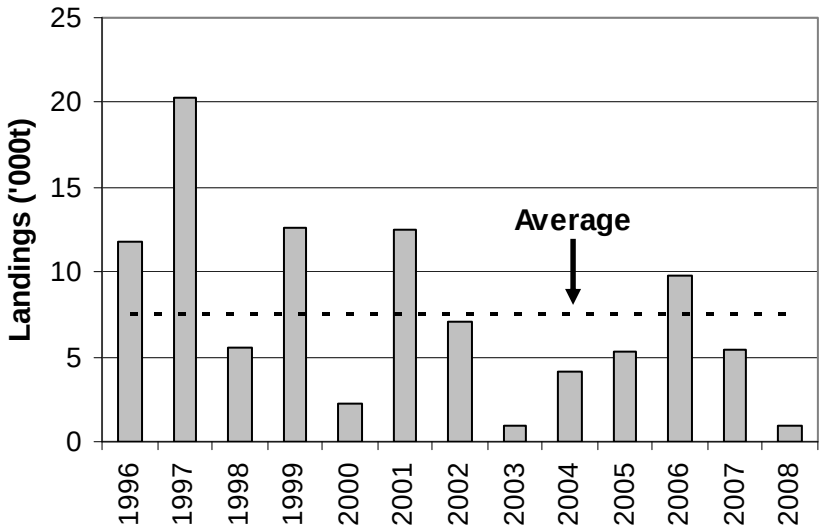


Figure 30. Scotian Shelf Banks landings from all gears since 1996 with the average for the period.

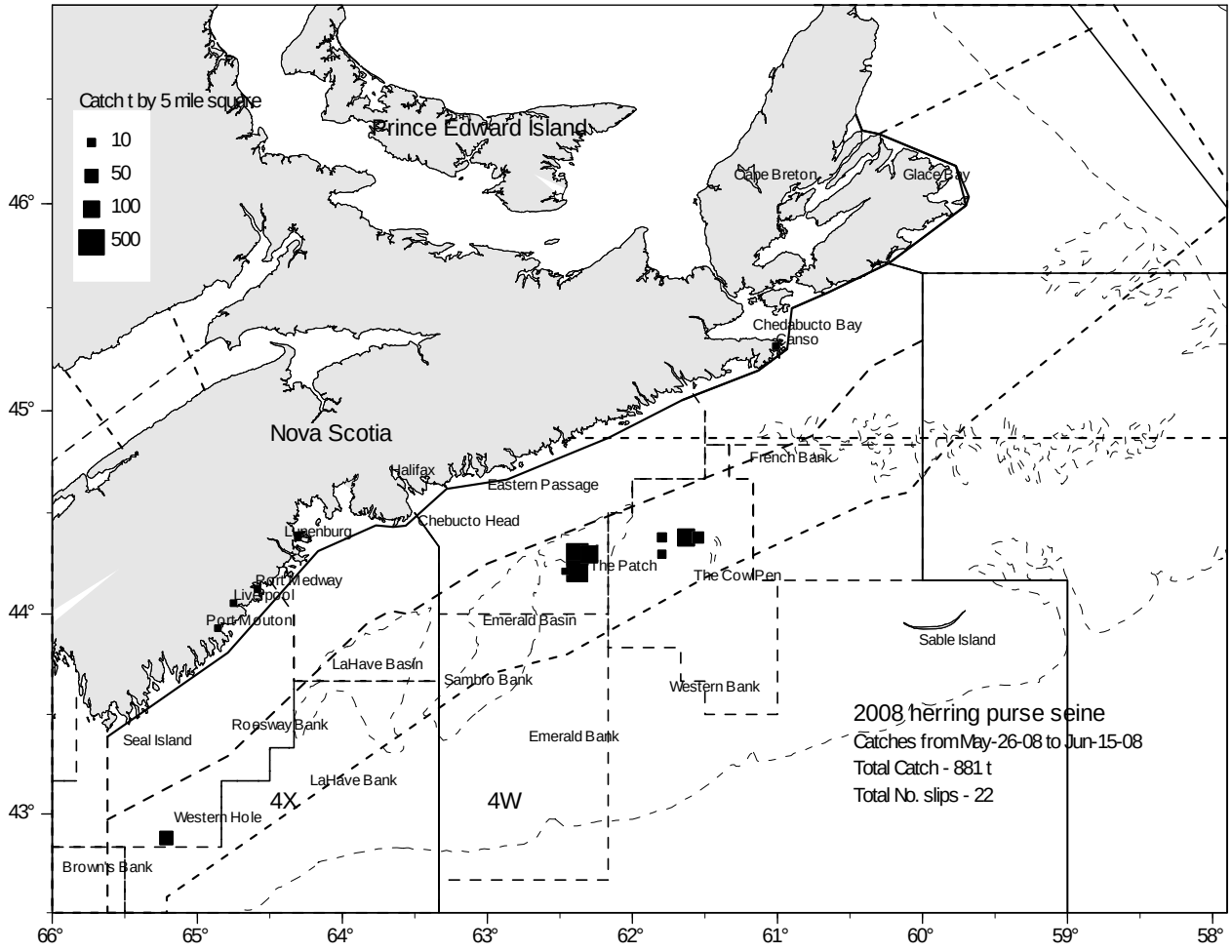


Figure 31. 2008 herring purse seine on the offshore Scotian Shelf banks with embayment and offshore 25 and 50 mile lines shown.

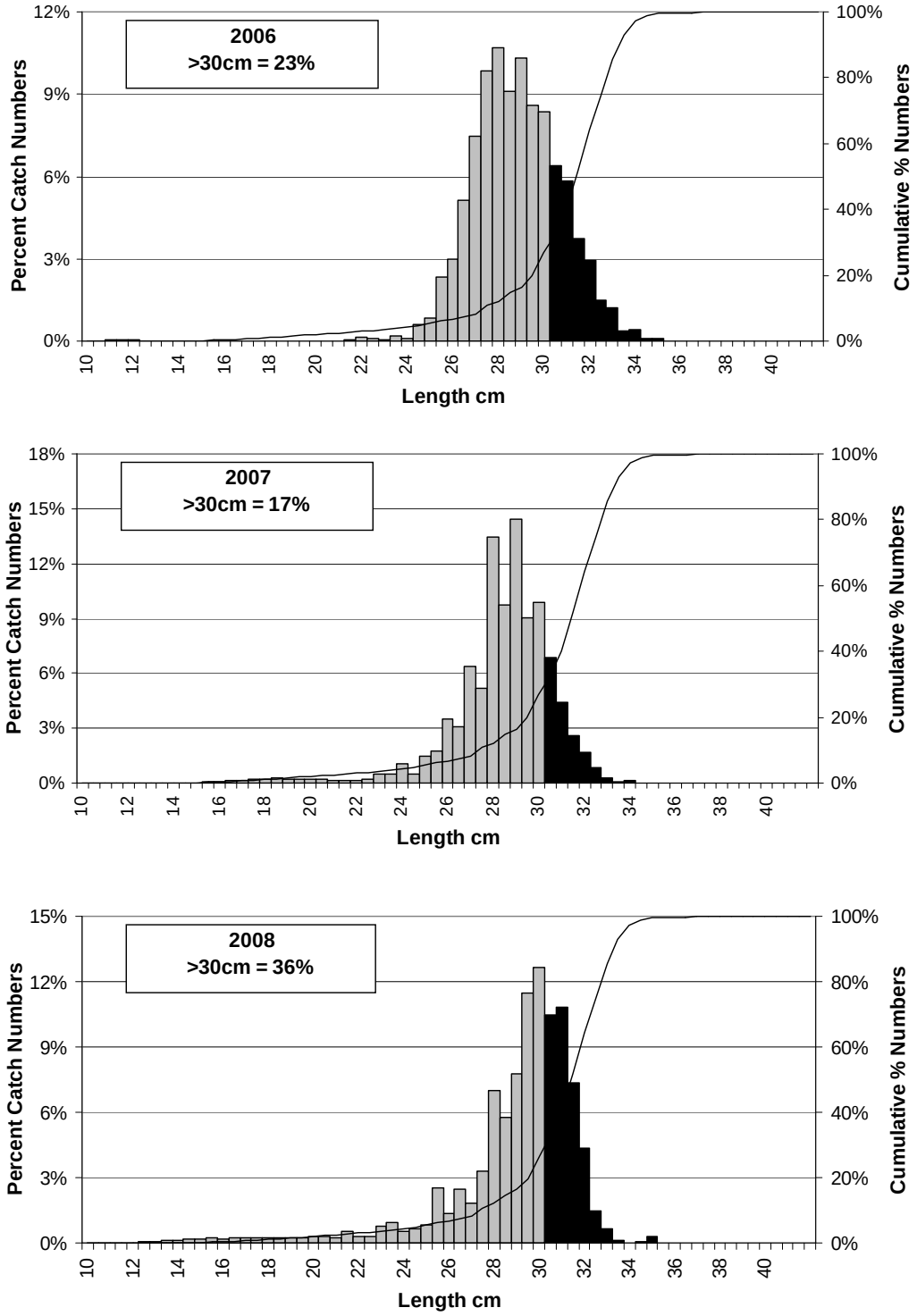


Figure 32. Catch at length (% number) for the 206-2008 offshore Scotian Shelf Banks herring spawning component. Highlighted dark bars represent sizes larger than 30cm.

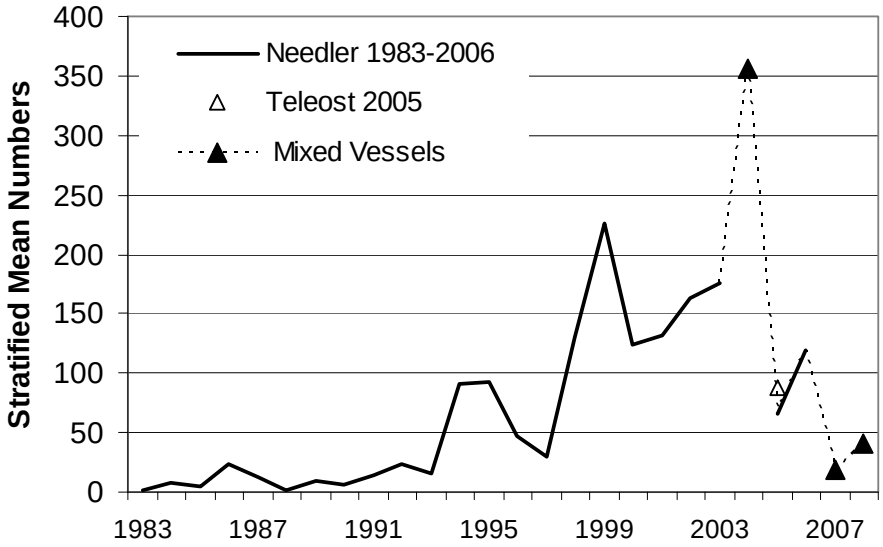


Figure 33. Number of herring caught per standard tow in the DFO summer bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 2008 (strata 55-78; from Sable Island to the Baccaro Line).

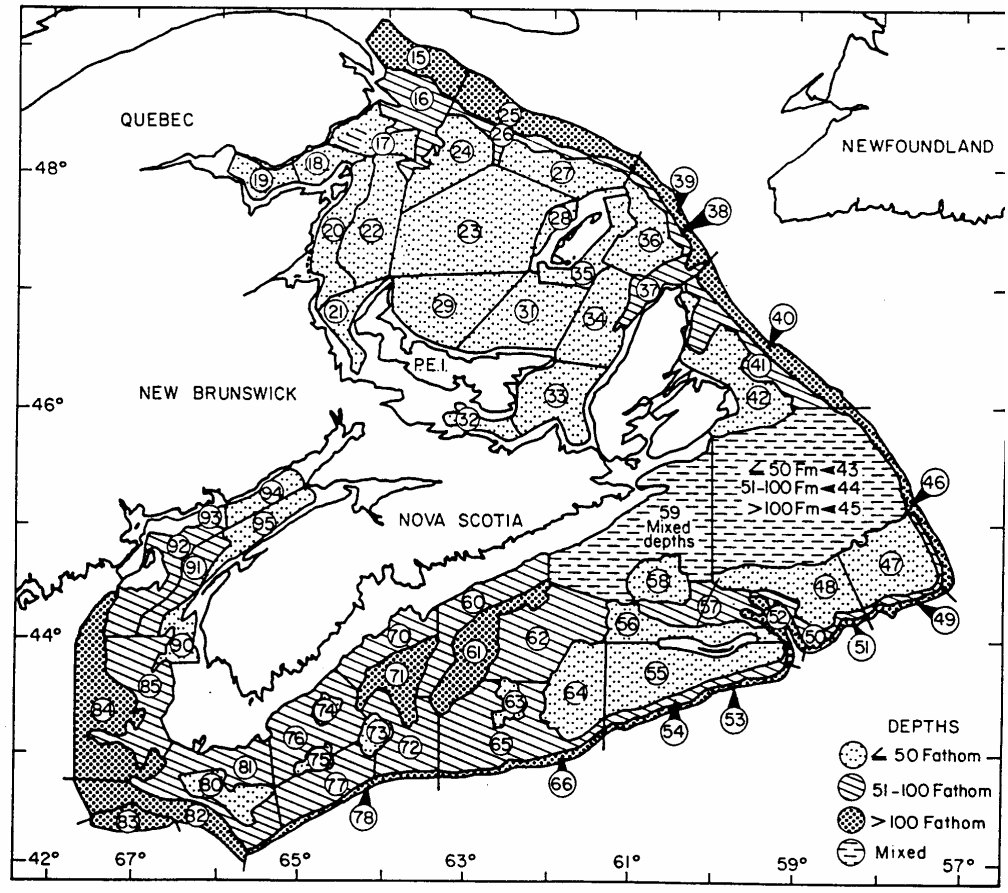


Figure 34. Research bottom trawl survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday, 1981).

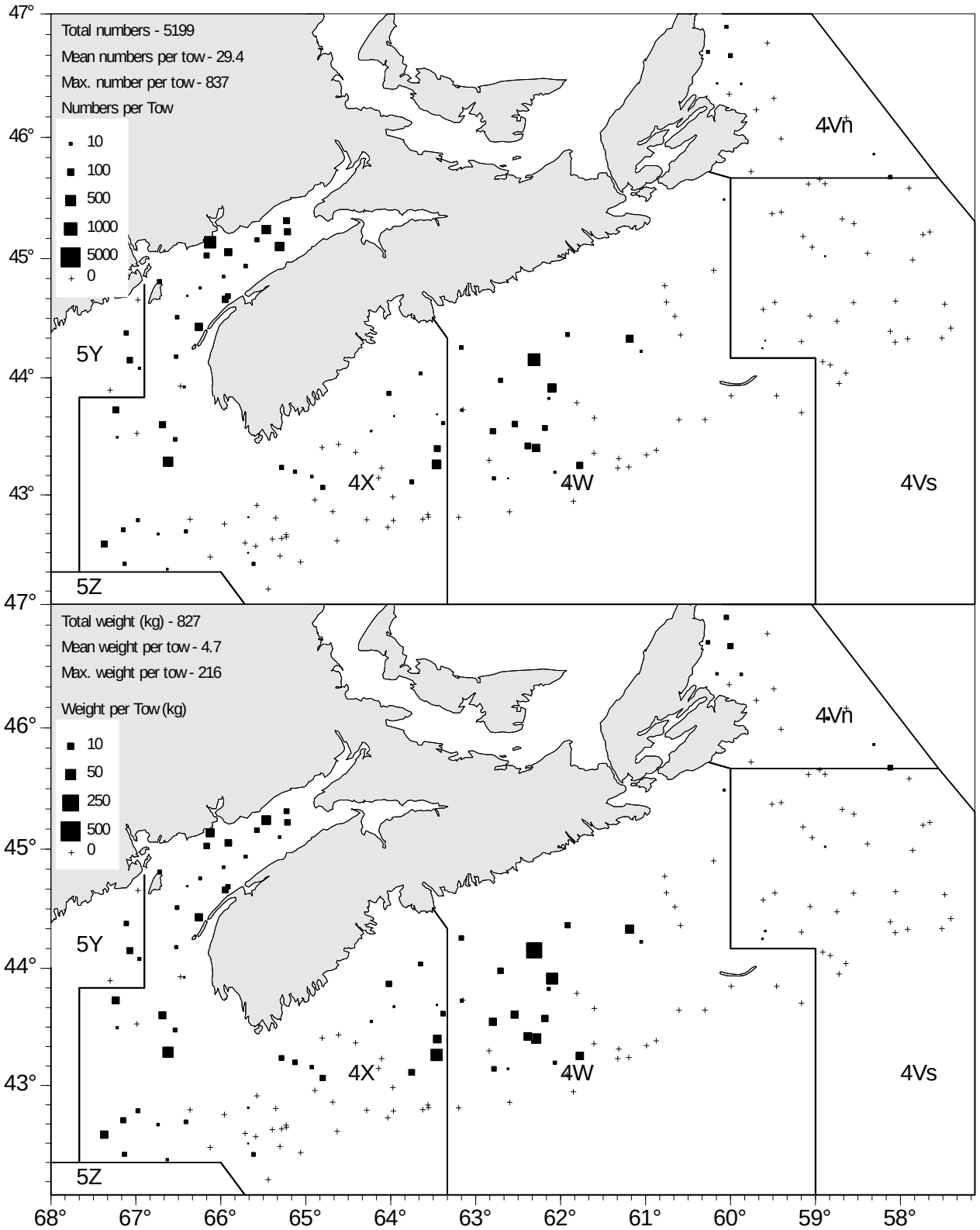


Figure 35. Herring catches in number and weight per tow for the 2008 DFO summer bottom trawl research survey (TEM2008-830: July 5-Aug. 1, 2008).

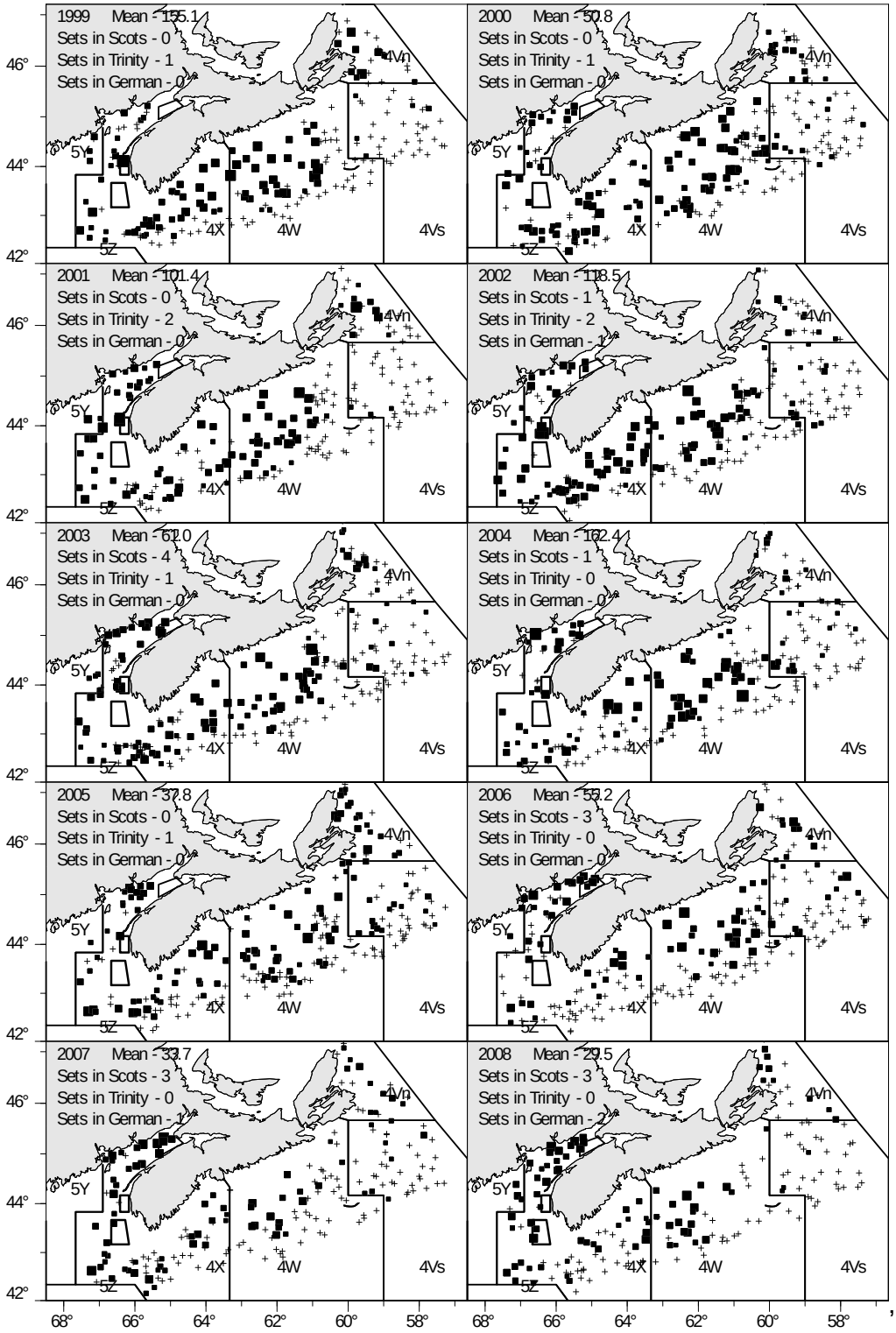


Figure 36. Herring catches from the DFO summer bottom trawl research survey for 1999-2008 (2005 using Alfred Needler data only). Mean numbers per standard tow and count of sets in Scots, Trinity and German spawning areas.

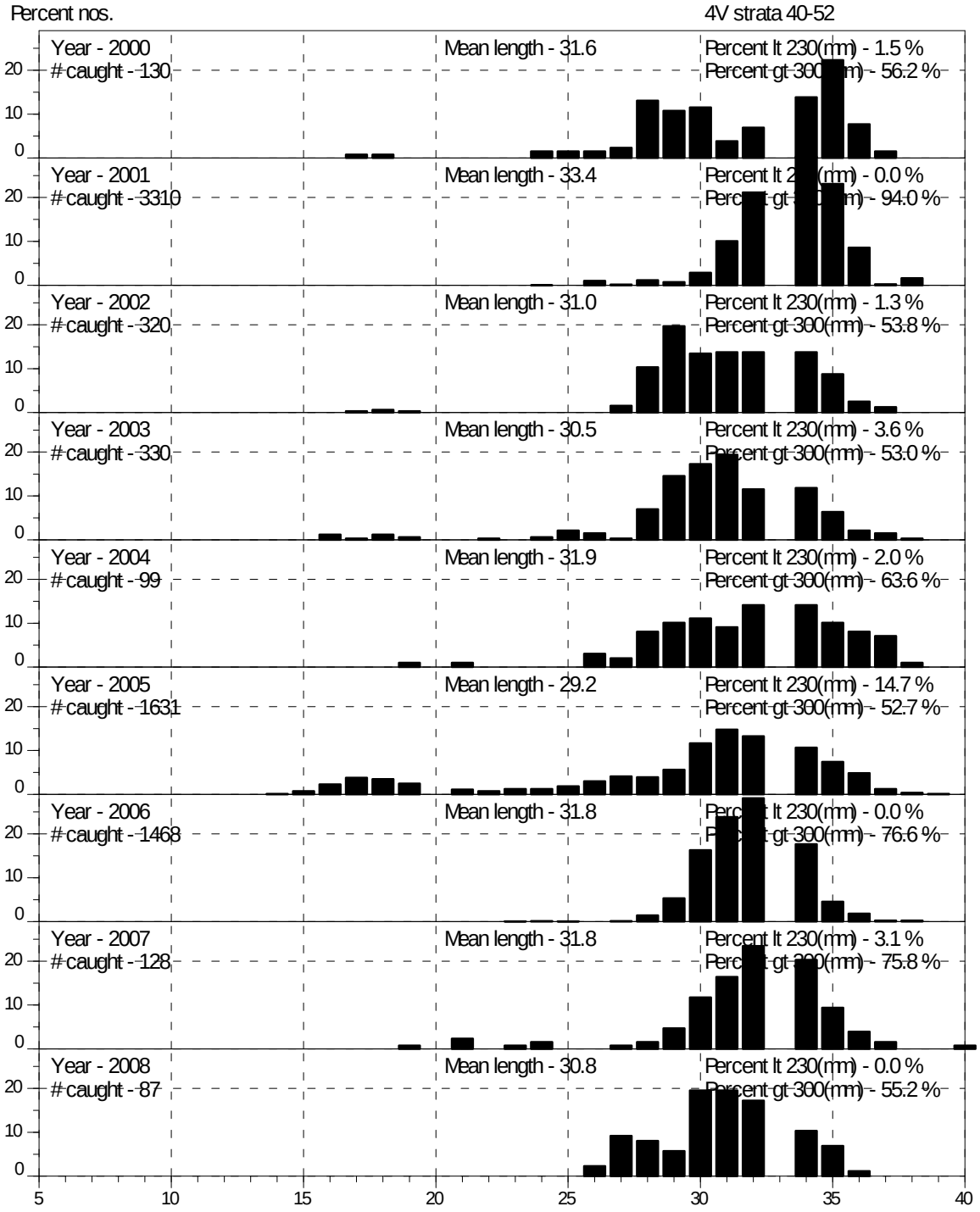


Figure 37. Herring size distribution in the DFO summer bottom trawl research survey for 4V STRATA from 2000 to 2008 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

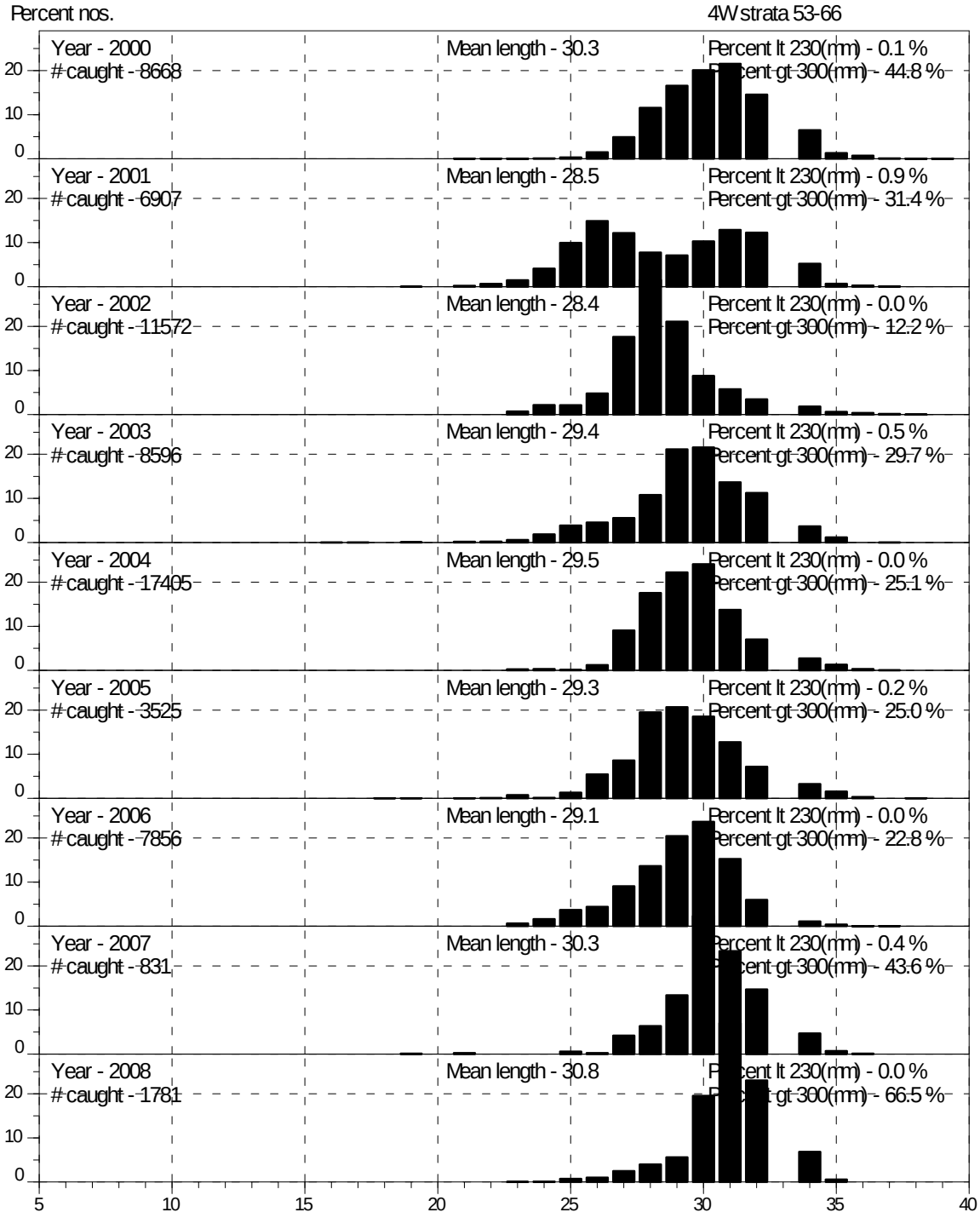


Figure 38. Herring size distribution in the DFO summer bottom trawl research survey for 4W STRATA from 2000 to 2008 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

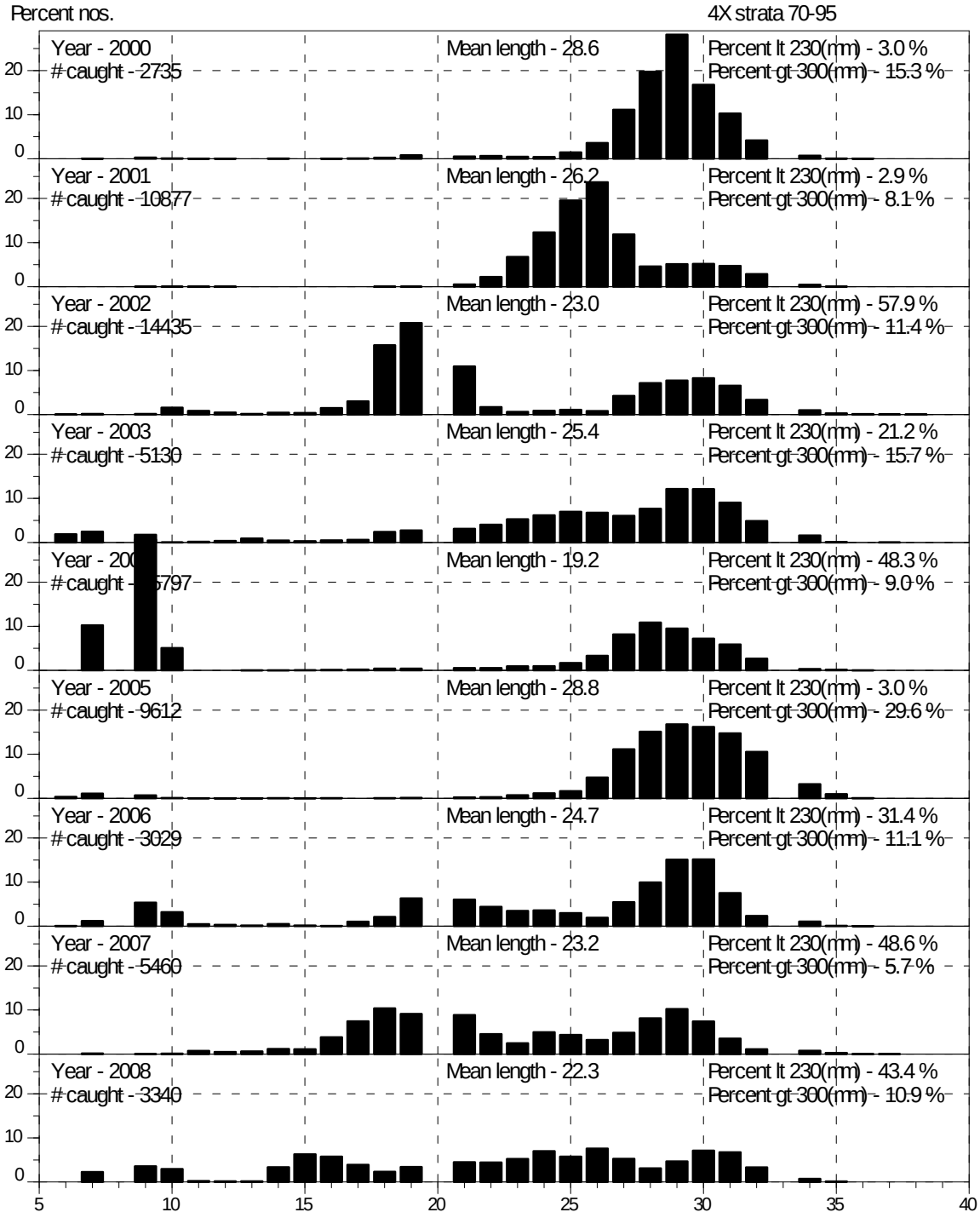


Figure 39. Herring size distribution in the DFO summer bottom trawl research survey for 4X STRATA from 2000 to 2008 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

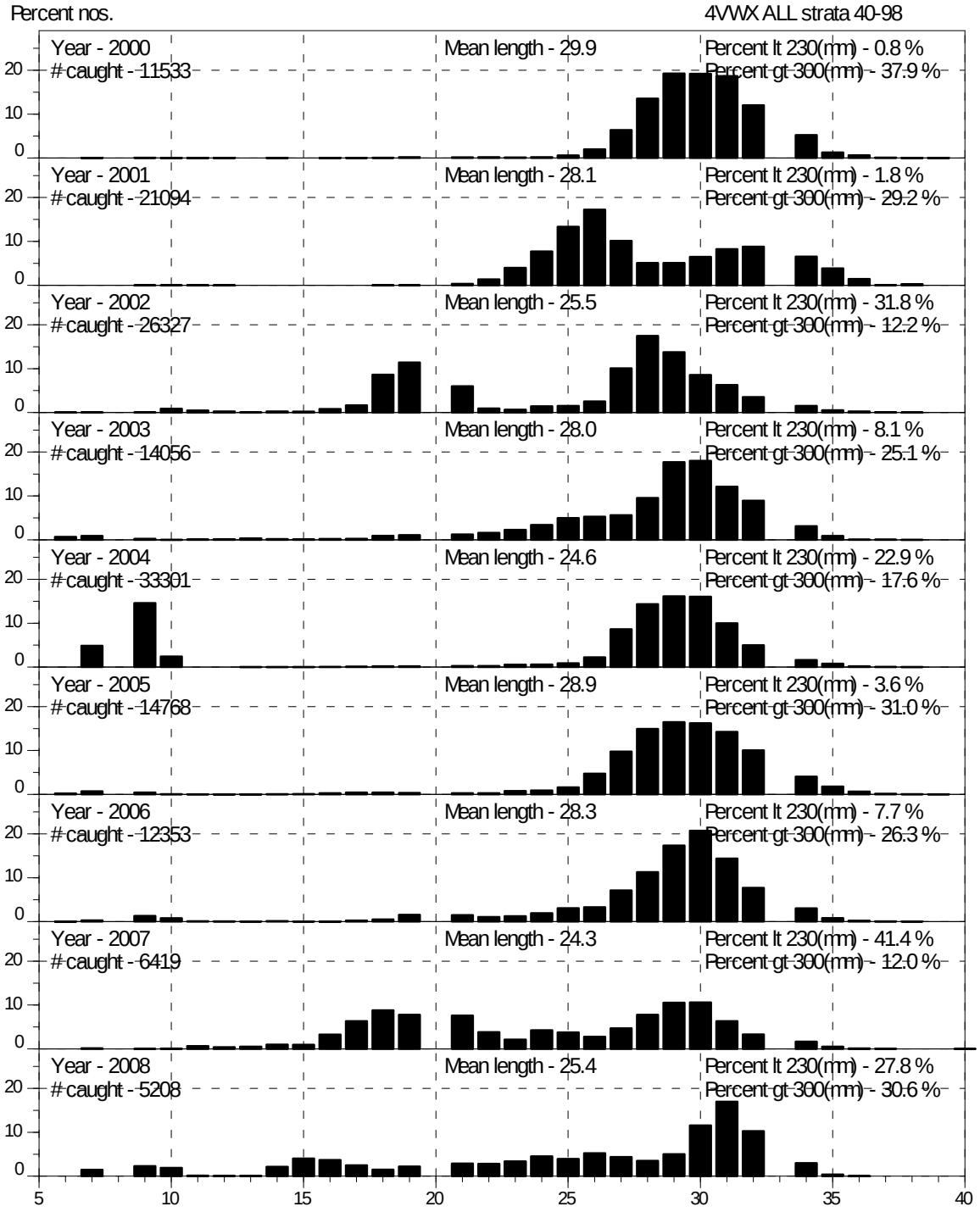


Figure 40. Herring size distribution in the DFO summer bottom trawl research survey for 4VWX ALL STRATA from 2000 to 2008 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

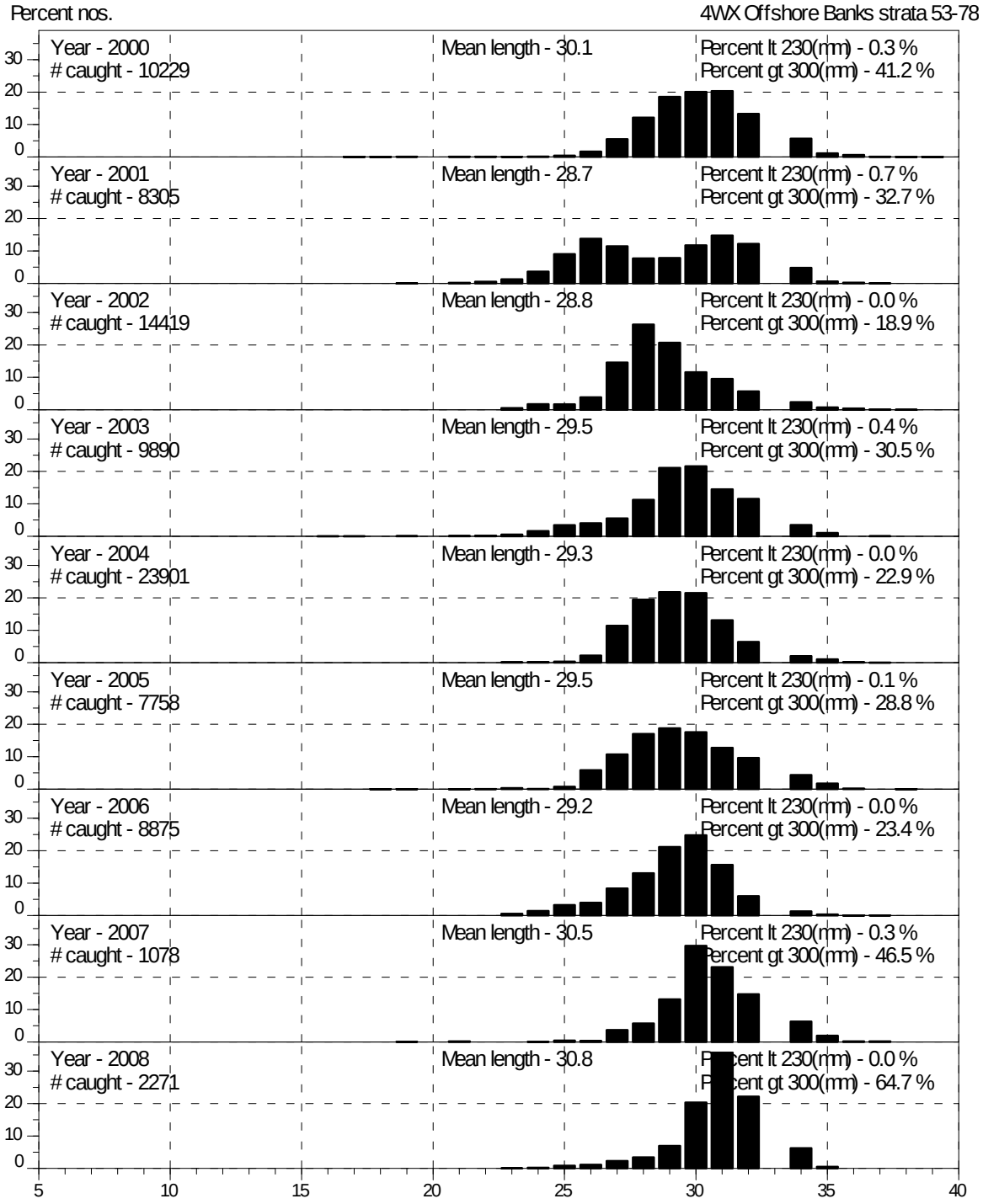


Figure 41. Herring size distribution in the DFO summer bottom trawl research survey for the Offshore Banks area (strata 53 to 78) from 2000 to 2008 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

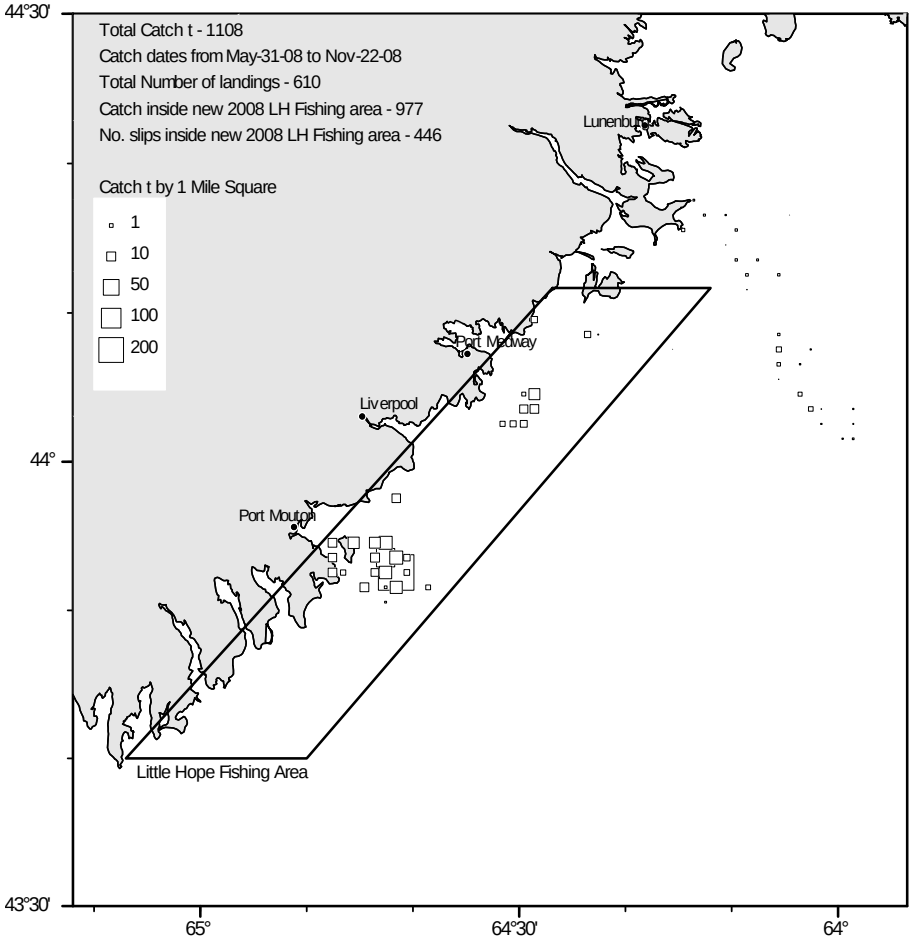


Figure 42. 2008 herring gillnet catch locations for landings in statistical districts 23-31 with amount caught within the Little Hope Fishing Area.

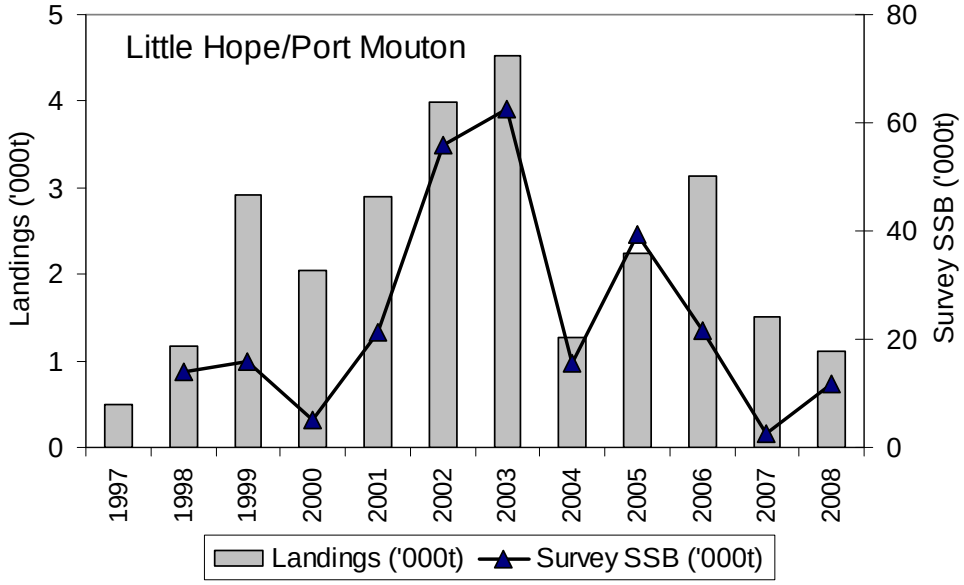


Figure 43. Herring landings and acoustic survey biomass (‘000t) for the Little Hope/Port Mouton gillnet fishery from 1997-2008.

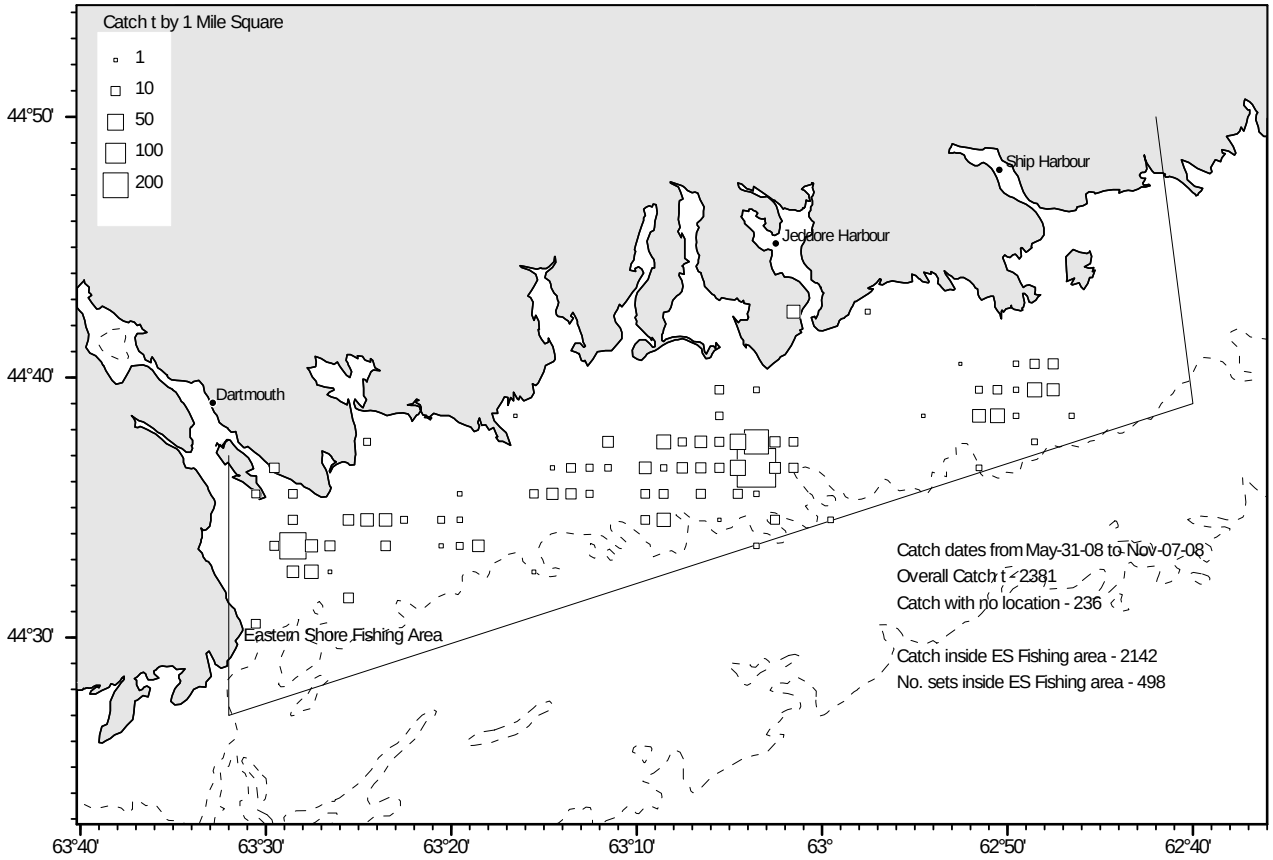


Figure 44. Gillnet herring catches for the 2008 fall fishery along the Eastern Shore Fishing Area (catches by 1 mile squares).

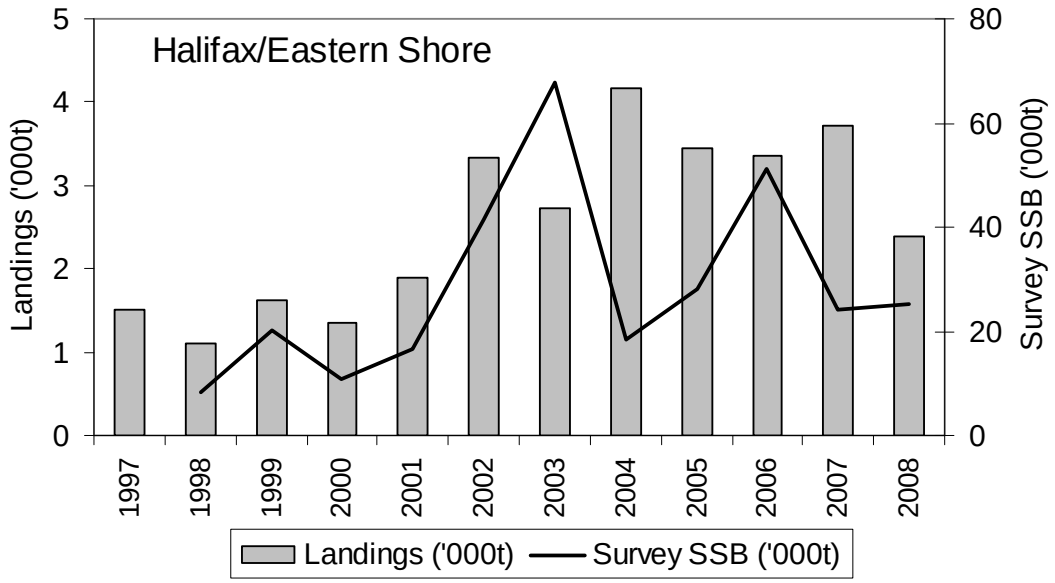


Figure 45. Herring landings and acoustic survey biomass (‘000t) for the Halifax/Eastern Shore gillnet fishery from 1997-2008.

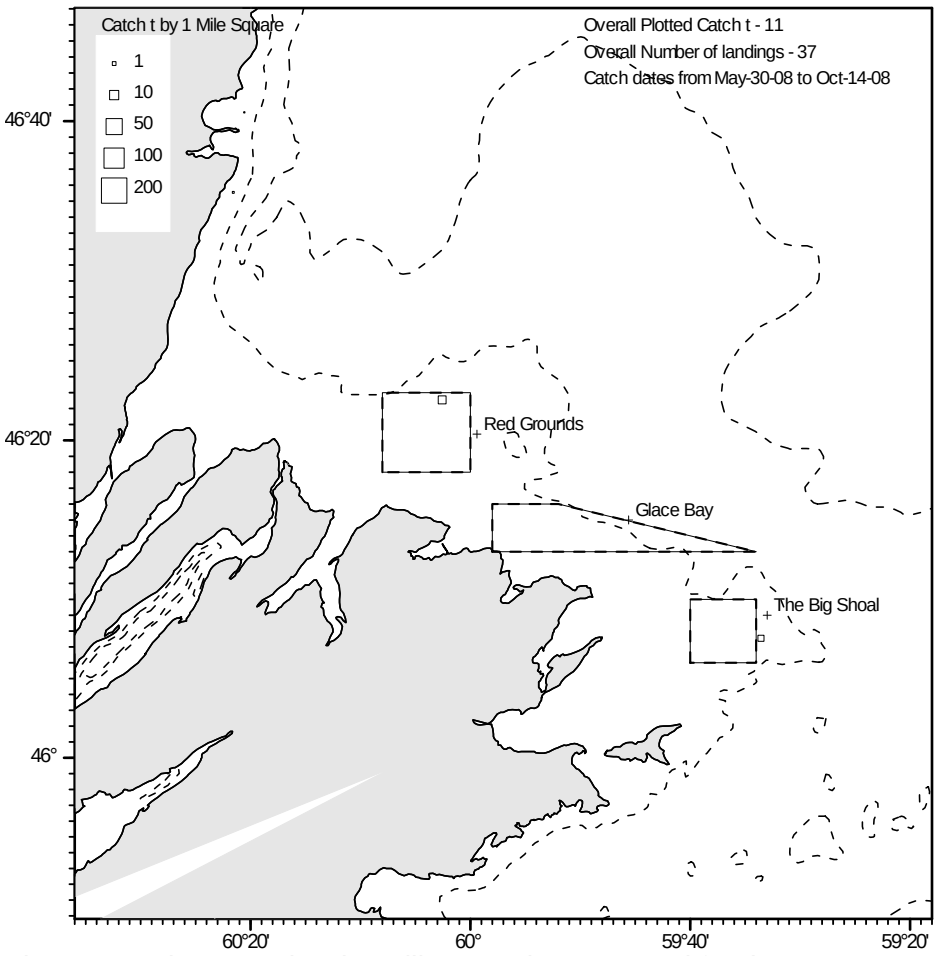


Figure 46. Glace Bay herring gillnet catches reported for the 2008 season.

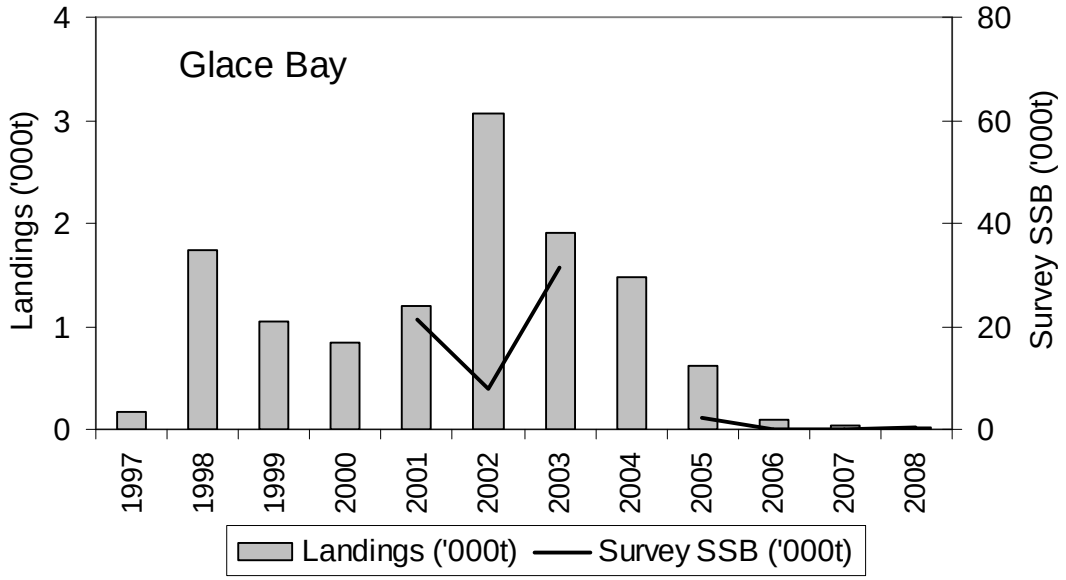


Figure 47. Herring landings and acoustic survey biomass (‘000t) for the Glace Bay gillnet fishery from 1997-2008.

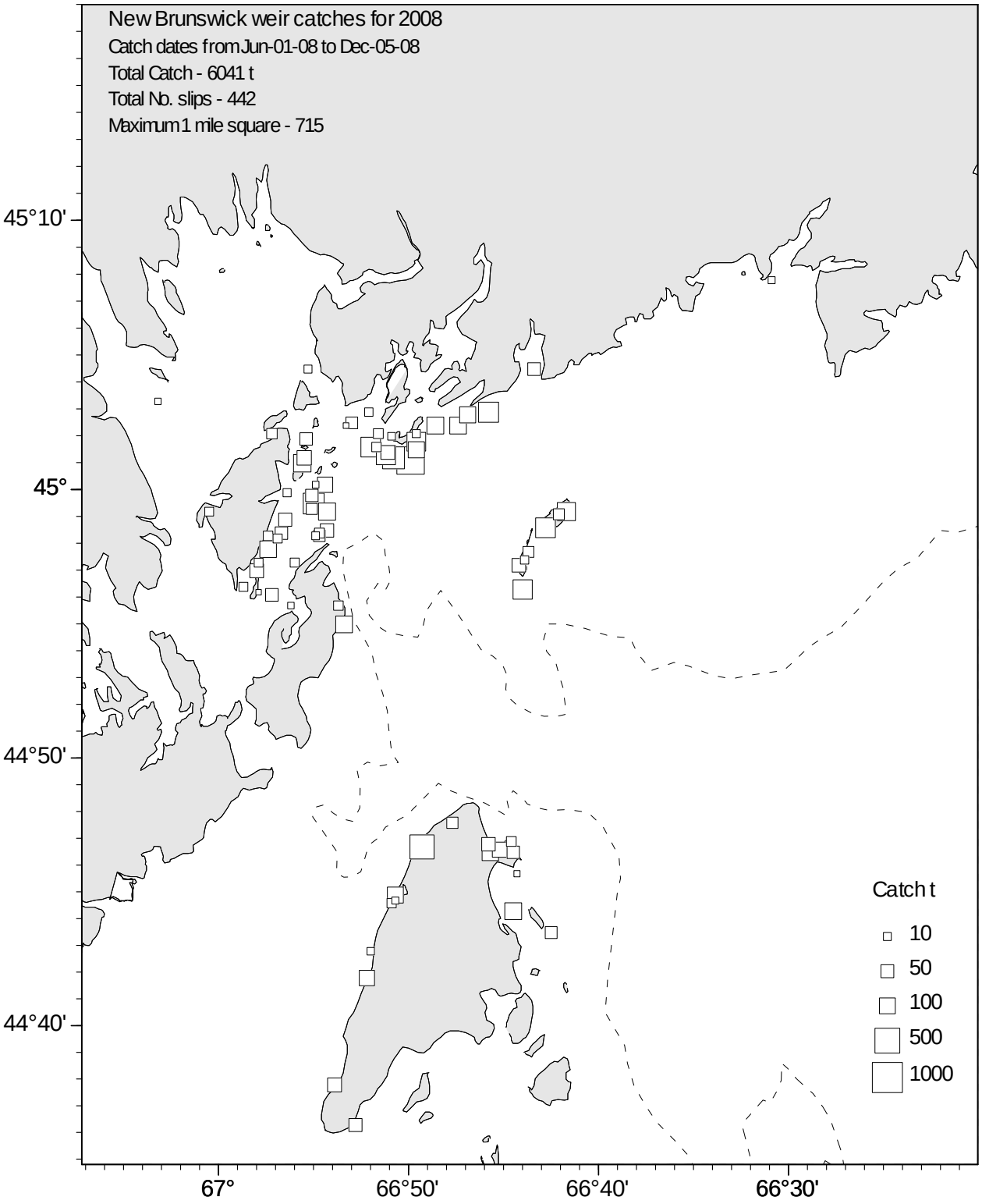


Figure 48. New Brunswick herring weir catches by location for the 2008 fishing season (data summed by one mile squares).

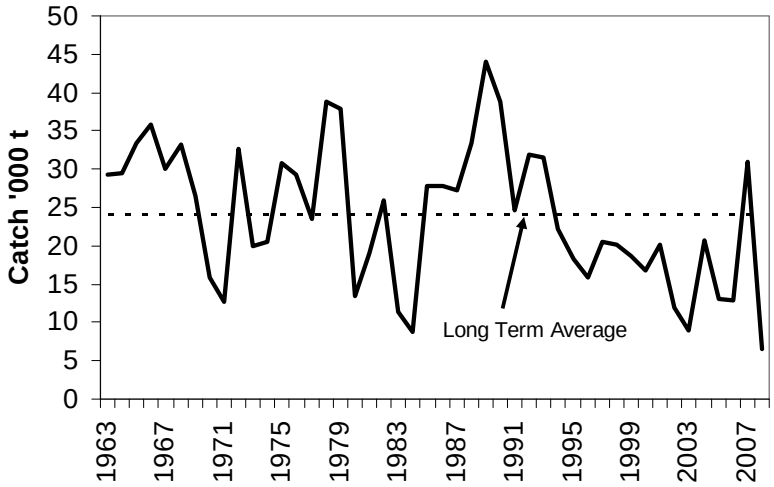


Figure 49. Herring landings from the southwest New Brunswick weir and shutoff fishery for 1963-2008 with the overall long term average.

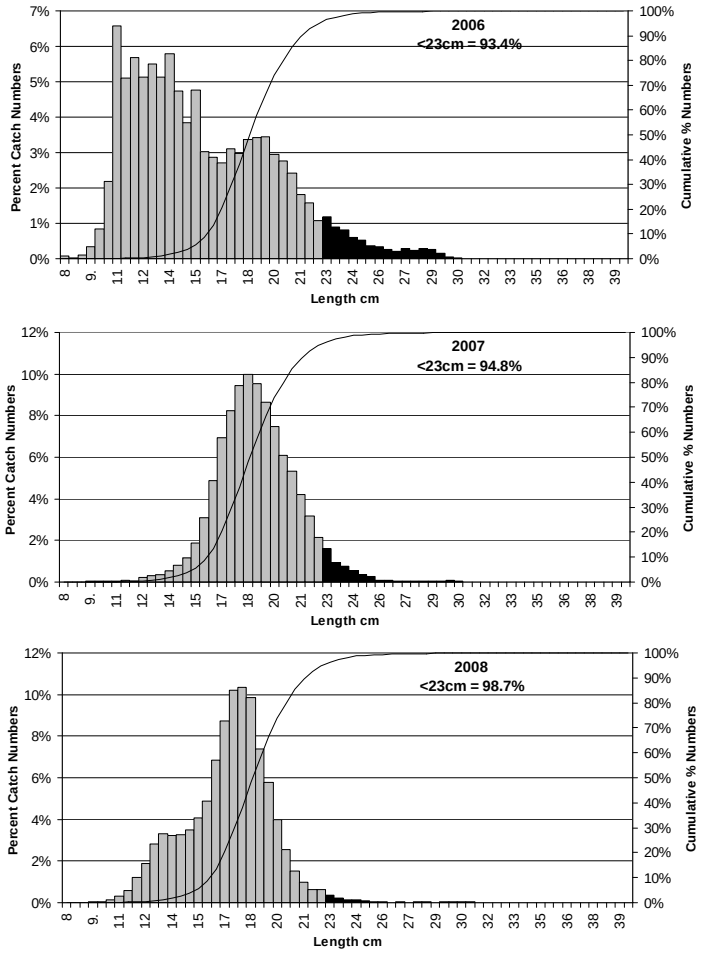
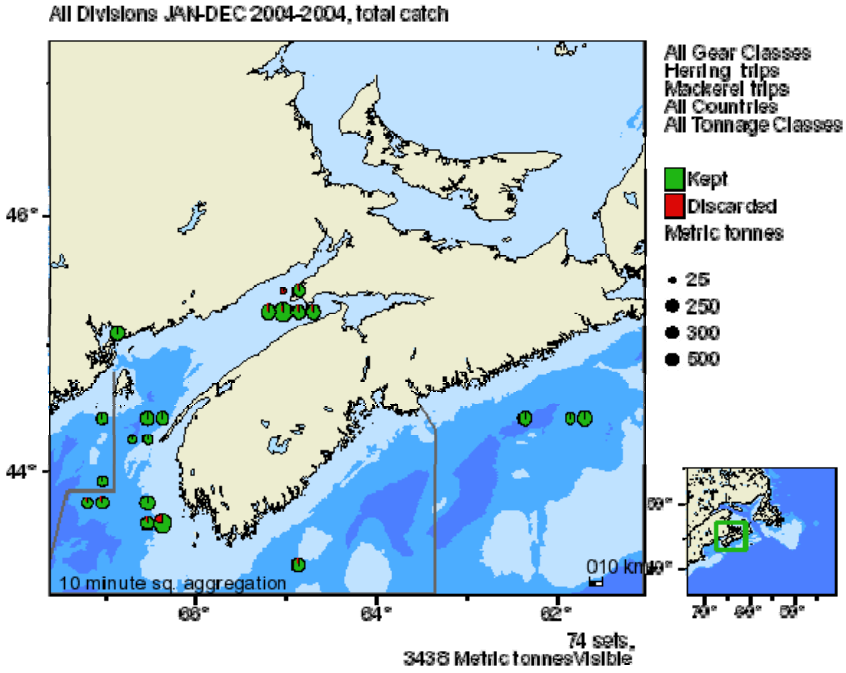


Figure 50. Catch at length for the New Brunswick weir fishery in 2008 with estimated percent numbers caught. Size categories 23cm and greater are shaded in black.

Appendix A – Observer reports for herring directed trips from 2004-2008.

2004 Observer data

- 47 trips, purse seine only with 128 sets monitored
- NAFO area 4W on 'The Patch' in June to Scots Bay in July/Aug and 4X in Oct
- purse seine from June to Oct with various by-catch species observed
- herring was the main discard species with 148t released followed by 1 whale released (presumably unharmed)

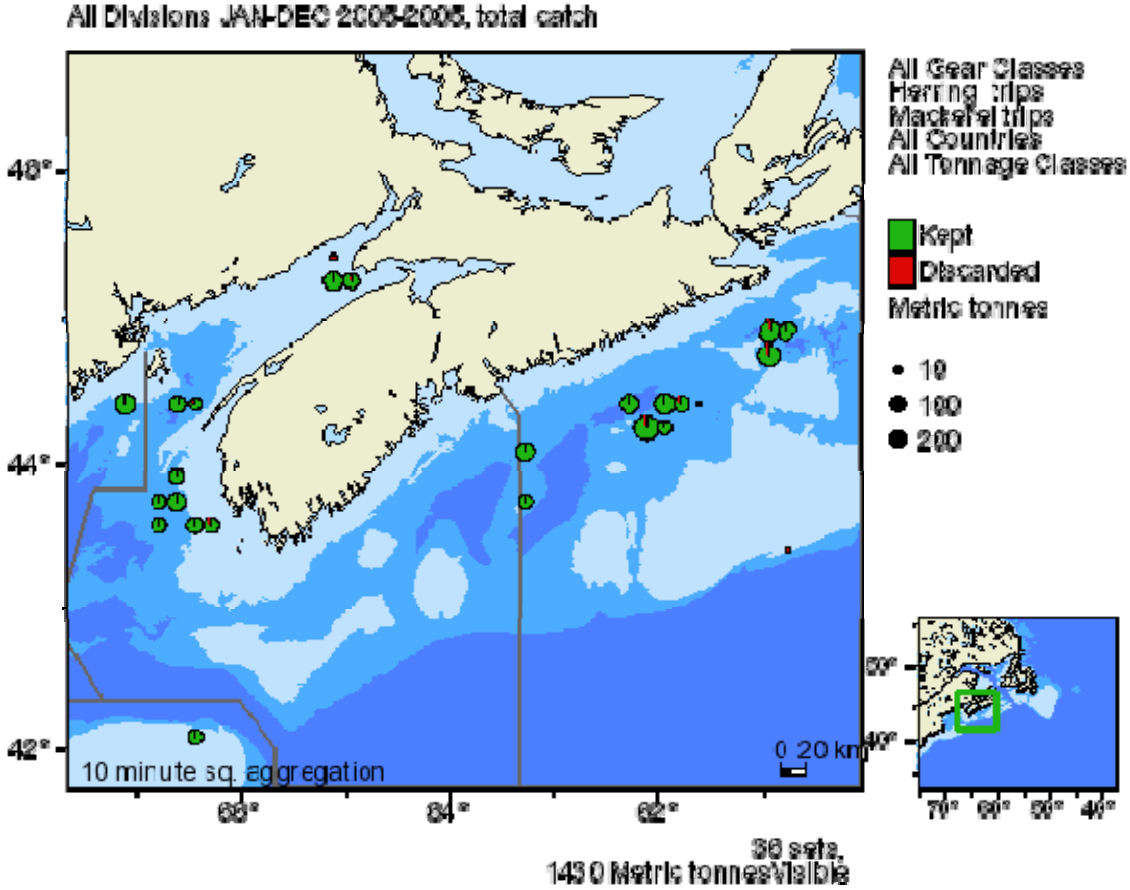


2004 Catch Composition (Metric tonnes)

Species	Kept 2004	Discarded 2004
HERRING(ATLANTIC)	3250.34	148.207
MACKEREL(ATLANTIC)	1	0
SHORT-FIN SQUID	0.006	0.001
WHALES (NS)	0	35
SPINY DOGFISH	0	2.876
SHORTFIN MAKO	0	0.35
THRESHER SHARK	0	0.15
COD(ATLANTIC)	0	0.145
PORBEAGLE,MACKEREL SHARK	0	0.1
MONKFISH,GOOSEFISH,ANGLER	0	0.009
WINTER FLOUNDER	0	0.001
SHAD AMERICAN	0	0.001
LUMPFISH	0	0.001

2005 Observer data

- 16 trips, 5 midwater and 11 purse seine, 46 sets monitored
- midwater trawl in area 4WX (offshore Scotian Shelf) in Nov-Dec
- purse seine from June to Sept with lumpfish, dogfish and mackerel by-catch observed

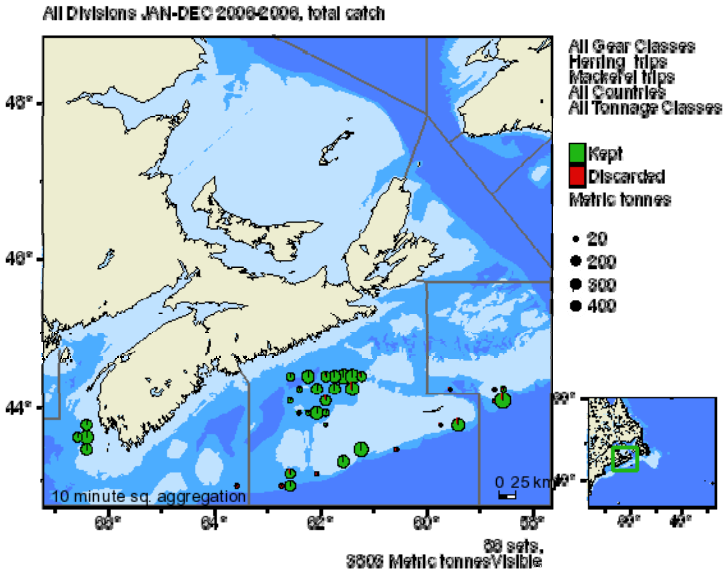


2005 Catch Composition (Metric tonnes)

Species	Kept 2005	Discarded 2005
HERRING(ATLANTIC)	1424.83	2.775
ALEWIFE	1.7	0
MACKEREL(ATLANTIC)	0.075	0
SPINY DOGFISH	0	0.5
SILVER HAKE	0	0.4
PORBEAGLE,MACKEREL SHARK	0	0.03
BARRACUDINA,UNIDENTIFIED	0	0.03
MONKFISH,GOOSEFISH,ANGLER	0	0.002
LUMPFISH	0	0.001

2006 Observer data

- 41 trips, 28 midwater and 13 purse seine, 150 sets monitored
- midwater trawl in area 4VWX (offshore Scotian Shelf) from Jan to Nov
- purse seine from June to Sept with mackerel and squid by-catch observed

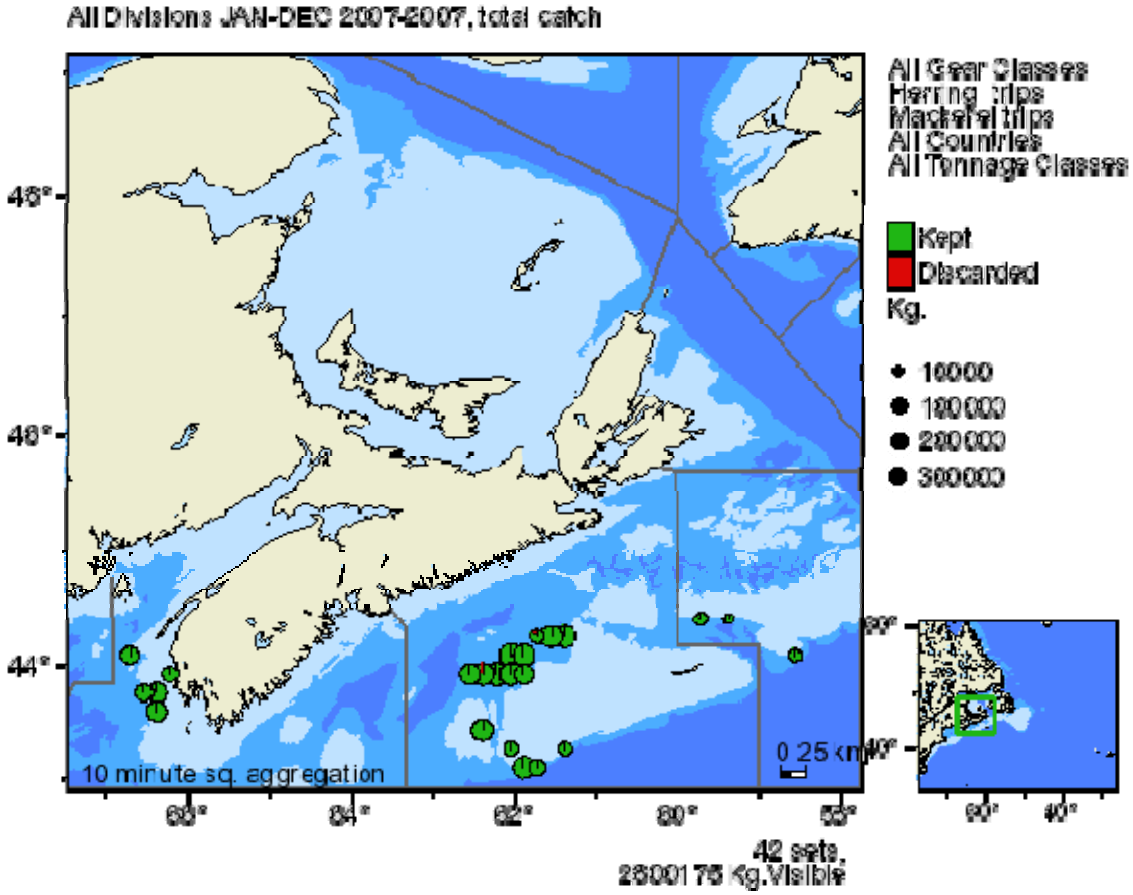


2006 Catch Composition (Metric tonnes)

Species	Kept 2006	Discarded 2006
HERRING(ATLANTIC)	3755.48	1.213
MACKEREL(ATLANTIC)	31.486	1.113
SHORT-FIN SQUID	2.877	4.335
SILVER HAKE	0.401	0.01
POLLOCK	0.01	0.002
HADDOCK	0.008	0.001
REDFISH UNSEPARATED	0.006	0
SPINY DOGFISH	0.005	0.029
ALEWIFE	0.001	2.96
PORBEAGLE,MACKEREL SHARK	0	1.405
BLUEFIN TUNA	0	1.35
WHITE BARRACUDINA	0	0.05
LANTERNFISH (NS)	0	0.05
SAND LANCES (NS)	0	0.04
SNOW CRAB (QUEEN)	0	0.002
SHAD AMERICAN	0	0.002
SPONGES	0	0.001
JONAH CRAB	0	0.001

2007 Observer data

- 25 trips, 19 midwater and 6 purse seine, 54 sets monitored
- midwater trawl in area 4VW (Patch /Sable area) in May to June
- purse seine from July to Oct with no by-catch (herring only observed)

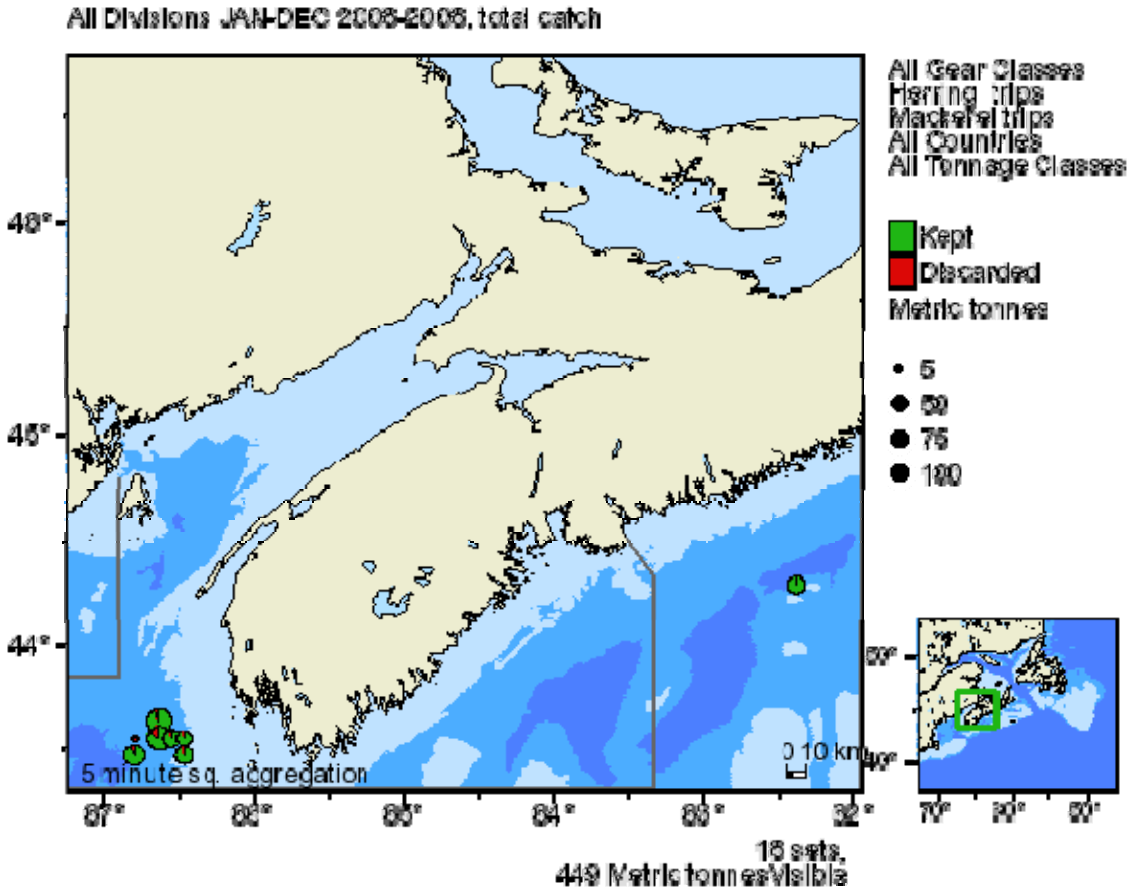


2007 Catch Composition (Metric tonnes)

Species	Kept 2007	Discarded 2007
HERRING(ATLANTIC)	2797.16	0
MACKEREL(ATLANTIC)	0.915	0
REDFISH UNSEPARATED	0.105	0
SHORT-FIN SQUID	0.1	0.05
SILVER HAKE	0.05	0
PORBEAGLE,MACKEREL SHARK	0	1.8

2008 Observer data

- 11 trips, 30 sets monitored, purse seine gear only
- 1 trip in area 4W (Patch area) in June and rest in 4X during July and August
- only herring and dogfish observed; protocols checked and observers will be monitoring catch more closely in 2009 with more trips planned through FAM



2008 Catch Composition (Metric tonnes)

Species	Kept 2008	Discarded 2008
HERRING(ATLANTIC)	406.68	25.226
SPINY DOGFISH	0	17.535