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2007 Evaluation of 4VWX Herring

Évaluation des stocks de hareng de 4VWX en 2007

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ABSTRACT

Landings in the southwest Nova Scotia/Bay of Fundy spawning component in 2006 of 49,160t were about the same as the previous year. The reduced quota has not been in place for a sufficient time to result in improvements to the biological characteristics of the population. There continued to be signs of deterioration in the state of the stock. Size distribution in the catch remained contracted, with little improvement in the proportion of larger and older fish in the fishery. The acoustic survey index from the spawning grounds in 2006 indicated a slight increase in spawning stock biomass (SSB) from 2005. There has also been little progress towards defined conservation objectives in recent years and most objectives are not being met.

There was an increase in landings to 9,800t from the offshore Scotian Shelf banks by purse seine, midwater and bottom trawl. The bottom trawl research survey catches demonstrated herring widely distributed over the Scotian Shelf but survey catches have declined substantially from the high of 2004.

There was an increase in surveyed acoustic biomass in the Halifax/Eastern Shore area while the Little Hope area saw a large decline. There was no survey effort and little catch in the Glace Bay area in 2006. The Bras d'Or lakes fishery was again closed and there was no sampling from this area.

The landings in the traditional New Brunswick weir and shutoff juvenile herring fishery remained low at 12,900t and there is a trend of decreasing landings over the past ten years. There was a large proportion of small recruiting herring in the weir catches during the 2006 season.

RÉSUMÉ

En 2006, les débarquements de géniteurs dans le sud-ouest de la Nouvelle-Écosse et dans la baie de Fundy se sont chiffrés à 49 160 t, soit environ l'équivalent de ceux de l'année précédente. La réduction des quotas n'a pas été appliquée pendant une période suffisamment longue pour produire des améliorations au niveau des caractéristiques biologiques de la population. On observe encore des signes de détérioration de l'état du stock. La distribution des tailles des poissons capturés est demeurée restreinte, même si de légères améliorations sont survenues dans la proportion de poissons plus gros et plus âgés débarqués. L'indice du relevé acoustique effectué sur les frayères en 2006 indique une légère hausse de la biomasse du stock reproducteur par rapport à 2005. Au cours des dernières années, on a également enregistré peu de progrès relativement aux objectifs de conservation établis, et la plupart de ces objectifs n'ont pas été atteints.

Les débarquements de poissons provenant des pêches à la senne coulissante, au chalut pélagique et au chalut de fond menées sur les bancs au large du plateau néo-écossais ont connu une hausse pour s'établir à 9 800 t. Malgré un déclin important depuis le pic de 2004, les prises au chalut de fond effectuées lors des relevés scientifiques démontrent que le hareng est fortement répandu sur le plateau néo-écossais.

On enregistre une augmentation de la biomasse calculée au moyen de relevés acoustiques dans la zone de Halifax et de la côte est, tandis que la zone de Little Hope affiche un déclin important. Aucun effort d'échantillonnage n'a été consenti et de faibles prises ont été enregistrées dans le secteur de Glace Bay en 2006. La pêche a de nouveau été interdite dans le lac Bras d'Or, et l'on n'a pas effectué d'échantillonnage dans cette zone.

Au Nouveau-Brunswick, les débarquements de la pêche au hareng juvénile traditionnelle à la fascine et à la senne de plage sont demeurés faibles, à 12 900 t, et l'on observe une tendance à la baisse pour ce qui est des débarquements au cours des dix dernières années. On a observé une grande proportion de petits harengs recrues dans les prises à la fascine durant la saison 2006.

2006 Evaluation of 4VWX Herring

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, there were no herring landings in 2006 from the Canadian portion of Georges Bank (Table 1). This fishery is included in the Gulf of Maine stock complex and has been recently evaluated separately (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”.

Three conservation objectives developed and reviewed by Sinclair (1997) 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.

2) SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

2.1 The Fishery

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). Landings for the 2005/06 quota year (from Oct. 15, 2005 to Oct. 14, 2006) were 49,160t for the SW Nova Scotia / Bay of Fundy component (Table 1). There were additional landings of 29,360t in the non-stock components for an area total of 78,520t. Landings for the current 2006/07 quota year were 2,300t as of March 28, 2007 (Table 2).

Landings have tracked the TAC in recent years with most of the quota being taken for each year since 2002 (Table 3, Figure 6). Total landings from this component in 2005 and 2006 are among the lowest on record since 1963. Most of the catch over the history of this fishery has been caught by purse seine gear with the 4X summer purse seine component being the most important (Figure 7). Landings by the purse seine sector accounted for most of the component catch in 2006 (Figure 7, 8), with minimal landings by the gillnet sector (720t) and the Nova Scotia weirs (2,500t) (Table 1). Eighty percent of the catch limit was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. Transfer of unused quota to the mobile fleet occurred in September, 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 (Figure 5). The spatial distribution of the purse seine fishery in 2006 was similar to the previous year with the largest catches occurring on German Bank and around Grand Manan (Table 4, Figure 9). Landings of about 16,500t from the German Bank area made up about 35% of the catch. There was a substantial decrease in the 2006 landings for Scots Bay to 3,400t from the high of 24,900t recorded for this area in 2004 and there was also a large decline in landings from the Long Island area to only 1,900t. Small increases in landings of summer feeding fish from the Gannet/Dry Ledge and Lurcher areas were recorded. Catches of non-stock component herring by purse seine came mainly from the offshore Scotian Shelf area (Table 5).

During the 1970’s and 1980’s, a large purse seine fishery took place on over-wintering aggregations in Chedabucto Bay. 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.

In the 2005-2006 quota year, purse seine landings of 470t were reported in Oct. 2005 and 460t in Jan. 2006 (Table 1, Figure 10, 11). The summer purse seine fishery took place in similar areas as in previous years (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).

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, 13). The peak year of 2004 was unusual in several aspects, with the highest recorded catch of 24,400t and the longest season extending to Sept. 16. In 2004, the distribution of catches was also more widespread extending both north and east of the innermost strata survey area (Figure 12). In 2005 the overall catch was reduced to only 5,870t and was limited to areas 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 was similar in overall duration to the previous year with catches scattered within the defined spawning area but there was a reduction in overall fishing activity with 3,350t landed and less than half of the number of landings (slips) than in the previous year (Table 6). 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.

German Bank:

German Bank is usually the location of one of the major summer herring purse seine fisheries with catches since 1985 ranging from 9,000 to 36,000t during the overall fishery period of early May to late October (Table 7). Catches during the spawning period from August 15 to October 31 have been reduced since the reduction in the quota in 2003 with about 12,000t landed from the main strata survey area. The percentage of the total German Bank catch taken during the spawning period has remained steady between 50 and 70%, 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 concentrated mostly within the defined survey box area (Strata area). This differed from previous years since about 2000 when catches were more widely scattered over the larger catch area (Figure 16). Catches during the spawning period in 2006 were very similar to those of 2005 with two localized groups of presumed spawning herring seen within the Strata area and more scattered groups seen north of the survey box (Figure 17). These scattered groups are usually shown from sampling to be pre-spawning or juvenile sized herring.

Daily catches in 2006 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 appeared to be reduced compared to recent years, with totals of less than 500t per day.

Trinity Ledge:

The Trinity Ledge spawning ground is still considered to be recovering and is closed to purse seine gear from Aug. 15 to Sept. 15. In 2006 there were acoustic surveys followed by some catch by drift gillnet gear. The herring gillnet fishery in the Trinity Ledge and Spectacle Buoy fishing area took place between June 3 and Sept. 21, 2006 with total landings of 719 t (Table 1, Figure 19). On Trinity Ledge catches began around Sept. 7 with landings of less than 50t/day until Sept 14; these then increased to about 100t/day with some gaps until Sept 21 (Figure 20).

Outside of this component additional catches by drift gillnet gear occurred in Sept. to Oct. in the Little Hope/Port Mouton spawning grounds. There were also set gillnet catches along the Eastern Shore to the east of Halifax and near Glace Bay in Cape Breton (Figure 21).

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. In 2005, a single survey of the Spectacle Buoy area was undertaken on June 6 which estimated a total survey biomass of only 292t in an area of 0.57 km^2. Landings were minimal in the Spectacle Buoy area in June 2006 with less than 10t reported and no surveying completed. A single acoustic survey of Spectacle Buoy was completed on Sept 10, 2006 during the fall spawning season. Purse seine vessels also explored the area on Sept. 15 during one of the German Bank surveys but documented no herring.

Nova Scotia weirs:

Catches in the Nova Scotia weirs of 2,500t were just below average after the record lows of 2000 and 2003 (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. The seasonal timing of the Nova Scotia weir landings has shifted in the last 4 years with a higher proportion of landings now as late as August. and September, compared with the traditional early fishery seen in May and June previously (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 but the catch per weir (t) for the Nova Scotia weir fishery has been above average in recent years (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 and showed little trend and are considered unrepresentative due to the very small amount of catch and effort (Power et al., 2004). This trend of reduced catch and effort continued in the 2006 fishing season and so this data was not reexamined.

Purse seine landings make up most of the overall catch and are allocated 80% of the TAC in 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 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 to find these schools with catch rates remaining high or stable at even low stock levels.

2.2 Resource Status

Acoustic Surveys

Automated acoustic recording systems deployed on commercial fishing vessels were used to document the distribution and abundance of herring by industry vessel surveys (Power et al. 2007). Scheduled surveys were conducted every 2 to 3 weeks on the main spawning components and an index of spawning stock biomass for each component was estimated by summing these results (Table 11). A major source of uncertainty continues to be the assumption that the biomass estimates from the surveys are simply additive. If herring remain on the spawning grounds for more than one survey then the estimate of total SSB will be significantly biased upward due to double counting. If herring move on and off the spawning grounds between surveys then the estimate of total SSB will be an underestimate. As well, in recent years herring have been observed close to bottom, making them difficult to enumerate acoustically which may also lead to an under-estimation of biomass from acoustic surveys.

In 2006, three surveys were conducted in Scots Bay, a reduction of one survey over the previous two years. Four surveys were completed on German Bank. Additional data from fishing or survey nights in Scots Bay, German Bank, Browns Bank, Seal Island and Spectacle Buoy areas were examined. Five surveys were conducted on Trinity Ledge and the documented amount of spawning fish was higher for this area than the past two years but survey area coverage was again limited. There were no surveys and no reports of spawning herring on Lurcher Shoal. The Seal Island and Browns Bank area grounds had only fishing night estimates of presumed spawning fish. For German Bank and Scots Bay areas these surveys provided good coverage of the spawning areas consistent with previous years and with established protocols. Biomass estimates for Scots Bay, Trinity Ledge and German Bank were approximately 28,600t, 8,500t, and 245,500t for an estimated total SSB of 282,600t in the traditional survey areas, which is an increase from 2005 but still well below average for the eight year series (Table 11, Figure 24).

From 1999 to 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 growth in the population has not been observed in the surveys and an increase in proportion of larger/older fish has not been observed in either the surveys or the fisheries. The small proportion of larger/older fish in the population indicates that the total mortality on this stock is high.

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 Banks 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 in 2001 all tag returns were from within 8 days of tagging but 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 after tagging. As a result, acoustic surveys that were spaced at 2 week intervals were surveying some of the same fish twice. 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 in 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 which should include work on the duration of the maturation process, further tagging with more frequent intervals to estimate turnover rates and increased survey frequency to reflect maturity stage duration.

Exploitation Rates on Spawning Grounds

The acoustic survey estimates and catches from individual spawning areas were examined in an attempt to estimate partial exploitation rates on the different spawning groups and for the overall complex. This information can be used to assess the impact of fishing and to estimate the relative size of individual spawning units within the complex (Table 12). For this analysis only the three spawning components for Scots Bay, German Bank, Trinity Ledge which have received relatively consistent survey effort since 1997 were included. Since there are also issues regarding comparability of acoustic surveys, in terms of the area of survey coverage among years, only data since 1999 were included in the overall averages (Table 12-A1). Catches throughout the year directly from the spawning grounds areas were assumed to be site specific (Table 12-C1), while catches from all other areas were considered non-spawning and were allocated based on the relative spawning ground SSB proportions (Table 12-A2, C2). In addition the SSB for Seal Island and Spectacle Buoy were allocated to the German Bank spawning area. The exploitation rates were calculated from both the actual catch on the spawning grounds and the overall adjusted catch as a simple proportion (Catch / SSB) (Table12-P1, P2).

Calculation of exploitation rates by component since 1999 (Table 12-P2) showed that the larger grounds (German Bank and Scots Bay) had an average exploitation of 15 to 23% while Trinity Ledge was calculated as 51%. Individual values for specific years and areas were highly variable (from 12 to 146%) due to catch allocation as well as inconsistent survey effort over the period. The overall exploitation rate for the 4WX stock ranged between 14 and 21%, which is close to the target of $F_{0.1}$ = 0.22 (exploitation of 18%). 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.

Sampling

Comprehensive biological sampling continued with substantial involvement of the fishing industry. In 2006 a total of 1,250 samples (147,500 fish) were measured for length while 5,510 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 purse seine 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 25).

Catch at Age

Recent developments since the April 2006 herring RAP have identified inconsistencies in ageing that may have an impact on the age based assessment results. 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).

However, for comparison purposes and 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 2006 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 age and 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 26). The series is now 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 results in reduced yield and is reflected as a decrease in the average weight of fish in the overall catch at age (Figure 27). This indicator has declined from an average fish weight of 160 to 180g in the 1980's and 1990's to an average fish weight of about 90g in the 2003. 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 industry (Iles 1993). If there is a recruitment fishery on younger ages , a lack of knowledge on the size of the incoming year-classes is a cause for concern. However, the most recent years have seen a trend toward a larger average fish size with the 2006 average size near the long term average of 125g.

Size composition of catch

The size composition of the catch was determined from the length sampling data and was calculated for the stock component using the appropriate catches and monthly length weight relationships. The 1992 catch at length was also determined for comparison with the current data. The time around 1992 is considered to be a period when the stock was known to have a broad size and age distribution but was also in a state of decline (Power et al 2006a). The catch at length for 1992 had a broad distribution of sizes from less than 10cm to 38cm with a substantial proportion (21%) greater than 30cm (approximate mean size for a 5-6 year old herring) (Table 16, Figure 28).

In 2006, the catch at length was composed of 35% <23cm (50% maturity at length), 63% from 23 to 30cm and 1.7% for sizes larger than 30cm (Table 16, Figure 29). There has been an absence of older/larger fish in the catch since 1999 (Figure 30). The length distribution in the catch for sizes greater than 30cm declined between 2000 and 2003 and remains low at around 2% (Figure 31).

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, which had been as high as 60% in 2003 (Table 16). This, combined with the reduced TAC, has led to an increase in the proportion of adult fish from 23 to 30cm in the catch (Figure 31). The total removal of fish by numbers was also reduced by close to 50% in 2005/2006 relative to 2004 (Table 16).

Stock Trends

A population model (Virtual Population Analysis, VPA) was conducted on this stock component in 2005 (Power et al., 2006a). Estimates of relative abundance from the acoustic surveys were used to calibrate the analysis. While the trends in modelled abundance followed those in the survey, there was an inconsistency in the absolute estimate of biomass determined by the VPA and the absolute estimate provided by the acoustic survey. 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).

In April of 2006, ageing inconsistencies were identified that may have an impact on the age based assessment results (DFO 2006) (Figure 32). The terms of reference for the 2007 RAP assessment meeting requested "An evaluation of the southwest Nova Scotia / Bay of Fundy spawning component, including an evaluation of the implications of the aging errors uncovered in 2006 on the current VPA-based assessment formulation." (Melvin and Power, 2007) 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. The estimated fishing mortalities for 1995-2006 from these simulations (Figure 33) were variable and consistent with the previous investigation (Figure 32), and no scenario produced fishing mortalities at or below $F_{0.1}$ (F=0.23).

Fishing mortality remains high and is considered to be well above $F_{0.1}$. This is supported by the simulations and the contracted size range observed in the catch and survey (Figure 29). The recent increase in abundance of herring in the 23-30cm size range is a positive signal for potential future population growth (Figure 31). On balance however, the stock is still low relative to historical levels.

2.3 Sources of Uncertainty

The potential benefits of the reduced quota in 2005 and 2006 will take time to be reflected in the biological characteristics of the population. 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 herring year-classes is highly variable and there is no index of recruitment. Anecdotal information of widespread abundance of small fish and significant catches of small fish in the New Brunswick weirs of the 2005 year class may indicate the presence of a strong year-class. However, large numbers of young fish in the 1980 New Brunswick weir catch did not translate into a strong year class in the southwest Nova Scotia / Bay of Fundy spawning component.

2.4 Ecosystem Considerations

Herring is 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.

Recent 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 Outlook

Recent assessments of the SWNS/BOF spawning component suggested that fishing mortality should remain below $F_{0.1}$ (about 20% exploitation rate) for a number of years in order to rebuild spawning stock biomass in all spawning areas and to expand the age composition so as to meet the explicit biological objectives of management (Power et al, 2006a).

The rapid decline in year-classes (failure to reach older ages), even with relatively strong recent year-classes, indicates high total mortality. It seems that the current catch is substantially higher than would be consistent with a moderate F. Recent catches have been mostly consistent with the survey, assess, fish protocol of less than 20% of surveyed biomass. However the size of fish reflected in the catch at age/length indicates that total mortality may be considerably higher.

2.6 Management Considerations

An evaluation of progress in recent years against biological objectives in the management plan (DFO 2003b) indicate that most objectives are not being met (Table 17). The biomass estimates for all spawning areas increased slightly from 2005 but are still at historically low levels with a substantial decline from 2004. The Scots Bay, Trinity Ledge, Lurcher Shoal and Seal Island spawning grounds remain 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 is likely high and well above $F_{0.1}$ and the SSB is near the lowest recorded level since 1999 from acoustic surveys.

The proportion of larger (30cm+) sizes in the catch has contracted and is very low and the age composition is assumed to be truncated with an absence of larger fish in the population. The recent increase in abundance of herring in the 23-30cm size range is a positive signal for potential future population growth.

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. Surveys conducted in 2006 conformed to the proposed survey design. 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.

3) OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

3.1 The Fishery

A foreign fishery during 1963-1973 is estimated to have removed as much as 60,000t per year 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 4WX purse seine fleet and 11,700t were taken (Table 3). Since 1996, 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. The variability in catch levels was often due to problems of fish being too deep, weather and market conditions rather than in the abundance of herring in these areas.

Total landings in 2006 increased to 9,800t with most landings by purse seine and midwater trawl in May to July, in the vicinity of the Patch, Emerald and Western Bank (Figure 34, 35). Landings of the 2006 fishery on the Scotian Shelf Banks were near the ten year average (approx. 9,000t) (Figure 36). In 2006, herring continued to be caught as by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope with 42t reported (Table 1). There was also effort in the late fall by midwater trawlers with 885t caught in the offshore area east of Sable Island (Table 1, Figure 35). Records by observers on herring and mackerel directed trips by both purse seine and midwater trawl gear types in the offshore showed a mixture of species and discards were low relative to the overall kept catch (Table 18).

In 2006, the size composition of the catch from the offshore Scotian Shelf banks showed mostly adult fish >23cm (50% maturity at length) with a substantial proportion (23%) larger than 30cm and a modal size of 28cm (Figure 37).

3.2 Research and Industry Surveys

<u>Industry Surveys</u>

There have been no industry surveys of the offshore Scotian Shelf area since 2001. Acoustic recorders were activated in 2006 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. Acoustic records were made by the *Julianne III,* a purse seine/midwater trawl vessel, during operations in the offshore. A large aggregation was reported and recordings were made in an area east of Sable Island along the shelf edge during Nov. and Dec. 2006. The acoustic system, which is a Simrad 200kHz ES60, has yet to be calibrated and so the data have not been analyzed. Consequently, no acoustic biomass estimates were available from the Scotian Shelf in 2006 (Power et al. 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 showed a substantial decline from the high in the previous year (Table 19, Figure 38). Inter-vessel conversion factors established for differences in fishing efficiency by species are being developed from the comparative surveys completed in 2005.

The decreasing trend for the most recent years from the bottom trawl survey is also similar to the trend seen in NAFO areas 4W and 4X for the combined strata (Table 19, Figure 39). The strata areas used for selection of trawling stations in this bottom trawl survey series are shown in Figure 40 (Doubleday 1981). Herring catches from the 2006 summer survey were again widely distributed on banks west of Sable Island (Figure 41) and were comparable to average catches from the last nine years (Figure 42). 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 43).

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

The summer bottom trawl research survey demonstrates that there is a considerable abundance of herring widely spread over the offshore banks of the Scotian Shelf. Information from previous assessments indicated the presence of at least some autumn spawning on Western Bank in recent years. There is very little new information to add and no reason to change the previous outlook:

• Recorded landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.

• The initial catch allocation for 2006 should not exceed the 12,000t reference value used in the recent fishing plans.

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.

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 various 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.

In addition to traditional coastal fixed gear fisheries for subsistence and personal bait, there has been an increase in the number of active gillnet licenses in recent years aimed at spawning herring for the roe market (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 eleventh year for a fishery on spawning fish off Halifax/Eastern Shore and the tenth year of gillnet roe fisheries off Little Hope/Port Mouton and Glace Bay.

The recorded landings (6,600t) in 2006 in the four major gillnet fisheries along the coast of Nova Scotia were about the same for the Eastern Shore area, minimal for Glace Bay, but higher for Little Hope/Port Mouton (Table 20). The Bras d’Or Lakes fishery remained closed.

<u>Little Hope</u>

The 2006 herring gillnet fishery in the Little Hope/Port Mouton fishing area took place primarily between Sept. 28 and Oct. 28, 2006 with total landings of 3,133t (Figure 44). This is primarily a herring roe fishery with catches reported from two main areas; near Little Hope Island and east of Liverpool. Daily landings were less than 100t/day until Oct. 4, and then increased to about 150-300t/day with some gaps until Oct. 27. The roe fishery finished on Oct. 28 but there continued to be small amounts landed for bait.

Acoustic surveys were completed in each of the primary fishing areas near Little Hope/Port Mouton on Oct. 7, 17, 19, 22 and 25 with total SSB estimated as 21,700t, a large decline from 2005 (Table 21, Figure 45).

<u>East of Halifax (4W Eastern Shore)</u>

The 2006 herring gillnet fishery in the Eastern Shore fishing area took place between Sept. 18 and Oct. 17 2006 with total landings of 3,348t (Figure 46). This is 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. Daily landings were less than 100t/day until Oct. 1, then increased to about 300t/day until Oct. 10. The fishery finished on Oct. 17 after a few days of reduced catches, around 150t/day, from the eastern part of the defined fishing area.

Spawning bed surveys using acoustic equipment were completed in each of the primary fishing areas along the Eastern Shore from Halifax Harbour to near Ship Harbour, N.S. on Sept. 26, Oct. 6 and 15. The total SSB estimated from the three surveys was 51,100t which was a substantial increase since 2005 (Table 21, Figure 47).

Glace Bay

There was minimal catch of 85t in the Glace Bay area in 2006 due to the poor price for herring roe. As a consequence of this the acoustic survey vessel was not calibrated and there was no survey activity.

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.

4.2 Outlook and Management Considerations

There was an increase in surveyed acoustic biomass in the Halifax/Eastern Shore areas while the Little Hope area saw a large decline (Table 21, 22). A survey with an acoustic recorder was completed for the first time in the Glace Bay area in 2005 but there was no survey effort in 2006. As indicated for the SW Nova Scotia / Bay of Fundy spawning 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 of these spawning components using "survey, assess, then fish (<10%)" protocol is considered useful when the components are considered to be healthy and of sufficient size. The history of the application of this protocol has had some mixed success due to some occasional problems in executing surveys.

Management approaches and recent research efforts have improved knowledge in these three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been little 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 should experience a large effort increase until much more information is available on the state of that spawning group, and there should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. With no sampling or acoustic surveys conducted in 2006, there is no evidence of any improvement. It is therefore appropriate to reiterate from a biological perspective, that no fishing take place on this spawning component.

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 over the past decade in the Passamaquoddy Bay area (Table 1, 3, 8-9). In 2003 there was a large drop in landings in the traditional New Brunswick weir and shutoff fishery to 9,000t - the lowest since 1983 – and there was concern expressed for this fishery. In 2004 weir landings increased to 20,600t, the highest since 1994, 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 (Figure 48, 49).

Additional analysis was done by weir interaction areas which were first used by Stephenson (1990) to compare weir and aquaculture activities and interactions (Figure 50). Catches by area and month for 2005-2006 showed a shift from Campobello and the Wolves to the Bliss Harbour and Grand Manan areas (Table 23-24). There is a trend of decreasing landings in this fishery with catches below the 10 year average for 4 out of the last 5 years (Table 3, Figure 51).

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 size of herring caught from this fishery was abnormally small throughout the season and impeded markets (Figure 52). In 2006, the size composition indicated that the catch was composed primarily of juvenile fish (<23cm) with a substantial proportion (47%) less than 15cm, which is considered to be mostly age 1. While large proportions of age 1 fish have been found in the SW New Brunswick catches in the past, for example 70% in 1980, these have not translated into strong recruitment in subsequent years (Figure 53).

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 2005-2006 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 (2005)										468			468
		Winter P. Seine (2006)	462												462
		Summer P. Seine (2006)					381	2,505	15,263	11,472	10,624	4,757			45,002
		Gillnet "Stock"						2		23	694				719
		N.S. Weirs			3	8	199	138	414	1,449	182	115			2,508
S.W. Nova Scotia Total			462	-			580	2,645	15,677	12,943	11,500	5,340	-	-	49,159
Coastal Nova	4Vn	Glace Bay Gillnet				0	2	1			4	79			85
(South Shore,	4W	Eastern Shore Gillnet					1	0			436	2,930	0		3,367
Eastern Shore,	4X	Trap					63	9	25						97
Cape Breton)	4X	Little Hope Gillnet					1	0		0	72	3,065	1		3,139
Coastal Nova Scotia Total								10	25	0	512	6,074	1		6,687
Offshore S.S.	4WX	Offshore P. Seine				408	458	4,031	142						5,038
		Midwater Trawl	729				665	1,039	478	40			464	1,314	4,729
		Bottom Trawl + Misc.	1	1	1	4	5	6	8	3	3	7	3	1	42
Offshore S.S. Total			730	1	1	412	1,127	5,075	628	43	3	7	467	1,315	9,809
Migrant	4X	N.B. Weirs					8	43	1,112	3,731	3,832	2,328	125	462	11,641
Juveniles		N.B. Shutoff								109	720	393			1,222
Migrant Juveniles Total							8	43	1,112	3,840	4,552	2,721			12,863
Georges Bank	5ZE	5Z Purse Seine													-
		Midwater Trawl													-
Georges Bank Total										-	-				-

Total 2005-2006	78,518

Table 2. 4WX herring fishery landings (t) by month and gear sector for 2006-2007 quota year (as of March 28, 2007).

	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
2006-07 quota year	4X	Fall 2006 P. Seine										948	149		1,097
		Winter 2007 P. Seine	1,001												1,001
2007 Calendar year	4X	N.B. Weirs	182		20										202
	4WX	Bottom Trawl	1	0	0										1
2006-07 Total			1,184	0	20							948	149		2,301

Table 3. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2006 (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	Nova Scotia Weir	Stock Nominal Landings	Stock Adjusted Landings*	Stock TAC	4Xs N.B. Weir & Shutoff	Scotian Shelf Banks	4WX 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	11,745	85,726
1997	1,759	2,926	40,357	6,816	4,019	56,117	56,117	57,000	20,552	20,261	96,930
1998	1,405	1,494	67,433	2,231	4,464	77,027	77,027	90,000	20,091	5,591	102,709
1999	1,235	4,764	64,432	1,660	5,461	77,552	77,552	105,000	18,644	12,646	108,842
2000	1,012	4,738	78,010	823	701	85,284	85,284	100,000	16,829	2,182	104,295
2001	0	4,001	62,004	1,857	3,708	71,570	71,570	78,000	20,209	12,503	104,282
2002	367	5,257	69,894	393	1,143	77,054	77,054	78,000	11,874	7,039	95,967
2003	0	8,860	79,140	439	921	89,360	89,360	93,000	9,003	998	99,361
2004	0	5,659	69,015	225	3,130	78,029	78,029	83,000	20,686	4,165	102,880
2005	0	2,601	43,487	566	2,245	48,899	48,899	50,000	13,055	5,263	67,217
2006	0	930	45,002	719	2,508	49,159	49,159	50,000	12,863	9,809	71,831

^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 2006 for the 4WX stock component.

a) Herring purse seine catches (t) by grounds for the 4WX stock area from 1985-2006.

Stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Recent Decade Average 97-06	All Series Avg 85-06
Browns Bank		732						86		1,903	1,554	40	14	3,139	2,197	1,137	486			45		88	1,015	888
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							915	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	6,594	6,000
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	19,736	16,361
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	11,394	7,848
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	10,062	9,083
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	2,547	1,624
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	1,785	1,381
Pollock Point																	1,563						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	1,167	1,383
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	9,842	7,904
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	543	6,336
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	1,858	5,546
Yankee Bank				194	250	3,647	817	119	10	175	323	9	4	159	82	133	8	78			528	2	124	370
Unknown	184	500	200			200	579	494	140		73			62	84	27			1,103	127	181	396	283	289
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	66,355	66,583

b) Herring purse seine catches as percentage by grounds for the 4WX stock area from 1985-2006.

Stock Areas	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Recent Decade Average 97-06	All Series Avg 85-06
Browns Bank		1%						0%		4%	3%	0%	0%	4%	3%	1%	1%			0%		0%	1%	1%
Chedabucto Bay	5%	13%	9%	7%	11%	13%	15%	5%	5%	3%	4%	4%		2%	2%	0%							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%	10%	9%
German Bank	19%	23%	23%	18%	10%	12%	28%	6%	15%	19%	40%	33%	34%	29%	34%	31%	37%	29%	25%	19%	32%	35%	30%	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%	17%	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%	15%	13%
Lurcher	1%	0%		3%	0%	0%	0%	4%	6%	1%	1%	1%	1%	0%		1%	0%	10%	2%	10%	4%	6%	3%	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%	3%	2%
Pollock Point																	2%						0%	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%	2%	3%
Scots Bay		0%	5%	4%	8%	10%	10%	14%	19%	22%	2%	19%	12%	11%	2%	13%	16%	11%	22%	33%	14%	7%	14%	12%
Seal Island	17%	15%	16%	19%	30%	27%	15%	18%	14%	6%	1%	3%	1%	1%	1%	0%	0%	0%	1%		3%	0%	1%	8%
Trinity	43%	23%	26%	18%	0%	1%	4%	8%	5%	5%	1%	7%	13%	4%	2%	0%	0%	2%		0%	3%	8%	3%	8%
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 2006 from non-stock component areas.

a) Herring purse seine catches (t) by grounds for non-stock component areas from 1985-2006.

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	Recent Decade Average 97-06	All Series Avg 85-06
Georges Bank						91	64			266		2,491	79			265							172	489
Liverpool							13		4,067	4,177														2,752
Shelburne			59				64		526	161		56									29		29	115
Halifax									652	1,945		585	455			1,002	472	367					459	660
Offshore Banks												11,800	18,770	4,284	8,669	1,645	3,977	5,078	722	4,054	4,115	4,846	5,616	5,660
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	1,441	1,236
Sydney Bight	3,511	4,250	1,751	2,100	1,330	3,591	3,606		396		3,951	4,267		52									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	7,185	6,202

b) Herring purse seine catches as percentage by grounds for non-stock component areas from 1985-2006.

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	Recent Decade Average 97-06	All Series Avg 85-06
Georges Bank						2%	2%			3%		13%	0%			9%							1%	1%
Liverpool							0%		52%	52%														5%
Shelburne			3%				2%		7%	2%		0%									1%		0%	1%
Halifax									8%	24%		3%	2%			34%	4%	5%					5%	4%
Offshore Banks												61%	94%	80%	89%	56%	33%	69%	82%	100%	94%	96%	79%	41%
Western Hole		1%	8%				5%	100%	29%	19%	3%	1%	3%	19%	11%	2%	63%	26%	18%		5%	4%	15%	14%
Sydney Bight	100%	99%	89%	100%	100%	98%	91%		5%		97%	22%		1%									0%	35%
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 2006 Scots Bay herring purse seine catches.

Year	Min. Date	Max. Date	No. Days	Catch t	No. Slips	Catch/Day	Catch/Slip
1987	08-Jul-87	06-Aug-87	30	3,398	91	113.25	37.34
1988	20-Jul-88	29-Jul-88	10	3,780	65	377.99	58.15
1989	19-Jul-89	13-Sep-89	57	6,021	164	105.64	36.72
1990	22-Jul-90	14-Aug-90	24	8,088	108	336.98	74.89
1991	05-Jul-91	14-Aug-91	41	7,365	163	179.63	45.18
1992	25-Jul-92	11-Aug-92	18	7,960	189	442.22	42.12
1993	25-Jul-93	01-Sep-93	39	5,228	100	134.04	52.28
1994	10-Jul-94	25-Aug-94	47	10,610	286	225.74	37.10
1995	24-Jul-95	26-Jul-95	3	907	33	302.33	27.48
1996	25-Jul-96	20-Aug-96	27	8,939	151	331.06	59.20
1997	30-Jul-97	27-Aug-97	29	4,847	91	167.14	53.26
1998	20-Jul-98	10-Sep-98	53	7,880	163	148.68	48.34
1999	19-Jul-99	17-Aug-99	30	1,789	40	59.63	44.73
2000	25-Jul-00	30-Aug-00	37	10,853	171	293.34	63.47
2001	10-Jul-01	21-Aug-01	43	10,739	176	249.74	61.02
2002	22-Jul-02	09-Sep-02	50	7,994	160	159.88	49.96
2003	21-Jul-03	05-Sep-03	47	19,196	237	408.43	81.00
2004	19-Jul-04	16-Sep-04	60	24,388	330	406.47	73.90
2005	26-Jul-05	09-Sep-05	46	5,872	96	127.65	61.17
2006	24-Jul-06	04-Sep-06	43	3,352	43	77.95	77.95

Table 7. Summary of 1985 to 2006 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%

Table 8. Monthly weir landings (t) for weirs located in New Brunswick and Nova Scotia; 1978 to 2006.

		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
NB Average Catch (t)		155	34	3	40	135	330	3,763	8,491	5,732	3,059	722	133	22,087
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
NS Average Catch (t)					5	399	1,125	888	597	200	72	65	79	3,197

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 2006.

	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
Average	22,087	3,197	25,284	127	16	143	174	217	178

Table 10. Purse seine effort, catch and CPUE levels for 1989 to 2006.

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

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 integration calibration factor. (Power et al., 2007)

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	Average 1999-2006
Scots: lines	41,000	106,300	163,900	141,000	133,900	107,600	15,000	2,660	88,920
Scots:schools							1,800	25,900	13,850
Scots Bay total	41,000	106,300	163,900	141,000	133,900	107,600	16,800	28,560	92,383
German Bank	460,800	356,400	190,500	393,100	343,500	367,600	211,000	245,500	321,050
Trinity Ledge	3,900	600	14,800	8,100	14,500	6,500	5,100	8,500	7,750
Spec Buoy - Spring	0	0	1,100		1,400	n/s	300	n/s	560
Spec Buoy - Fall			87,500					**0**	43,750
Sub-Total	505,700	463,300	457,800	542,200	493,300	481,700	233,200	282,560	432,470
German (outside box)								4,100	4,100
Seal Island			3,300	1,200	12,200			8,100	6,200
Browns Bank			45,800					6,100	25,950
Total	505,700	463,300	506,900	543,400	505,400	481,700	233,200	300,860	442,558
Overall SE t	94,600	64,900	50,800	49,500	86,100	74,200	64,900	47,251	66,531
Overall SE %	19	14	10	9	17	15	28	16	16

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

Table 12. Partial exploitation rates (%) by major spawning grounds and for the overall Bay of Fundy/SW Nova component of the 4WX stock complex with (A1) acoustic survey SSB, (A2) acoustic survey proportion of total SSB, (C1) allocated catch by spawning component, (C2) adjusted catch including non-spawning area catches, exploitation rate as percentage of acoustic SSB for (P1) spawning area catch and (P2) adjusted catch.

A1) Acoustic Survey SSB (t)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	160,168	72,473	40,972	106,316	163,900	141,000	133,900	107,600	16,800	28,600	92,386
Trinity	23,000	6,762	3,885	621	14,800	8,100	14,500	6,500	5,100	8,500	7,751
German Bank	385,400	442,033	460,823	356,372	282,400	394,357	357,100	367,600	211,000	249,600	334,907
Total SSB	568,568	521,268	505,680	463,309	461,100	543,457	505,500	481,700	232,900	286,700	435,043

A2) Acoustic Survey Proportions	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	28%	14%	8%	23%	36%	26%	26%	22%	7%	10%	20%
Trinity	4%	1%	1%	0%	3%	1%	3%	1%	2%	3%	2%
German Bank	68%	85%	91%	77%	61%	73%	71%	76%	91%	87%	78%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

C1) Catch by Spawn Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	4,894	8,210	1,789	10,926	10,739	8,202	19,196	24,869	6,239	3,352	10,664
Trinity (purse seine+gillnet)	8,820	4,512	2,526	843	1,271	1,865	369	595	2,014	4,444	1,741
German Bank	13,576	20,556	24,660	25,631	24,139	22,355	21,573	14,175	14,171	16,522	20,403
Spawn Area Total	27,290	33,278	28,974	37,400	36,149	32,422	41,138	39,639	22,424	24,318	32,808
Overall SW Nova Catch	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	72,136

C2) Adjusted Catch by Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	13,015	14,293	5,725	21,914	23,330	19,782	31,996	33,444	8,155	5,830	18,772
Trinity	9,986	5,080	2,899	907	2,408	2,530	1,755	1,113	2,596	5,181	2,424
German Bank	33,116	57,655	68,929	62,462	45,832	54,742	55,710	43,472	38,231	38,148	50,941
Adjusted Catch Total	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	72,136
Overall SW Nova Catch	56,117	77,027	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	72,136

P1) Percentage (C1/SSB)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	3%	11%	4%	10%	7%	6%	14%	23%	37%	12%	14%
Trinity	38%	67%	65%	136%	9%	23%	3%	9%	39%	52%	42%
German Bank	4%	5%	5%	7%	9%	6%	6%	4%	7%	7%	6%
Overall (C1/SSB)	5%	6%	6%	8%	8%	6%	8%	8%	10%	8%	8%

P2) Percentage adjusted (C2/SSB)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Avg 99-06
Scots Bay	8%	20%	14%	21%	14%	14%	24%	31%	49%	20%	23%
Trinity	43%	75%	75%	146%	16%	31%	12%	17%	51%	61%	51%
German Bank	9%	13%	15%	18%	16%	14%	16%	12%	18%	15%	15%
Overall Adjusted (C2/SSB)	10%	15%	15%	18%	16%	14%	18%	16%	21%	17%	17%

Table 13. Summary of biological samples by gear and month as collected during the 2006 4VWX herring fisheries. ‘NO_LF’ is the number of length frequency samples collected, ‘NO_MEAS’ is the number of length frequency fish measured and ‘Aged’ is the number of detail fish with age determined.

		Month												
Gearname	Data	1	2	3	5	6	7	8	9	10	11	12	4	Grand Total
4Vn Trap	Sum of No. LF Samples					1	1							2
	Sum of No. Measured					35	255							290
	Sum of No Processed					32	37							69
4W Purse Seine	Sum of No. LF Samples				1	20	1							22
	Sum of No. Measured				101	2370	204							2675
	Sum of No Processed				0	61	0							61
5Y CAN P.Seine	Sum of No. LF Samples					11	52	23	1	4				91
	Sum of No. Measured					1336	6172	2742	122	449				10821
	Sum of No Processed					55	236	88	0	23				402
5Y USA P.Seine/MWT	Sum of No. LF Samples				7	12	7	4		4		2		36
	Sum of No. Measured				762	1603	804	480		449		229		4327
	Sum of No Processed				0	0	0	0		0		0		0
5Z USA P.Seine/MWT	Sum of No. LF Samples	29	15	15						4		2		65
	Sum of No. Measured	3443	1789	1846						467		211		7756
	Sum of No Processed	0	0	0						0		0		0
Gillnet	Sum of No. LF Samples								3	34				37
	Sum of No. Measured								254	4004				4258
	Sum of No Processed								126	325				451
N.B. Purse Seine	Sum of No. LF Samples	9					1	3	1	16				30
	Sum of No. Measured	1117					227	332	115	1859				3650
	Sum of No Processed	49					31	0	9	28				117
N.B. Shut-off	Sum of No. LF Samples								17	13	1	1		32
	Sum of No. Measured								1960	1617	103	110		3790
	Sum of No Processed								15	19	0	0		34
N.B. Weirs	Sum of No. LF Samples				1	2	39	151	96	81	2	1		373
	Sum of No. Measured				104	359	4807	18676	11321	9634	219	109		45229
	Sum of No Processed				0	38	91	265	117	107	0	18		636
N.S. Purse Seine	Sum of No. LF Samples				3	25	84	93	94	43				342
	Sum of No. Measured				360	3344	11116	12259	12246	5449				44774
	Sum of No Processed				53	131	203	222	240	223				1072
N.S. Weirs	Sum of No. LF Samples				4	4	10	17	2					37
	Sum of No. Measured				482	580	1361	2288	250					4961
	Sum of No Processed				30	25	121	107	0					283
Resrch. Otter Trawl	Sum of No. LF Samples		10	40			46	2						98
	Sum of No. Measured													
	Sum of No Processed		50	389			456	22						917
USA Weirs	Sum of No. LF Samples								5					5
	Sum of No. Measured								615					615
	Sum of No Processed								0					0
4V Midwater Trawl	Sum of No. LF Samples	4			4						2	7		17
	Sum of No. Measured	385			880						410	1258		2933
	Sum of No Processed	75			85						55	86		301
4W Midwater Trawl	Sum of No. LF Samples	4			15	34	4	1			3		2	63
	Sum of No. Measured	971			2852	5463	757	181			685		411	11320
	Sum of No Processed	61			350	567	33	35			73		49	1168
USA Shut-off	Sum of No. LF Samples								1					1
	Sum of No. Measured								119					119
	Sum of No Processed								0					0
Total Sum of No. LF Samples		46	25	55	35	109	245	294	220	199	8	13	2	1251
Total Sum of No. Measured		5916	1789	1846	5541	15090	25703	36958	27002	23928	1417	1917	411	147518
Total Sum of No Processed		185	50	389	518	909	1208	739	507	725	128	104	49	5511

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
Average	**148**	**1,262**	**71**	**242**	**114**	**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 1999-2006.

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

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
<23cm	27%	46%	48%	23%	45%	60%	51%	30%	35%
23-30cm	51%	50%	46%	71%	51%	38%	48%	69%	63%
>30cm	21%	4%	6%	6%	4%	2%	2%	2%	2%
Total	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. Report of species composition from observer data for all 2006 herring and mackerel directed trips in the Scotia-Fundy region with kept (t) and discarded amount (t).

Catch Composition (Metric tonnes)

Species	Kept 2006	Discarded 2006
HERRING(ATLANTIC)	3005.65	1.213
MACKEREL(ATLANTIC)	16.926	1.113
SHORT-FIN SQUID	1.977	4.335
SILVER HAKE	0.401	0.01
POLLOCK	0.01	0.002
HADDOCK	0.008	0.001
REDFISH UNSEPARATED	0.006	0
SPINY DOGFISH	0.005	0.029
ALEWIFE	0.001	2.96
PORBEAGLE,MACKEREL SHARK	0	1.405
BLUEFIN TUNA	0	1.35
WHITE BARRACUDINA	0	0.05
LANTERNFISH (NS)	0	0.05
SAND LANCES (NS)	0	0.04
SNOW CRAB (QUEEN)	0	0.002
SHAD AMERICAN	0	0.002
SPONGES	0	0.001
JONAH CRAB	0	0.001

Table 19. Herring abundance indices from the July bottom trawl survey (stratified numbers per tow): 1970-2006.

	July ground trawl survey by-catch for herring (stratified mean numbers)													
	4WX area combined				4W Only		4X Only		4X BOF		4V only		Offshore Banks	
	Strata 453/495				Strata 453/466		Strata 470/495		Strata 480/495		Strata 442/452		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

Table 20. Recorded herring landings (t) from gillnet fisheries in the coastal N.S. spawning component, 1996-2006.

Landings (t)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	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	3,029	2,467
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	3,406	2,346
Glace Bay		170	1,730	1,040	834	1,204	3,058	1,905	1,481	626	85	1,431	1,213
Bras d'Or Lakes	170	160	120	31	56	0	1	4	0	0	0	1	49
Total	1,450	2,340	4,120	5,618	4,283	6,006	10,375	9,162	6,924	6,311	6,566	7,868	5,741

Table 21. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2006 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	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	3,906	2,797
Halifax/Eastern Shore	8,300	20,200	**10,900**	16,700	**41,500**	67,602	18,200	28,100	51,100	4,130	2,918
Glace Bay		2,000		21,200	7,700	31,500		2,200	n/s	1,380	1,292
Bras d'Or Lakes		530	70	n/s	n/s	n/s	n/s	n/s	n/s	n/s	30

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

Table 22. Summary of herring acoustic spawning biomass from gillnet surveys in the coastal N.S. spawning component from 1998-2006 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	10% SSB Average Last 4 yr	10% SSB Average All years
Little Hope/Port Mouton						**53,100**	22,500	44,700	24,100	3,610	3,610
Halifax/Eastern Shore						92,600	28,400	36,950	68,900	5,671	5,671
Glace Bay						31,500		3,180	n/s	1,734	1,734
Bras d'Or Lakes						n/s	n/s	n/s	n/s	n/s	n/a

Note 1: shaded cells include mapping surveys; bold cells include mapping and acoustic surveys.

Note 2: data prior to 2003 calculated with the Calibration Integration Factor (CIF) are not available.

Table 23. Bay of Fundy herring weir catches (t) by interaction area from 1992 to 2006 with overall average for the series.

Area	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
Unspecified												10	1,529		392	644
1-Chance Hbr.	427	370	281	735			91		52	91		12	1		32	209
2-Maces Bay	86	97	701	33	39	92	353		5	274		93	41	43		155
3-Beaver Hbr.	102	244	164		47	176	311	42		35	19	182	323	296	409	181
4-Bliss Hbr.	553	1,547	1,177	526	1,322	755	2,196	3,035	1,199	2,348	681	976	1,568	2,371	3,087	1,556
5-Back Bay	617	808	199	569	471	543	630	846	110	766	541	698	1,271	649	559	618
6-Letite Passage	865	127	351	202	178	397	207	369	48	113	116	352	162	106	286	259
7-Lords Cove	274	203	76	29	50	235	151	548	10	387	148	82	194	338	1,329	270
8-Simpson Isl.	3,294	1,288	1,097	1,259	730	2,118	1,233	1,067	1,723	1,648	1,314	393	769	157	642	1,249
9-Indian Isl.	459	526	334	611	469	556	409	648	379	646	498	255	227	338	912	484
10-Campobello West	770	688	571	369	141	144	165	35	25	155	17	77	265	137	25	239
11-Campobello East	4,522	3,230	2,842	4,212	2,907	6,146	2,671	1,374	1,302	2,011	933	230	2,281	1,496	626	2,452
12-Deer Isl. West														6		6
13-Mascarene Shore	90	118	38	3					10			9	80	147	41	60
14-Upper Pass. Bay	463	17						23								168
15-Chamcook	875	21	223	5	26	88	25	18								160
17-The Wolves	3,153	2,850	2,865	3,355	2,229	3,819	2,989	4,292	4,086	4,191	1,412	1,132	4,472	4,310	492	3,043
18-West Grand Manan	4,149	3,697	2,553	1,192	1,414	602	1,732	479	979	1,552	1,059	2,091	3,482	1,394	1,842	1,881
19-Whale Cove	2,116	4,437	1,550	2,266	1,121	743	2,324	3,097	1,054	1,960	1,951	562	2,656	600	363	1,787
20-East Grand Manan	6,614	8,619	4,068	2,479	4,237	3,775	3,177	2,249	5,435	3,825	3,118	1,835	2,706	237	693	3,538
21-Green Islands	1,601	1,405	765	181	349	202	336	8	113	3		17				453
22-Seal Cove Sound	952	1,037	763	203	53	4	114	12	139	11		7	122		48	267
98-N.S. Weirs	2,224	2,662	2,045	3,049	3,476	4,019	4,464	5,461	692	3,708	1,143	921	3,130	2,245	2,374	2,774
Total Weir Catch	**34,206**	**33,990**	**22,662**	**21,277**	**19,257**	**24,415**	**23,577**	**23,600**	**17,358**	**23,724**	**12,951**	**9,933**	**25,279**	**14,870**	**14,149**	**21,417**

Table 24. Bay of Fundy herring weir catches in percentages by interaction area from 1992 to 2006 and overall average.

Area	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
Unspecified	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	3%	1%
1-Chance Hbr.	1%	1%	1%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
2-Maces Bay	0%	0%	3%	0%	0%	0%	1%	0%	0%	1%	0%	1%	0%	0%	0%	1%
3-Beaver Hbr.	0%	1%	1%	0%	0%	1%	1%	0%	0%	0%	0%	2%	1%	2%	3%	1%
4-Bliss Hbr.	2%	5%	5%	2%	7%	3%	9%	13%	7%	10%	5%	10%	6%	16%	22%	8%
5-Back Bay	2%	2%	1%	3%	2%	2%	3%	4%	1%	3%	4%	7%	5%	4%	4%	3%
6-Letite Passage	3%	0%	2%	1%	1%	2%	1%	2%	0%	0%	1%	4%	1%	1%	2%	1%
7-Lords Cove	1%	1%	0%	0%	0%	1%	1%	2%	0%	2%	1%	1%	1%	2%	9%	1%
8-Simpson Isl.	10%	4%	5%	6%	4%	9%	5%	5%	10%	7%	10%	4%	3%	1%	5%	6%
9-Indian Isl.	1%	2%	1%	3%	2%	2%	2%	3%	2%	3%	4%	3%	1%	2%	6%	2%
10-Campobello West	2%	2%	3%	2%	1%	1%	1%	0%	0%	1%	0%	1%	1%	1%	0%	1%
11-Campobello East	13%	10%	13%	20%	15%	25%	11%	6%	7%	8%	7%	2%	9%	10%	4%	11%
12-Deer Isl. West	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13-Mascarene Shore	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%
14-Upper Pass. Bay	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15-Chamcook	3%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17-The Wolves	9%	8%	13%	16%	12%	16%	13%	18%	24%	18%	11%	11%	18%	29%	3%	15%
18-West Grand Manan	12%	11%	11%	6%	7%	2%	7%	2%	6%	7%	8%	21%	14%	9%	13%	9%
19-Whale Cove	6%	13%	7%	11%	6%	3%	10%	13%	6%	8%	15%	6%	11%	4%	3%	8%
20-East Grand Manan	19%	25%	18%	12%	22%	15%	13%	10%	31%	16%	24%	18%	11%	2%	5%	16%
21-Green Islands	5%	4%	3%	1%	2%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	1%
22-Seal Cove Sound	3%	3%	3%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	1%
98-N.S. Weirs	7%	8%	9%	14%	18%	16%	19%	23%	4%	16%	9%	9%	12%	15%	17%	13%
Total Weir Catch	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

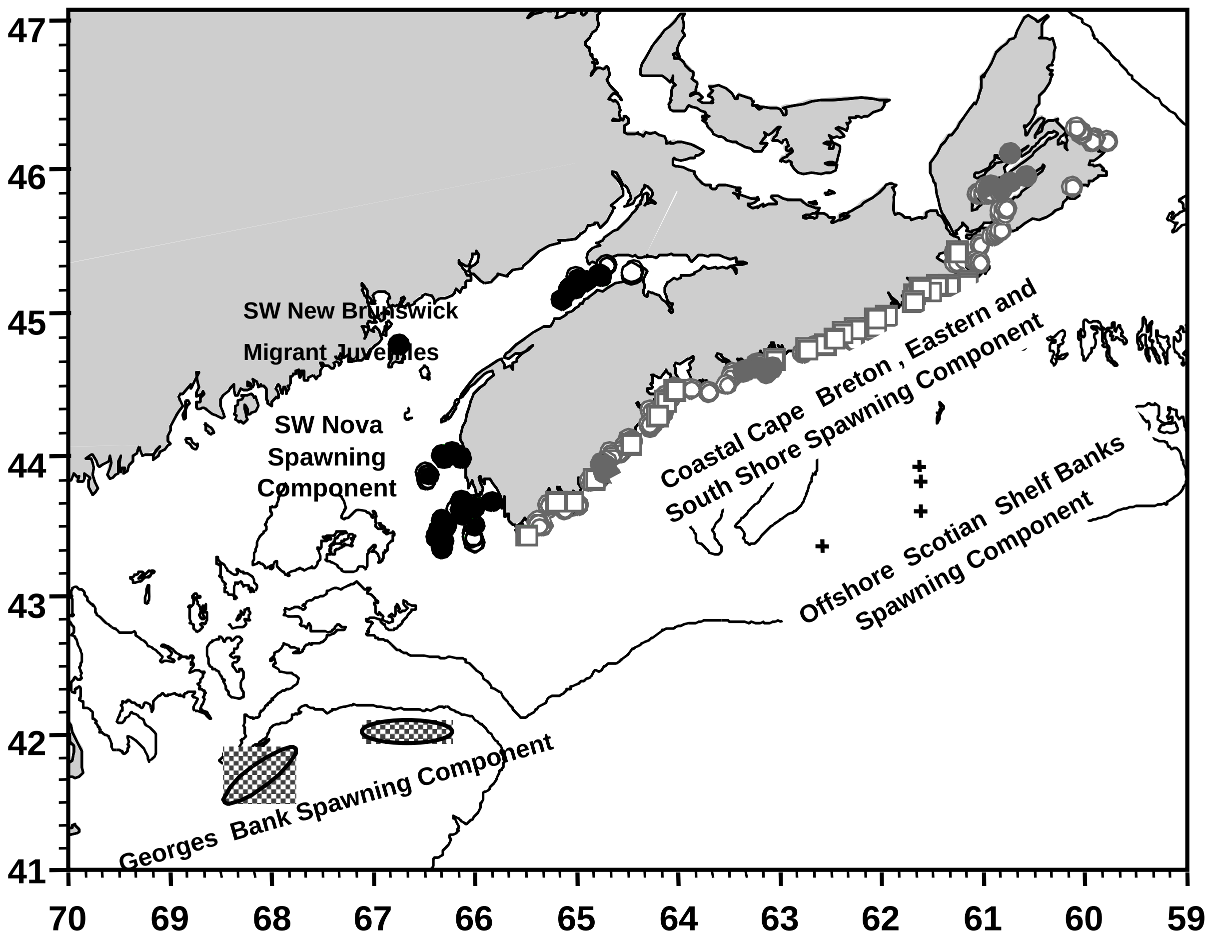


Figure 1. Management units for herring in areas 4VWX and 5YZ showing locations of known current (solid) and historical (open) spawning locations.

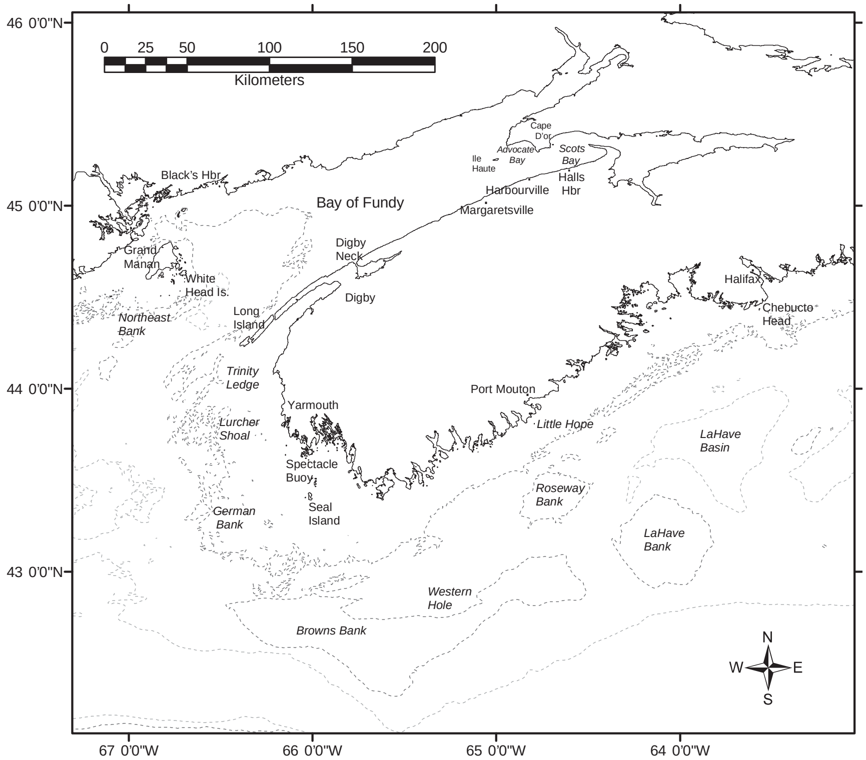


Figure 2. Fishing locations for herring in southwest and coastal Nova Scotia.

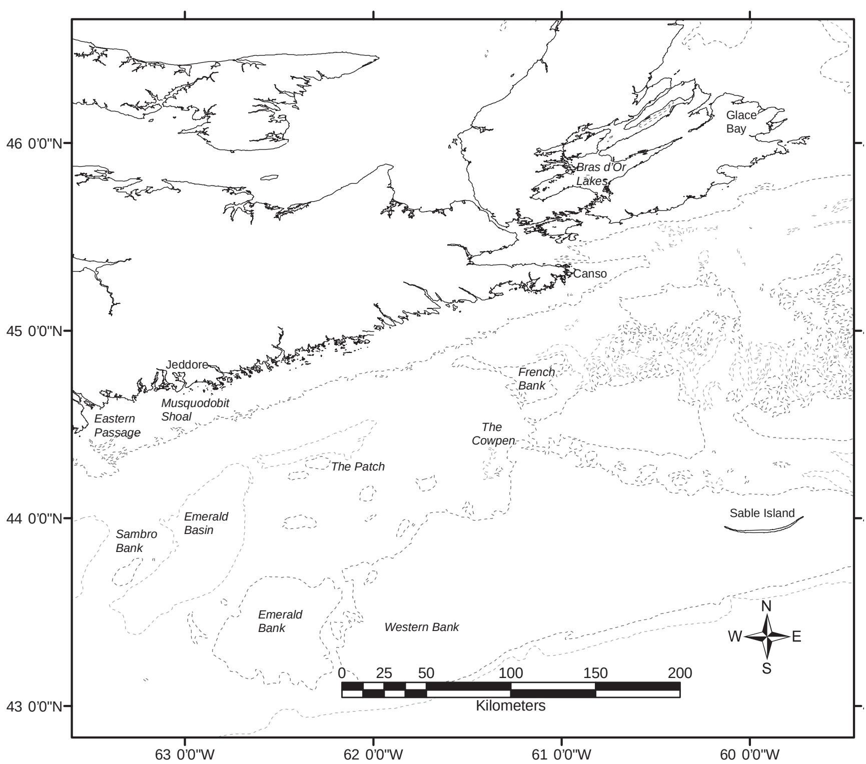


Figure 3. Fishing locations for herring on the eastern Scotian Shelf and offshore banks.

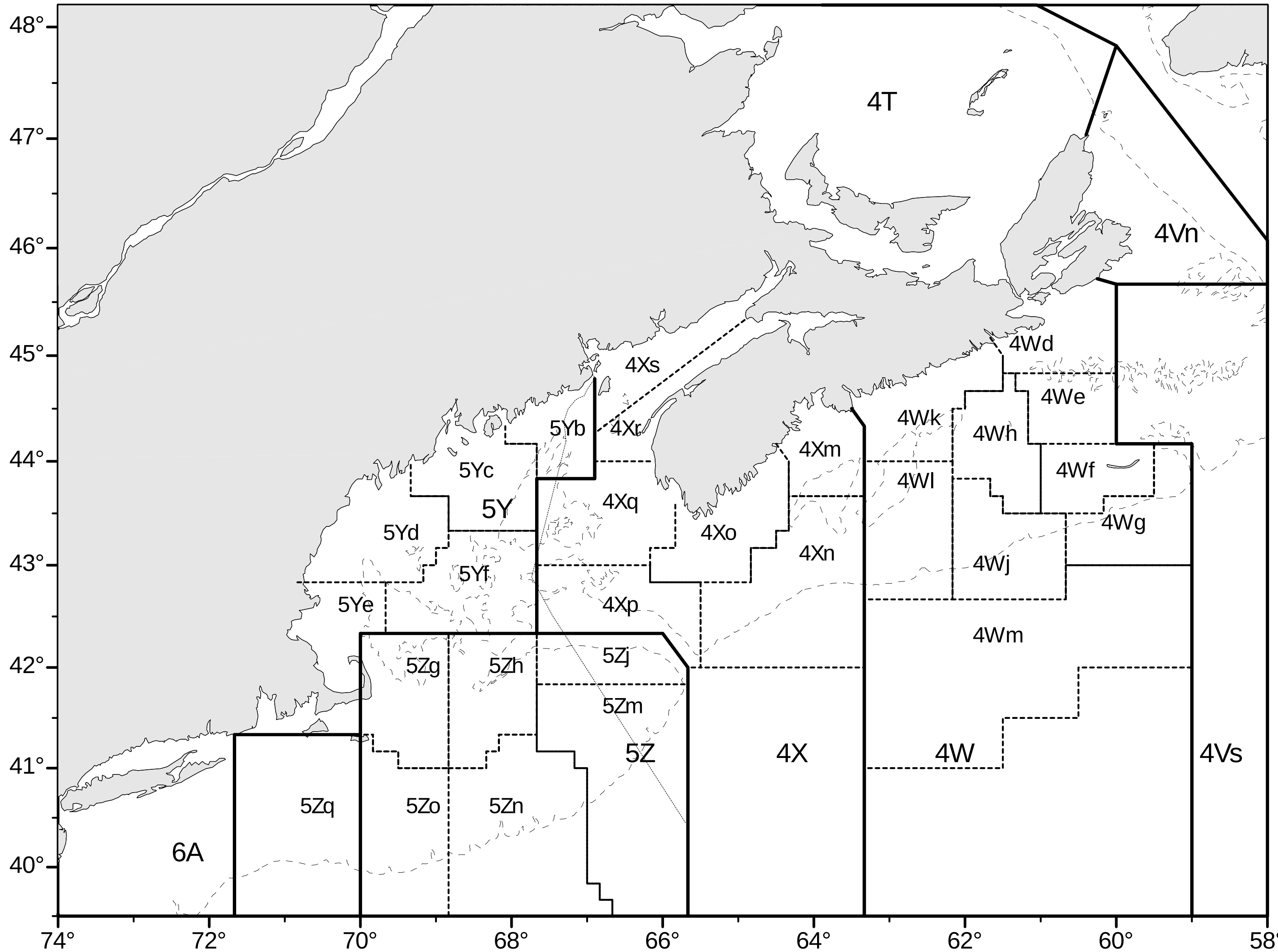


Figure 4. Major and minor NAFO unit areas used for sample and catch data aggregation.

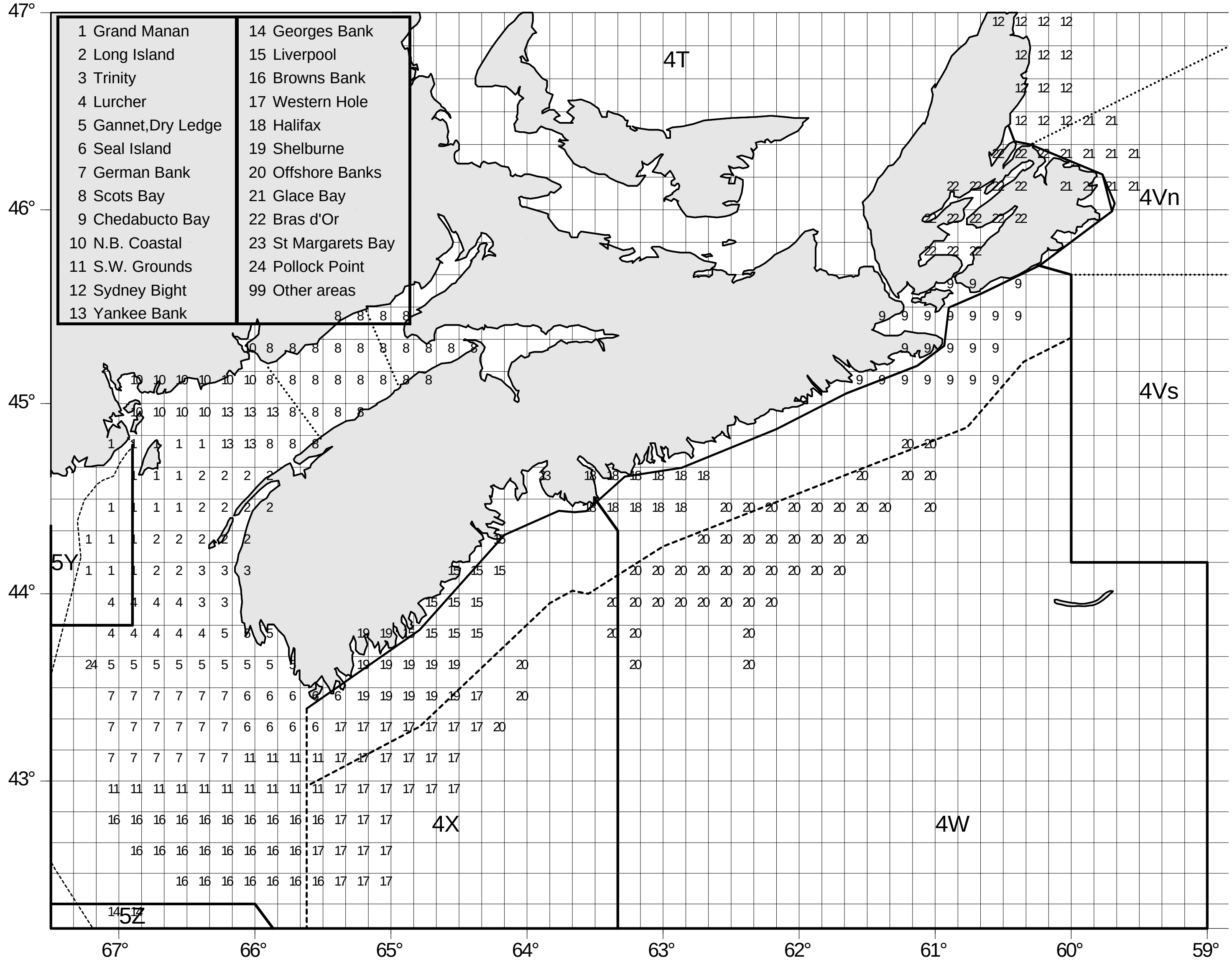


Figure 5. Herring fishing ground areas by 10 mile boxes and management lines for NAFO areas, 25 mile offshore line, coastal embayment line and herring area lines.

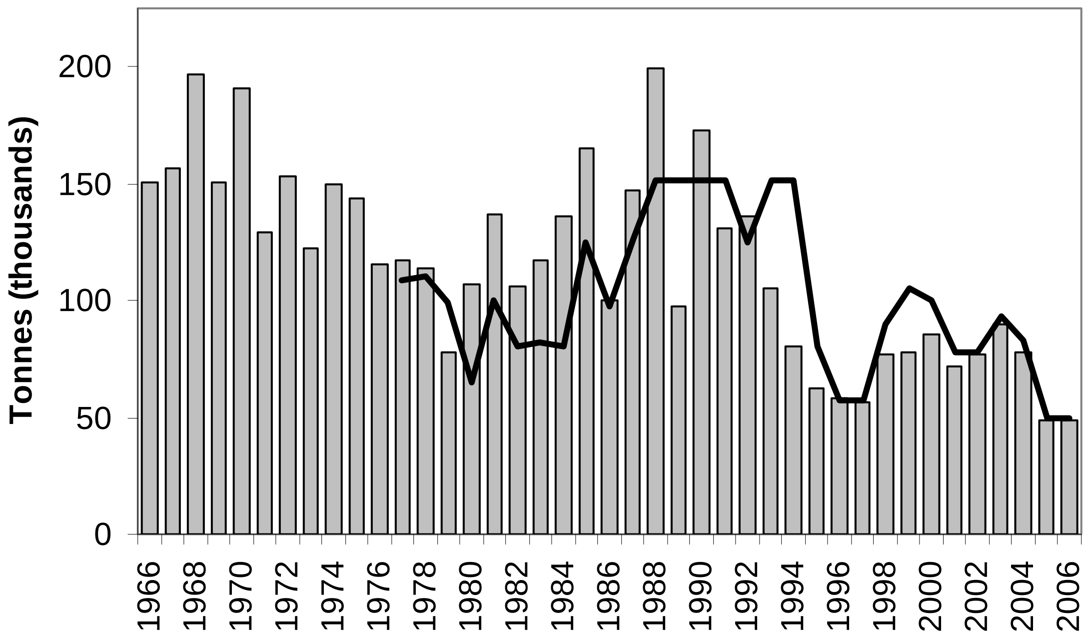


Figure 6. Annual herring landings [bars] and TAC [solid line] (quota) for the southwest Nova Scotia spawning component (4WX stock).

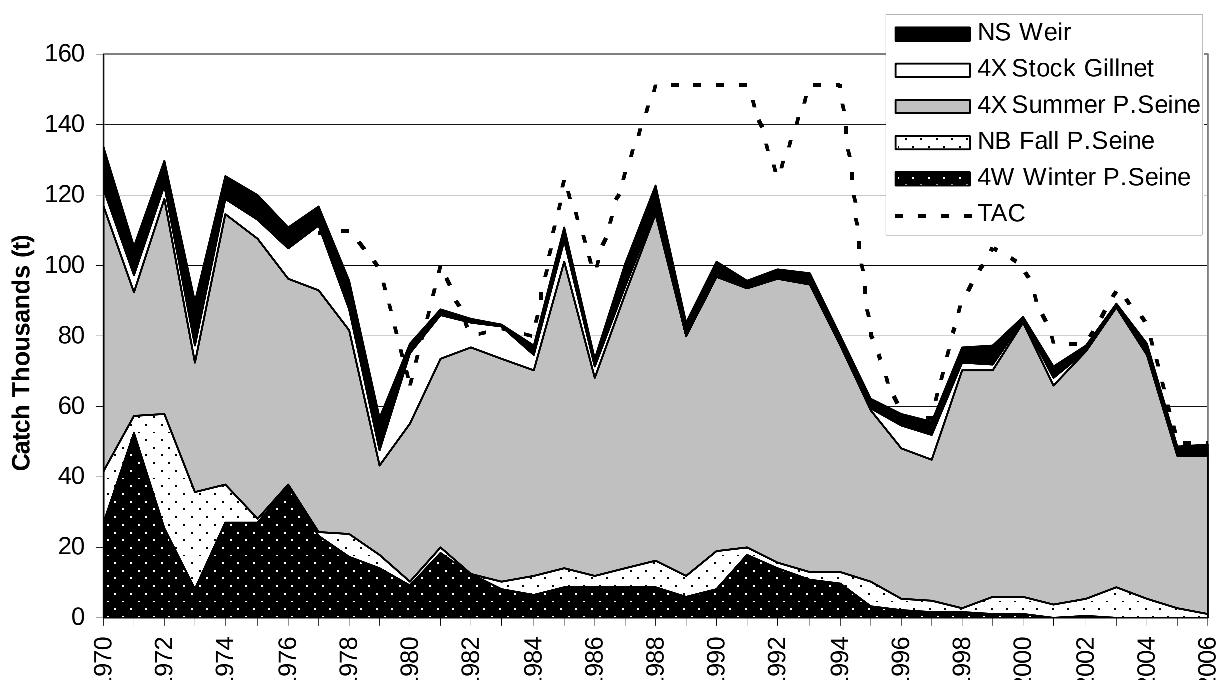


Figure 7. Annual herring landings by gear component for the southwest Nova Scotia spawning component (4WX stock).

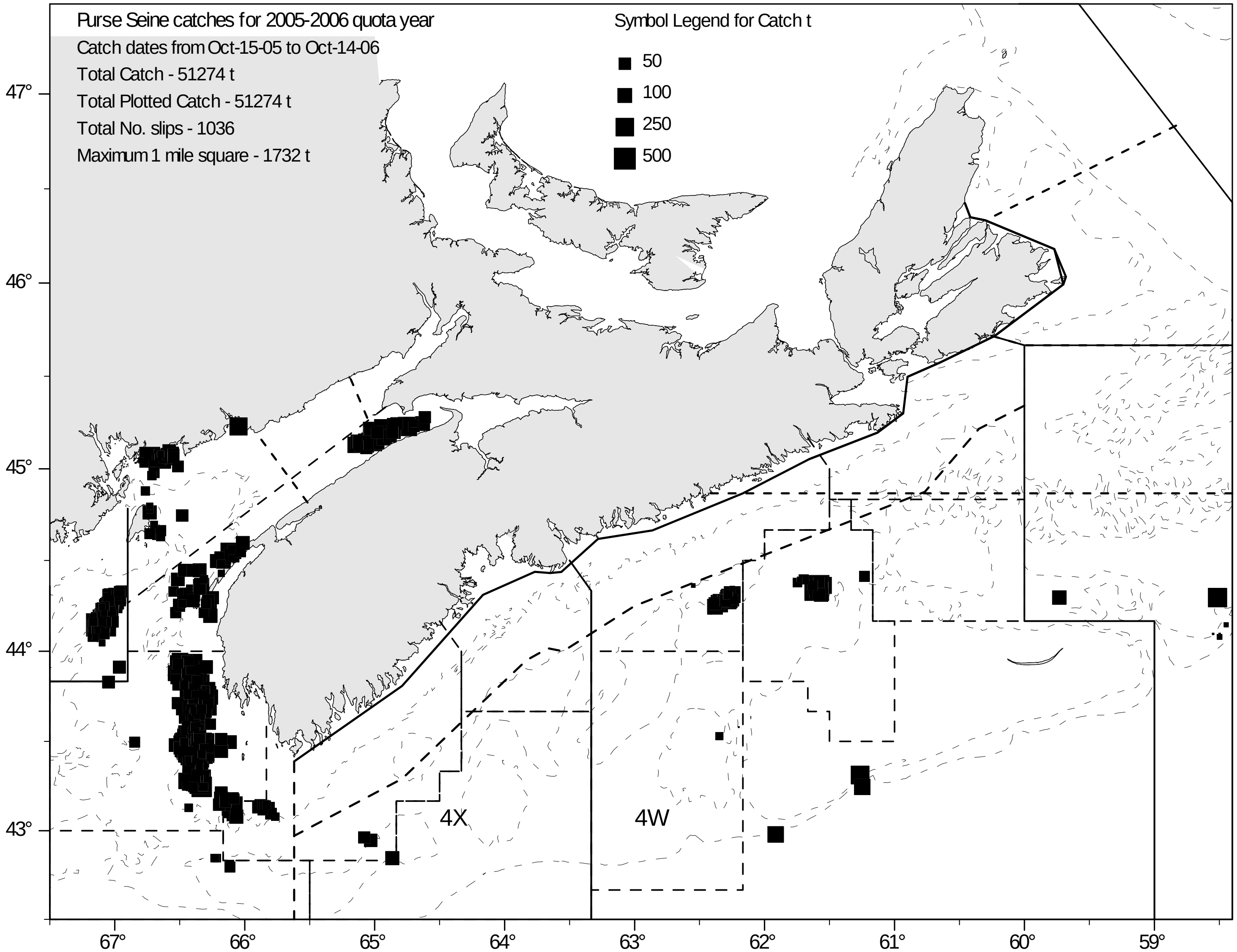


Figure 8. Overall 2005-2006 quota year herring purse seine catches (t) for NAFO areas 4WX (from Statistics Division MARFIS database).

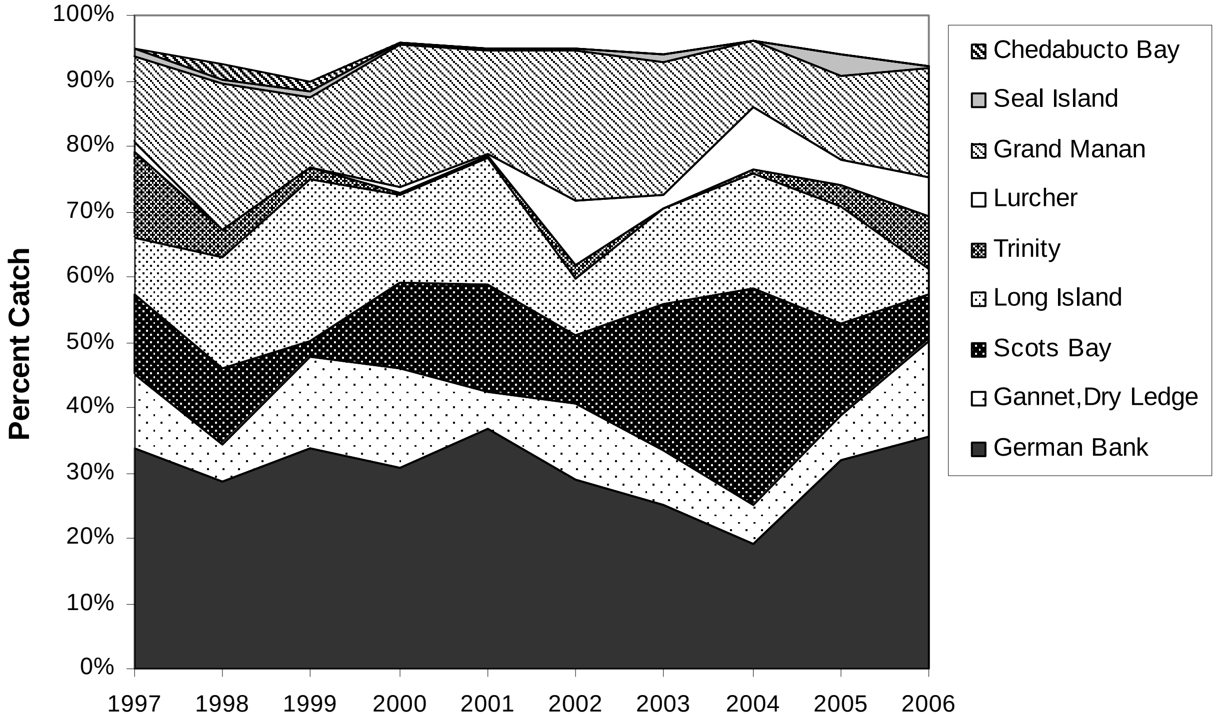


Figure 9. Herring purse seine catches as a proportion of overall landings for selected fishing grounds in the southwest Nova Scotia spawning component from 1997-2006.

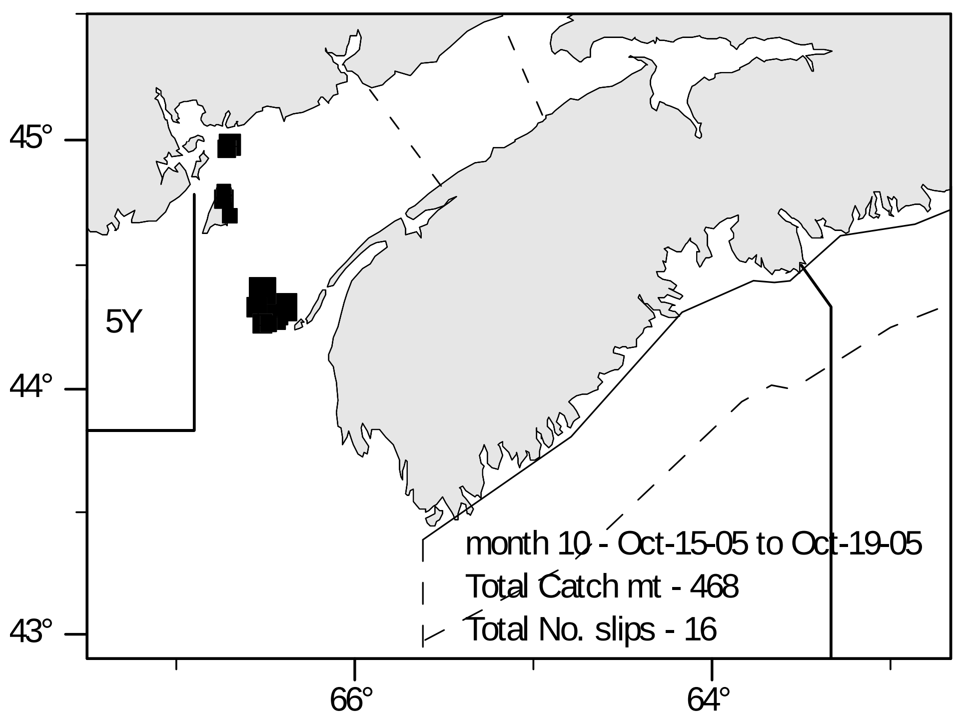


Figure 10. 2005 fall fishery herring purse seine catches (t) by month in NAFO areas 4WX from 2005-2006 quota year (from Statistics Division MARFIS database).

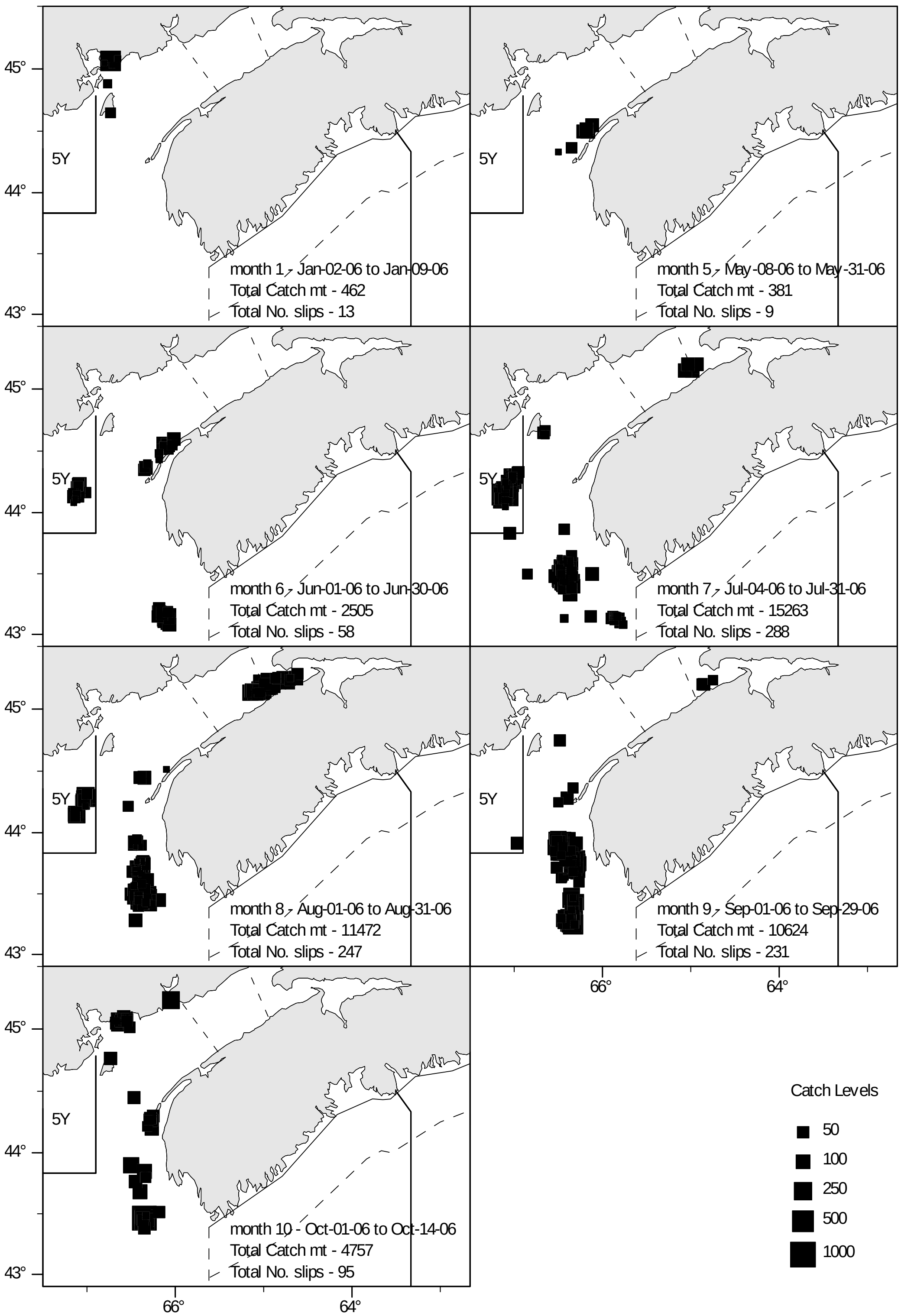


Figure 11. 2006 herring purse seine catches (t) by month in NAFO areas 4WX from 2005-2006 quota year (from Statistics Division MARFIS database)

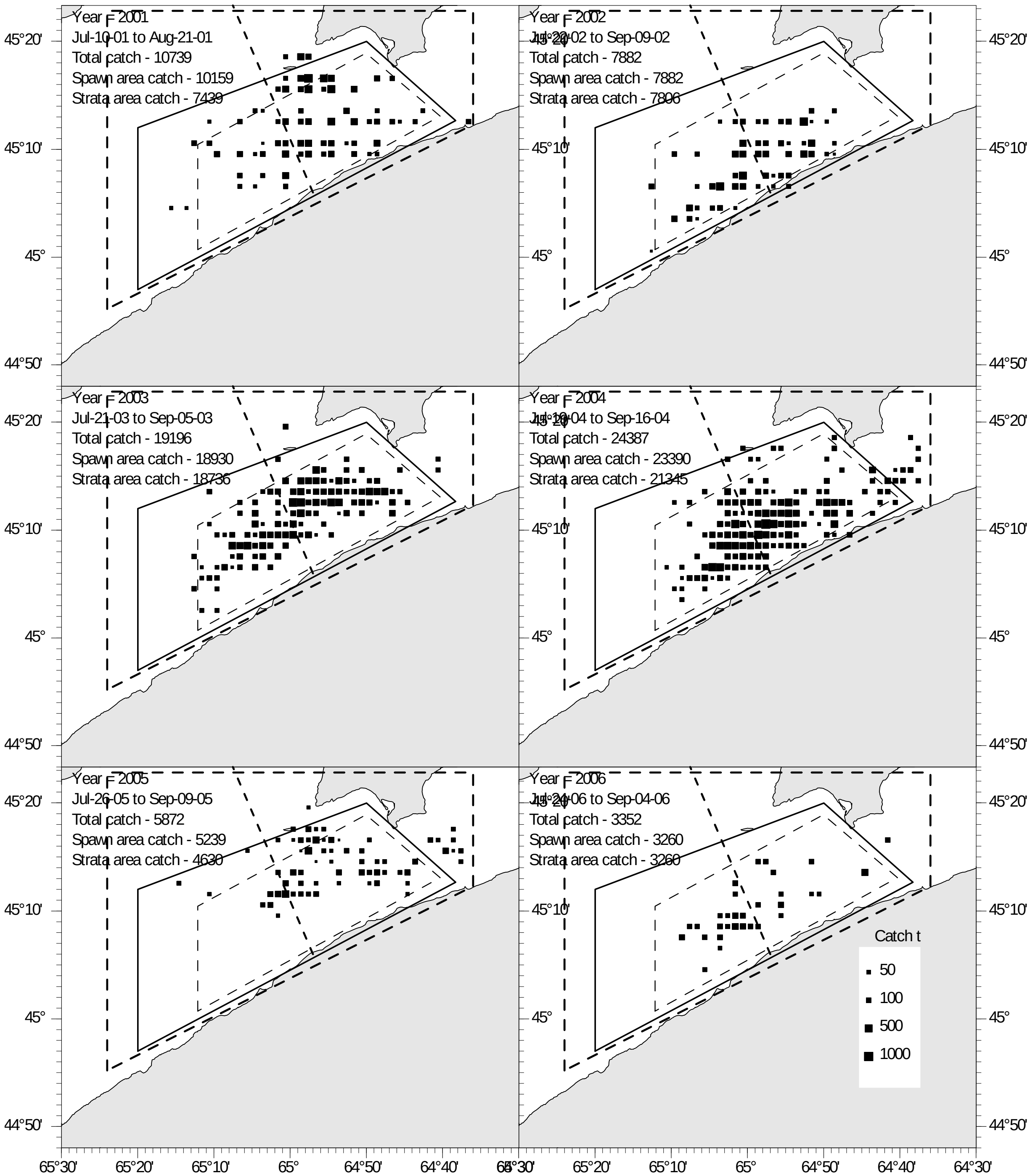


Figure 12. Herring purse seine catches for the Scots Bay area from 2001-2006 with catch totals for the overall area, the middle 'Spawning' area and the inner 'Strata' area which was used as the primary search area in acoustic surveys.

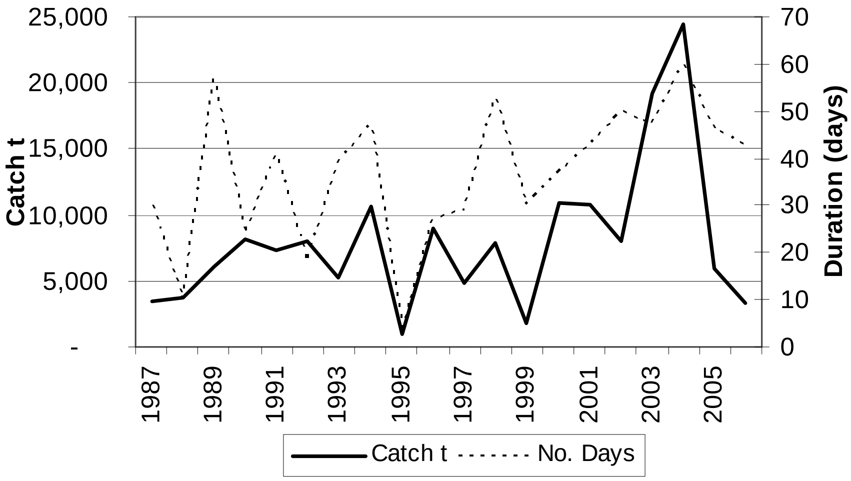


Figure 13. Annual herring purse seine catches for the Scots Bay area from 1987-2006 with duration of fishery in days (start date to end date).

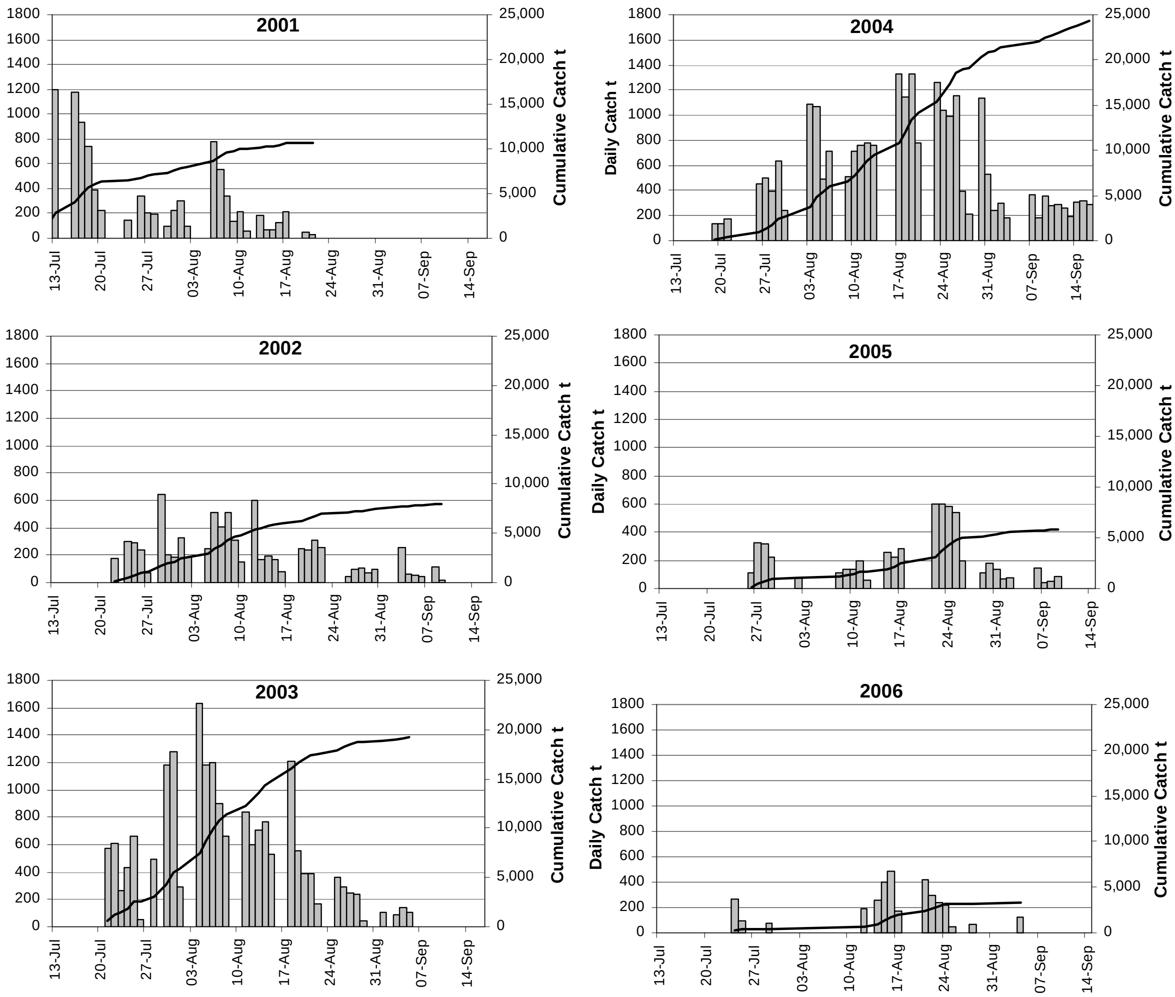


Figure 14. 2001 to 2006 daily purse seine herring catches in tonnes (bars) for Scots Bay with the cumulative total catch (solid line) over the entire fishing season.

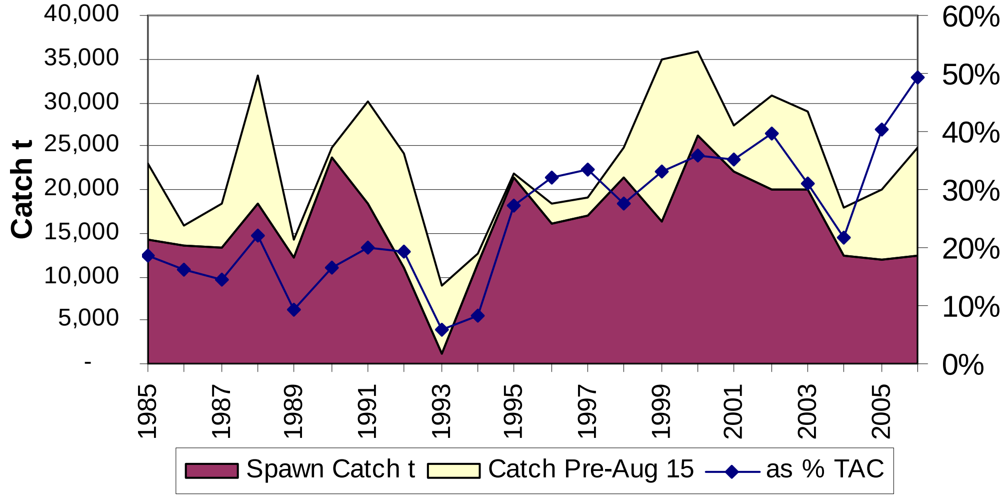


Figure 15. Annual herring purse seine catches for the German Bank area from 1985-2006 with pre-spawning and spawning period catches based on an Aug. 15 start date for the defined spawning period and overall German Bank catches as a proportion of the TAC.

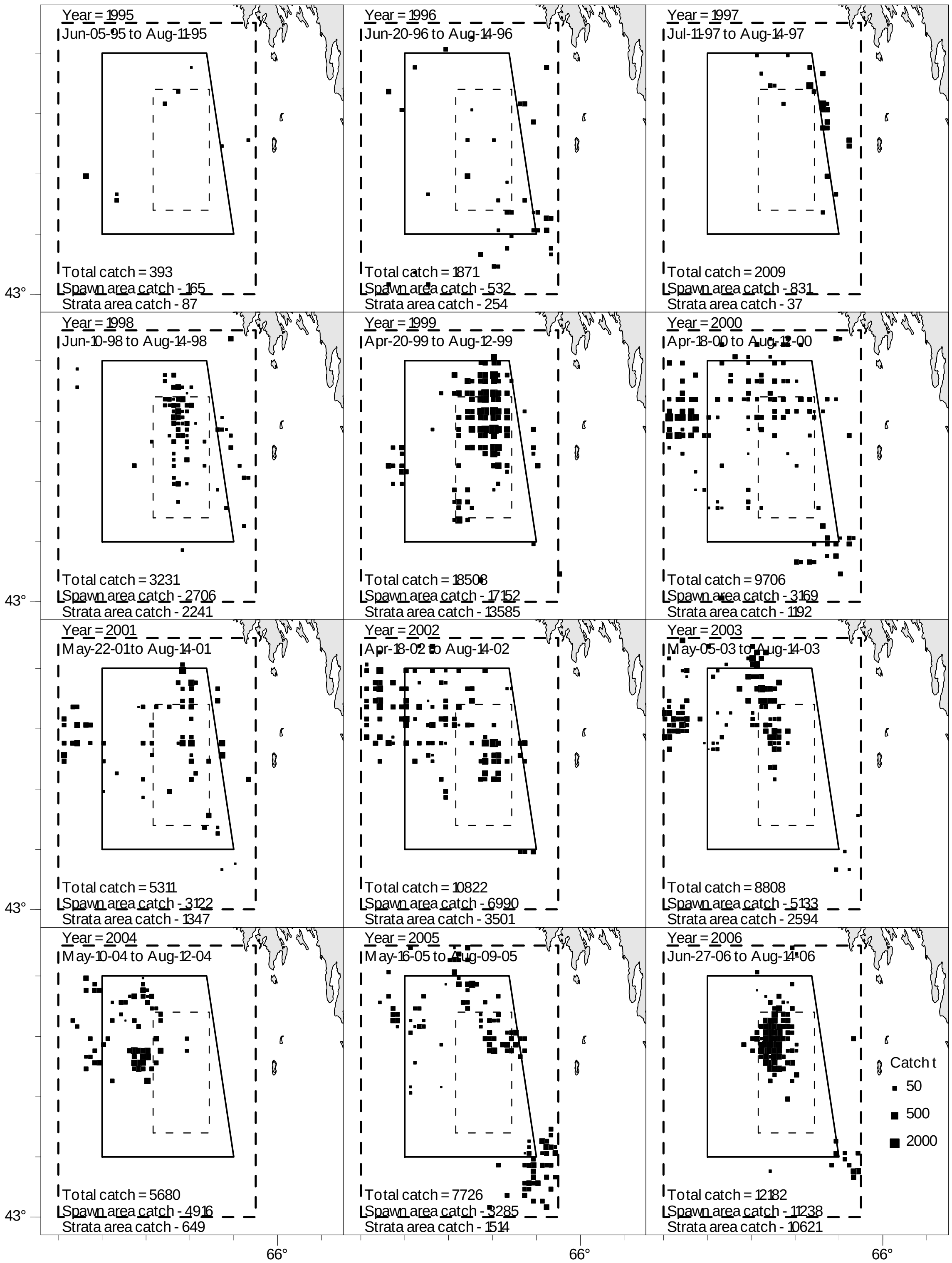


Figure 16. Herring purse seine pre-spawning period catches (May 1 to Aug. 14) for German Bank from 1995-2006 with catch totals for the overall catch area, the middle ‘Spawn Box’ and the inner ‘Strata Box’ which was used as the primary search area in acoustic surveys.

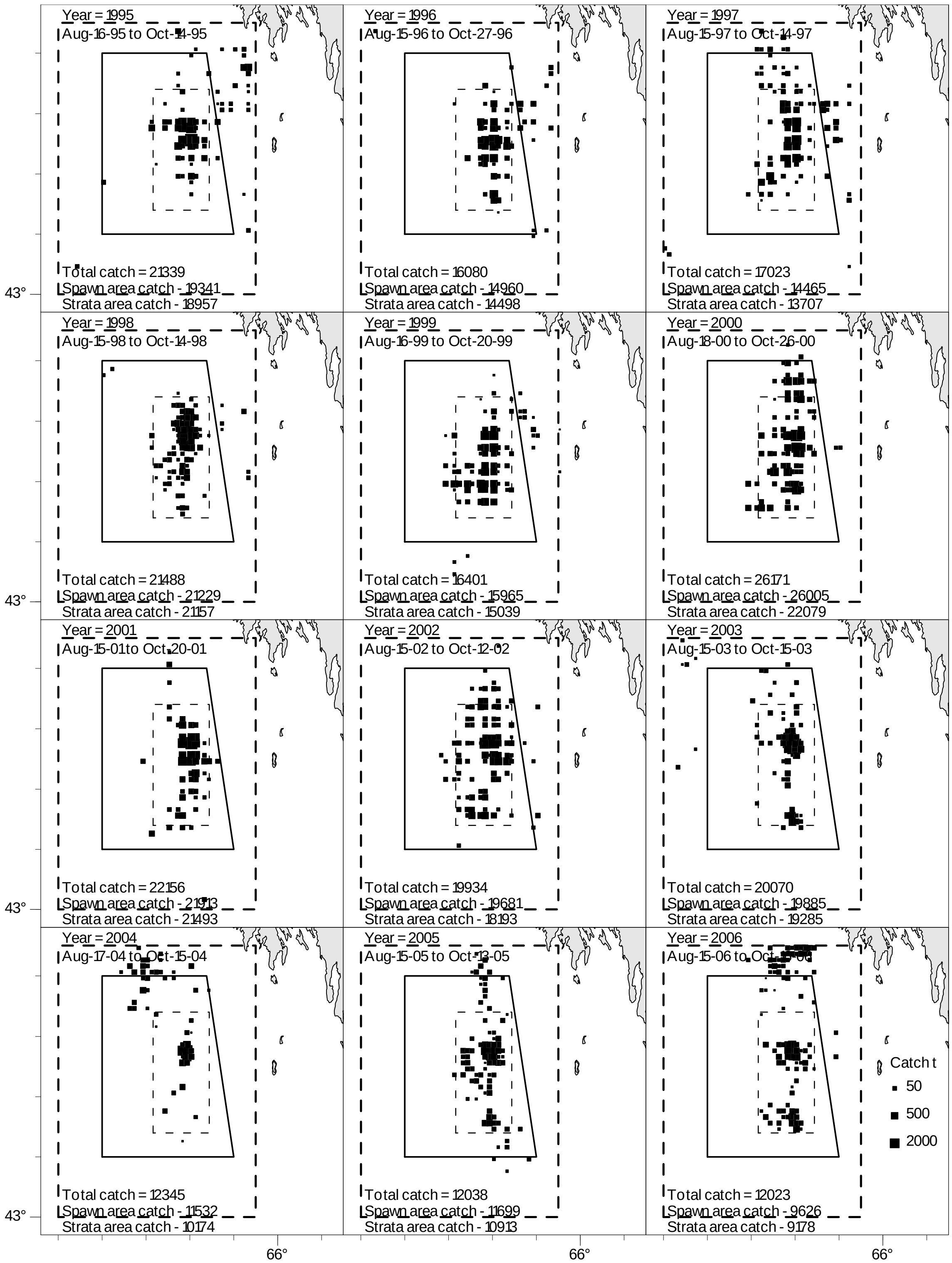


Figure 17. Herring purse seine spawning period catches (Aug. 15 to Oct. 31) for German Bank from 1995-2006 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

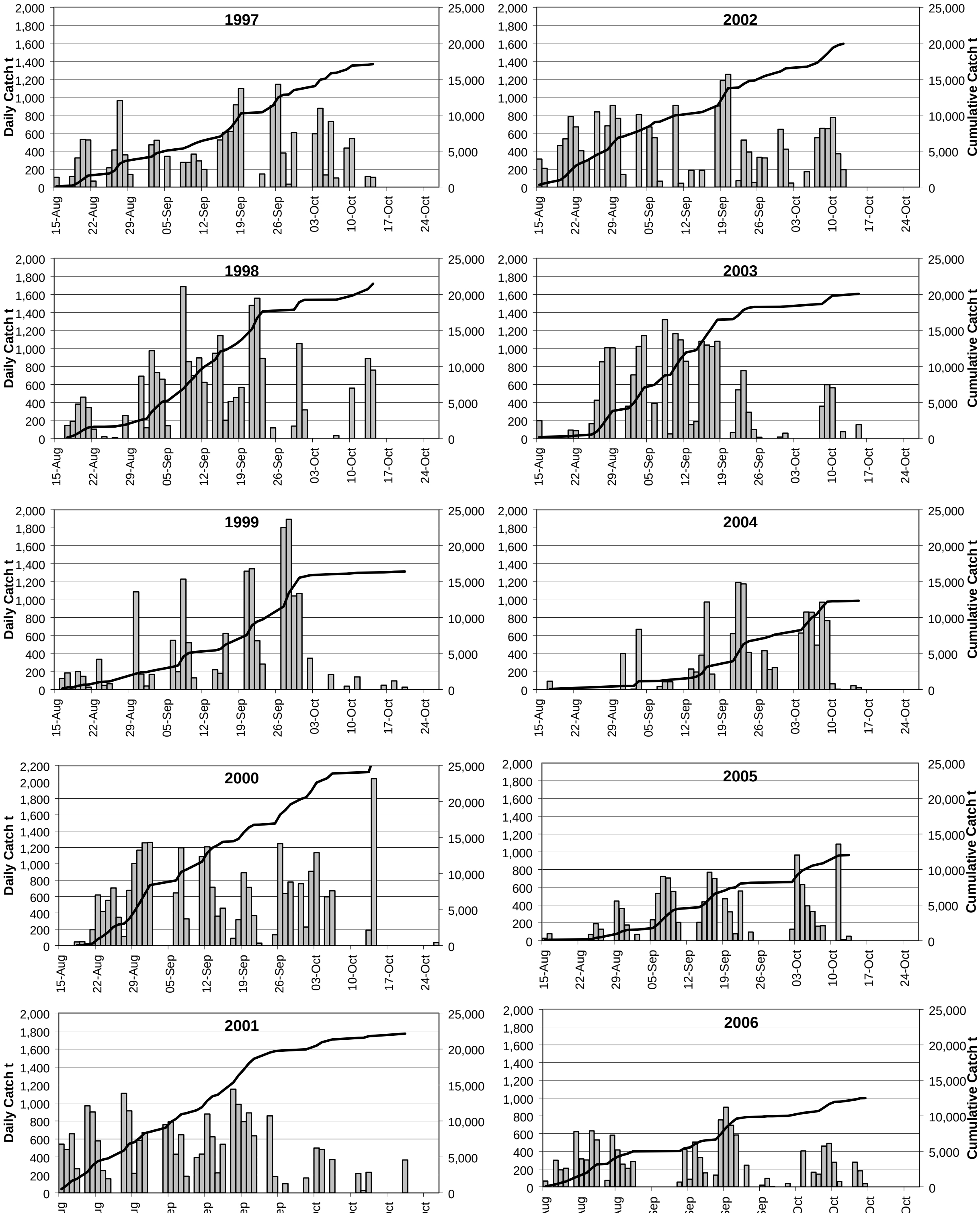


Figure 18. 1997 to 2006 daily purse seine herring catches in tonnes (bars) for German Bank with the cumulative total catch (solid line) over the defined spawning season from Aug. 15 to Oct. 30.

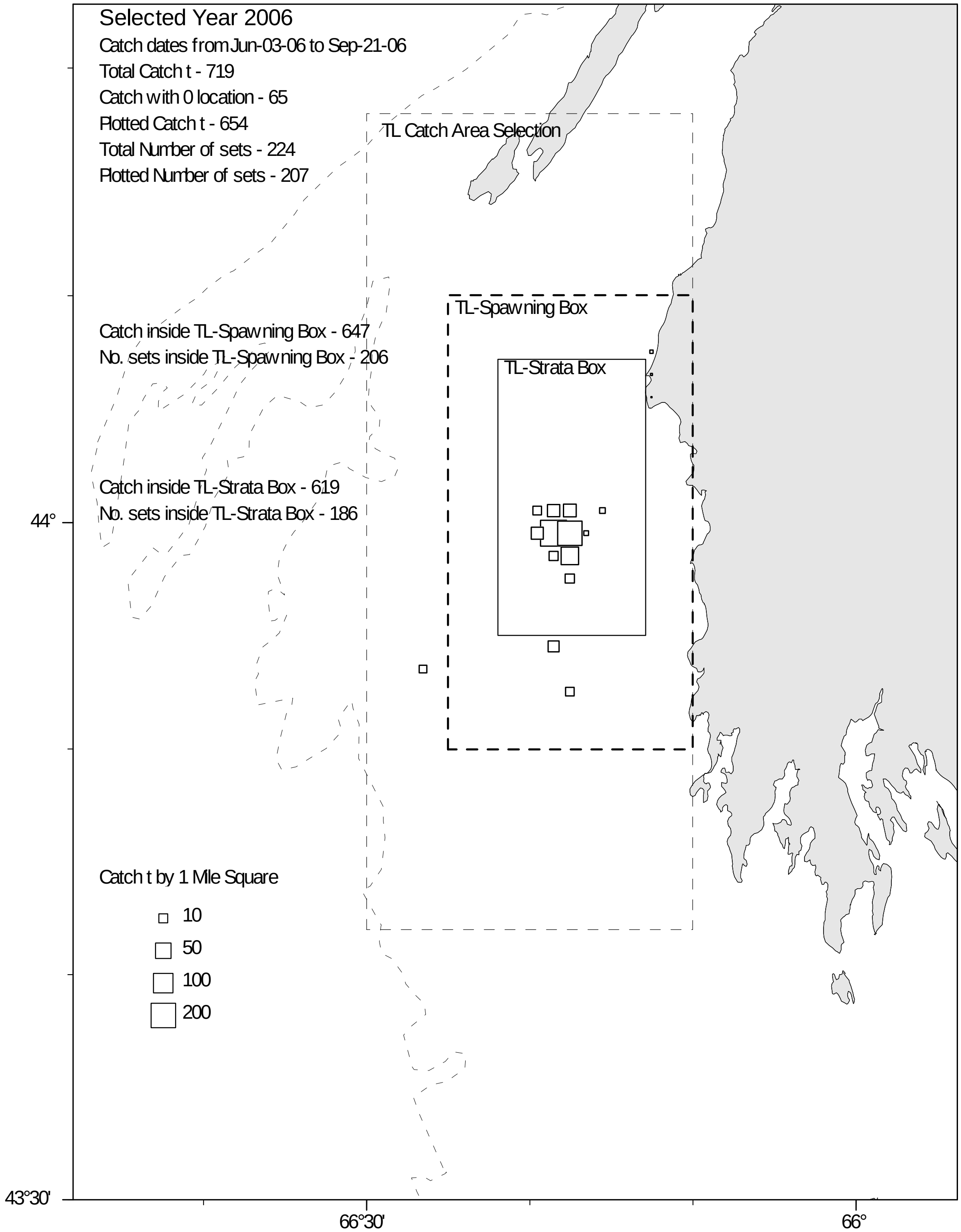


Figure 19. Trinity Ledge/Spectacle Buoy herring catches for 2006 with overall catch amounts and catch portions within the defined spawning area (TL-Spawning Box) and survey areas (TL-Strata Box).

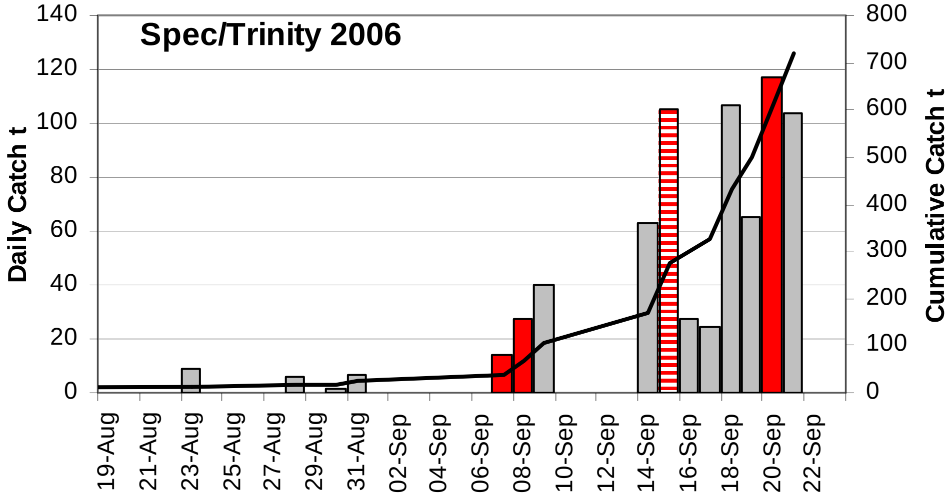


Figure 20. Daily herring landings for 2006 Trinity Ledge/Spectacle Buoy area with acoustic survey dates highlighted in red (darkened) for nights of Sept. 7, 8, 15 (purse seiner) and 20th. Note that an additional survey on Sept. 3 where there were no landings is not shown.

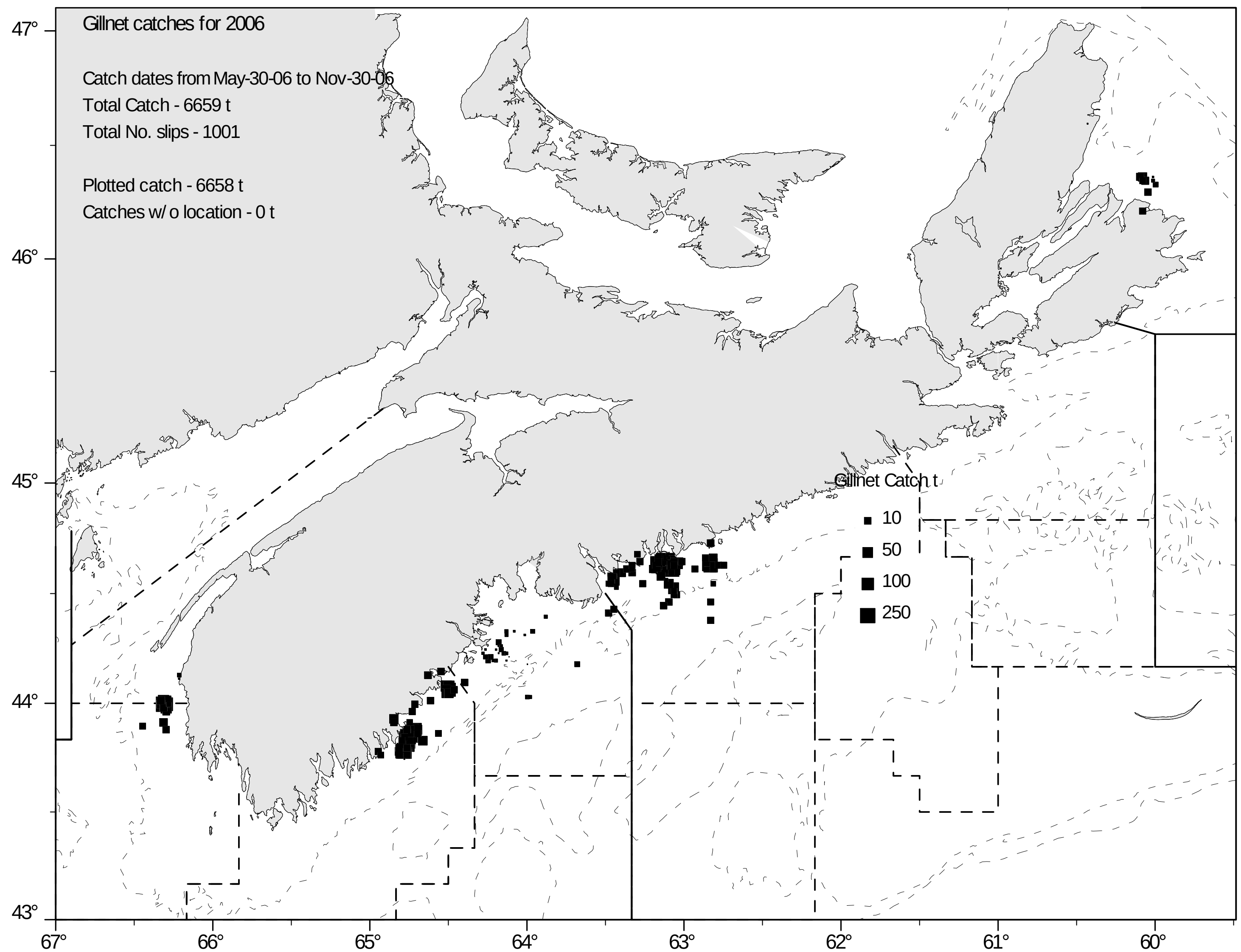


Figure 21. Herring set and drift gillnet catches (t) for 2006 calendar year for NAFO areas 4VWX (data from Statistics Division MARFIS database).

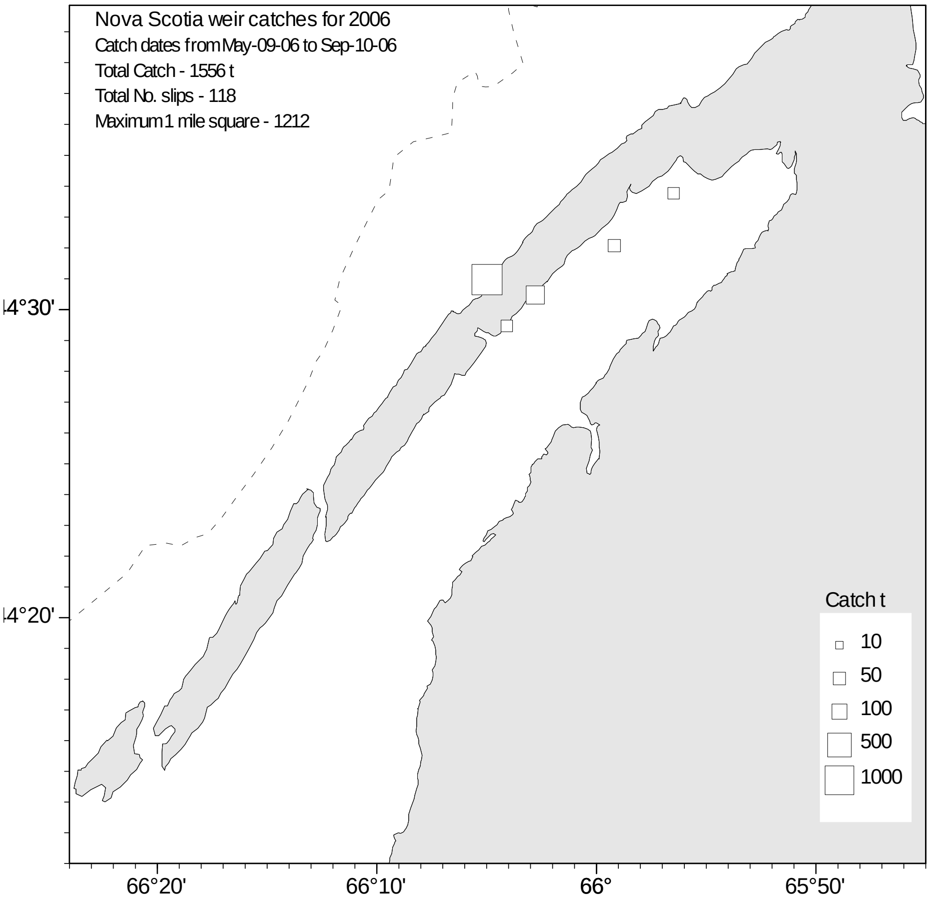


Figure 22. Nova Scotia herring weir catches for the 2006 calendar year.

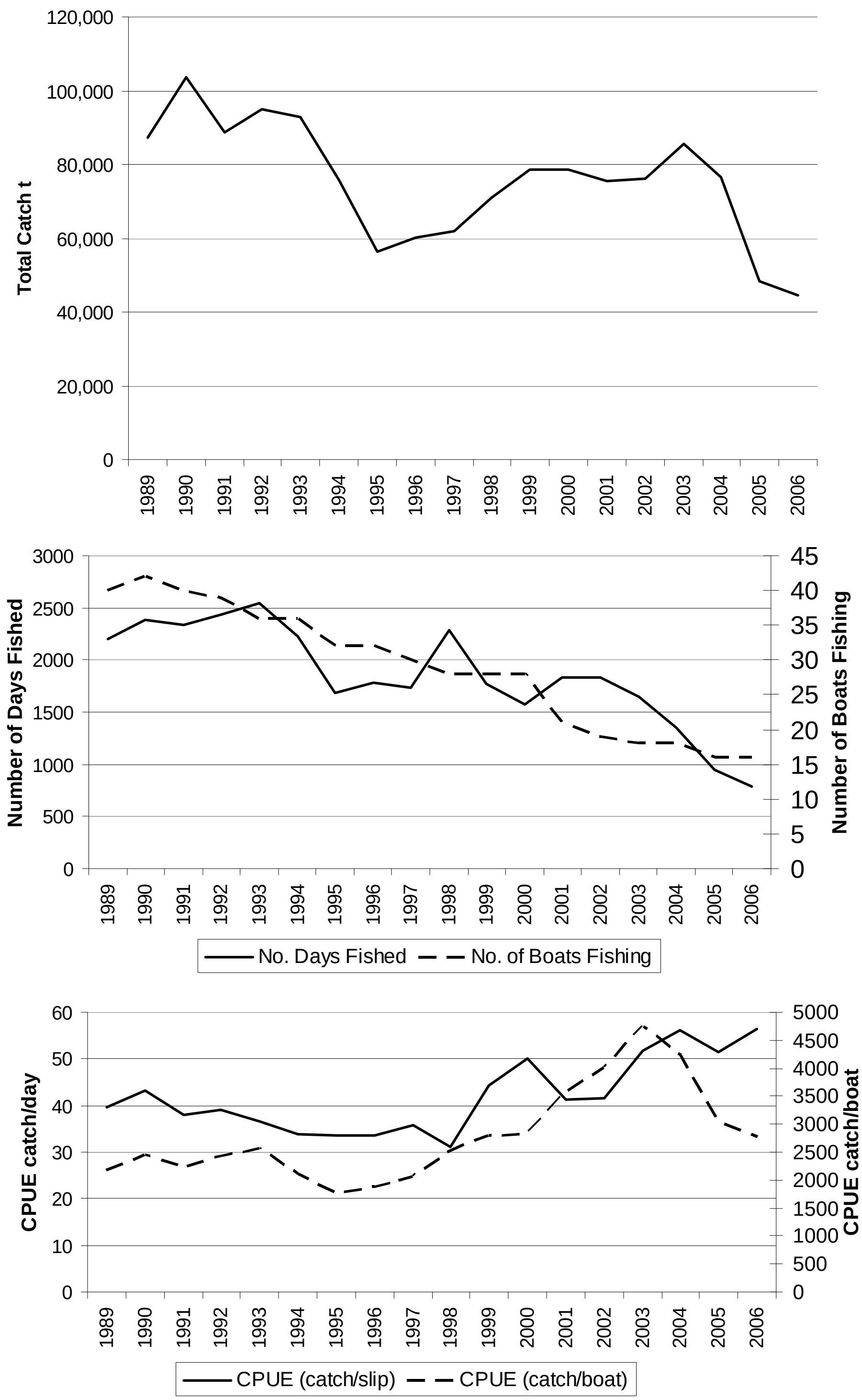


Figure 23. Purse seine catch (top panel), effort (middle panel) and CPUE (bottom) from 1989 to 2006 annual 4WX herring landings data for the SW Nova Scotia/Bay of Fundy spawning component.

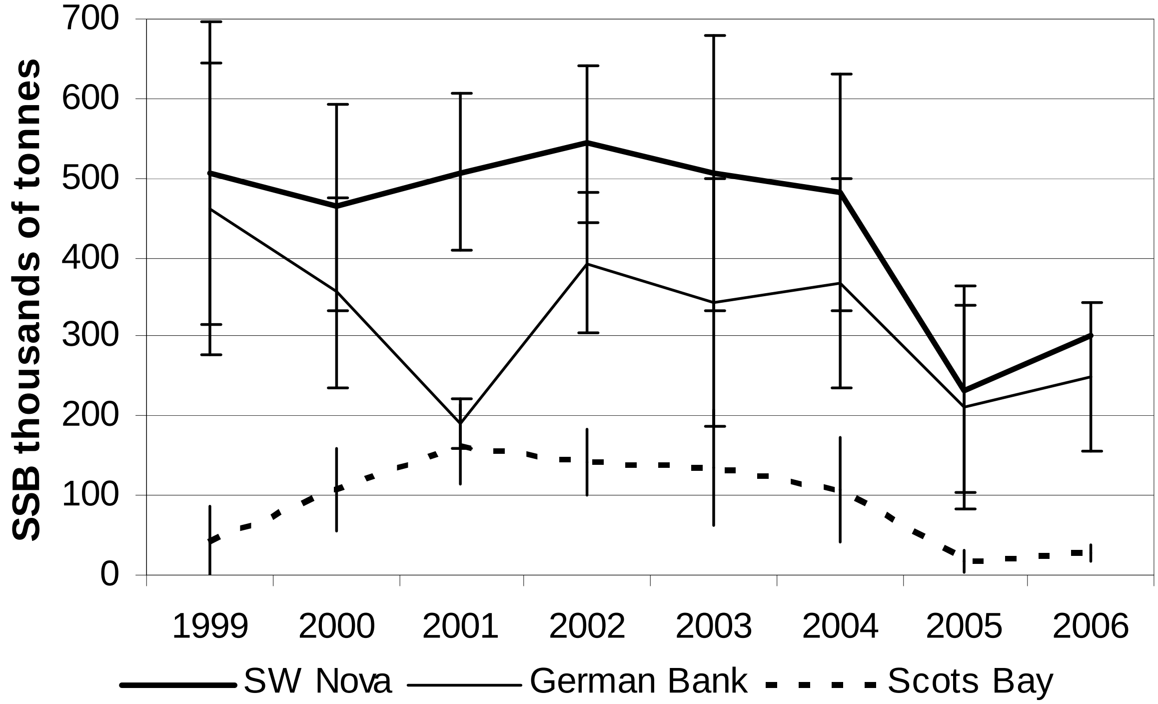


Figure 24. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component overall area and for the German Bank and Scots Bay areas.

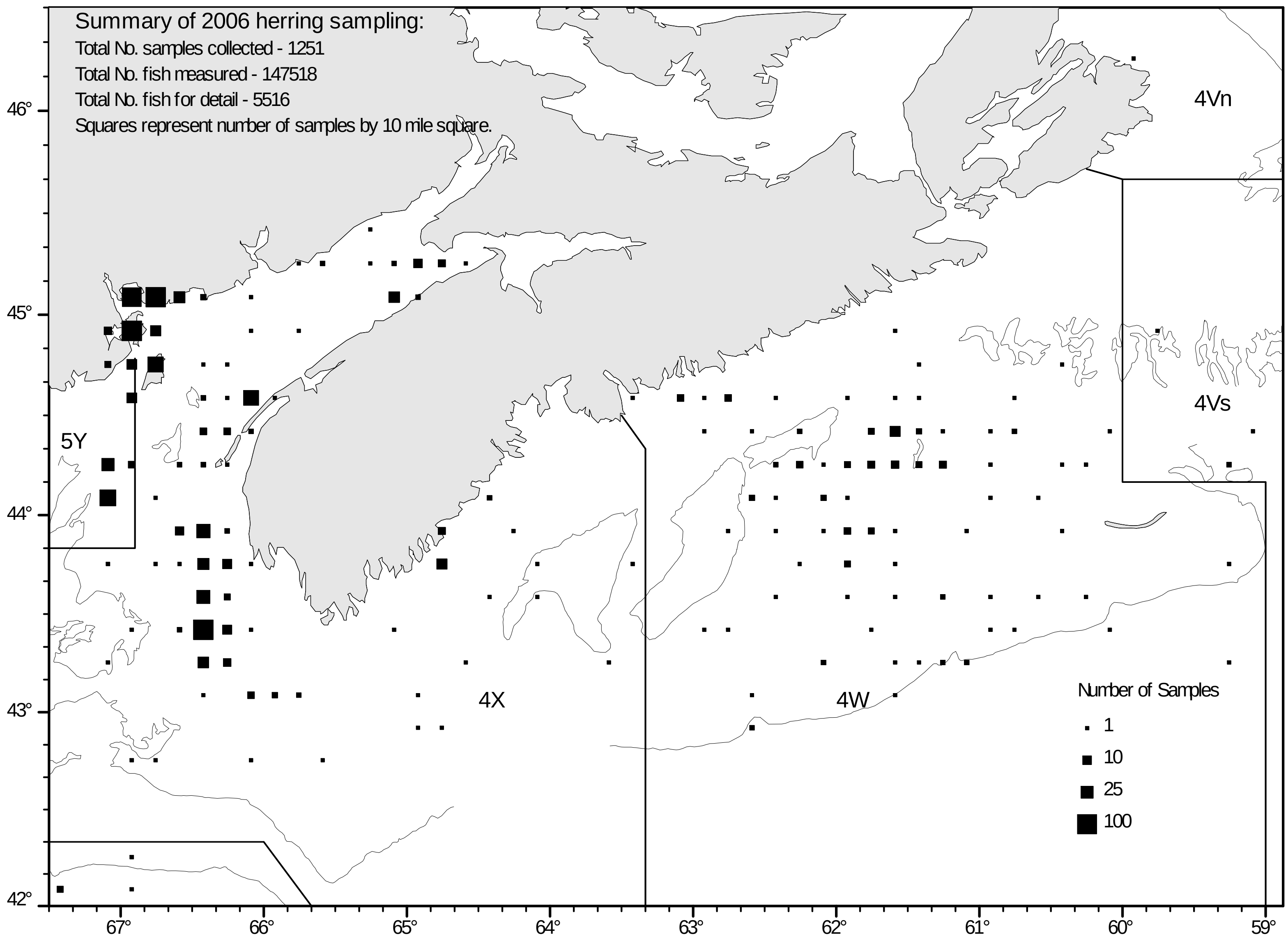


Figure 25. 2005 herring sampling coverage from all sources (number of length frequency samples by 10 mile square).

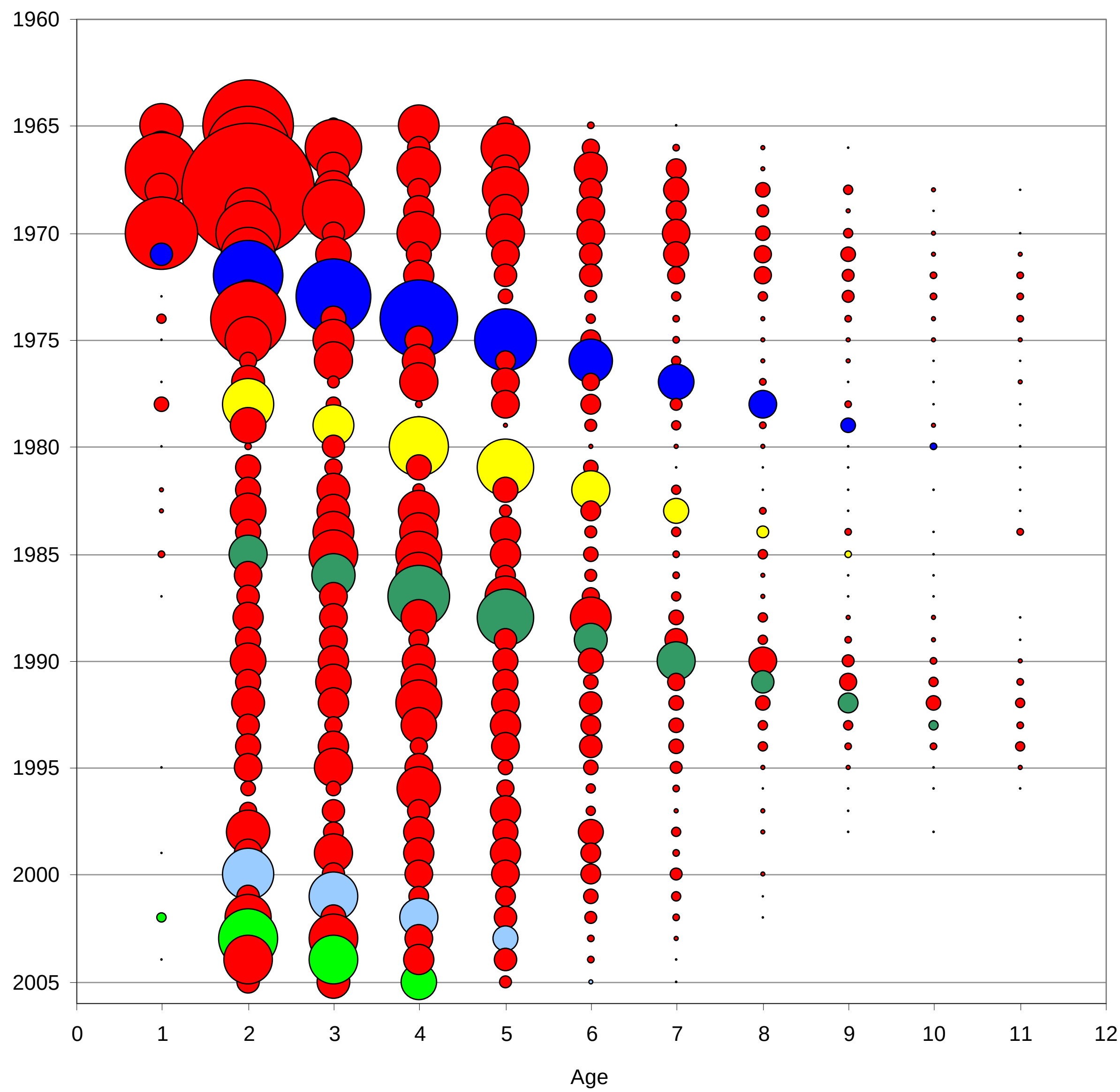


Figure 26. Historical catch at age (numbers) for the SW Nova Scotia / Bay of Fundy spawning component. Refer to Table 18 for actual numbers represented by symbol size. The value for 1968 at age 2 represents the maximum in the series of 2.389 billion. Several of the stronger year-classes are highlighted including the 1970, 1976, 1983, 1998 and 2001 year-classes (from Power et al, 2006a).

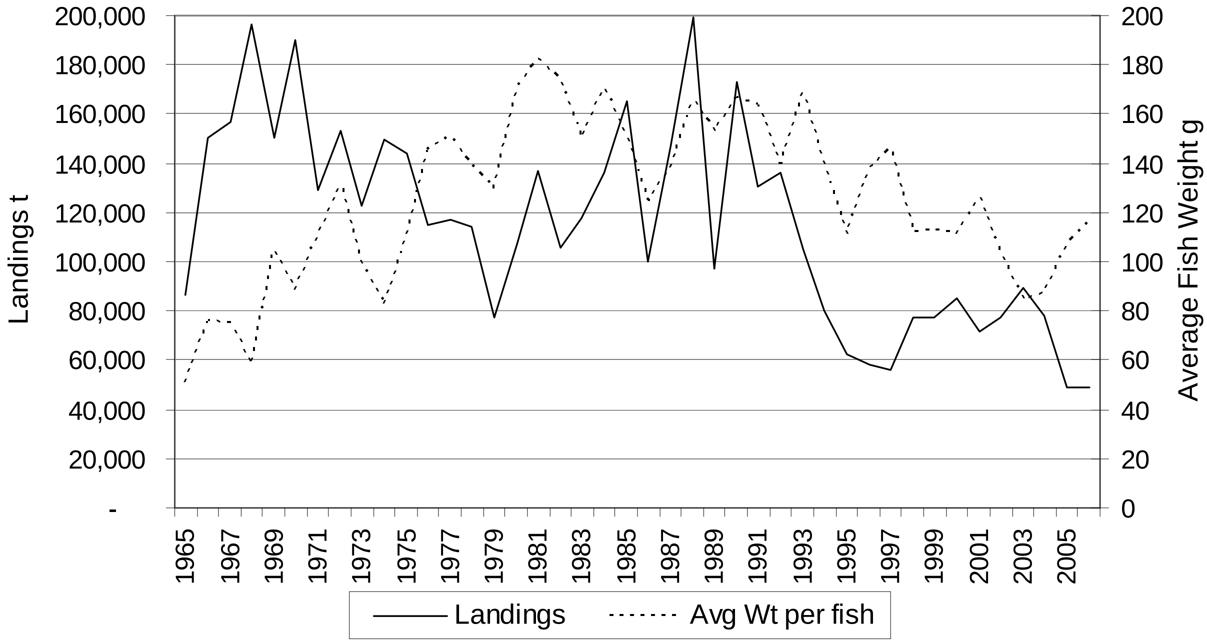


Figure 27. SW Nova Scotia spawning component overall landings (t) and average fish weight in the catch for the period 1965-2006.

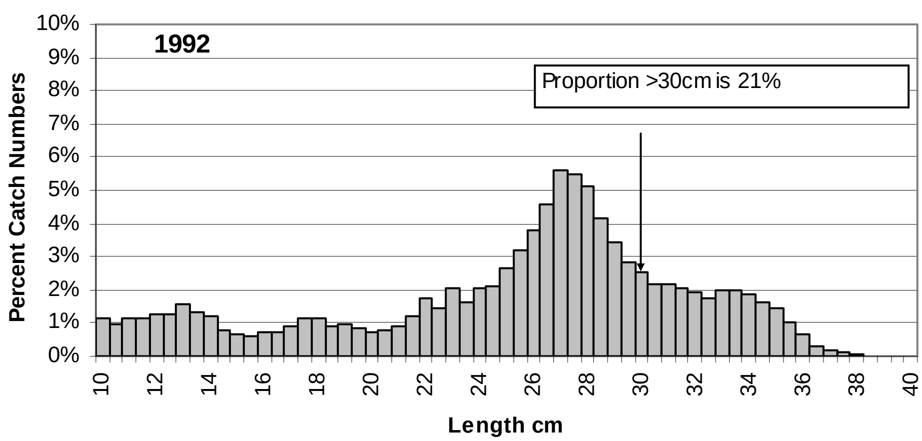


Figure 28. Catch at length (% number) for the 1992 overall SW Nova Scotia / Bay of Fundy herring spawning component.

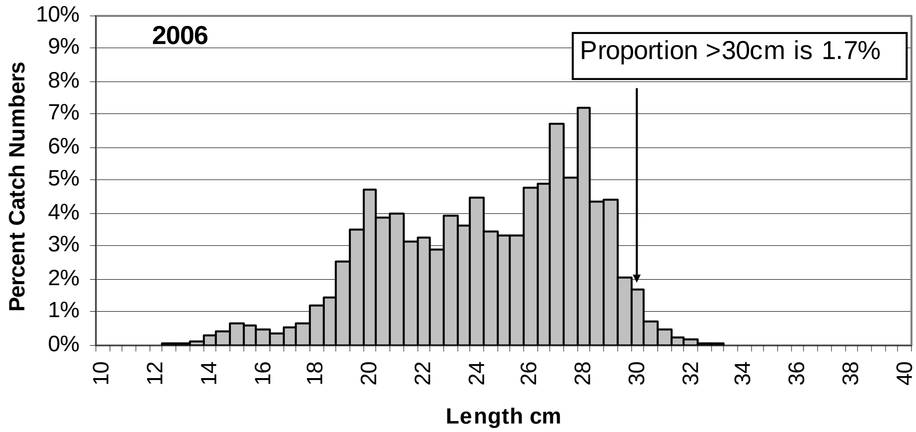


Figure 29. Catch at length (% number) for the 2006 overall SW Nova Scotia / Bay of Fundy herring spawning component.

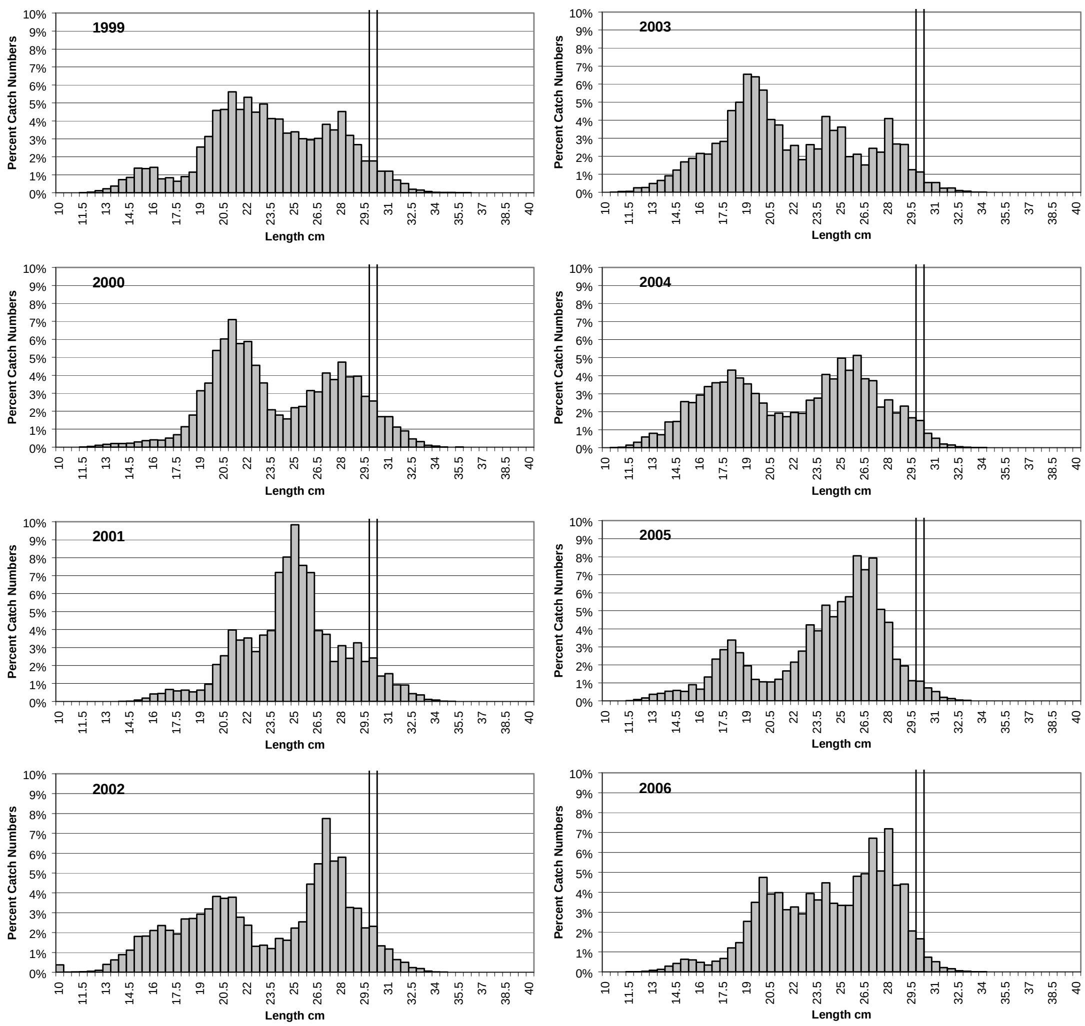


Figure 30. Catch at length (% number) for the 1999-2006 overall SW Nova Scotia / Bay of Fundy herring spawning component. Open bar is used to designate the 30cm interval for comparison between years.

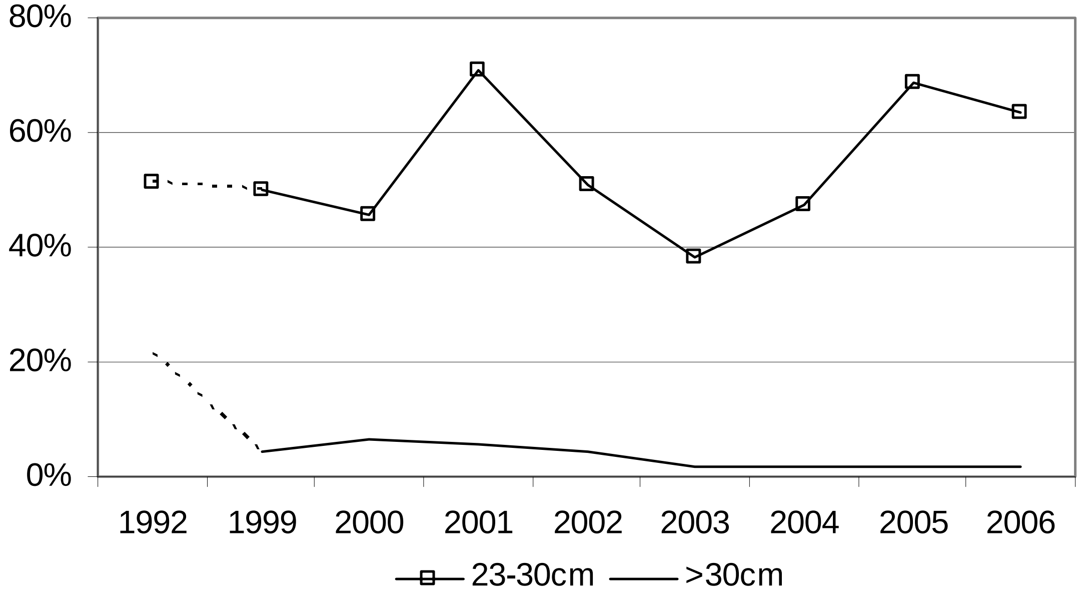


Figure 31. Proportions of size groups (% number) 23-30cm and >30cm herring in the catch from the SW Nova Scotia / Bay of Fundy spawning component for 1992 and 1999-2006.

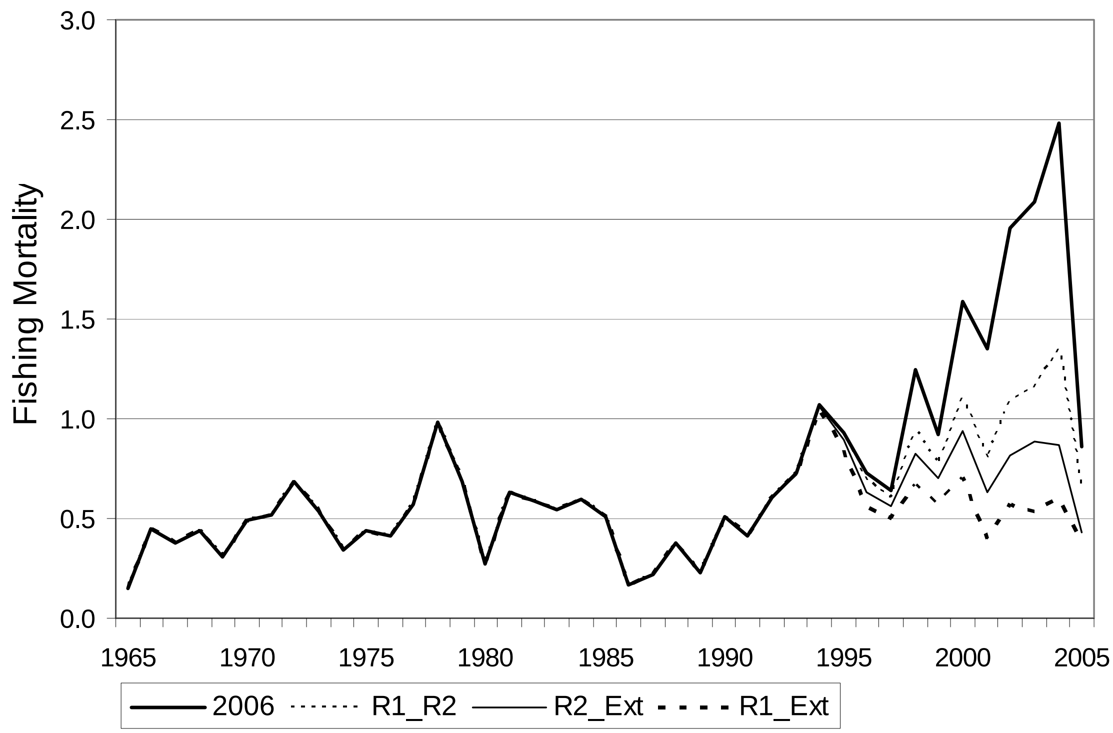


Figure 32. Fishing mortality (ages 5-8 weighted by population numbers) from a series of VPA's calibrated with the German Bank acoustic index for the Expert Opinion (DFO 2006).

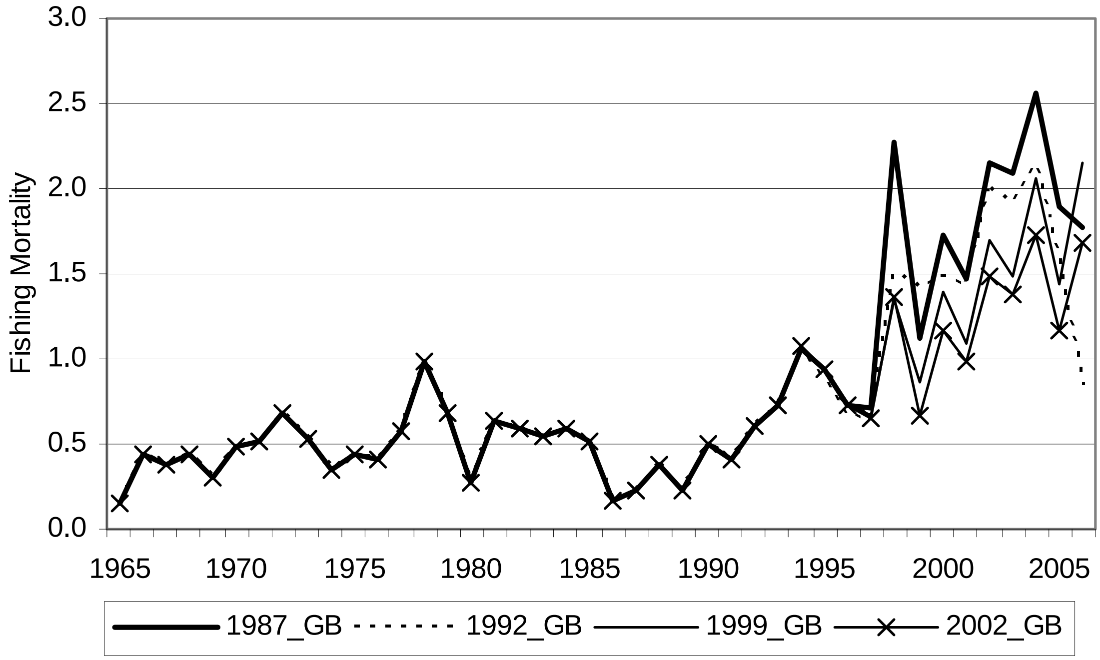


Figure 33. Fishing mortality (ages 5-8 weighted by population numbers) from a series of VPA’s calibrated with the German Bank acoustic index for this assessment (Melvin and Power, 2007).

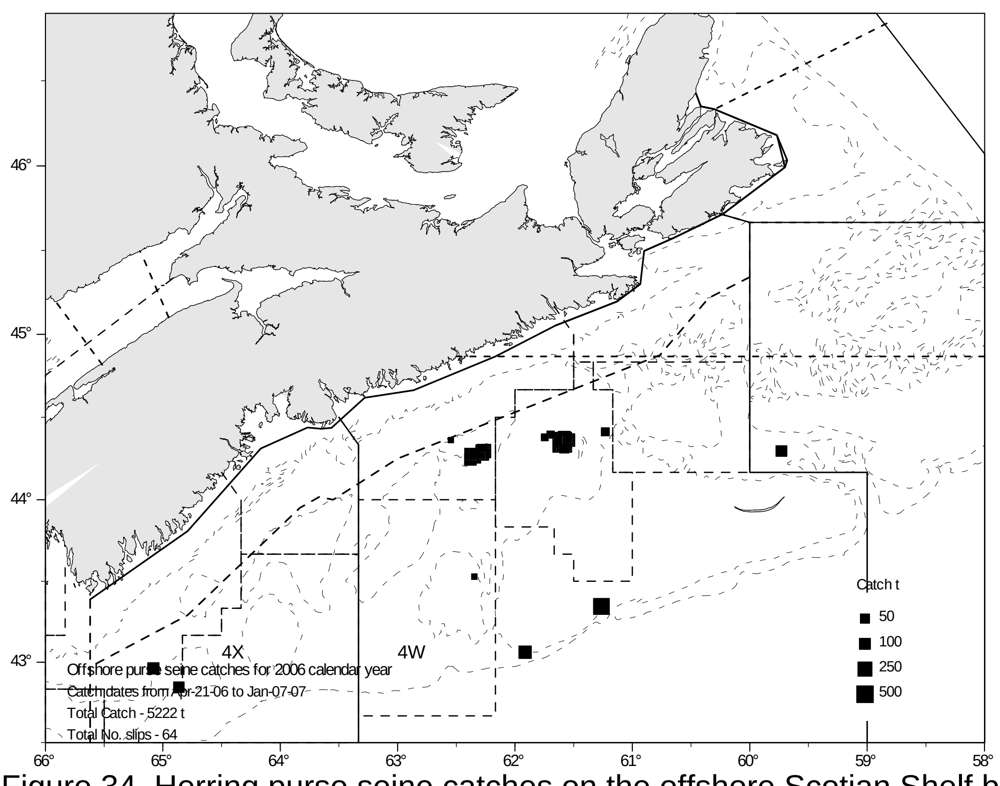


Figure 34. Herring purse seine catches on the offshore Scotian Shelf banks for 2006 with embayment and offshore 25 mile lines shown.

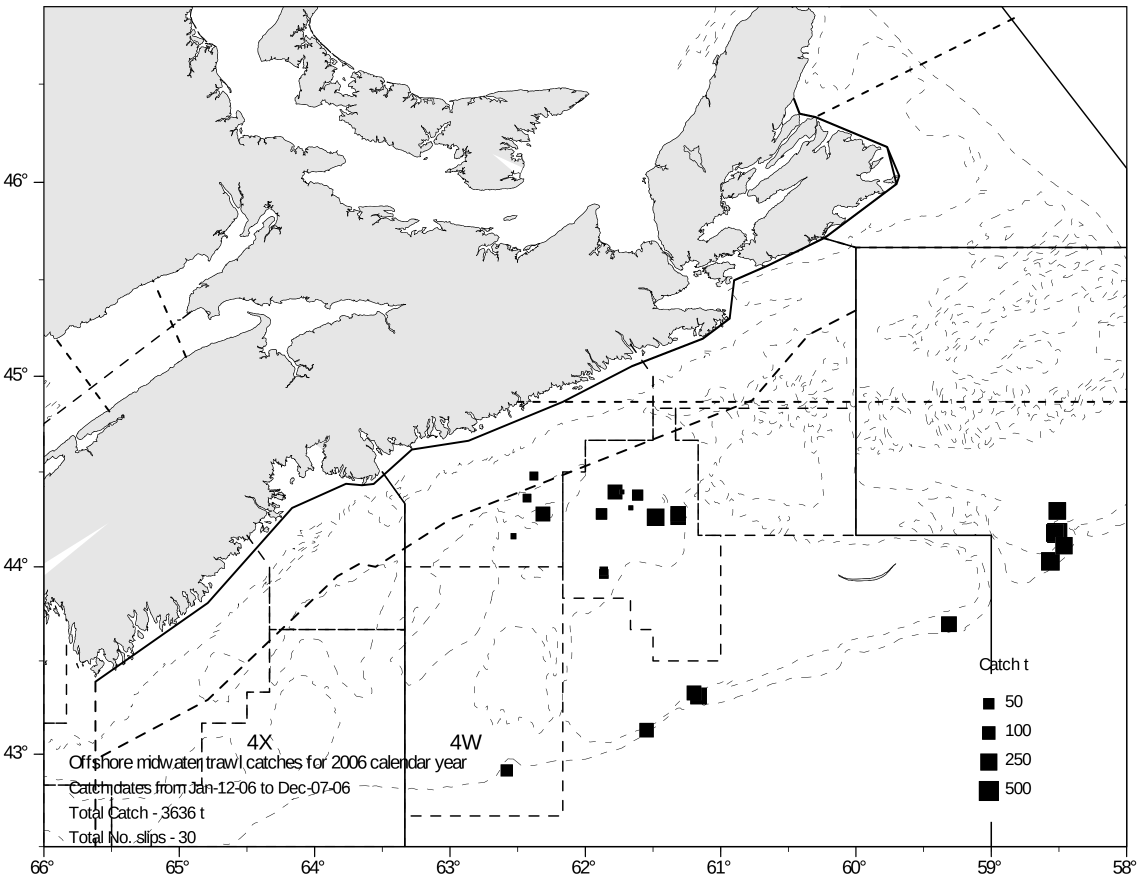


Figure 35. Herring midwater trawl catches on the offshore Scotian Shelf banks for 2006 with embayment and offshore 25 mile lines shown.

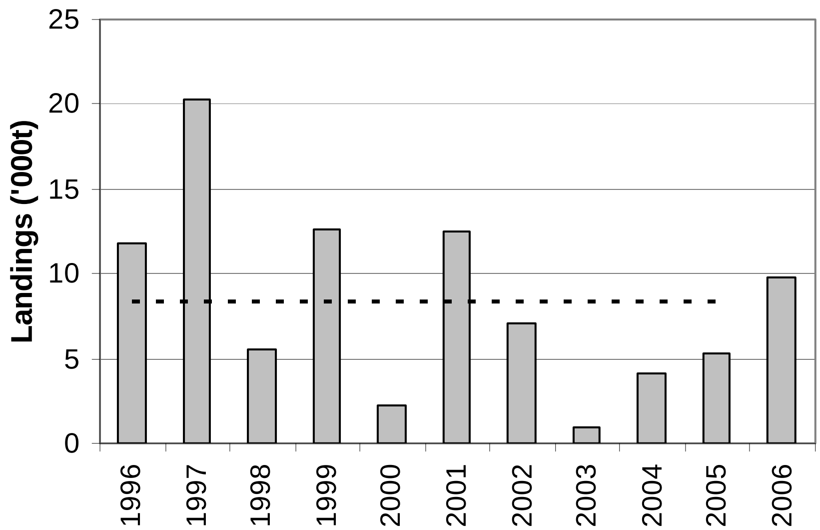


Figure 36. Scotian Shelf Banks landings from all gears since 1996 with the average for the period.

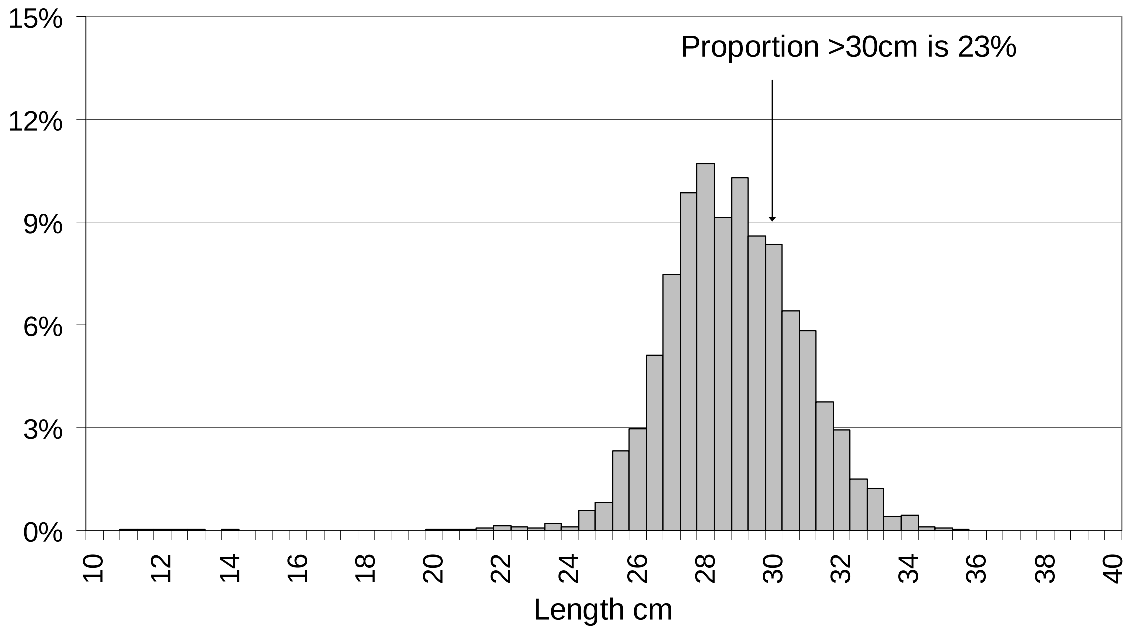


Figure 37. Catch at length (% number) for the 2006 offshore Scotian Shelf Banks herring spawning component.

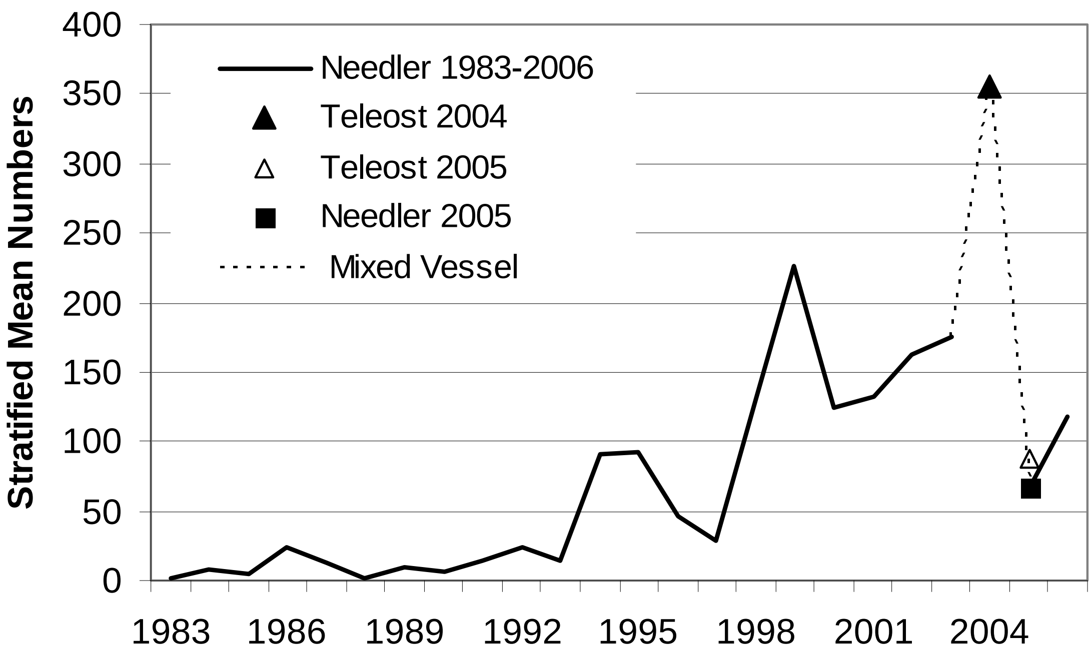


Figure 38. Number of herring caught per standard tow in the DFO summer bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 2006 (strata 55-78; from Sable Island to Baccaro Line).

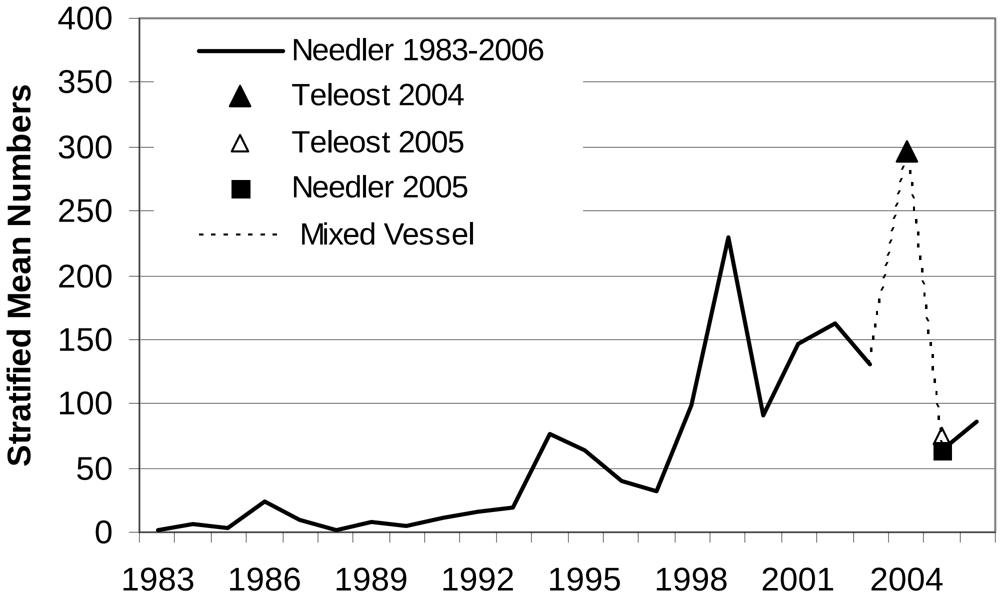


Figure 39. Number of herring caught per standard tow in the DFO summer bottom trawl research survey for 1983 to 2006 for area 4WX (strata 53-95).

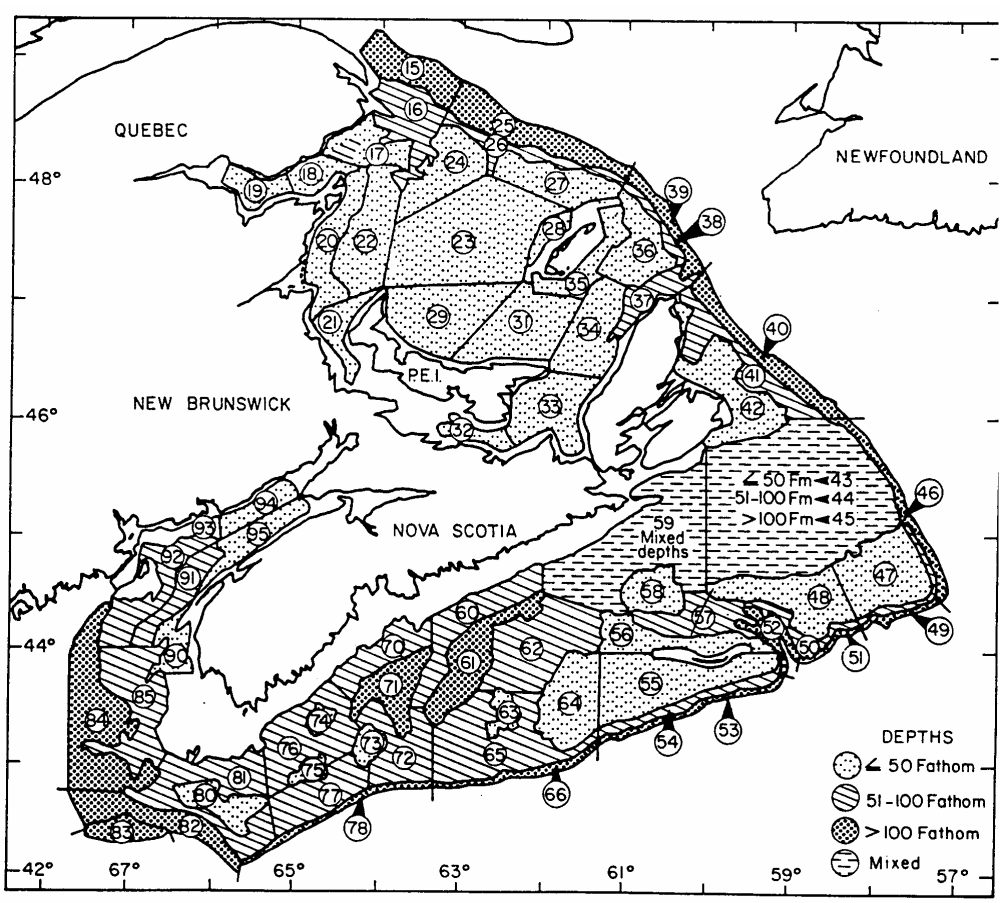


Figure 40. Research bottom trawl survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday, 1981).

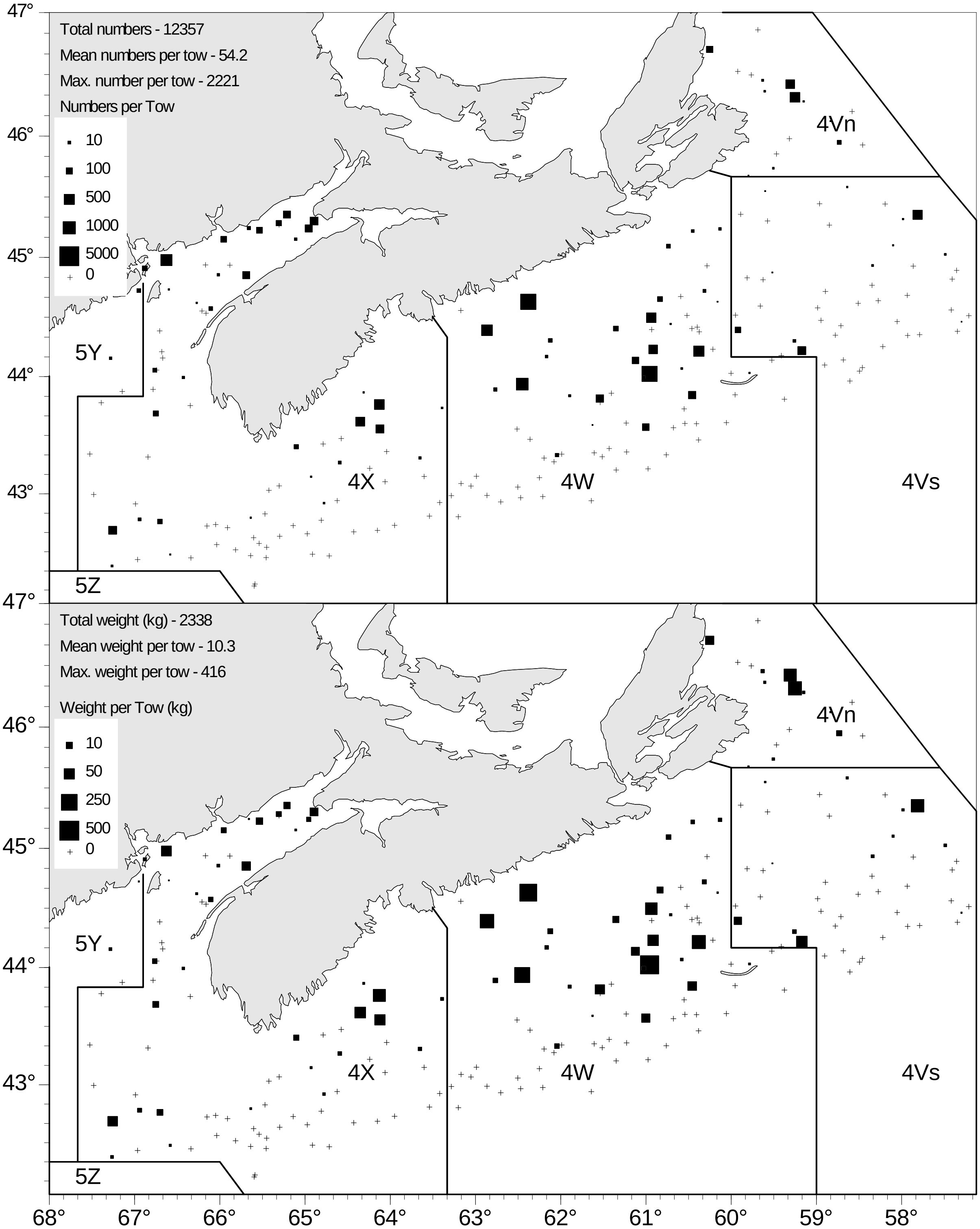


Figure 41. Herring catches in number and weight per tow for the 2006 DFO summer bottom trawl research survey (NED2006-030/036: July 6-Aug. 3, 2006).

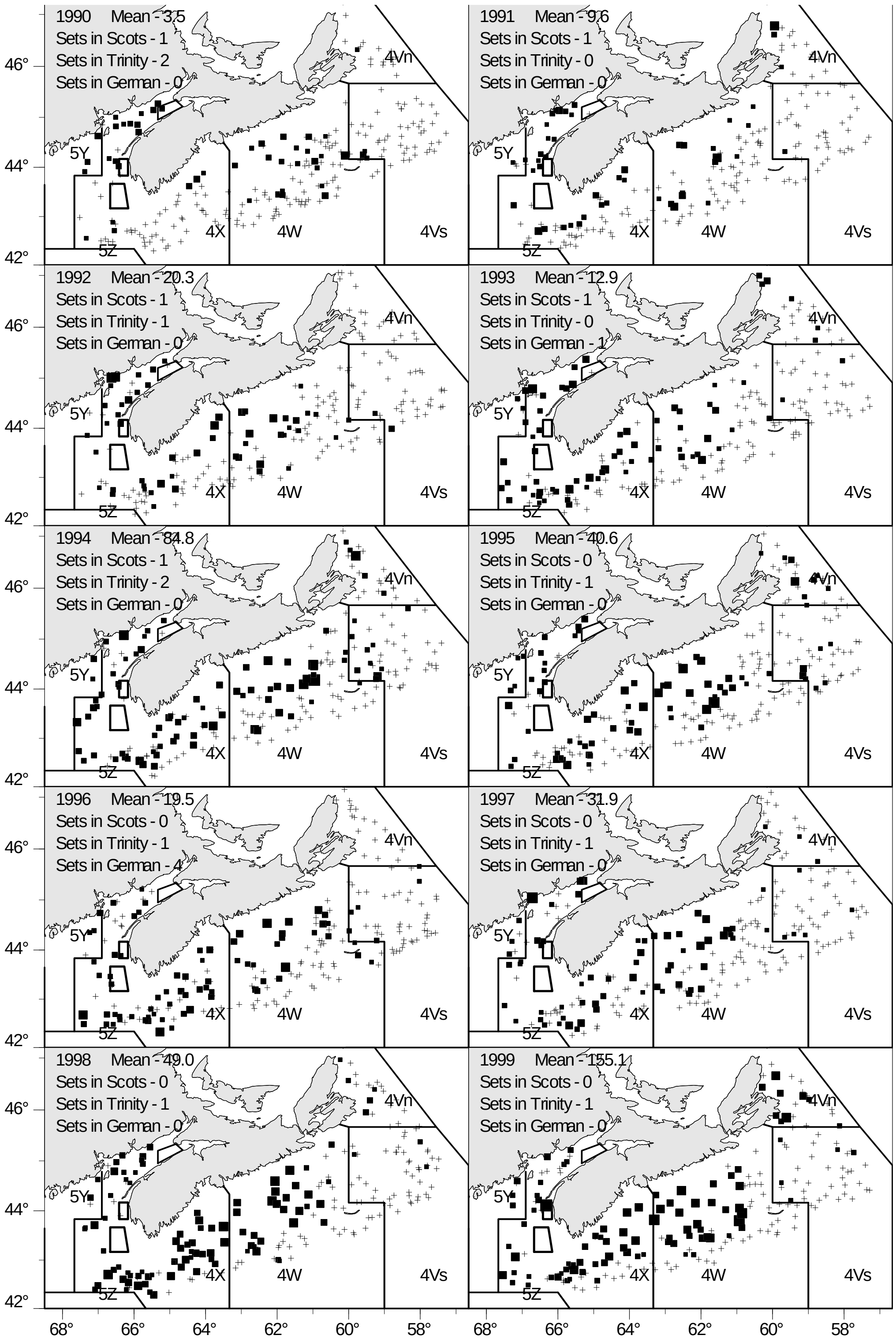


Figure 42. Herring catches from the DFO summer bottom trawl research survey for 1990-1999. Mean numbers per standard tow and count of sets in Scots, Trinity and German areas.

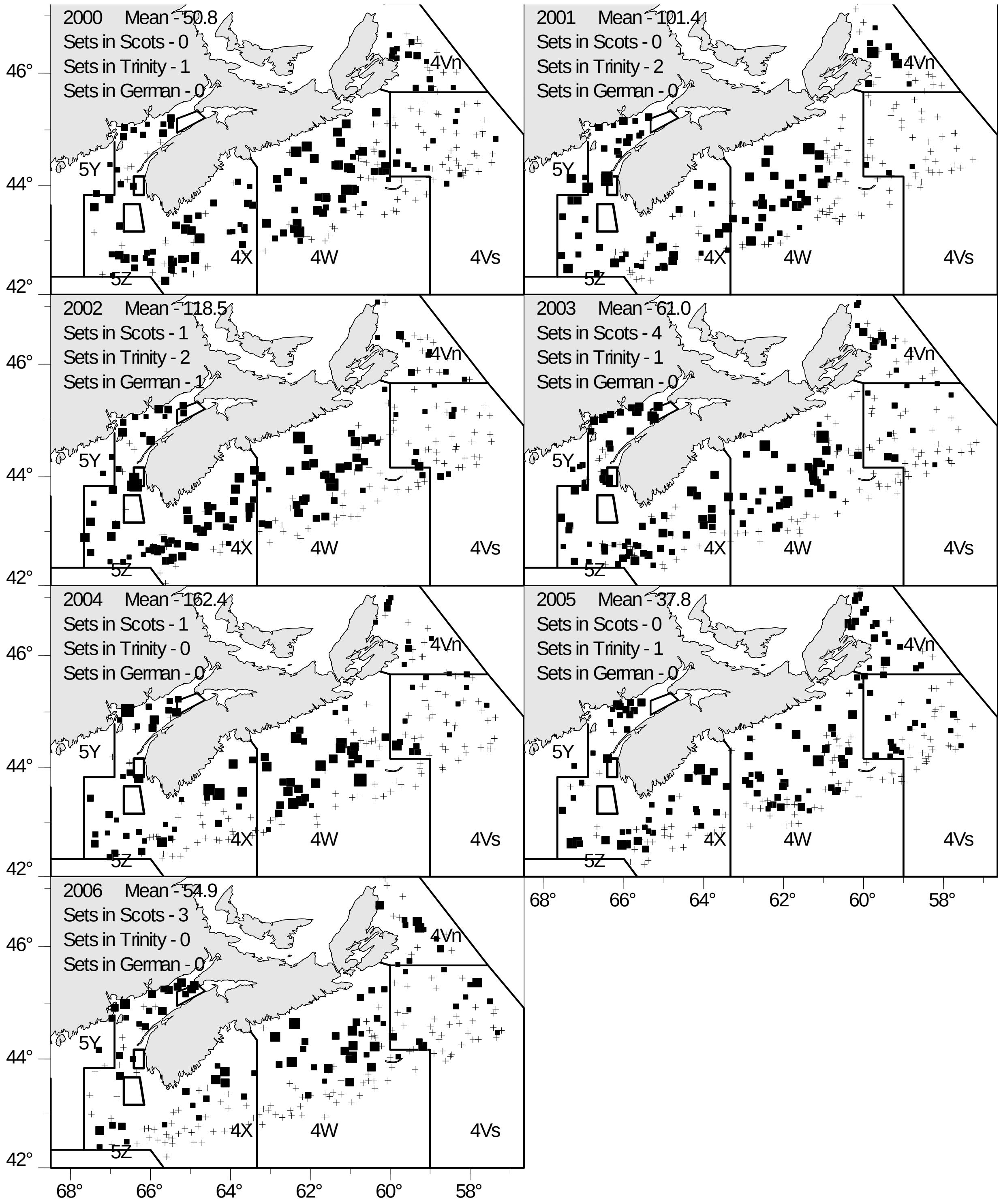


Figure 42 (cont.). Herring catches from the DFO summer bottom trawl research survey for 2000-2006 (2005 with Alfred Needler only). Mean numbers per standard tow and count of sets in Scots, Trinity and German areas.

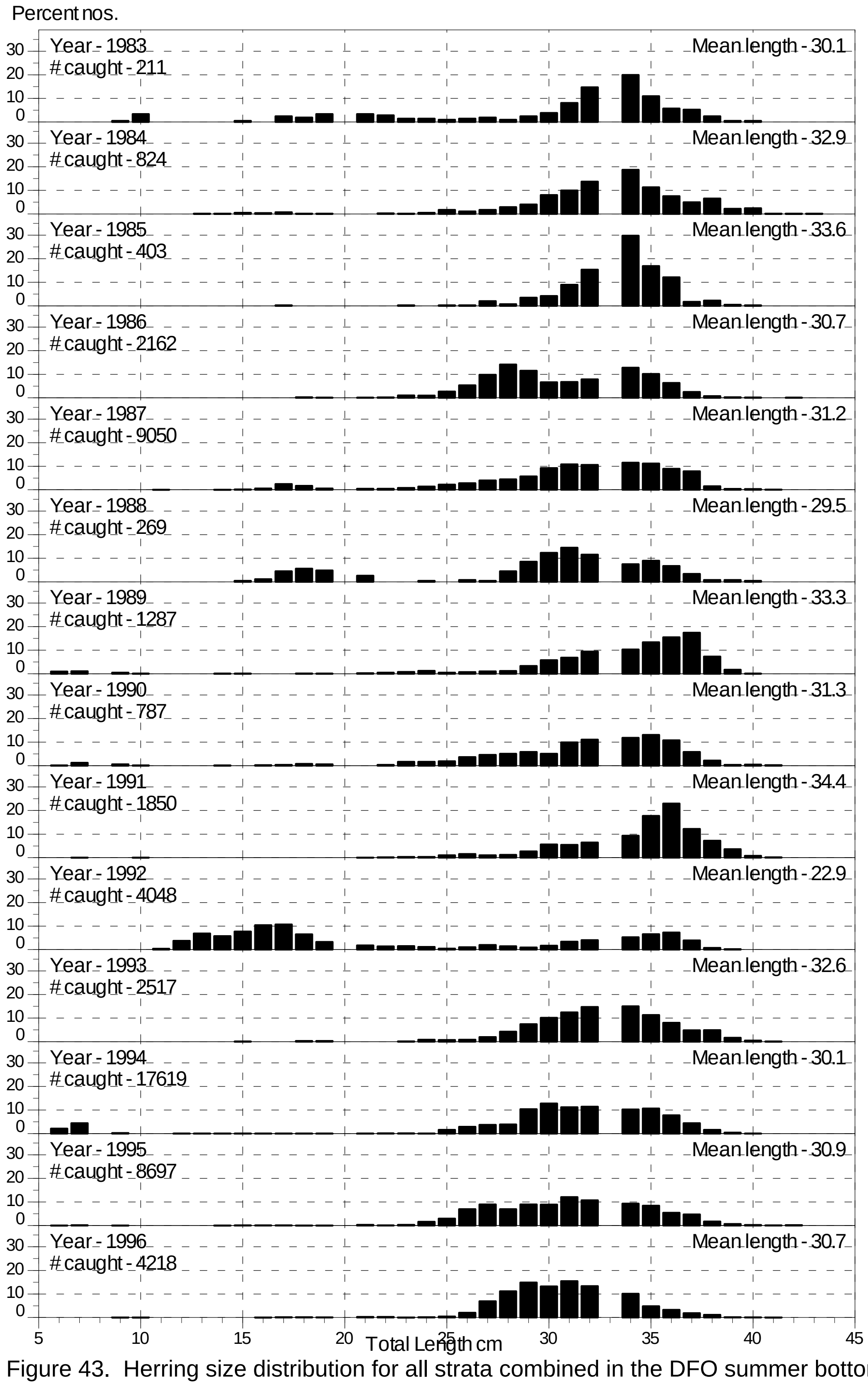


Figure 43. Herring size distribution for all strata combined in the DFO summer bottom trawl research surveys from 1983 to 1996 (sizes converted from fork length to total length cm results in a gaps at the 20 and 33cm sizes).

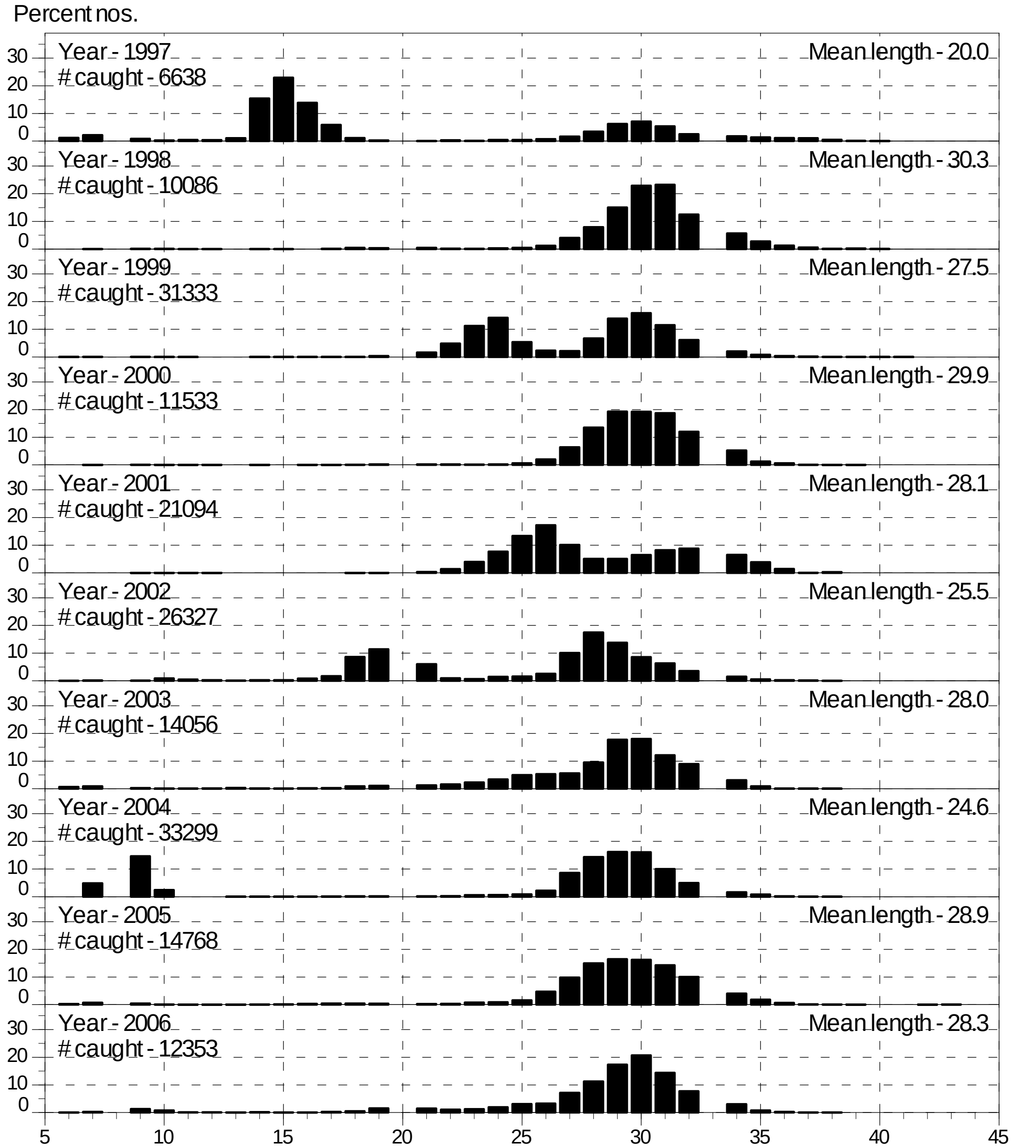
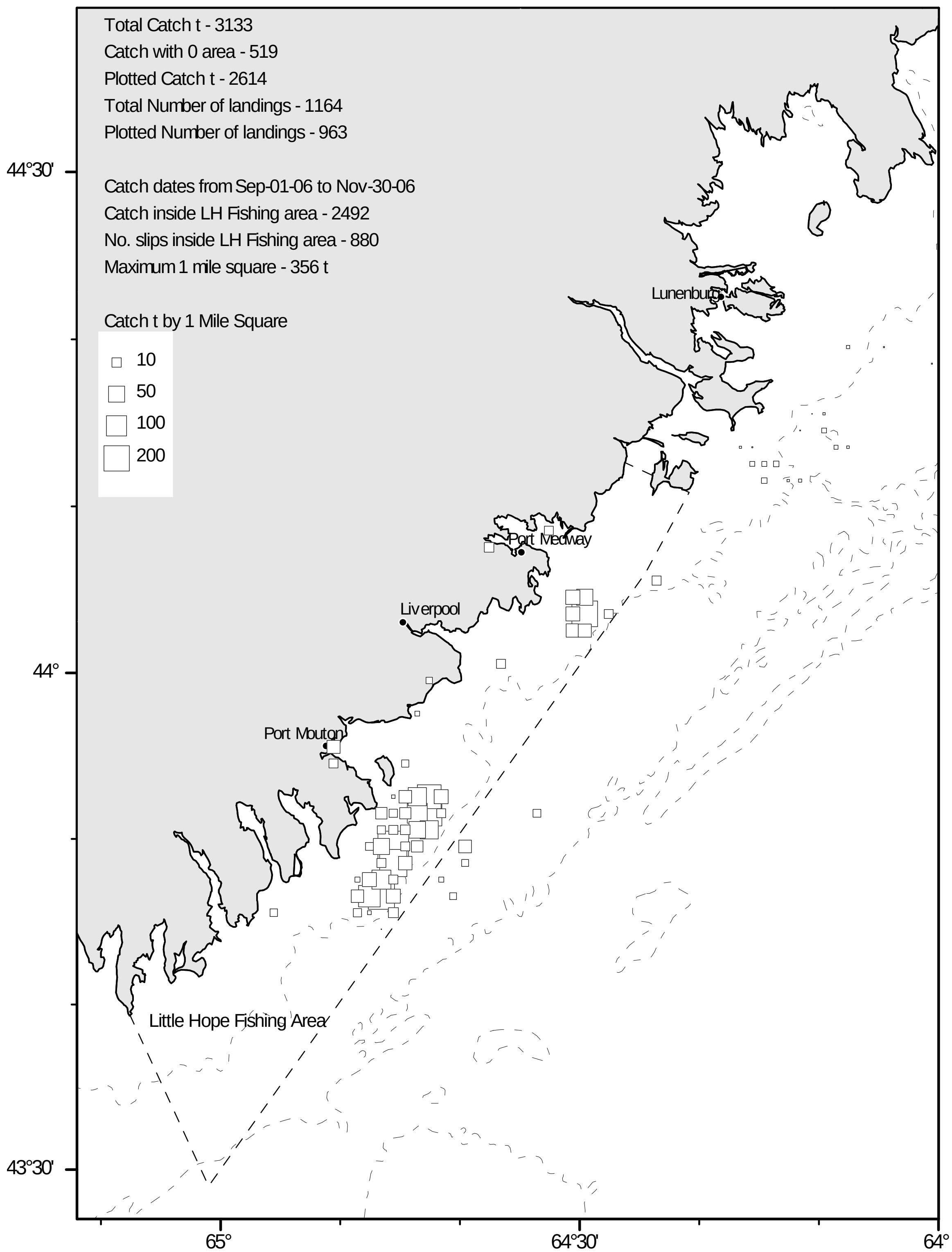


Figure 43 (cont.). Herring size distribution for all strata combined in the DFO summer bottom trawl research surveys from 1997 to 2006 (sizes converted from fork length to total length cm results in a gaps at the 20 and 33cm



sizes).

Figure 44. Gillnet herring catches for the 2006 fall fishery from Sept. 1 to Nov. 30, 2006 along the Little Hope fishing area (catches summed by 1 mile square).

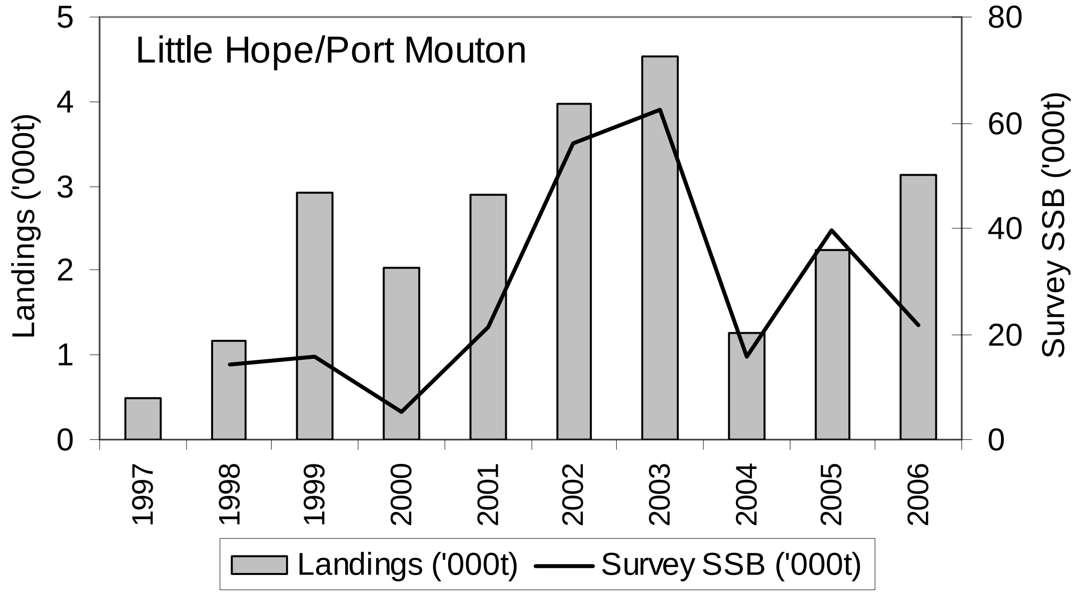


Figure 45. Landings and acoustic survey SSB (‘000t) for the Little Hope/Port Mouton gillnet fishery for 1997-2006.

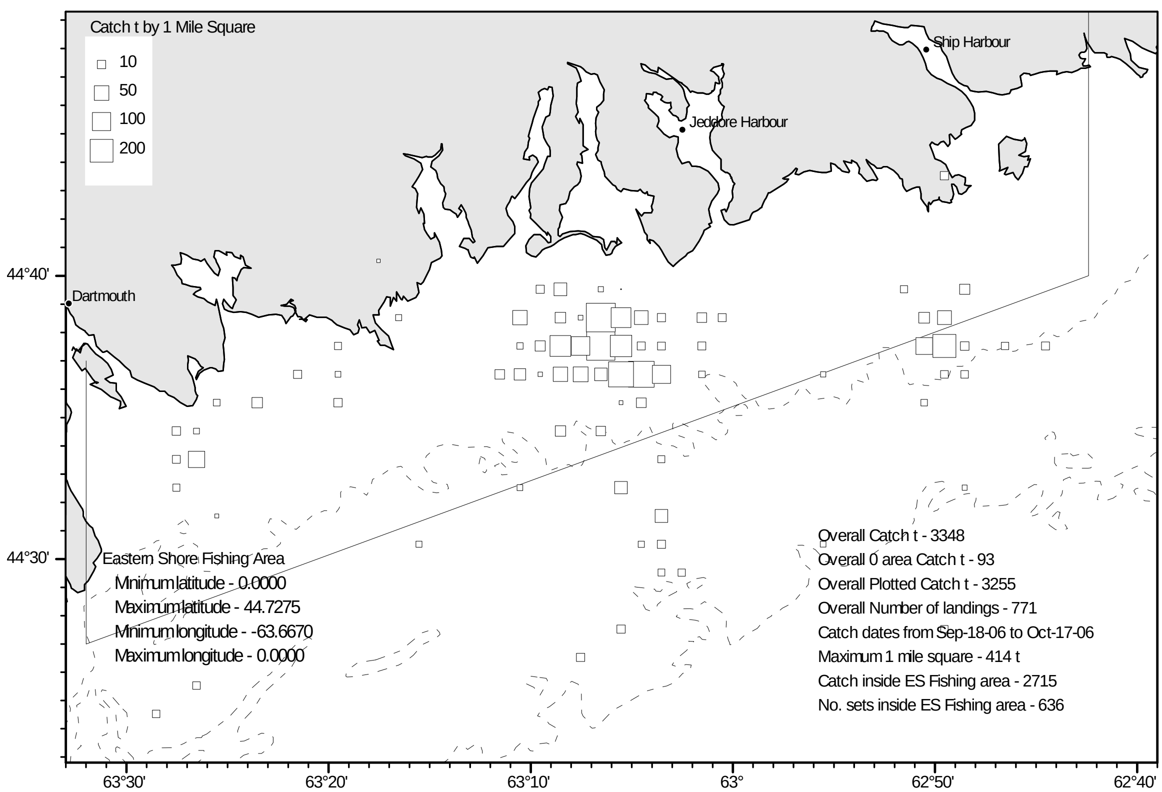


Figure 46. Gillnet herring catches for the 2006 fall fishery from Sept. 18 to Oct. 17, 2006 along the Eastern Shore Fishing Area (catches summed by 1 mile squares).

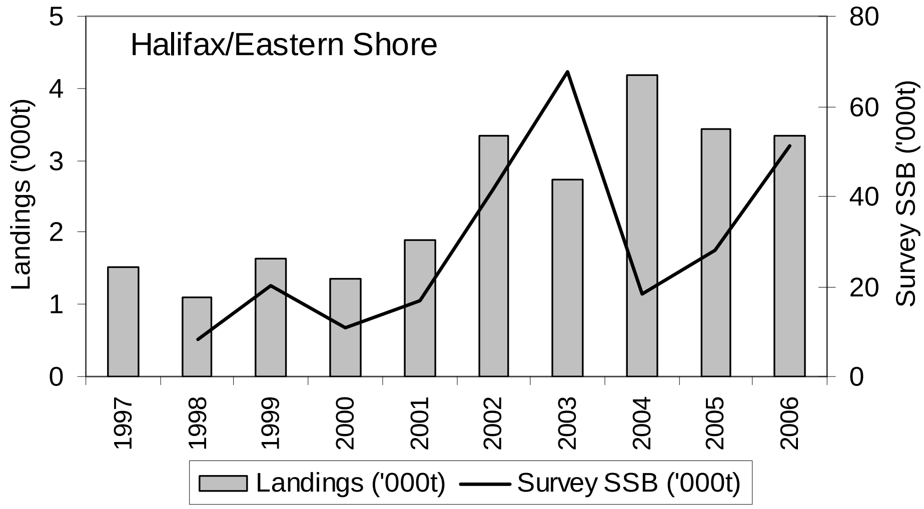


Figure 47. Landings and acoustic survey SSB (‘000t) for the Little Hope/Port Mouton gillnet fishery for 1997-2006.

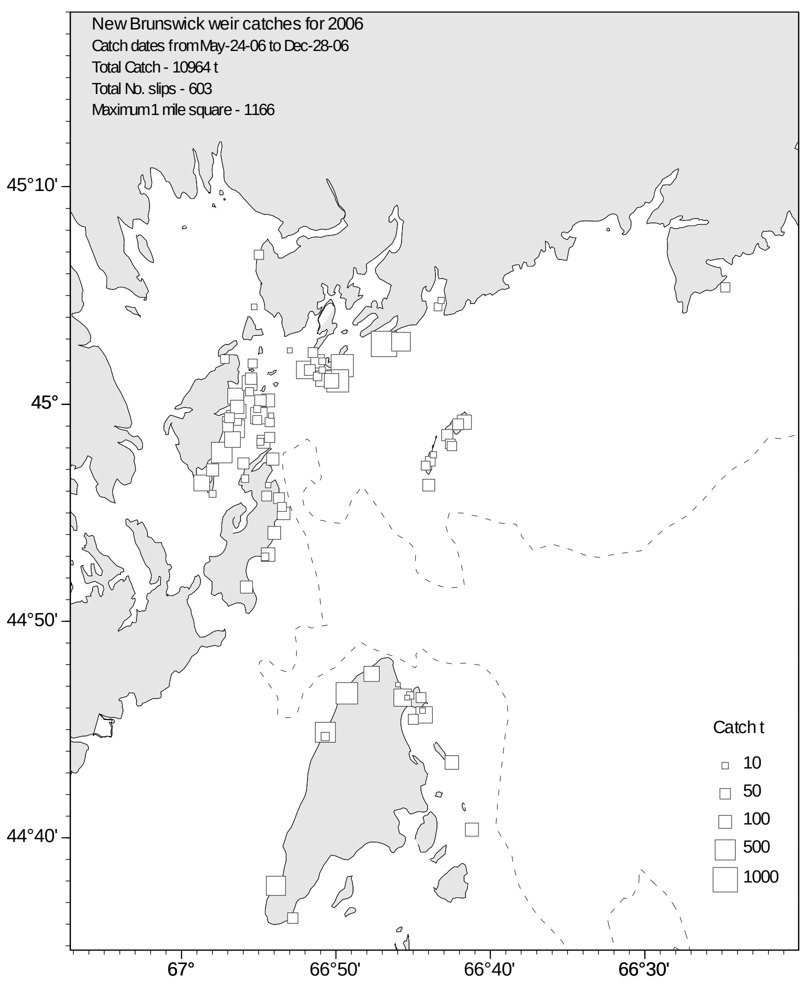


Figure 48. Overall New Brunswick herring weir catches for the 2006 fishing season.

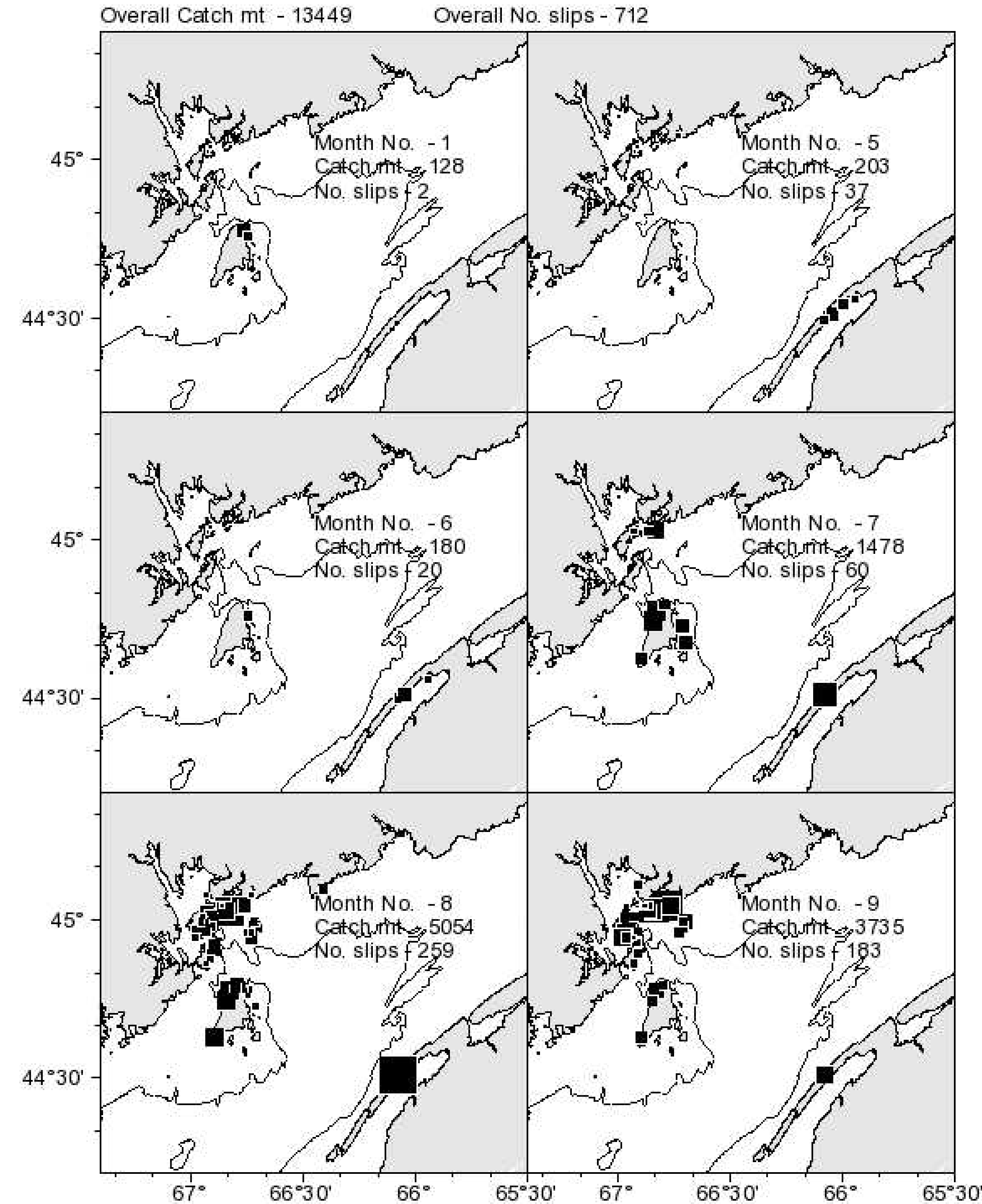


Figure 49. New Brunswick herring weir catches by month for the 2006 fishing season.

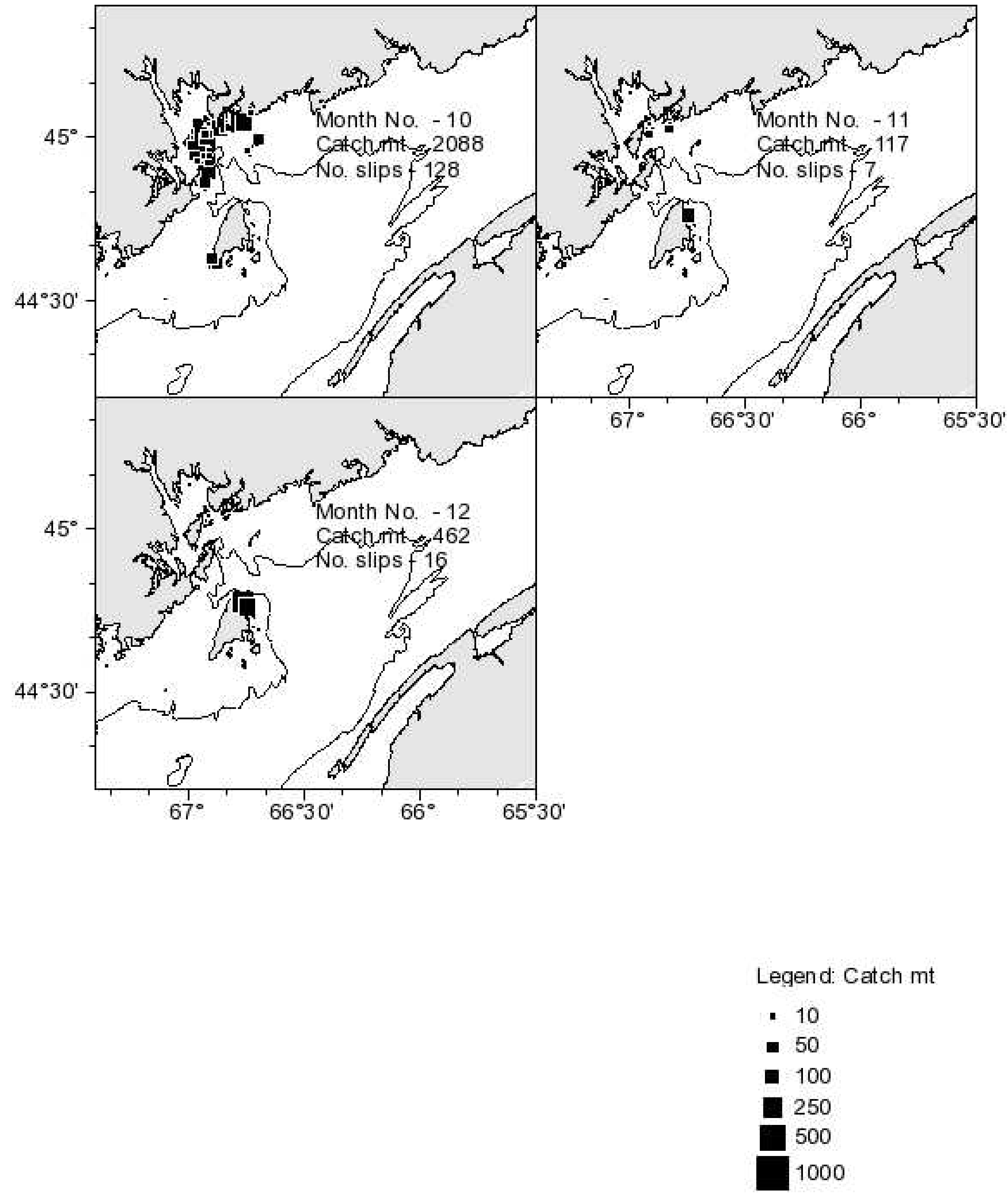


Figure 49 (cont.). New Brunswick herring weir catches by month for the 2006 fishing season.

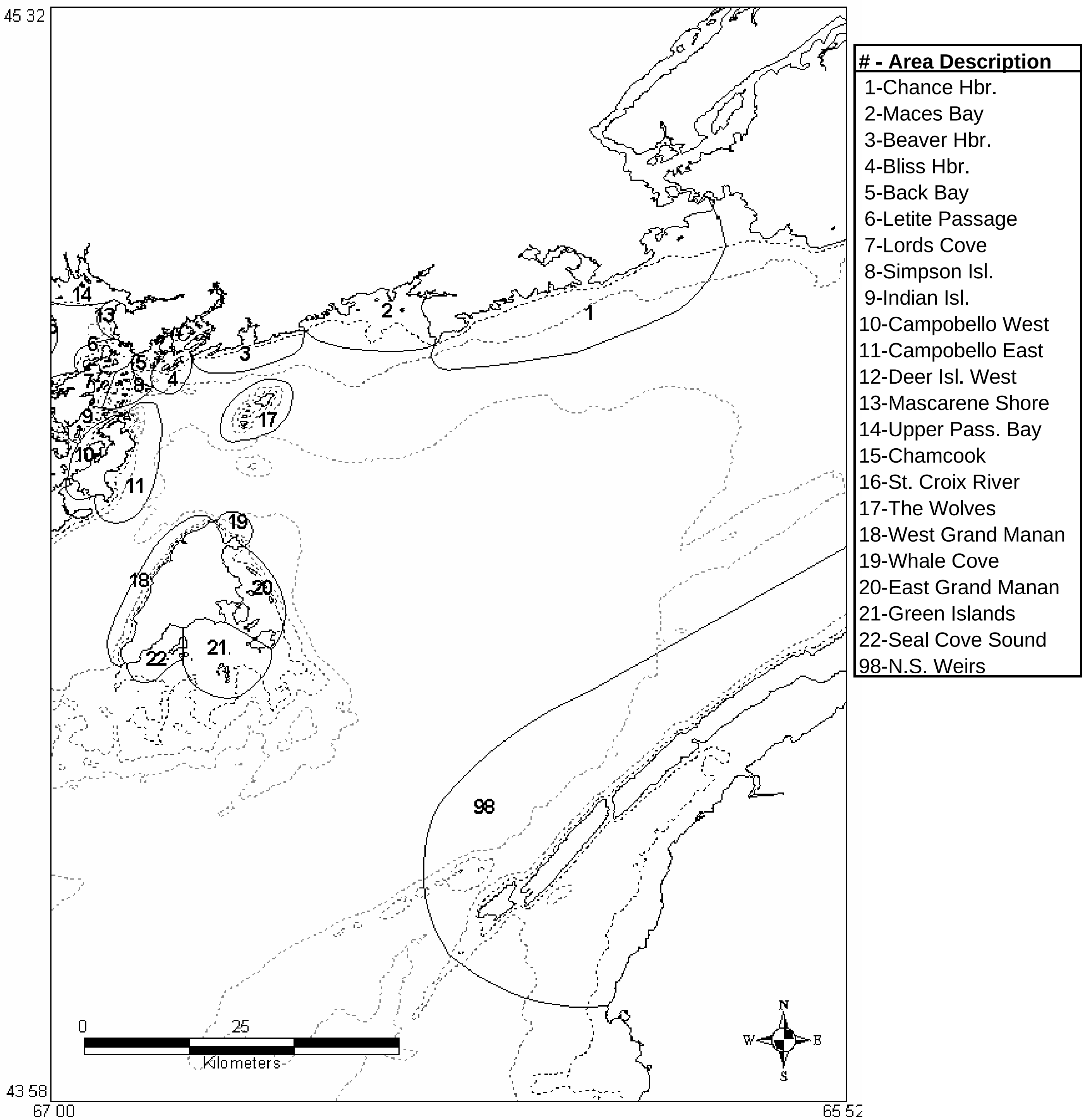


Figure 50. Herring weir areas used for grouping of catches for New Brunswick and Nova Scotia.

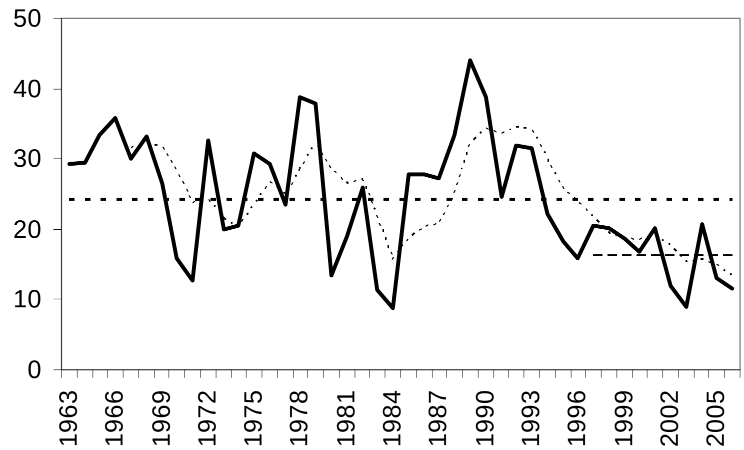


Figure 51. Herring landings from the southwest New Brunswick weir and shutoff fishery, 1963-2006 with overall time period average and recent 10 year average.

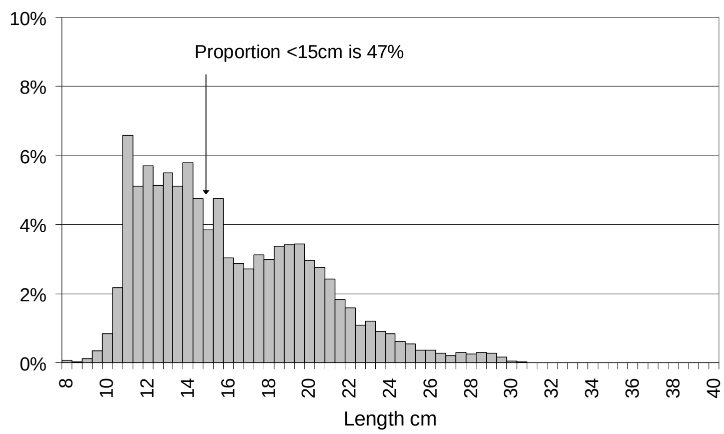


Figure 52. Catch at length (% numbers) for the 2006 SW New Brunswick migrant juvenile herring component.

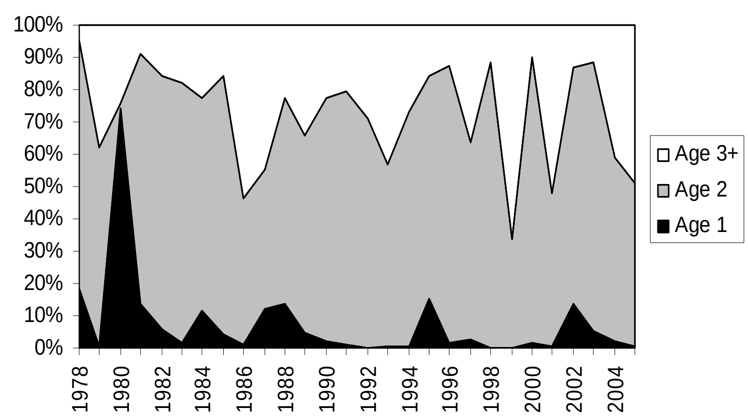


Figure 53. Catch at age (% numbers) for the 1978-2005 SW New Brunswick migrant juvenile herring component.