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# 2008 Evaluation of 4VWX Herring

# Évaluation des stocks de hareng de 4VWX en 2008

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## ABSTRACT

Quota landings in 2006/07 were 50,360t against a TAC of 50,000t for the SW Nova Scotia / Bay of Fundy component. The benefits of the reduced quota and other rebuilding measures are now starting to be reflected in the improved biological characteristics of the population. Acoustic biomass estimates in the traditional survey areas for Scots Bay, Trinity Ledge and German Bank increased by approximately 100,000t from 2006. Some conservation objectives specified for this fishery are being met but there are still concerns for spawning areas other than German Bank. This assessment indicates an improvement from the low level of the resource noted in recent assessments.

There was a decrease in landings to 5,400t from the offshore Scotian Shelf banks by purse seine, midwater and bottom trawl. Since the summer bottom trawl research survey is not considered indicative of overall herring abundance, the industry has been encouraged to explore and undertake structured surveys of the offshore area but this has not occurred in recent years.

The recorded landings of 5,300t in 2007 in the four major gillnet fisheries along the coast of Nova Scotia is a decline from 2006. There was a reduction 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 and no herring surveys took place in the Bras d'Or Lakes. The decline in, or lack of, surveyed biomass in three of the major coastal spawning groups is cause for concern.

The latest landings for the 2007 New Brunswick weir and shutoff fishery were 30,900t which is the highest catch for this component since 1993. The number of active weirs with catch increased from the low of 76 in 2005 to 98 in the 2007 season. 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 4WX quota.

## RÉSUMÉ

En 2006-2007, les débarquements se sont chiffrés à 50,360 t par rapport à un TAC de 50 000 t, pour ce qui concerne la composante du sud-ouest de la Nouvelle-Écosse et de la baie de Fundy. On commence à voir les retombées positives de la réduction du quota et des autres mesures de rétablissement sous forme d'amélioration des caractéristiques biologiques de la population. L'estimation de la biomasse à l'aide des relevés acoustiques dans les zones de relevé traditionnelles de la baie Scots, de la chaussée Trinity et du banc German a augmenté d'environ 100 000 t par rapport à 2006. Certains des objectifs de conservation fixés pour cette pêche sont atteints, mais certaines frayères autres que celles du banc German suscitent des préoccupations. Cette évaluation dénote une amélioration par rapport au faible niveau des ressources mentionnées dans les évaluations récentes.

On note une diminution à 5 400 t des débarquements des pêches à la senne coulissante, au chalut pélagique et au chalut de fond pratiquées sur les bancs, au large du plateau Néo-Écossais. Puisque le relevé scientifique d'été au chalut de fond n'est pas jugé indicatif de l'abondance globale du hareng, l'industrie a été encouragée à explorer la zone du large et à y effectuer des relevés, mais cela n'a pas été fait ces dernières années.

Les débarquements déclarés en 2007 (5 300 t) par les pêcheurs au filet maillant des quatre grandes pêches pratiquées le long des côtes de la Nouvelle-Écosse étaient en baisse par rapport à 2006. Le relevé acoustique a fait état d'une diminution de la biomasse dans les régions de Halifax/côte est et de Little Hope depuis l'année précédente. Des relevés ont aussi été effectués près de Glace Bay, mais on constate peu de harengs géniteurs documentés ou de prises déclarées et aucun relevé du hareng dans le lac Bras d'Or. La diminution ou l'absence de relevés de la biomasse de trois des principaux groupes de géniteurs côtiers suscite des préoccupations.

Les plus récents débarquements des parcs à hareng et des sennes de rivage au Nouveau-Brunswick en 2007 totalisaient 30 900 t, soit le total le plus élevé pour cette composante depuis 1993. Le nombre de parcs à hareng actifs pour lesquels des prises sont déclarées est passé d'un minimum de 76 en 2005 à 98 pour la saison de 2007. L'ensemble de ces poissons serait constitué d'un mélange de jeunes, dominés par ceux qui sont issus du segment reproducteur de la sous-zone 5 de l'OPANO, et ils sont par conséquent exclus du quota de 4WX.

## 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 28 cm or 9 to 11 in), 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 and 2006, there were no herring landings in 2007 from the Canadian portion of Georges Bank although some searching of the area did occur by purse seine and midwater trawl vessels (Table 1). This fishery is included in the Gulf of Maine stock complex and was last evaluated in 2006 (DFO 2003a, 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, continued 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 recent years. A major portion of the herring industry (including the purse seine sector and major processors) forms the Herring Science Council (HSC), and some members of the fixed gear sector have undertaken a separate Joint Project Agreement with DFO to undertake collaborative scientific projects. The herring industry has continued to provide biological sampling and samples while the purse seine and gillnet sectors undertook key acoustic surveys. Under the auspices of the HSC a dedicated field biologist also takes part in initiatives such as tagging, a summary of fleet activities and analysis of acoustic records from fishing trips.

In 2007 the HSC biologist was not deployed and the field activities were covered by the HSC manager 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 2-5).

Quota landings in 2006/07 were 50,360t against a TAC of 50,000t for the SW Nova Scotia / Bay of Fundy component (Table 1). There were additional landings of 41,600t in the non-stock components with 5,300t for 'Coastal Nova Scotia', 5,400t for the 'Offshore Scotian Shelf' and 30,900t for the 'SW New Brunswick Migrant Juveniles' for an area total of 91,963t. There was an increased proportion of catches from the New Brunswick weirs in 2007. Landings for the current 2007/08 quota year were 2,084t as of April 1, 2008 (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 6). As a result of the reduced quota, total landings from this component for 2005 to 2007 are 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 7, 8). In 2007, landings by the purse seine sector accounted for 95% of the component catch with minimal landings by the gillnet sector (1,300t) and the Nova Scotia weirs (1,100t). 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 5). Catches by fishing grounds were compared to recent years with the largest proportions coming from the German Bank (15,085t), Gannet Dry Ledge (11,344t) and Grand Manan (10,011t) areas (Table 4, Figure 9). Landings of about 15,100t from the German Bank grounds alone made up about 30% of the purse seine catch. There was an increase in catch from summer feeding areas on the Gannet/Dry Ledge grounds adjacent to German Bank and the fishing grounds southwest of Grand Manan. Catches of non-stock component herring by purse seine came mainly from the offshore Scotian Shelf area (Table 5).

There were 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 either getting fish at dusk or at dawn as the fish go on or off the shore.

Purse seine landings of 850t were reported in Oct.-Nov. 2006 fall fishery and 1,000t in the January 2007 winter fishery (Table 1, Figure 10, 11). The summer purse seine fishery took place in similar areas and months as in previous years with total landings of 46,050t (Table 1, Figure 11). A large part of this fishery was directed on the major spawning grounds in Scots Bay and on German Bank where recent catches are primarily within the pre-defined acoustic survey catch areas (Melvin and Power 1999).

During the 1970's and 1980's, a large purse seine fishery took place on over-wintering aggregations in Chedabucto Bay (Table 3). In recent years however, there has been no fishing effort in this area 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 there has been a small fishery on over-wintering herring in January off Halifax Harbour (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 12). 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 catches recorded (Figure 13). In 2004, the distribution of catches was also more widespread extending both north and east of the innermost strata survey area (Figure 12). The overall catch in 2005 under area restrictions was reduced to 5,870t and included catches to the north and east of the main survey area. The fishing season 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 14). The combination of these factors resulted in fewer vessels fishing in Scots Bay and participating in the surveys and therefore there was less survey and catch information collected about Scots Bay spawning aggregations in 2006.

In 2007 catches of 4,100t in Scots Bay were down from average due to the continued restrictions placed on this area including an overall cap of 5,000t and 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.

German Bank

German Bank is one of the major summer herring purse seine grounds. Catches from these grounds since 1985, ranged from 9,000 to 36,000t during the overall fishery period of early May to late October (Table 7). Catches during the spawning period (defined as August 15 to October 31) have declined since the reduction in the quota in 2003 with about 12,000t landed per year. The percentage of the total German Bank catch taken during the spawning period has actually declined in recent years, but the percent contribution of the German Bank catch to the overall landings has been increasing, reflecting an increased reliance on this area (Table 7, Figure 15).

Catches in 2006 for the pre-spawning period prior to Aug. 15 were unusual in that they were concentrated mostly within the defined survey box area (Strata area). This differed from 2000 to

2005 when catches were more widely scattered over a larger area (Figure 16). In 2007 catches were more widely distributed than in 2006 with locations mostly to the north and northwest of the defined strata area. The catch distributions were still more concentrated than in the past.

Catches during the spawning period in 2007 within the Strata area were similar to those of 2005 and 2006 with two localized groups of spawning herring found and documented during surveys. In 2007 very little herring were caught north of the spawning area box during the spawning period as seen in previous years (Figure 17). These northern scattered groups have been usually shown from sampling to be pre-spawning or juvenile sized herring while those within the strata area are almost always confirmed to be spawning fish.

Daily catches in 2006 and 2007 were spread out through the spawning season with an early cluster of catches from mid to late August, which was not seen in 2004 or 2005 (Figure 18). The daily landings at the end of the season were reduced compared to recent years, likely due to the restricted quota nearly being reached, with totals of less than 500t per day.

Trinity Ledge

The Trinity Ledge spawning ground is considered to be still recovering and is closed to purse seine gear from Aug. 15 to Sept. 15. In 2007 there were acoustic surveys and catches by drift gillnet gear only. The 2007 herring gillnet fishery on Trinity Ledge took place between Aug. 27 and Sept. 20 with total reported landings of 1,091t with most of the catch from a small localized area (Figure 19). The total catch for this area has increased over the past few years and this year was the highest since 2001 (Table 3). The daily landings in 2007 were quite different from those in 2006 with two distinct pulses of catch peaking on Aug. 29 and Sept. 18 (Figure 20). There was continuous daily searching of the grounds reported between these two peaks but there was little or no catch.

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 may or may not occur in any given year.

This fishery has been quite variable in recent years with catches from 0 to 700t and acoustic surveys documenting up to 1,400t. In June 2005 124t of catch were recorded and a single survey estimated a total biomass of only 292t in an area of 0.57 $km^2$. In June 2006 landings were minimal in the Spectacle Buoy area with less than 10t reported and no surveying was completed. Acoustic surveys of Spectacle Buoy were also completed during the fall 2006 spawning season but documented no herring.

The 2007 herring gillnet fishery in the Spectacle Buoy fishing area occurred from May 27 to June 22, 2007 with total landings of 243t (Figure 21). This was a roe fishery on spring spawning herring with fish reported to be in spawning condition. No samples were available for size or maturity condition of the fish. Three acoustic surveys were completed which documented a total survey biomass of 310t which was only equivalent to the amount landed.

Nova Scotia weirs

The 2007 catches of 1,130t in the Nova Scotia weirs were below average after some improvement in recent years (Table 8; Figure 22). The annual variation in catch has been attributed to problems in availability of fish to this fixed stationary gear as there are usually substantial purse seine catches in the nearby Long Island area on the Bay of Fundy side of Digby Neck. There was a reduction in the amount and proportion of purse seine catch in the Long Island area in 2007 but this was attributed to better availability in areas closer to the fleet's home markets and not to lack of fish. The seasonal timing of the Nova Scotia weir landings has also shifted to the later months of the season in recent years with a higher proportion of landings now in August and September, compared with the traditional early fishery seen in May and June previous to 2000 (Table 8). Catches in recent years for the Nova Scotia weirs have been highly variable 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 6-10 active weirs in the last decade and the catch per weir (t) for the Nova Scotia weir fishery was also below average in 2007 (Table 9).

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 amount and variable timing and location of catch and effort (Power et al., 2004). This trend of reduced catch and effort remains and so this data was not reexamined in 2007.

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 reflecting changes in the TAC (Table 10, Figure 23). The overall number of boats fishing and days fished has been dropping since 1990 due to fleet rationalization. This has likely resulted in increases in catch per boat and catch per day in recent years. 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 schools. Catch rates 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 2007 a total of 10 individual surveys were completed within the Bay of Fundy/SW Nova Scotia stock component (Power and Melvin, 2009).

A major source of uncertainty continues to be the assumption that the results of the surveys are additive. However, if herring do not move 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. Other significant issues relate to the survey area, 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 (Melvin et al 2004). 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 has yet to be completed.

Similar to most previous years, four surveys were conducted in Scots Bay in 2007. The duration of the spawning fishery period in Scots Bay was extended through the entire 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 at the end of the season which was not included in the estimates. The duration of the spawning fishery on German Bank was similar to previous years but ended in early October due to the lack of quota. Additional acoustic data from fishing nights on German Bank were examined but not included in the overall biomass estimate. Individual survey area coverage was satisfactory as well as being consistent with established protocols.

The amount of spawning fish documented on Trinity Ledge was extremely low but survey coverage was improved. There were no surveys and no reports of spawning herring around Seal Island and Browns Bank grounds. A small spawning fishery occurred near Spectacle Buoy in June with limited survey effort. Biomass estimates in the traditional survey areas for Scots Bay, Trinity Ledge and German Bank were approximately 45,700t, 1,400t, and 337,200t respectively for an estimated total SSB of 384,400t which is an increase of approximately 100,000t from 2006 (Table 11). The 2007 overall SSB estimate is below the long term average.

While the acoustic biomass signal is greater than in 2006, it still remains below the average for 1999-2007 (Figure 24). The overall biomass index estimated from acoustic surveys in 2007 represents an increase of 28% since 2006. The index from acoustic surveys has increased by 64% over the last two years and is at a moderate level, 12% below the average of the nine year series.

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 the 2002 fishing season. The results are summarized by Melvin et al. (2003, 2004, Power et al. 2005) and were used to assist in the evaluation of turnover timing and 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 Pelagics Science 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 even 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 to avoid double sampling. 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 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 relative exploitation rates on the different spawning groups and for the overall complex. 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 12). 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 can 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 Seal Island and Spectacle Buoy were also allocated to the German Bank spawning area. All catches throughout the year from each spawning ground were assumed to be site specific (Table 12-C1), while catches from other areas were allocated based on the relative spawning ground SSB proportions from annual acoustic surveys (Table 12-A2, C2). Exploitation rates were calculated from both the actual catch on the spawning grounds and the overall adjusted catch as straight proportions (Catch / SSB) (Table12-E1, E2).

Calculation of exploitation rates by component since 1999 (Table 12-E2) showed that the larger grounds (German Bank and Scots Bay) had an average exploitation of 15 to 23% while Trinity Ledge was much higher at 56%. Individual values for specific years and areas were highly variable (from 12 to 146%) and this is attributed to inconsistent survey effort, especially for the

Trinity Ledge area over the period. These data show a trend of overall declining exploitation rate since 2005. Fishing mortality cannot be specifically determined but appears to be decreasing based on the trends of relative exploitation rates from acoustic surveys. (Figure 25).

Biological Sampling

Comprehensive biological sampling continued with substantial involvement of the fishing industry. In 2007 a total of 1,315 samples (145,200 fish) were measured for length while 4,620 fish were sampled for sex, weight, maturity and age (Table 13). The sources of the samples are shown in Table 14, 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 was well matched to the spatial and temporal distribution of the fishery. Additional sampling from research vessel surveys during the spring and summer resulted in widespread geographic coverage as in the past (Figure 26).

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). The impact of these comparisons will be further investigated, but it is unlikely they will be resolved until the winter of 2008/09 (DFO, 2007). In the interim any analysis using age data is considered unreliable and other approaches will be applied (Melvin and Power, 2007).

An internal review in 2007 of the 4VWX herring ageing by Dr. Stephen Campana of the Bedford Institute of Oceanography recommended two new studies be undertaken: a Bomb Radiocarbon (BRC) age validation study of a small number of otoliths and a study to track a dominant year class as it moved through the fishery. A Canada/USA workshop was held in January of 2008 to discuss the ageing issues and the preliminary findings of these studies. The results of these studies confirmed that there were major inconsistencies in the ageing of herring amongst the readers and in the historical database. The degree of difference varied depending upon the reader. Each institute must examine the extent of these inconsistencies, identify their potential impact, and determine a course of action to overcome this problem. The current 4VWX otolith reader has consistently under aged the test otoliths, relative to the other readers and the database. 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, the 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 (e.g., preproduction testing, and random comparisons with a second reader). However, although these practices will improve the ageing in future years, they will not correct the past. It is therefore likely that a significant number of the 4VWX herring otoliths will have to be re-read following the new protocols and quality control procedures. At a minimum it is recommended that the otoliths be re-read back to 1997 and preferably back to the late 1980's. Not all previously read otoliths need to be re-read – a sub-sample should be sufficient. 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 are to be completed by December 2008, as planned under the current Framework Review (DFO 2007). This will, however, depend upon the availability of a reader and procurement of new equipment, including a variable zoom binocular microscope, image analysis system and software to annotate and catalogue the images.

Catch at Age

Consistent with previous assessments, the catch at length and age was constructed using the 'Catch at Age' application (version 10.4) 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 in 2007 the catch at age was not available. Runs were made using the 2005 ages as the default in order to create catch at length keys for use with the analysis. 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 and monthly age-length keys were applied to length frequencies to produce catch at length statistics by NAFO unit area, 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 in recent years and has been dominated by ages 2 through 4 since 1998 (Table 15, Figure 27). Since 1995 the series is 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. The rapid decline of year-classes (including the presumed moderately strong 1998 year-class) implies a high total mortality (Power et al, 2006a).

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 28). This indicator has declined from an average fish weight of 130 to 180g in the 1980's and 1990's to an average fish weight of about 90g 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 2007 average size near the long term average of 125g. The total removals of fish by numbers have also been reduced by close to 50% in 2005/2007 relative to 2004 (Table 16, Figure 28).

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.

In 2006, the catch at length was composed of 35% <23cm (size of 50% mature), 63% from 23 to 30cm and 1.7% for sizes larger than 30cm (Table 16, Figure 29). In 2007 the catch at length size composition was comprised of 46% fish less than 23cm, 49% fish 23 to 30cm and 5% sizes larger than 30cm.

The 1992 catch at length was 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 16, Figure 30).

There has been a recent increase of older/larger fish in the catch but the percentage is well below pre-1999 levels (Figure 30). The number of smaller fish in the catch (less than 23cm) was similar to other years. Small fish were seen in abundance in both the stock fishery and in New Brunswick weirs suggesting a strong year-class. The proportion of the catch greater than 30cm increased in 2007 to 5% from 2% in 2006.

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, has allowed the proportion of adult fish from 23 to 30cm to increase (Figure 30).

Growth trends for 2006-2007

Length frequency samples from the 2006/2007 herring fishery suggested that there was a substantial increase in the percent of fish >30cm. Given what we know about herring growth it has been asked if the increase in frequency of large fish can be attributed to growth. In other words, could the size distribution of herring observed in 2007 be obtained by the 2006 fish growing or must other factors be considered (e.g. immigration from elsewhere or targeting on larger sizes).

Examination of the catch weighted length frequency distribution from the Southwest Nova Scotia and the Bay of Fundy fishery (SWNS/BOF) clearly illustrated a forward modal progression in the size of mature fish from 2004 to 2007 (Figure 31). In 2004 the fish were approximately 24-26 cm and by 2007 these fish had grown to approximately 28-30 cm. The percent of herring greater than or equal to 30 cm showed a trend of increase but remained around 3% until 2007. The percent of herring ≥30cm was 3.3%, 2.7%, 3.4% and 9.9% respectively in 2004, 2005, 2006, and 2007.

While the progression observed in the overall length frequency distribution of SWNS/BOF appeared to be consistent with growth there was a general feeling that the increase in larger herring observed on the spawning grounds might not be accountable simply by growth and that the observed increase in the percentage of herring ≥ 30 cm might not have been achievable in a single year. A generalized herring growth model was therefore used to determine if the observed increase in size could be achieved through natural process.

The program FISAT II (Version 1.2.2) from FAO_ICLARM (Gayanilo et al. 2005) was used to estimate the growth parameters ($L_{inf}$, K, and $t_0$) of Atlantic herring collected in southwest Nova Scotia during the month of September. Because of the uncertainty with ages the growth parameters were estimated for each year from 1980 to 2005 to explore the range of possible values observed over the past 25 years. Several options are available in the software to best fit

the growth equation. In this case we selected to iterate either using a fixed $t_0$ or a floating $t_0$. The former fixes $t_0$ as 0 forcing the curve x-intercept through 0 and the latter allows $t_0$ to be estimated for the best fit to the observations (Figure 32). When $t_0$ is allowed to float more variability is observed in the growth rate but there is still a major shift that occurs between 1999 and 2000 that may be due to ageing inconsistencies. The Von Bertalanffy growth equation equals:

$$L_t = L_{inf}\,(1\text{-}e^{-K(t-t_0)})$$

where:

t = time in years
$t_0$ = age of fish at 0 length
$L_t$ = length at time t
$L_{inf}$ = theoretical maximum length
K = growth constant

In summary there was a general declining growth rate from 1982 to 1999 for both the fixed and the floating $t_0$ estimates of "K". The parameter estimation for K with the fixed $t_0$ was chosen in the final analysis due to the reduced variability for the time series while showing a similar trend.

Using the von Bertalanffy growth equation and the length frequency from 2006, the number of fish for each 0.5cm length interval in 2007 was estimated using K = 0.38 (fixed $t_0$) and $L_{inf}$ = 344mm. The graph clearly indicated that it was possible to move from the length frequency observed in 2006 to the length frequency observed in Southwest Nova in 2007 using the average growth parameters from 1980 to 1999 (Figure 33). If the growth parameters from the most recent period (2000-2005) were used to estimate the 2007 length increment, it was unlikely that the 2007 length frequency for fish ≥30cm could be achieved since a relatively small proportion of the fish >31.5 cm was predicted. In the extreme case of using the 2000 growth parameters to estimate length, it was virtually certain that the 2007 length distribution of larger fish could not have been obtained.

In summary, it was concluded that the observed increase in the percent of herring greater than or equal to 30 cm could be achieved by annual growth of SWNS fish if we assumed the average growth rate observed between 1980 and 1999. However, using the growth rates estimated for the most recent years (2000-2005) it is unlikely that growth alone could account for the increased proportion of larger fish. Given the inconsistencies observed in the ageing it is unlikely these growth rates have increased to the levels estimated for the period 2000 to 2005.

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.

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. The expected increase in the SSB due to the reduced quota since 2005 is now being observed in the surveys.

There are several positive signals for this component. Fishing mortality was not determined but appeared to be decreasing based on the trends from relative exploitation rates from acoustic surveys. There are indications that a strong year-class may be 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. There has also been an increase in acoustic survey biomass in recent years, but the stock biomass at 384,400t remains below historical levels (average of 427,600t since 1999).

### 2.3 Sources of Uncertainty

There are several sources of uncertainty in this assessment that need to be considered. 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 are signs of a strong incoming year-class with substantial numbers of smaller fish (between18-23cm) in the 2007 catch but the strength of this year-class is still unknown.

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

### 2.4 Ecosystem Considerations

Herring is a keystone forage species prominent in the diet of many fish, seabirds and marine mammals, and should be managed with these interactions in mind. At present, use of a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

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

In the previous assessment an evaluation of progress in recent years against biological objectives in the management plan indicated that most objectives were not being met (Table 17) (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 normal, unlike 2005, but there was a mid-season gap in spawning in Scots Bay. Fishing mortality was considered likely high and well above $F_{0.1}$ and the SSB near the lowest recorded level since 1999 from acoustic surveys.

The objectives for this stock from the management plan and the current observations are summarized for the 2007 fishing season (Table 18). Some conservation objectives specified for this fishery are being met but there are still concerns with all spawning areas other than German Bank which is considered at or above average biomass.

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, 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.

The potential benefits of the reduced quota and other rebuilding measures from 2005 through to 2007 are now starting to be reflected in the improved biological characteristics of the population. This current assessment indicates an 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. Despite the increase in acoustic SSB and the improved proportion of larger fish, 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 34). 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 (Figure 35). 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 2007, the size composition of the catch was very similar to previous years: mostly adult fish >23cm (50% maturity at length) with a substantial proportion (27%) larger than 30cm (Figure 36). Biological sampling from the catches found fish in the early ripening maturation stages (stage 3 and 4) with good fat content of 12 to 15.5%.

### 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 2007.

July Bottom Trawl Survey

Previous results from the summer research bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's 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 high in the previous year (Table 19, Figure 37). In 2006 this index increased slightly but then declined again in 2007 to the lowest value since 1993. The strata areas used for selection of trawling stations in this bottom trawl survey series are shown in Figure 38 (Doubleday 1981). Herring catches from the 2007 summer survey were again widely distributed on banks west of Sable Island but were less abundant compared to the last seven years (Figure 39, 40). Size distribution of catches from the research trawl survey shows a distribution similar to that seen in the catch with a large proportion greater than 30cm (Figure 41).

The summer bottom trawl research survey which previously demonstrated considerable abundance and distribution of herring widely spread over the Scotian Shelf, has declined substantially 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. The bottom trawl data, while useful for documenting size, maturity and distribution, are not considered indicative of overall herring abundance.

Fall Herring Research Survey

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

### 3.3 Outlook and Management Considerations

There continues to be insufficient documentation of stock size, distribution and spawning behavior for this component. There have been no industry surveys of the offshore Scotian Shelf area 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 2008 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, participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol. This was the twelfth year for a fishery on spawning fish off Halifax/Eastern Shore and the eleventh year of gillnet roe fisheries off Little Hope/Port Mouton and Glace Bay.

The recorded landings of 5,300t in 2007 in the four major gillnet fisheries along the coast of Nova Scotia declined from 2006 (Table 20) (Figure 42). They were much lower for the Little Hope/Port Mouton area, slightly higher for the Eastern Shore area, and minimal for Glace Bay, while the Bras d'Or Lakes area remained closed.

Little Hope/Port Mouton

The 2007 herring gillnet fishery in the Little Hope/Port Mouton fishing area took place primarily during a one week period between Oct. 16 and Oct. 23, 2007 with total landings of 1,506t (Figure 43). This is primarily a roe fishery with catches from two main areas, near Little Hope Island and east of Liverpool. The 2007 fishery was unusual in comparison to the previous year in that the fishery started late, most catches were recorded off Liverpool, and few herring were caught or recorded near Little Hope Island. The start of the spawning fishery was also delayed by nearly 2 weeks compared to 2006 with few catches before mid-October. The roe fishery finished on Oct. 23 but there continued to be small amounts landed for bait.

Acoustic surveys were completed on Oct. 18, Oct. 21 and Nov. 18 with both the schools and the area between schools surveyed (Power and Melvin, 2009). 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 2007 season for the larger night of Oct. 18 and Nov. 18 resulted in a total estimate of 2,780t with the calibration integration factor (CIF) or 2,390t without the CIF (Table 21-22, Figure 44).

The total biomass of 2,780t is the lowest recorded since spawning surveys began in 1998 and the total catch was close to the total amount surveyed. The lack of fish documented, in particular around Port Mouton Island, rather than the issue of double counting and turnover rates on the spawning grounds is the primary issue. The fishery ended just after the second survey and sampling showed the presence of spent fish, indicating that the surveys may have occurred after the peak abundance and that the fish may have already spawned and were moving away. It is also possible that there were very few fish around to document. The fact that no significant amounts of herring were documented near Port Mouton Island over the entire season and that the total biomass surveyed was only slightly more than the amount of catch recorded is cause for concern.

East of Halifax (4W Eastern Shore)

The 2007 herring gillnet fishery in the Eastern Shore fishing area began on Sept. 25 and ended on Nov. 20 with total landings of 3,727t (Figure 45). 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 catch and duration were similar to those of 2006 with daily landings of 150-300t and majority of catches occuring by mid October. There was no landings after October 23 except on November 20-21 when about 60t were caught and a survey completed near the Halifax Harbour area.

In 2006 the total SSB estimated from the three surveys was 51,100t which was a substantial increase since 2005. In 2007 surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, N.S. on October 2, October 8, October 22 and November 20 (Power and Melvin, 2009). The overall estimates are 28,280t with the CIF and 24,040t without the CIF. In 2007 there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50% from the previous year (Table 21-22, Figure 46). This was attributed by industry representatives to a lack of survey effort in the Eastern Passage area and high turnover rates on the spawning grounds.

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 (Figure 47). 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 (Power and Melvin, 2009). The overall biomass estimate (taken as the sum of the surveys) is 240t with the CIF and 110t without the CIF (Table 21-22, Figure 48).

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 2007 there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50% from the previous year (Table 21-22, Figure 46). The Little Hope area saw an even larger decline of almost 90% from the previous year (Table 21-22, Figure 44). There were no significant amounts of herring documented over the entire season on the normal spawning area near Port Mouton Island and the total biomass surveyed was only slightly more than the recorded catch. Surveys were also completed near Glace Bay but few spawning herring were documented and only 5t of landings were reported. (Figure 48). No herring surveys took place in the Bras d'Or Lakes.

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. As in the past five years, it is recommended that no coastal spawning areas experience a large effort increase 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.

The decline in or lack of surveyed biomass of all three major coastal spawning groups is cause for concern. Recent management of these areas has used a five year average of recent catches and/or surveyed acoustic biomass to set removal levels. The provision to document sufficient quantities of fish each year before the fishery begins has been waived recently due to substantial abundances from previous years. It is recommended that given the current situation of declining biomass in all areas the "survey, assess, then fish" protocol should be reinstated.

## 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 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 (Table 1, 3, 8-9) (Stephenson, 1990). In 2003 there was a large drop in landings in the traditional New Brunswick weir and shutoff fishery to 9,000t - the lowest landings since 1983 – and there was concern expressed for this fishery. In 2004 weir landings increased to 20,600t, while in 2005 landings again decreased to 13,055t (Table 3). In 2006 landings remained low with about 14,100t recorded for the New Brunswick weir and shutoff fishery. The size of herring caught in 2006 was abnormally small throughout the season and this impeded markets.

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 latest landings for the 2007 New Brunswick weir and shutoff fishery were 30,921t which is the highest catch for this component since 1993 (Figure 49, 50). The size composition of herring caught was well suited to the sardine market and was primarily of juvenile size with 95% by number less than 23 cm (the size used to separate juveniles and adults) (Figure 51). This also confirms the presence of the large 2005 year-class which was observed in high numbers in the previous season as small unmarketable fish. The number of active weirs with catch increased to 98 in the 2007 season from the low of 76 in 2005.

### 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 2006-2007 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 (2006) | | | | | | | | | | 697 | 149 | | 846 |
| | 4X | Winter P. Seine (2007) | 1,001 | | | | | | | | | | | | 1,001 |
| | 4X | Summer P. Seine (2007) | | | | | 371 | 4,860 | 16,231 | 9,460 | 12,035 | 3,088 | | | 46,045 |
| | 4X | Gillnet "Stock" | | | | | 0 | 243 | | 477 | 614 | | | | 1,334 |
| | 4X | N.S. Weirs | | | | | 26 | 11 | 290 | 579 | 224 | | | | 1,130 |
| **S.W. Nova Scotia Total** | | | 1,001 | - | | | 398 | 5,114 | 16,521 | 10,516 | 12,873 | 3,785 | 149 | - | 50,356 |
| **Coastal Nova Scotia** | 4Vn | Trap | | | | | 3 | 35 | | | | | | | 38 |
| (South Shore, | 4Vn | Glace Bay Gillnet | | | | | 1 | 1 | | | 5 | | | | 7 |
| Eastern Shore, | 4W | Eastern Shore Gillnet | | | | | | | | | 436 | 3,230 | 61 | | 3,727 |
| Cape Breton) | 4X | Little Hope Gillnet | | | | | | 1 | | 1 | 7 | 1,496 | 1 | | 1,506 |
| **Coastal Nova Scotia Total** | | | | | | | | 37 | - | 1 | 449 | 4,726 | 62 | | 5,278 |
| **Offshore Scotian Shelf** | 4WX | Offshore P. Seine | | | | | 540 | 2,074 | 121 | | | | | | 2,735 |
| | 4WX | Midwater Trawl | | | | | 797 | 1,772 | | | | | | | 2,569 |
| | 4WX | Bottom Trawl + Misc. | 1 | 0 | 0 | 3 | 19 | 13 | 11 | 6 | 5 | 14 | 8 | 0 | 81 |
| **Offshore Scotian Shelf Total** | | | 1 | 0 | 0 | 3 | 1,356 | 3,859 | 132 | 6 | 5 | 14 | 8 | 0 | 5,385 |
| **S.W. New Brunswick** | 4X | N.B. Weirs | 182 | | 20 | 30 | 84 | 633 | 3,241 | 11,363 | 7,637 | 6,567 | 314 | 73 | 30,145 |
| **Migrant Juveniles** | 4X | N.B. Shutoff | | | | | | | | 107 | 103 | 589 | | | 799 |
| **S.W. New Brunswick Migrant Juveniles Total** | | | | | | | 84 | 633 | 3,241 | 11,471 | 7,740 | 7,156 | | | 30,944 |
| **Georges Bank** | 5ZE | 5Z Purse Seine | | | | | | | | | | | | | - |
| | 5ZE | Midwater Trawl | | | | | | | | | | | | | - |
| **Georges Bank Total** | | | | | | | | | | - | - | | | | - |

| Total 2006-2007 | 91,963 |
|---|---|

Table 2. 4WX herring fishery landings (t) by month and gear sector for 2007-2008 quota year (as of April 1, 2008).

| | Area | Gear | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2007-08 quota year** | 4X | Fall 2007 P. Seine | | | | | | | | | | 1,087 | 538 | | 1,626 |
| | | Winter 2008 P. Seine | 457 | | | | | | | | | | | | 457 |
| **2008 Calendar year** | 4WX | Bottom Trawl | 1 | - | | | | | | | | | | | 1 |
| **2007-08 Total** | | | 458 | - | - | | | | | | | 1,087 | 538 | | 2,084 |

Table 3. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2007 (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 |

^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 4. Herring purse seine catches (t) and percentage by fishing ground areas from 1985 to 2007 for the 4WX stock component.

**a) Herring purse seine catches (t) by grounds for the 4WX stock area from 1985-2007.**

| Stock Areas | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | All Series Avg 85-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Browns Bank | | 732 | | | | | | 86 | | 1,903 | 1,554 | 40 | 14 | 3,139 | 2,197 | 1,137 | 486 | | | 45 | | 88 | 34 | 831 |
| 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 | | 1,583 | 1,151 | 10 | | | | | | | | 4,521 |
| 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 | 4,590 | 4,156 | 10,296 | 12,674 | 3,877 | 9,047 | 6,965 | 4,456 | 3,117 | 6,764 | 11,344 | 6,251 |
| 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 | 13,576 | 20,556 | 24,660 | 25,631 | 24,139 | 22,355 | 21,573 | 14,175 | 14,171 | 16,522 | 15,085 | 16,314 |
| 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 | 5,312 | 15,983 | 7,912 | 18,185 | 10,545 | 17,753 | 17,258 | 7,542 | 5,740 | 7,716 | 10,011 | 7,958 |
| 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 | 3,557 | 12,360 | 18,286 | 11,199 | 12,904 | 6,642 | 12,639 | 13,115 | 8,037 | 1,884 | 4,604 | 8,900 |
| Lurcher | 476 | 132 | | 2,928 | 18 | 65 | 151 | 2,141 | 1,560 | 530 | 382 | 243 | 599 | 57 | | 715 | 227 | 7,683 | 1,872 | 7,268 | 1,692 | 2,809 | 2,305 | 1,663 |
| N.B. Coastal | 188 | 621 | 960 | 1,031 | 3,033 | 2,347 | 488 | 992 | 598 | 99 | 1,502 | 271 | 1,176 | 782 | 1,867 | 361 | 1,250 | 3,113 | 3,914 | 2,707 | 787 | 1,889 | 851 | 1,357 |
| Pollock Point | | | | | | | | | | | | | | | | | 1,563 | | | | | | | 1,563 |
| S.W. Grounds | 558 | 1,108 | 184 | 181 | 276 | 56 | 521 | 225 | 2,961 | 3,444 | 6,205 | 3,035 | 797 | 1,239 | 3,241 | 1,879 | 53 | 791 | 73 | | 1,228 | 1,206 | 30 | 1,320 |
| Scots Bay | | 36 | 3,822 | 4,145 | 6,583 | 9,003 | 7,982 | 7,987 | 5,258 | 10,840 | 980 | 8,984 | 4,894 | 8,210 | 1,789 | 10,926 | 10,739 | 8,202 | 19,196 | 24,869 | 6,239 | 3,352 | 4,116 | 7,735 |
| 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 | 492 | 617 | 567 | 206 | 101 | 238 | 1,096 | | 1,358 | 209 | | 6,337 |
| Trinity | 35,860 | 13,505 | 18,744 | 18,539 | 266 | 1,113 | 3,259 | 4,612 | 1,348 | 2,366 | 370 | 3,448 | 5,308 | 2,825 | 1,220 | 103 | 113 | 1,609 | | 370 | 1,448 | 3,725 | 112 | 5,284 |
| Yankee Bank | | | | 194 | 250 | 3,647 | 817 | 119 | 10 | 175 | 323 | 9 | 4 | 159 | 82 | 133 | 8 | 78 | | | 528 | 2 | 62 | 354 |
| Unknown | 184 | 500 | 200 | | | 200 | 579 | 494 | 140 | | 73 | | | 62 | 84 | 27 | | | 1,103 | 127 | 181 | 396 | 39 | 273 |
| 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 | 40,319 | 71,727 | 73,350 | 83,186 | 66,005 | 77,511 | 85,689 | 74,674 | 44,526 | 46,561 | 48,594 | 65,868 |

**b) Herring purse seine catches as percentage by grounds for the 4WX stock area from 1985-2007.**

| Stock Areas | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | All Series Avg 85-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Browns Bank | | 1% | | | | | | 0% | | 4% | 3% | 0% | 0% | 4% | 3% | 1% | 1% | | | 0% | | 0% | 0% | 1% |
| Chedabucto Bay | 5% | 13% | 9% | 7% | 11% | 13% | 15% | 5% | 5% | 3% | 4% | 4% | | 2% | 2% | 0% | | | | | | | | 4% |
| Gannet,Dry Ledge | 7% | 4% | 2% | 15% | 3% | 4% | 8% | 32% | 11% | 5% | 5% | 4% | 11% | 6% | 14% | 15% | 6% | 12% | 8% | 6% | 7% | 15% | 23% | 10% |
| German Bank | 19% | 23% | 23% | 18% | 10% | 12% | 28% | 6% | 15% | 19% | 40% | 33% | 34% | 29% | 34% | 31% | 37% | 29% | 25% | 19% | 32% | 35% | 31% | 25% |
| Grand Manan | 6% | 10% | 6% | 4% | 5% | 6% | 5% | 5% | 3% | 14% | 11% | 13% | 13% | 22% | 11% | 22% | 16% | 23% | 20% | 10% | 13% | 17% | 21% | 12% |
| Long Island | 1% | 6% | 10% | 11% | 28% | 20% | 12% | 6% | 10% | 15% | 16% | 9% | 9% | 17% | 25% | 13% | 20% | 9% | 15% | 18% | 18% | 4% | 9% | 13% |
| Lurcher | 1% | 0% | | 3% | 0% | 0% | 0% | 4% | 6% | 1% | 1% | 1% | 1% | 0% | | 1% | 0% | 10% | 2% | 10% | 4% | 6% | 5% | 2% |
| N.B. Coastal | 0% | 1% | 1% | 1% | 4% | 2% | 1% | 2% | 2% | 0% | 3% | 1% | 3% | 1% | 3% | 0% | 2% | 4% | 5% | 4% | 2% | 4% | 2% | 2% |
| Pollock Point | | | | | | | | | | | | | | | | | 2% | | | | | | | 0% |
| S.W. Grounds | 1% | 2% | 0% | 0% | 0% | 0% | 1% | 0% | 11% | 7% | 13% | 6% | 2% | 2% | 4% | 2% | 0% | 1% | 0% | | 3% | 3% | 0% | 2% |
| Scots Bay | | 0% | 5% | 4% | 8% | 10% | 10% | 14% | 19% | 22% | 2% | 19% | 12% | 11% | 2% | 13% | 16% | 11% | 22% | 33% | 14% | 7% | 8% | 12% |
| Seal Island | 17% | 15% | 16% | 19% | 30% | 27% | 15% | 18% | 14% | 6% | 1% | 3% | 1% | 1% | 1% | 0% | 0% | 0% | 1% | | 3% | 0% | | 8% |
| Trinity | 43% | 23% | 26% | 18% | 0% | 1% | 4% | 8% | 5% | 5% | 1% | 7% | 13% | 4% | 2% | 0% | 0% | 2% | | 0% | 3% | 8% | 0% | 7% |
| Yankee Bank | | | | 0% | 0% | 4% | 1% | 0% | 0% | 0% | 1% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | | | 1% | 0% | 0% | 0% |
| Unknown | 0% | 1% | 0% | | | 0% | 1% | 1% | 1% | | 0% | | | 0% | 0% | 0% | | | 1% | 0% | 0% | 1% | 0% | 0% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 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 area from 1985 to 2007 from non-stock component areas.

**a) Herring purse seine catches (t) by grounds for non-stock component areas from 1985-2007.**

| Non-stock Areas | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | All Series Avg 85-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Georges Bank | | | | | | 91 | 64 | | | 266 | | 2,491 | 79 | | | 265 | | | | | | | | 503 |
| Liverpool | | | | | | | 13 | | 4,067 | 4,177 | | | | | | | | | | | | | | |
| Shelburne | | | 59 | | | | 64 | | 526 | 161 | | 56 | | | | | | | | | 29 | | | 115 |
| Halifax | | | | | | | | | 652 | 1,945 | | 585 | 455 | | | 1,002 | 472 | 367 | | | | | | 660 |
| Offshore Banks | | | | | | | | | | | | 11,800 | 18,770 | 4,284 | 8,669 | 1,645 | 3,977 | 5,078 | 722 | 4,054 | 4,115 | 4,846 | 2,515 | 5,319 |
| Western Hole | | 41 | 154 | | | | 213 | 3,451 | 2,255 | 1,495 | 108 | 127 | 691 | 1,012 | 1,057 | 47 | 7,712 | 1,884 | 156 | | 214 | 192 | 220 | 1,180 |
| Sydney Bight | 3,511 | 4,250 | 1,751 | 2,100 | 1,330 | 3,591 | 3,606 | | 396 | | 3,951 | 4,267 | | 52 | | | | | | | | | | 2,405 |
| Nonstock Total | 3,511 | 4,291 | 1,964 | 2,100 | 1,330 | 3,682 | 3,959 | 3,451 | 7,896 | 8,044 | 4,059 | 19,325 | 19,995 | 5,348 | 9,726 | 2,958 | 12,161 | 7,329 | 878 | 4,054 | 4,358 | 5,038 | 2,735 | 5,985 |

**b) Herring purse seine catches as percentage by grounds for non-stock component areas from 1985-2007.**

| Non-stock Areas | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | All Series Avg 85-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Georges Bank | | | | | | 2% | 2% | | | 3% | | 13% | 0% | | | 9% | | | | | | | | 1% |
| Liverpool | | | | | | | 0% | | 52% | 52% | | | | | | | | | | | | | | 4% |
| Shelburne | | | 3% | | | | 2% | | 7% | 2% | | 0% | | | | | | | | | 1% | | | 1% |
| Halifax | | | | | | | | | 8% | 24% | | 3% | 2% | | | 34% | 4% | 5% | | | | | | 4% |
| Offshore Banks | | | | | | | | | | | | 61% | 94% | 80% | 89% | 56% | 33% | 69% | 82% | 100% | 94% | 96% | 92% | 43% |
| Western Hole | | 1% | 8% | | | | 5% | 100% | 29% | 19% | 3% | 1% | 3% | 19% | 11% | 2% | 63% | 26% | 18% | | 5% | 4% | 8% | 14% |
| Sydney Bight | 100% | 99% | 89% | 100% | 100% | 98% | 91% | | 5% | | 97% | 22% | | 1% | | | | | | | | | | 33% |
| Non-stock Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Table 6. Summary of 1987 to 2007 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 |

Table 7. Summary of 1985 to 2007 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% |

Table 8. Monthly weir landings (t) for weirs located in New Brunswick and Nova Scotia; 1978 to 2007.

| | | MONTH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROVINCE | YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 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 |
| NB Average Catch (t) | | 160 | 34 | 9 | 38 | 134 | 340 | 3,745 | 8,587 | 5,796 | 3,180 | 706 | 127 | 22,356 |
| 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 |
| NS Average Catch (t) | | | | | 5 | 385 | 1,088 | 868 | 596 | 201 | 72 | 65 | 79 | 3,128 |

Table 9. 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 2007.

| | 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 |
| Average | 22,356 | 3,128 | 25,484 | 126 | 16 | 141 | 178 | 215 | 182 |

Table 10. Purse seine effort, catch and CPUE levels for 1989 to 2007.

| 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 |

Table 11. 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, 2009)

| **Location/Year** | 1997* | 1998* | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 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 | 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 | 7,044 |
| German Bank (in) | 370,400 | 440,700 | 460,800 | 356,400 | 190,500 | 393,100 | 343,500 | 367,600 | 211,000 | 245,500 | 337,200 | 322,844 |
| - German (out) | | | | | | | | | | 4,100 | | 4,100 |
| Spectacle Buoy | | | | | | | | | | | | |
| - Spring | 15,000 | 1,300 | 0 | 0 | 1,100 | | 1,400 | n/s | 300 | n/s | 100 | 483 |
| - Fall | | | | | 87,500 | | | | | **0** | **0** | 29,167 |
| Sub-Total | 568,600 | 521,300 | 505,700 | 463,300 | 457,800 | 542,200 | 493,300 | 481,700 | 233,200 | 286,700 | 384,400 | 427,589 |
| 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 | 384,400 | 436,100 |
| 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 | 69,612 |
| Overall SE % | n/a | n/a | 19 | 14 | 10 | 9 | 17 | 15 | 28 | 16 | 25 | 17 |

*Biomass estimates prior to 1999 are not considered comparable due to variation in the coverage area.

Table 12. 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 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 40,972 | 106,316 | 163,900 | 141,000 | 133,900 | 107,600 | 16,800 | 28,600 | 45,700 | 87,199 |
| Trinity | 3,885 | 621 | 14,800 | 8,100 | 14,500 | 6,500 | 5,100 | 8,500 | 1,400 | 7,045 |
| German Bank | 460,823 | 356,372 | 282,400 | 394,357 | 357,100 | 367,600 | 211,000 | 249,600 | 337,300 | 335,172 |
| Total SSB | 505,680 | 463,309 | 461,100 | 543,457 | 505,500 | 481,700 | 232,900 | 286,700 | 384,400 | 429,416 |

| A2) Acoustic Survey Proportions | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 8% | 23% | 36% | 26% | 26% | 22% | 7% | 10% | 12% | 19% |
| Trinity | 1% | 0% | 3% | 1% | 3% | 1% | 2% | 3% | 0% | 2% |
| German Bank | 91% | 77% | 61% | 73% | 71% | 76% | 91% | 87% | 88% | 79% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| C1) Catch by Spawn Area | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 1,789 | 10,926 | 10,739 | 8,202 | 19,196 | 24,869 | 6,239 | 3,352 | 4,116 | 9,937 |
| Trinity (purse seine+gillnet) | 2,526 | 843 | 1,271 | 1,865 | 369 | 595 | 2,014 | 4,444 | 1,203 | 1,681 |
| German Bank | 24,660 | 25,631 | 24,139 | 22,355 | 21,573 | 14,175 | 14,171 | 16,522 | 15,085 | 19,812 |
| Spawn Area Total | 28,974 | 37,400 | 36,149 | 32,422 | 41,138 | 39,639 | 22,424 | 24,318 | 20,404 | 31,430 |
| Overall SW Nova Catch | 77,552 | 85,284 | 71,570 | 77,054 | 89,461 | 78,029 | 48,981 | 49,159 | 50,529 | 69,735 |
| Non-spawning area catch remaining | 48,578 | 47,884 | 35,421 | 44,632 | 48,323 | 38,390 | 26,557 | 24,841 | 30,125 | 38,306 |

| C2) Adjusted Catch by Area | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 5,725 | 21,914 | 23,330 | 19,782 | 31,996 | 33,444 | 8,155 | 5,830 | 7,697 | 17,542 |
| Trinity | 2,899 | 907 | 2,408 | 2,530 | 1,755 | 1,113 | 2,596 | 5,181 | 1,313 | 2,300 |
| German Bank | 68,929 | 62,462 | 45,832 | 54,742 | 55,710 | 43,472 | 38,231 | 38,148 | 41,519 | 49,894 |
| Adjusted Catch Total | 77,552 | 85,284 | 71,570 | 77,054 | 89,461 | 78,029 | 48,981 | 49,159 | 50,529 | 69,735 |

| E1) Percentage (C1/SSB) | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 4% | 10% | 7% | 6% | 14% | 23% | 37% | 12% | 9% | 14% |
| Trinity | 65% | 136% | 9% | 23% | 3% | 9% | 39% | 52% | 86% | 47% |
| German Bank | 5% | 7% | 9% | 6% | 6% | 4% | 7% | 7% | 4% | 6% |
| Overall (C1/SSB) | 6% | 8% | 8% | 6% | 8% | 8% | 10% | 8% | 5% | 7% |

| E2) Percentage adjusted (C2/SSB) | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | Avg 99-07 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scots Bay | 14% | 21% | 14% | 14% | 24% | 31% | 49% | 20% | 17% | 23% |
| Trinity | 75% | 146% | 16% | 31% | 12% | 17% | 51% | 61% | 94% | 56% |
| German Bank | 15% | 18% | 16% | 14% | 16% | 12% | 18% | 15% | 12% | 15% |
| Overall Adjusted (Catch/Acoustic SSB) | 15% | 18% | 16% | 14% | 18% | 16% | 21% | 17% | 13% | 16% |

Table 13. Summary of biological samples by gear and month as collected during the 2007 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 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Grand Total |
| 4Vn Trap | Sum of No. LF Samples | | | | | 1 | | | | | | 1 |
| | Sum of No. Measured | | | | | 209 | | | | | | 209 |
| | Sum of No Processed | | | | | 54 | | | | | | 54 |
| 4W Purse Seine | Sum of No. LF Samples | | | | 8 | 17 | | | | | | 25 |
| | Sum of No. Measured | | | | 939 | 1999 | | | | | | 2938 |
| | Sum of No Processed | | | | 0 | 0 | | | | | | 0 |
| 5Y CAN P.Seine | Sum of No. LF Samples | | | | | 26 | | 13 | 15 | 24 | | 78 |
| | Sum of No. Measured | | | | | 3129 | | 1525 | 1783 | 2857 | | 9294 |
| | Sum of No Processed | | | | | 39 | | 39 | 54 | 79 | | 211 |
| 5Y USA P.Seine/MWT | Sum of No. LF Samples | | 1 | | 9 | 3 | 1 | | | | | 14 |
| | Sum of No. Measured | | 126 | | 1151 | 363 | 126 | | | | | 1766 |
| | Sum of No Processed | | 0 | | 0 | 0 | 0 | | | | | 0 |
| 5Z USA P.Seine/MWT | Sum of No. LF Samples | 16 | 18 | | 6 | | | | | | | 40 |
| | Sum of No. Measured | 1956 | 2116 | | 715 | | | | | | | 4787 |
| | Sum of No Processed | 0 | 0 | | 0 | | | | | | | 0 |
| Gillnet | Sum of No. LF Samples | | | | | | | 2 | 1 | 21 | 1 | 25 |
| | Sum of No. Measured | | | | | | | 340 | 154 | 2900 | 94 | 3488 |
| | Sum of No Processed | | | | | | | 60 | 50 | 204 | 29 | 343 |
| N.B. Purse Seine | Sum of No. LF Samples | 15 | | | | | 21 | 3 | 10 | 19 | 5 | 73 |
| | Sum of No. Measured | 1754 | | | | | 2539 | 268 | 1066 | 2253 | 416 | 8296 |
| | Sum of No Processed | 17 | | | | | 34 | 18 | 66 | 56 | 30 | 221 |
| N.B. Shut-off | Sum of No. LF Samples | 2 | | | | | | | 1 | 3 | 1 | 7 |
| | Sum of No. Measured | 229 | | | | | | | 118 | 341 | 122 | 810 |
| | Sum of No Processed | 0 | | | | | | | 9 | 10 | 0 | 19 |
| N.B. Weirs | Sum of No. LF Samples | | | | 3 | 21 | 76 | 161 | 106 | 105 | 8 | 480 |
| | Sum of No. Measured | | | | 339 | 2488 | 10071 | 20248 | 13132 | 12558 | 908 | 59744 |
| | Sum of No Processed | | | | 46 | 45 | 148 | 85 | 97 | 136 | 30 | 587 |
| N.S. Purse Seine | Sum of No. LF Samples | | | | | 38 | 149 | 82 | 96 | 10 | | 375 |
| | Sum of No. Measured | | | | | 4464 | 17707 | 9878 | 11879 | 1270 | | 45198 |
| | Sum of No Processed | | | | | 82 | 324 | 280 | 459 | 91 | | 1236 |
| N.S. Weirs | Sum of No. LF Samples | | | | 3 | | 6 | 7 | | | | 16 |
| | Sum of No. Measured | | | | 368 | | 786 | 857 | | | | 2011 |
| | Sum of No Processed | | | | 0 | | 0 | 91 | | | | 91 |
| Resrch. Otter Trawl | Sum of No. LF Samples | | 22 | 42 | | | 71 | 2 | | | | 137 |
| | Sum of No. Measured | | | | | | | | | | | |
| | Sum of No Processed | | 142 | 355 | | | 572 | 12 | | | | 1081 |
| 4V Midwater Trawl | Sum of No. LF Samples | | | | 2 | | | | | | | 2 |
| | Sum of No. Measured | | | | | | | | | | | |
| | Sum of No Processed | | | | 54 | | | | | | | 54 |
| 4W Midwater Trawl | Sum of No. LF Samples | | | | 15 | 25 | | | | | | 40 |
| | Sum of No. Measured | | | | 2186 | 4246 | | | | | | 6432 |
| | Sum of No Processed | | | | 352 | 373 | | | | | | 725 |
| USA Shut-off | Sum of No. LF Samples | | | | | 1 | | | | | | 1 |
| | Sum of No. Measured | | | | | 111 | | | | | | 111 |
| | Sum of No Processed | | | | | 0 | | | | | | 0 |
| 4X Midwater Trawl | Sum of No. LF Samples | | | | | 1 | | | | | | 1 |
| | Sum of No. Measured | | | | | 126 | | | | | | 126 |
| | Sum of No Processed | | | | | 0 | | | | | | 0 |
| Total Sum of No. LF Samples | | 33 | 41 | 42 | 46 | 133 | 324 | 270 | 229 | 182 | 15 | 1315 |
| Total Sum of No. Measured | | 3939 | 2242 | | 5698 | 17135 | 31229 | 33116 | 28132 | 22179 | 1540 | 145210 |
| Total Sum of No Processed | | 17 | 142 | 355 | 452 | 593 | 1078 | 585 | 735 | 576 | 89 | 4622 |

Table 14. 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 |
| **Average** | **140** | **1,252** | **66** | **242** | **115** | **1,183** |

Table 15. 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 16. 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 1999-2007.

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

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 |
|---|---|---|---|---|---|---|---|---|---|---|
| <23cm | 27% | 46% | 48% | 23% | 45% | 60% | 51% | 30% | 35% | 46% |
| 23-30cm | 51% | 50% | 46% | 71% | 51% | 38% | 48% | 69% | 63% | 49% |
| >30cm | 21% | 4% | 6% | 6% | 4% | 2% | 2% | 2% | 2% | 5% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Table 17. 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 18. 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 19. Herring abundance indices from the July bottom trawl survey (stratified numbers per tow): 1970-2007.

| | July ground trawl survey by-catch for herring (stratified mean numbers) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |

Table 20. Recorded herring landings (t) from gillnet fisheries in the coastal N.S. spawning component, 1996-2007.

| Landings (t) | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 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 | 2,534 | 2,380 |
| **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 | 3,485 | 2,461 |
| **Glace Bay** | | 170 | 1,730 | 1,040 | 834 | 1,204 | 3,058 | 1,905 | 1,481 | 626 | 85 | 7 | 821 | 1,104 |
| **Bras d'Or Lakes** | 170 | 160 | 120 | 31 | 56 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 45 |
| **Total** | 1,450 | 2,340 | 4,120 | 5,618 | 4,283 | 6,006 | 10,375 | 9,162 | 6,924 | 6,311 | 6,566 | 5,240 | 7,430 | 5,700 |

Table 21. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2007 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 | 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 | 2,834 | 2,541 |
| **Halifax/Eastern Shore** | 8,300 | 20,200 | **10,900** | 16,700 | **41,500** | 67,602 | 18,200 | 28,100 | 51,100 | 24,000 | 3,780 | 2,866 |
| **Glace Bay** | | 2,000 | | 21,200 | 7,700 | 31,500 | | 2,200 | n/s | 100 | 1,127 | 1,078 |
| **Bras d'Or Lakes** | | 530 | 70 | n/s | n/s | n/s | n/s | n/s | n/s | n/s | n/s | 30 |

Table 22. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2007 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 | 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 | 2,944 | 2,944 |
| **Halifax/Eastern Shore** | | | | | | 92,600 | 28,400 | 36,950 | 68,900 | 28,300 | 5,103 | 5,103 |
| **Glace Bay** | | | | | | 31,500 | | 3,180 | n/s | 240 | 1,164 | 1,164 |
| **Bras d'Or Lakes** | | | | | | n/s | n/s | n/s | n/s | n/s | n/s | n/a |

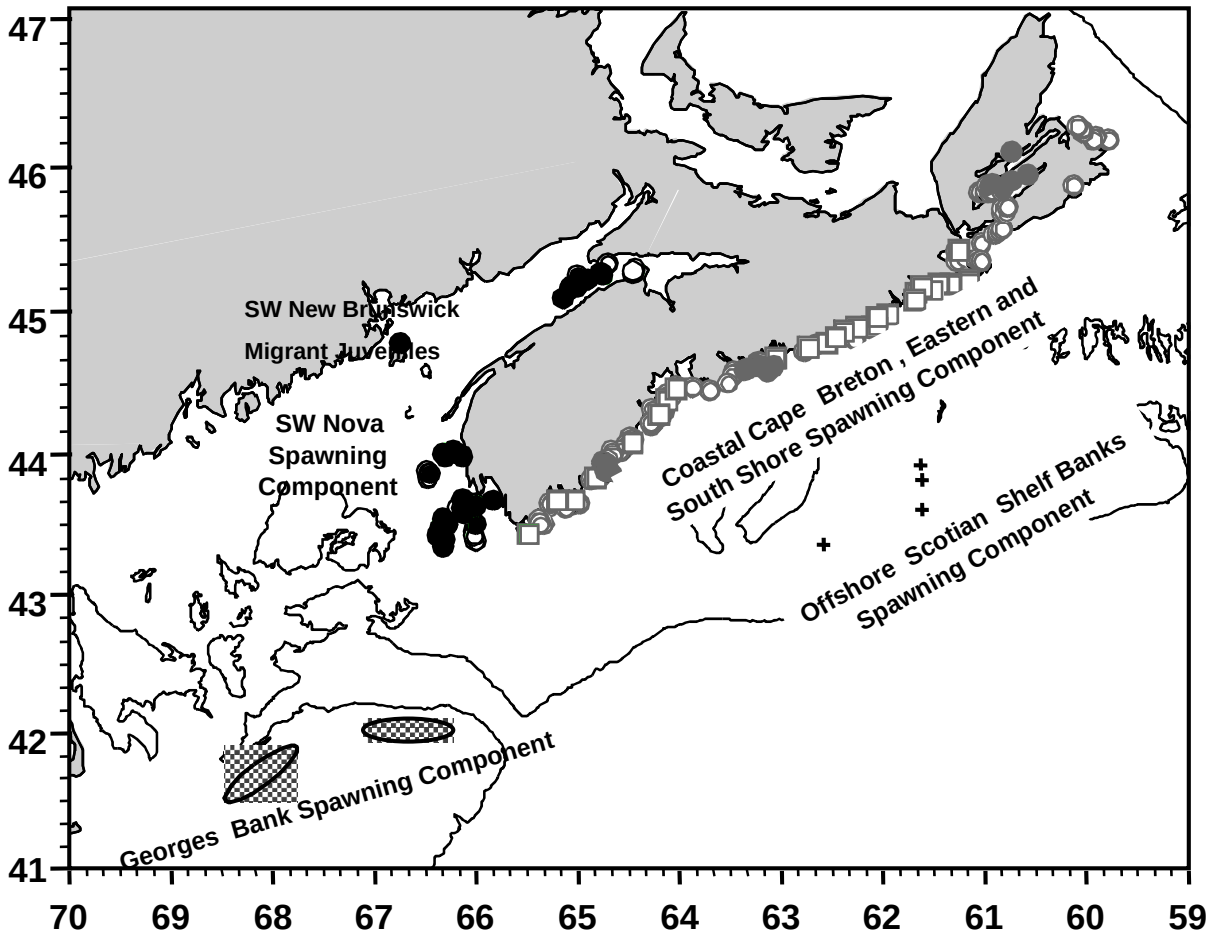


Figure 1. Management units for herring in areas 4VWX and 5YZ showing locations of known current (solid) and historical (open) spawning locations.

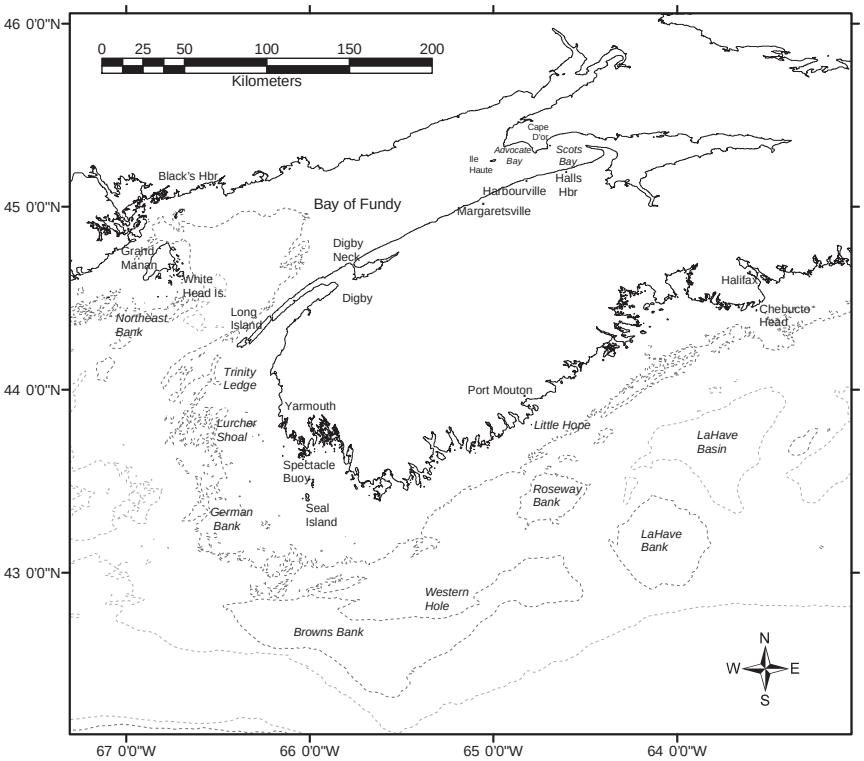


Figure 2. Fishing locations for herring in southwest and coastal Nova Scotia.

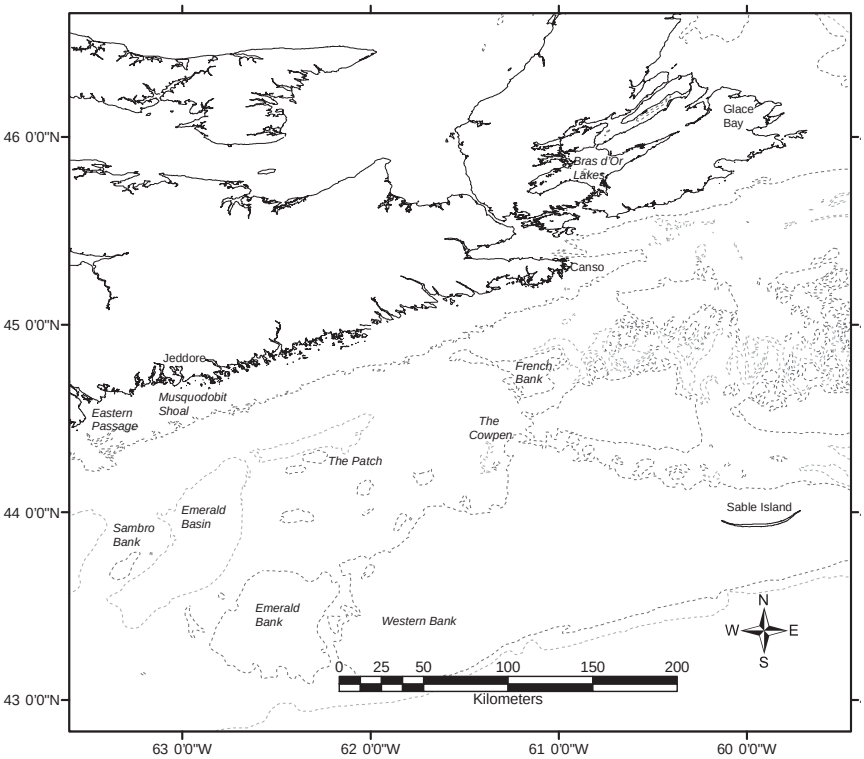


Figure 3. Fishing locations for herring on the eastern Scotian Shelf and offshore bank

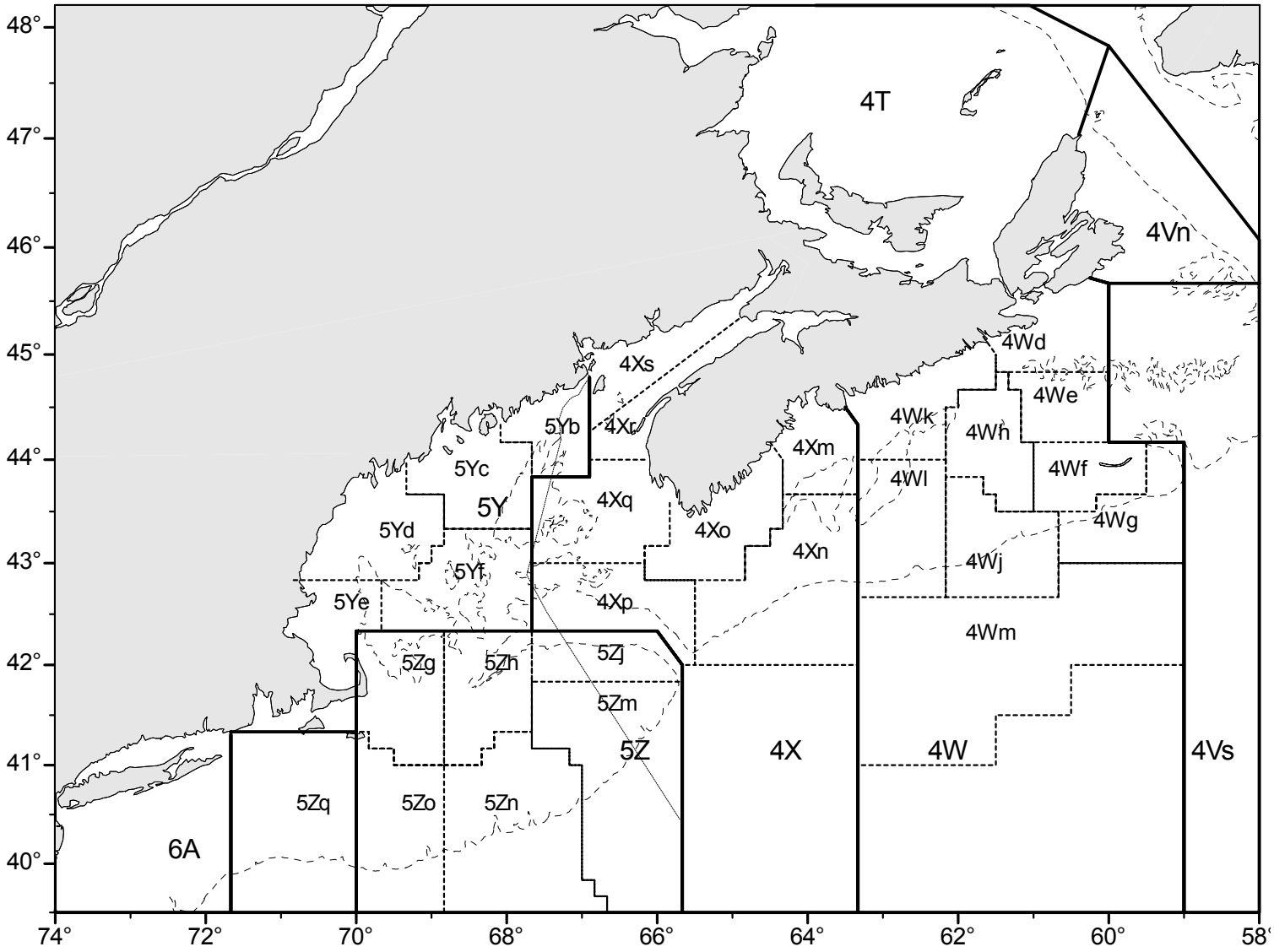


Figure 4. Major and minor NAFO unit areas used for sample and catch data aggregation.

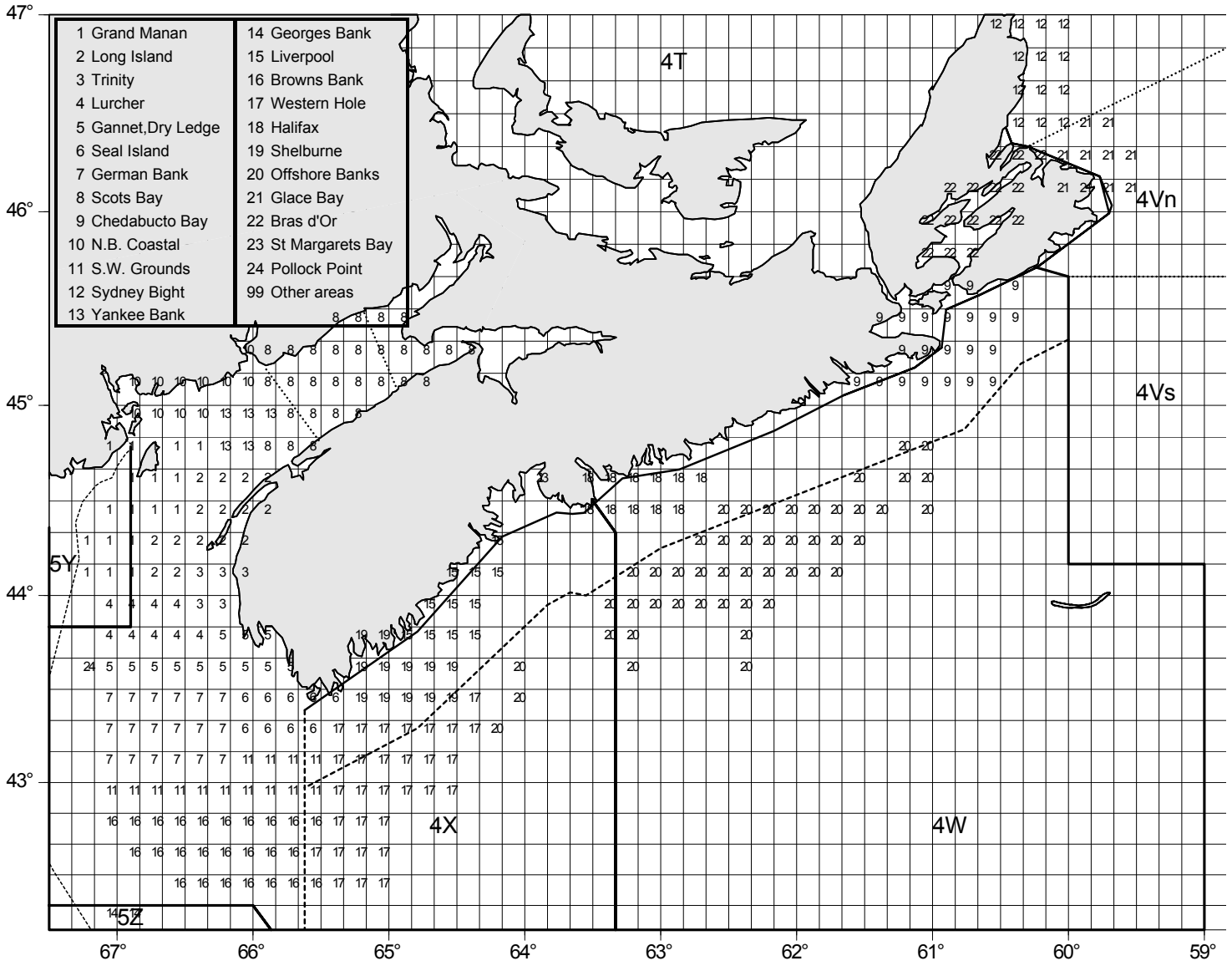


Figure 5. Herring fishing ground areas by 10 mile boxes and management lines for NAFO areas, 25 mile offshore line, coastal embayment line and herring area lines.

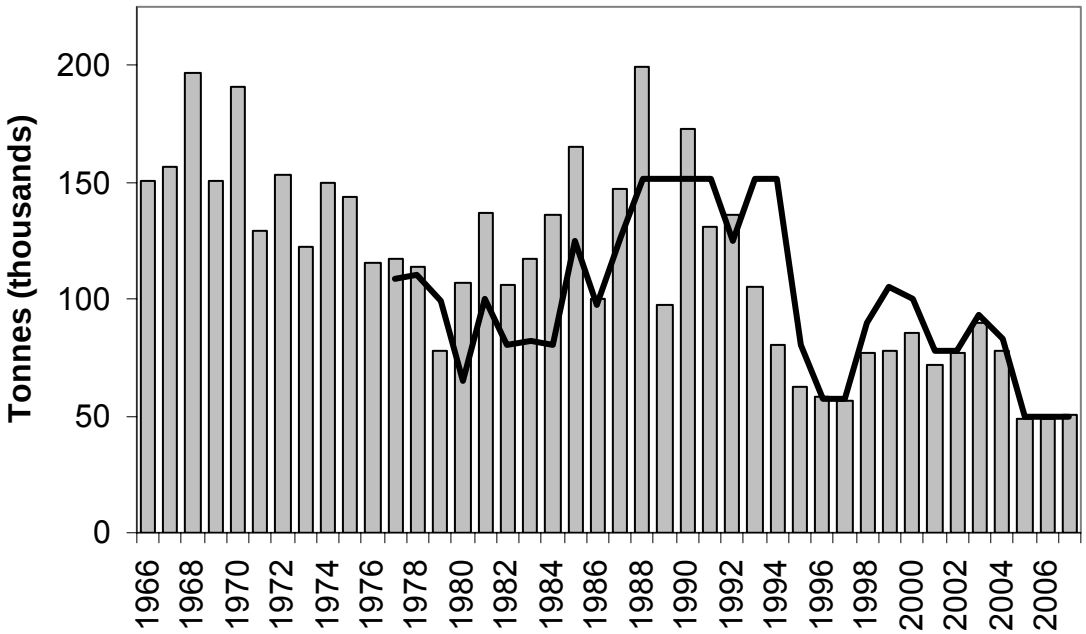


Figure 6. Annual herring landings [bars] and TAC [solid line] (quota) for the southwest Nova Scotia spawning component (4WX stock).

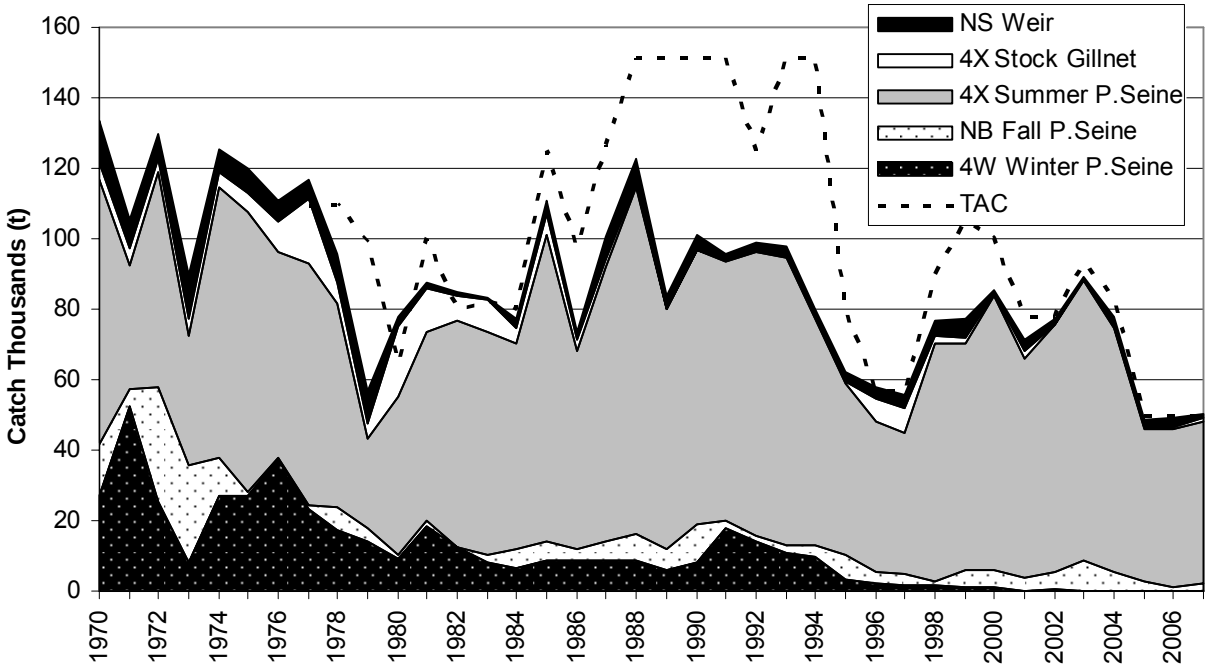


Figure 7. Annual herring landings by gear component for the southwest Nova Scotia spawning component (4WX stock).

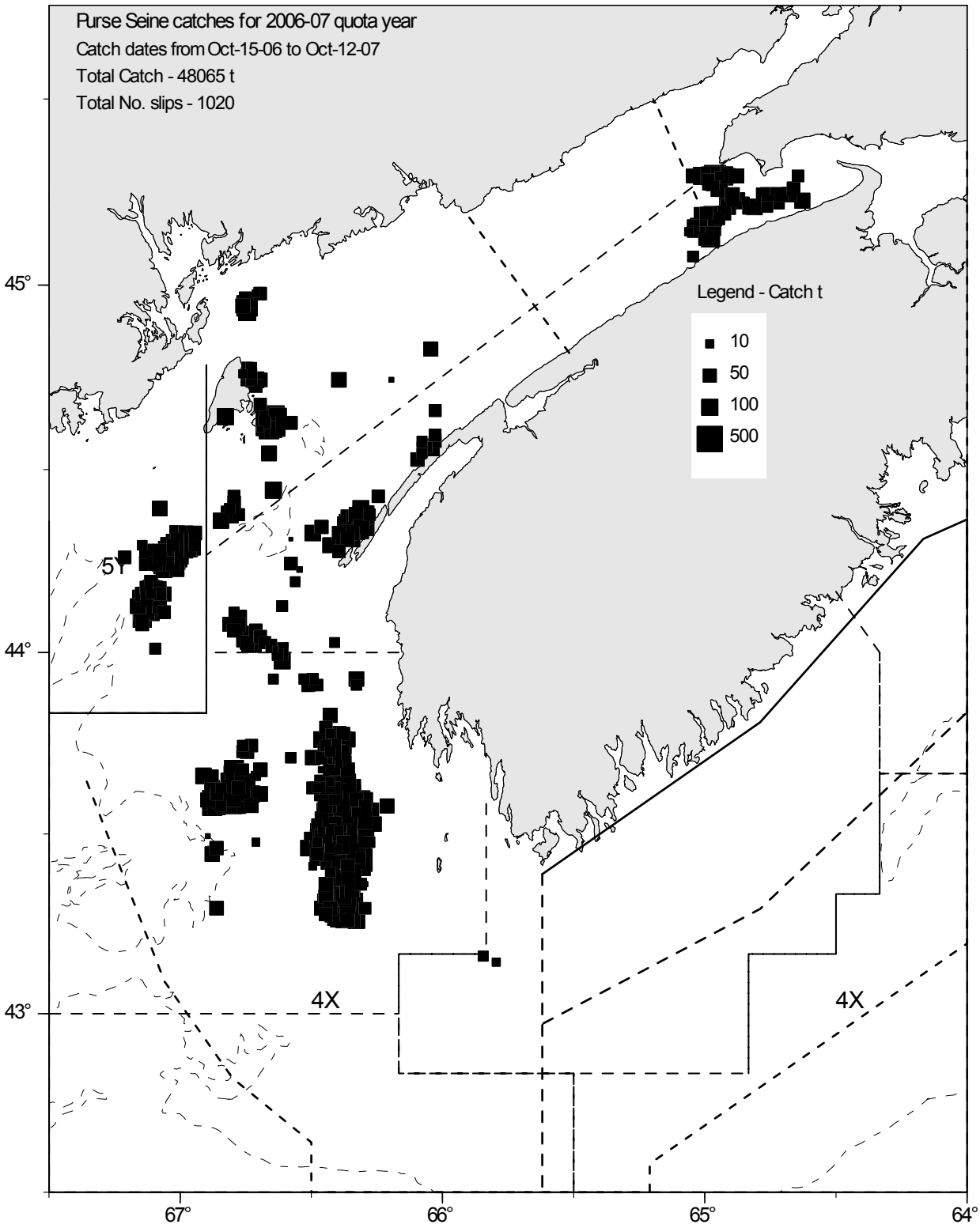


Figure 8. Overall 2006-2007 quota year herring purse seine catches (t) for NAFO areas 4WX (from Statistics Division MARFIS database).

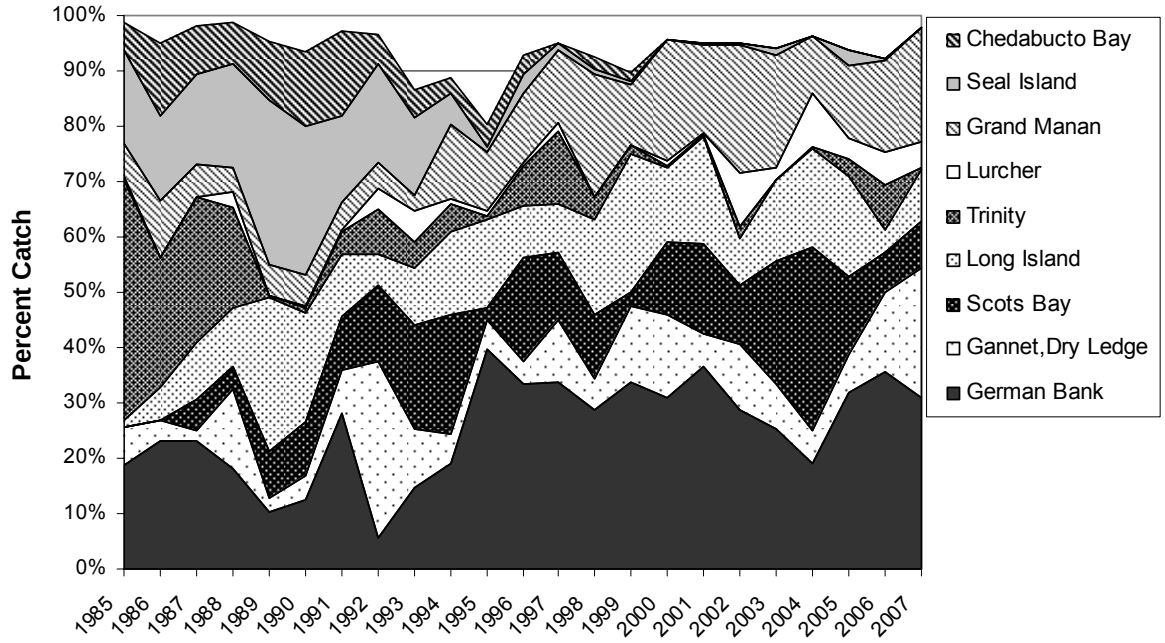


Figure 9. Herring purse seine catches as a proportion of overall landings for selected fishing grounds in the southwest Nova Scotia spawning component from 1997-2007.

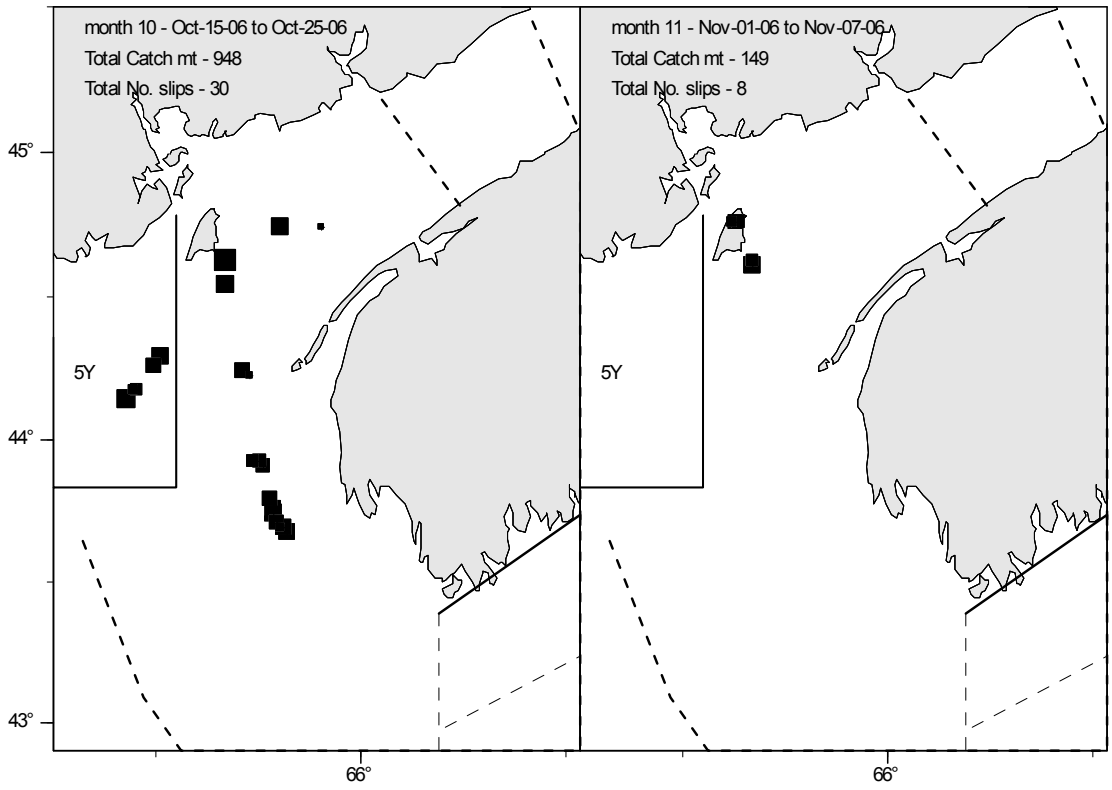


Figure 10. 2006 fall fishery herring purse seine catches (t) by month in NAFO areas 4WX from 2006-2007 quota year (from Statistics Division MARFIS database).

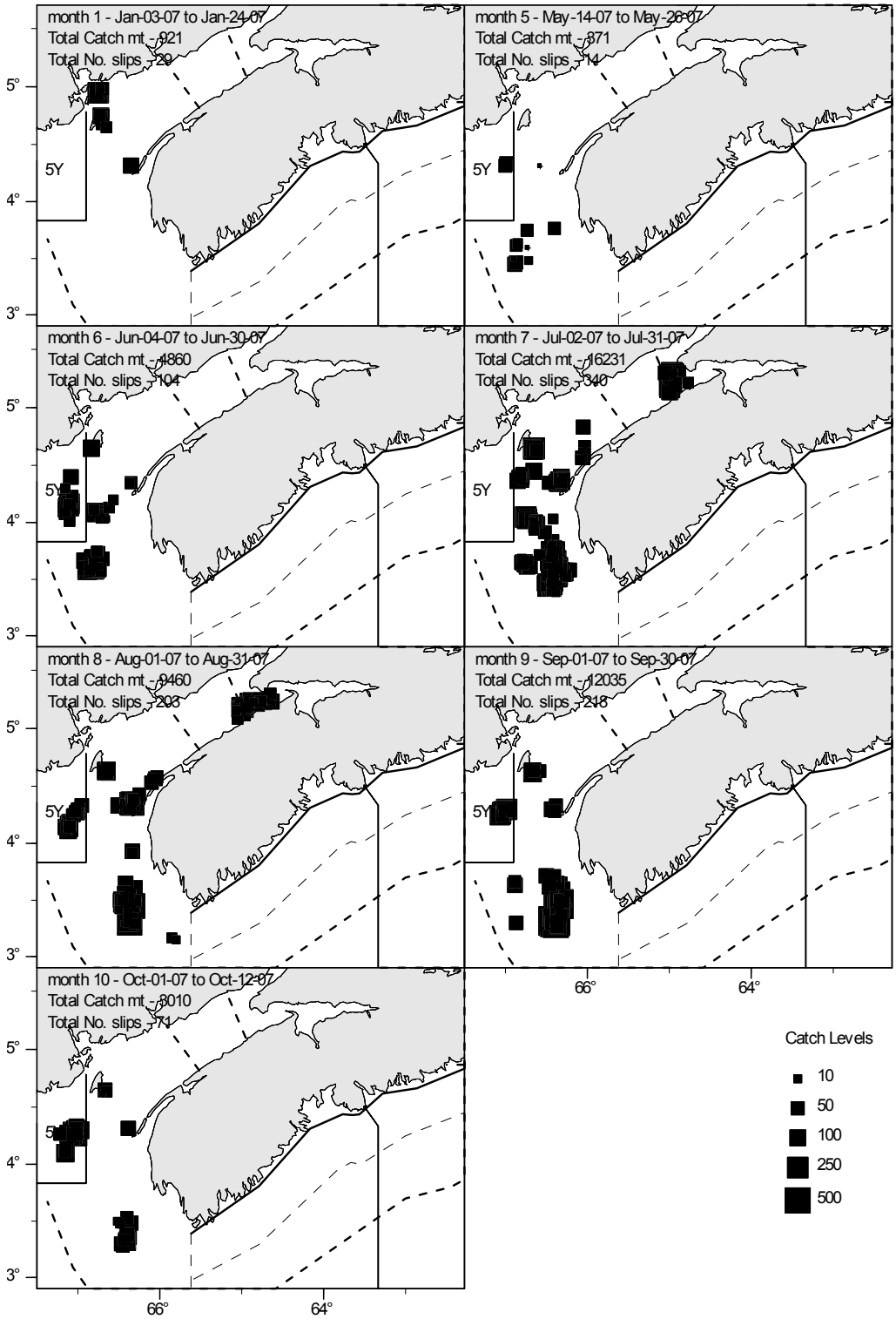


Figure 11. 2007 herring purse seine catches (t) by month in NAFO areas 4WX from 2006-2007 quota year (from Statistics Division MARFIS database).

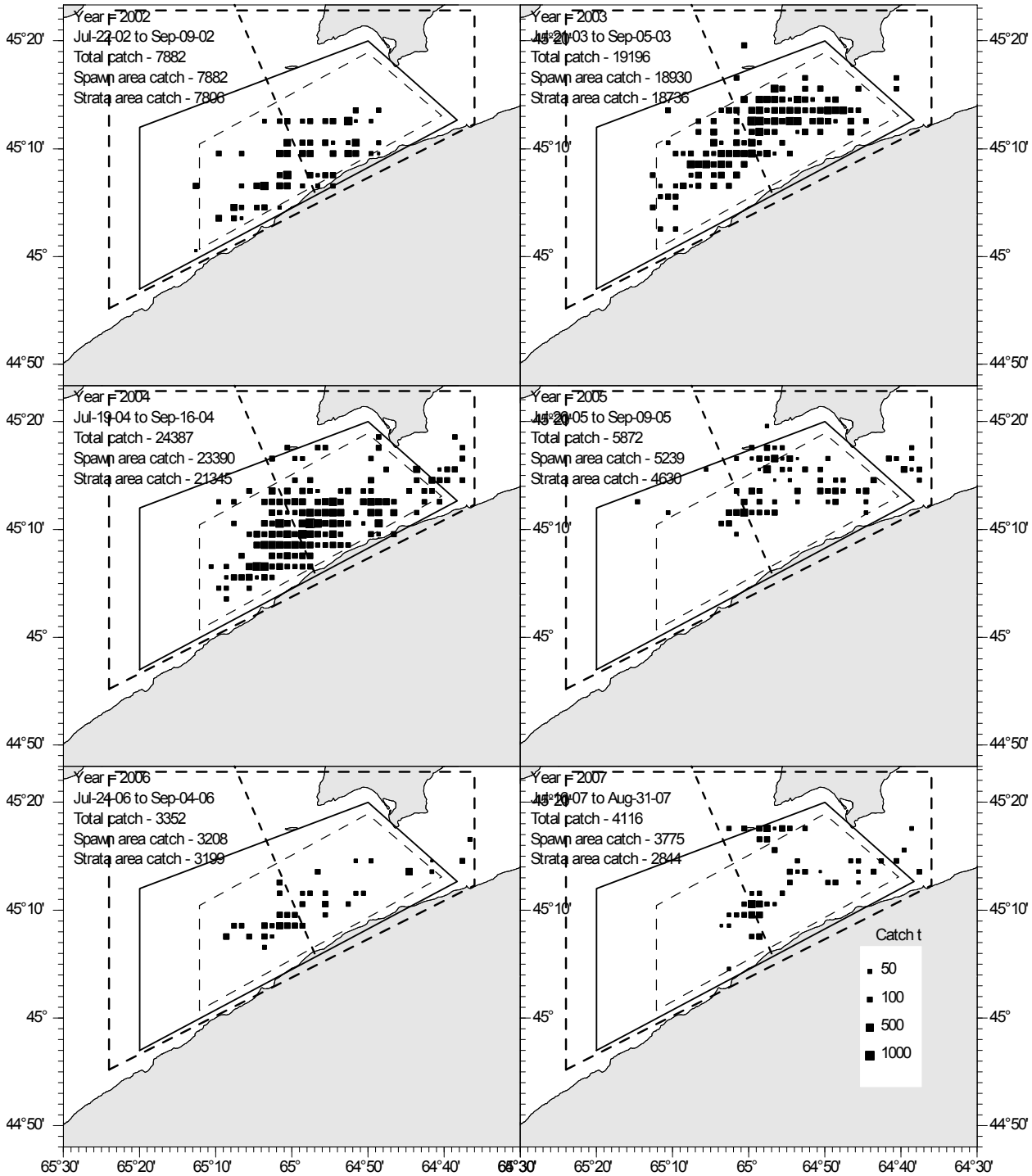


Figure 12. Herring purse seine catches for the Scots Bay area from 2002-2007 with catch totals for the overall area, the middle 'Spawning' area and the inner 'Strata' area which was used as the primary search area in acoustic surveys.

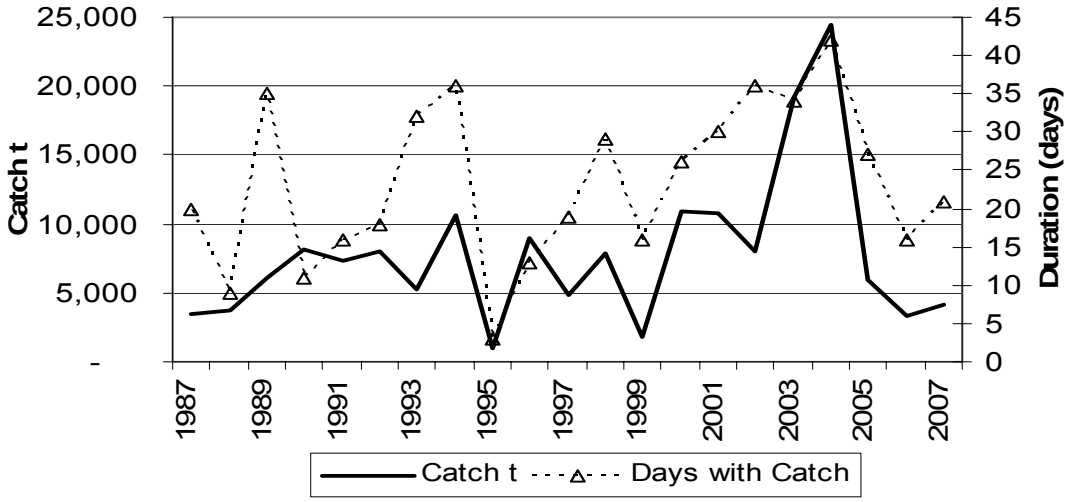


Figure 13. Annual herring purse seine catches for the Scots Bay area from 1987-2007 with duration of fishery in days (start date to end date).

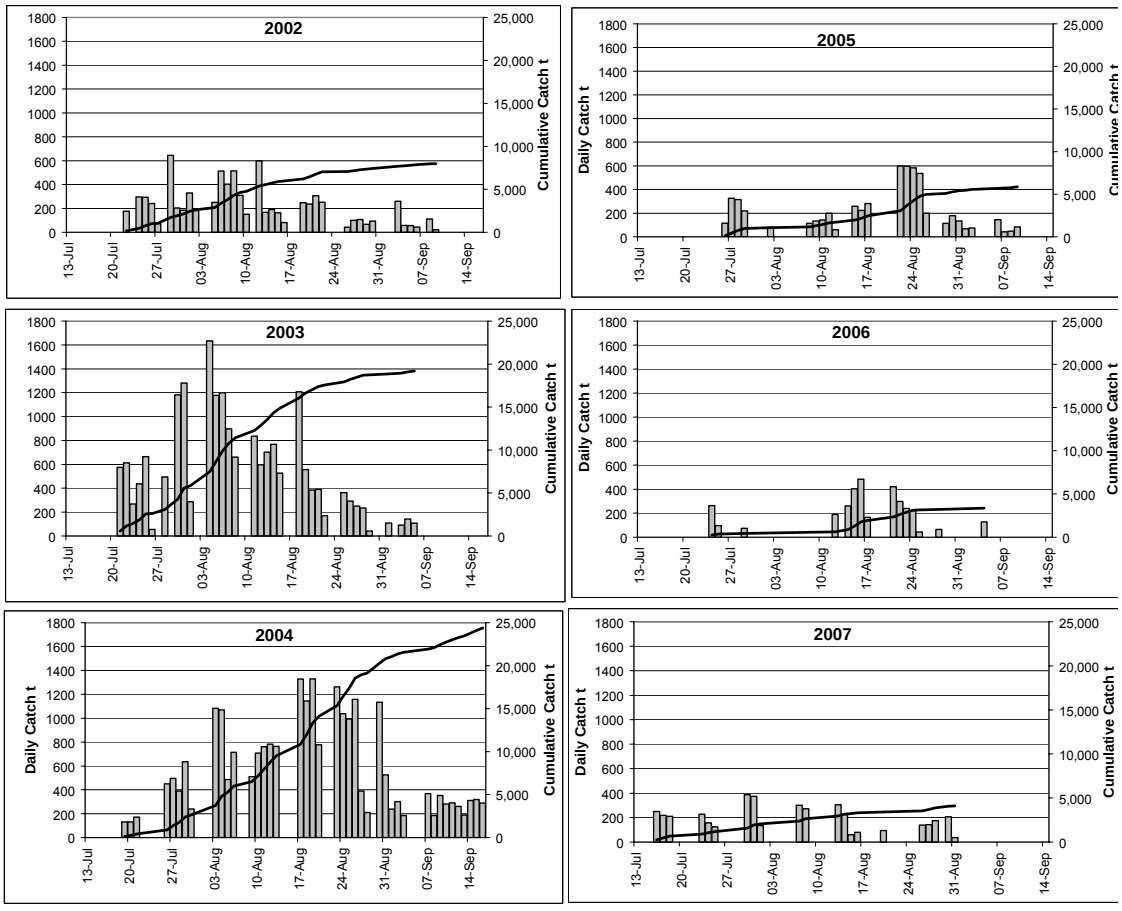


Figure 14. 2002 to 2007 daily purse seine herring catches in tonnes (bars) for Scots Bay with the cumulative total catch (solid line) over the entire fishing season.

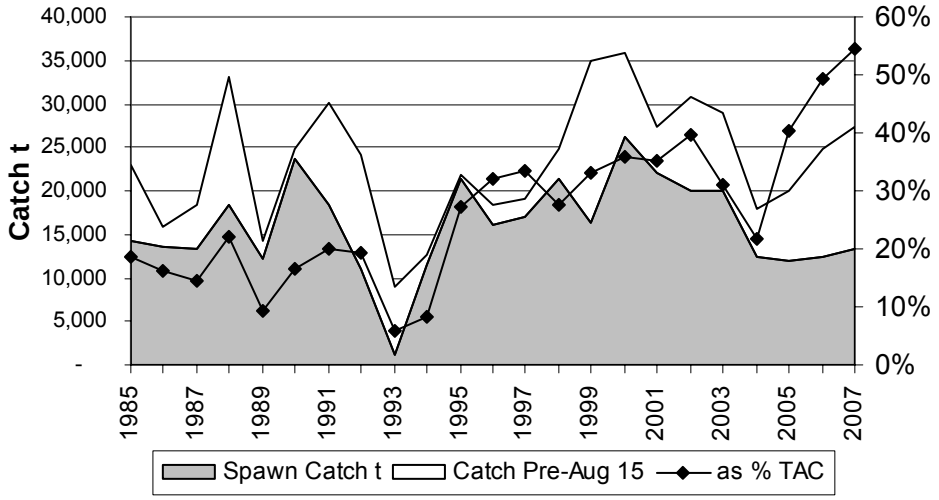


Figure 15. Annual herring purse seine catches for the German Bank area from 1985-2007 with pre-spawning and spawning period catches based on an Aug. 15 start date for the defined spawning period and overall German Bank catches as a proportion of the TAC.

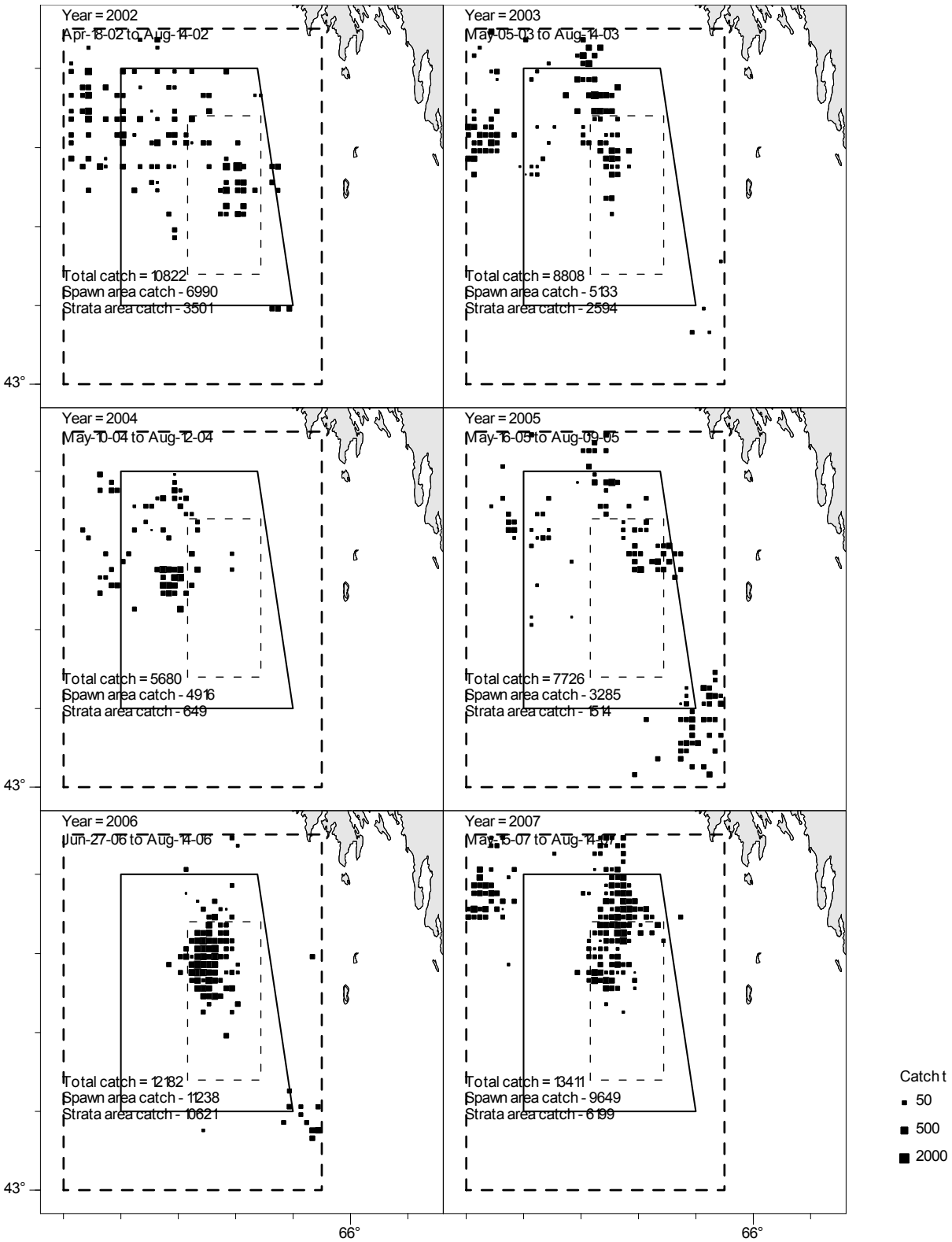


Figure 16. Herring purse seine pre-spawning period catches (May 1 to Aug. 14) for German Bank from 2002-2007 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

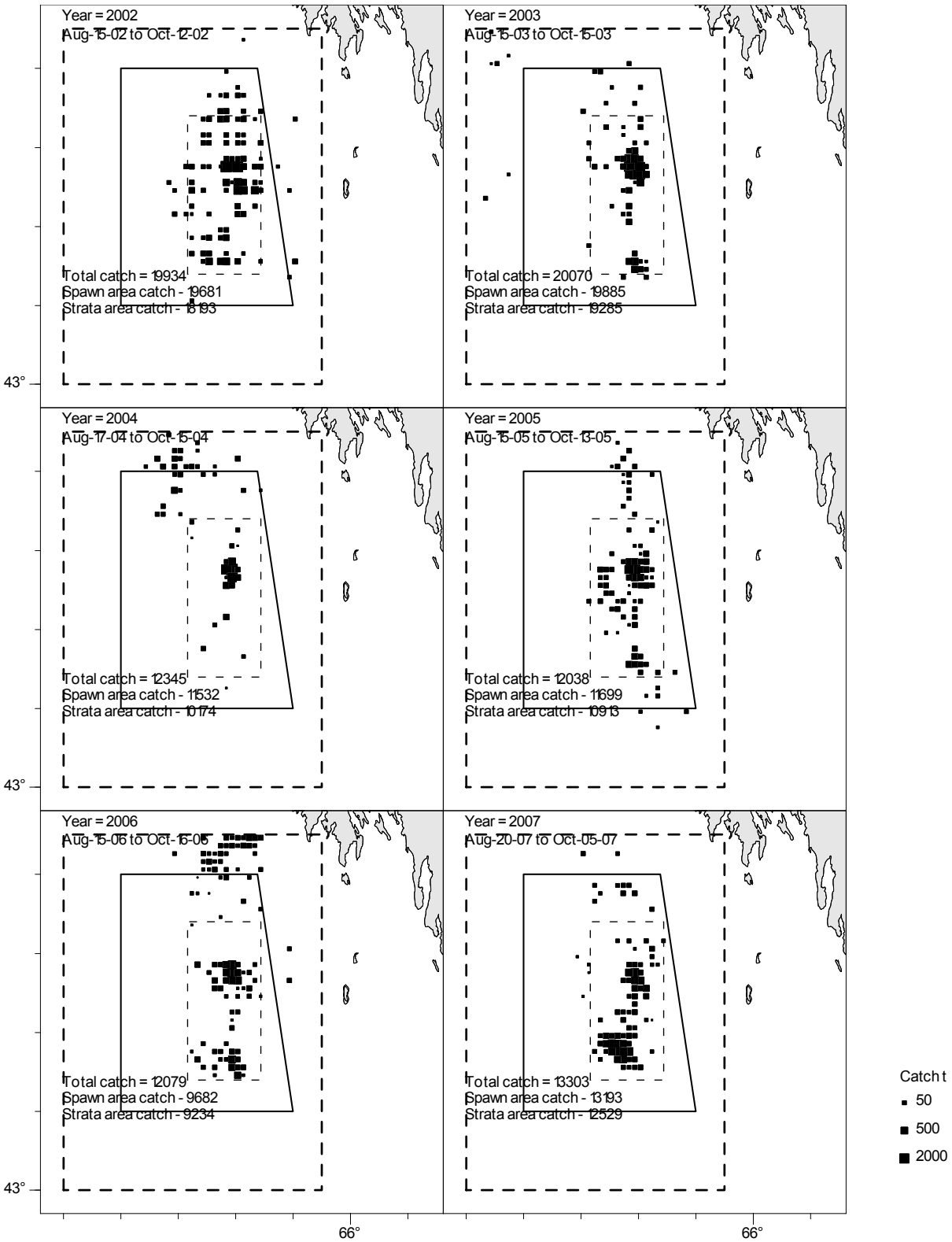


Figure 17. Herring purse seine spawning period catches (Aug. 15 to Oct. 31) for German Bank from 2002-2007 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

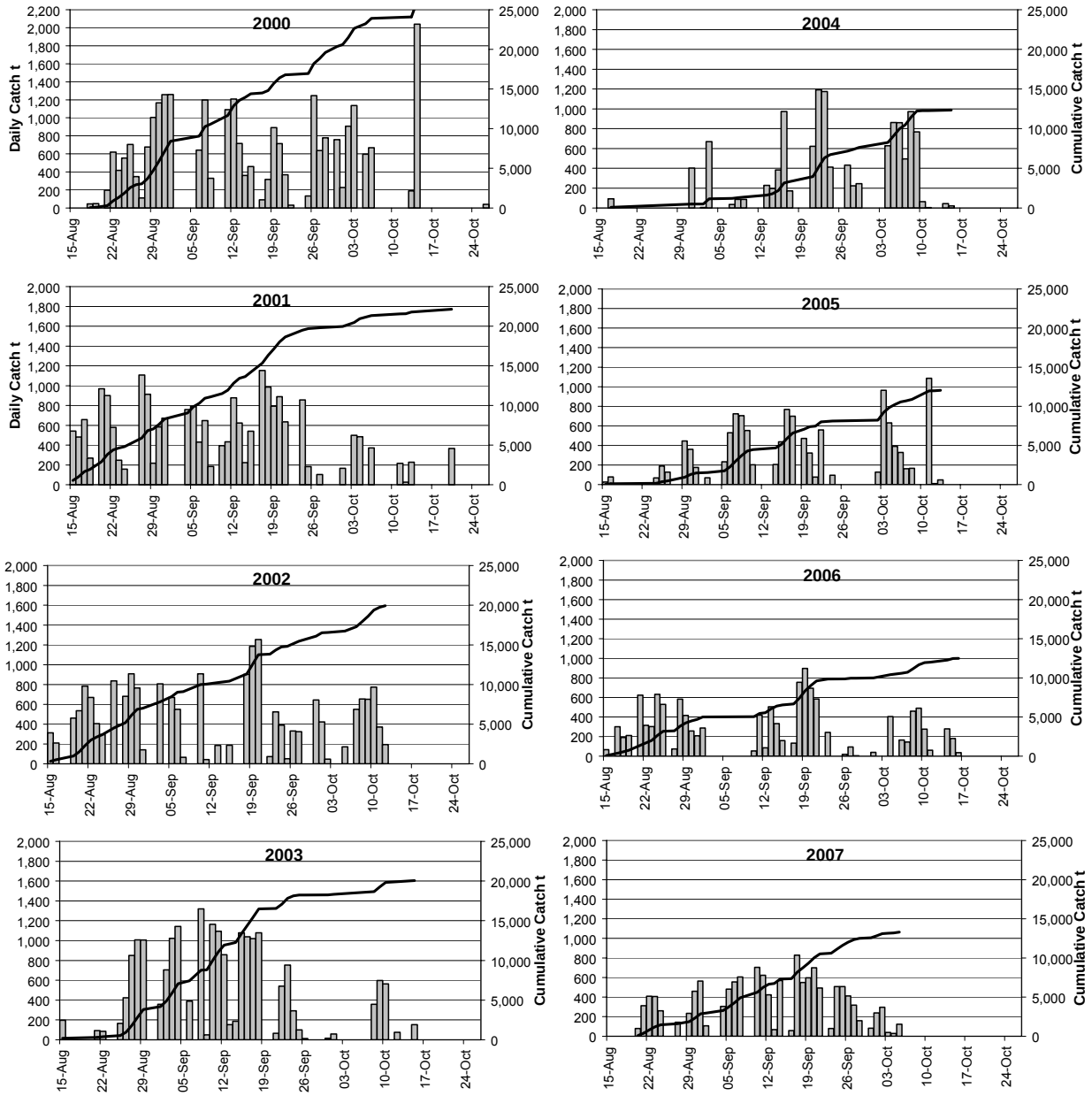


Figure 18. 1997 to 2007 daily purse seine herring catches in tonnes (bars) for German Bank with the cumulative total catch (solid line) over the defined spawning season from Aug. 15 to Oct. 30.

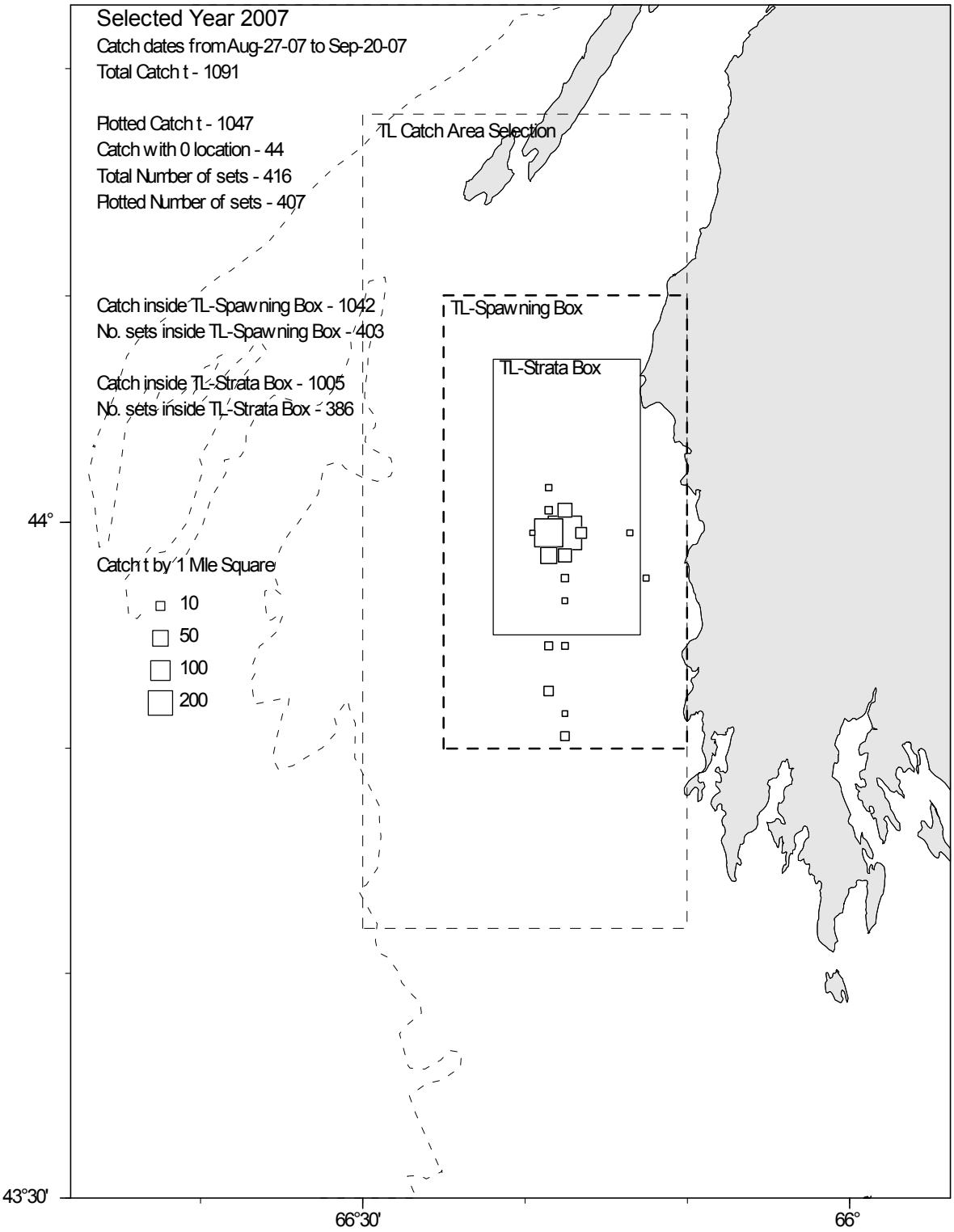


Figure 19. Trinity Ledge/Spectacle Buoy herring catches for 2007 with overall catch amounts and catch portions within the defined spawning area (TL-Spawning Box) and survey areas (TL-Strata Box).

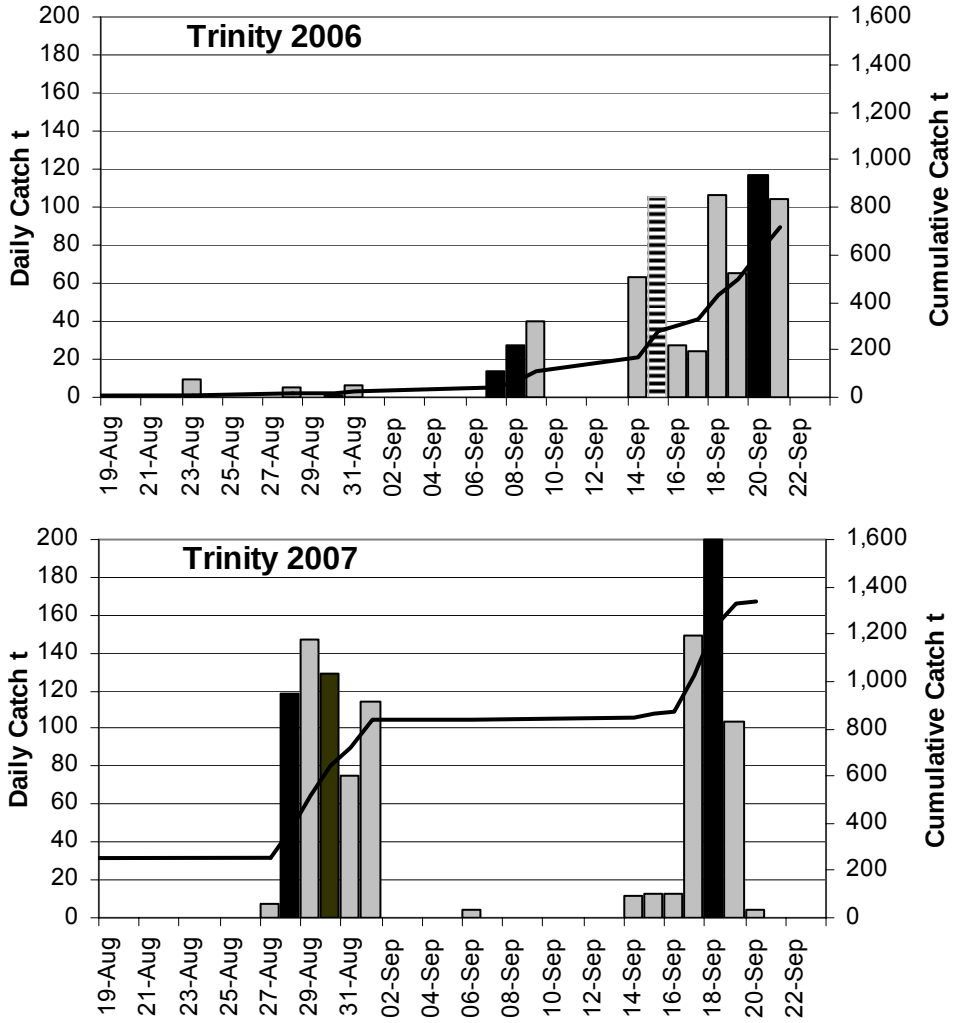


Figure 20. Daily herring landings for 2006 and 2007 Trinity Ledge area with acoustic survey dates highlighted (darkened bars) and cumulative catch (solid line) for overall gillnet catches for stock component.

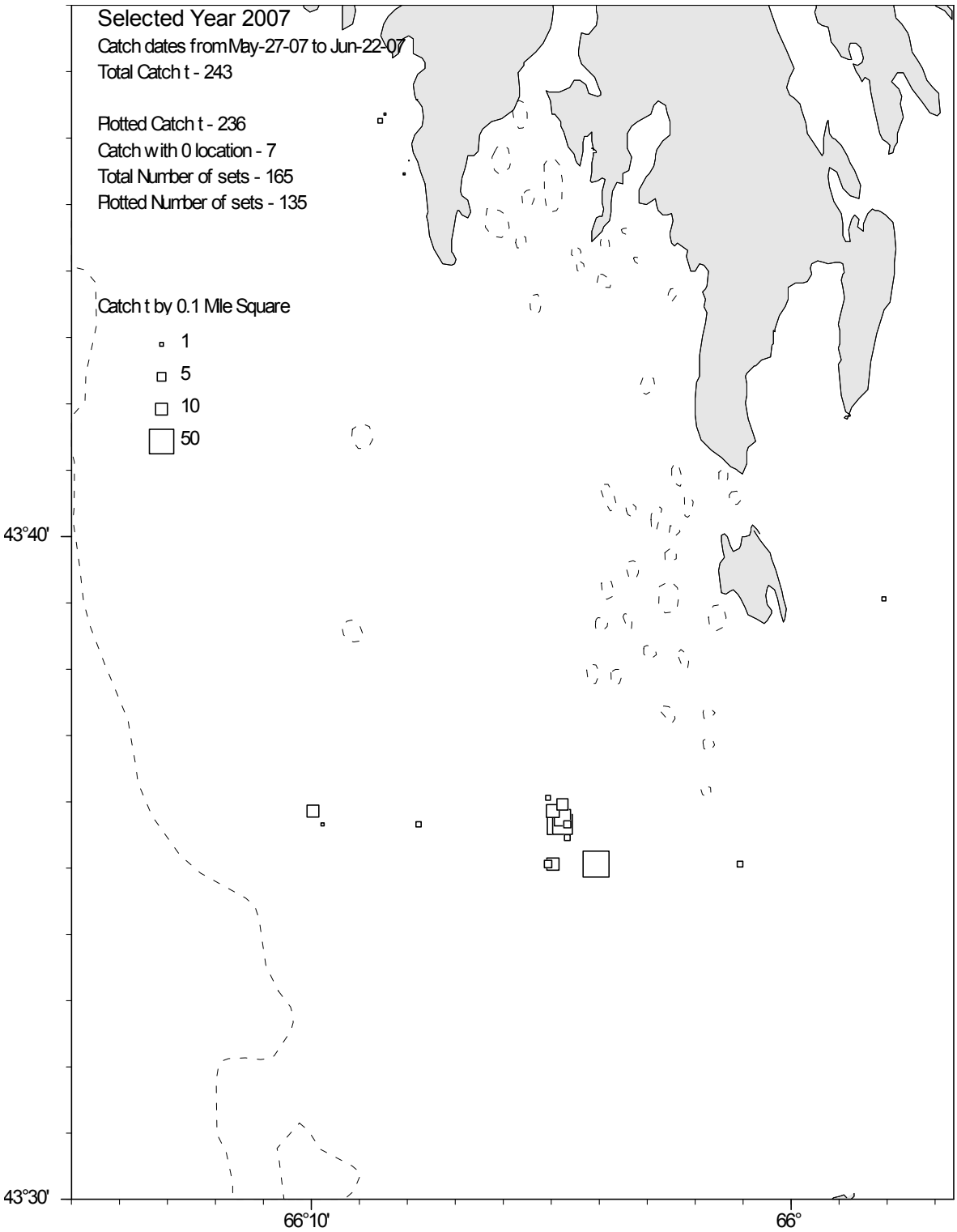

Figure 21. Spectacle Buoy area spring gillnet fishery herring catches for 2007.

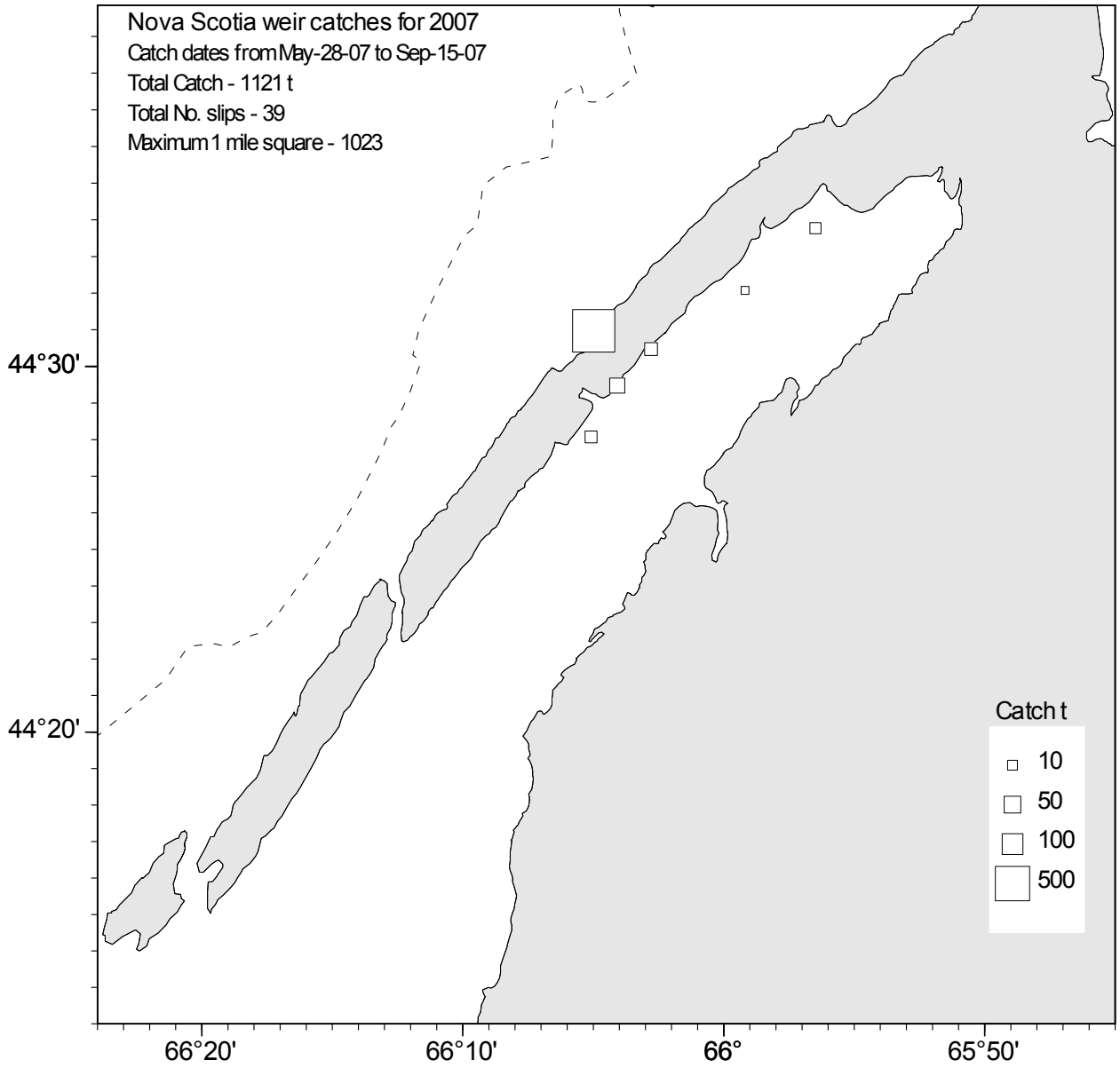

Figure 22. Nova Scotia herring weir catches for the 2007 calendar year.

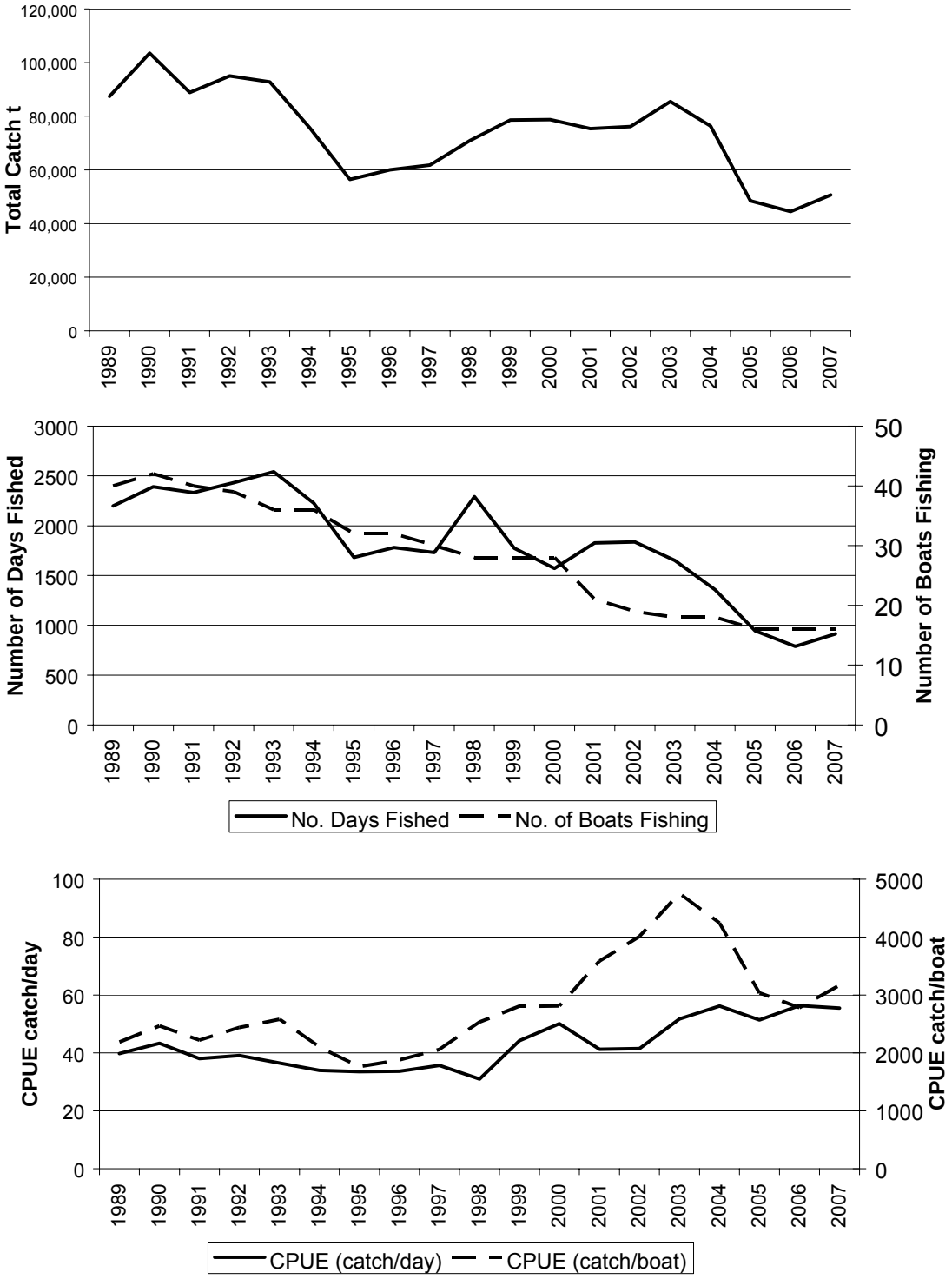


Figure 23. Purse seine catch (top panel), effort (middle panel) and CPUE (bottom) from 1989 to 2007 annual 4WX herring landings data for the SW Nova Scotia/Bay of Fundy spawning component.

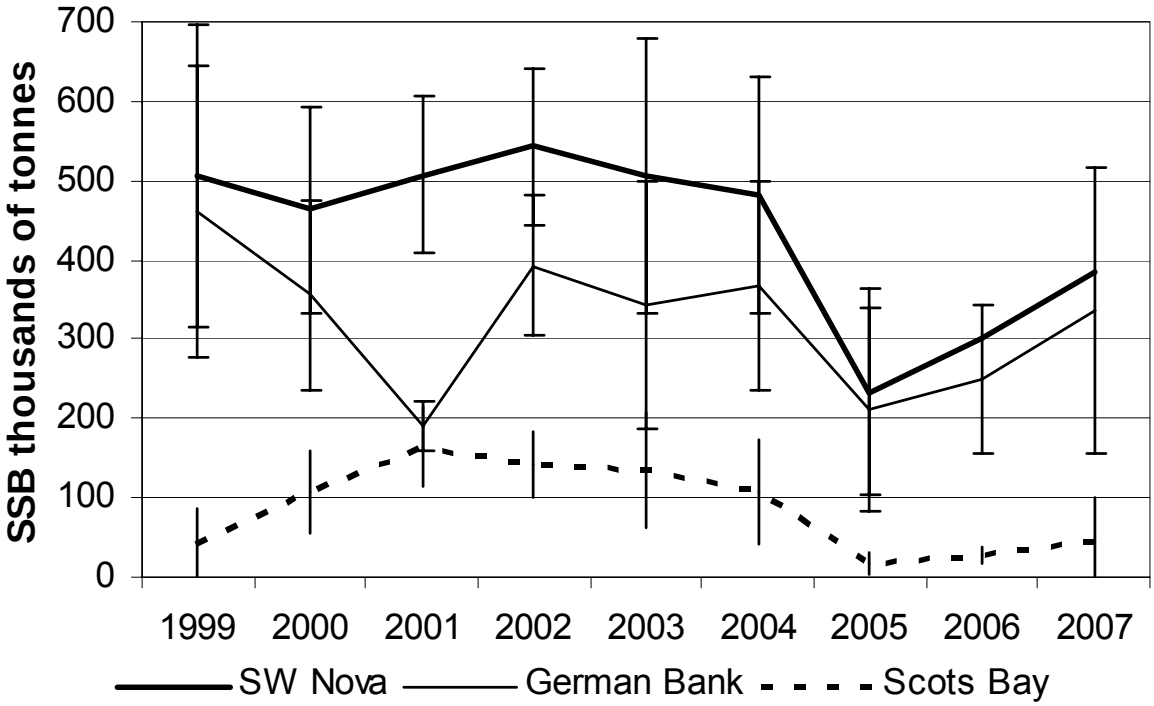


Figure 24. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component overall area and for the German Bank and Scots Bay areas.

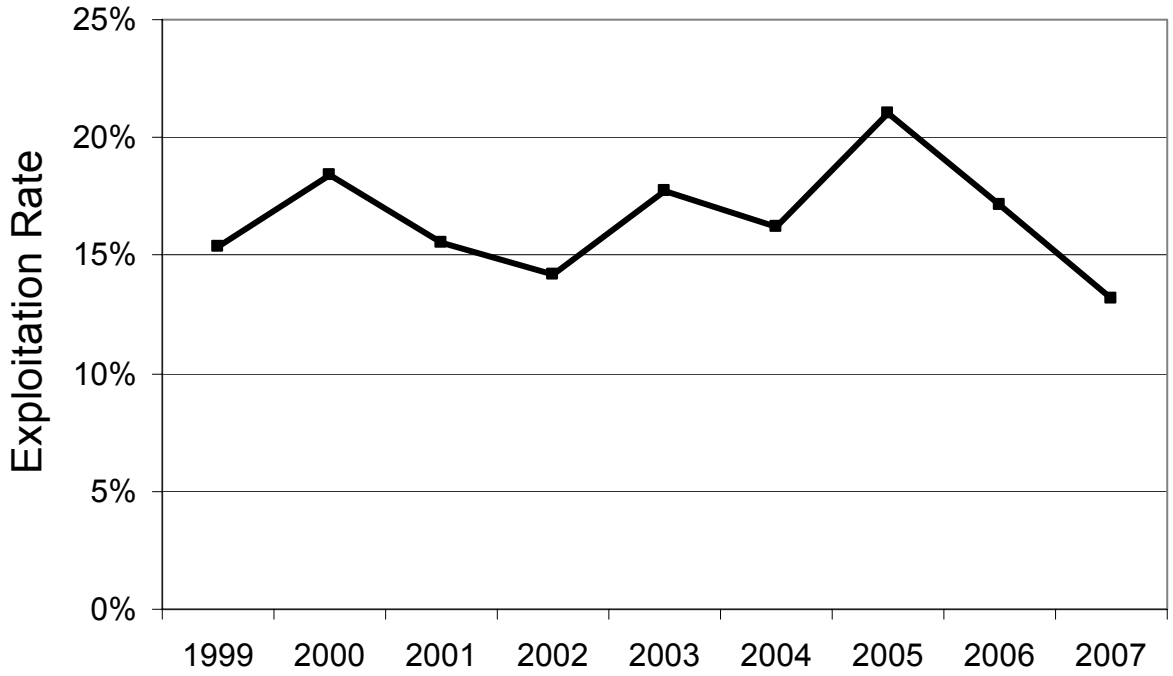


Figure 25. Relative exploitation rate for the SW Nova Scotia / Bay of Fundy spawning component using overall catch as a proportion of the overall acoustic SSB.

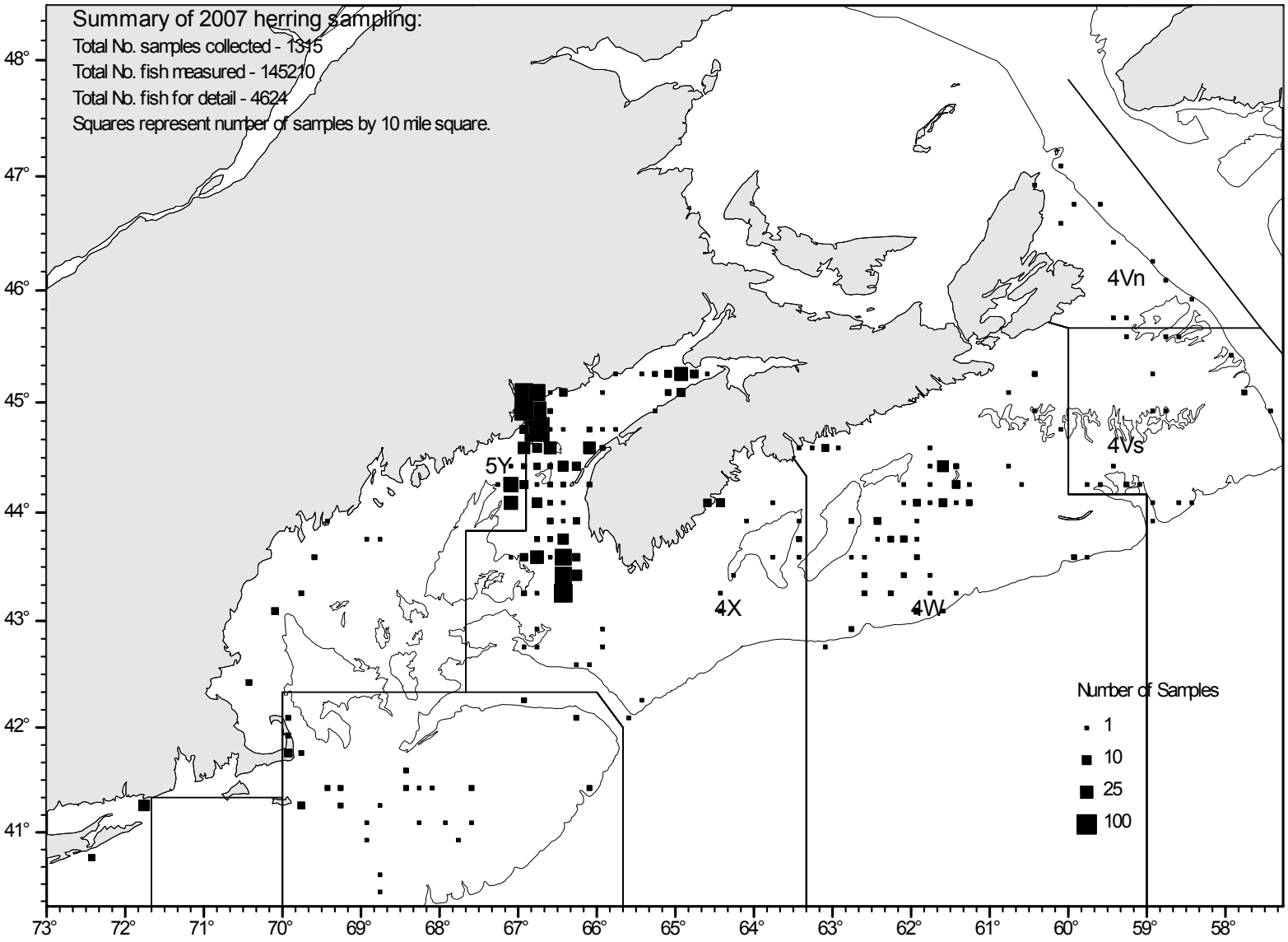


Figure 26. 2007 herring sampling coverage from all sources (number of length frequency samples by 10 mile square).

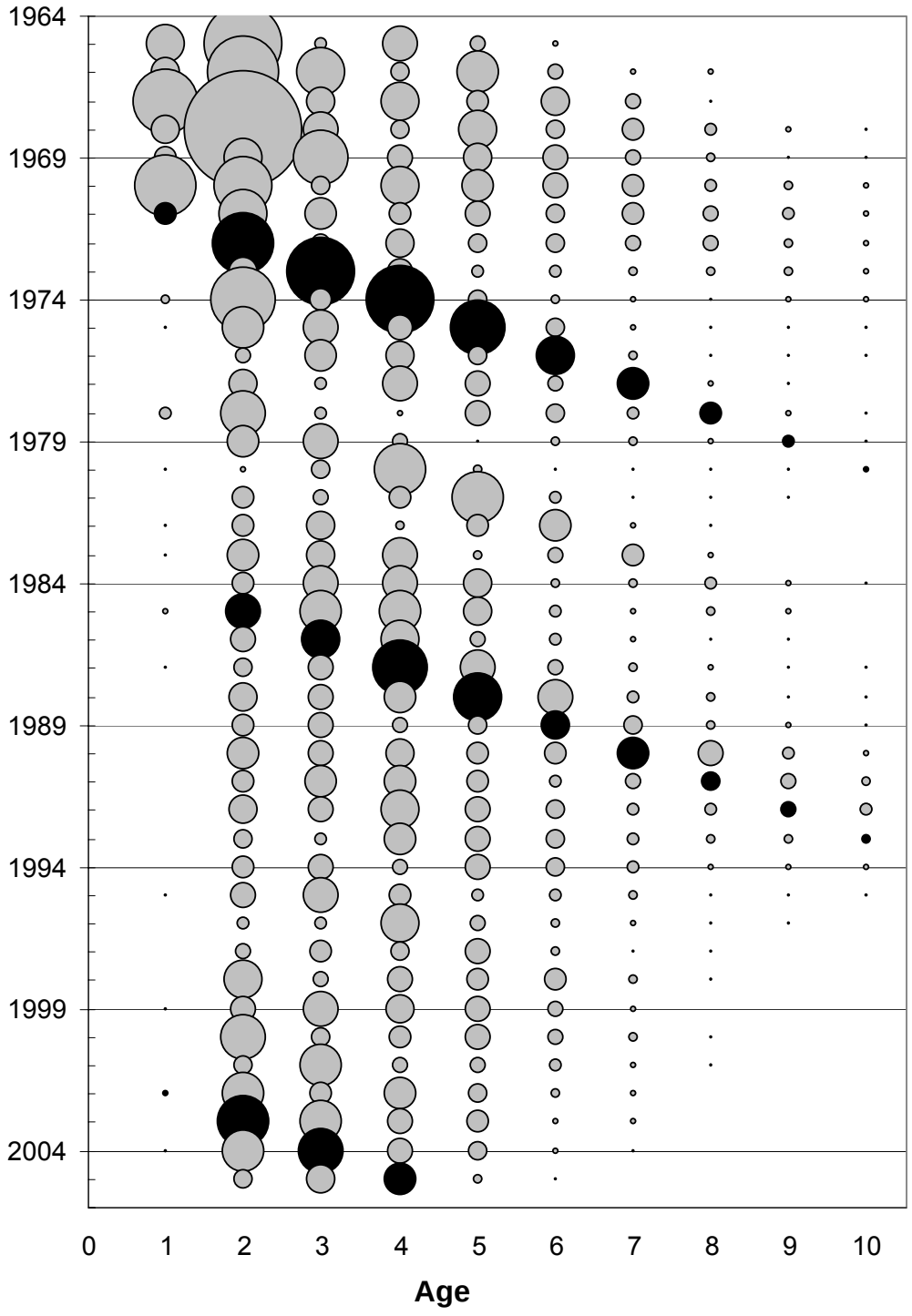


Figure 27. Historical catch at age (numbers) for the SW Nova Scotia / Bay of Fundy spawning component. Refer to Table 15 for actual numbers represented by symbol size. The value for 1968 at age 2 represents the maximum in the series of 2.389 billion. Several of the stronger year-classes are highlighted including the 1970, 1983 and 2001 year-classes (from Power et al, 2006a).

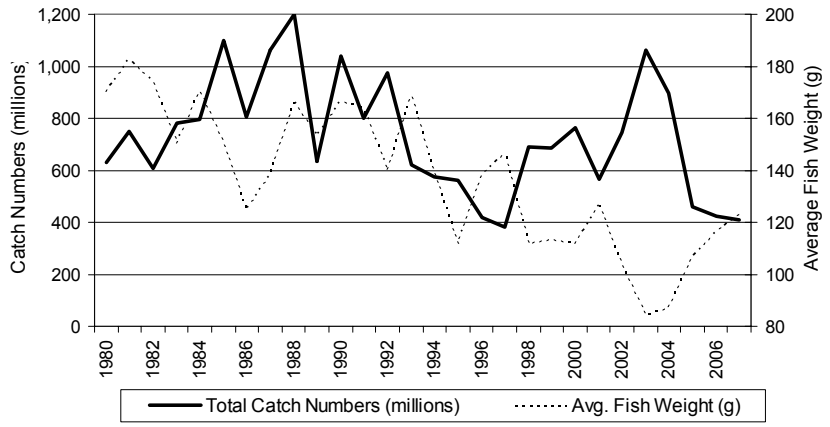


Figure 28. SW Nova Scotia spawning component total catch numbers (millions) and average fish weight (g) for the period 1980-2007.

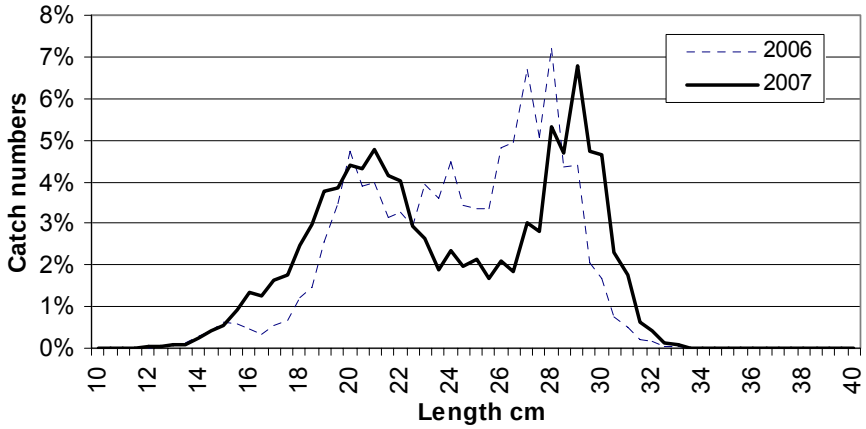


Figure 29. Catch at length (% number) for the 2006 and 2007 overall SW Nova Scotia / Bay of Fundy herring spawning component.

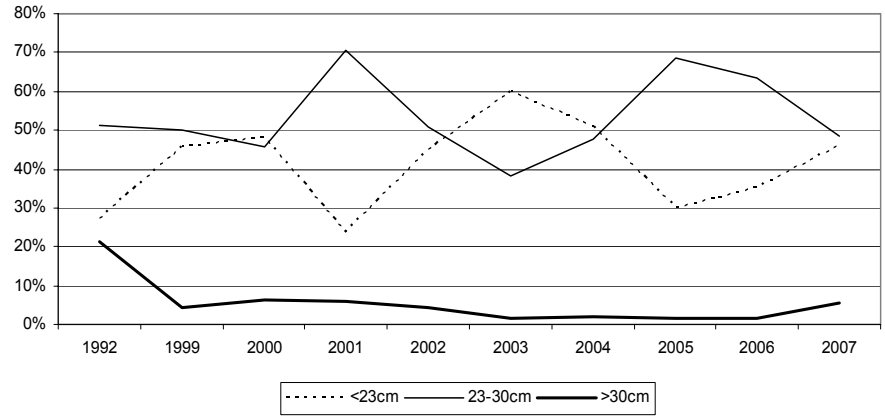


Figure 30. Proportions of size groups (% number) <23cm, 23-30cm and >30cm herring in the catch from the SW Nova Scotia / Bay of Fundy spawning component for 1992 and 1999-2007.

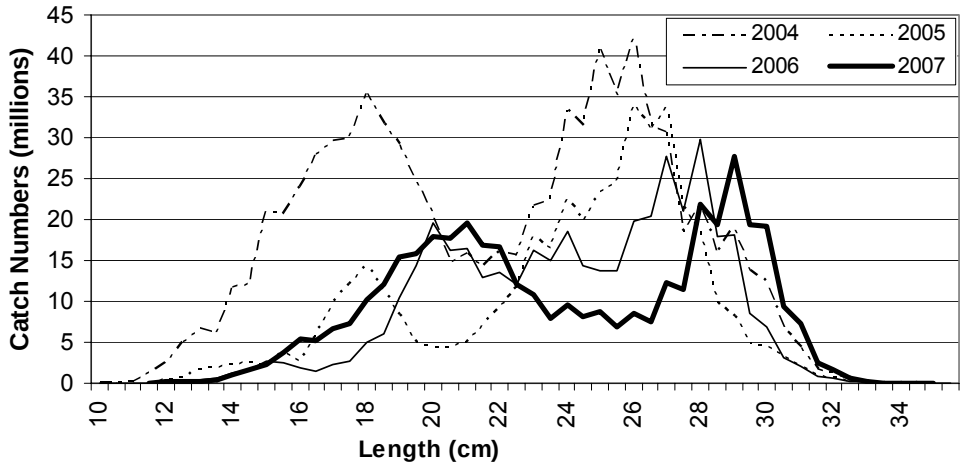


Figure 31. Catch weighted length frequency distribution of all herring from the SW Nova Scotia/Bay of Fundy spawning component from 2004 to 2007.

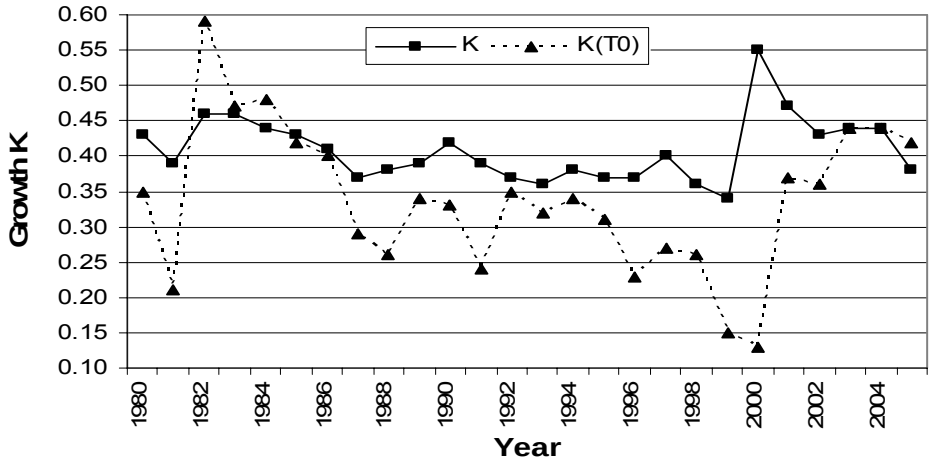


Figure 32. Comparison of growth rate K for a fixed and floating $t_0$ from 1980 to 2005.

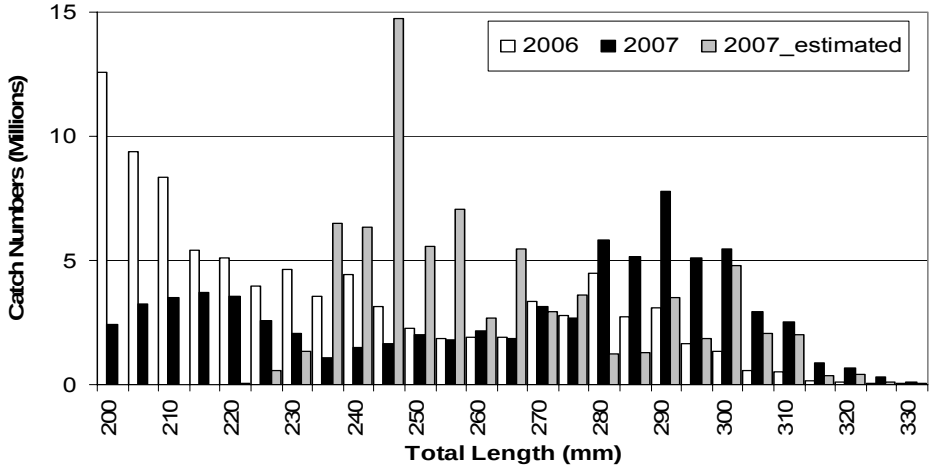


Figure 33: SWNS herring length frequency for 2006, 2007 and the estimated length frequency for 2007 where K= 0.38 and $L_{inf}$ = 344mm.

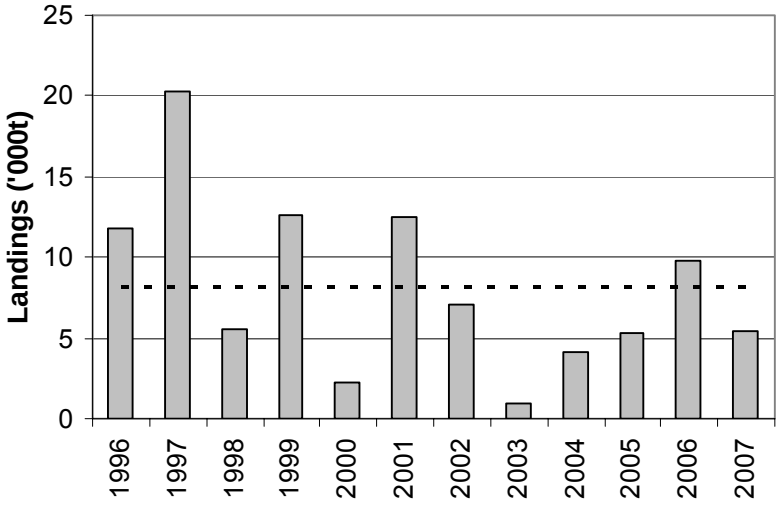


Figure 34. Scotian Shelf Banks landings from all gears since 1996 with the average for the period.

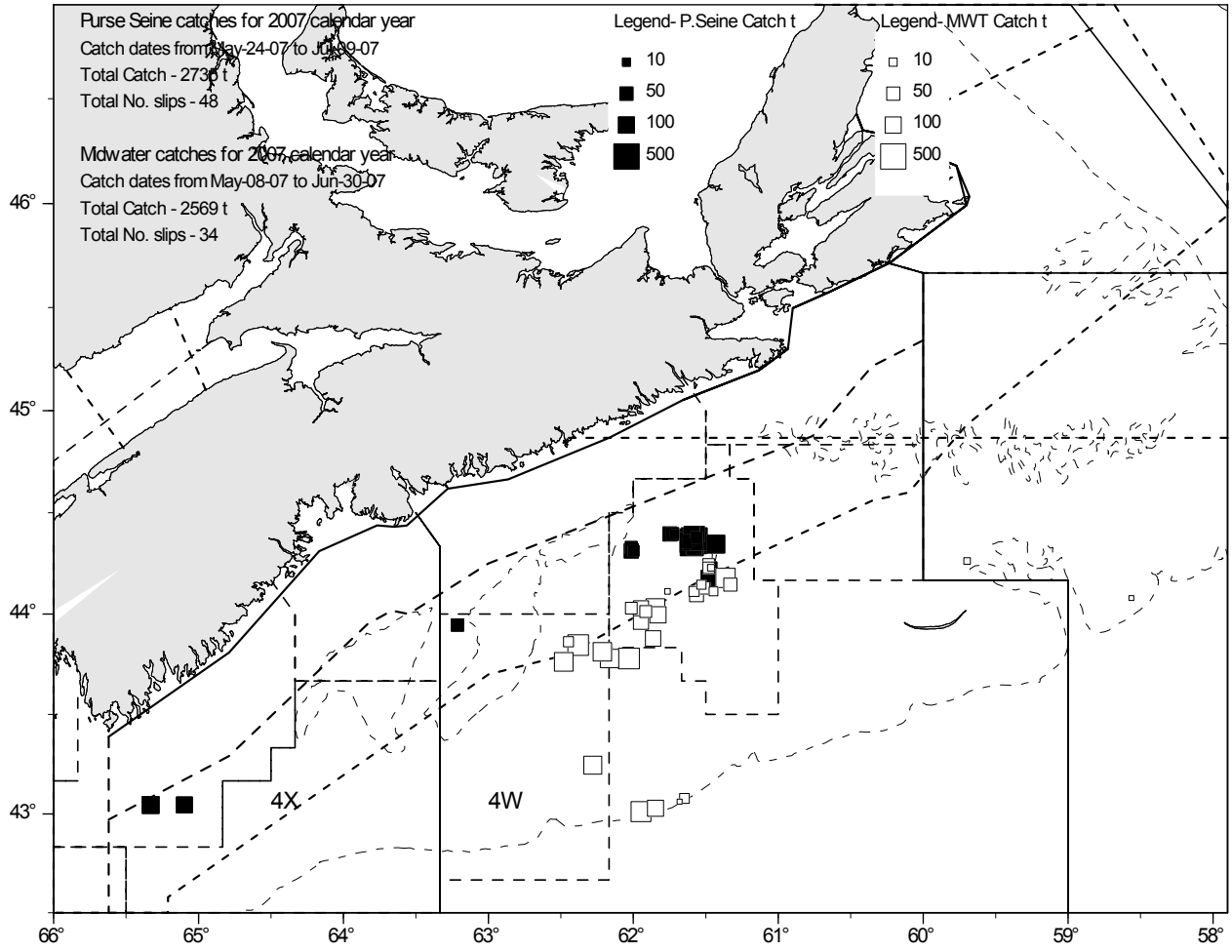


Figure 35. 2007 herring purse seine and midwater trawl catches on the offshore Scotian Shelf banks with embayment and offshore 25 and 50 mile lines shown.

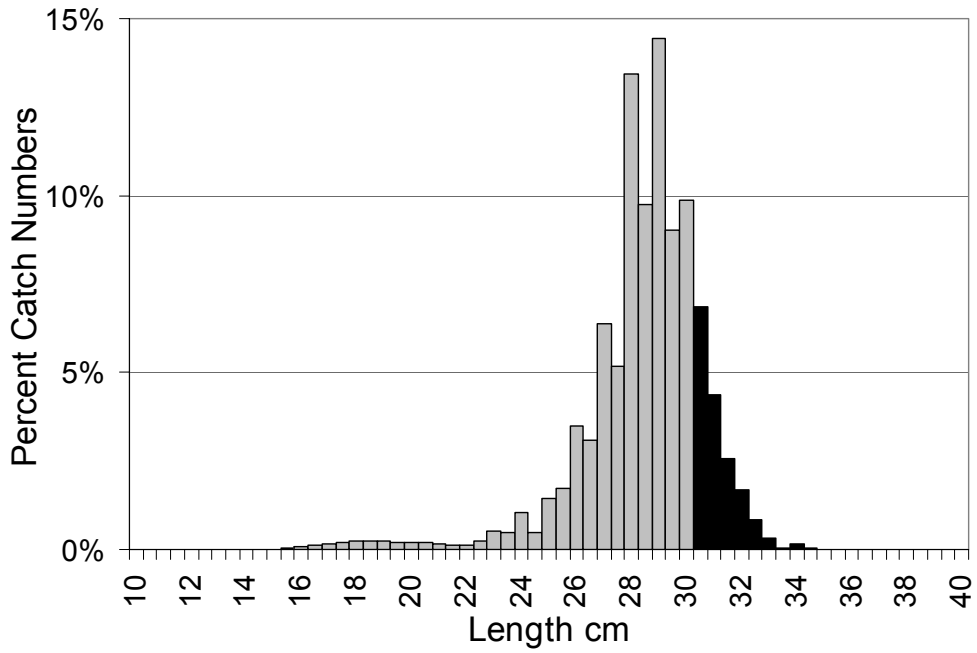


Figure 36. Catch at length (% number) for the 2006 offshore Scotian Shelf Banks herring spawning component. Highlighted dark bars represent sizes larger than 30cm.

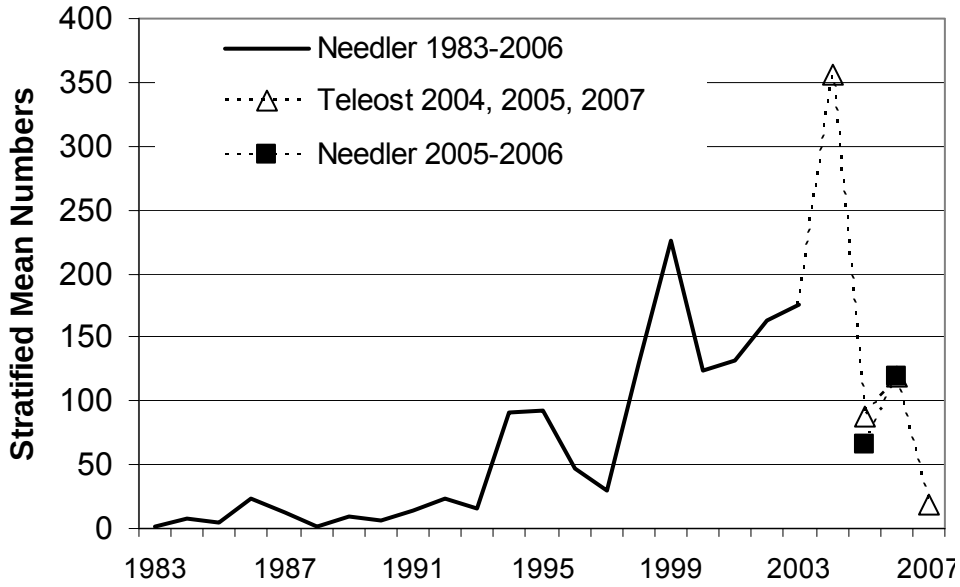


Figure 37. Number of herring caught per standard tow in the DFO summer bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 2007 (strata 55-78; from Sable Island to the Baccaro Line).

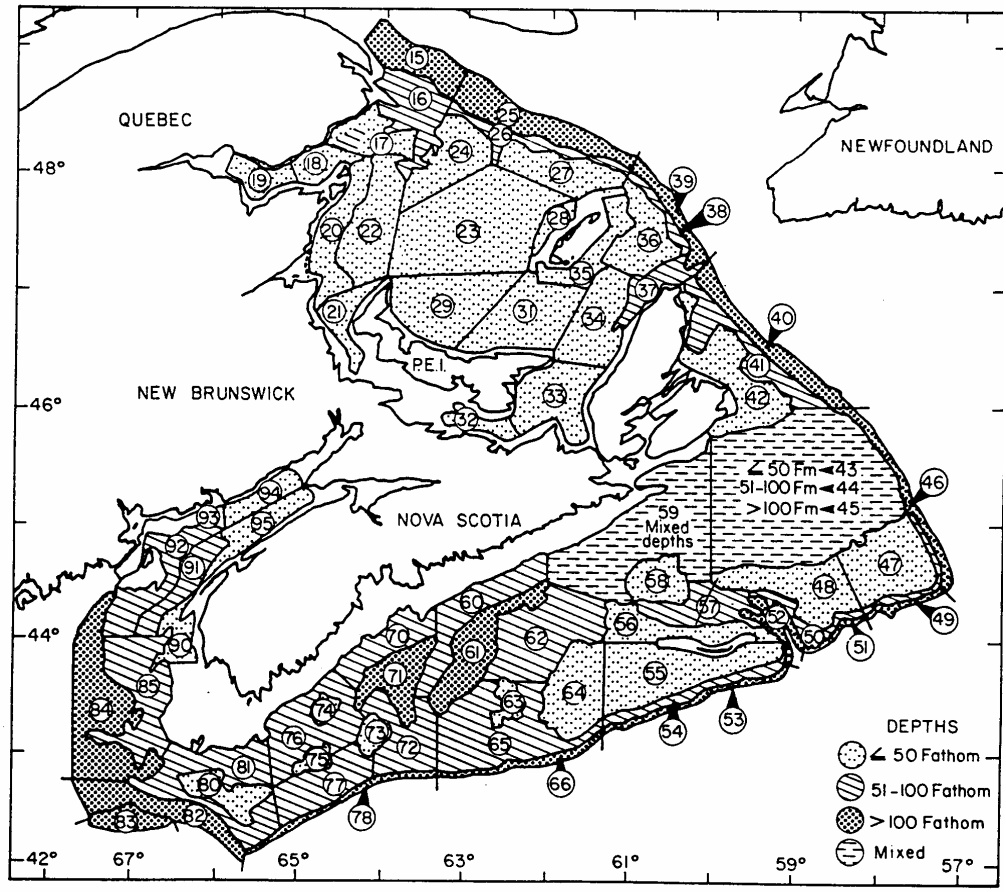


Figure 38. Research bottom trawl survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday, 1981).

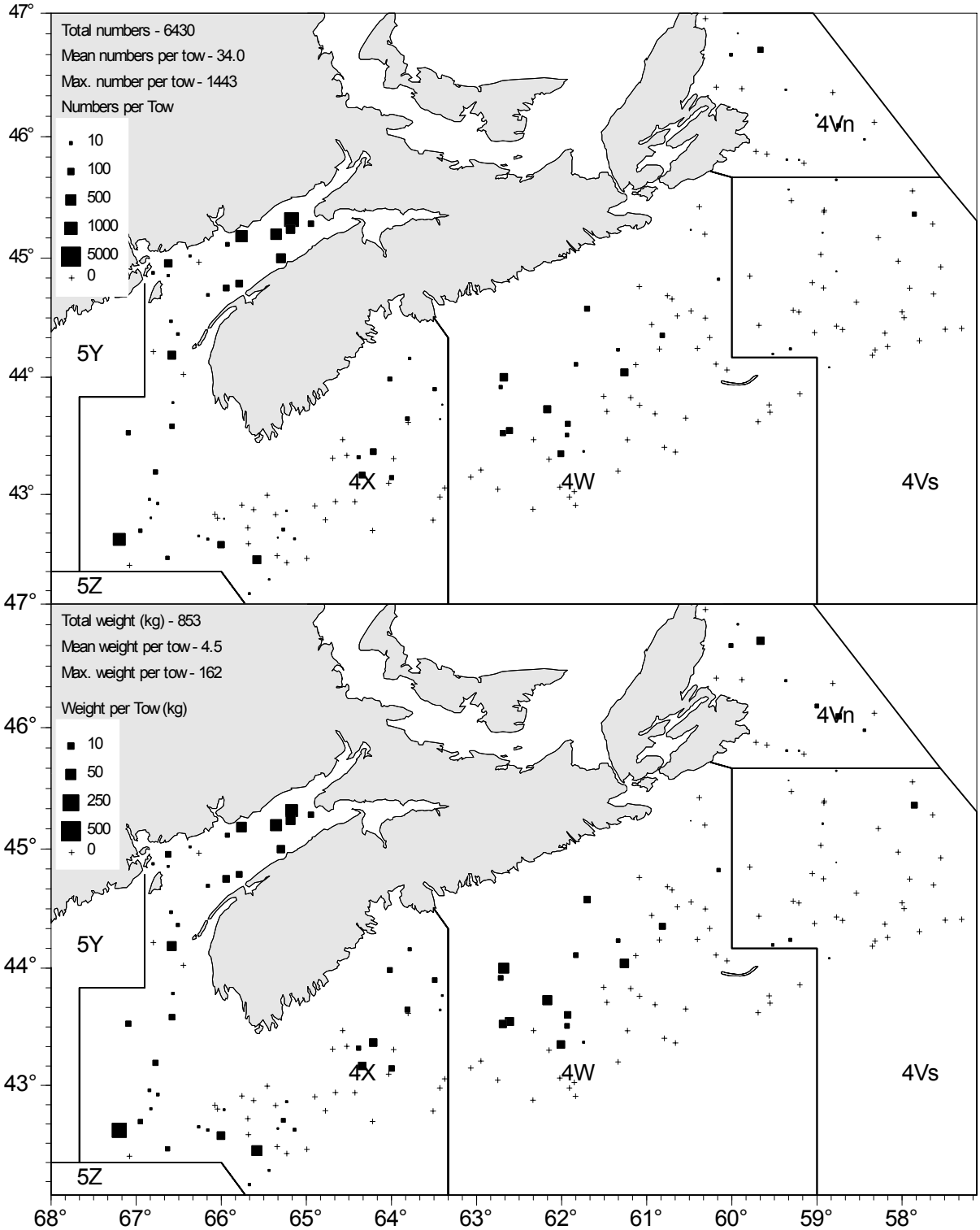


Figure 39. Herring catches in number and weight per tow for the 2007 DFO summer bottom trawl research survey (TEL2007-745: July 7-Aug. 2, 2007).

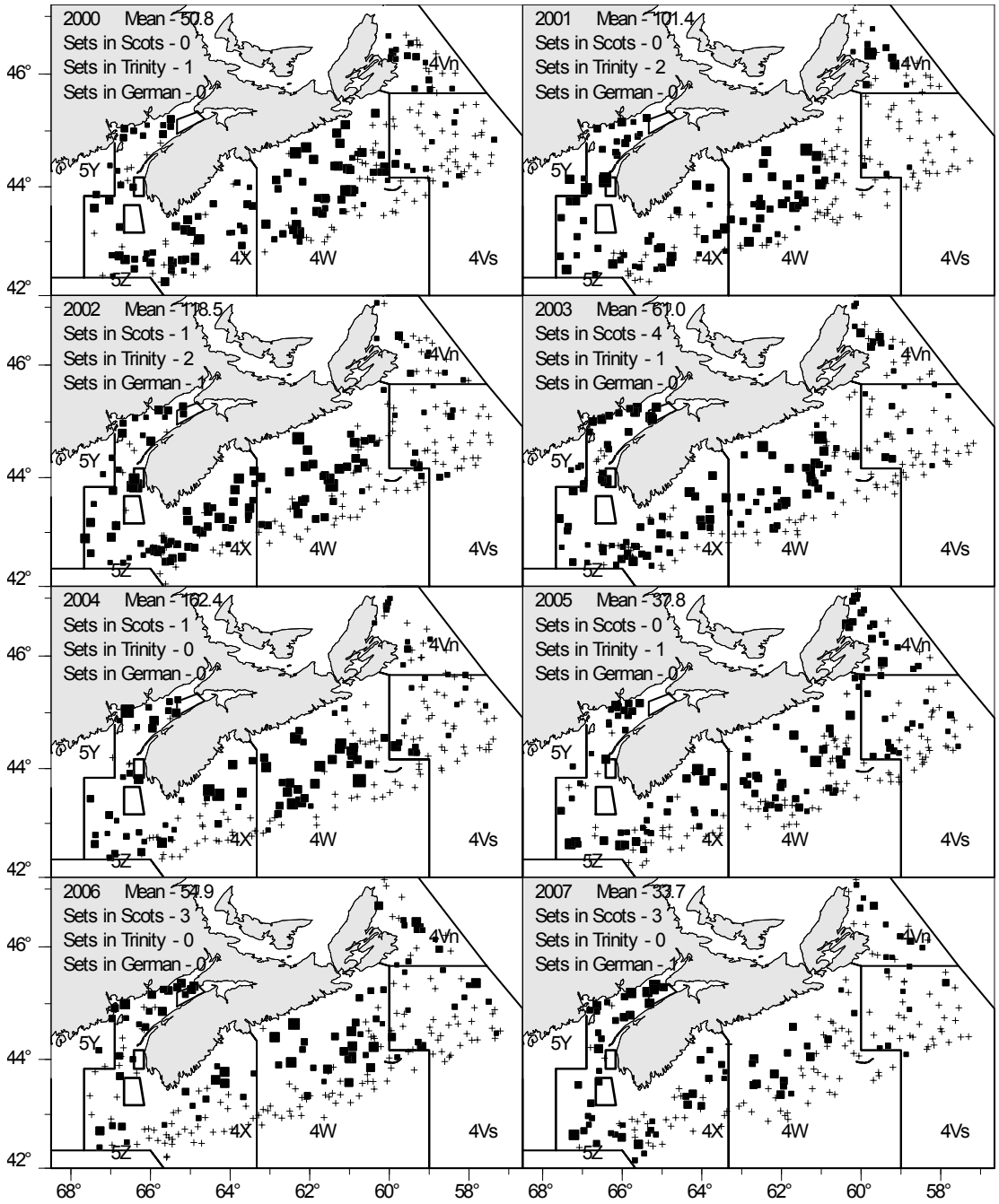


Figure 40. Herring catches from the DFO summer bottom trawl research survey for 2000-2007 (2005 using Alfred Needler data only). Mean numbers per standard tow and count of sets in Scots, Trinity and German spawning areas.

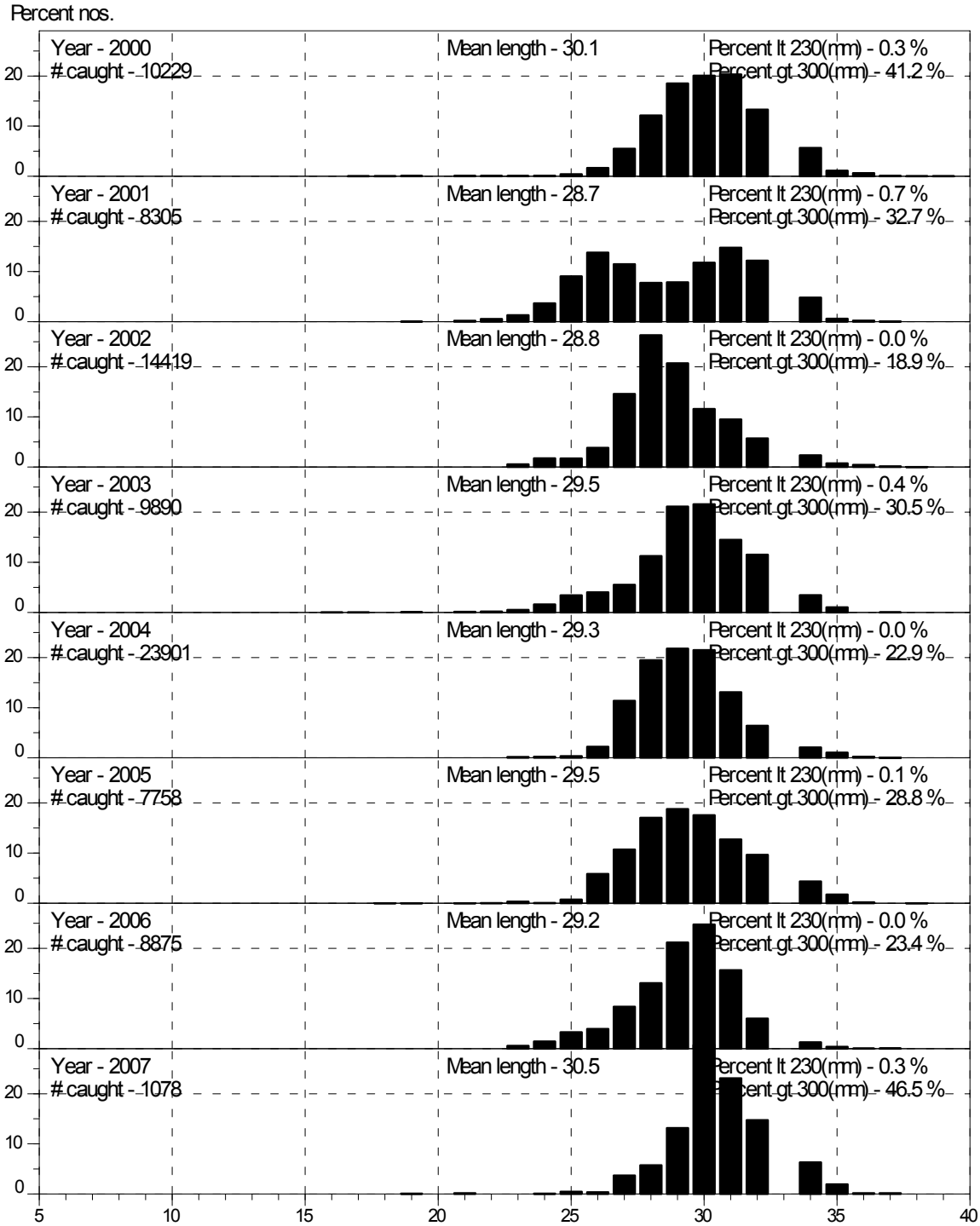

Figure 41. Herring size distribution in the DFO summer bottom trawl research survey for the Offshore Banks area (strata 53 to 78) from 2000 to 2007 (Note: sizes conversion from fork length to total length results in gaps at the 9, 20 and 33cm sizes).

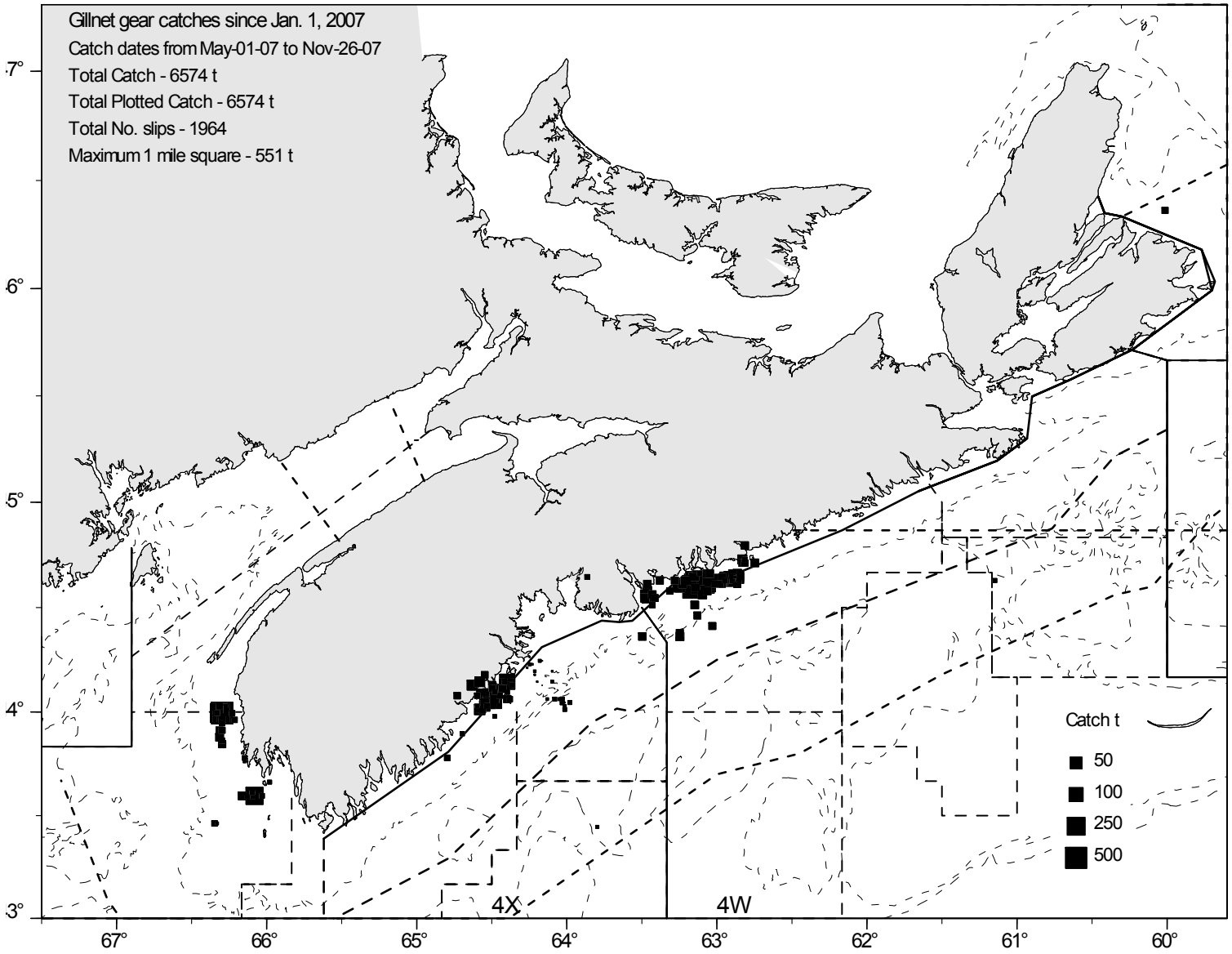


Figure 42. Herring set and drift gillnet catches (t) for 2007 calendar year for NAFO areas 4VWX (data from Statistics Division MARFIS database).

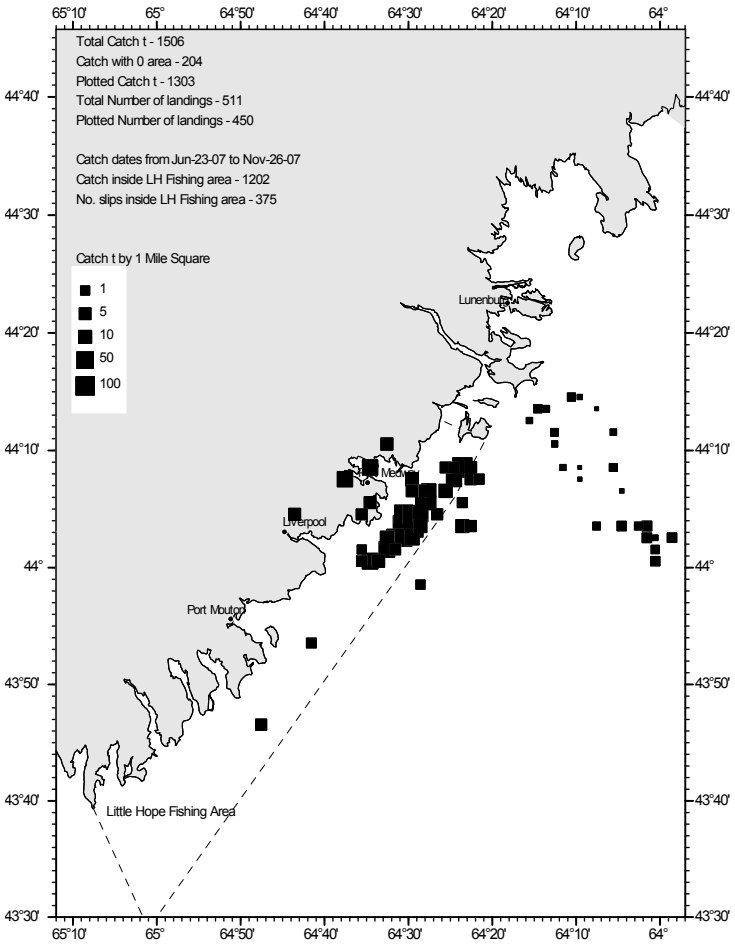


Figure 43. 2007 herring gillnet catch locations for landings in statistical districts 23-31 with amount caught within the Little Hope Fishing Area.

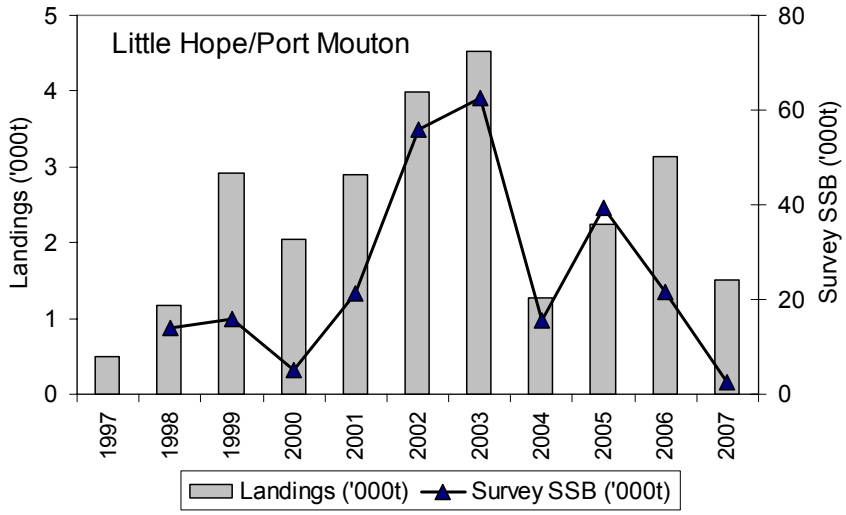


Figure 44. Herring landings and acoustic survey biomass (‘000t) for the Little Hope/Port Mouton gillnet fishery from 1997-2007.

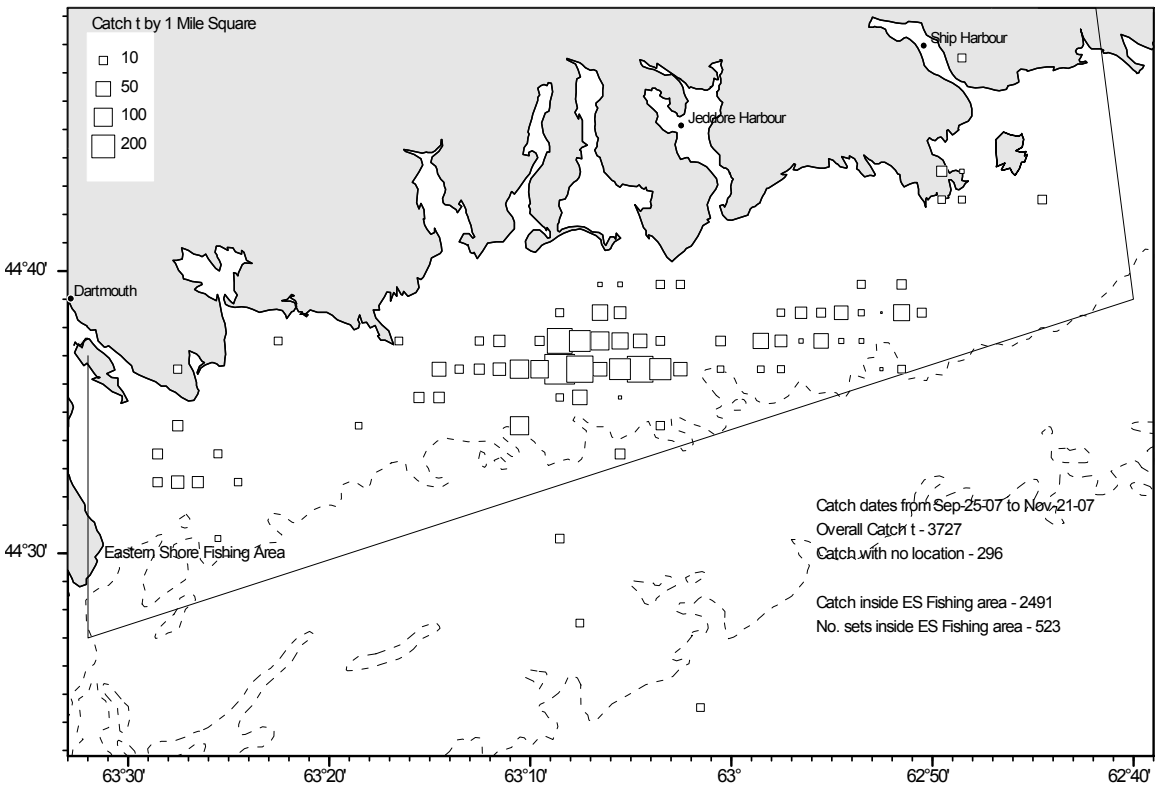


Figure 45. Gillnet herring catches for the 2007 fall fishery along the Eastern Shore Fishing Area (catches by 1 mile squares).

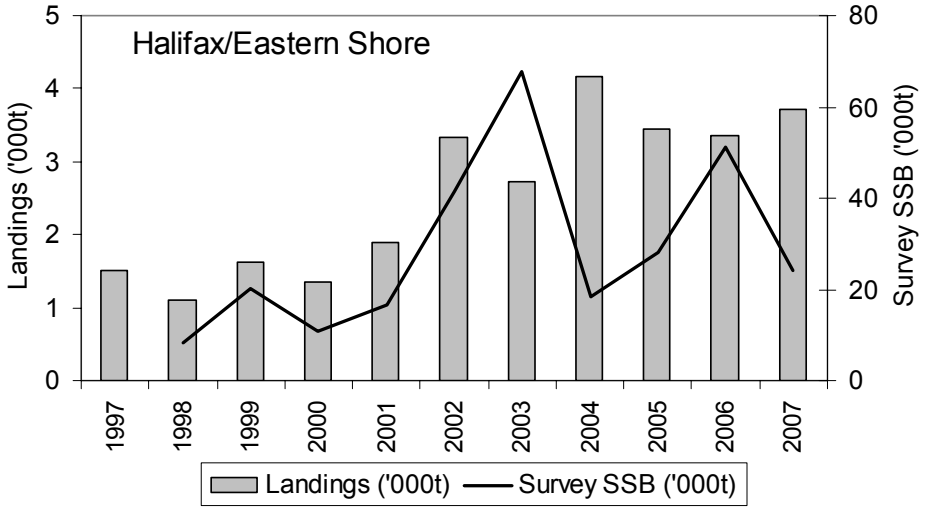


Figure 46. Herring landings and acoustic survey biomass (‘000t) for the Halifax/Eastern Shore gillnet fishery from 1997-2007.

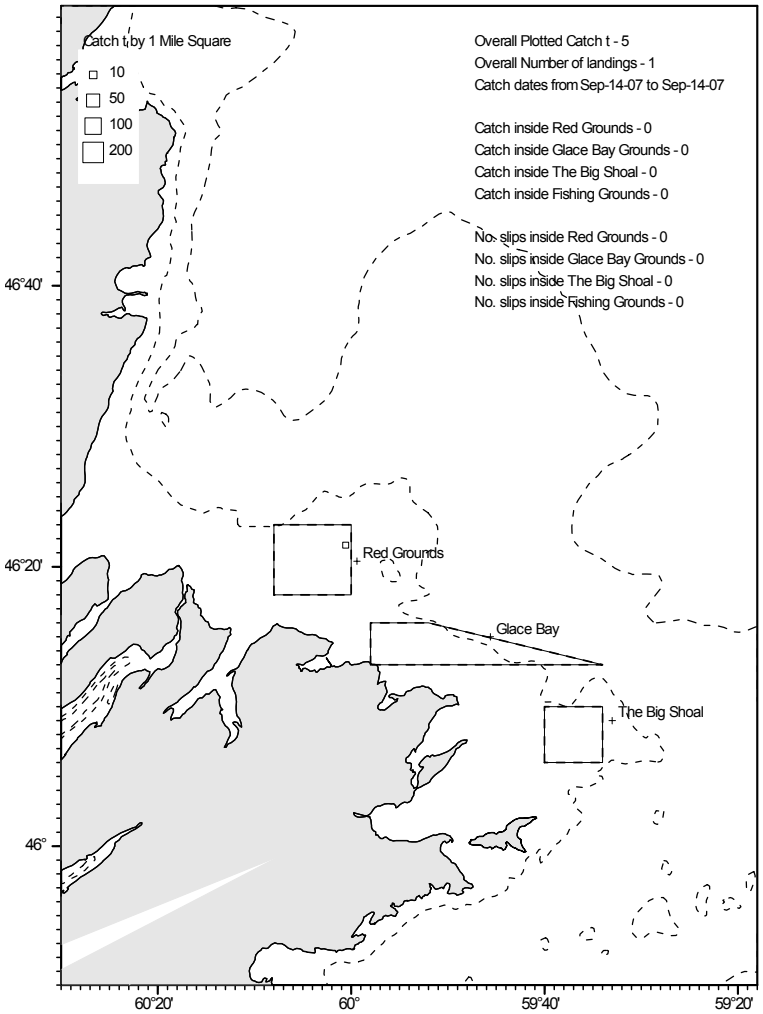


Figure 47. Glace Bay herring gillnet catches reported for the 2007 season. Note there was only one landing with 5t recorded.

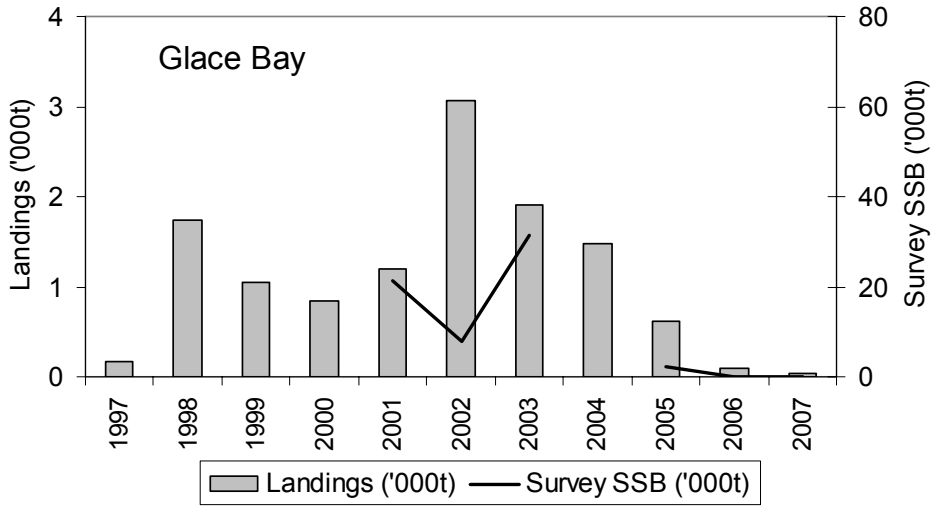


Figure 48. Herring landings and acoustic survey biomass (‘000t) for the Glace Bay gillnet fishery from 1997-2007.

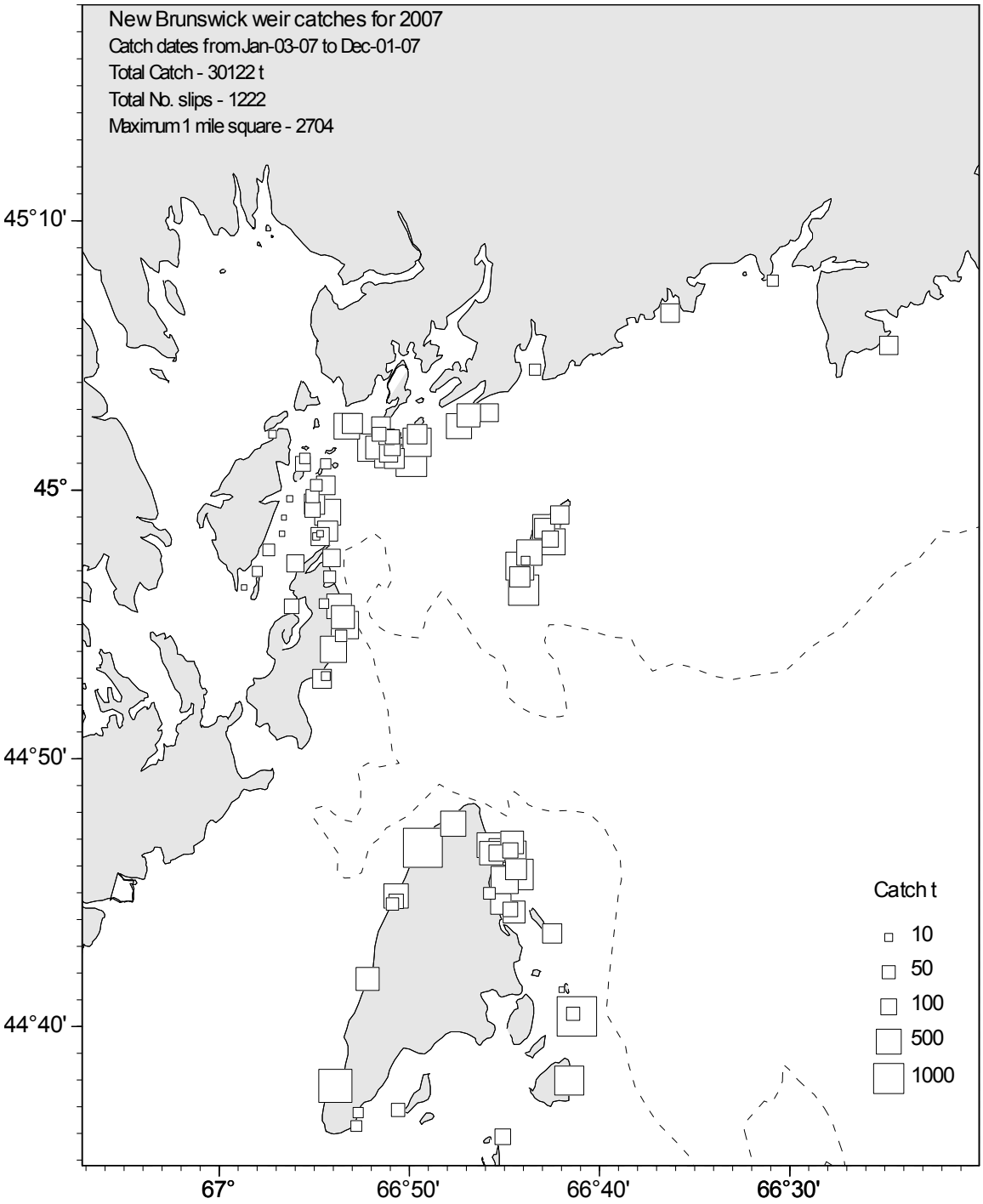


Figure 49. New Brunswick herring weir catches by location for the 2007 fishing season (data summed by one mile squares).

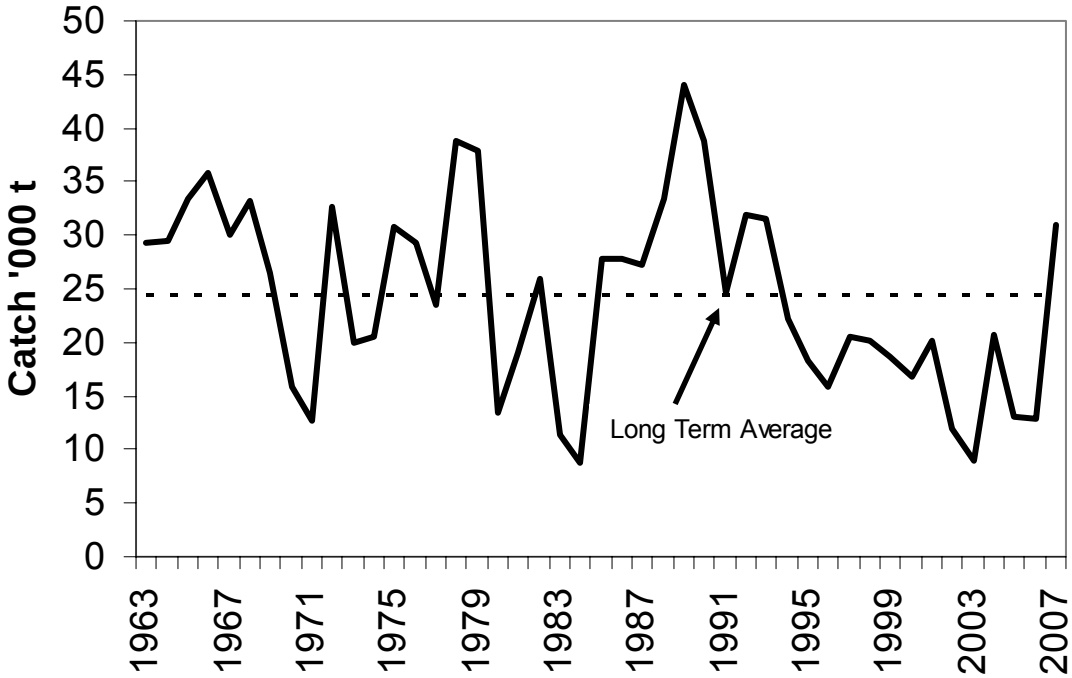


Figure 50. Herring landings from the southwest New Brunswick weir and shutoff fishery for 1963-2007 with the overall long term average.

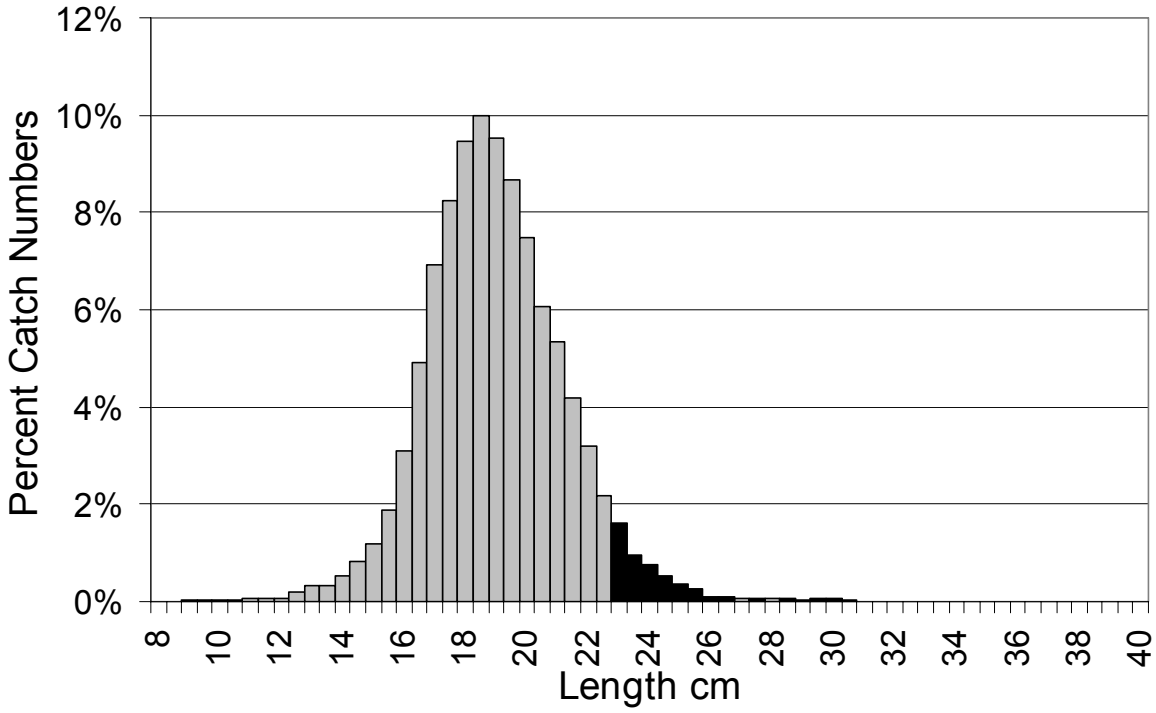


Figure 51. Catch at length for the New Brunswick weir fishery in 2007 with estimated percent numbers caught. Size categories 23cm and greater are shaded in black.