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2010 Evaluation of 4VWX Herring

Évaluation des stocks de hareng de 4VWX en 2010

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ABSTRACT

Quota landings in 2008-2009 were 54,113t against a Total Allowable Catch (TAC) of 55,000t for the Southwest Nova Scotia / Bay of Fundy (SWNS/BoF) component. Acoustic biomass estimates increased for each of the major survey areas in Scots Bay and on German Bank. In 2009, the fishery catch at age composition by number was comprised of 45% fish at 2 years of age, 20% at age 3, 24% at age 4, and 11% at older ages. This assessment indicates some improvement from the low level of the resource noted in the previous assessment, e.g., spawning stock biomass (SSB) estimated from the acoustic surveys is approaching the series average (1999-2009).

There was an increase in landings from 918t to 9,088t from the offshore Scotian Shelf banks mainly due to good weather conditions and fish being available to the purse seine gear. There was no midwater trawl activity in the offshore area in 2009 and only limited by-catch of herring from bottom trawl gear. Herring abundance in the summer bottom trawl research survey is at a low level after a decade of high values but is not considered indicative of overall abundance. There is no acoustic survey information for the offshore area although industry has been encouraged to explore and undertake structured surveys.

The recorded landings in the 2009 gillnet and trap net fisheries along the coast of Nova Scotia increased from 3,704t to 9,783t. There were increases in surveyed acoustic biomass in the Halifax/Eastern Shore and Little Hope areas from the previous year. Surveys were also completed near Glace Bay but there were few spawning herring documented or catch reported. No herring surveys took place in the Bras d'Or Lakes.

Landings in the 2009 New Brunswick weir and shut-off fishery were 4,031t, the lowest catch since 1963 and well below the long term average. Two years previously, in 2007, this fishery landed 30,944t, which was the highest catch since 1990. The age distribution of fish caught in the 2009 New Brunswick weir and shutoff fishery indicated mostly juveniles, with 86% at age 2. The success of this passive fishery is historically unpredictable, and catches are inherently susceptible to many natural variables in addition to abundance.

RÉSUMÉ

Les débarquements assujettis à quota en 2008-2009 se sont chiffrés à 54 113 t, par rapport à un total autorisé de captures (TAC) de 55 000 t, pour ce qui est de la composante du sud-ouest de la Nouvelle-Écosse et de la baie de Fundy. Les estimations de la biomasse d'après les relevés acoustiques ont augmenté dans chacune des principales zones de relevé de la baie Scots et du banc German. En 2009, la composition des captures (numériques) selon l'âge reflétaient 45 % de poissons d'âge 2, 20 % de poissons d'âge 3, 24 % de poissons d'âge 4 et 11 % de poissons plus vieux. Cette évaluation dénote une certaine amélioration par rapport aux bas niveaux de la ressource signalés dans l'évaluation précédente; en particulier, la biomasse du stock de reproducteurs (BSR) selon les relevés acoustiques approche de la moyenne de la série (1999-2009).

Les débarquements provenant de la composante des bancs du large du plateau néo-écossais ont augmenté, passant de 918 t à 9 088 t, en raison surtout des bonnes conditions météorologiques et de la disponibilité du poisson à la capture à la senne coulissante. Il n'y a pas eu de pêche au chalut pélagique sur les bancs du large en 2009 et seulement quelques captures accessoires de hareng au chalut à panneaux. L'abondance du hareng dans le relevé d'été au chalut de fond est faible après avoir élevée pendant dix ans, mais elle n'est pas jugée représentative de l'abondance globale. Il n'y a pas de données de relevé acoustique pour les bancs du large, bien qu'on ait encouragé l'industrie à envisager et entreprendre des relevés structurés.

Les débarquements déclarés dans la pêche au filet maillant et au filet-trappe le long des côtes de la Nouvelle-Écosse en 2009 ont augmenté, passant de 3 704 t à 9 783 t. On a observé des hausses de la biomasse lors du relevé acoustique dans les secteurs d'Halifax/côte est et de Little Hope par rapport à l'année précédente. Des relevés ont aussi été effectués près de Glace Bay, mais on y a observé peu de harengs en frai et il n'y a pas eu de captures déclarées dans ce secteur. Aucun relevé sur le hareng n'a eu lieu dans le lac Bras d'Or.

Les débarquements en provenance de la pêche au parc à hareng et à la senne de plage au Nouveau-Brunswick en 2009 se chiffraient à 4 031 t. Ils étaient les plus bas depuis 1963 et se situaient bien en dessous de la moyenne à long terme. Deux ans plus tôt, en 2007, ils avaient atteint 30 944 t, leur plus haut niveau depuis 1990. La composition des captures selon l'âge dans cette pêche révélait qu'elles étaient composées surtout de juvéniles, dont 86 % de harengs d'âge 2. Le succès de cette pêche passive a toujours été imprévisible et les captures sont influencées par bien des variables naturelles, outre l'abondance.

INTRODUCTION

Atlantic herring (*Clupea harengus*) 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, over wintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, over wintering, and spawning aggregations and has been dominated by purse seine, weir and gillnet gear types, with relatively minor landings by shutoff, trap and midwater trawl.

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 (SWNS/BoF) (also '4WX' in management plan);
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).

The Georges Bank spawning component is not included in this evaluation except to document Canadian fishing activity. There were no herring landings in 2009 from the Canadian portion of Georges Bank with the last recorded landings in 2004. This fishery is included in the Gulf of Maine stock complex and was last evaluated in 2006 (DFO 2003a, TRAC 2006).

1) OBJECTIVES AND MANAGEMENT

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

Three conservation objectives appear in the plan:

1) To maintain the reproductive capacity of herring in each management unit through:
   - persistence of all spawning components in the management unit;

- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth over fishing:

- continue to strive for fishing mortality at or below $F_{0.1}$

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 several of these objectives are not being met and little improvement has been seen from the low level of the resource noted in recent assessments despite efforts that have been made recently including a 5 years of a reduced Total Allowable Catch (TAC) (Power et al. 2006a, 2007, 2008, 2010a). There is also a need to better define these objectives in terms of minimum thresholds and to explicitly list the spawning components in terms of spatial and temporal expectations.

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continues to be used widely within the 4VWX management area (DFO 1997, Stephenson et al. 1996, 1999a). The approach encourages surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort is 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 which form 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 undertake biological sampling and to collect samples while the purse seine and gillnet sectors undertook key acoustic surveys. In 2009 field activities were covered by the HSC manager with assistance from St. Andrews Biological Station (SABS) / DFO staff, individual survey vessel captains and plant managers. In addition, downloading and data editing services were contracted by the HSC through A. Clay from FEMTO Electronics.

2) SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT (SWNS/BoF)

2.1 The Fishery

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff and trap. A variety of herring fishing locations, Northwest Atlantic Fisheries Organization (NAFO) areas and fishing ground areas are used to describe fishing activities and group the data for analysis of catch and sampling (Figures 2-4).

Quota landings for the SWNS/BoF stock component, the only component under TAC control were 54,113t against a Total Allowable Catch (TAC) of 55,000t for the 2008/2009 quota year (Table 1). The quota year begins on Oct. 15 and ends on Oct. 14 of the following year. Landings in the fall 2009 and winter 2010 purse seine fisheries for the 2009/2010 quota year were 2,787t as of March 2, 2010 (Table 2). There were additional landings of 22,902t from the non-stock components including Coastal Nova Scotia, the Offshore Banks and Southwest New Brunswick for an area total of 77,015t. There were a decreased proportion of landings from the New Brunswick weirs and shutoffs in 2009, and an increase in landings from the Coastal Nova Scotia and Scotian Shelf Banks components (Tables 1, 3).

Landings for the SWNS/BoF stock component have recently tracked the TAC with most of the quota being taken each year since 2002 (Figure 5). As a result of the reduced quota since 2005, total landings from this component remain near the lowest on record since 1963 (Table 3). Most of the catch over the history of this fishery has been caught by purse seine gear with the 4X summer purse seine fishery being the most important (Table 3, Figure 6, 7). In 2009, landings by the purse seine sector accounted for 99% of the component catch with minimal landings by the gillnet sector (117t) and below average landings from the Nova Scotia weirs (387t) (Table 1). According to the management plan, eighty percent of the TAC is initially allocated to the mobile gear sector and 20% to the fixed gear sector and, as in past years, transfer of unused quota to the mobile fleet occurred near the end of the fishing season.

Purse seine catches are summarized by fishing grounds using definitions of the various grounds based on groupings of 10 minute boxes of latitude and longitude (Table 4, Figure 4). Catches by fishing grounds were similar to recent years with the largest proportions from the German Bank (48%), Gannet/Dry Ledge (21%) and Grand Manan (31%) areas (Table 4, Figure 8). There was an increase in catches from the New Brunswick coastal area from 2,200t to 5,000t. Catches were again below average from Scots Bay and the Long Island shore areas. The lower catches off Long Island are attributed to less effort in these areas due to extensive aggregations on the Grand Manan grounds and German Bank areas that were more accessible and closer to market for the New Brunswick and SW Nova fleets. The Long Island shore area is also generally a more difficult fishing area, with the boats only able to get fish at dusk or at dawn as the fish go on or off the shore. The reduction in Scots Bay was mainly attributed to the distance to travel to the area and fuel costs with suitable market herring in more nearby areas. The 5,000t self imposed industry allocation for the Scots Bay area was again not limiting to the fishery in 2009, which caught only 902t in this area.

Purse seine landings of 1,875t were reported in the October/November 2008 fall fishery and 932t in the January 2009 winter fishery (Table 1, Figure 9). These fisheries which take place at the beginning of each quota year are usually concentrated on the New Brunswick side of the Bay of Fundy.

The largest single fishery of the SWNS/BoF stock component is the summer purse seine fishery which occurs from May to October in the Bay of Fundy area. In 2009 this fishery took place in similar areas and months as in previous years with total landings of 50,802t (Table 1, Figure 10). A large part of this fishery is directed toward pre-spawning, feeding aggregations in May and June. Catches on the major spawning grounds during the spawning period in Scots Bay and on German Bank are found primarily within the pre-defined acoustic survey areas (Melvin and Power 1999).

During the 1970s and 1980s, a large purse seine fishery took place on over-wintering aggregations in Chedabucto Bay with total landings as high as 17,878t as recently as 1991 (Table 3-4, Figure 8). There has been no fishing effort in this area since 1999 as traditional

vessels have been successfully fishing elsewhere and because the reduced TAC has resulted in conserving of quota for later in the season. In some years (2000 and 2002) there has been a small fishery on over-wintering herring in January near 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.

Catches of non-stock component herring by purse seine came mainly from the Offshore Banks and Western Hole areas on the Scotian Shelf with 9,032t landed in 2009 (Table 5). There have been no catches from the Georges Bank area since 2000 when 265t were landed (Table 5).

Main Fishing Areas for the SWNS/BoF Component

The main fishing areas for the SWNS/BoF component are the German Bank, Scots Bay, and Trinity Ledge areas which also include spawning grounds fisheries. Additional fishing takes place by the Nova Scotia weirs in St. Mary's Bay and along the Long Island shore. There is also an occasional small gillnet fishery in the spring on spawning herring near Spectacle Buoy which is just southeast of Yarmouth.

German Bank

German Bank is one of the primary herring fishing grounds in the Bay of Fundy area. Since 1985, catches from this area have ranged from 9,003 to 35,977t during the main fishery period from early May to late October (Table 7). Catches in the pre-spawning period (defined as the period from January 1 to August 14) have been increasing since 1994 reflecting a higher reliance on this area and also the availability of these roe fish closer to markets. Catches during the spawning period (defined as the period from August 15 to October 15) have declined to about 12,000t per year since the reduction in the quota in 2003. The proportion of total German Bank catch taken during the spawning period has declined in recent years due to the higher amounts of pre-spawning catch. The contribution of German Bank catch however has been increasing and is over 50% of the overall TAC (Table 7) (Figure 14).

Catches during the pre-spawning period for German Bank from May 1 to Aug. 14 on pre-spawning, feeding aggregations are usually widespread and not just confined to the spawning ground area. In 2008, catches during the pre-spawning period increased to 16,845t, the highest since 1999 (Table 7). They were very widely distributed in comparison to recent years and similar to catch area patterns seen in the past. This distribution pattern was attributed to the fish moving around in small groups or schools which were widely spaced. Fuel costs were not a major issue within the German Bank area itself, which is fairly close to the home ports.

Catches on German Bank during the spawning period within the spawning box area are primarily of spawning "roe" fish (Figure 15). However, not all catches are spawners, with juvenile sized non-spawning groups often located to the north of the spawning box. In 2007, catches within the survey area were similar to those of 2005 and 2006 with two separate localized groups of spawning herring which were also documented during surveys. Catches for 2008 were unusual with an absence of catches of spawning fish in the southern part of the spawning box as seen in previous years. Acoustic surveys did however document some fish in the southern central part of the survey box (Power and Melvin 2010).

In 2009 catches of spawning herring were more widespread with localized groups seen in both the northern and southern portions of the standard survey area on German Bank (Figure 15). The timing of the fishery catches during the spawning period was more evenly distributed in

2009 with average daily landings of 400 to 600t (Figure 16). The total catch for German Bank area declined slightly to 28,546t but remained above 50% of the overall TAC (Table 7).

Scots Bay

The Scots Bay herring purse seine fishery has been an important component of the summer fishery with catches since 1987 ranging from 907 to 24,388t during the period of early July to late August-early September (Table 6, Figure 11). The peak year of 2004 was unusual in several aspects, with the highest recorded catch of 24,400t, the longest season extending to Sept. 16 and the most days with catch recorded (Table 6, Figure 12, 13). In 2004, the distribution of catches was also more widespread extending both north and east of the innermost stratum survey area (Figure 12). The overall catch in the following year, 2005, with area restriction restraints was reduced to 5,870t and included catches to the north and east of the main survey area. The fishing season in 2005 also started later and was of shorter duration than the previous three years.

The 2006 fishery had catches scattered mainly within the defined spawning area but there was a further reduction in overall fishing activity with 3,350t landed and less than half of the number of daily landings (purchase slips) than in the previous year (Table 6, Figure 12). 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 which bisects the spawning and strata areas (Figure 12). The duration of the spawning fishery period in Scots Bay was similar to 2005 but there was no observed spawning in the spawning box during the middle of the spawning period in early August. The combination of these factors resulted in fewer vessels fishing in Scots Bay or participating in the surveys with less survey and catch information collected on spawning activity.

In 2007, catches of 4,116t from Scots Bay were subject to continued restrictions placed on the area including an overall cap of 5,000t and weekly trip limits to distribute effort over the season. The lack of availability of the Digby wharf and the distance to travel to Scots Bay also contributed to the reduced effort. The total duration of the fishery was extended due to the weekly restrictions, lasting from July 16 to Aug 31 with a total of 21 days with catch (Table 6, Figure 13).

The 2008 fishery again had a 5,000t cap due to the continued poor performance of the spawning component since 2005. There were also internal arrangements by industry to limit nightly and weekly catches in order to spread the effort over the season and to allow surveys to take place with the possibility of landing fish without being impeded by the cap. Landings in 2008 were substantially reduced from 2007 with 2,373t caught from July 14 to Aug. 27 (Table 6, Figure 13). There was a gap in landings similar to that seen in 2006 from July 22 to August 8, which was attributed to steaming distance and fuel costs, as well as better fish availability off Long Island shore and Grand Manan which were closer to markets.

The 2009 Scots Bay fishery continued to be restricted by a 5,000t cap imposed due to the poor performance of the spawning component since 2005. Landings in 2009 were substantially reduced from 2008 with only 902t caught from July 12 to Aug. 11 (Table 6, Figure 13). Sampling was adequate with samples from most landings allowing detailed description of the size and maturity of fish captured. Some immature juvenile fish were also picked up from research bottom trawl samples collected during July in the area. Five structured surveys were conducted during the 2009 spawning season in Scots Bay which is more than in previous years (Power et al. 2010b).

Trinity Ledge

Catches were very limited for Trinity Ledge in 2009 with 117t recorded between Sept. 1 to Sept. 11 (Table 8, Figure 17). In 2009 two acoustic surveys were conducted on the area with a total estimated biomass of 675t (Table 8). Given the continued erosion of spawning biomass there is cause for concern with this spawning group (Figure 18). More work is needed to monitor the status of this spawning area which once supported a major portion of the overall stock catch (Table 4a-b, Figure 8).

Nova Scotia Weirs

The 2009 Nova Scotia weir catch (4Xr) from weirs located in St. Mary's Bay and along the Long Island shore of 387t is the lowest on record (Table 3, 9; Figure 19). The annual variation in catch has been mainly attributed to problems in availability of fish to this fixed gear as there are often substantial purse seine catches in adjacent areas during years of poor weir catch (e.g. Long Island in 2000 and 2003, Table 4a). In 2008 and 2009, there was also a reduction in the amount and proportion of purse seine catch in the Long Island ground area and recent weir catches have been below average for this gear type. The seasonal timing of the Nova Scotia weir landings, which have shifted to the later months of the season in recent years, had the most catch in July in 2009 (Table 9). Catches for the Nova Scotia weirs have been highly variable in recent years and are not as consistent in their amount or timing, having occurred early in the season in the 1990's and later in the season in the last decade. There has also been a decline in the total number of herring weirs with 6-14 active weirs in the last decade, down from 20 or more in the 1980's, with only 7 reporting catch in 2009 (Table 10).

Spectacle Buoy

The spring gillnet fishery for roe has occurred in recent years for a short period in June in the vicinity of Spectacle Buoy located just southwest of Yarmouth, Nova Scotia. The fishery is dependent upon the availability of fish and to some extent market conditions, and may or may not occur in any given year. In 2008, there was virtually no fishery with only one landing of 6t and very limited acoustic surveys completed. In 2009 there was little fishing (less than 1t) and no survey activity in this area (Table 8).

2.2 Resource Status

Commercial Catch Rate Indices

Catch and effort for gillnet data in the SWNS/BoF spawning component have been examined in previous assessments. They showed little trend and were considered unrepresentative due to the small amounts and variable timing and location of catch and effort (Table 3) (Power et al. 2004). The limited gillnet catch and effort with only 117t in 2009 did not warrant reexamination.

Purse seine landings make up most of the overall catch and are allocated 80% of the TAC for the SWNS/BoF component under the current management plan. The purse seine catch has fluctuated between 44,476t and 103,537t since 1989 primarily reflecting changes in the TAC (Table 11, Figure 20). The number of boats fishing and days fished has dropped since 1990 due to fleet rationalization. This has resulted in increases in catch per boat and catch per day in recent years but these are also affected by the reduced TAC. In general, purse seine catch rates are not considered to reflect trends in population abundance due to the nature of herring schooling behavior and the acoustic technology used to find these concentrated schools. Catch

rates can remain high or stable even at low stock levels. These data are reported to document the overall effort by the purse seine fleet (Table 11).

Acoustic Surveys

Automated acoustic recording systems deployed on commercial fishing vessels have been used since 1997 to document the distribution and abundance of herring. Scheduled surveys are now conducted each year with surveys every two weeks on each of the main spawning components. An index of spawning stock biomass is estimated by summing these results (Melvin and Power 1999).

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

In 2003, an option to account for the non-square waveform observed in a ball calibration was incorporated into the HDPS software (Melvin et al., 2004). Given that the inclusion of the calibration integration factor (CIF) is deemed to provide a more accurate estimate of biomass, it was recommended that all future analyses utilize the CIF to calculate absolute biomass (Melvin et al. 2004). Re-analysis for earlier years was begun in 2008, however, the CIF adjustment has not yet been applied to all years of data, so, it was recommended that biomass estimates that exclude the adjustment be used until a time series which includes the CIF adjustment for all years has been established (Power and Melvin 2010)

In 2008, biomass estimates in the traditional survey areas of Scots Bay, Trinity Ledge and German Bank decreased by approximately 160,000t from the 2007 estimate. The 2008 estimate was a 42% decrease from 2007 and the lowest recorded since acoustic surveys began in 1997.

In 2009, a total of fourteen individual surveys were completed for the three major spawning areas of Scots Bay, Trinity Ledge and German Bank (Power et al. 2010b). Five surveys were conducted in Scots Bay. While there was no biological sampling of the first (relatively early) survey, it was assumed that fish detected were herring in spawning condition, and the survey was included in the SSB estimate. Seven surveys were conducted on German Bank, five of which were used in the estimate of SSB. Individual survey area coverage was good and consistent with established protocols. Survey coverage of Trinity Ledge was again very limited and the amount of spawning fish documented was extremely low. There were no surveys and no reports of spawning herring around Seal Island and Browns Bank grounds. No spring fishery or surveys were conducted on Spectacle Buoy in 2009.

In 2009, the biomass estimate for Scots Bay, Trinity Ledge and German Bank increased by approximately 156,000t to 377,000t (Table 12, Figure 21-22). While the overall acoustic biomass is higher than in 2008, it is not considered statistically different from the previous four years, which are all at a lower level than in 1999-2004. The 2009 estimate is approaching the long term average of 403,600t.

Spawning Ground Turnover Rates from Tagging Studies

The current acoustic survey methodology 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 intensive sampling for maturity stage has been undertaken since that time. The results are summarized by Melvin et al. (2003, 2004) and Power et al. (2005a) and were used to assist in the evaluation of turnover timing and as a rationale for the inclusion or exclusion of specific acoustic surveys.

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

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

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

A framework assessment meeting in January 2007 determined that double counting does occur but the extent has not been well determined (DFO 2007). However, it was recommended that surveys continue to be conducted at 10-14 day intervals. The timing/turnover issue was considered to be of highest importance for further study, including work on the duration of the maturation process, further tagging with shorter intervals to estimate turnover rates and increased survey frequency to reflect maturity stage duration. No additional experiments on turnover rates were completed in 2007 or 2008 due to a lack of funding.

A tagging study to examine herring turnover rate on the German Bank spawning grounds was conducted during the summer/fall of 2009 (Maxner et al. 2010). The ongoing project will continue in 2010 and 2011 in an attempt to gain a better understanding of residency time of herring throughout the spawning season for this area. In 2009, tagging was conducted whenever possible during August and September for a total of 15 tagging events. Altogether 10,338 tags were applied with a 4 month tag return rate of 0.7%. The tag return data were compared to previous turnover studies on German Bank and Scots Bay, which had similar return rates (all under 1%). Tag return data along with maturity information were used to determine the length of time herring remain on the spawning grounds. Based on recoveries from 69 tags recaptured, 52% were within the first week, 78% cumulatively by the second week, and 93% by the third week. Although the majority of the tags were returned by the first three

weeks after tagging, some remained on the spawning grounds for up to five weeks. Therefore, some double counting of spawning herring occurs in the annual biomass estimates of SSB for German Bank. A high correlation (r^2 = 0.972) was found between the proportion of fish remaining on the spawning grounds and the days at large. Current biomass estimates assume that fish remain in the same area for a maximum of 2 weeks before moving on. Adjusting the 2009 German Bank spawning biomass for elapsed time based on the 2009 tagging results reduces the biomass from 397,590t to 308,069t or by 22.5%.

Turnover information is critical for the acoustic assessment surveys, which currently assume a 10 to 14 day resident period. The final study conclusions will look at both annual and pooled multi-year tagging data to investigate inter and intra-year variability in turnover time. Upon completion of this three year study, recommendations will be made on how to adjust the acoustic biomass for herring moving on and off of the spawning grounds, thereby limiting the amount of double counting among surveys. Until then, no adjustments will be made to the acoustic survey estimates as reported in the annual survey reports (Power et al. 2010b).

Exploitation Rates on Spawning Grounds

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

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

The trends in spawning area proportions as estimated from acoustic surveys (Table 13-A2) have been stable since 2005 with about 80-90% of survey SSB found in the German Bank area and 10-20% in the Scots Bay area. The increase in 2005 for German Bank corresponds with a dramatic decline seen in Scots Bay in 2005 which made up as much as 36% of the overall SSB before this decline.

Calculation of exploitation rates since 1999 by component (Table 13-E2) shows that the larger grounds (Scots Bay and German Bank) have an average exploitation of 22% and 16% respectively. The smaller Trinity Ledge area has a very high average exploitation of 54% which is attributed to inconsistent survey effort. The overall adjusted exploitation rate for the three areas combined show a range from 14-25% from 1999 to 2009 (Figure 23). This is close to the desired $F_{0.1}$ reference level of 19% but these exploitation levels cannot be inferred to be absolute in relation to this reference. These exploitation values are useful in a relative sense for year to year comparisons and show that the overall adjusted estimate was stable between 14-

18% between 1999 and 2004. There was an increase to 21% in 2005 coinciding with a large decrease in total survey biomass. The rate declined in 2006 to 2007 to a low of 13% followed by an increase to the series high of 25% in 2008. In 2009 the rate again declined to 14% reflecting the variability in the acoustic estimates while catches have remained relatively stable in recent years (Table 13-E2, Figure 23).

Biological Sampling

Comprehensive biological sampling continued for this fishery with substantial involvement of the fishing industry which supplies data in the form of length frequencies and maturity reports and saves frozen fish samples for analysis by DFO personnel. In 2009 a total of 1141 samples (131,915 fish) were measured for length while 3,784 fish were sampled for sex, weight, maturity and age (Table 14). The sources of the samples are shown in Table 15, with the bulk coming from the processing industry since 1996. Additional samples were collected by DFO personnel, observers deployed on fishing vessels and from DFO research surveys. Sampling from the commercial fishery was well matched to the spatial and temporal distribution of the fishery and additional sampling from research vessel surveys during the spring and summer resulted in widespread geographic coverage as in the past (Figure 24).

Ageing Review and Revision

Inconsistencies in ageing Atlantic herring were first noted in 2003 (Melvin et al. 2010). Following a number of regional and international exchanges, concern was expressed about the implication of under ageing error on the evaluation of the Gulf of Maine stock complex and the 4WX herring stock. Simulation studies indicated that within the bounds of observed differences between individual readers, significant differences in the Virtual Population Analysis (VPA) output could occur affecting the interpretation of stock status.

Based on the results of otolith exchanges and simulation studies, the 4WX herring analytical assessment was suspended in 2006 until the ageing problem was resolved (DFO 2006). To test the sensitivity of the VPA to changes in the age input, several growth models using age-length keys from selected years were applied to the catch at age (CAA) and the indices of abundance from 1999 to 2006 and input into the 2005 VPA formulation (Melvin and Power 2007). The estimated fishing mortalities for 1995-2006 from these simulations were variable and consistent with the previous investigation, and no scenario produced fishing mortalities at or below $F_{0.1}$ (where $F_{0.1}$ is F=0.23).

The herring ageing workshop in January 2008 concluded that there were major inconsistencies with herring ageing amongst the readers and with the historical database. A number of recommendations to improve the ageing of herring were made at the ageing workshop. These included using a new mounting media for the otoliths, the absence of length data during the reading process, a reference collection for quality control, and new ageing protocols to ensure reader consistency and quality control (e.g., new equipment, preproduction ageing testing, the use of image analysis to annotate and catalogue the images and finally random comparisons with secondary readers). The workshop also recommended that the otoliths from 1999 to 2005 be re-aged and that a revised catch at age needed to be developed from the new ages. Bomb radiocarbon assays were used to validate that the herring otolith rings were true annuli and age interpretations showed a pattern of under-ageing by the primary 4WX herring reader which was consistent with other exchanges and comparisons (Melvin and Campana 2010).

From 2008 to 2009 several attempts were made to re-train the primary 4WX reader to meet the comparison criteria for acceptance of age data. In the end, this reader was removed from

ageing herring and was replaced with a new reader to complete the re-ageing exercise. Quality control measures were implemented to ensure the re-aged otoliths met the standard of 80% agreement, a CV of less than 5% and no bias. A random selection of 100 aged otoliths from each year that was re-aged was also sent to the external expert for comparison. Only when the reader met the acceptance criteria were the ages from a given year used to generate an age-length key for the new data.

Given the almost two year delay in trying to improve the accuracy of the ages and the urgency to have an age based assessment, three readers became involved in the final ageing of 1000 otoliths per year for 1999 to 2009: the external expert from DFO Gulf Region, the secondary reader from DFO-SABS (Reader 2) and the new reader from DFO-SABS. Whenever possible, otoliths aged by Reader 2 were included in the age-length key as all earlier comparisons between this reader and the external expert met the acceptability criteria. Each reader was assigned several complete years for ageing.

Quality control measures were implemented for both the SABS secondary reader and the new SABS reader. Several hundred otoliths from the 2009 collection using the new mounting media were selected at random for both the external reader and the secondary reader to age. Immediately evident in the results was the fact that for selected otoliths which were rated as "good or readable" otoliths the desired acceptance criteria were met. This is likely reflective of the clarity of the new media and the experience gained by this study, especially for the new reader. For the 2009 ages, percent agreement between readers ranked in the high 80's for the "good" otoliths (Melvin et al. 2010).

The re-aged otoliths were used to develop age length keys for the period 1999 to 2005 and newly aged otoliths provided age data for the 2006 to 2009 period.

Catch at Age

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

The size and age composition was characterized by month, unit area and gear type using all available length and age samples (Tables 16 and 17). The length-weight relationships, needed for the calculations, were calculated on a monthly basis. The catch at 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 or combined and then age-length keys were applied to length frequencies to produce catch at age statistics by NAFO unit area, gear-type and month. The re-aged and newly aged otoliths were used to develop age length keys for the period 1999 to 2009 and were applied to the lengths at age to create a revised catch at age for this period (Tables 16 and 17). This revised CAA also includes for the first time ageing of otoliths from 2006-2009.

The 1999 to 2005 catch at age was revised to reflect the re-aging and the time series extended to include 2006 to 2009 and is reported as total number caught and percent by age in Table 18 and Figure 26. Several year-classes are easily traceable in the revised catch at age. In particular the 1998 year-class can be followed from age 2 in 2000 to age 7 in 2005 and the 2001 year class is seen through to age 8 in 2009. While the numbers of older fish above age 8 are

not large in the revised CAA, they are now at least present unlike in the original CAA which had virtually nothing older than age 7 (Power et al. 2006a).

The 2009 catch was dominated by the 2007 year-class (at age 2) representing about 45% of the numbers and 20% of the weight of herring landed in the Southwest Nova Scotia / Bay of Fundy component (Table 17, Figure 25). The 2005 year-class (at age 4) was the second most important by number at 24% but contributed the highest proportion by weight at 35% of the landings. The proportion of the catch older than age 5 decreased in 2009 to 7% from 17% in 2008. This decrease of older/larger fish in the catch was due to the high proportion of 2 year olds (potentially indicating a strong 2007 year class). The total number of fish removed by the fishery in 2009 was calculated to be 587 million, an increase of 130 million or 28% from 2008 which has the same overall TAC as 2009.

The historical time series of catch at age still shows very few fish older than age 8 since 1995 and has been dominated by ages 2 through 5 (Table 18, Figure 26). Older ages had been a feature when strong year-classes (i.e. 1976 and 1983) were progressing through the fishery. These stronger year-classes had persisted in the catch to older ages in the 70's through to early 90's. In recent years, the rapid decline of year-classes in the catch and the continued lack of older fish imply 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 (Figure 27). This indicator has declined recently from an average fish weight of 130-170g in the 1980's and early 1990's to an average fish weight below 90g in 2003-2004. These levels had not been observed since 1973-1975, just prior to the closure of the meal fishery which targeted very small fish as 'grinders'. The implementation of individual boat quotas and the conversion to a food fishery by the herring industry resulted in an improvement of average size after 1975 (Iles 1993). Recent years from 2005 to 2008 have seen a trend of increasing average fish weight which was close to the long term average of about 113g. The switch in the 2009 fishery toward smaller fish (two year olds predominated the catch by number) resulted in a dramatic decline to about 90g average fish catch weight for this year.

Weight at Age

The fishery weighted average weight at age continues to be below the long term 1965-2009 average in recent years possibly reflecting changes in fishing patterns and timing (Table 19, Figure 28). There was a general decline in weight at age that occurred for all ages around 1987 (Figure 29). A further decline is also apparent for older ages (6 to 10) after 1997 with 8+ fish now consistently below 300g. A similar declining trend is not apparent in recent years for younger ages (1 to 5) which exhibit variable trends in the last few years (Figure 29). The 2009 weights at age in particular are similar to the most recent 5 year and 10 year averages which are consistently lighter than the overall series average (Figure 28).

Total Mortality Estimates from Acoustic Data

Estimates of total mortality (Z = Fishing mortality + Natural mortality) were calculated using the acoustic catch at age data. Z calculations are typically quite variable when done in this manner but can often be used to detect broad patterns and for confirmation of general VPA results. Total mortality was calculated using ages 4 to 8 combined compared with ages 5 to 9 in the following year. The acoustic age composition is assumed to be representative of the overall spawning biomass at these ages. The results for 2000 to 2009 have highly variable values of Z between 0 and 1.8 (Figure 33). There is no apparent trend as the series is very short; however

these values appear consistent with the higher F's for the most recent years as estimated from the VPA.

Calibration of VPA Analysis

The last time a Virtual Population Analysis (VPA) was used to provide management advice in this fishery was in 2006 (Power et al. 2006a). Due to discrepancies between the acoustic survey estimate of the Stock Spawning Biomsss (SSB) and the VPA results, as well as identified problems with aging of 4VWX herring, the use of the VPA was suspended until these issues were resolved. Aging issues have now been resolved, quality control measures have been implemented, otoliths from 1999 to 2005 were re-read, otoliths from 2006-2009 were read for the first time, and a revised catch at age was developed along with a revised age disaggregated acoustic survey index.

Calibrated Virtual Population Analysis (VPA) was used to estimate stock parameters. The adaptive framework, ADAPT, (Gavaris 1988) was used to calibrate the VPA with the acoustic survey data. Previous assessments (Power et al. 2005b, Power et al. 2006a) concluded that the SSB from acoustic surveys summed together results in an overestimate but that as an index of abundance, acoustic surveys follow the biomass trend from the population model. The discrepancy between the acoustic estimate of absolute SSB abundance and the VPA remains unresolved; there are several potential explanations which continue to be explored including tagging studies to investigate turnover and residence time on the spawning grounds. The difference could also relate to other issues including an inappropriate target strength coefficient for converting backscatter to biomass or unaccounted mortality.

Age specific indices of abundance were constructed from the acoustic survey data using samples appropriate for each survey by area and year for 1999 to 2009 and applying the biomass estimates that were determined for the overall survey areas (Table 20). These indices were also constructed for the German Bank spawning area, separately from the overall combined surveys (Table 21, Figure 30). The acoustic surveys that document primarily spawning fish have an age composition differing from the fishery with few fish younger than age 3, the highest proportion at age 4 and higher numbers in proportion, up to age 11, than was seen in the catch (Table 18, 21; Figure 26, 30). These indices were then used for tuning or calibration of the VPA which was used to reconstruct the population history from the catch at age (Table 18, Figure 26).

Population reconstruction from the catch at age requires several assumptions to be made about conditions in the terminal year. One assumption concerns the exploitation pattern at age (partial recruitment to the fishery) for ages which are not fully recruited to the fishery. An exploitation pattern at age of 0.2, 0.4, 0.7 and 0.9 for ages 2-5 and 1.0 for age 6 and older as used in previous assessments was considered a reasonable initial approximation (Power et al., 2005b, 2006a). A preliminary VPA analysis used to re-examine this pattern suggested that the partial recruitment may actually be higher for ages 2 and 3 with the recent 10 year average showing values of 0.4 and 0.7 respectively but the PRs were not revised for this analysis (Table 22, Figure 31, 32). Other assumptions for the population estimation follow traditional approaches from the previous assessments with natural mortality = 0.2, F for age 10 = population weighted average for ages 6-9, and estimation of the 1st fully recruited age at age 7 in the terminal year of 2010.

The VPA was calibrated with the German Bank acoustic index using a proportional model (survey to population numbers), as had been accepted in the 2006 assessment (Power et al.

2006a). The German Bank area index alone was previously selected to overcome uncertainty with survey coverage and timing in other areas, especially for Scots Bay.

Statistical properties of the estimates are presented in Figure 34. (See Appendix B for ADAPT output). The population abundance at age 7 in 2009 was estimated as 10,536 million with a moderate standard error of 28% and a low bias of 3%. Survey catchabilities (q's) for ages 4 to 8 had low standard errors of 16% and low bias of 1%. The trend of increasing q's at age with a leveling off for older ages (Figure 34) was not seen in the previous VPA results from the 2006 evaluation which used the 'old' age data that was shown to be inaccurate.

The pattern of residuals is acceptable with a mixture of moderate size positive and negative residuals (Figure 35). There are some year effects for 2000, 2001 and 2008. Age by age and the overall combined plots of the observed abundance index versus predicted population numbers from the VPA run showed a generally decreasing trend in the last few years for ages 5-7 and an increasing trend for ages 4 and 8 (Figure 36). Age by age plots of the (ln) observed and (ln) predicted abundance index versus (ln) population numbers showed significant fits for ages 4 to 7 but not for age 8 (Figure 37). A VPA run without the age 8 survey index may provide a better overall fit. The model output showed low but stable SSB and total biomass at levels between 100 and 200 thousand tons since 1994 (Table 23, Figure 38-39). Fishing mortality (ages 5 to 8 weighted by population numbers) is higher than $F_{0.1}$ (F=0.228) since 1990 with a recent increase in 2008 and 2009 to near F=0.7 (Table 24, Figure 40).

Recruitment at age 1 has been lower than overall average recruitment of 1.8 billion for most years as far back as 1986 but with above an average estimate for the most recent year class. The 2007 year class estimate (age 1 in 2008) is higher than average but there is more uncertainty with this initial estimate. The 2005 year class (age 1 in 2006), which dominated the catch in terms of weight, was below average at 1.3 billion and has more confidence because this year class has been observed in the fishery over a longer period.

Retrospective analysis for the VPA with German Bank acoustic index (ages 4 to 8) with successive years of analysis removed was completed going back for 6 years with the 11 year survey index (Figure 42). Results for this analysis with fishing mortality (F), showed a general overestimation of F in most years. The F values tended to be overestimated initially but still remain high above 0.4. Recruitment at age 1 tended to be substantially over-estimated for most years with the initial estimate often double the revised estimate with more years of data. There was general deterioration in the model after 5-6 years of data were removed with even higher discrepancies. Beginning of year SSB and beginning of year total biomass estimation was variable with underestimates in recent years. The model performed less well in earlier years due to the limited length of the survey index and the effect of removing data while doing this analysis.

The fishery catches used in this analysis are assumed to be reasonably reliable and complete. It is not thought that large amounts of unreported catch have occurred in recent years as was documented and adjusted for in the 70's and 80's (Mace 1985, Stephenson 1993). Age interpretation has been resolved and appears to track strong and weak year-classes historically and there is consistency of age interpretation between and within readers across years. There are also older ages appearing in the catch albeit at small numbers but they are being tracked up to age 10.

There is strong support for the interpretation that biomass is at a low level with relatively little change over recent years and the spawning stock biomass is less than half of the acoustic survey estimate. It should be noted that the acoustic index only provides information on about

50% of the total biomass while younger ages up to age 5 estimated in the model with average partial recruitment.

The reduced quota since 2005 has resulted in a lowering of F in 2005-2006 but it then increased in 2007-2009 and is still high relative to $F_{0.1}$(F=0.228). This analysis indicates that spawning stock biomass has been below 200,000t and fishing mortality has been above to $F_{0.1}$ since 1992, which is cause for concern (Figure 46). This VPA assessment analysis confirmed a continued deterioration in the state of the resource, as noted in previous assessments.

Outlook

Projection results and risk analysis are provided in terms of the consequences with respect to the harvest reference points for alternative catch quotas in 2010 (Figure 43-44) (Appendix B). The projection inputs for exploitation rate, natural mortality, partial recruitment, maturities and weights at age which were used are similar to those chosen in the 2006 evaluation (Table 25) (Power et al. 2006a). The results are shown in terms of the probability of exceeding F_{ref} in 2010 and the probability of achieving biomass increases of 0, 20 and 40% for various yields (Figure 45). A catch of 25,800t in 2010 results in a neutral risk of exceeding $F_{0.1}$ (F=0.228). A status quo catch of 55,000t would result in a 30% (low) risk that the biomass in 2011 will not increase by 40%. This expected increase is attributable to the potentially strong recruiting 2007 year class.

This assessment was reviewed through the Maritimes Region Advisory Process (RAP) on 14-15 April 2010. Although the formulation used in this assessment was the accepted approach used in 2006, this assessment was rejected due to the following concerns:

1) It was argued that the VPA was might be confounded by (unspecified) technical errors that made the VPA approach unsuitable. An appropriate VPA model should be achieved through a new framework assessment.
2) The model formulation had not been fully explored before being presented and the herring assessment team needs to explore other possibilities. It was recommended that a DFO internal workshop to conduct a framework assessment review should be the next step. A solution that is scientifically defensible and for which consensus can be obtained would restore industry confidence.
3) It was felt that the terminal F from the VPA calibration was too high (0.7) in comparison with the relative exploitation rate obtained from the acoustics data which indicated that F has decreased. Based on total mortality calculations from the catch at age per year, the real population level is likely between the acoustics and the VPA estimates and there is a chance that the stock is being slightly over fished at present. It was recognized that the number of assessment models that are applicable to age structured data are limited. A statistical catch-at-age model would have the advantage of not relying on a terminal F and would provide another perspective. However, as with any model, this type of analysis also requires assumptions to be made that may be difficult to support. It was also noted that work was being done on a multi-species VPA (MSVPA) which could provide additional perspectives.

In conclusion, it was not determined whether the VPA modelling approach is appropriate for provision of 4VWX herring management advice or what alternate modelling approaches should be pursued in the framework assessment. There are outstanding concerns with the VPA updated with the revised catch at age that will be investigated further, along with other model options, at a subsequent framework meeting.

Since the VPA formulation was not accepted, fishing mortality could not be determined. Relative exploitation rate decreased in 2009 based on the acoustic SSB estimate and catch. Stock status

and scientific advice in 2010 are based on the acoustic survey index and evaluation of the management objectives.

Stock Trends

The 2005 assessment compared a population model (VPA), calibrated with the relative abundance from the acoustic surveys, with the overall absolute abundance estimated from these same acoustic surveys (Power et al. 2006a). While the trends in modelled abundance followed those in the survey, there was an inconsistency with a lower estimate of biomass determined by the VPA compared with the absolute estimate provided by the acoustic surveys. This inconsistency is being investigated and may be due to issues with the survey (e.g. double counting, target strength) and/or the VPA (e.g. ageing, unaccounted mortality). The 2007 Framework (DFO 2007) concluded that while the current acoustic survey can only provide a relative index of abundance, efforts should continue towards developing them as an absolute estimator.

In the 2007 fishery assessment, it appeared that the expected increase in the SSB due to the reduced quota since 2005 was being observed in the acoustic surveys which showed an increase over two consecutive years (Power et al. 2008). Fishing mortality was not determined but appeared to be decreasing based on the trends from relative exploitation rates from acoustic surveys. There were also indications that a strong year-class was entering the fishery with a large number of smaller fish in the catch (less than 23cm) seen in both the stock fishery and in non-stock NB weirs. Despite the increase in acoustic survey biomass in 2006 and 2007 the estimated acoustic survey biomass at 384,300t in 2007 remained below average.

In 2008 acoustic biomass estimates decreased for all survey areas in Scots Bay, Trinity Ledge and German Bank to an overall amount of 223,100t (Power et al. 2010a). This was a 42% decrease from the previous year and is the lowest recorded since acoustic surveys began in 1997. The 2008 acoustic SSB estimate for the overall area remained well below the long term average as it has since 2005. The proportion of the catch greater than 30cm increased slightly in 2008 which may indicate improved survival but it is important to note that these catch data may not reflect the overall population composition and so must be used with caution when considering population trends.

In the past, industry and management have explored ways to manage the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and taking appropriate account of the interaction among components (such as fishing restrictions on some areas of mixing). Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in lost potential yield. Since 2005/2006, industry made a concerted effort to avoid small fish (less than 23cm or 2 years old). The result was a decrease in the proportion of fish less than 3 years old in the catch from 2005-2008. This, combined with the reduced TAC, has allowed year classes to survive to older ages (e.g., the 2001 year class has tracked through to age 8). The total removals of fish by number were reduced by close to 50% from 2005 to 2008 relative to 2004 but increased in 2009 when the catch consisted of 45% by number of 2 year olds. This increase in the catch of 2 year olds was attributed to a potentially large year class.

2.3 Sources of Uncertainty

There are several sources of uncertainty in this assessment that need to be considered. The use of the acoustic survey results as a measure of absolute abundance has a number of unknowns including residence time on the spawning grounds and estimation of biomass in the

acoustic dead/blind zones at the surface and close to bottom. Between 1999 and 2003 acoustic survey results were used as minimum estimates of absolute SSB abundance and the population was considered to be approximately 500,000t. An SSB of that size would have been expected to result in substantial growth of the population, improved age composition and low fishing mortality, given reasonable recruitment and the landings over that period. This has not occurred.

Other significant issues relate to the completeness of coverage of the survey area on Trinity Ledge, inter-annual turn-over processes on each area, and factors that influence the target strength and acoustic backscatter (DFO 2007).

The acoustic survey index provides fisheries independent information on the spawning stock biomass but does not provide data on younger age classes. The size of recruiting herring year-classes is known to be highly variable and with no index of recruitment there is a large fraction of the catch dependent on recruiting year classes of uncertain abundances. For example the size of an apparently strong 2007 recruiting year class is unknown but made up 45% (by number) of the catch in 2009.

2.4 Ecosystem Considerations

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

The by-catch of other species besides herring in herring directed fishing is detailed in Appendix A for the years 2004-2009. Previous analysis has found no major concerns for these fisheries with very low by-catch reported (DFO 2007). In 2008 there were a total of 11 trips or 30 sets monitored with only herring and dogfish recorded. The lack of observer recording of other incidental species was noted as a possible protocol error by the monitors. We were informed that protocols have not changed and that observers continue to look for non-target species in the catch but that they are difficult to observe in purse seine catches which are pumped directly into the fish hold. Observers will be monitoring catch more closely in 2010 with more trips planned.

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

2.5 Management Considerations

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

<u>2006 Fishery Evaluation</u>

In the assessment of the 2006 fishery an evaluation of progress in recent years against biological objectives in the management plan indicated that most objectives were not being met

(Table 26) (Power et al. 2007). The biomass estimates for all spawning areas increased slightly from 2005 but were still at historically low levels with a substantial decline from 2004. The Scots Bay, Trinity Ledge, Lurcher Shoal and Seal Island spawning grounds remained at very low biomass. In 2006 the beginning and duration of spawning in Scots Bay and German Bank occurred as normal, unlike 2005, but there was a mid-season gap in spawning in Scots Bay. Fishing mortality was considered likely high and well above $F_{0.1}$ and the SSB near the lowest recorded level since 1999 from acoustic surveys.

2007 Fishery Evaluation

Evaluation of objectives for the 2007 fishing season showed that some conservation objectives were being met but there were concerns with most spawning areas except German Bank which was considered at or above average biomass (Table 27). The potential benefits of the reduced quota and other rebuilding measures from 2005 through to 2007 were thought to be reflected in the improved biological characteristics of the population (catch size composition).

2008 Fishery Evaluation

The assessment of the 2008 fishery indicated little improvement from the low level of the resource noted in recent assessments (Table 28). Acoustic biomass estimates decreased and are near the lowest level in the time series for all major survey areas in Scots Bay, Trinity Ledge and German Bank. This resulted in an overall 42% decrease from the previous year and is the lowest recorded since acoustic surveys began in 1997. There were now concerns for spawning in all areas including German Bank. The 2008 SSB estimate for the overall area remains well below the long term average or at very low biomass (Trinity Ledge) for all areas surveyed.

The duration of spawning was shorter for Scots Bay and appeared to be missing waves in mid-Sept on German Bank. There appeared to be insufficient spawning in all areas and reduction of diversity of spawning in both time and space. Overall length composition in the catch had improved with the proportion of larger (30 cm+) sizes increasing. There was an increase in medium sized (23-30cm) fish but strength of incoming year-class was unknown. Without a population model, catch is the best available proxy of the population.

There were few positive signs from this fishery in 2008 and few of the conservation objectives appear to have been met (Table 28). Fishing mortality was not determined but appeared to have increased based on the trends from relative exploitation rates from acoustic surveys. The benefits of the reduced quota and other rebuilding measures which had started to be reflected in the improved biological characteristics of the population now appeared to be limited. This assessment indicated that a low resource level was cause for concern.

2009 Fishery Evaluation

This assessment indicated improvements from the low level of the resource noted in the previous assessment (Power et al. 2010a), e.g., SSB estimated from the acoustic surveys is approaching the series average (1999-2008). Spawning was observed in Scots Bay and German Bank but Trinity Ledge had minimal spawning, with acoustic survey SSB for this area extremely low. Acoustic biomass estimates increased for two of the major survey areas. There appeared to be a broad range of ages in the commercial catch (1-9), as well as in the acoustic survey catch at age (3-11). The presence of two apparently strong recruiting year classes is likely to increase biomass levels in the next few years. A harvest strategy that exercises continued caution to facilitate further rebuilding is recommended. Catch levels that remain near

the current status quo would help to reduce risks related to uncertainties in estimating SSB, recruitment, and the exploitation rate for this stock.

Other Considerations

Pooling or sharing of catches amongst vessels to minimize sets and discards has reduced fishing effort and minimized occurrence of discards in recent years.

Increases in grey seal abundance and changes in distribution have raised concerns about changes in herring behaviour (e.g., distribution in water column and spawning timing).

Observer reports of by-catch in purse seine sets have reported very small amounts of mackerel, squid, and dogfish.

Reports by fishermen indicate that spawning may be starting earlier in the season. Surveys with validation sampling (e.g., biological sampling in addition to acoustic survey) would help to confirm spawning timing and annual variability.

3) OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

There continues to be little information on stock size, distribution and spawning behavior for this offshore component which currently supports a limited spring fishery on feeding herring. Recent information comes primarily from sampling of this fishery and from catches and samples from the summer research bottom trawl survey. There is no information on spawning timing or location for the offshore area which is presumed to take place in the fall.

3.1 The Fishery

A foreign fishery during 1963-1973 is estimated to have removed an average of 28,000t per year and as much as 121,000t in 1969 from the offshore Scotian Shelf banks (Stephenson et al. 1987). Few herring were caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the Scotia-Fundy purse seine fleet and 11,700t were taken (Table 3). Since 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 (Figure 47). The variability in catch levels is often due to problems of fish being too deep, weather and market conditions rather than in the abundance of herring in these areas.

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

In 2008 total catches for the area were the lowest since 1996 with 920t reported. Most landings (880t) were by purse seine in May and June, in the vicinity of ‘The Patch’, Emerald Bank and Western Bank. The weather and lack of fish available to the gear remained a problem with catching fish. There was only one observed trip by fishery observers for the Patch area and no by-catch was recorded (Appendix A).

In 2009 total landings were above average at 9,088t, up from only 920t in 2008. Most landings were caught by purse seine gear in May and June, in the vicinity of the Patch, Emerald and the

Western Hole (Figure 48). The age composition of the catch was primarily adult herring (age 3+) with substantial proportions at age 4 and age 8 (Figure 49).

3.2 Research and Industry Surveys

Industry Surveys

There were no industry surveys of the offshore Scotian Shelf area from 2002-2008. Acoustic recorders were activated on a few occasions but insufficient quantities of fish were observed to warrant analysis or the information was of poor quality with excessive interference from other electronics. An industry survey of the offshore Scotian Shelf area near the herring fishing grounds was conducted in June 2009, but, due to timing, few herring were observed and the results were not considered to be useful.

July Bottom Trawl Survey

Summer research bottom trawl surveys (Doubleday 1981, Figure 50) 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). This DFO summer ecosystem trawl survey, which continues to demonstrate that herring are widely spread over the Scotian Shelf, declined substantially from a high in 2004 (355 mean number per tow) to a below average level in 2009 (39 mean number per tow) (Table 30, Figure 51). There are several shortcomings to this data series which preclude its use as an indicator of overall abundance for a schooling pelagic species like herring. These include variable behavior and availability to the gear from year to year and the lack of year-class tracking when this was explored previously (Power et al., 2005b) The bottom trawl data, while useful for documenting size, maturity and distribution, are not considered indicative of overall herring abundance.

Fall Herring Research Survey

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

3.3 Outlook and Management Considerations

The industry has been encouraged to explore and undertake structured surveys of the offshore area. Industry, DFO Science and Management continue to work together to improve the biological basis for management. There is little new information to add and no reason to change the previous recommendation that the initial catch allocation for 2010 should not exceed the 12,000t as described in the fishing plan.

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

There is no quota for the coastal Nova Scotia spawning component and, apart from three areas, the size and historical performance of spawning groups are poorly documented. A fourth area the Bras d'Or Lakes has had no research or surveys for herring since 2000 and this fishery remains closed. As the inshore gillnet roe fisheries off Glace Bay, East of Halifax and Little Hope have developed (since 1996), participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol. In addition to the

traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds in recent years (Clark et al. 1999).

4.1 The Fishery and Resource Status

The landings in the gillnet roe fisheries along the coast of Nova Scotia increased from 3,500t in 2008 to 9,780t in 2009 (Table 31). From 2008 to 2009, landings increased from 1,108t to 3,731t in the Little Hope/Port Mouton area and from 2,381t to 6,045t in the Eastern Shore area. Increases were managed within season based on observed acoustic biomass during the season (using the "survey, assess and fish" protocol). There was an additional 6t landed from trap nets located in Cape Breton and St. Margaret's Bay (Table 1).

Little Hope/Port Mouton

The 2009 herring gillnet fishery in Little Hope/Port Mouton area began in early September and extended to October 26, 2009. The total catch was up substantially to 3,730t from 1,100t in 2008 with the majority of the catch occurring between Sept. 19 and October 17 (Power et al. 2010b). The catches occurred in 3 main areas off Port Mouton, near Liverpool and Port Medway (Figure 52). Overall, four acoustics surveys were conducted in the Little Hope/ Port Mouton area between September 14 and October 11. There was a large increase in the surveyed biomass in 2009 for the Little Hope/Port Mouton area from 14,500t to 36,600t which was well above the recent 5 year average of 24,500t (Table 31b, Figure 53).

East of Halifax (4W Eastern Shore)

The 2009 herring gillnet fishery in the Eastern Shore fishing area began on Sept. 13 and ended on Oct. 26 with total landings of 6,045 which was over double that recorded in 2008. The increase was due to quota allocation increases during the season related to the improved biomass observed with in-season acoustic surveys. The fishery duration was similar to recent years with most catches occurring between Sept. 16 and Oct. 24. Once again, this was primarily a herring roe fishery with catches reported from three main areas; near Halifax Harbour approaches, southwest of Jeddore Head and south of Ship Harbour. Catches were well distributed in the area but effort was less concentrated in the area south of Ship Harbour (Figure 54). Surveys were completed in each of the primary fishing areas from Halifax Harbour to near Ship Harbour, N.S. on Sept. 16 and 24, Oct 2, 9 and 20. The surveyed biomass in the Halifax/Eastern shore area saw a slight increase in 2008 and a large increase in 2009 from 30,300t to 54,200t, which is above the recent 5 year average SSB of 43,700t observed for this area (Table 31b, Figure 55).

Glace Bay

Landings were minimal for Glace Bay with only 4t reported in May and June. Survey coverage for the Glace Bay area was poor in 2009 with three surveys attempted on July 27, Sept. 12 and Oct. 2. There has been no spawning fishery in the area for the past 4 years mainly due to a lack of markets and the lack of fishing activity precluded the opportunity for other boats to participate or assist in the searching and survey activities (Figure 56).

Bras d'Or Lakes

This fishery remained closed. No sampling or acoustic surveys have been undertaken in the Bras d'Or lakes to document the size distribution or abundance of herring since 2000. It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern.

With no sampling or acoustic surveys in recent years, there is no evidence to support any change. It is therefore appropriate to reiterate, from a biological perspective, that no fishing should take place on this spawning component.

Age Composition

In 2009, the age composition of the catch for the overall coastal Nova Scotia spawning component was primarily adult herring from this size selective gillnet fishery with a substantial proportion (99%) at age 4 and older (Figure 57).

4.2 Outlook and Management Considerations

In 2007 there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50%, while the Little Hope area saw an even larger decline of almost 90%. In 2008, there was an increase in surveyed acoustic biomass in the Little Hope/Port Mouton area from the low of the previous year, but biomass was still below average while the Halifax/Eastern Shore area remained about the same. In 2009, surveyed biomass for both of these areas saw large increases which were above the long term average SSB. Surveys were also completed near Glace Bay but there were very few spawning herring documented and only minimal catch reported. No herring surveys have been conducted in the Bras d'Or Lakes since 2000.

As indicated for the SWNS/BoF 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 usually undertaken on spatially separated spawning aggregations of fish.

Management approaches and recent research efforts have improved knowledge in the three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no information for any adjacent areas. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. It has been recommended that no coastal spawning area experience a large effort increase in new areas until enough information is available to evaluate the status of the new group.

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

The main areas for Little Hope/Port Mouton and Halifax/Eastern Shore use a five-year average of recent catches and/or 10% of surveyed acoustic biomass calculated with the CIF to set annual removals. The provision to document sufficient quantities of fish each year before the fishery begins had been waived in some recent years due to substantial abundances. It is recommended that given the recent variability in survey biomass from year to year, the "survey, assess, then fish" protocol should be adhered to.

5) SW NEW BRUNSWICK MIGRANT JUVENILES

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

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

Catches in the last decade for this fishery have been highly variable and unpredictable. In 2002 and 2003 landings dropped from 20,209t to 9,003t (Table 3) - the lowest since 1983 – and there was concern expressed for this fishery. In 2004 weir landings increased to 20,686t and concerns abated but in the following year landings again decreased to 13,055t. In 2006 landings remained low with 12,863t recorded, while the size of herring caught was abnormally small throughout the season impeding markets. Landings in 2007 nearly tripled to 30,944t, the highest catch for this component since 1993. Catches also confirmed the presence of the 2005 year-class which was observed in high numbers in the previous season as small and mostly unmarketable fish. The number of active weirs with catch increased to 97 in the 2007 season from a low of 76 in 2005. Following near record catches in 2007, landings in the 2008 were 6,447t which was the lowest catch recorded since 1963 and well below the long term average. In 2008, weir fishermen in most areas reported good abundance close to their weirs, but catches remained low throughout the season with the fish not moving into the weirs.

Landings for 2009 were 4,031t, now the lowest catch since 1963 (Table 32; Figure 58). Two years previously this fishery landed substantially more than the long term average of 23,560t (Figure 59). The number of active weirs with catch decreased to only 38 in the 2009 season from a recent high of 97 in 2007 (Table 10).

The age distribution of fish caught in the 2009 New Brunswick weir and shutoff fishery indicated mostly juveniles, which are well suited to the sardine market, with 86% at age 2 (Figure 60). In 2009, weir fishermen in most areas reported good abundance close to their weirs, but weir catches remained low throughout the season. After mid-October 2009, when an area restriction was removed, purse seiners caught 1,664t of herring within this area and an additional 1,100t were also taken in January 2010 (Table 2).

6) 5Z GEORGES BANK

The activities of midwater trawlers and herring purse seiners on the Canadian portion of Georges Bank (area 5Z) are monitored using the Vessel Monitoring System (VMS) and there were no trips to the area and no reported landings.

7) BAY OF FUNDY LARVAL HERRING SURVEY

From 1972 to 1998 annual plankton research surveys were conducted in late October / early November in the southwest Nova Scotia / Bay of Fundy area to determine larval herring distribution and abundance (Stephenson et al., 1999b). This series was ended for fiscal reasons and because the survey had limited use in the stock assessment. Scientifically these data are very valuable in documenting the success of spawning and the distribution of various fish larvae, fish egg and planktonic invertebrate species.

This survey was reinstituted in 2009 for a single year in order to provide a ‘snapshot’ of the marine plankton environment for comparison with the earlier data series and as a measure of the biodiversity of this ecosystem. The 2009 survey will provide a reference point on the distribution of herring larvae as well as other fish larvae, fish eggs and other plankton in relation

to historical patterns. Of particular interest is the spatial distribution and abundance of herring larvae in relation to historical distribution and in comparison to known spawning grounds.

The spatial distribution of herring larvae was sampled using bongo gear and a fixed grid station design as was used in the past. The initial emphasis was to complete the standard 79 index stations used for the historical herring assessment (Figure 61). This 27 year time series was previously undertaken using the *E.E. Prince* (1972-1993) and the *Alfred Needler* (1994-1998). There has been an eleven year gap since the last survey was completed in 1998 (Figure 62). This year's survey was completed by the charter vessel *Dominion Victory* using the same 61cm bongo gear and following the same methods (see below) as previously established. The survey timing was also within the range of previous surveys with the mid-date of the survey only a few days later than the average (Figure 63).

The overall objectives of the survey were all achieved with a total of 100 sets completed between October 26 and November 10, 2009 (Figure 61, Table 33). All of the 'index stations', those 79 historic stations used to calculate the larval abundance index were completed by 1500hr on Nov. 8. An additional 19 non-index plankton station locations were sampled near the approaches to the Bay of Fundy and in the Grand Manan area. Temperature and salinity profiles were completed at all locations and additional water samples for phytoplankton analysis were collected at 13 locations. The larval abundance index of 19.9 larvae m^2 was lower than the previous value of 33.6 larvae m^2 recorded in 1998 (Figure 62, Table 33) and above the average of the 27 year time series (25.6) with similar distribution patterns as seen by the earlier surveys.

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Table 1. 4VWX herring fishery landings (t) by month, gear sector and management unit for 2008-2009 quota year.

			Month												
	Area	**Gear**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
S.W. Nova Scotia	4X	Fall P. Seine (2008)										1,314	561		1,875
	4X	Winter P. Seine (2009)	932												932
	4X	Summer P. Seine (2009)					2,093	5,720	11,949	13,731	11,811	5,498			50,802
	4X	Gillnet "Stock" (2009)						0			116				117
	4X	N.S. Weirs (2009)						110	233	44	0				387
S.W. Nova Scotia total for 2008-2009 quota year			932	-			2,093	5,830	12,182	13,775	11,927	6,812	561	-	54,113
Coastal Nova Scotia	4Vn, 4X	Trap					1	0		1		0			3.1
(South Shore,	4Vn	Glace Bay Gillnet					1	3	0		-	-			3.5
Eastern Shore,	4W	Eastern Shore Gillnet					0	0		0	2,735	3,310	0		6,045
Cape Breton)	4X	Little Hope Gillnet					0	0		-	1,613	2,118			3,731
Coastal Nova Scotia total for 2009 calendar year							2	3	0	2	4,348	5,429	0		9,783
Offshore Scotian Shelf	4WX	Offshore P. Seine					1,865	7,179							9,044
	4WX	Bottom Trawl + Misc.	0	1	0	3	6	7	9	8	5	4	0		44
Offshore Scotian Shelf total for 2009 calendar year			0	1	0	3	1,871	7,186	9	8	5	4	0	-	9,088
S.W. New Brunswick	4X	N.B. Weirs					5	239	699	1,111	1,219	330			3,603
Migrant Juveniles	4X	N.B. Shutoff									428				428
S.W. New Brunswick Migrant Juveniles for 2009 calendar year							5	239	699	1,111	1,647	330			4,031

Total 2008-2009	77,015

Table 2. 4WX herring fishery landings (t) by month and gear sector for 2009-2010 quota year (as of March 2, 2010).

B) 4VWX herring fishery landings (t) by month, gear sector and management unit for 2009-2010 quota year (as of March 2, 2010).

			Month												
	Area	**Gear**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
2009-2010 quota year	4X	Fall 2009 P. Seine										1,091	573		1,664
		Winter 2010 P. Seine	1,123												1,123
2010 Calendar year	4WX	Bottom Trawl	0	0											0
2009-2010 Total (from Oct. 15, 2009 to March 2, 2010)			1,123	0	-							1,091	573		2,787

Table 3. Historical series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2009 (the 1963-73 Offshore Scotian Shelf landings are from Stephenson et al. (1987)).

Year^	4W Winter Purse Seine	4Xs Fall&Winter Purse Seine	4Xqr Summer Purse Seine	4X Summer Gillnet	4Xr Nova Scotia Weir	4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs N.B. Weir & Shutoff	4VWX Coastal Nova Scotia	Offshore Scotian Shelf Banks	Total 4VWX Adjusted Landings
1963		6,871	15,093	2,955	5,345	30,264	30,264		29,366		3,000	62,630
1964		15991	24,894	4,053	12,458	57,396	57,396		29,432		2,000	88,828
1965		15,755	54,527	4,091	12,021	86,394	86,394		33,346		6,000	125,740
1966		25,645	112,457	4,413	7,711	150,226	150,226		35,805		2,000	188,031
1967		20,888	117,382	5,398	12,475	156,143	156,741		30,032		1,000	187,773
1968		42,223	133,267	5,884	12,571	193,945	196,362		33,145		18,000	247,507
1969	25,112	13,202	84,525	3,474	10,744	137,057	150,462		26,539		121,000	298,001
1970	27,107	14,749	74,849	5,019	11,706	133,430	190,382		15,840		87,000	293,222
1971	52,535	4,868	35,071	4,607	8,081	105,162	129,101		12,660		28,000	169,761
1972	25,656	32,174	61,158	3,789	6,766	129,543	153,449		32,699		21,000	207,148
1973	8,348	27,322	36,618	5,205	12,492	89,985	122,687		19,935		14,000	156,622
1974	27,044	10,563	76,859	4,285	6,436	125,187	149,670		20,602			170,272
1975	27,030	1,152	79,605	4,995	7,404	120,186	143,897		30,819			174,716
1976	37,196	746	58,395	8,322	5,959	110,618	115,178		29,206			144,384
1977	23,251	1,236	68,538	18,523	5,213	116,761	117,171	109,000	23,487			140,658
1978	17,274	6,519	57,973	6,059	8,057	95,882	114,000	110,000	38,842			152,842
1979	14,073	3,839	25,265	4,363	9,307	56,847	77,500	99,000	37,828			115,328
1980	8,958	1,443	44,986	19,804	2,383	77,574	107,000	65,000	13,525			120,525
1981	18,588	1,368	53,799	11,985	1,966	87,706	137,000	100,000	19,080			156,080
1982	12,275	103	64,344	6,799	1,212	84,733	105,800	80,200	25,963			131,763
1983	8,226	2,157	63,379	8,762	918	83,442	117,400	82,000	11,383			128,783
1984	6,336	5,683	58,354	4,490	2,684	77,547	135,900	80,000	8,698			144,598
1985	8,751	5,419	87,167	5,584	4,062	110,983	165,000	125,000	27,863			192,863
1986	8,414	3,365	56,139	3,533	1,958	73,409	100,000	97,600	27,883			127,883
1987	8,780	5,139	77,706	2,289	6,786	100,700	147,100	126,500	27,320			174,420
1988	8,503	7,876	98,371	695	7,518	124,653	199,600	151,200	33,421			233,021
1989	6,169	5,896	68,089	95	3,308	83,557	97,500	151,200	44,112			141,612
1990	8,316	10,705	77,545	243	4,049	102,627	172,900	151,200	38,778			211,678
1991	17,878	2,024	73,619	538	1,498	97,010	130,800	151,200	24,576			155,376
1992	14,310	1,298	80,807	395	2,227	100,227	136,000	125,000	31,967			167,967
1993	10,731	2,376	81,478	556	2,662	98,464	105,089	151,200	31,573			136,662
1994	9,872	3,174	64,509	339	2,045	80,099	80,099	151,200	22,241			102,340
1995	3,191	7,235	48,481	302	3,049	62,499	62,499	80,000	18,248			80,747
1996	2,049	3,305	42,708	6,340	3,476	58,068	58,068	57,000	15,913	1,450	11,745	87,176
1997	1,759	2,926	40,357	6,816	4,019	56,117	56,117	57,000	20,552	2,340	20,261	99,270
1998	1,405	1,494	67,433	2,231	4,464	77,027	77,027	90,000	20,091	4,120	5,591	106,829
1999	1,235	4,764	64,432	1,660	5,461	77,552	77,552	105,000	18,644	5,618	12,646	114,460
2000	1,012	4,738	78,010	823	701	85,284	85,284	100,000	16,829	4,283	2,182	108,578
2001	0	4,001	62,004	1,857	3,708	71,570	71,570	78,000	20,209	6,006	12,503	110,288
2002	367	5,257	69,894	393	1,143	77,054	77,054	78,000	11,874	10,375	7,039	106,342
2003	0	8,860	79,140	439	921	89,360	89,360	93,000	9,003	9,162	998	108,523
2004	0	5,659	69,015	225	3,130	78,029	78,029	83,000	20,686	6,924	4,165	109,804
2005	0	2,601	43,487	566	2,245	48,899	48,899	50,000	13,055	6,311	5,263	73,528
2006	0	930	45,002	719	2,508	49,159	49,159	50,000	12,863	6,566	9,809	78,397
2007	0	1,847	46,045	1,334	1,130	50,356	50,356	50,000	30,944	5,240	5,385	91,925
2008	0	2,000	50,022	15	2,524	54,561	54,561	55,000	6,447	3,704	918	65,631
2009	0	2,807	50,802	117	387	54,113	54,113	55,000	4,031	9,783	9,088	77,015

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

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

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

Table 4a. Herring purse seine catches (t) by fishing ground areas from 1985 to 2009 for the 4WX stock component.

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

Stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Recent Decade Average 00-09	2009 vs Avg 00-09	All Series Avg 85-09
Browns Bank	14	3,139	2,197	1,137	486			45		88	34			358		818
Chedabucto Bay		1,583	1,151	10										10		4,762
Gannet,Dry Ledge	4,590	4,156	10,296	12,674	3,877	9,047	6,965	4,456	3,117	6,764	11,344	10,006	8,656	7,691	965	6,456
German Bank	13,576	20,556	24,660	25,631	24,139	22,355	21,573	14,175	14,171	16,522	15,085	22,437	19,354	19,544	-190	16,538
Grand Manan	5,312	15,983	7,912	18,185	10,545	17,753	17,258	7,542	5,740	7,716	10,011	10,493	12,368	11,761	607	8,079
Long Island	3,557	12,360	18,286	11,199	12,904	6,642	12,639	13,115	8,037	1,884	4,604	3,207	2,983	7,721	-4,738	8,385
Lurcher	599	57		715	227	7,683	1,872	7,268	1,692	2,809	2,305	684	3,676	2,893	782	1,661
N.B. Coastal	1,176	782	1,867	361	1,250	3,113	3,914	2,707	787	1,889	851	2,205	5,023	2,210	2,813	1,522
Pollock Point					1,563									1,563	-1,563	1,563
S.W. Grounds	797	1,239	3,241	1,879	53	791	73		1,228	1,206	30	752	178	688	-510	1,259
Scots Bay	4,894	8,210	1,789	10,926	10,739	8,202	19,196	24,869	6,239	3,352	4,116	2,373	902	9,091	-8,189	7,143
Seal Island	492	617	567	206	101	238	1,096		1,358	209		15	12	404	-392	6,039
Trinity	5,308	2,825	1,220	103	113	1,609		370	1,448	3,725	112		325	976	-651	5,243
Yankee Bank	4	159	82	133	8	78			528	2	62	178	131	140	-9	345
Unknown		62	84	27			1,103	127	181	396	39		14	270	-256	259
4WX Stock Total	40,319	71,727	73,350	83,186	66,005	77,511	85,689	74,674	44,526	46,561	48,594	52,350	53,621	63,272	-9,650	64,784

Table 4b. Herring purse seine catches (%) by fishing ground areas from 1985 to 2009 for the 4WX stock component.

b) Percentage by grounds for the 4WX stock area from 1985-2009.

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

Stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Recent Decade Average 00-09	2009 vs Avg 00-09	All Series Avg 85-09
Browns Bank	0%	4%	3%	1%	1%			0%		0%	0%			0%		1%
Chedabucto Bay		2%	2%	0%										0%		4%
Gannet,Dry Ledge	11%	6%	14%	15%	6%	12%	8%	6%	7%	15%	23%	19%	16%	13%	6%	10%
German Bank	34%	29%	34%	31%	37%	29%	25%	19%	32%	35%	31%	43%	36%	32%	11%	26%
Grand Manan	13%	22%	11%	22%	16%	23%	20%	10%	13%	17%	21%	20%	23%	18%	2%	13%
Long Island	9%	17%	25%	13%	20%	9%	15%	18%	18%	4%	9%	6%	6%	13%	-7%	12%
Lurcher	1%	0%		1%	0%	10%	2%	10%	4%	6%	5%	1%	7%	4%	-3%	3%
N.B. Coastal	3%	1%	3%	0%	2%	4%	5%	4%	2%	4%	2%	4%	9%	3%	1%	2%
Pollock Point					2%									0%		0%
S.W. Grounds	2%	2%	4%	2%	0%	1%	0%		3%	3%	0%	1%	0%	1%	0%	2%
Scots Bay	12%	11%	2%	13%	16%	11%	22%	33%	14%	7%	8%	5%	2%	12%	-8%	11%
Seal Island	1%	1%	1%	0%	0%	0%	1%		3%	0%		0%	0%	1%	-1%	8%
Trinity	13%	4%	2%	0%	0%	2%		0%	3%	8%	0%		1%	2%		7%
Yankee Bank	0%	0%	0%	0%	0%	0%			1%	0%	0%	0%	0%	0%	0%	0%
Unknown		0%	0%	0%			1%	0%	0%	1%	0%		0%	0%		0%
Total	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 for 1985 to 2009 from non-stock areas.

a) Catches (t) by grounds for non-stock areas from 1985-2009.

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

Non-stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average 00-09	Avg 85-09
Georges Bank	79			265										265	542
Liverpool															2,752
Shelburne									29					29	128
Halifax	455			1,002	472	367								460	685
Offshore Banks	18,770	4,284	8,669	1,645	3,977	5,078	722	4,054	4,115	4,846	2,515	829	8,918	3,670	5,348
Western Hole	691	1,012	1,057	47	7,712	1,884	156		214	192	220	52	114	1,177	1,060
Nonstock Total	19,995	5,296	9,726	2,958	12,161	7,329	878	4,054	4,358	5,038	2,735	881	9,032	4,942	10,515

b) Percentage by grounds for non-stock areas from 1985-2009.

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

Non-stock Areas	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average 00-09	Avg 85-09
Georges Bank	0%			9%										1%	6%
Liverpool															5%
Shelburne									1%					0%	2%
Halifax	2%			34%	4%	5%								4%	4%
Offshore Banks	94%	81%	89%	56%	33%	69%	82%	100%	94%	96%	92%	94%	99%	82%	54%
Western Hole	3%	19%	11%	2%	63%	26%	18%		5%	4%	8%	6%	1%	13%	29%
Non-stock Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 6. Scots Bay herring purse seine catches for 1987 to 2009.

Year	Min. Date	Max. Date	Duration in Days	Days with Catch	Catch t	No. Slips	Catch/Day with Catch	Catch/Slip
1987	08-Jul-87	06-Aug-87	30	20	3,398	91	169.88	37.34
1988	20-Jul-88	29-Jul-88	10	9	3,780	65	419.99	58.15
1989	19-Jul-89	13-Sep-89	57	35	6,021	164	172.04	36.72
1990	22-Jul-90	14-Aug-90	24	11	8,088	108	735.24	74.89
1991	05-Jul-91	14-Aug-91	41	16	7,365	163	460.30	45.18
1992	25-Jul-92	11-Aug-92	18	18	7,960	189	442.22	42.12
1993	25-Jul-93	01-Sep-93	39	32	5,228	100	163.36	52.28
1994	10-Jul-94	25-Aug-94	47	36	10,610	286	294.72	37.10
1995	24-Jul-95	26-Jul-95	3	3	907	33	302.33	27.48
1996	25-Jul-96	20-Aug-96	27	13	8,939	151	687.58	59.20
1997	30-Jul-97	27-Aug-97	29	19	4,847	91	255.11	53.26
1998	20-Jul-98	10-Sep-98	53	29	7,880	163	271.72	48.34
1999	19-Jul-99	17-Aug-99	30	16	1,789	40	111.81	44.73
2000	25-Jul-00	30-Aug-00	37	26	10,853	171	417.44	63.47
2001	10-Jul-01	21-Aug-01	43	30	10,739	176	357.97	61.02
2002	22-Jul-02	09-Sep-02	50	36	7,994	160	222.06	49.96
2003	21-Jul-03	05-Sep-03	47	34	19,196	237	564.59	81.00
2004	19-Jul-04	16-Sep-04	60	42	24,388	330	580.67	73.90
2005	26-Jul-05	09-Sep-05	46	27	5,872	96	217.48	61.17
2006	24-Jul-06	04-Sep-06	43	16	3,352	43	209.50	77.95
2007	16-Jul-07	31-Aug-07	47	21	4,116	79	196.00	52.10
2008	14-Jul-08	27-Aug-08	45	14	2,373	43	169.50	55.19
2009	12-Jul-09	11-Aug-09	31	8	902	18	112.75	50.11

Table 7. German Bank herring purse seine catches for 1985 to 2009 with start date, end date, catch before Aug.15 (pre-spawning period), catch after Aug. 14 (defined as spawning period) and proportion of TAC.

Year	Start Date	End Date	Duration No. Days	Total No. Slips	Catch before Aug. 15 (prespawn)	Catch on/after Aug. 15 (spawning)	Total Catch t	% Catch on/after Aug-14	TAC	German as % TAC
1985	22-Jun-85	08-Oct-85	109	428	8,856	14,228	23,084	62%	125,000	18%
1986	18-Jun-86	01-Oct-86	106	349	2,349	13,542	15,892	85%	97,600	16%
1987	26-May-87	14-Oct-87	142	403	5,138	13,218	18,357	72%	126,500	15%
1988	29-May-88	06-Oct-88	131	610	14,776	18,348	33,125	55%	151,200	22%
1989	28-May-89	15-Oct-89	141	313	2,061	12,087	14,148	85%	151,200	9%
1990	23-May-90	23-Oct-90	154	428	1,220	23,647	24,867	95%	151,200	16%
1991	02-Jun-91	15-Oct-91	136	621	11,800	18,328	30,127	61%	151,200	20%
1992	31-May-92	04-Oct-92	127	556	13,175	10,985	24,160	45%	125,000	19%
1993	24-May-93	29-Sep-93	129	192	7,912	1,092	9,003	12%	151,200	6%
1994	05-May-94	28-Sep-94	147	252	1,186	11,454	12,641	91%	151,200	8%
1995	05-Jun-95	06-Oct-95	124	301	434	21,339	21,773	98%	80,000	27%
1996	20-Jun-96	27-Oct-96	130	260	2,229	16,091	18,320	88%	57,000	32%
1997	11-Jul-97	14-Oct-97	96	327	2,009	17,110	19,119	89%	57,000	34%
1998	10-Jun-98	14-Oct-98	127	516	3,231	21,489	24,720	87%	90,000	27%
1999	20-Apr-99	20-Oct-99	184	666	18,508	16,401	34,909	47%	105,000	33%
2000	18-Apr-00	26-Oct-00	192	598	9,806	26,171	35,977	73%	100,000	36%
2001	22-May-01	20-Oct-01	152	521	5,312	22,156	27,468	81%	78,000	35%
2002	18-Apr-02	12-Oct-02	178	643	10,871	19,935	30,806	65%	78,000	39%
2003	05-May-03	15-Oct-03	164	392	8,900	20,070	28,970	69%	93,000	31%
2004	10-May-04	15-Oct-04	159	238	5,680	12,345	18,025	68%	83,000	22%
2005	16-May-05	13-Oct-05	151	364	8,069	12,039	20,107	60%	50,000	40%
2006	27-Jun-06	16-Oct-06	112	475	12,227	12,504	24,731	51%	50,000	49%
2007	15-May-07	05-Oct-07	144	540	13,948	13,307	27,255	49%	50,000	55%
2008	03-May-08	16-Oct-08	167	590	16,845	14,447	31,291	46%	55,000	57%
2009	05-May-09	13-Oct-09	162	502	12,092	16,454	28,546	58%	55,000	52%

Table 8. Summary of 1998 to 2009 Spectacle Buoy and Trinity Ledge herring gillnet catches with start and end dates, catches and overall amounts.

Year	Spec. Buoy catches and surveys				Trinity Ledge catches and surveys				Overall
	Min. Day	Max.Day	Catch t	Survey SSB t*	Min. Day	Max.Day	Catch t	Survey SSB t*	Gillnet catch
1998	10-May-98	30-Jun-98	484		24-Aug-98	21-Sep-98	1,668		2,153
1999	10-May-99	16-Jul-99	355	n/s	12-Aug-99	15-Sep-99	1,257	3,885	1,612
2000	11-Jun-00	14-Jun-00	80	n/s	30-Aug-00	12-Sep-00	734	621	814
2001	11-Jun-01	10-Jul-01	699	1,110	21-Aug-01	26-Sep-01	1,012	14,797	1,711
2002	15-May-02	01-Jul-02	137	n/s	02-Sep-02	30-Sep-02	256	8,096	393
2003	04-Jun-03	06-Jun-03	69	1,420	21-Aug-03	18-Sep-03	369	14,512	439
2004	17-Jun-04	15-Jul-04	5	n/s	02-Sep-04	15-Sep-04	225	6,511	229
2005	09-Jun-05	11-Jul-05	124	290	05-Sep-05	20-Sep-05	447	5,071	570
2006	03-Jun-06	22-Jun-06	2	n/s	23-Aug-06	21-Sep-06	717	8,486	719
2007	07-May-07	22-Jun-07	243	310	27-Aug-07	20-Sep-07	1,091	1,357	1,334
2008	29-May-08	19-Jun-08	6	0	21-Aug-08	25-Sep-08	7	273	13
2009	11-Jun-09	25-Jun-09	0.2	n/s	01-Sep-09	11-Sep-09	116	675	117
Avg.			184	626			658	5,844	842

* Survey SSB calculated without Calibration Integration Factor.

Table 9. Monthly Nova Scotia weir landings (t) for 1978 to 2009.

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Total
1978				1	490	3,704	2,990	239	46	111	198	79	7,858
1979					811	3,458	1,418	420	39	136	57		6,339
1980					69	647	1,271	395					2,383
1981					50	437	983	276	37		41		1,824
1982					16	267	468	195	172	12			1,130
1983				2	286	141	188	208	53		18		896
1984					113	1,032	736	602	220				2,702
1985					378	1,799	1,378	489			11		4,055
1986					385	403	71	704	390	5			1,957
1987					1,503	2,526	1,215	1,166	367				6,776
1988					1,217	2,976	1,696	1,204	386				7,480
1989					340	1,018	870	843	226				3,296
1990					208	973	1,482	879	538	52			4,132
1991				3	23	149	719	342	262				1,498
1992					35	659	405	754	371				2,224
1993					226	908	608	867	53				2,662
1994					111	736	499	519	180				2,045
1995					236	1,255	1,059	470	29				3,049
1996					430	1,267	1,232	358	188				3,476
1997					70	1,874	1,739	271	65				4,019
1998					1,304	1,677	390	359	317				4,048
1999					1,958	1,513	547	488	31				4,537
2000						16	151	326	191				683
2001					105	1,439	1,565	391	207				3,708
2002					23	95	240	558	228				1,143
2003					98	126	68	344	284				921
2004						667	873	1,370	219				3,130
2005				11	84	731	472	828	118				2,245
2006					195	138	414	1,447	182	115			2,491
2007					26	11	290	579	224				1,130
2008						1,136	381	836	171				2,524
2009						110	233	44	0				387
NS Average Catch (t)				5	385	1,090	852	604	200	72	65	79	3,108
NS Minimum Catch (t)				1	16	11	68	44	0	5	11	79	387
NS Maximum Catch (t)				11	1,958	3,704	2,990	1,447	538	136	198	79	7,858

Table 10. Annual catch (t), number of active weirs and the catch per weir (t) for New Brunswick and Nova Scotia weirs from 1978 to 2009.

	Annual Catch (t)			No. Active Weirs			Catch per weir (t)		
Year	NB	NS	Total Catch	NB	NS	Total No.	NB	NS	Average
1978	33,599	7,858	41,458	208	31	239	162	253	173
1979	32,579	6,339	38,918	210	27	237	155	235	164
1980	11,066	2,383	13,449	120	29	149	92	82	90
1981	14,968	1,824	16,793	147	28	175	102	65	96
1982	22,181	1,130	23,311	159	19	178	140	59	131
1983	12,568	896	13,464	143	23	166	88	39	81
1984	8,353	2,702	11,056	116	13	129	72	208	86
1985	26,718	4,055	30,774	156	14	170	171	290	181
1986	27,516	1,957	29,473	105	18	123	262	109	240
1987	26,621	6,776	33,397	123	21	144	216	323	232
1988	38,235	7,480	45,715	191	21	212	200	356	216
1989	43,520	3,296	46,817	171	20	191	255	165	245
1990	39,808	4,132	43,940	154	22	176	258	188	250
1991	23,717	1,498	25,216	143	20	163	166	75	155
1992	31,981	2,224	34,206	151	12	163	212	185	210
1993	31,328	2,662	33,990	145	10	155	216	266	219
1994	20,618	2,045	22,662	129	11	140	160	186	162
1995	18,228	3,049	21,277	106	10	116	172	305	183
1996	15,781	3,476	19,257	101	12	113	156	290	170
1997	20,396	4,019	24,415	102	15	117	200	268	209
1998	19,529	4,048	23,577	108	15	123	181	270	192
1999	19,063	4,537	23,600	100	14	114	191	324	207
2000	16,376	683	17,058	77	3	80	213	228	213
2001	20,064	3,708	23,772	101	14	115	199	265	207
2002	11,807	1,143	12,950	83	9	92	142	127	141
2003	9,003	921	9,924	78	8	86	115	115	115
2004	20,620	3,130	23,750	84	8	92	245	391	258
2005	12,639	2,245	14,884	76	10	86	166	225	173
2006	11,641	2,491	14,132	89	6	95	131	415	149
2007	30,145	1,130	31,275	97	8	105	311	141	298
2008	6,041	2,524	8,565	76	8	84	79	315	102
2009	3,603	387	3,990	38	7	45	95	55	89
Average	21,260	3,023	24,283	121	15	137	173	213	176

Table 11. Annual effort with number of days fished, number of active boats, total catch (t), average catch per day and average catch per boat for 1989 to 2009 herring purse seine boats from all areas in 4WX-5Y.

Year	No. Days Fished	No. of Boats Fishing	Total Catch t	CPUE (catch/day)	CPUE (catch/boat)
1989	2198	40	87,383	40	2185
1990	2390	42	103,537	43	2465
1991	2333	40	88,830	38	2221
1992	2431	39	95,072	39	2438
1993	2542	36	92,828	37	2579
1994	2227	36	75,652	34	2101
1995	1682	32	56,441	34	1764
1996	1781	32	60,038	34	1876
1997	1731	30	61,769	36	2059
1998	2290	28	70,931	31	2533
1999	1775	28	78,574	44	2806
2000	1572	28	78,727	50	2812
2001	1826	21	75,343	41	3588
2002	1838	19	76,210	41	4011
2003	1652	18	85,499	52	4750
2004	1358	18	76,361	56	4242
2005	945	16	48,517	51	3032
2006	789	16	44,476	56	2780
2007	914	16	50,667	55	3167
2008	923	16	53,019	57	3314
2009	1099	15	62,162	57	4144

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

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average 1999-2009
Scots Bay (inbox)	41,000	106,300	163,900	141,000	133,900	107,600	16,800	28,600	45,700	19,400	67,600	79,255
Trinity Ledge	3,900	600	14,800	8,100	14,500	6,500	5,100	8,500	1,400	300	700	5,855
German Bank (inbox)	460,800	356,400	190,500	393,100	343,500	367,600	211,000	245,500	337,200	201,700	308,700	310,545
Spec Buoy (fall)			87,500									87,500
Sub-Total	505,700	463,300	456,700	542,200	491,900	481,700	232,900	282,600	384,300	221,400	377,000	403,609
Scots Bay (outbox)											5,300	5,300
German Bank (outbox)								4,100	2,820	1,700	1,400	2,505
Spec Buoy (spring)	0	0	1,100		1,400	n/s	300	n/s	100	0	n/s	414
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	300,900	387,220	223,100	383,700	412,229
Overall SE t	94,600	64,900	50,800	49,500	86,100	74,200	64,900	47,251	94,255	61,075	61,425	68,091
Overall SE %	19	14	10	9	17	15	28	16	25	27	27	19

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

A1) Acoustic Survey SSB (t)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	40,972	106,316	163,900	141,000	133,900	107,600	16,800	28,600	45,700	19,400	67,600	79,253
Trinity	3,885	621	14,800	8,100	14,500	6,500	5,100	8,500	1,400	300	700	5,855
German Bank	460,823	356,372	282,400	394,357	357,100	367,600	211,000	249,600	337,300	201,700	308,700	320,632
Total SSB	505,680	463,309	461,100	543,457	505,500	481,700	232,900	286,700	384,400	221,400	377,000	405,741

A2) Acoustic Survey Proportions	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	8%	23%	36%	26%	26%	22%	7%	10%	12%	9%	18%	18%
Trinity	1%	0%	3%	1%	3%	1%	2%	3%	0%	0%	0%	1%
German Bank	91%	77%	61%	73%	71%	76%	91%	87%	88%	91%	82%	81%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

C1) Catch by Spawn Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	1,789	10,926	10,739	8,202	19,196	24,869	6,239	3,352	4,116	2,373	902	8,428
Trinity (purse seine+gillnet)	2,526	843	1,271	1,865	369	595	2,014	4,444	1,203	15	442	1,417
German Bank	24,660	25,631	24,139	22,355	21,573	14,175	14,171	16,522	15,085	22,437	19,354	20,009
Spawn Area Total	28,974	37,400	36,149	32,422	41,138	39,639	22,424	24,318	20,404	24,825	20,698	29,854
Overall SW Nova Catch	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	50,529	54,561	54,113	66,936
Non-spawning area catch remaining	48,578	47,884	35,421	44,632	48,323	38,390	26,557	24,841	30,125	29,736	33,415	37,082

C2) Adjusted Catch by Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	5,725	21,914	23,330	19,782	31,996	33,444	8,155	5,830	7,697	4,979	6,894	15,431
Trinity	2,899	907	2,408	2,530	1,755	1,113	2,596	5,181	1,313	55	504	1,933
German Bank	68,929	62,462	45,832	54,742	55,710	43,472	38,231	38,148	41,519	49,527	46,715	49,572
Adjusted Catch Total	77,552	85,284	71,570	77,054	89,461	78,029	48,981	49,159	50,529	54,561	54,113	66,936

E1) Exploitation rate (C1/SSB)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	4%	10%	7%	6%	14%	23%	37%	12%	9%	12%	1%	12%
Trinity	65%	136%	9%	23%	3%	9%	39%	52%	86%	5%	63%	45%
German Bank	5%	7%	9%	6%	6%	4%	7%	7%	4%	11%	6%	7%
Overall (C1/SSB)	6%	8%	8%	6%	8%	8%	10%	8%	5%	11%	5%	7%

E2) Exploitation rate adjusted (C2/SSB)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Avg 99-09
Scots Bay	14%	21%	14%	14%	24%	31%	49%	20%	17%	26%	10%	22%
Trinity	75%	146%	16%	31%	12%	17%	51%	61%	94%	18%	72%	54%
German Bank	15%	18%	16%	14%	16%	12%	18%	15%	12%	25%	15%	16%
Overall Adjusted (Catch/Acoustic SSB)	15%	18%	16%	14%	18%	16%	21%	17%	13%	25%	14%	16%

Table 14. Summary of biological samples by gear and month as collected during the 2009 4VWX herring fisheries. 'No. LF Samples' is the number of length frequency samples collected, 'No. Measured' is the number of lengths taken and 'No. Processed' is the number of detail fish with sex and maturity determined.

		Month											
Gearname	Data	1	2	3	4	5	6	7	8	9	10	11	Total
4W Purse Seine	# LF Samples					19	43						62
	# Measured					2829	6180						9009
	# Aged					62	113						175
	# Processed					62	113						175
5Y CAN P.Seine	# LF Samples					6	19	54	34	10	1		124
	# Measured					816	2353	6636	3975	1187	111		15078
	# Aged					0	40	183	75	70	18		386
	# Processed					0	40	186	77	70	19		392
5Y USA P.Seine/MWT	# LF Samples										4	14	18
	# Measured										477	1651	2128
	# Aged										0	0	0
	# Processed										0	0	0
5Z USA P.Seine/MWT	# LF Samples	39	32	18						14	10		113
	# Measured	4810	4055	2185						1641	1128		13819
	# Aged	0	0	0						0	0		0
	# Processed	0	0	0						0	0		0
Gillnet	# LF Samples									6	18		24
	# Measured									903	2399		3302
	# Aged									24	0		24
	# Processed									122	240		362
N.B. Purse Seine	# LF Samples	46					4	1	19	23	65	16	174
	# Measured	5644					498	135	2189	2831	8641	1750	21688
	# Aged	164					19	0	87	11	141	0	422
	# Processed	167					20	0	106	11	246	12	562
N.B. Shut-off	# LF Samples									10			10
	# Measured									1166			1166
	# Aged									0			0
	# Processed									8			8
N.B. Weirs	# LF Samples					1	9	24	38	38	13		123
	# Measured					104	1048	3789	5150	4882	1362		16335
	# Aged					8	49	83	79	101	12		332
	# Processed					8	50	186	157	102	35		538
N.S. Purse Seine	# LF Samples					23	57	75	84	103	15		357
	# Measured					2742	7464	9731	11440	14414	2280		48071
	# Aged					90	216	122	264	520	47		1259
	# Processed					90	216	187	265	575	47		1380
N.S. Weirs	# LF Samples						6	4	1				11
	# Measured						722	466	131				1319
	# Aged						13	56	0				69
	# Processed						13	57	0				70
Resrch. Otter Trawl	# LF Samples		13	10	6			96					125
	# Measured												
	# Aged		78	69	63			907					1117
	# Processed		78	69	63			933					1143
Total # LF Samples		85	45	28	6	49	138	254	176	204	126	30	1141
Total # Measured		10454	4055	2185		6491	18265	20757	22885	27024	16398	3401	131915
Total # Aged		164	78	69	63	160	450	1351	505	726	218	0	3784
Total # Processed		167	78	69	63	160	452	1549	605	888	587	12	4630

Table 15. Number of herring samples from 4VWX-5Y collected by DFO personnel from commercial fisheries (Commercial), by members of the fishing industry (Industry), observer program (Observer), independent observers on foreign vessels (OSS) and DFO research surveys (Research).

	Sample Source					
Year	**Commercial**	**Industry**	**Observer**	**OSS**	**Research**	**Total**
1990	422			185		607
1991	448			167	1	616
1992	330			205	1	536
1993	183			421		604
1994	223			228	14	465
1995	138			244	108	490
1996	127	868	49		69	1,113
1997	78	1,443			114	1,635
1998	225	1,376			98	1,699
1999	49	1,388	89		198	1,724
2000	34	1,387	108		177	1,706
2001	47	1,455	96		190	1,788
2002	17	1,339	84		181	1,621
2003	58	1,292	56		199	1,605
2004	50	1,270	60		105	1,485
2005	48	1,017	23		152	1,240
2006	33	1,049	70		99	1,251
2007	10	1,139	29		137	1,315
2008	16	781	17		130	944
2009	26	980	20*		135	1,161
Average	**128**	**1,199**	**62**	**242**	**117**	**1,183**

* 2009 observer samples from observer database

Table 16. Herring catch at age for the 1999-2008 purse seine, gillnet and weir fisheries conducted on the SW Nova Scotia/Bay of Fundy spawning component. (Note 1999 to 2005 is revised and 2006-2008 is new.)

1999 4WX Stock Combined - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	8,851	151,039	252,738	71,618	103,543	62,952	26,311	6,226	2,085	388	664	686,415	
% numbers	1%	22%	37%	10%	15%	9%	4%	1%	0%	0%	0%	100%	
Catch wt. (t)	211	7,827	21,971	9,815	17,222	12,549	5,603	1,510	540	120	182	77,552	
% catch wt.	0%	10%	28%	13%	22%	16%	7%	2%	1%	0%	0%	100%	
Avg. len (cm)	14.9	18.7	22.3	25.7	27.3	29.0	29.7	31.0	31.7	33.5	32.3	23.5	Avg. Len
Avg. wt. (g)	23.9	51.8	86.9	137.1	166.3	199.3	212.9	242.6	259.1	310.6	274.1	113.0	Avg. wt

2000 Assessment Overall Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	458	377,737	53,091	123,143	109,079	56,447	30,188	11,736	1,459	642	255	764,236	
% numbers	0%	49%	7%	16%	14%	7%	4%	2%	0%	0%	0%	100%	
Catch wt. (t)	11	23,246	5,048	17,077	18,873	11,190	6,456	2,722	394	190	79	85,285	
% catch wt.	0%	27%	6%	20%	22%	13%	8%	3%	0%	0%	0%	100%	
Avg. len (cm)	15.3	20.5	23.6	26.5	28.4	29.7	30.5	31.2	32.8	33.3	34.2	24.1	Avg. Len
Avg. wt. (g)	23.1	61.5	95.1	138.7	173.0	198.2	213.8	231.9	270.4	295.1	311.4	111.6	Avg. wt

2001 SW Nova Scotia Stock - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	79	80,842	310,871	53,995	64,106	30,769	17,119	4,620	3,363	237	191	566,193	
% numbers	0%	14%	55%	10%	11%	5%	3%	1%	1%	0%	0%	100%	
Catch wt. (t)	2	4,655	33,754	7,946	11,887	6,805	4,259	1,243	883	75	60	71,570	
% catch wt.	0%	6%	47%	11%	17%	10%	6%	2%	1%	0%	0%	100%	
Avg. len (cm)	15.3	20.0	24.3	26.6	28.5	30.1	31.1	31.8	31.6	33.5	33.1	25.0	Avg. Len
Avg. wt. (g)	22.7	57.6	108.6	147.2	185.4	221.2	248.8	269.0	262.7	317.0	312.0	126.4	Avg. wt

2002 SW Nova Scotia Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	15,637	310,284	106,948	189,078	84,275	24,536	9,430	5,885	3,011	2,438	1,815	753,337	
% numbers	2%	41%	14%	25%	11%	3%	1%	1%	0%	0%	0%	100%	
Catch wt. (t)	290	13,915	11,472	28,109	14,871	5,271	2,294	1,479	717	615	498	79,531	
% catch wt.	0%	17%	14%	35%	19%	7%	3%	2%	1%	1%	1%	99%	
Avg. len (cm)	13.6	18.7	24.5	27.0	28.4	30.1	31.2	31.6	31.3	31.6	32.2	23.3	Avg. Len
Avg. wt. (g)	18.6	44.8	107.3	148.7	176.5	214.8	243.3	251.3	238.1	252.3	274.3	105.6	Avg. wt

2003 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	91	478,583	254,757	80,673	108,638	18,949	9,942	3,108	2,871	1,815	1,156	960,583	
% numbers	0%	50%	26%	8%	11%	2%	1%	0%	0%	0%	0%	100%	
Catch wt. (t)	1	20,922	22,887	11,767	19,074	3,720	2,237	788	717	467	301	82,881	
% catch wt.	0%	25%	28%	14%	23%	4%	3%	1%	1%	1%	0%	100%	
Avg. len (cm)	12.9	18.3	22.9	26.6	28.2	29.1	30.4	31.5	31.3	31.6	31.7	21.8	Avg. Len
Avg. wt. (g)	13.4	43.7	89.8	145.9	175.6	196.3	225.0	253.4	249.8	257.3	260.3	86.3	Avg. wt

Table 16 (continued). Herring catch at age for the 1999-2008 purse seine, gillnet and weir fisheries conducted on the SW Nova Scotia/Bay of Fundy spawning component. (Note 1999 to 2005 is revised and 2006-2008 is new.)

2004 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	3,590	321,791	315,227	161,333	39,533	36,688	10,713	1,908	3,175	1,249	1,663	896,870	
% numbers	0%	36%	35%	18%	4%	4%	1%	0%	0%	0%	0%	100%	
Catch wt. (t)	40	11,322	26,496	21,876	7,047	7,140	2,188	462	725	311	421	78,028	
% catch wt.	0%	14%	34%	28%	9%	9%	3%	1%	1%	0%	1%	99%	
Avg. len (cm)	12.4	17.1	22.3	26.1	28.4	29.1	29.5	31.1	30.6	31.3	31.5	21.8	Avg. Len
Avg. wt. (g)	11.0	35.2	84.1	135.6	178.3	194.6	204.2	242.2	228.4	249.3	253.0	87.0	Avg. wt

2005 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	510	66,456	130,574	173,597	59,342	12,273	8,654	4,208	1,009	102	538	457,262	
% numbers	0%	15%	29%	38%	13%	3%	2%	1%	0%	0%	0%	100%	
Catch wt. (t)	11	2,306	9,641	22,514	9,063	2,252	1,795	902	249	28	137	48,898	
% catch wt.	0%	5%	20%	46%	18%	5%	4%	2%	1%	0%	0%	100%	
Avg. len (cm)	15.1	17.2	21.5	25.7	27.0	28.6	29.7	30.0	31.3	32.3	31.6	23.6	Avg. Len
Avg. wt. (g)	22.3	34.7	73.8	129.7	152.7	183.5	207.5	214.4	246.4	273.0	254.4	106.9	Avg. wt

2006 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	2,649	111,810	102,318	68,387	81,548	34,414	16,298	3,859	419	216	136	422,056	
% numbers	1%	26%	24%	16%	19%	8%	4%	1%	0%	0%	0%	100%	
Catch wt. (t)	62	6,232	9,276	9,614	13,359	6,237	3,321	855	106	58	42	49,161	
% catch wt.	0%	13%	19%	20%	27%	13%	7%	2%	0%	0%	0%	100%	
Avg. len (cm)	15.3	19.7	22.8	26.2	27.4	28.3	29.3	30.1	31.2	31.8	33.0	24.2	Avg. Len
Avg. wt. (g)	23.4	55.7	90.7	140.6	163.8	181.2	203.7	221.6	252.0	266.7	306.6	116.5	Avg. wt

2007 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	14	185,513	55,970	33,654	38,506	70,868	25,268	7,346	1,289	467	230	419,125	
% numbers	0%	44%	13%	8%	9%	17%	6%	2%	0%	0%	0%	100%	
Catch wt. (t)	0	10,243	5,847	4,990	7,103	14,426	5,426	1,781	347	125	66	50,356	
% catch wt.	0%	20%	12%	10%	14%	29%	11%	4%	1%	0%	0%	100%	
Avg. len (cm)	16.2	19.6	23.8	26.4	28.2	29.1	29.6	30.7	31.7	31.6	32.2	24.0	Avg. Len
Avg. wt. (g)	26.8	55.2	104.5	148.3	184.5	203.6	214.7	242.5	269.6	268.6	287.5	120.1	Avg. wt

2008 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	1,152	78,374	219,897	52,978	24,831	32,050	31,086	11,402	4,225	481	77	456,552	
% numbers	0%	17%	48%	12%	5%	7%	7%	2%	1%	0%	0%	100%	
Catch wt. (t)	29	3,896	20,900	7,714	4,345	6,624	7,084	2,732	1,072	141	25	54,562	
% catch wt.	0%	7%	38%	14%	8%	12%	13%	5%	2%	0%	0%	100%	
Avg. len (cm)	15.6	19.1	23.0	26.2	27.7	29.1	30.0	30.5	31.0	32.4	33.5	24.1	Avg. Len
Avg. wt. (g)	24.7	49.7	95.0	145.6	175.0	206.7	227.9	239.6	253.6	292.9	325.3	119.5	Avg. wt

Table 17. Herring catch at age for the 2009 purse seine, gillnet and weir fisheries conducted on the SW Nova Scotia/Bay of Fundy spawning component (4WX stock).

2009 SW NS Stock Component - catch at age in numbers and weight with average length and weight by age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	702	263,298	117,708	138,589	22,198	11,954	11,487	13,084	6,008	1,418	314	586,760	
% numbers	0%	45%	20%	24%	4%	2%	2%	2%	1%	0%	0%	100%	
Catch wt. (t)	8	10,846	9,990	19,106	3,817	2,429	2,660	3,221	1,545	399	93	54,113	
% catch wt.	0%	20%	18%	35%	7%	4%	5%	6%	3%	1%	0%	100%	
Avg. len (cm)	12.2	18.1	22.3	25.9	27.7	29.1	30.2	30.8	31.2	32.0	32.6	22.1	Avg. Len
Avg. wt. (g)	10.8	41.2	84.9	137.9	171.9	203.2	231.5	246.2	257.2	281.2	297.4	92.2	Avg. wt

Table 18a. Catch at age (thousands) for the SW Nova Scotia / Bay of Fundy herring spawning component for 1965-2009 with revisions from 1999-2005 and new data for 2006-2009.

	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	8,851	151,039	252,738	71,618	103,543	62,952	26,311	6,226	2,085	388	664	686,415
2000	458	377,737	53,091	123,143	109,079	56,447	30,188	11,736	1,459	642	255	764,236
2001	79	80,842	310,871	53,995	64,106	30,769	17,119	4,620	3,363	237	191	566,193
2002	15,637	310,284	106,948	189,078	84,275	24,536	9,430	5,885	3,011	2,438	1,815	753,337
2003	91	478,583	254,757	80,673	108,638	18,949	9,942	3,108	2,871	1,815	1,156	960,583
2004	3,590	321,791	315,227	161,333	39,533	36,688	10,713	1,908	3,175	1,249	1,663	896,870
2005	510	66,456	130,574	173,597	59,342	12,273	8,654	4,208	1,009	102	538	457,262
2006	2,649	111,810	102,318	68,387	81,548	34,414	16,298	3,859	419	216	136	422,056
2007	14	185,513	55,970	33,654	38,506	70,868	25,268	7,346	1,289	467	230	419,125
2008	1,152	78,374	219,897	52,978	24,831	32,050	31,086	11,402	4,225	481	77	456,552
2009	702	263,298	117,708	138,589	22,198	11,954	11,487	13,084	6,008	1,418	314	586,760

Table 18b. Catch at age (percent numbers) for the SW Nova Scotia / Bay of Fundy herring spawning component, 1965-2009 with revisions from 1999-2009 . Proportions for some relatively strong year-classes that persisted in the fishery catch have been highlighted.

	Age										
Year	1	2	3	4	5	6	7	8	9	10	11+
1965	16	64	2	14	3	1	0	0	0	0	0
1966	8	46	23	4	16	2	1	0	0	0	0
1967	35	29	7	13	5	8	3	0	0	0	0
1968	5	71	7	2	9	2	3	1	0	0	0
1969	8	20	37	9	11	8	4	2	0	0	0
1970	33	27	4	13	9	6	5	2	1	0	0
1971	8	35	16	9	10	6	8	4	3	1	0
1972	-	55	6	13	7	6	4	4	2	1	1
1973	0	13	63	11	3	2	2	2	2	1	1
1974	1	42	5	44	4	1	1	0	1	0	0
1975	0	24	18	10	40	5	1	0	0	0	0
1976	0	7	26	19	9	34	3	1	0	0	0
1977	0	20	4	28	15	7	23	2	0	0	1
1978	4	47	5	2	15	8	4	13	1	0	0
1979	0	31	42	9	1	4	3	2	7	1	0
1980	0	2	13	75	4	1	1	1	0	2	0
1981	-	14	7	14	60	4	0	0	0	0	0
1982	1	17	25	4	16	35	2	0	0	0	0
1983	1	25	19	31	3	8	12	1	0	0	0
1984	-	11	31	28	18	3	3	4	1	0	1
1985	1	20	31	28	13	4	1	2	1	0	0
1986	0	16	34	36	7	4	1	1	0	0	0
1987	0	8	12	50	23	4	2	1	0	0	0
1988	0	12	9	16	36	20	4	2	0	0	0
1989	0	16	18	10	12	27	12	3	1	1	0
1990	-	17	13	17	9	10	19	11	3	1	1
1991	-	12	22	23	11	5	6	10	6	2	2
1992	0	17	14	29	13	8	4	4	6	4	2
1993	0	12	7	31	21	11	5	3	4	3	2
1994	0	18	25	9	20	13	6	3	2	2	3
1995	0	20	39	20	7	7	4	1	1	1	1
1996	-	9	9	61	13	4	2	1	0	0	0
1997	0	15	23	20	34	5	1	1	0	0	0
1998	0	38	9	20	14	14	3	1	0	0	0
1999	1	22	37	10	15	9	4	1	0	0	0
2000	0	49	7	16	14	7	4	2	0	0	0
2001	0	14	55	10	11	5	3	1	1	0	0
2002	2	41	14	25	11	3	1	1	0	0	0
2003	0	50	27	8	11	2	1	0	0	0	0
2004	0	36	35	18	4	4	1	0	0	0	0
2005	0	15	29	38	13	3	2	1	0	0	0
2006	1	26	24	16	19	8	4	1	0	0	0
2007	0	44	13	8	9	17	6	2	0	0	0
2008	0	17	48	12	5	7	7	2	1	0	0
2009	0	45	20	24	4	2	2	2	1	0	0

Table 19. Average (fishery weighted) weights at age (g) for the SW Nova Scotia/Bay of Fundy component of the 4WX herring fishery for 1965-2009. Data for 1965-1967 and 1979-1983 are averages for the period 1968-1978.

AvgWt g	1	2	3	4	5	6	7	8	9	10	11
1965	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1966	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1967	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.392
1968	0.010	0.033	0.112	0.148	0.185	0.244	0.276	0.399	0.338	0.410	0.409
1969	0.010	0.037	0.105	0.162	0.207	0.242	0.282	0.306	0.334	0.390	0.391
1970	0.010	0.032	0.119	0.169	0.211	0.257	0.292	0.332	0.369	0.389	0.389
1971	0.010	0.066	0.143	0.199	0.230	0.254	0.293	0.329	0.362	0.388	0.388
1972	0.010	0.044	0.138	0.192	0.223	0.262	0.292	0.322	0.345	0.380	0.380
1973	0.010	0.029	0.106	0.143	0.225	0.252	0.279	0.331	0.360	0.389	0.389
1974	0.010	0.048	0.110	0.175	0.206	0.240	0.277	0.322	0.342	0.352	0.344
1975	0.010	0.021	0.094	0.179	0.216	0.240	0.268	0.333	0.358	0.379	0.379
1976	0.010	0.033	0.114	0.159	0.233	0.249	0.277	0.317	0.382	0.404	0.404
1977	0.010	0.065	0.113	0.174	0.214	0.274	0.293	0.325	0.328	0.416	0.416
1978	0.010	0.028	0.112	0.181	0.229	0.259	0.302	0.330	0.351	0.397	0.397
1979	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1980	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1981	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1982	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1983	0.010	0.041	0.112	0.172	0.218	0.254	0.286	0.323	0.354	0.389	0.389
1984	0.010	0.038	0.132	0.191	0.229	0.259	0.280	0.296	0.309	0.364	0.364
1985	0.010	0.053	0.118	0.204	0.249	0.278	0.315	0.334	0.344	0.440	0.440
1986	0.010	0.055	0.124	0.182	0.239	0.271	0.306	0.329	0.360	0.400	0.399
1987	0.012	0.050	0.098	0.153	0.199	0.245	0.274	0.290	0.318	0.350	0.349
1988	0.013	0.021	0.088	0.154	0.196	0.242	0.281	0.304	0.327	0.341	0.371
1989	0.007	0.033	0.079	0.162	0.207	0.238	0.274	0.303	0.324	0.353	0.365
1990	0.010	0.031	0.092	0.161	0.200	0.234	0.255	0.287	0.319	0.336	0.364
1991	0.010	0.048	0.100	0.147	0.186	0.217	0.251	0.270	0.303	0.322	0.332
1992	0.009	0.025	0.100	0.148	0.181	0.216	0.252	0.275	0.295	0.313	0.333
1993	0.018	0.029	0.108	0.153	0.188	0.215	0.251	0.279	0.302	0.324	0.357
1994	0.012	0.037	0.079	0.131	0.175	0.203	0.223	0.253	0.289	0.304	0.326
1995	0.015	0.042	0.076	0.136	0.187	0.223	0.247	0.293	0.300	0.326	0.363
1996	0.010	0.033	0.098	0.137	0.168	0.228	0.266	0.308	0.332	0.355	0.384
1997	0.019	0.034	0.080	0.161	0.190	0.238	0.284	0.314	0.358	0.376	0.397
1998	0.010	0.038	0.076	0.131	0.177	0.210	0.251	0.296	0.308	0.337	0.376
1999	0.024	0.052	0.087	0.137	0.166	0.199	0.213	0.243	0.259	0.311	0.274
2000	0.023	0.062	0.095	0.139	0.173	0.198	0.214	0.232	0.270	0.295	0.311
2001	0.023	0.058	0.109	0.147	0.185	0.221	0.249	0.269	0.263	0.317	0.312
2002	0.019	0.045	0.107	0.149	0.176	0.215	0.243	0.251	0.238	0.252	0.274
2003	0.013	0.044	0.090	0.146	0.176	0.196	0.225	0.253	0.250	0.257	0.260
2004	0.011	0.035	0.084	0.136	0.178	0.195	0.204	0.242	0.228	0.249	0.253
2005	0.022	0.035	0.074	0.130	0.153	0.184	0.207	0.214	0.246	0.273	0.254
2006	0.023	0.056	0.091	0.141	0.164	0.181	0.204	0.222	0.252	0.267	0.307
2007	0.027	0.055	0.104	0.148	0.184	0.204	0.215	0.242	0.270	0.269	0.287
2008	0.025	0.050	0.095	0.146	0.175	0.207	0.228	0.240	0.254	0.293	0.325
2009	0.011	0.041	0.085	0.138	0.172	0.203	0.232	0.246	0.257	0.281	0.297
Average	0.013	0.041	0.103	0.159	0.200	0.234	0.264	0.296	0.317	0.349	0.357
Minimum	0.007	0.021	0.074	0.130	0.153	0.181	0.204	0.214	0.228	0.249	0.253
Maximum	0.027	0.066	0.143	0.204	0.249	0.278	0.315	0.399	0.382	0.440	0.440

Table 20. Acoustic age composition for the overall SW Nova Scotia/Bay of Fundy component from 1999 to 2009.

Year and Area	Type Data	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
1999 Acoustics Overall (newages)	% catch wt.	0%	0%	4%	14%	34%	31%	12%	3%	1%	0%	0%	100%
2000 Acoustics Overall (newages)	% catch wt.	0%	2%	3%	24%	29%	18%	14%	7%	1%	0%	0%	100%
2001 Sub-total Stock Acoustic (newages)	% catch wt.	0%	2%	38%	14%	21%	14%	8%	2%	2%	0%	0%	100%
2002 Acoustics Stock Overall (newages)	% catch wt.	0%	1%	15%	45%	21%	7%	4%	3%	2%	1%	1%	99%
2003 Overall Acoustics (newages)	% catch wt.	0%	2%	28%	21%	33%	7%	4%	1%	1%	1%	1%	99%
2004 Acoustics Overall (newages)	% catch wt.	0%	0%	21%	43%	16%	11%	3%	1%	2%	0%	1%	99%
2005 Acoustics Overall (newages)	% catch wt.	0%	0%	10%	47%	20%	8%	8%	4%	1%	0%	1%	99%
2006 Acoustics Overall (newages)	% catch wt.	0%	0%	8%	21%	37%	19%	11%	3%	0%	0%	0%	100%
2007 Overall Acoustics (newages)	% catch wt.	0%	1%	8%	13%	18%	37%	19%	3%	1%	0%	0%	100%
2008 Overall Acoustics (newages)	% catch wt.	0%	0%	24%	12%	9%	14%	24%	12%	5%	1%	0%	100%
2009 Acoustics Overall	% catch wt.	0%	1%	17%	49%	8%	5%	6%	8%	4%	1%	0%	100%
1999 Acoustics Overall (newages)	% numbers	0%	0%	6%	16%	37%	28%	10%	2%	1%	0%	0%	100%
2000 Acoustics Overall (newages)	% numbers	0%	7%	5%	29%	28%	15%	11%	5%	1%	0%	0%	100%
2001 Sub-total Stock Acoustic (newages)	% numbers	0%	4%	49%	14%	17%	9%	5%	1%	1%	0%	0%	100%
2002 Acoustics Stock Overall (newages)	% numbers	0%	3%	19%	47%	19%	5%	3%	2%	1%	1%	1%	99%
2003 Overall Acoustics (newages)	% numbers	0%	5%	37%	20%	27%	5%	3%	1%	1%	0%	0%	100%
2004 Acoustics Overall (newages)	% numbers	0%	1%	28%	45%	12%	9%	2%	1%	2%	0%	1%	99%
2005 Acoustics Overall (newages)	% numbers	0%	0%	14%	50%	19%	7%	6%	3%	1%	0%	0%	100%
2006 Acoustics Overall (newages)	% numbers	0%	0%	12%	23%	37%	17%	9%	2%	0%	0%	0%	100%
2007 Overall Acoustics (newages)	% numbers	0%	1%	13%	16%	17%	33%	17%	2%	1%	0%	0%	100%
2008 Overall Acoustics (newages)	% numbers	0%	0%	35%	14%	8%	12%	18%	9%	3%	0%	0%	100%
2009 Acoustics Overall	% numbers	0%	3%	23%	52%	7%	4%	4%	5%	2%	1%	0%	100%
1999 Acoustics Overall (newages)	Catch wt. (t)	-	84	22,216	69,469	173,595	155,515	61,022	16,493	4,242	1,754	1,291	505,680
2000 Acoustics Overall (newages)	Catch wt. (t)	-	11,400	14,380	112,184	134,684	84,156	66,464	32,791	4,742	2,039	469	463,309
2001 Sub-total Stock Acoustic (newages)	Catch wt. (t)	-	7,001	176,018	62,399	94,533	62,077	38,372	9,330	7,312	769	8	457,820
2002 Acoustics Stock Overall (newages)	Catch wt. (t)	52	5,304	80,806	244,021	116,212	40,702	22,607	14,424	9,574	4,792	4,906	543,401
2003 Overall Acoustics (newages)	Catch wt. (t)	-	11,921	144,848	104,594	167,789	36,704	19,940	6,841	5,765	3,767	3,263	505,432
2004 Acoustics Overall (newages)	Catch wt. (t)	-	1,706	101,072	207,633	75,581	55,374	16,618	5,998	11,296	1,917	4,568	481,764
2005 Acoustics Overall (newages)	Catch wt. (t)	-	219	23,804	111,443	47,155	18,710	18,720	8,591	2,414	456	1,656	233,168
2006 Acoustics Overall (newages)	Catch wt. (t)	-	349	22,840	59,161	105,088	52,822	32,210	8,241	934	636	265	282,548
2007 Overall Acoustics (newages)	Catch wt. (t)	-	2,115	32,457	50,989	67,778	142,394	72,708	9,699	4,516	982	741	384,379
2008 Overall Acoustics (newages)	Catch wt. (t)	-	13	53,013	26,693	19,720	30,353	54,061	26,910	10,370	1,716	221	223,071
2009 Acoustics Overall	Catch wt. (t)	-	4,314	63,651	186,373	30,773	20,455	24,377	28,454	14,128	3,727	780	377,031
1999 Acoustics Overall (newages)	Numbers (x1,000)	-	854	167,854	437,601	970,567	733,451	257,034	60,631	13,956	5,445	3,389	2,650,782
2000 Acoustics Overall (newages)	Numbers (x1,000)	-	176,913	128,754	770,463	744,375	412,096	303,870	139,098	16,532	6,648	1,175	2,699,924
2001 Sub-total Stock Acoustic (newages)	Numbers (x1,000)	-	108,158	1,446,910	413,181	504,205	276,744	151,010	33,231	27,607	2,419	25	2,963,491
2002 Acoustics Stock Overall (newages)	Numbers (x1,000)	2,037	92,602	643,349	1,611,858	664,014	188,737	91,655	55,810	40,093	17,737	17,489	3,425,381
2003 Overall Acoustics (newages)	Numbers (x1,000)	-	187,496	1,317,612	719,568	968,611	191,900	90,384	27,540	23,373	14,877	12,977	3,554,338
2004 Acoustics Overall (newages)	Numbers (x1,000)	-	27,081	912,633	1,458,078	396,624	278,517	79,659	24,488	49,614	6,788	18,011	3,251,491
2005 Acoustics Overall (newages)	Numbers (x1,000)	-	4,483	209,985	765,947	290,870	99,540	87,118	39,532	9,769	1,670	6,702	1,515,617
2006 Acoustics Overall (newages)	Numbers (x1,000)	-	4,970	197,497	380,770	609,173	278,179	153,090	36,457	3,710	2,381	930	1,667,157
2007 Overall Acoustics (newages)	Numbers (x1,000)	-	21,462	266,920	331,681	364,304	696,015	346,312	37,429	17,093	3,456	2,516	2,087,187
2008 Overall Acoustics (newages)	Numbers (x1,000)	-	162	446,066	174,742	104,483	144,766	230,953	110,028	39,693	5,922	731	1,257,545
2009 Acoustics Overall	Numbers (x1,000)	-	65,642	586,617	1,297,340	176,290	98,834	103,880	113,808	53,951	13,370	2,616	2,512,347

Table 21. Acoustic age composition for the German Bank only component from 1999 to 2009.

Year and Area	Type Data	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
1999 German Bank Acoustic Overall (newag	% catch wt.	0%	0%	4%	14%	34%	31%	12%	3%	1%	0%	0%	100%
2000 German Bank Overall (newages)	% catch wt.	0%	3%	3%	24%	28%	17%	15%	7%	1%	0%	0%	100%
2001 German Bank Acoustic (newages)	% catch wt.	0%	4%	40%	12%	18%	13%	8%	2%	2%	0%	0%	100%
2002 German Bank Overall (newages)	% catch wt.	0%	1%	16%	42%	22%	7%	4%	3%	2%	1%	1%	99%
2003 German Bank Acoustics (newages)	% catch wt.	0%	3%	33%	20%	29%	8%	4%	1%	1%	1%	1%	99%
2004 Acoustics German Bank (newages)	% catch wt.	0%	0%	19%	46%	16%	10%	3%	1%	3%	0%	1%	99%
2005 German Bank Acoustics (newages)	% catch wt.	0%	0%	11%	47%	20%	8%	8%	4%	1%	0%	1%	99%
2006 German Bank Acoustics (newages)	% catch wt.	0%	0%	8%	21%	37%	19%	12%	3%	0%	0%	0%	100%
2007 German Bank Acoustics (newages)	% catch wt.	0%	1%	8%	12%	17%	38%	21%	2%	1%	0%	0%	100%
2008 German Bank Acoustics (newages)	% catch wt.	0%	0%	24%	12%	9%	13%	24%	12%	5%	1%	0%	100%
2009 German Bank Acoustics-v2	% catch wt.	0%	1%	16%	49%	8%	5%	6%	8%	4%	1%	0%	100%
1999 German Bank Acoustic Overall (newag	% numbers	0%	0%	6%	17%	36%	28%	10%	2%	1%	0%	0%	100%
2000 German Bank Overall (newages)	% numbers	0%	8%	5%	28%	26%	14%	12%	5%	1%	0%	0%	100%
2001 German Bank Acoustic (newages)	% numbers	0%	8%	50%	12%	15%	9%	5%	1%	1%	0%	0%	100%
2002 German Bank Overall (newages)	% numbers	0%	4%	20%	44%	20%	5%	3%	2%	1%	0%	0%	100%
2003 German Bank Acoustics (newages)	% numbers	0%	6%	41%	19%	23%	6%	3%	1%	1%	0%	0%	100%
2004 Acoustics German Bank (newages)	% numbers	0%	1%	26%	48%	12%	7%	2%	1%	2%	0%	1%	99%
2005 German Bank Acoustics (newages)	% numbers	0%	0%	14%	50%	19%	7%	6%	3%	1%	0%	0%	100%
2006 German Bank Acoustics (newages)	% numbers	0%	0%	12%	22%	36%	17%	9%	2%	0%	0%	0%	100%
2007 German Bank Acoustics (newages)	% numbers	0%	1%	12%	15%	17%	34%	18%	2%	1%	0%	0%	100%
2008 German Bank Acoustics (newages)	% numbers	0%	0%	36%	14%	8%	11%	19%	9%	3%	0%	0%	100%
2009 German Bank Acoustics-v2	% numbers	0%	2%	23%	52%	7%	4%	4%	5%	2%	1%	0%	100%
1999 German Bank Acoustic Overall (newag	Catch wt. (t)	-	82	20,275	64,082	156,669	141,083	55,806	15,607	4,213	1,726	1,280	460,823
2000 German Bank Overall (newages)	Catch wt. (t)	-	11,254	12,282	86,545	101,223	60,508	54,444	24,364	3,954	1,329	467	356,372
2001 German Bank Acoustic (newages)	Catch wt. (t)	-	6,761	77,041	23,033	35,156	25,112	15,986	3,598	3,410	396	-	190,494
2002 German Bank Overall (newages)	Catch wt. (t)	52	5,107	62,843	167,061	85,780	28,917	17,045	11,138	8,662	3,049	3,468	393,121
2003 German Bank Acoustics (newages)	Catch wt. (t)	-	9,507	112,696	67,780	99,837	27,194	13,970	4,477	3,513	2,068	2,445	343,486
2004 Acoustics German Bank (newages)	Catch wt. (t)	-	1,486	70,123	170,087	59,916	36,320	10,979	4,713	9,571	1,052	3,382	367,629
2005 German Bank Acoustics (newages)	Catch wt. (t)	-	205	22,372	100,193	42,169	17,344	17,060	7,550	2,122	422	1,523	210,959
2006 German Bank Acoustics (newages)	Catch wt. (t)	-	320	20,746	50,548	90,762	45,815	28,381	7,326	805	539	238	245,480
2007 German Bank Acoustics (newages)	Catch wt. (t)	-	1,782	25,749	41,552	57,675	127,509	69,264	7,873	4,291	869	628	337,192
2008 German Bank Acoustics (newages)	Catch wt. (t)	-	-	49,681	23,880	17,720	25,789	49,830	24,853	9,912	1,521	221	203,407
2009 German Bank Acoustics-v2	Catch wt. (t)	-	2,997	50,191	152,788	24,885	16,561	20,001	24,304	12,700	3,520	768	308,713
1999 German Bank Acoustic Overall (newag	Numbers (x1,000)	-	832	153,058	403,585	877,171	664,394	233,385	57,062	13,860	5,352	3,362	2,412,061
2000 German Bank Overall (newages)	Numbers (x1,000)	-	175,500	110,521	594,633	558,315	302,698	251,590	105,361	13,780	4,298	1,171	2,117,866
2001 German Bank Acoustic (newages)	Numbers (x1,000)	-	105,643	654,813	156,616	190,336	113,455	63,690	12,901	13,236	1,241	-	1,311,930
2002 German Bank Overall (newages)	Numbers (x1,000)	2,021	89,756	504,599	1,102,271	493,104	134,970	69,343	43,173	36,391	11,165	12,237	2,499,028
2003 German Bank Acoustics (newages)	Numbers (x1,000)	-	154,745	1,018,475	477,351	578,705	143,619	63,515	18,151	14,263	8,160	9,889	2,486,873
2004 Acoustics German Bank (newages)	Numbers (x1,000)	-	23,650	638,371	1,197,723	310,760	183,630	53,172	19,343	42,320	3,373	13,418	2,485,760
2005 German Bank Acoustics (newages)	Numbers (x1,000)	-	4,212	196,739	683,438	258,828	92,400	79,193	34,675	8,605	1,550	6,205	1,365,846
2006 German Bank Acoustics (newages)	Numbers (x1,000)	-	4,567	178,930	322,966	523,053	239,322	134,161	32,351	3,208	2,040	839	1,441,435
2007 German Bank Acoustics (newages)	Numbers (x1,000)	-	17,815	210,166	268,885	309,544	621,725	330,001	29,818	16,301	3,030	2,134	1,809,417
2008 German Bank Acoustics (newages)	Numbers (x1,000)	-	-	418,278	156,610	93,175	123,733	213,104	102,230	37,838	5,239	731	1,150,937
2009 German Bank Acoustics-v2	Numbers (x1,000)	-	43,736	457,872	1,057,905	141,452	79,524	84,240	96,383	48,112	12,595	2,574	2,024,393

Table 22. Partial recruitment or exploitation pattern at age for 1965 to 2009 and various periods from the initial VPA calculated based on mean population weighted F for ages 6 to 8. The 2009 values represent the assumptions used in the terminal year of the VPA.

	Age										
Partial Recruitment	1	2	3	4	5	6	7	8	9	10	11
1965	0.8	3.5	0.4	2.1	1.6	1.3	0.4	1.5	0.4	1.0	0.0
1966	0.3	2.0	1.0	0.4	2.1	1.0	1.1	1.1	4.2	1.0	0.0
1967	0.3	0.8	0.3	0.5	0.5	1.1	1.0	0.2	0.0	1.0	0.3
1968	0.4	2.2	0.6	0.2	1.0	0.6	1.6	1.5	1.9	1.0	7.0
1969	0.2	1.3	1.6	0.7	0.9	1.0	1.1	1.1	0.7	1.0	0.3
1970	0.9	1.5	0.4	1.4	1.3	0.8	1.3	0.9	1.5	1.0	0.6
1971	0.0	0.9	0.8	0.9	1.0	0.9	1.1	1.1	1.4	1.0	0.8
1972	0.0	0.2	0.2	1.1	1.0	1.2	0.9	0.9	0.9	1.0	1.4
1973	0.0	0.4	0.4	0.6	0.8	1.1	1.0	0.9	1.2	1.0	2.4
1974	0.0	1.4	0.4	0.9	0.8	1.0	1.1	0.9	1.9	1.2	2.3
1975	0.0	0.6	0.6	0.7	0.8	1.1	0.9	0.7	0.9	1.0	1.1
1976	0.0	0.9	0.8	1.0	1.0	1.0	0.9	1.1	1.6	1.0	0.9
1977	0.0	0.6	0.7	1.3	1.2	1.1	1.0	0.8	0.9	1.0	1.0
1978	0.0	0.2	0.2	0.3	1.5	1.2	1.1	0.9	0.9	1.0	0.4
1979	0.0	0.2	0.1	0.3	0.2	1.0	0.9	1.2	0.8	0.9	0.7
1980	0.0	0.1	0.3	0.9	0.6	0.5	1.2	1.9	2.4	1.1	2.0
1981	0.0	0.2	0.5	0.6	1.6	1.1	0.4	1.4	1.2	1.0	0.3
1982	0.0	0.1	0.3	0.2	0.6	1.1	0.5	0.3	0.9	1.0	0.1
1983	0.0	0.2	0.3	0.8	0.3	0.7	1.4	0.7	0.3	1.0	0.2
1984	0.0	0.1	0.5	1.0	1.6	0.7	0.7	1.9	2.7	1.1	8.6
1985	0.0	0.1	0.4	1.1	1.3	1.1	0.8	1.0	1.5	1.0	0.4
1986	0.0	0.5	0.5	0.9	0.7	1.1	1.0	0.8	0.6	1.0	0.5
1987	0.0	0.6	0.8	1.6	1.3	0.9	1.1	1.1	1.1	1.0	0.5
1988	0.0	0.4	0.6	0.9	1.1	1.1	0.7	1.0	0.5	1.0	0.5
1989	0.0	0.4	0.7	0.8	0.9	1.1	0.9	0.6	1.0	1.0	0.7
1990	0.0	0.3	0.4	0.8	0.8	0.8	1.1	1.0	0.7	1.0	0.6
1991	0.0	0.3	0.5	1.0	0.9	0.8	0.9	1.2	1.0	1.0	1.5
1992	0.0	0.8	0.4	1.0	1.0	1.1	0.9	0.9	1.3	1.1	1.1
1993	0.0	0.2	0.3	0.8	0.9	1.0	1.0	1.1	1.0	1.0	0.4
1994	0.0	0.1	0.3	0.4	0.9	1.0	1.2	0.9	0.8	1.0	0.4
1995	0.0	0.2	0.2	0.5	0.6	0.9	1.2	0.8	0.8	1.0	0.1
1996	0.0	0.1	0.1	0.7	0.9	1.0	1.1	0.9	0.9	1.0	0.1
1997	0.0	0.2	0.4	0.5	1.2	0.9	1.0	1.7	0.7	1.0	0.1
1998	0.0	0.3	0.2	0.5	0.6	1.0	1.2	0.7	1.2	1.0	0.0
1999	0.0	0.4	0.8	0.4	0.9	1.0	0.9	1.7	1.3	1.0	0.1
2000	0.0	0.4	0.2	0.7	1.1	1.0	1.1	0.8	1.4	1.0	0.0
2001	0.0	0.2	0.6	0.4	1.0	1.1	1.0	0.5	0.6	1.0	0.0
2002	0.0	0.4	0.4	0.8	1.2	1.1	0.9	0.8	0.7	1.0	0.4
2003	0.0	0.5	0.6	0.7	1.3	0.9	1.5	0.8	1.1	1.0	0.3
2004	0.0	0.5	0.4	0.6	0.5	1.1	0.9	0.7	2.3	1.1	0.4
2005	0.0	0.5	1.0	1.1	0.9	0.6	1.7	2.7	2.2	1.0	0.4
2006	0.0	0.8	1.3	0.9	0.8	0.9	1.3	1.8	0.6	1.0	0.1
2007	0.0	0.3	0.6	0.7	0.7	1.0	0.9	0.9	1.2	1.0	0.2
2008	0.0	0.2	0.6	0.9	0.9	1.1	1.0	0.8	1.1	1.0	0.1
2009	0.0	0.2	0.4	0.7	0.9	1.0	1.0	1.0	1.0	1.0	0.2
Avg 1965-1974	0.3	1.4	0.6	0.9	1.1	1.0	1.1	1.0	1.4	1.0	1.5
Avg 1975-1984	0.0	0.3	0.4	0.7	0.9	0.9	0.9	1.1	1.3	1.0	1.5
Avg 1985-1994	0.0	0.4	0.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.6
Avg 1995-2004	0.0	0.3	0.4	0.6	0.9	1.0	1.1	0.9	1.1	1.0	0.2
Avg last 5yr (2004-08)	0.0	0.5	0.8	0.8	0.8	0.9	1.2	1.4	1.5	1.0	0.2
Avg last 10yr (1999-08)	0.0	0.4	0.7	0.7	0.9	1.0	1.1	1.2	1.3	1.0	0.2
Avg all years (65-08)	0.1	0.6	0.5	0.8	1.0	1.0	1.0	1.1	1.2	1.0	0.9

Table 23. Beginning of year population abundance (bias adjusted numbers 000's) for the SW Nova Scotia/Bay of Fundy component from a virtual population analysis with the German Bank only index (ages 4-8) as proportional to population numbers.

Pop #s Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	Total PopNos '000s	SSB PopNos '000s	Total Biomass t	SSB t	Recruits
1965	3,503,535	3,848,688	995,990	1,312,007	348,049	92,556	44,658	4,104	1,354	406	500	10,151,846	2,170,428	448,087	300,898	3,503,535
1966	2,737,874	2,624,572	2,177,169	784,001	863,223	239,988	66,231	35,035	2,855	1,060	707	9,532,715	3,003,285	576,773	425,460	2,737,874
1967	6,078,739	2,102,325	1,329,624	1,378,701	575,717	418,512	155,171	41,661	21,740	836	1,253	12,104,280	3,120,534	630,087	489,869	6,078,739
1968	1,286,168	4,325,977	1,170,158	950,143	889,042	372,334	200,109	75,150	30,056	17,430	1,311	9,317,878	3,025,639	626,821	489,669	1,286,168
1969	1,754,254	904,620	1,415,817	755,635	702,962	467,578	239,085	82,892	32,938	10,845	9,244	6,375,871	2,933,525	540,773	461,717	1,754,254
1970	2,304,088	1,338,028	480,252	682,955	499,558	429,512	281,595	139,599	47,575	21,258	13,377	6,237,797	2,287,259	493,606	435,671	2,304,088
1971	7,460,432	1,258,575	579,796	324,285	303,152	228,973	243,661	130,382	77,266	19,947	19,640	10,646,109	1,604,776	419,035	326,535	7,460,432
1972	1,138,008	6,028,997	667,900	309,749	169,890	146,502	119,687	115,682	61,966	30,575	20,551	8,809,507	1,277,577	428,207	258,055	1,138,008
1973	2,336,523	931,722	4,350,865	481,941	121,064	70,133	52,761	54,102	51,165	27,434	19,153	8,496,862	3,004,990	499,075	317,206	2,336,523
1974	1,625,831	1,912,064	612,116	2,859,204	277,070	63,139	30,305	23,481	26,162	20,577	15,921	7,465,869	3,335,997	576,321	466,982	1,625,831
1975	247,160	1,314,490	880,009	416,859	1,619,379	165,492	34,562	15,639	13,330	10,013	15,485	4,732,418	2,689,078	516,958	461,143	247,160
1976	721,831	199,468	790,743	505,120	229,480	864,261	76,168	17,278	8,846	6,633	11,863	3,431,690	2,064,507	389,191	357,216	721,831
1977	4,140,114	590,768	113,392	461,879	275,573	126,138	466,418	43,094	9,150	3,713	10,203	6,240,442	1,406,675	342,006	292,235	4,140,114
1978	1,346,661	3,388,582	345,413	64,490	183,137	119,042	57,492	223,174	22,748	4,650	6,640	5,762,027	847,629	264,623	185,612	1,346,661
1979	449,237	1,070,607	2,428,575	245,952	41,189	41,881	36,645	19,393	85,500	8,737	5,577	4,433,292	1,674,565	262,989	167,678	449,237
1980	1,572,744	367,495	710,920	1,762,615	152,257	28,831	13,695	13,722	5,372	33,071	5,530	4,666,253	2,194,292	368,395	304,635	1,572,744
1981	1,669,838	1,285,541	289,592	509,479	1,017,323	99,522	19,666	7,007	5,380	1,742	19,618	4,924,709	1,773,586	362,554	311,394	1,669,838
1982	2,303,789	1,367,148	959,566	191,298	324,700	429,503	51,913	13,922	3,261	2,688	15,069	5,662,856	1,493,007	320,766	246,539	2,303,789
1983	4,080,696	1,882,941	1,027,198	649,865	136,217	177,720	163,392	29,370	9,525	1,459	12,507	8,170,890	1,628,668	348,654	245,770	4,080,696
1984	5,029,406	3,336,034	1,368,811	705,598	313,564	89,490	91,116	53,695	14,770	6,243	9,667	11,018,396	1,897,990	424,739	277,192	5,029,406
1985	1,833,037	4,117,730	2,651,469	901,483	376,462	126,284	52,859	55,136	18,753	3,662	3,342	10,140,217	2,773,568	582,687	376,506	1,833,037
1986	1,060,823	1,492,615	3,175,719	1,866,648	466,629	176,055	65,377	30,635	28,842	8,204	4,234	8,375,781	4,047,819	763,267	567,439	1,060,823
1987	1,399,834	868,471	1,109,045	2,351,244	1,264,625	330,734	115,701	43,830	21,191	20,962	8,648	7,534,285	4,476,332	820,213	714,998	1,399,834
1988	1,404,778	1,144,010	636,260	794,050	1,450,813	817,103	229,403	77,190	29,320	14,323	20,846	6,618,096	3,671,774	703,653	643,174	1,404,778
1989	1,749,312	1,149,998	802,926	419,031	474,794	798,182	457,064	149,543	44,154	20,234	22,821	6,088,059	2,745,383	559,652	508,659	1,749,312
1990	1,190,311	1,432,208	849,747	554,605	287,374	317,200	501,483	305,176	105,942	28,708	29,064	5,601,819	2,498,966	519,386	463,190	1,190,311
1991	597,768	974,544	1,011,715	578,483	300,157	154,616	169,053	229,934	145,300	58,499	31,676	4,251,743	2,115,725	406,366	346,342	597,768
1992	860,592	489,411	710,472	666,791	308,898	166,380	89,449	93,196	115,909	78,131	45,329	3,624,558	1,852,640	343,149	298,373	860,592
1993	1,813,553	704,585	249,618	462,322	289,434	139,738	68,806	42,388	44,635	42,185	51,754	3,909,018	1,219,838	250,619	204,263	1,813,553
1994	962,586	1,484,662	507,992	164,975	204,860	120,204	53,995	26,165	15,554	17,014	48,410	3,606,419	888,677	189,152	130,544	962,586
1995	1,007,729	787,962	1,121,821	288,181	86,914	62,813	34,034	12,299	8,182	4,989	30,363	3,445,289	1,059,870	167,889	107,277	1,007,729
1996	742,889	823,405	542,933	720,736	135,473	38,270	19,072	8,266	4,303	2,941	23,104	3,061,391	1,151,557	176,503	129,384	742,889
1997	1,293,940	608,226	640,304	410,492	360,656	62,123	16,264	7,448	3,815	1,929	18,705	3,423,903	1,160,536	198,932	148,727	1,293,940
1998	723,652	1,059,067	446,972	445,504	265,809	177,876	33,889	8,714	2,854	2,320	15,549	3,182,204	1,131,449	198,715	151,158	723,652
1999	1,832,367	592,353	629,069	309,808	240,274	130,681	58,885	9,392	3,689	801	13,124	3,820,441	1,050,206	188,563	126,577	1,832,367
2000	710,869	1,492,221	349,280	288,901	189,268	104,161	50,818	24,704	2,178	1,166	10,456	3,224,023	817,402	192,035	108,981	710,869
2001	1,606,945	581,597	882,344	238,153	126,437	57,993	35,027	14,792	9,751	493	8,713	3,562,245	908,715	195,673	109,558	1,606,945
2002	2,155,117	1,315,584	403,345	443,837	146,440	46,367	20,075	13,406	7,966	4,969	7,153	4,564,260	847,502	202,420	112,866	2,155,117
2003	1,050,105	1,750,337	798,211	234,171	194,338	44,975	16,107	8,018	5,716	3,826	6,119	4,111,924	888,959	187,720	100,942	1,050,105
2004	456,748	859,671	1,003,286	425,025	119,418	62,462	19,878	4,366	3,782	2,120	5,482	2,962,238	1,101,675	167,858	111,267	456,748
2005	460,754	370,711	415,676	538,651	203,530	62,325	18,542	6,736	1,870	325	3,622	2,082,742	989,574	138,346	108,355	460,754
2006	1,312,530	376,773	243,699	223,196	285,322	113,372	39,986	7,454	1,783	632	2,656	2,607,404	773,932	140,818	98,425	1,312,530
2007	879,748	1,072,216	208,131	108,028	121,379	160,395	61,942	18,158	2,664	1,083	2,376	2,636,120	569,287	150,983	85,896	879,748
2008	2,654,619	720,264	710,864	120,136	58,255	64,838	67,994	28,110	8,294	1,031	2,207	4,436,612	694,283	189,618	85,148	2,654,619
2009	1,000,000	2,172,377	519,055	384,724	51,017	25,495	24,499	27,905	12,814	3,024	2,153	4,223,064	752,686	180,275	85,965	1,000,000
2010	1,000,000	818,097	1,541,313	319,142	190,828	21,929	10,202	9,803	11,166	5,127	2,690	3,930,295	1,309,628	210,274	126,755	1,000,000

Table 24. Fishing mortality rate for the SW Nova Scotia/Bay of Fundy component from a virtual population analysis with the German Bank only index (ages 4-8) as proportional to population numbers.

F Bias Adj(analytical)	1	2	3	4	5	6	7	8	9	10	11	F5-7(wtd)	F5-8 (weighted)	F6-8(wtd)	Maximum (F)
1965	0.09	0.37	0.04	0.22	0.17	0.13	0.04	0.16	0.04	0.11	0.00	0.15	0.15	0.11	0.37
1966	0.06	0.48	0.26	0.11	0.52	0.24	0.26	0.28	1.03	0.25	0.00	0.45	0.45	0.25	1.03
1967	0.14	0.39	0.14	0.24	0.24	0.54	0.53	0.13	0.02	0.49	0.14	0.38	0.38	0.51	0.54
1968	0.15	0.92	0.24	0.10	0.44	0.24	0.68	0.62	0.82	0.44	2.94	0.42	0.43	0.42	2.94
1969	0.07	0.43	0.53	0.21	0.29	0.31	0.34	0.36	0.24	0.32	0.09	0.31	0.31	0.32	0.53
1970	0.40	0.64	0.19	0.61	0.58	0.37	0.57	0.39	0.67	0.45	0.25	0.50	0.49	0.44	0.67
1971	0.01	0.43	0.43	0.45	0.53	0.45	0.54	0.54	0.73	0.53	0.38	0.51	0.51	0.51	0.73
1972	0.00	0.13	0.13	0.74	0.68	0.82	0.59	0.62	0.61	0.68	0.96	0.71	0.69	0.69	0.96
1973	0.00	0.22	0.22	0.35	0.45	0.64	0.61	0.53	0.71	0.62	1.40	0.54	0.54	0.60	1.40
1974	0.01	0.58	0.18	0.37	0.32	0.40	0.46	0.37	0.76	0.47	0.96	0.34	0.34	0.41	0.96
1975	0.01	0.31	0.36	0.40	0.43	0.58	0.49	0.37	0.50	0.54	0.58	0.44	0.44	0.55	0.58
1976	0.00	0.36	0.34	0.41	0.40	0.42	0.37	0.44	0.67	0.42	0.38	0.41	0.41	0.41	0.67
1977	0.00	0.34	0.36	0.73	0.64	0.59	0.54	0.44	0.48	0.54	0.54	0.58	0.57	0.54	0.73
1978	0.03	0.13	0.14	0.25	1.28	0.98	0.89	0.76	0.76	0.84	0.32	1.11	0.98	0.84	1.28
1979	0.00	0.21	0.12	0.28	0.16	0.92	0.78	1.08	0.75	0.83	0.64	0.61	0.68	0.90	1.08
1980	0.00	0.04	0.13	0.35	0.23	0.18	0.47	0.74	0.93	0.43	0.78	0.24	0.27	0.39	0.93
1981	0.00	0.09	0.21	0.25	0.66	0.45	0.15	0.56	0.49	0.41	0.13	0.63	0.63	0.41	0.66
1982	0.00	0.09	0.19	0.14	0.40	0.77	0.37	0.18	0.60	0.71	0.08	0.59	0.59	0.71	0.77
1983	0.00	0.12	0.18	0.53	0.22	0.47	0.91	0.49	0.22	0.65	0.12	0.55	0.55	0.67	0.91
1984	0.00	0.03	0.22	0.43	0.71	0.33	0.30	0.85	1.19	0.48	3.75	0.57	0.59	0.44	3.75
1985	0.01	0.06	0.15	0.46	0.56	0.46	0.35	0.45	0.63	0.44	0.17	0.52	0.51	0.43	0.63
1986	0.00	0.10	0.10	0.19	0.14	0.22	0.20	0.17	0.12	0.20	0.10	0.17	0.17	0.21	0.22
1987	0.00	0.11	0.13	0.28	0.24	0.17	0.20	0.20	0.19	0.18	0.09	0.22	0.22	0.18	0.28
1988	0.00	0.15	0.22	0.31	0.40	0.38	0.23	0.36	0.17	0.34	0.16	0.38	0.38	0.35	0.40
1989	0.00	0.10	0.17	0.18	0.20	0.26	0.20	0.14	0.23	0.23	0.16	0.23	0.22	0.23	0.26
1990	0.00	0.15	0.18	0.41	0.42	0.43	0.58	0.54	0.39	0.52	0.30	0.50	0.51	0.53	0.58
1991	0.00	0.12	0.22	0.43	0.39	0.35	0.40	0.48	0.42	0.42	0.63	0.38	0.41	0.42	0.63
1992	0.00	0.47	0.23	0.63	0.59	0.68	0.55	0.54	0.81	0.66	0.69	0.61	0.60	0.61	0.81
1993	0.00	0.13	0.21	0.61	0.68	0.75	0.77	0.80	0.76	0.76	0.27	0.71	0.72	0.76	0.80
1994	0.00	0.08	0.37	0.44	0.98	1.06	1.28	0.96	0.94	1.10	0.43	1.05	1.04	1.11	1.28
1995	0.00	0.17	0.24	0.55	0.62	0.99	1.22	0.85	0.82	1.03	0.14	0.86	0.86	1.05	1.22
1996	0.00	0.05	0.08	0.49	0.58	0.66	0.74	0.57	0.60	0.67	0.08	0.61	0.61	0.67	0.74
1997	0.00	0.11	0.16	0.23	0.51	0.41	0.42	0.76	0.30	0.43	0.05	0.49	0.49	0.44	0.76
1998	0.00	0.32	0.17	0.42	0.51	0.91	1.08	0.66	1.07	0.92	0.03	0.70	0.70	0.92	1.08
1999	0.01	0.33	0.58	0.29	0.64	0.74	0.67	1.26	0.95	0.75	0.06	0.67	0.69	0.75	1.26
2000	0.00	0.33	0.18	0.63	0.98	0.89	1.03	0.73	1.29	0.91	0.03	0.96	0.95	0.91	1.29
2001	0.00	0.17	0.49	0.29	0.80	0.86	0.76	0.42	0.47	0.74	0.02	0.81	0.79	0.77	0.86
2002	0.01	0.30	0.34	0.63	0.98	0.86	0.72	0.65	0.53	0.76	0.33	0.93	0.91	0.79	0.98
2003	0.00	0.36	0.43	0.47	0.94	0.62	1.11	0.55	0.79	0.73	0.23	0.89	0.88	0.72	1.11
2004	0.01	0.53	0.42	0.54	0.45	1.01	0.88	0.65	2.25	1.02	0.40	0.67	0.67	0.97	2.25
2005	0.00	0.22	0.42	0.44	0.39	0.24	0.71	1.13	0.88	0.42	0.18	0.38	0.39	0.41	1.13
2006	0.00	0.39	0.61	0.41	0.38	0.40	0.59	0.83	0.30	0.47	0.06	0.40	0.41	0.47	0.83
2007	0.00	0.21	0.35	0.42	0.43	0.66	0.59	0.58	0.75	0.64	0.11	0.56	0.57	0.64	0.75
2008	0.00	0.13	0.41	0.66	0.63	0.77	0.69	0.59	0.81	0.71	0.04	0.70	0.68	0.71	0.81
2009	0.00	0.14	0.29	0.50	0.64	0.72	0.72	0.72	0.72	0.72	0.17	0.68	0.69	0.72	0.72

Table 25. Deterministic projection inputs used for SW Nova Scotia/Bay of Fundy herring spawning component. The $F_{0.1}$ and F_{max} were as calculated in a 2004 yield per recruit analysis. The other inputs for partial recruitment, weights at age from 2009 and maturity at age were as used in as in the ADAPT analysis.

	F level	Exploitation rate u	1/u
F0.1	0.228	0.185	5.3913
test F	0.200	0.165	6.0665
Fmax	0.568	0.396	2.5223

	Age										
	1	2	3	4	5	6	7	8	9	10	11
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Partial Recruitment	0	0.2	0.4	0.7	0.9	1	1	1	1	1	1
Beg. Year Avg. Wt 2010	0.004	0.032	0.065	0.114	0.158	0.189	0.219	0.237	0.248	0.267	0.295
Beg. Year Avg. Wt 2011	0.004	0.032	0.065	0.114	0.158	0.189	0.219	0.237	0.248	0.267	0.295
Mid Year Avg. Wt 2010	0.011	0.041	0.085	0.138	0.172	0.203	0.232	0.246	0.257	0.281	0.297
Maturity 2010	0	0	0.5	0.9	1	1	1	1	1	1	1
Maturity 2011	0	0	0.5	0.9	1	1	1	1	1	1	1

Table 26. Progress against biological objectives in the management plan of the SW Nova Scotia/Bay of Fundy herring spawning component for the 2006 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 $F_{0.1}$	Fishing mortality is likely high and well above $F_{0.1}$.
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 as estimated from the acoustic surveys.

Table 27. Progress against biological objectives in the management plan of the SW Nova Scotia/Bay of Fundy herring spawning component for the 2007 fishery.

Objective	**2007: Observations**
Persistence of all spawning components	Biomass increases in Scots Bay and German Bank. Spawning not observed on Seal Island. Trinity Ledge is at the lowest level recorded.
Maintain biomass of each component	German Bank biomass estimate is now at or above average. Scots Bay, Trinity Ledge and Seal Island remain well below average or at very low biomass.
Maintain broad age composition	Proportion of larger (30 cm+) sizes has increased consistent with average growth rates. Age composition is still assumed to be truncated with few larger fish in the population. Possible strong year-class with 18-23cm size range abundant in both the New Brunswick weir and purse seine fisheries.
Maintain long spawning period	Start and duration of spawning in 2007 for German Bank and Scots Bay was typical but not for Trinity Ledge.
Fishing mortality at or below $F_{0.1}$	Fishing mortality was not determined but appears to be decreasing based on the trends from relative exploitation rates from acoustic surveys.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in all areas except for German Bank and Scots Bay.
Maintain biomass at moderate to high levels	SSB index from the acoustic surveys has increased by 64% over the last two years and is at a moderate level, 12% below the nine year average.

Table 28. Progress against biological objectives in the management plan of the SW Nova Scotia/Bay of Fundy herring spawning component for the 2008 fishery.

Objective	**2008: Observations**
Persistence of all spawning components	Spawning observed in Scots Bay and German Bank. Spawning activity could not be determined on Seal Island or Browns due to a lack of fishing or survey effort. Trinity Ledge with minimal spawning.
Maintain biomass of each component	Acoustic biomass estimates decreased and are near the lowest in the time series for each of the major survey areas. Taking into consideration confidence intervals, overall SSB for the past 4 years has been steady, at a lower level than in the 1999-2004 period. SSB in 2008 is the lowest in the time series.
Maintain broad age composition	Overall length composition in the catch has improved. Proportion of larger (30 cm+) sizes continues to increase. Increase in medium sized (23-30cm) fish but strength of incoming year-class is unknown. Without a population model catch is the best available proxy of the population.
Maintain long spawning period	Start of spawning in 2008 for German Bank and Scots Bay was typical. Virtually no spawning on Trinity Ledge. The duration appeared shorter for Scots Bay.
Fishing mortality at or below $F_{0.1}$	Fishing mortality could not be determined. Relative exploitation rates based on acoustic surveys increased in 2008.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in all areas except for German Bank. Scots Bay area appeared less diverse.
Maintain biomass at moderate to high levels	Herring are a key component in the ecosystem. SSB continues to be at a low level. Recently observed changes in environment may have an impact on spawning type (season) prevalence and abundance.

Table 29. Progress against biological objectives in the management plan of the SW Nova Scotia/Bay of Fundy herring spawning component for the 2009 fishery.

Objective	**2009: Observations**
Persistence of all spawning components	Spawning observed in Scots Bay and German Bank. Spawning activity could not be determined on Seal Island or Browns due to a lack of fishing or survey effort. Trinity Ledge had minimal spawning.
Maintain biomass of each component	Acoustic biomass estimates increased for each of the major survey areas. Taking into consideration confidence intervals, overall SSB for the past 5 years has been steady, at a lower level than in the 1999-2004 period. SSB for Trinity is extremely low.
Maintain broad age composition	Appears to be a broad range of ages in the commercial catch (1-9), as well as in the acoustic survey catch at age (3-11).
Maintain long spawning period	Start of spawning in 2009 for German Bank was earlier based on survey results. Spawning in Scots Bay appeared to start earlier and end earlier than in previous years. Virtually no spawning occurred on Trinity Ledge.
Fishing mortality at or below $F_{0.1}$	Fishing mortality could not be determined. Relative exploitation rates based on acoustic SSB estimates and catch decreased in 2009.
Maintain spatial and temporal diversity of spawning	Broader spatial distribution of spawning on German Bank. Duration of spawning in Scots was improved in 2009. Trinity spawning is very restricted in space and time. There is a lack of documented spawning in other areas.
Maintain biomass at moderate to high levels	There was an increase in acoustic SSB for Scots Bay and German Bank; however, SSB appears to be slightly below but approaching the 1999-2008 average. The presence of two apparently strong recruiting year classes is likely to increase biomass levels in the next few years.

Table 30. Herring abundance indices from the July bottom trawl survey (stratified numbers per tow): 1970-2009. Note 2005 had duplicate coverage of the entire area with comparative surveys by the Alfred Needler and Templeman.

		4WX area combined strata 453/495			4W Only strata 453/466		4X Only strata 470/495		4X BOF strata 480/495		4V only strata 442/452		Offshore Banks strata 455/478	
Year	Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE	Mean#	SE
1970	A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6	1.0	0.6	12.8	9.8	5.7	2.4
1971	A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6	1.4	1.0	4.4	4.4	5.3	2.8
1972	A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1	0.3	0.1	4.5	3.7	2.0	1.0
1973	A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4	1.0	0.4	19.2	19.2	0.9	0.4
1974	A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4	1.4	0.6	0.0	0.0	0.5	0.2
1975	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4	1.3	0.7	2.2	2.2	0.7	0.4
1976	A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3	0.9	0.6	0.0	0.0	0.1	0.1
1977	A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5	1.5	0.9	1.6	1.4	0.1	0.1
1978	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.5	0.5
1979	A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7	1.5	1.3	0.0	0.0	0.2	0.2
1980	A306/307	0.5	0.5	105	0.0	0.0	0.8	0.8	1.6	1.6	0.0	0.0	0.0	0.0
1981	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1	4.6	4.1	0.0	0.0	0.0	0.0
1982	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4	0.8	0.3	0.0	0.0	2.5	1.7
1983	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	3.1	1.6	0.1	0.0	2.1	1.0
1984	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	4.6	2.5	4.0	2.9	8.5	5.4
1985	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	0.4	0.2	0.0	0.0	5.0	2.9
1986	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	24.9	22.3	0.5	0.4	23.4	20.3
1987	N85/86/87	10.4	5.6	135	17.0	11.3	4.0	1.8	6.3	2.8	117.4	90.5	12.9	8.6
1988	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	2.3	0.8	0.3	0.2	2.0	0.9
1989	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	4.9	1.4	3.6	3.1	9.8	2.7
1990	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	3.4	0.8	0.3	0.2	6.5	2.9
1991	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	4.9	2.3	10.2	9.9	14.3	9.0
1992	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	41.8	22.2	0.2	0.1	23.6	7.4
1993	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	27.6	10.3	1.0	0.6	15.0	4.7
1994	N221/222	76.4	30.2	140	108.4	58.9	45.9	18.4	51.1	26.0	25.7	22.0	91.1	45.1
1995	N226/227	63.5	24.2	140	100.5	47.9	28.4	12.8	11.4	5.4	7.9	6.1	92.7	37.6
1996	N246/247	40.2	14.2	135	53.2	24.5	27.1	14.1	32.1	20.8	0.2	0.1	46.5	19.5
1997	N726/734	31.8	15.3	137	34.6	10.1	51.3	39.3	72.8	60.9	0.2	0.1	29.3	7.7
1998	N827/832	99.52	20.65	131	147.6	39.92	54.76	14.5	45.6	19.4	0.8	0.3	130.3	30.3
1999	N925/929	229.8	83.8	133	264.2	101.0	199.4	130.2	251.4	203.6	24.9	15.2	226.2	74.4
2000	N426/431	90.6	20.0	146	146.3	40.6	38.7	7.4	29.5	9.1	2.0	0.6	124.7	30.5
2001	N2001-032/037	145.9	47.7	139	152.7	81.3	139.5	52.5	181.3	80.9	53.9	49.2	132.4	60.9
2002	N2002-037/040	161.9	48.6	147	172.7	81.3	151.9	55.6	170.9	85.3	4.9	2.6	162.6	61.1
2003	N2003-036/042	130.6	70.5	153	207.8	145.4	58.7	14.5	50.3	14.0	4.9	2.0	175.8	108.6
2004t	TEL2004-529/530	295.9	100.2	205	307.6	134.5	285.0	147.4	198.0	170.9	1.4	0.4	355.6	127.6
2005t	TEL2005-605/633	74.1	13.7	118	13.7	8.7	130.5	23.1	51.8	34.4	7.4	2.2	88.0	6.6
2005n	NED2005-027/034	63.1	20.9	150	36.0	13.1	88.2	38.5	61.0	30.2	13.6	5.4	66.2	28.4
2006	NED2006-030/036	85.7	29.7	150	133.3	59.2	40.7	15.5	26.7	9.8	15.2	11.0	118.6	45.6
2007	TEL2007-745	40.7	9.8	121	20.0	8.0	59.9	17.3	85.8	26.9	0.9	0.5	19.0	6.2
2008	TEM2008-830	43.7	12.9	118	46.8	24.7	40.9	10.1	50.8	14.3	2.0	0.8	40.2	18.1
2009	NED2009-027	53.3	11.9	136	44.6	21.0	61.4	12.1	85.4	18.1	6.1	4.8	38.6	15.9

Table 31. Coastal N.S. spawning component summary of a) herring landings (t) from gillnet fisheries 1996-2009 b) spawning biomass from acoustic surveys in the coastal N.S. spawning component from 1998-2009 and c) estimated exploitation as calculated as catch/SSB.

a - Landings by spawning area along coastal Nova Scotia with 5 year and overall averages

Landings (t)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average Catch Last 5 yr.	Average Catch All Years
Little Hope/Port Mouton		490	1,170	2,919	2,043	2,904	3,982	4,526	1,267	2,239	3,133	1,506	1,108	3,731	2,343	2,386
Halifax/Eastern Shore	1,280	1,520	1,100	1,628	1,350	1,898	3,334	2,727	4,176	3,446	3,348	3,727	2,381	6,045	3,789	2,711
Glace Bay		170	1,730	1,040	834	1,204	3,058	1,905	1,481	626	85	7	12	4	147	935
Bras d'Or Lakes	170	160	120	31	56	0	1	4	0	0	0	0	0	0	0	39
Total	1,450	2,340	4,120	5,618	4,283	6,006	10,375	9,162	6,924	6,311	6,566	5,240	3,500	9,780	6,279	5,834

b - Acoustic SSB for coastal Nova Scotia with 5 year and overall averages (with CIF since 2003; w/o CIF pre-2003)

Survey SSB (t)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	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	**53,100**	22,500	44,700	24,100	2,800	14,500	36,588	2,454	2,589
Halifax/Eastern Shore			8,300	20,200	**10,900**	16,700	**41,500**	92,600	28,400	36,950	68,900	28,300	30,300	54,236	4,374	3,644
Glace Bay				2,000		21,200	7,700	31,500		3,180	n/s	240	500	94	100	830
Bras d'Or Lakes				530	70	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	30

Note 1: shaded cells include mapping surveys which estimated biomass based on visual sounder estimates; bold cells include mapping and acoustic surveys.

c - Exploitation estimates for spawning components along coastal Nova Scotia with 5 year and overall averages (with CIF)

Survey SSB (t) with CIF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	10% SSB Average Last 5 yr	10% SSB Average All years
Little Hope/Port Mouton								**9%**	6%	5%	13%	54%	8%	10%	18%	15%
Halifax/Eastern Shore								3%	15%	9%	5%	13%	8%	11%	9%	9%
Glace Bay								6%		20%		3%	2%	4%	7%	7%
Bras d'Or Lakes																

Note 2: data prior to 2003 calculated with the Calibration Integration Factor (CIF) are not available and estimates of exploitation were not made for these years.

Table 32. Monthly landings (t) from weirs located in New Brunswick for 1978 to 2009.

	MONTH												
YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Total
1978	3				512	802	5,499	10,275	10,877	4,972	528	132	33,599
1979	535	96			25	1,120	7,321	9,846	4,939	5,985	2,638	74	32,579
1980					36	119	1,755	5,572	2,352	1,016	216		11,066
1981					70	199	4,431	3,911	2,044	2,435	1,686	192	14,968
1982		17			132	30	2,871	7,311	7,681	3,204	849	87	22,181
1983					65	29	299	2,474	5,382	3,945	375		12,568
1984					6	3	230	2,344	2,581	3,045	145		8,353
1985					22	89	4,217	8,450	6,910	4,814	2,078	138	26,718
1986	43				17		2,480	10,114	5,997	6,233	2,564	67	27,516
1987	39	21	6	12	10	168	2,575	10,893	6,711	5,362	703	122	26,621
1988		12	1	90	657	287	5,993	11,975	8,375	8,457	2,343	43	38,235
1989		24		95	37	385	8,315	15,093	10,156	7,258	2,158		43,520
1990					93	20	4,915	14,664	12,207	7,741	168		39,808
1991					57	180	4,649	10,319	6,392	2,028	93		23,717
1992				15	50	774	5,477	10,989	9,597	4,395	684		31,981
1993					14	168	5,561	14,085	8,614	2,406	470	10	31,328
1994				18		55	4,529	10,592	3,805	1,589	30		20,618
1995					15	244	4,517	8,590	3,956	896	10		18,228
1996					19	676	4,819	7,767	1,917	518	65		15,781
1997				8	153	1,017	6,506	7,396	5,316				20,396
1998					560	713	3,832	8,295	5,604	525			19,529
1999					690	805	5,155	9,895	2,469	48			19,063
2000					10	7	2,105	7,533	4,940	1,713	69		16,376
2001					35	478	3,931	8,627	5,514	1,479			20,064
2002					84	20	1,099	6,446	2,878	1,260	20		11,807
2003					257	250	1,423	3,554	3,166	344	10		9,003
2004					21	336	2,694	8,354	8,298	913	3		20,620
2005						213	802	7,145	3,729	740	11		12,639
2006					8	43	1,112	3,731	3,832	2,328	125	462	11,641
2007	182		20	30	84	633	3,241	11,363	7,637	6,567	314	73	30,145
2008						81	1,502	2,479	1,507	389	49	32	6,041
2009					5	239	699	1,111	1,219	330			3,603
NB Average Catch (t)	160	34	9	38	134	331	3,673	8,390	5,657	3,087	682	119	21,829
NB Minimum Catch (t)	3	12	1	8	5	3	230	1,111	1,219	48	3	10	3,603
NB Maximum Catch (t)	535	96	20	95	690	1,120	8,315	15,093	12,207	8,457	2,638	462	43,520

Table 33. Herring larval abundance index from autumn Bay of Fundy / southwest Nova Scotia plankton surveys (average number of larvae per m^2 to bottom from 79 index stations) for 1972 to 1998 and 2009. Note there were no larval surveys in this area from 1999 to 2008.

Year	Survey	No. per m2 to bottom Mean	SE	N
1972	P109	9.4	1.8	79
1973	P127	6.6	1.3	79
1974	P147	49.5	10.9	79
1975	P160	11.7	1.5	58
1976	P175	13.5	2.9	79
1977	P190	6.3	1.0	79
1978	P207	4.5	0.5	77
1979	P232	7.1	2.1	79
1980	P246	26.2	6.7	79
1981	P263	2.7	0.3	78
1982	P280	10.6	1.2	77
1983	P298	13.9	1.6	74
1984	P315	12.7	1.4	78
1985	P329	40.8	4.6	79
1986	P344	18.9	2.1	78
1987	P361	27.9	3.2	78
1988	P377	100.7	11.5	76
1989	P391	54.5	6.1	79
1990	P408	27.2	3.1	79
1991	P422	48.2	5.5	78
1992	P437	57.0	6.4	79
1993	P451	55.0	6.2	78
1994	N211	5.4	0.7	77
1995	N232	20.3	4.6	78
1996	N252	9.5	1.6	77
1997	N765	23.3	2.7	77
1998	N865	33.6	3.8	77
2009	DV-57	19.9	4.2	79

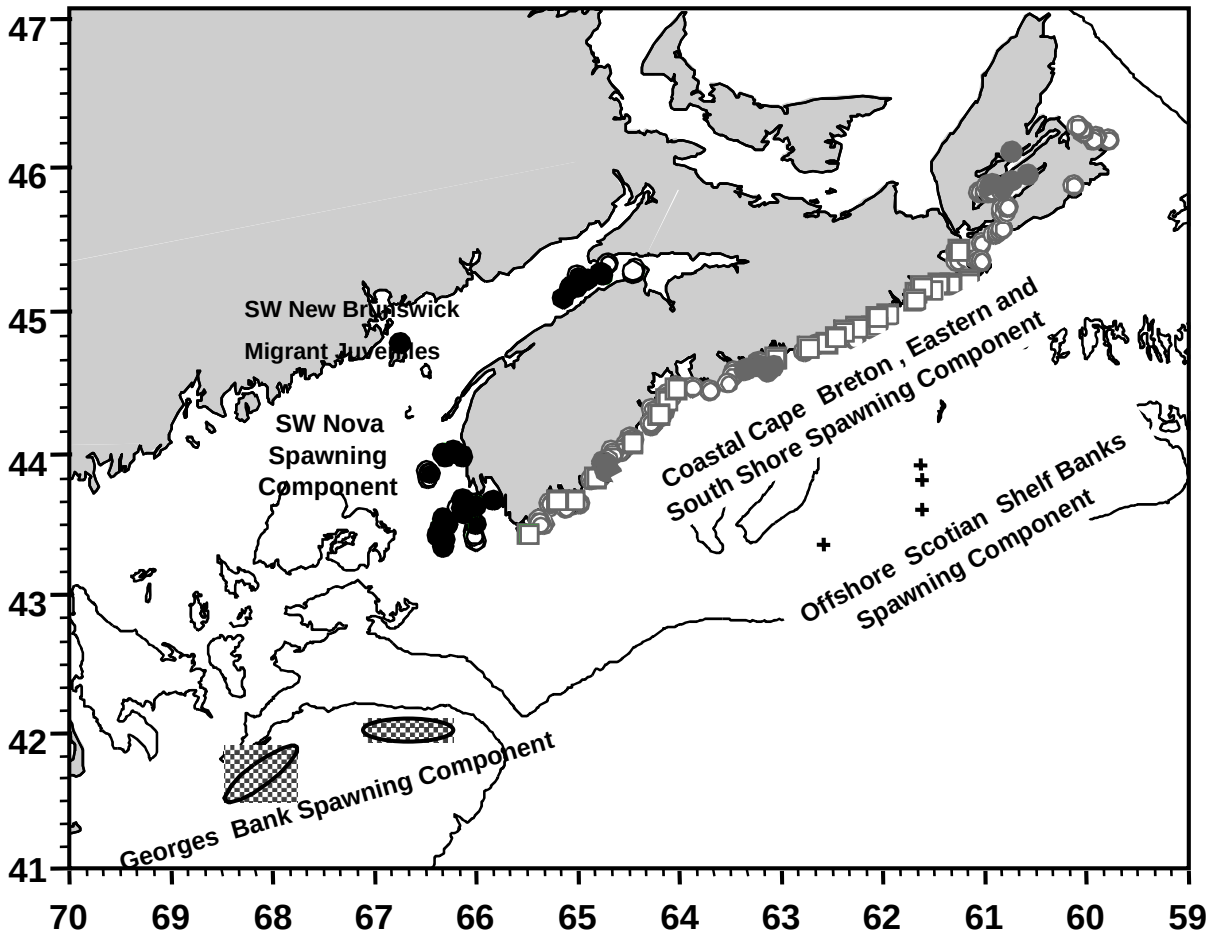


Figure 1. Management units for herring in areas 4VWX and 5YZ showing locations of known current (solid) and historical (open) spawning locations.

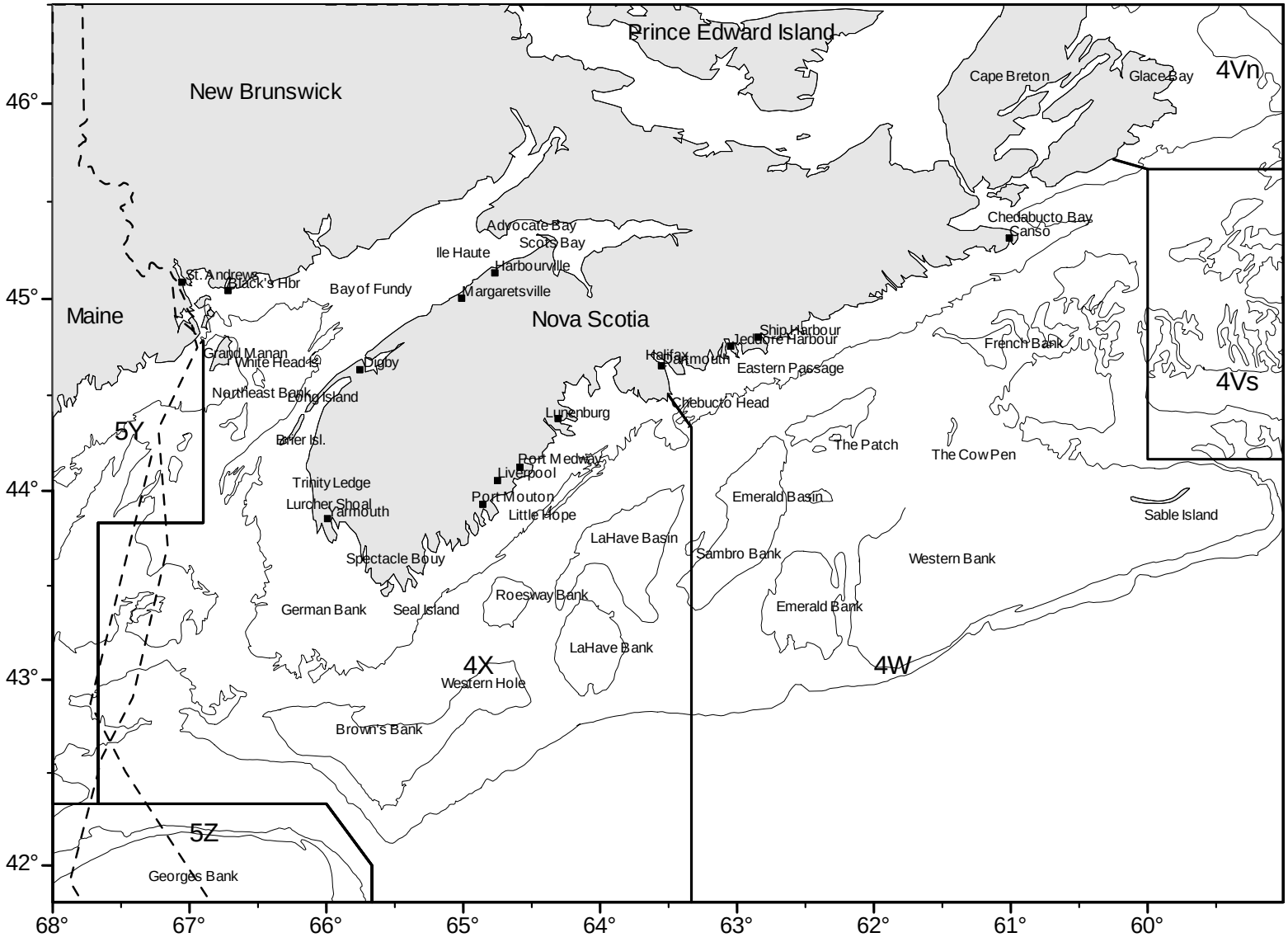


Figure 2. Place names and fishing locations for southwest New Brunswick, coastal Nova Scotia and Scotian Shelf.

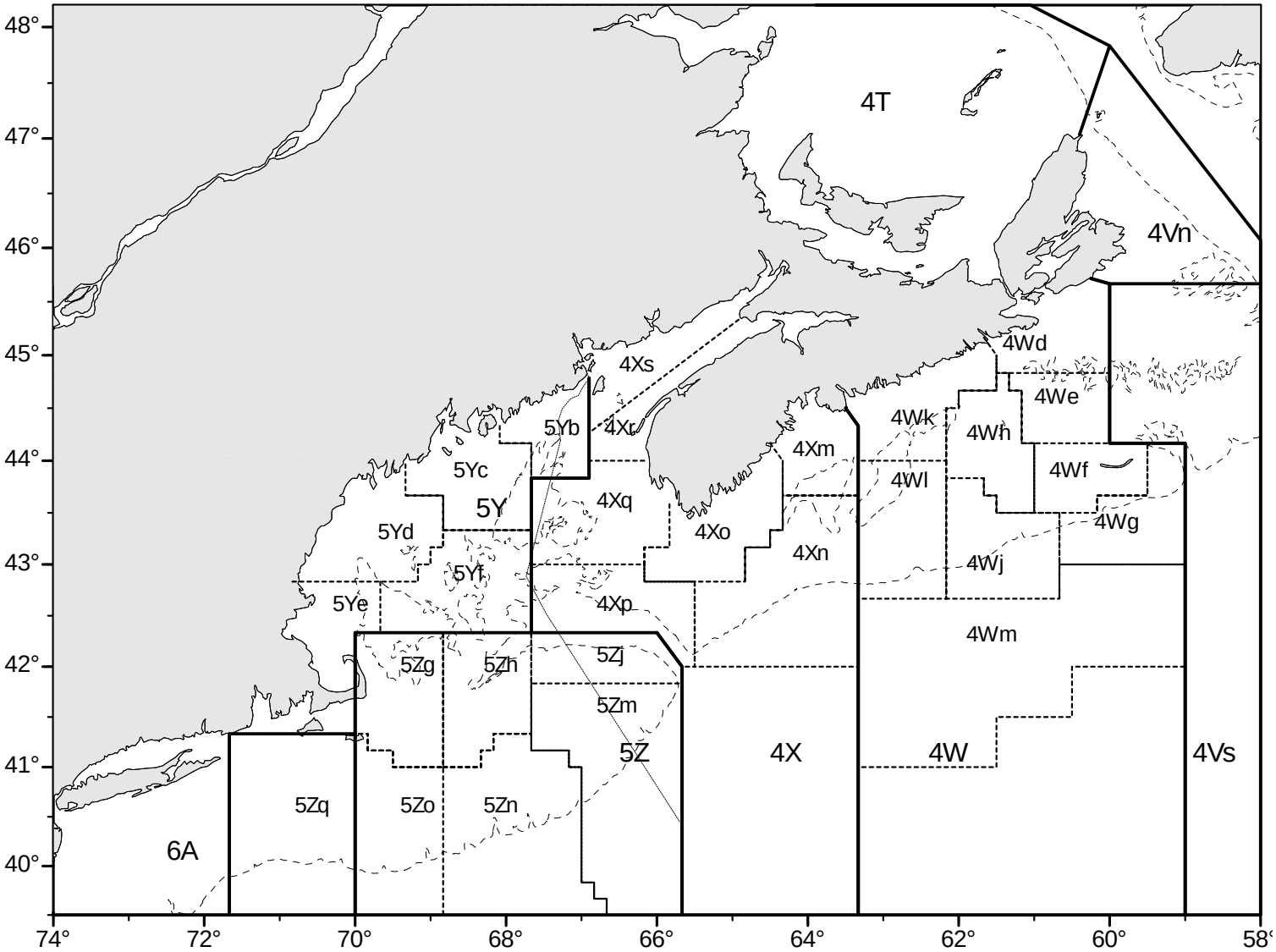


Figure 3. NAFO divisions, subareas and unit areas used for sample and catch data aggregation.

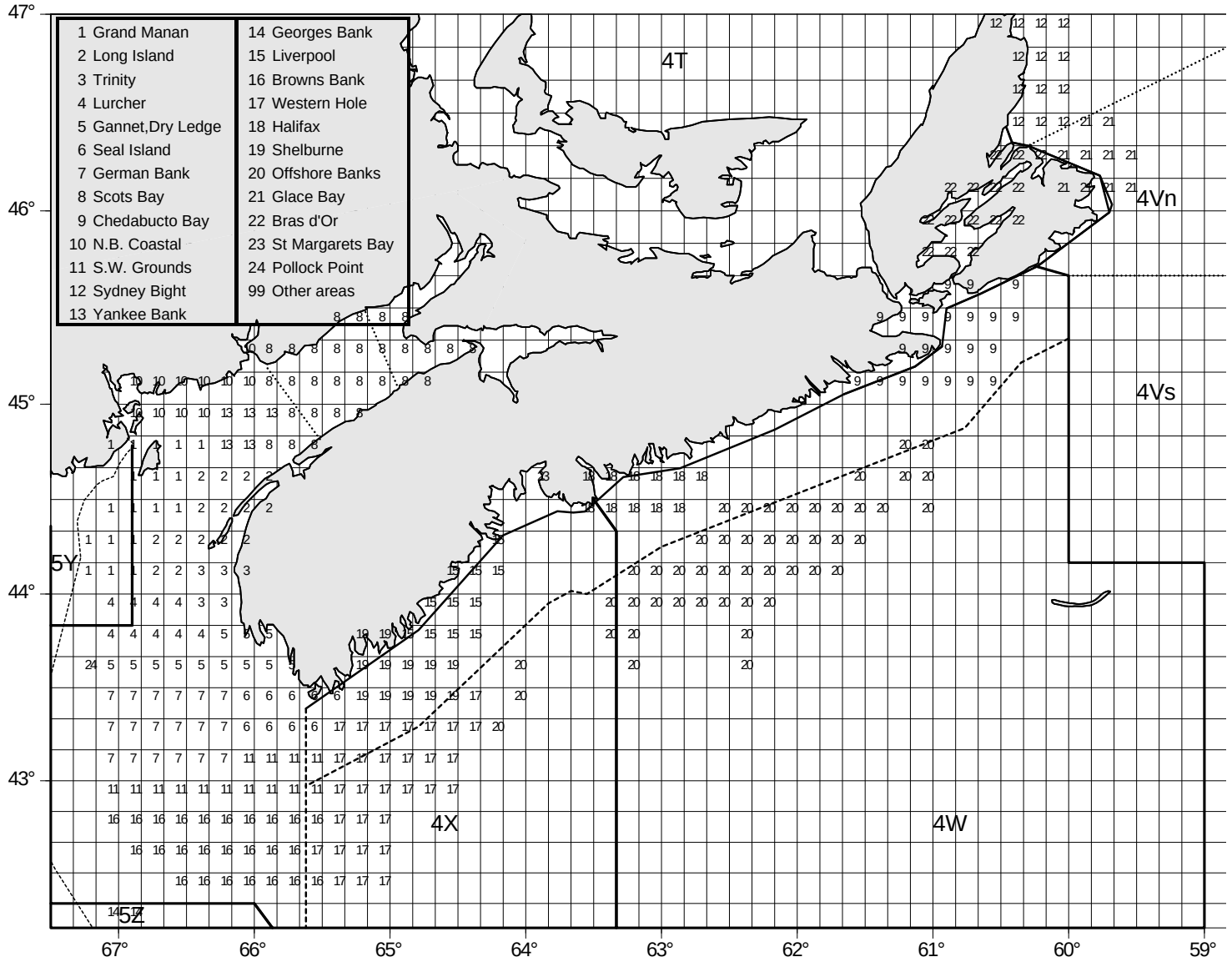


Figure 4. Herring fishing ground areas by 10 mile boxes and management lines for NAFO divisions, 25 mile offshore line, coastal embayment line and herring area lines.

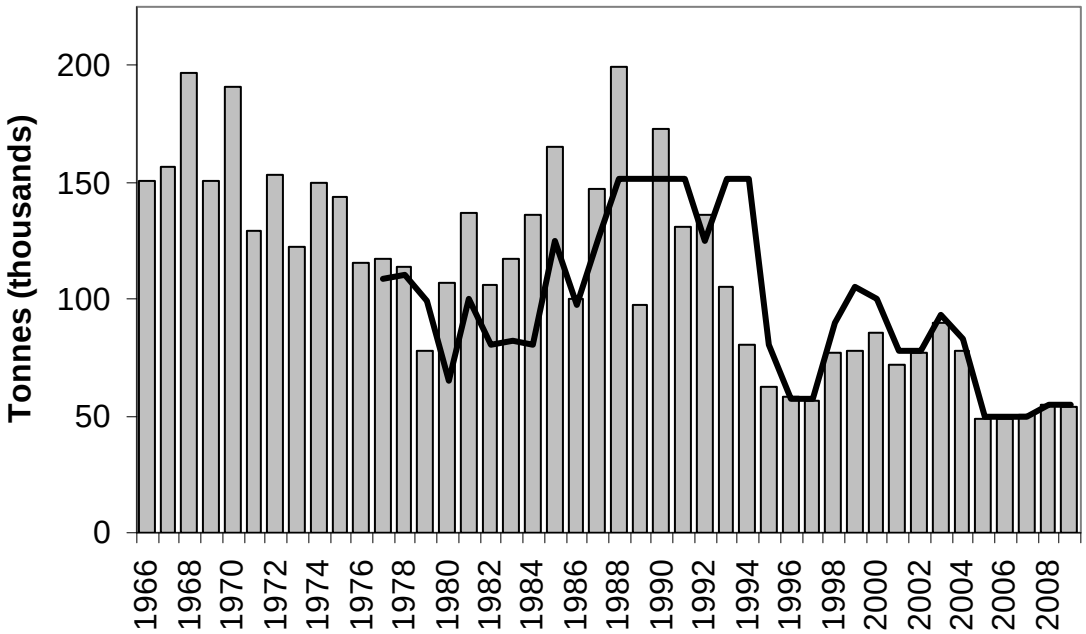


Figure 5. Annual adjusted herring landings [bars] and TAC [solid line] (quota) for the southwest Nova Scotia spawning component (4WX stock).

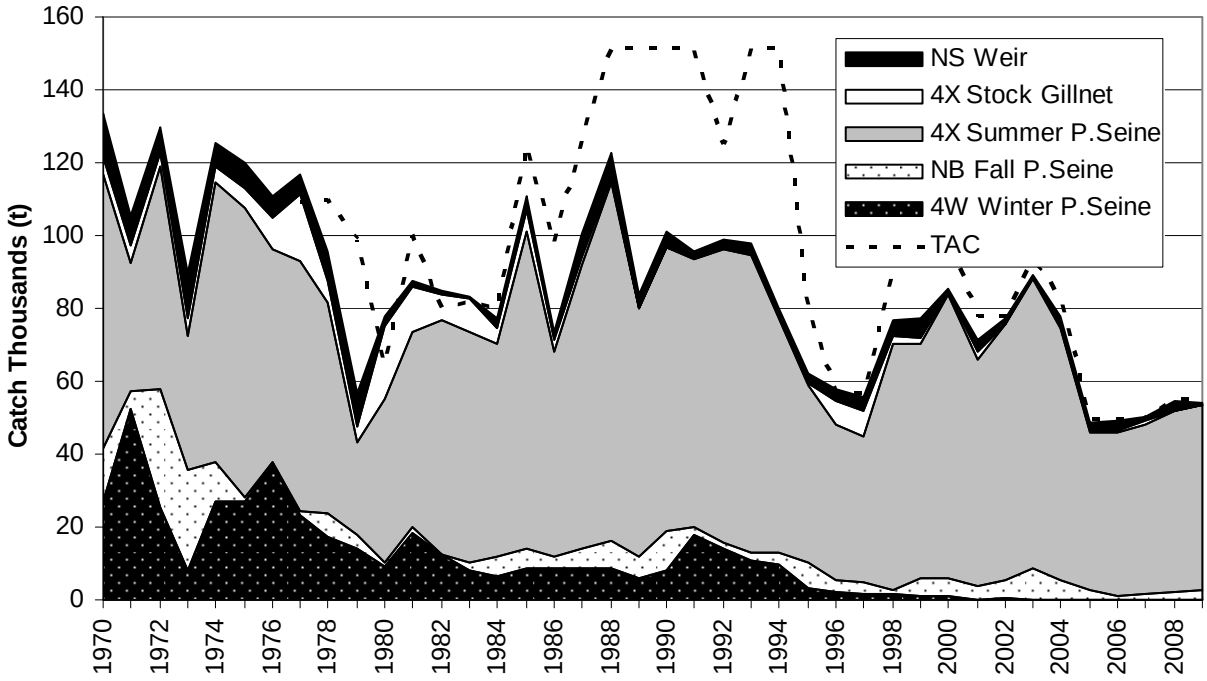


Figure 6. Annual herring landings by gear component for the southwest Nova Scotia spawning component (4WX stock).

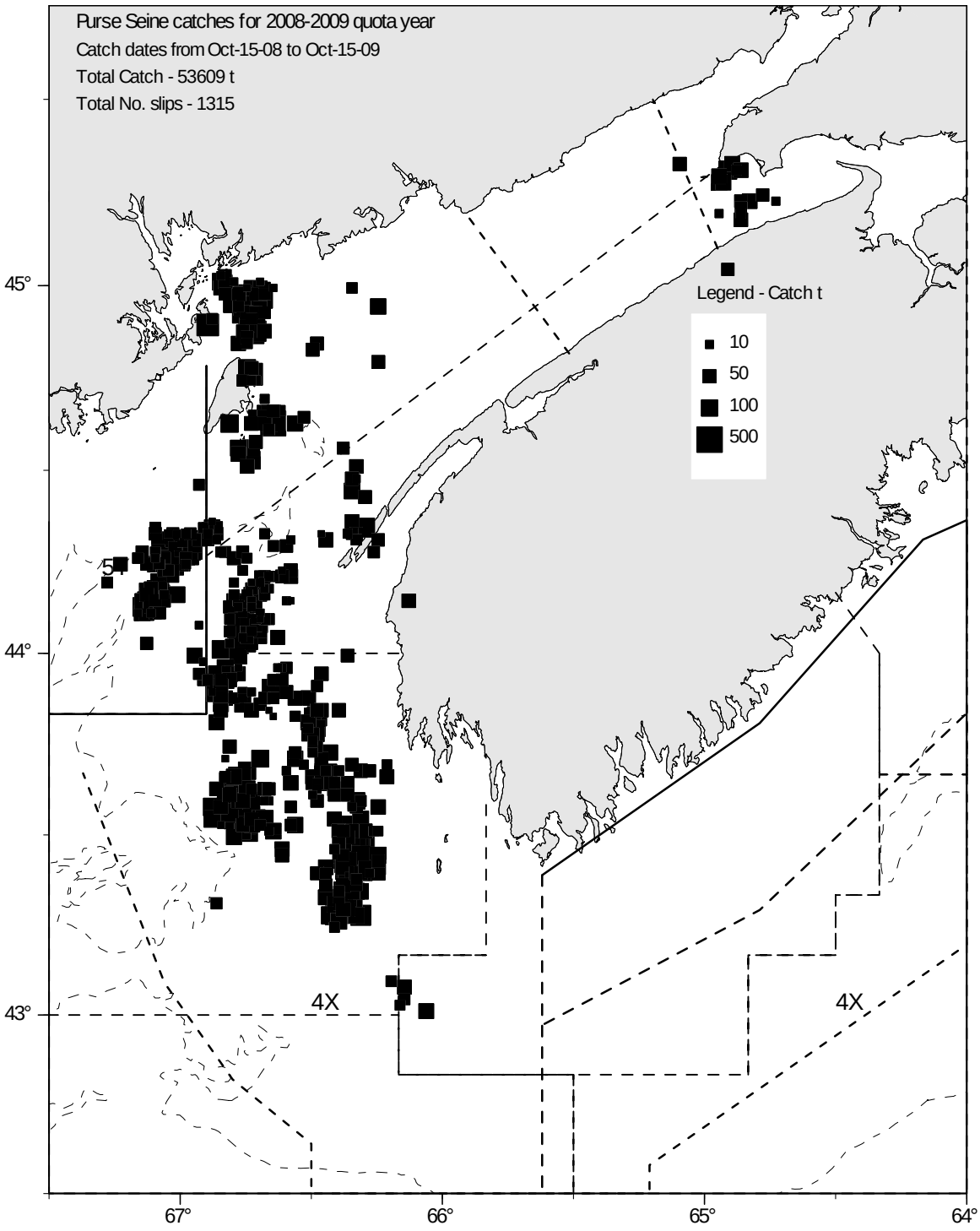


Figure 7. 2008-2009 quota year herring purse seine catches (t) for NAFO areas 4X (from Statistics Division MARFIS database).

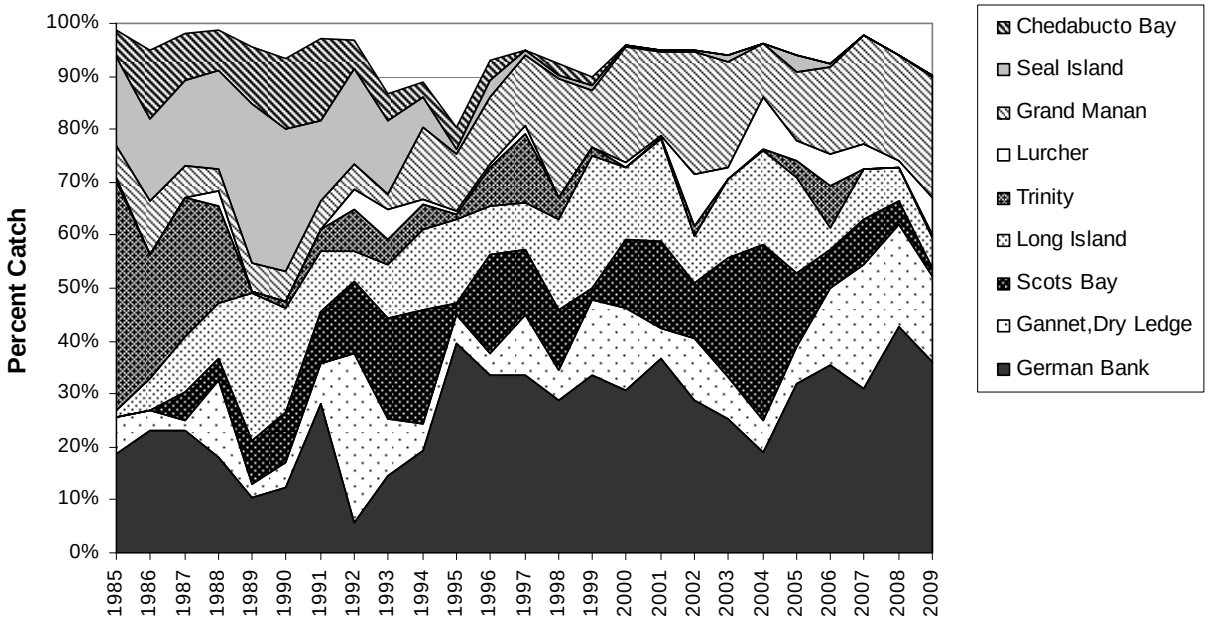


Figure 8. Herring purse seine catches as a proportion of overall landings for selected fishing grounds in the southwest Nova Scotia spawning component from 1985-2009.

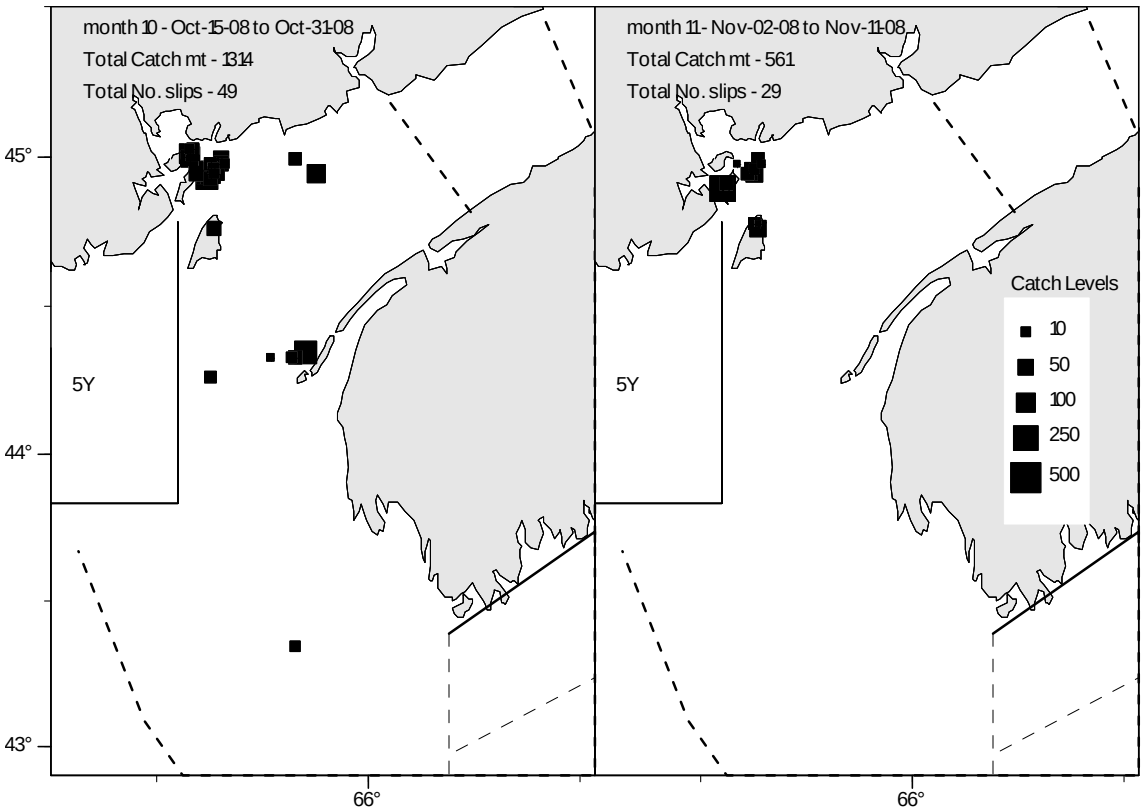


Figure 9. Fall 2008 herring purse seine catches by month in NAFO sub area 4X (part of 2008-2009 quota year).

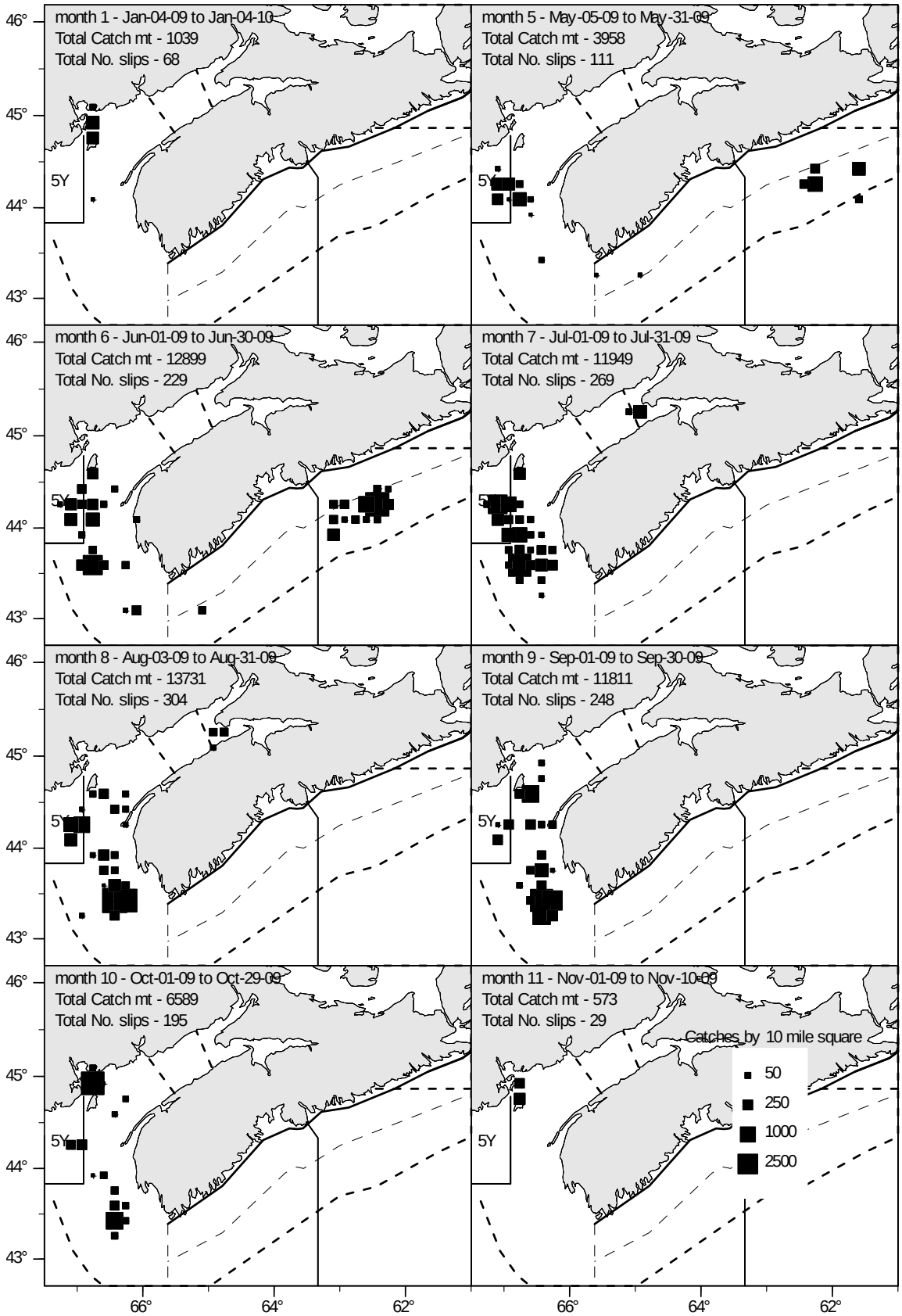


Figure 10. 2009 herring purse seine catches by month in NAFO subareas 4WX for calendar year 2009 from Statistics Division MARFIS database.

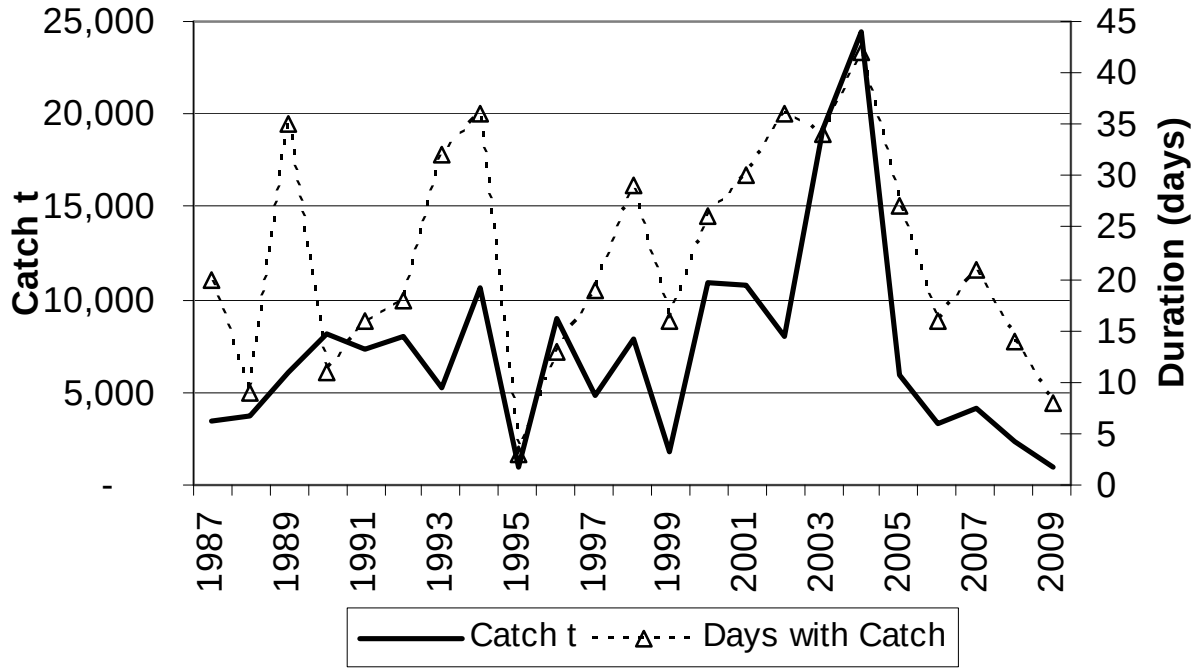


Figure 11. Annual herring purse seine catches for the Scots Bay area from 1987-2009 with duration of fishery in days (start date to end date).

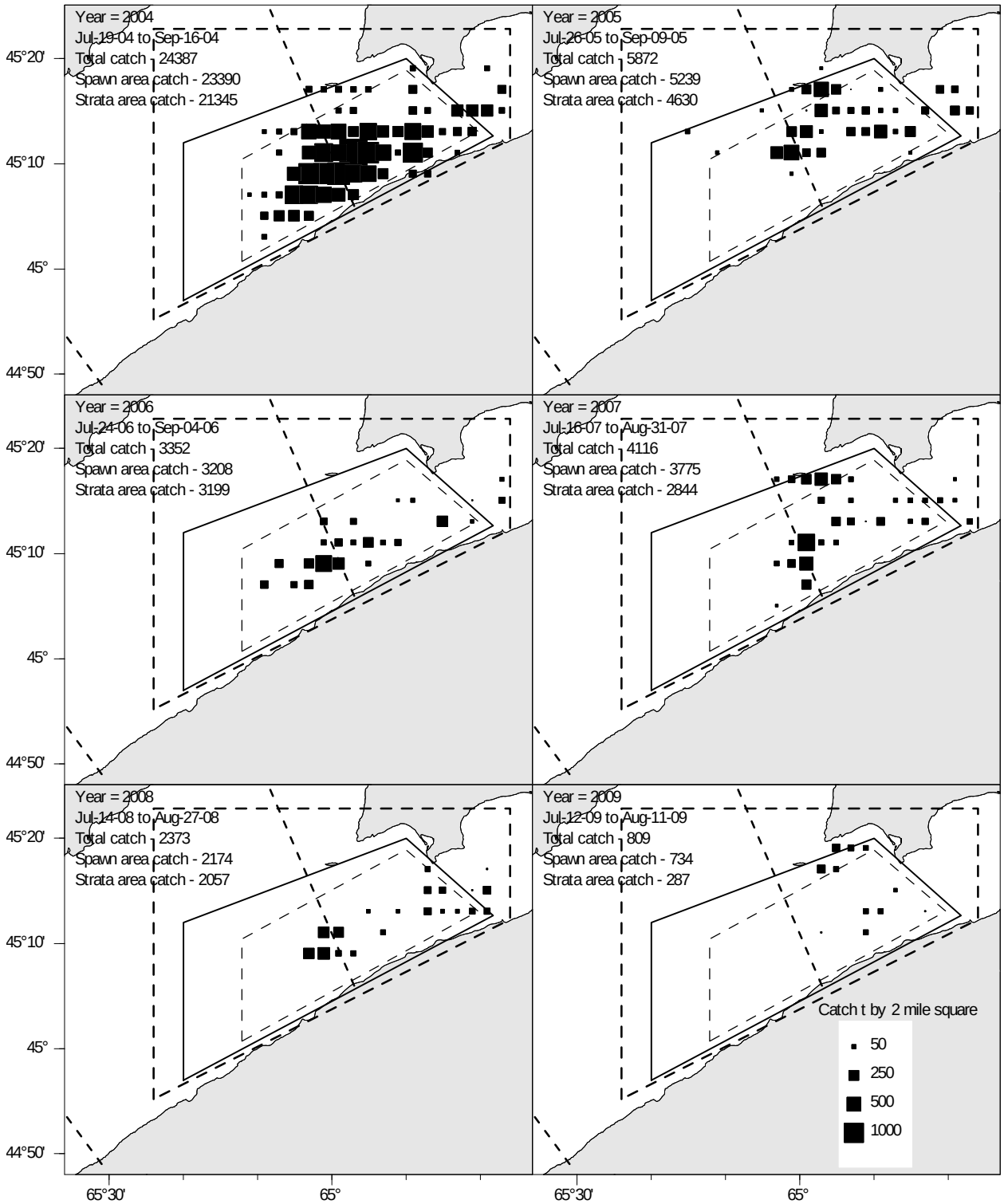


Figure 12. Herring purse seine catches for the Scots Bay area from 2004-2009 with catch totals for the overall area, the middle 'Spawning' area and the inner 'Strata' area which is used as the primary search area in acoustic surveys.

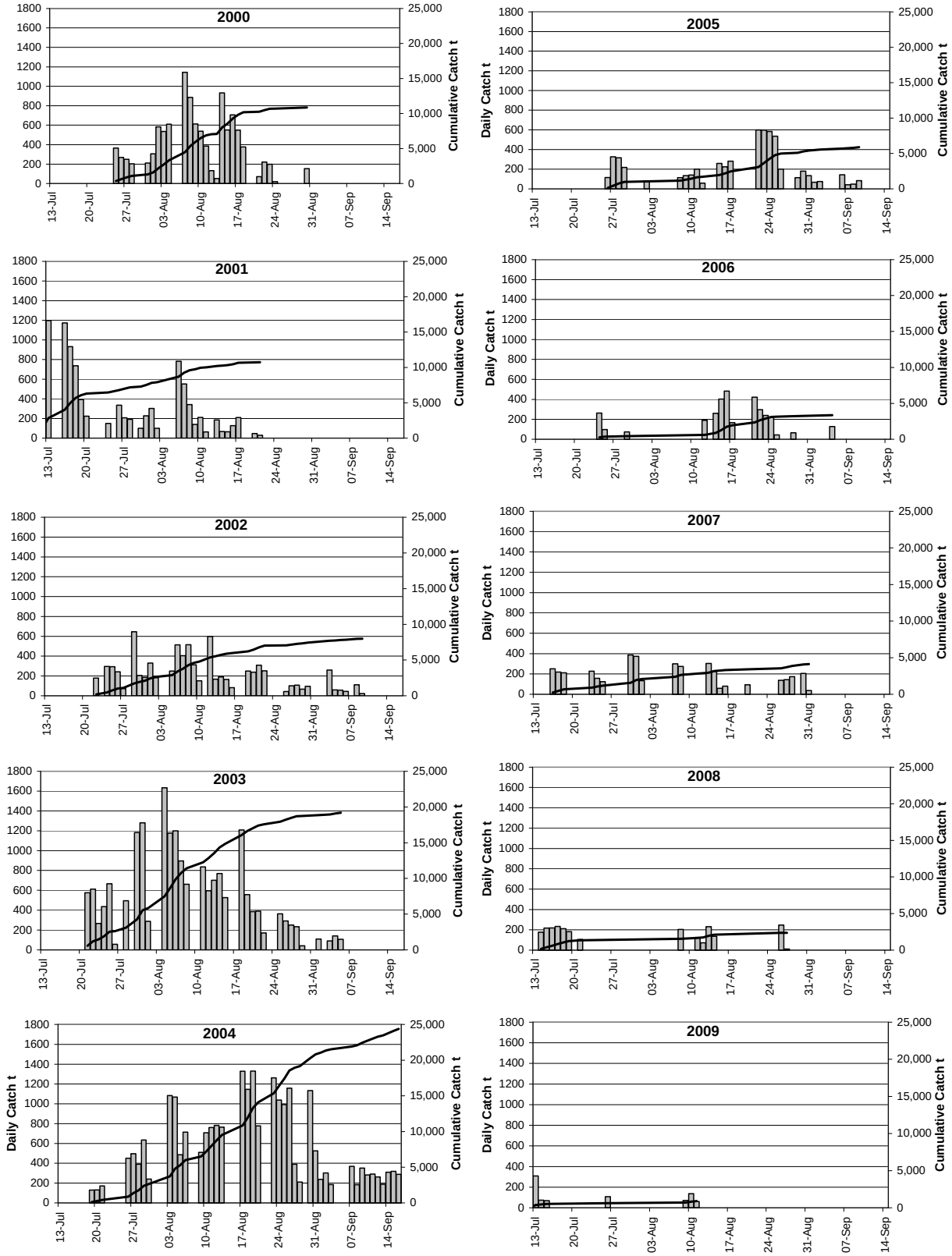


Figure 13. 2000 to 2009 Scots Bay daily purse seine herring catches (t) [bars] for Scots Bay with the cumulative total catch [solid line] over the entire fishing season.

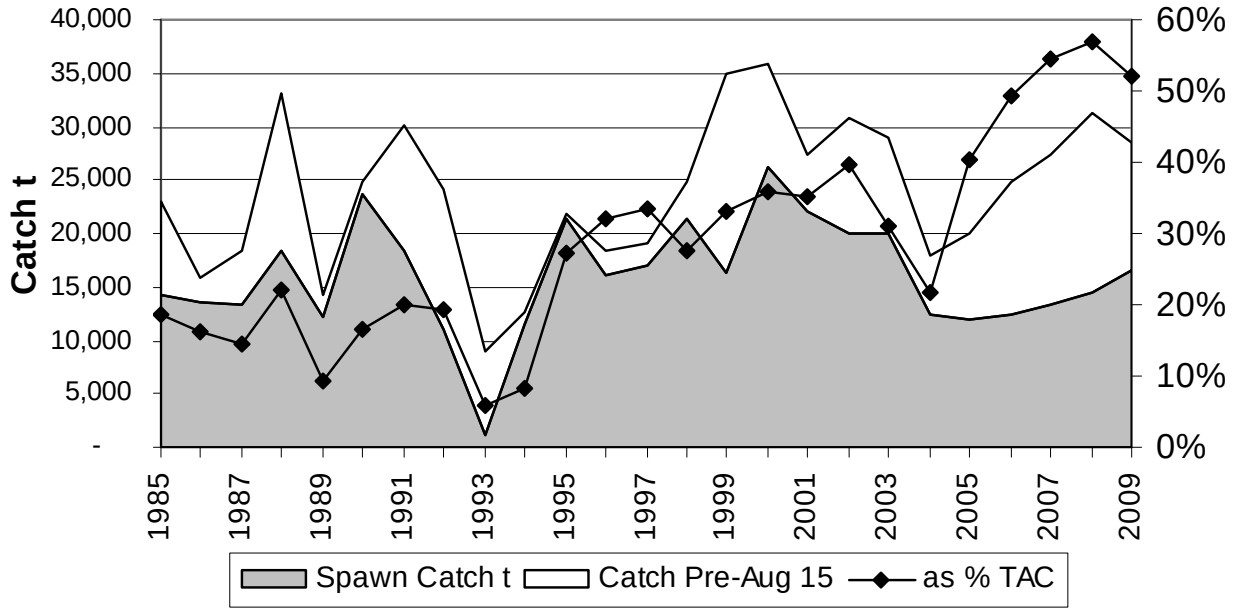


Figure 14. Annual herring purse seine catches for the German Bank area from 1985-2009 with pre-spawning and spawning period catches based on an Aug. 15 start date for the defined spawning period and overall German Bank catches as a proportion of the TAC.

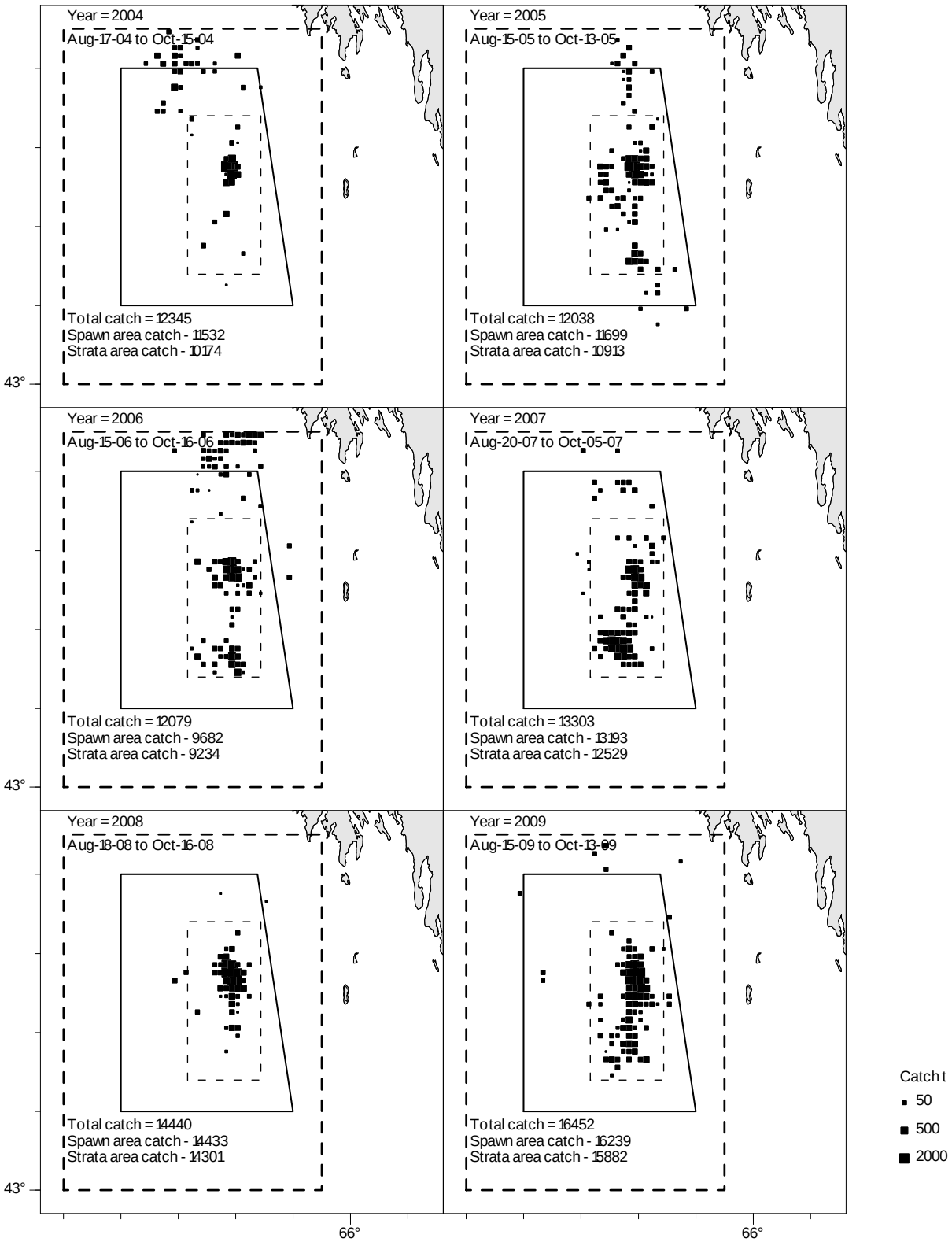


Figure 15. Herring purse seine <u>spawning</u> period catches (Aug. 15 to Oct. 31) for German Bank from 2004-2009 with catch totals for the overall catch area, the middle 'Spawn Box' and the inner 'Strata Box' which was used as the primary search area in acoustic surveys.

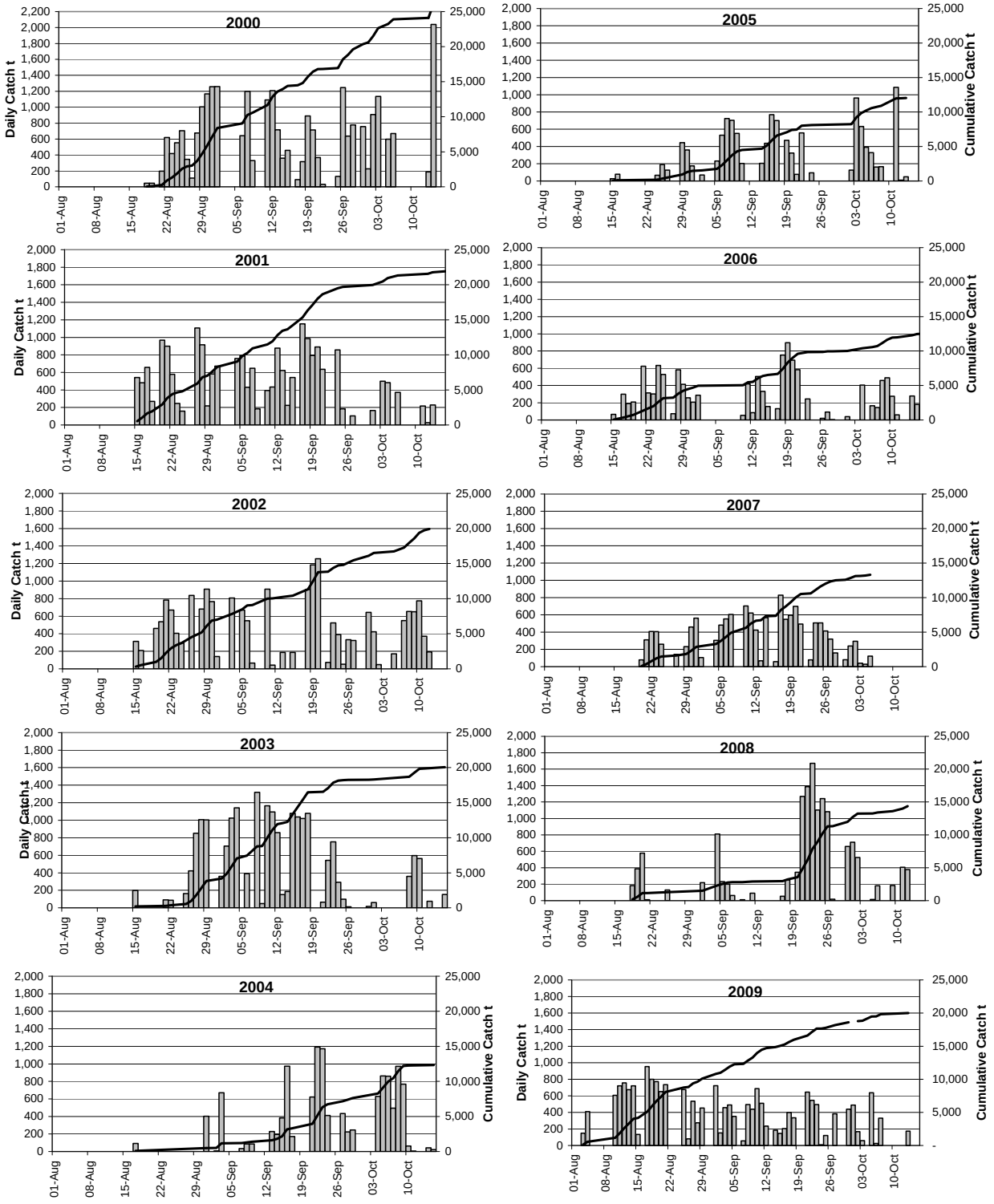


Figure 16. 2000 to 2009 daily purse seine herring catches (t) [bars] for German Bank with the cumulative total catch [solid line] over the defined spawning season from Aug. 15 to Oct. 30 (note 2009 includes catch from Aug. 1 to Aug. 14).

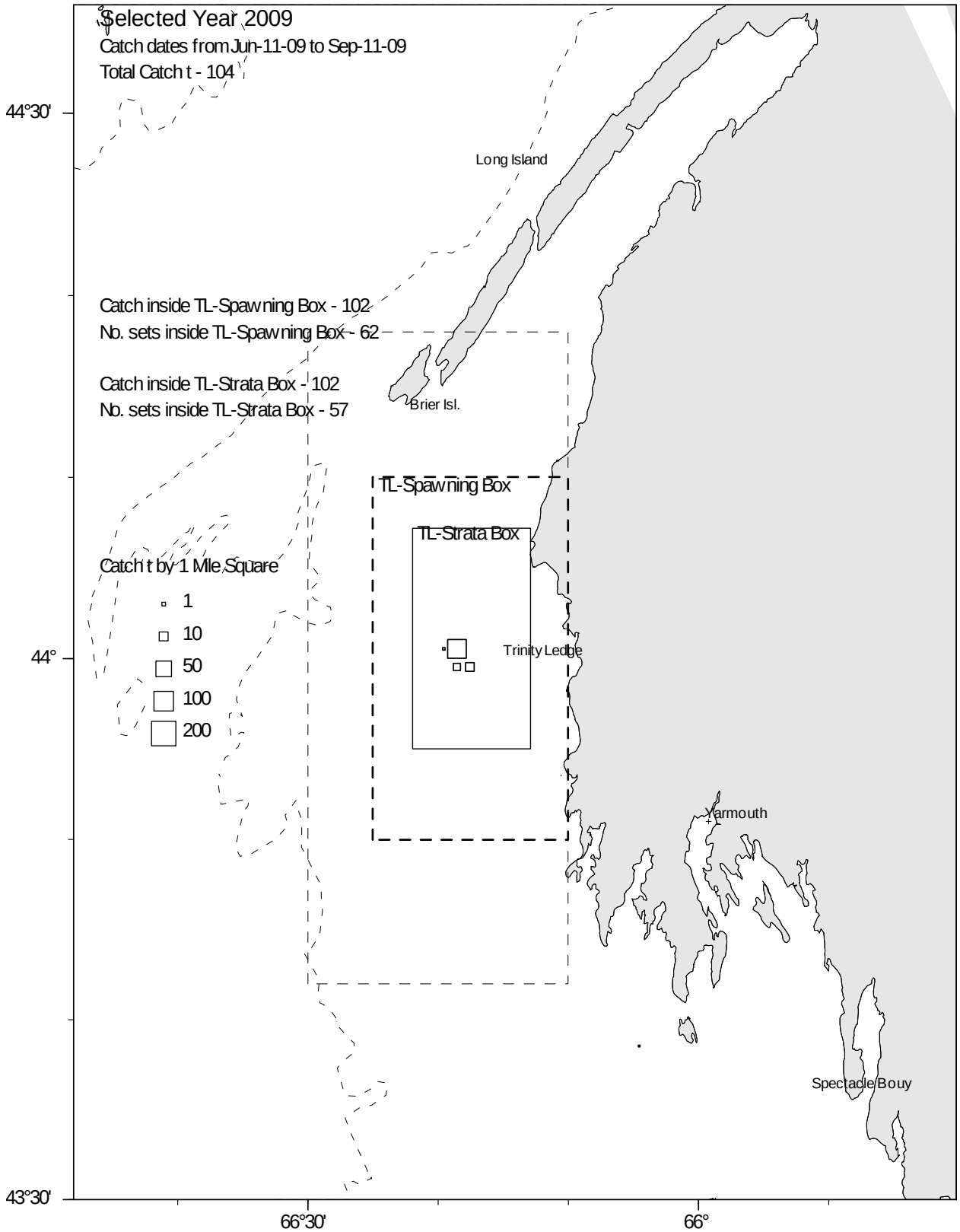


Figure 17. 2009 Trinity Ledge herring gillnet catches in the survey strata box and spawning area box areas.

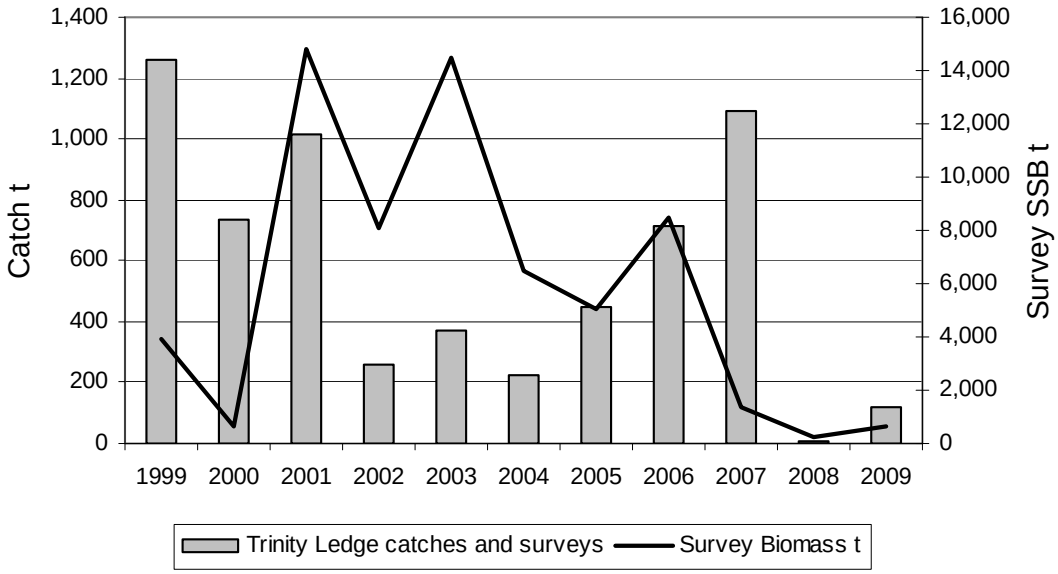


Figure 18. Trinity Ledge herring catches and acoustic survey biomass estimates from 1999 to 2009. All acoustic estimates were calculated without the Calibration Integration Factor.

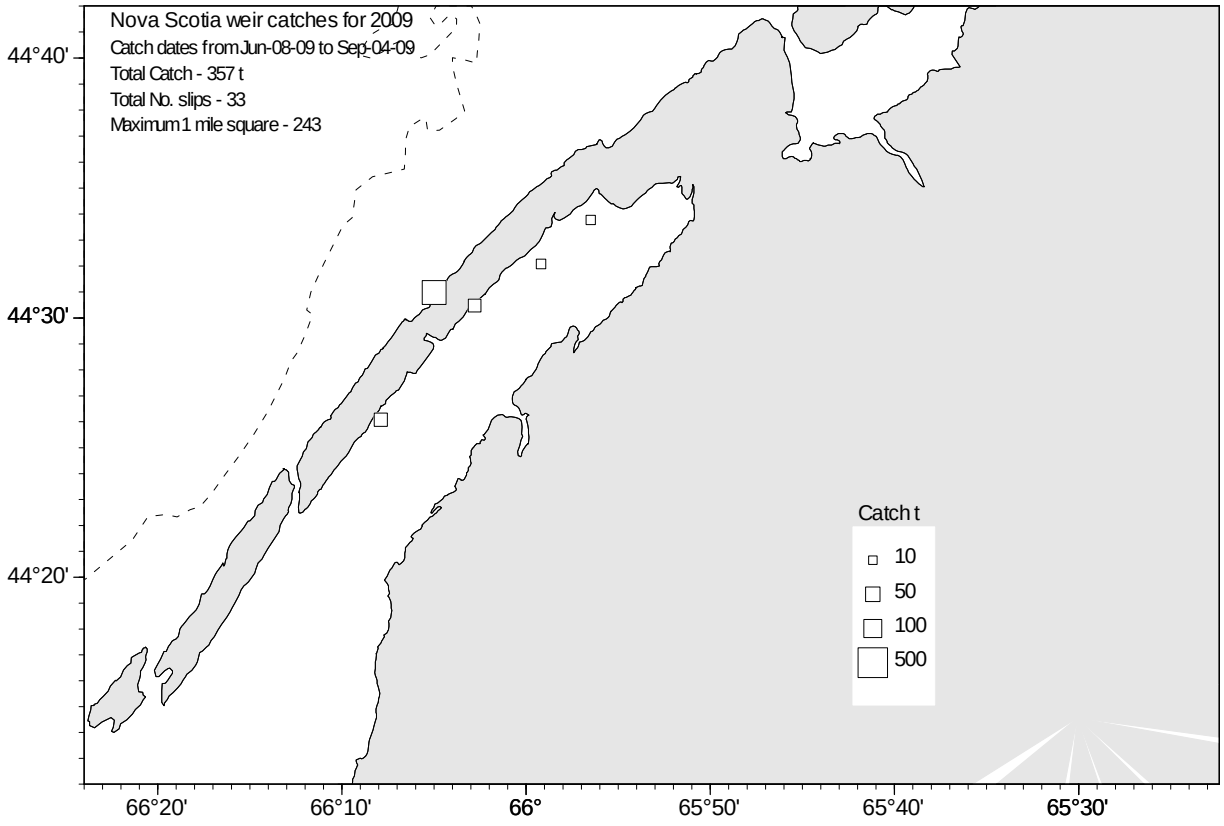


Figure 19. Nova Scotia herring weir catches by location for the 2009 calendar year.

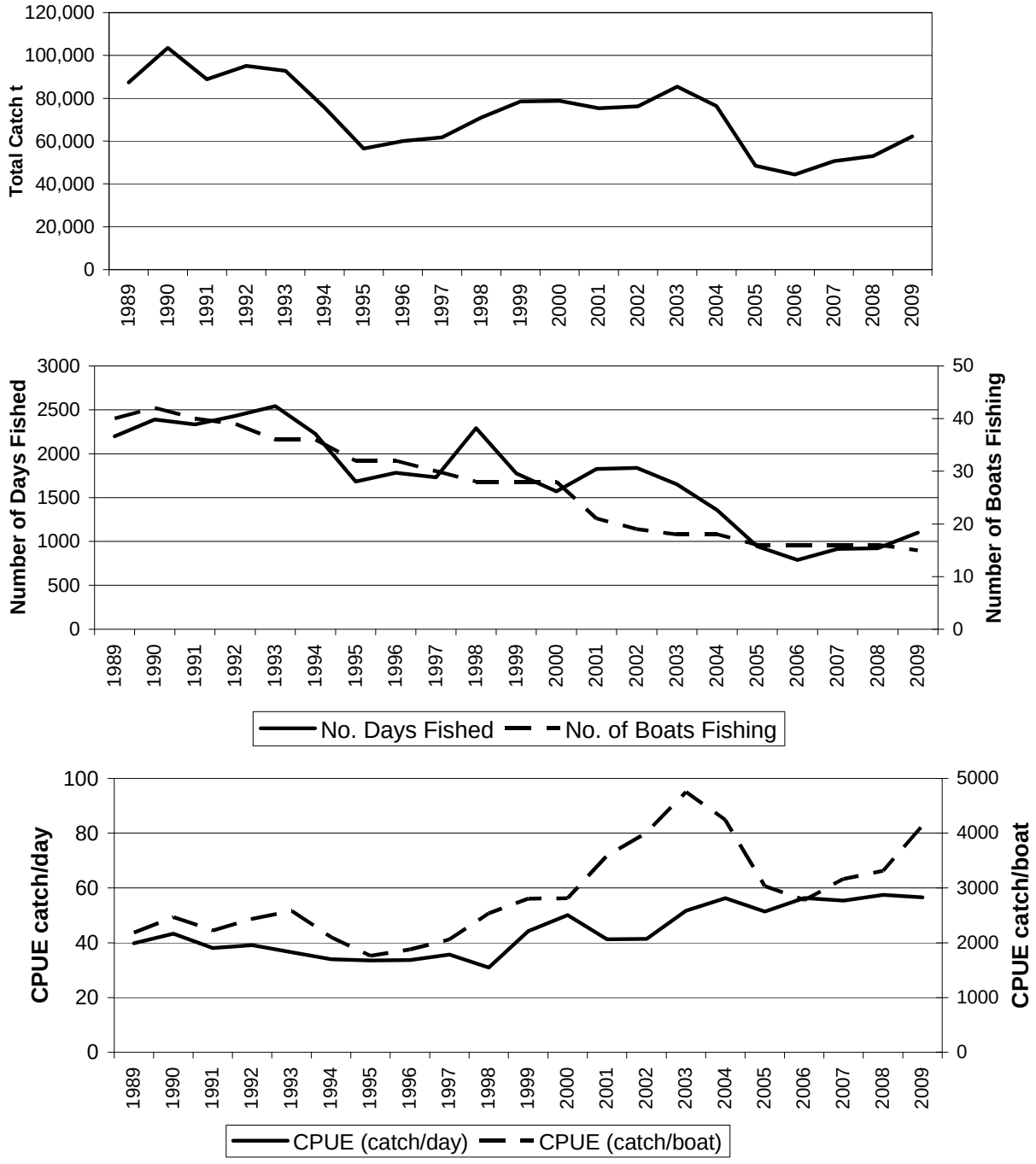


Figure 20. Purse seine catch (top panel), effort (middle panel) and CPUE (bottom) from 1989 to 2009 annual 4WX herring landings data for the SW Nova Scotia/Bay of Fundy spawning component.

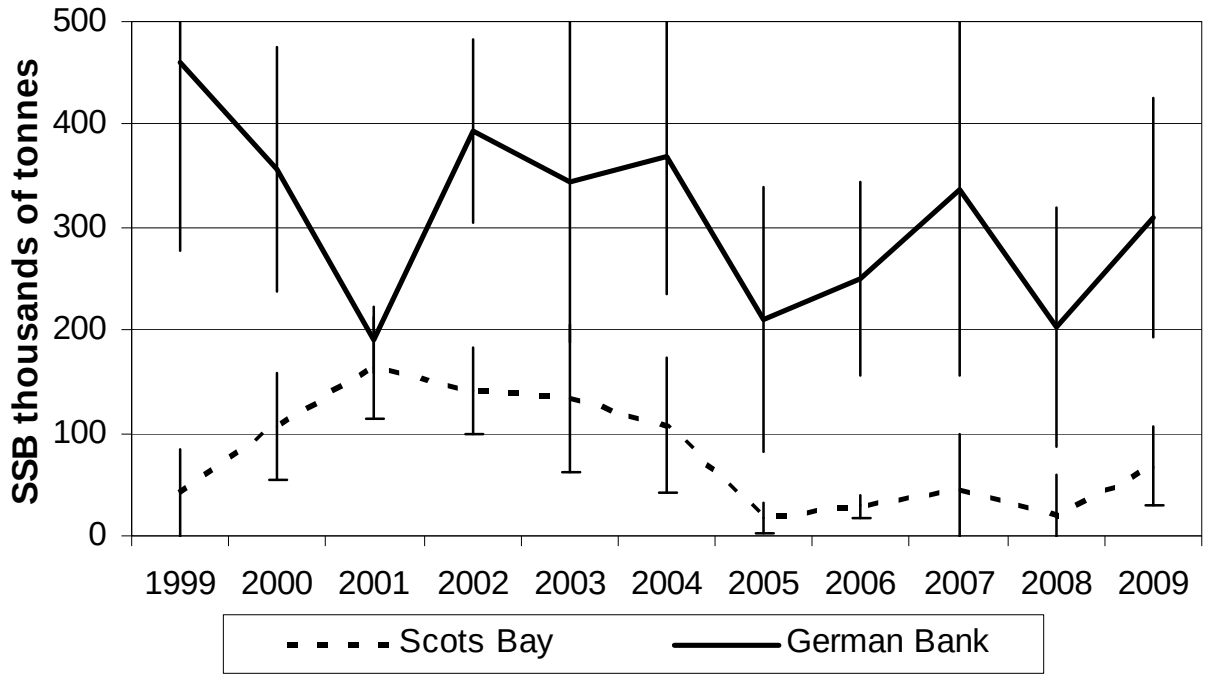


Figure 21. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component for the German Bank and Scots Bay areas with 95% confidence intervals (equivalent to 2 times SE).

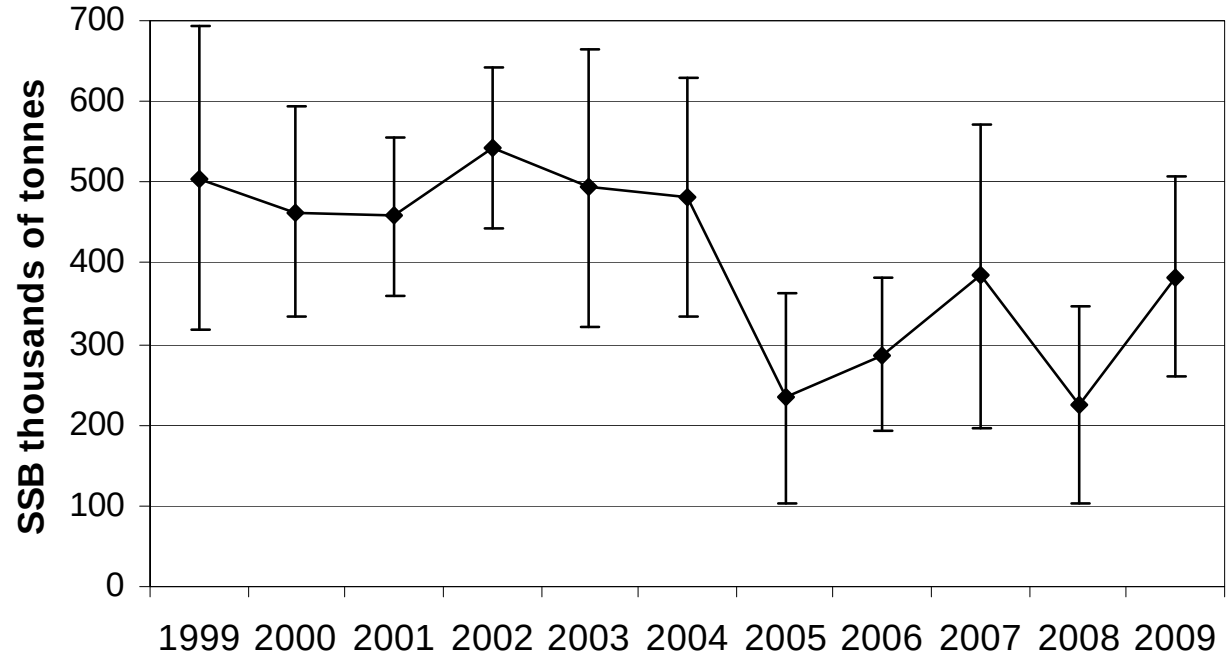


Figure 22. Herring spawning stock biomass from acoustic surveys for the combined SW Nova Scotia / Bay of Fundy spawning component with 95% confidence intervals (equivalent to 2 times SE).

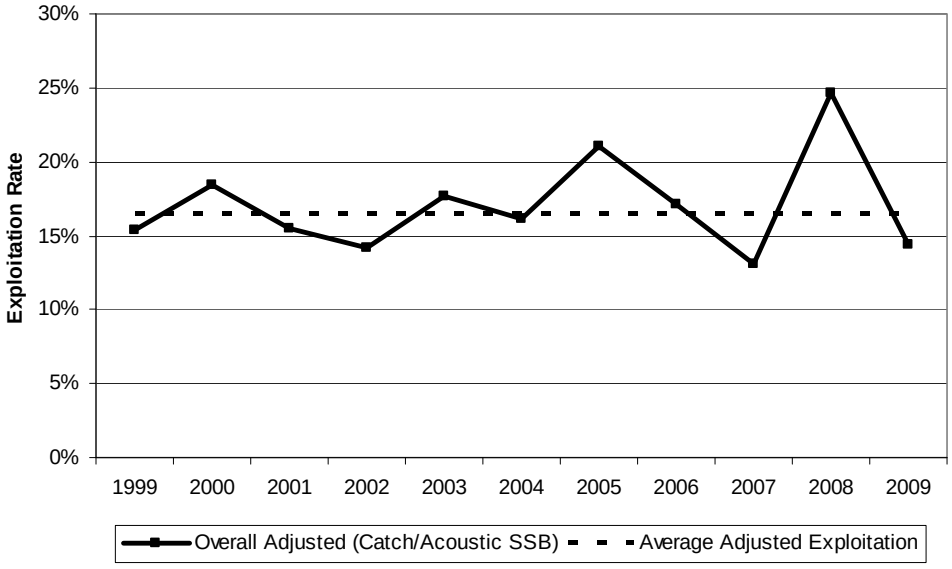


Figure 23. Relative exploitation rate for the SW Nova Scotia / Bay of Fundy spawning component using overall catch as a proportion of the overall acoustic SSB.

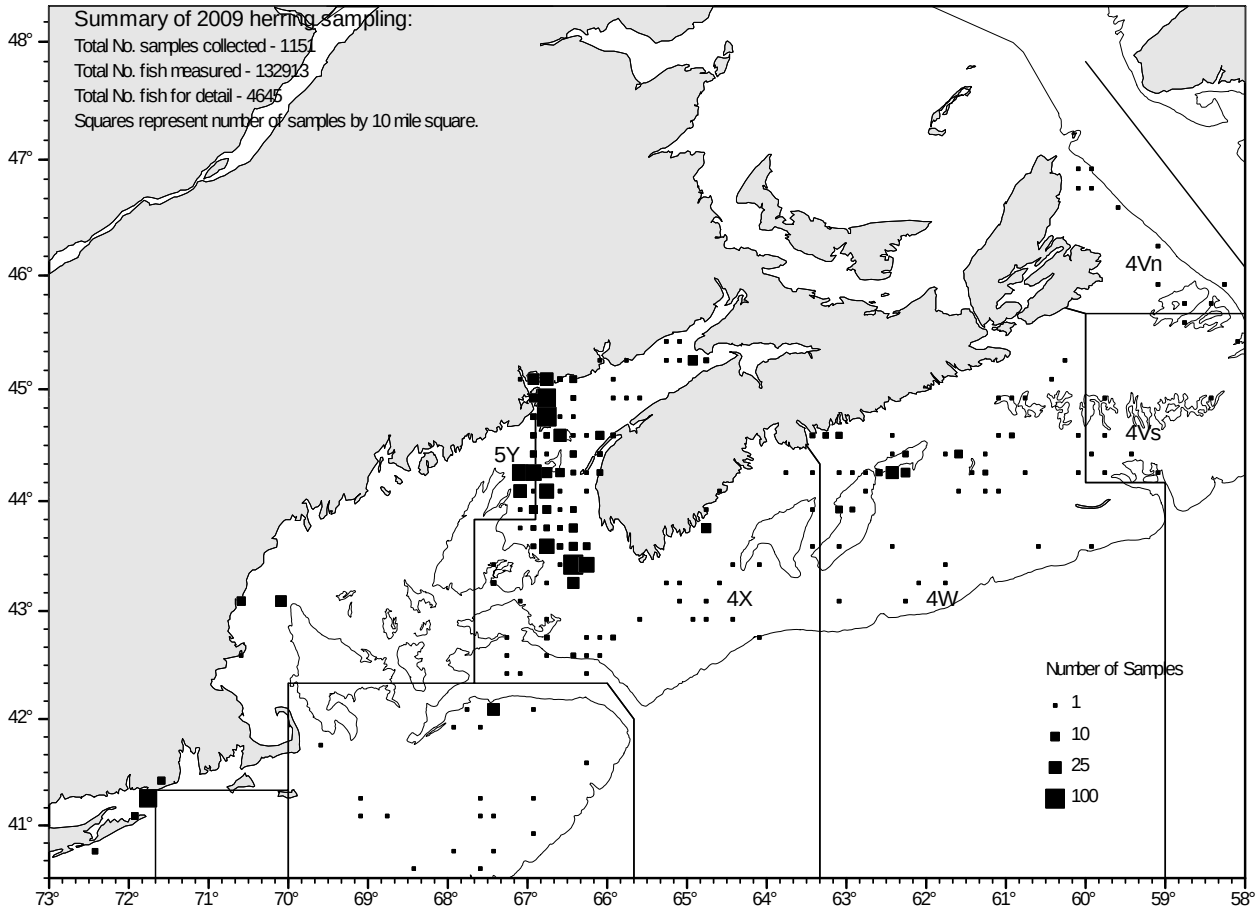


Figure 24. 2009 herring sampling coverage by location from all sources (numbers of length frequency samples grouped by 10 mile square).

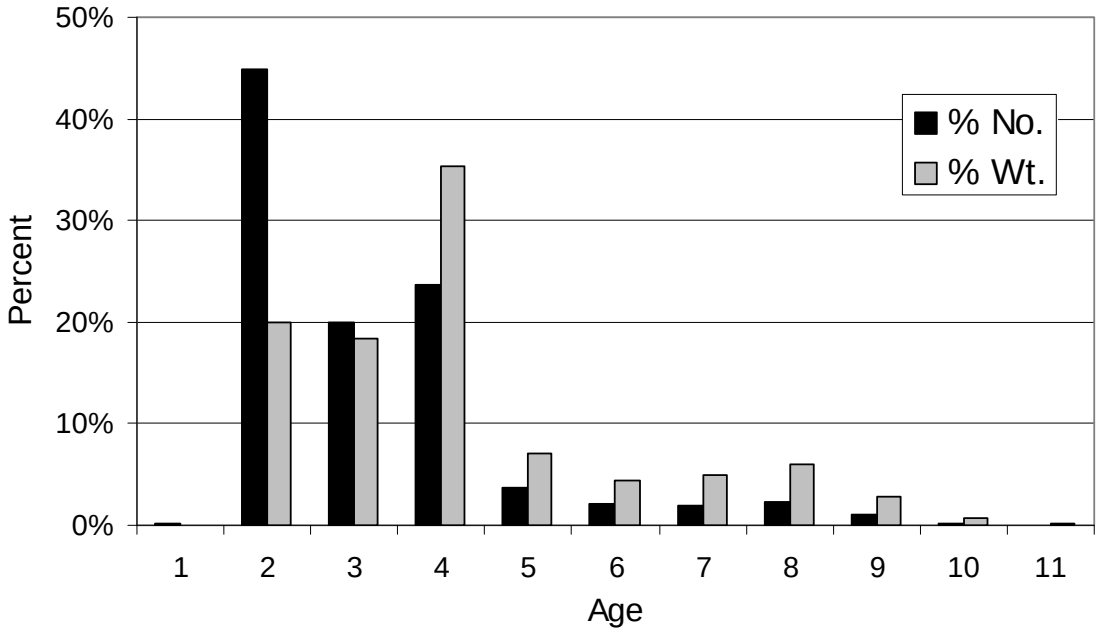


Figure 25. Fishery catch at age (% numbers and % weight) from the 2009 SW Nova Scotia/Bay of Fundy spawning component.

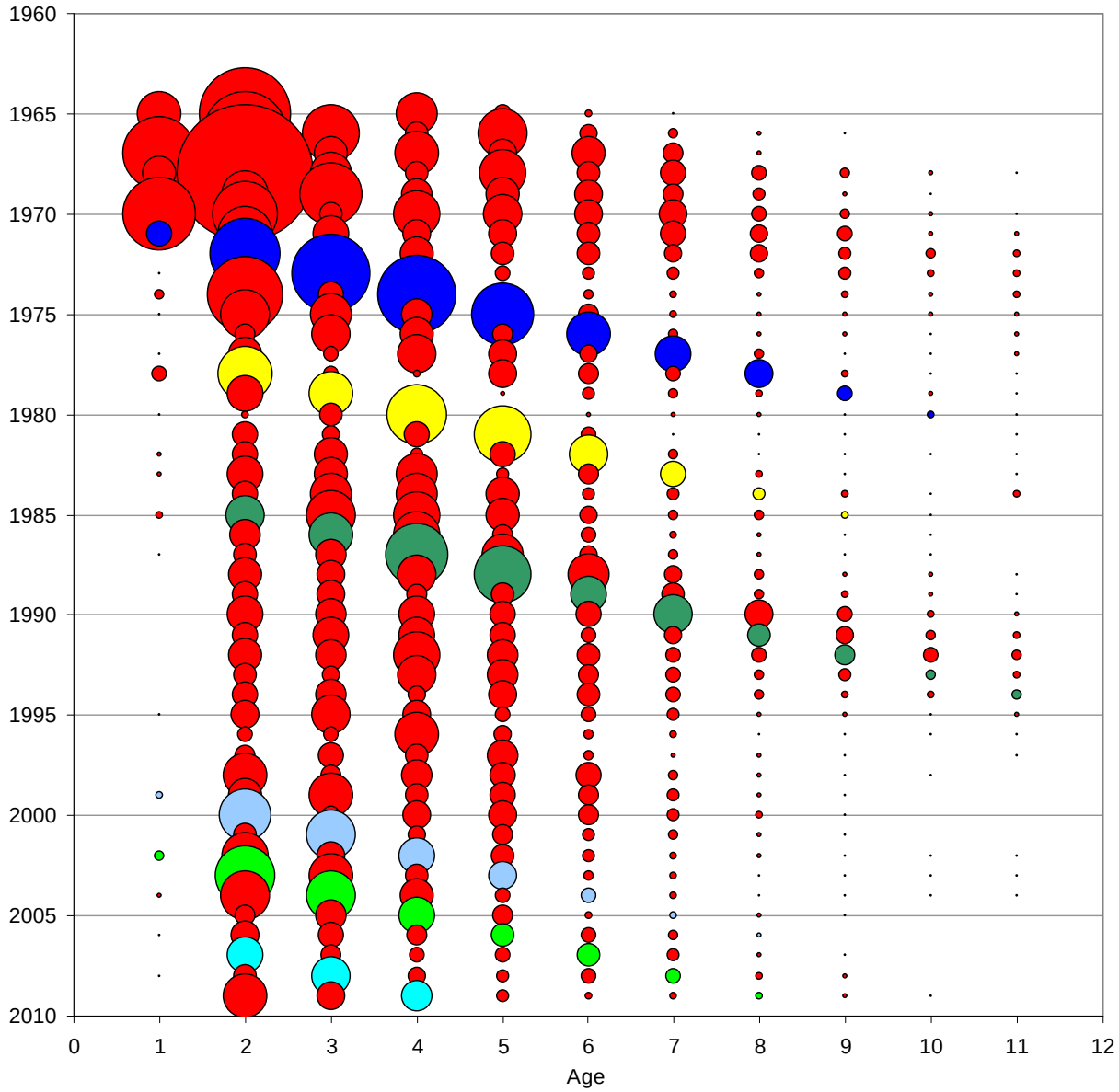


Figure 26. Historical catch at age (numbers) for the SW Nova Scotia / Bay of Fundy herring spawning component from 1965-2009. Several of the stronger year-classes are highlighted including the 1970, 1978, 1983, 1998, 2001 and 2005 year-classes.

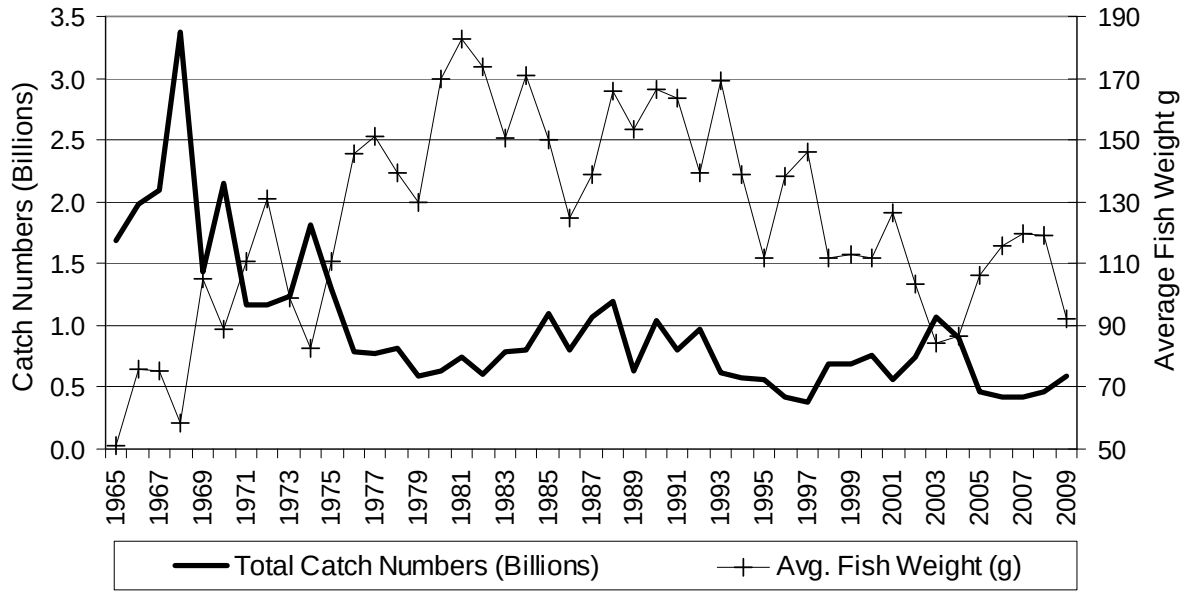


Figure 27. Total removals (billions) and average fish weight for the combined annual catch from the SW Nova Scotia spawning component for 1965 to 2009.

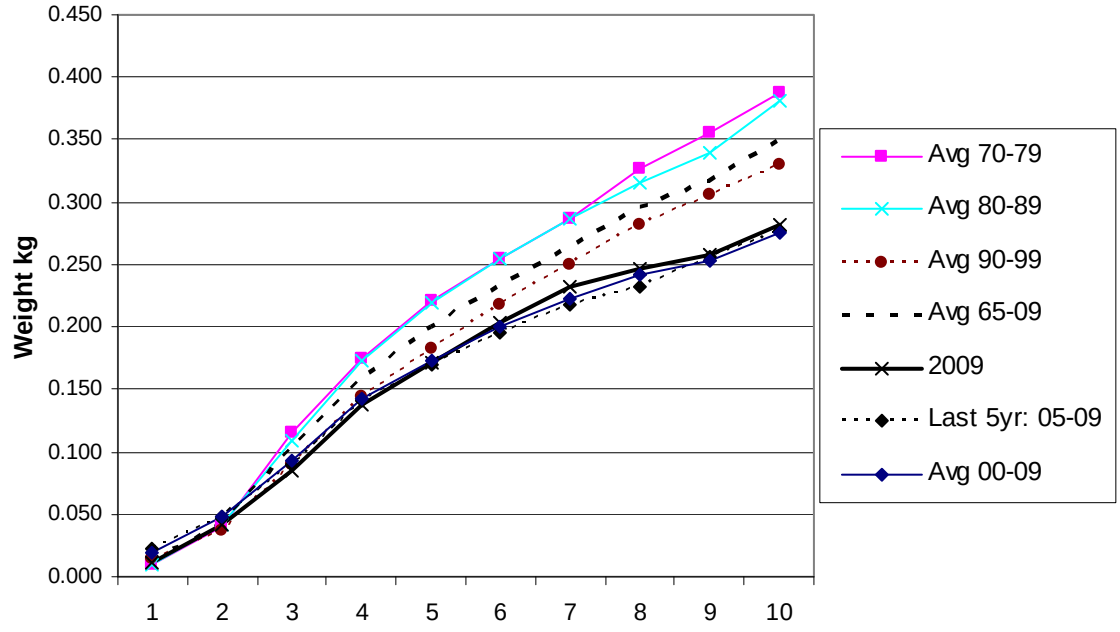


Figure 28. Average weights at age (kg) for the SW Nova Scotia / Bay of Fundy component of the 4WX herring fishery (fishery weighted) for the most recent year and by decade for the historical series.

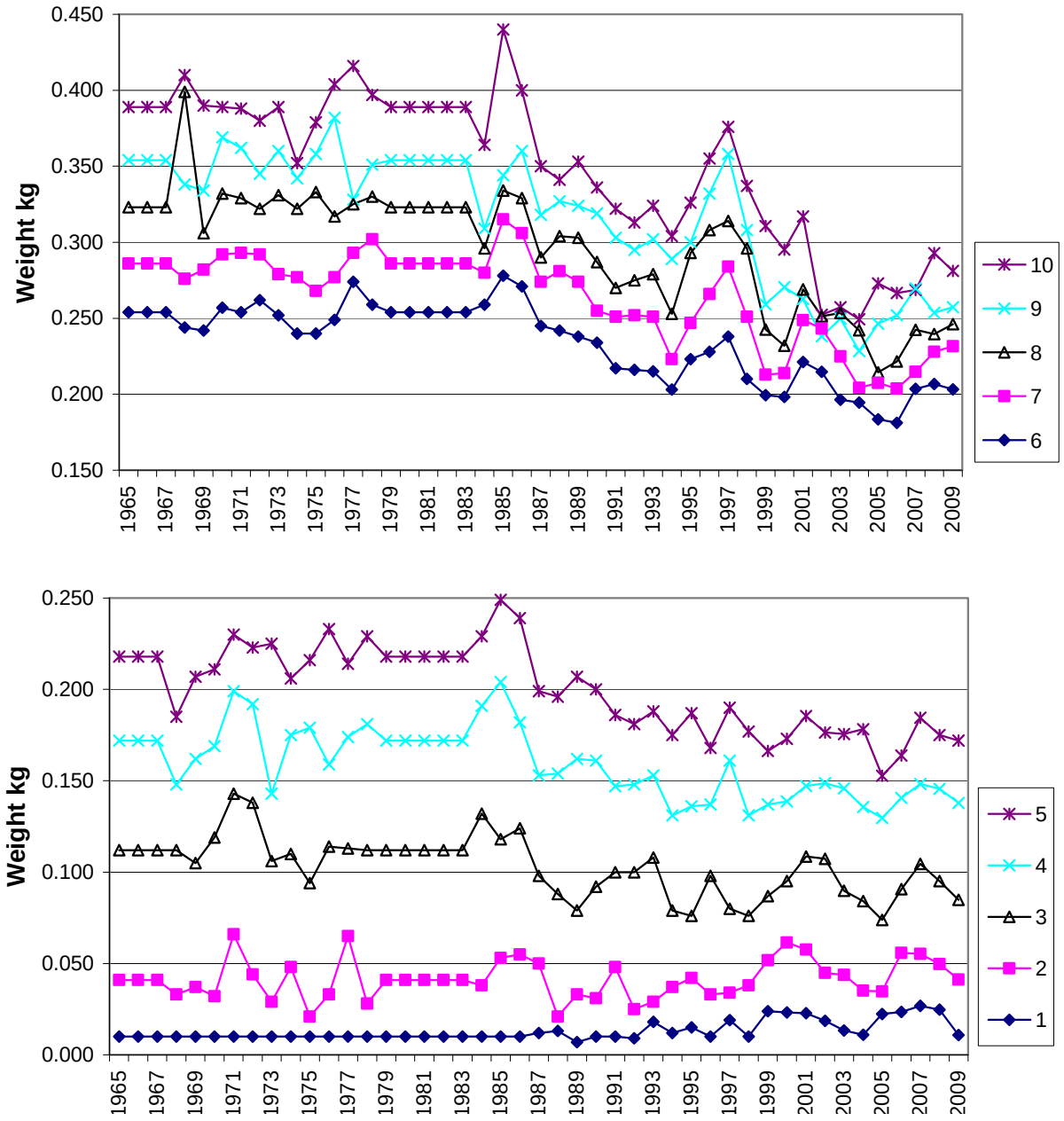


Figure 29. Average weights at age (kg) for the SW Nova Scotia / Bay of Fundy component of the 4WX herring fishery (fishery weighted) for 1965-2009.

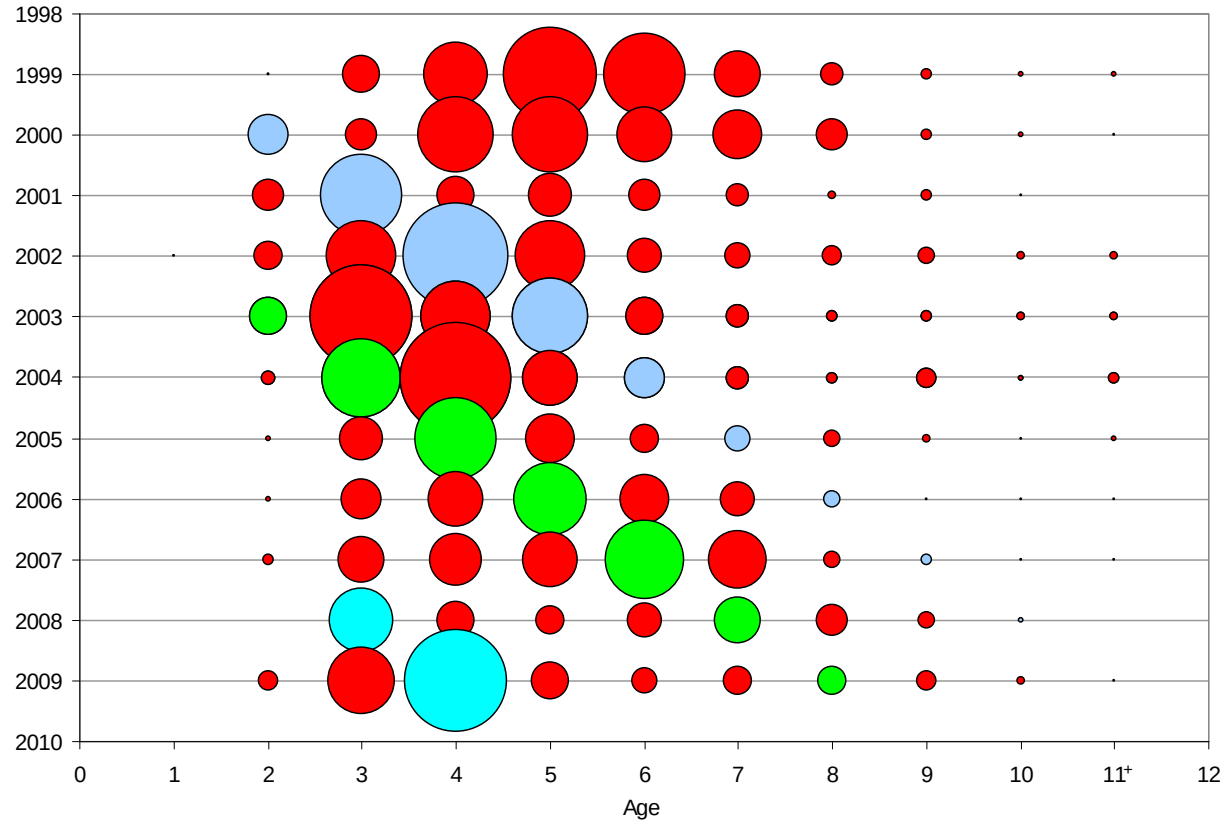


Figure 30. Acoustic survey catch at age (bubble size for numbers) for the German Bank spawning area in the SW Nova Scotia / Bay of Fundy component.

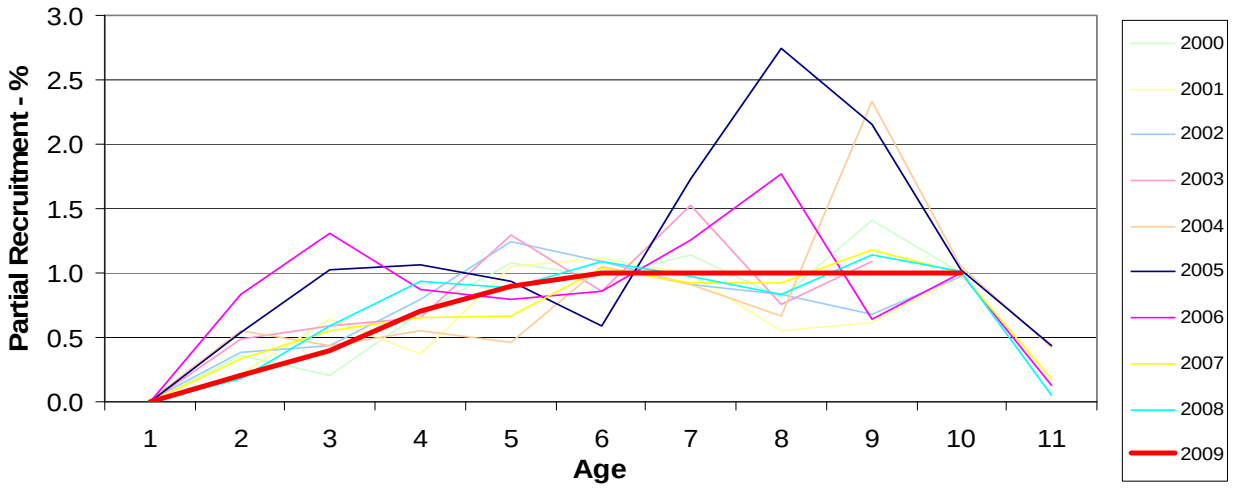


Figure 31. Partial recruitment or exploitation pattern at age by year for 2000-2009 from the VPA. The 2009 line represents the assumptions made in the terminal year.

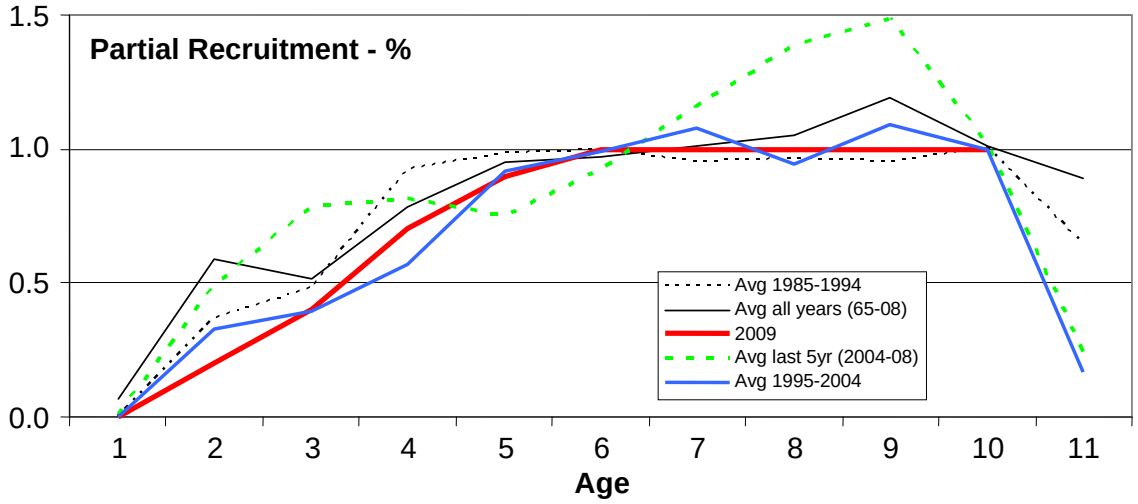


Figure 32. Partial recruitment or exploitation pattern at age for various periods from the VPA. The 2009 line represents the assumptions made in the terminal year.

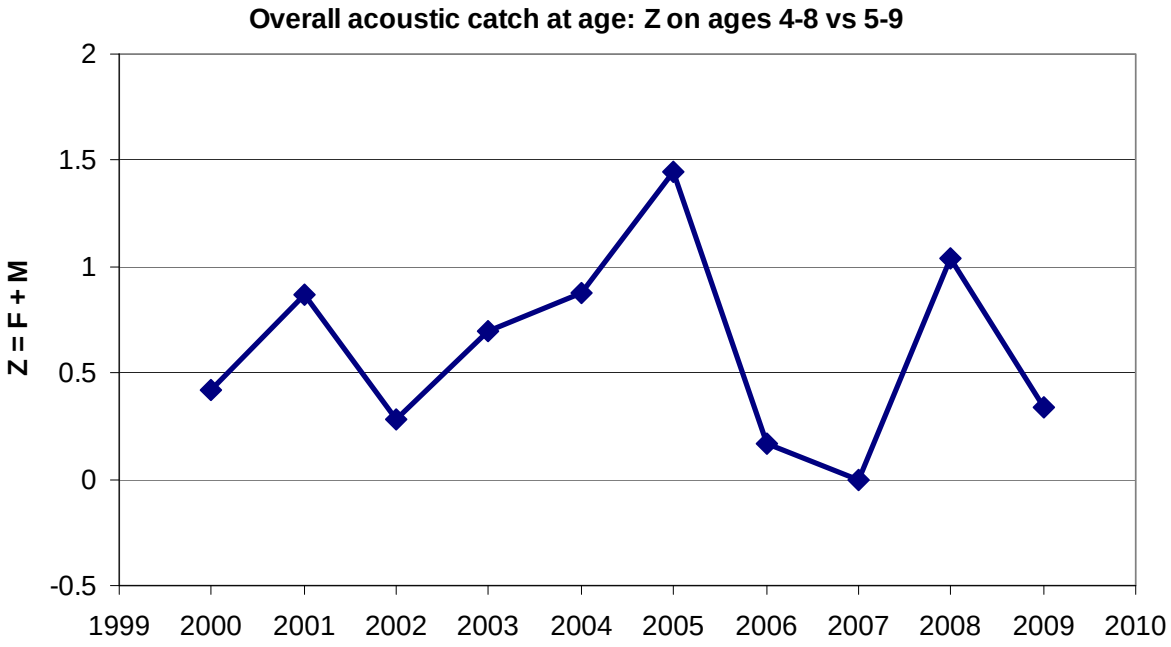


Figure 33. Total mortality estimates (Z=F+M) from the overall acoustic catch at age data for ages 4 to 8 combined, compared with ages 5 to 9 in the following year.

Age	Parameter	Estimate	Standard Error	Bias	%SE	% Bias	Avg Squared Residual
	N[2010 7]	10536.22	2930.53	334.62	28%	3%	0.22
4	q ID#[1]	2.67	0.42	0.03	16%	1%	0.22
5	q ID#[2]	4.06	0.64	0.04	16%	1%	0.18
6	q ID#[3]	4.86	0.76	0.05	16%	1%	0.17
7	q ID#[4]	6.60	1.03	0.07	16%	1%	0.09
8	q ID#[5]	5.82	0.91	0.06	16%	1%	0.44
9							
10							

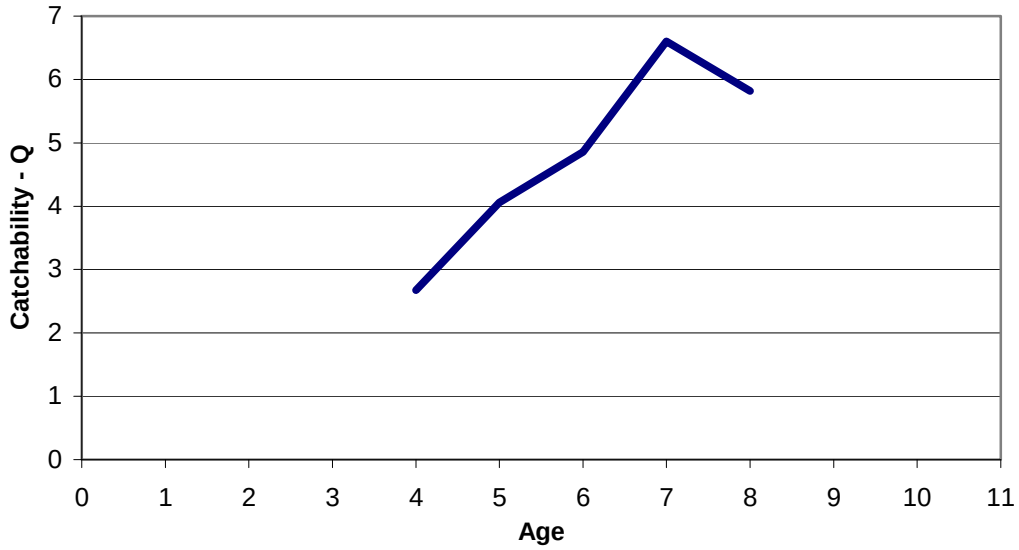


Figure 34. Parameter estimates and plot of catchability by age (q) from the VPA calibrated with the German Bank acoustic index (ages 4 to 8).

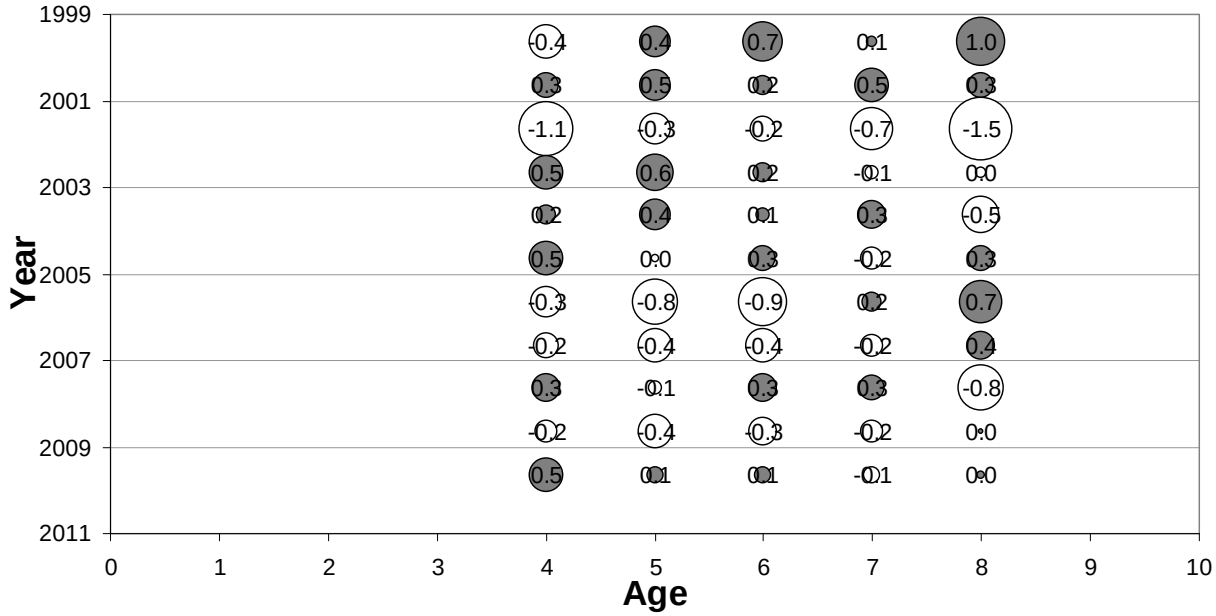


Figure 35. Residuals by age and year from the VPA calibrated with the German Bank acoustic index (ages 4 to 8).

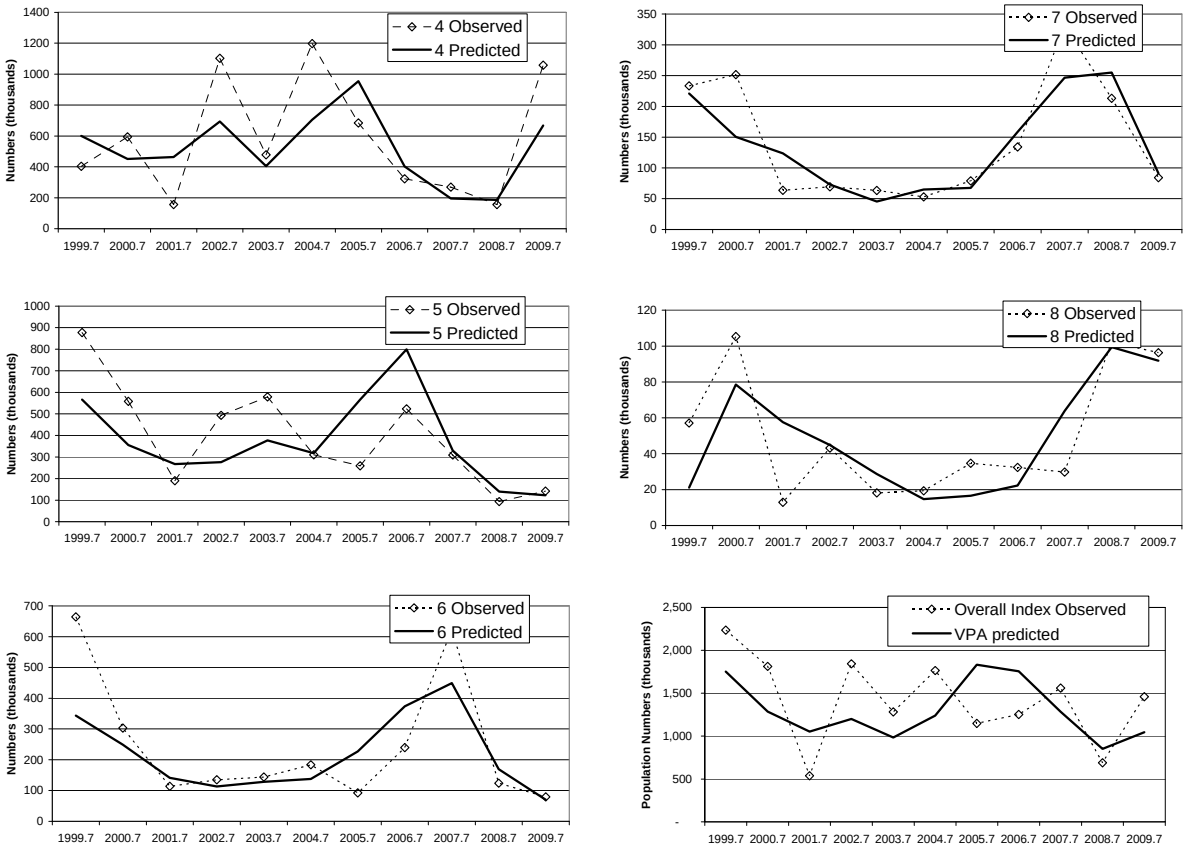
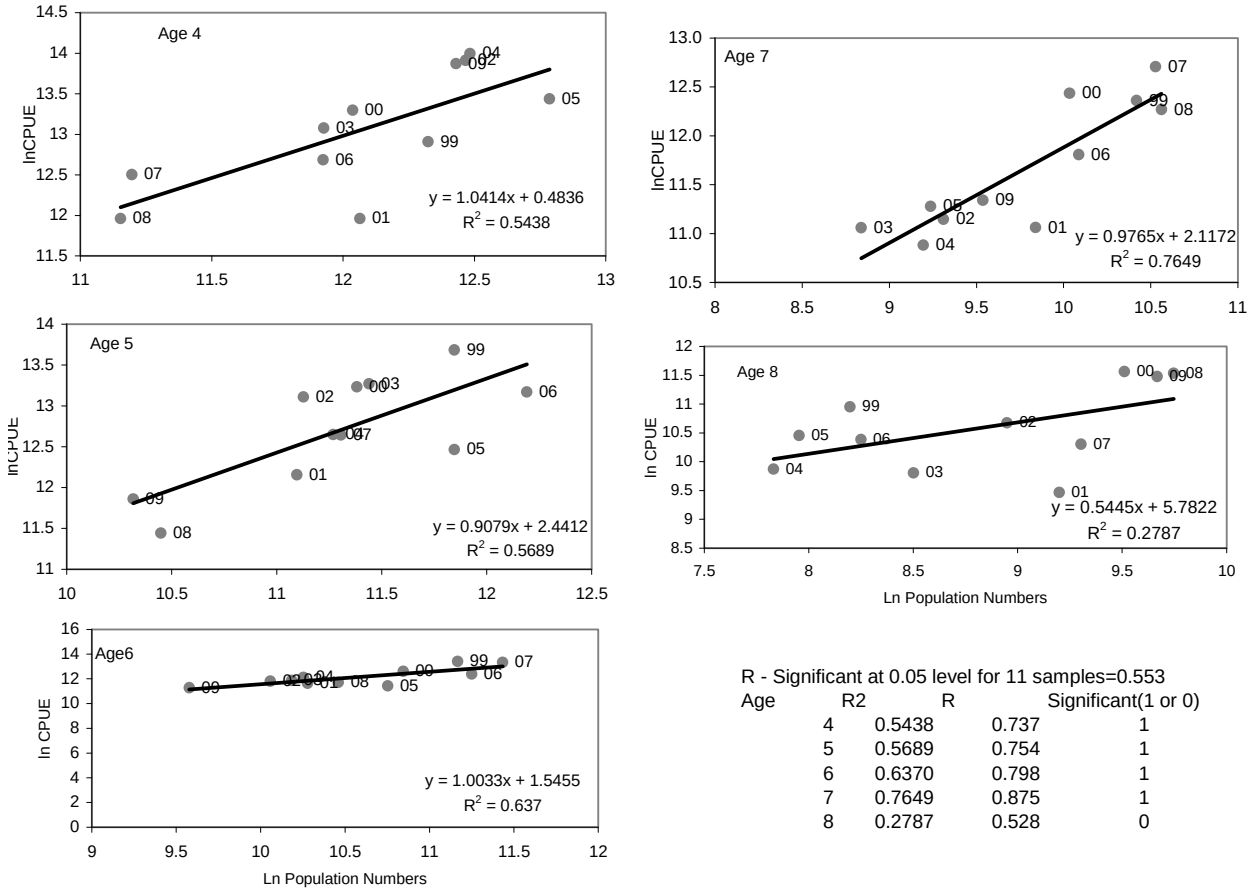


Figure 36. Age by age and overall combined plots of the observed abundance index and predicted population numbers versus year from the VPA calibrated with the German Bank acoustic index (ages 4 to 8).



R - Significant at 0.05 level for 11 samples=0.553

Age	R2	R	Significant(1 or 0)
4	0.5438	0.737	1
5	0.5689	0.754	1
6	0.6370	0.798	1
7	0.7649	0.875	1
8	0.2787	0.528	0

Figure 37. Age by age plots of the observed and predicted abundance index versus population numbers from a VPA calibrated with the German Bank acoustic index (ages 4 to 8) for the SW Nova Scotia / Bay of Fundy component.

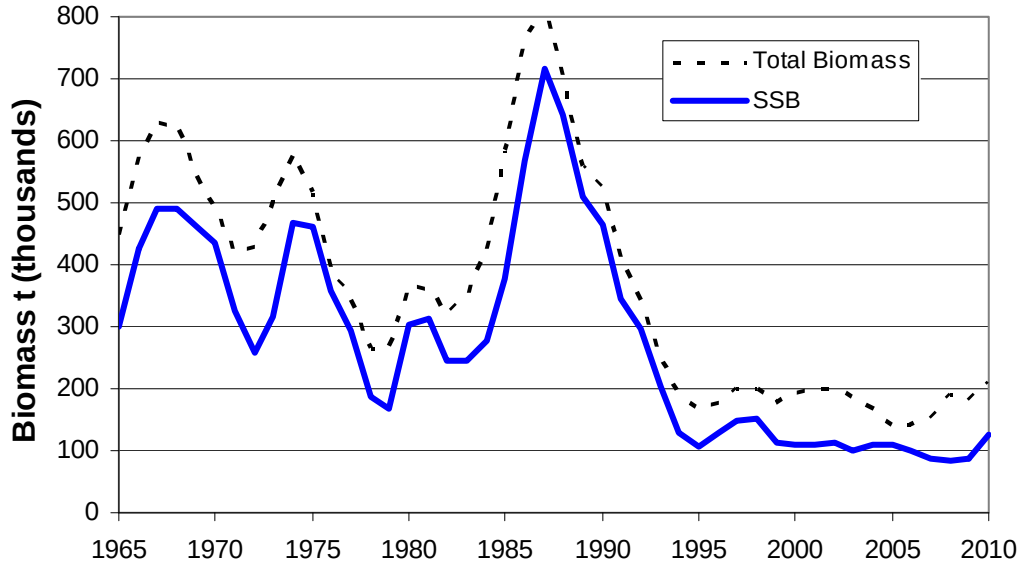


Figure 38. Beginning of year spawning stock biomass and total biomass for the VPA calibrated with the German Bank acoustic index (ages 4 to 8) from 1965 to 2010.

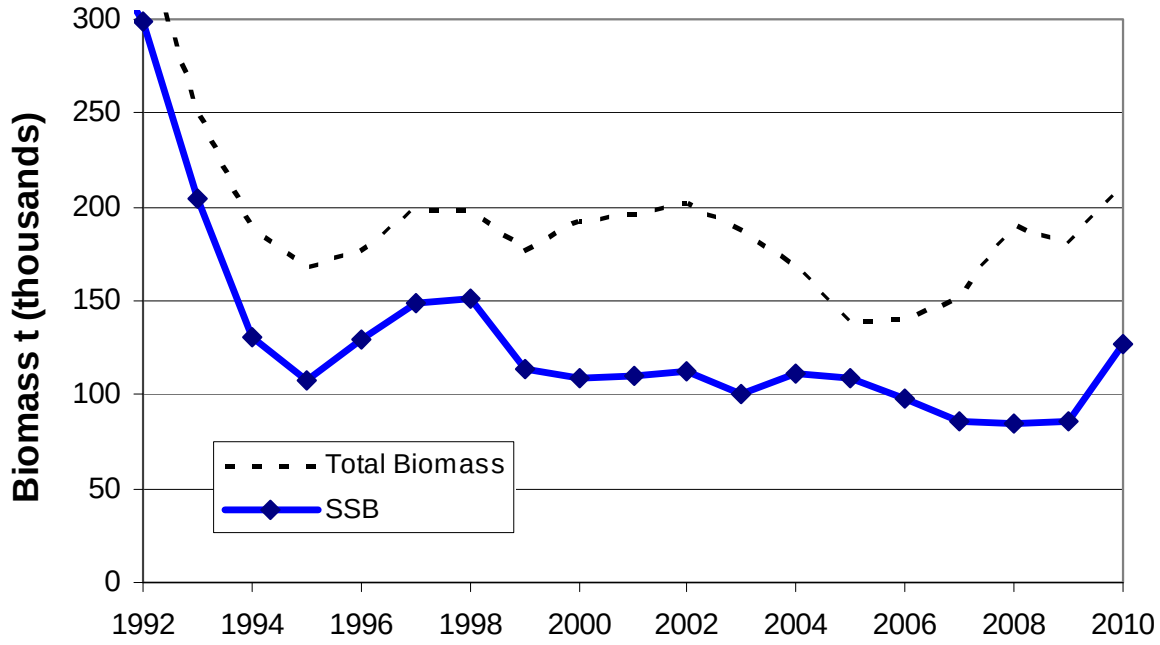


Figure 39. Beginning of year spawning stock biomass and total biomass for the VPA calibrated with the German Bank acoustic index (ages 4 to 8) from 1992 to 2010.

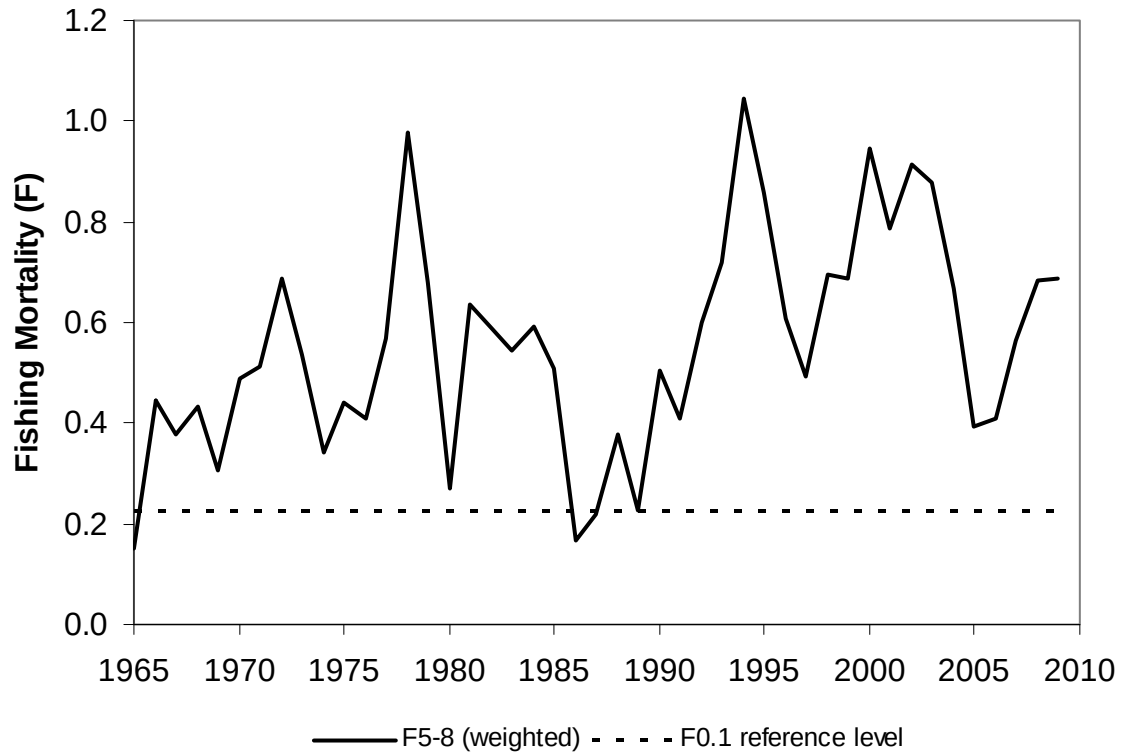


Figure 40. Fishing mortality (ages 5 to 8 weighted by population numbers) for the VPA calibrated with the German Bank acoustic index with $F_{0.1}$ reference level (F=0.228).

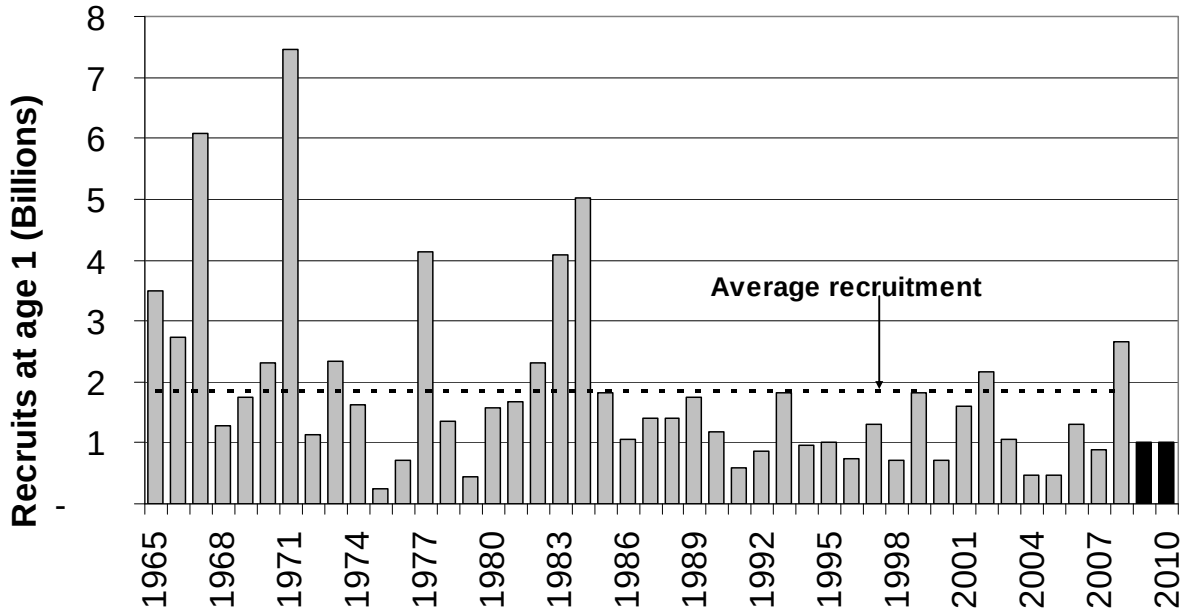


Figure 41. Recruitment at age 1 from the VPA calibrated with the German Bank only acoustic index and average recruitment for 1965 to 2008. Values of 1 billion were used for age 1 in 2009 and 2010 in the VPA formulation.

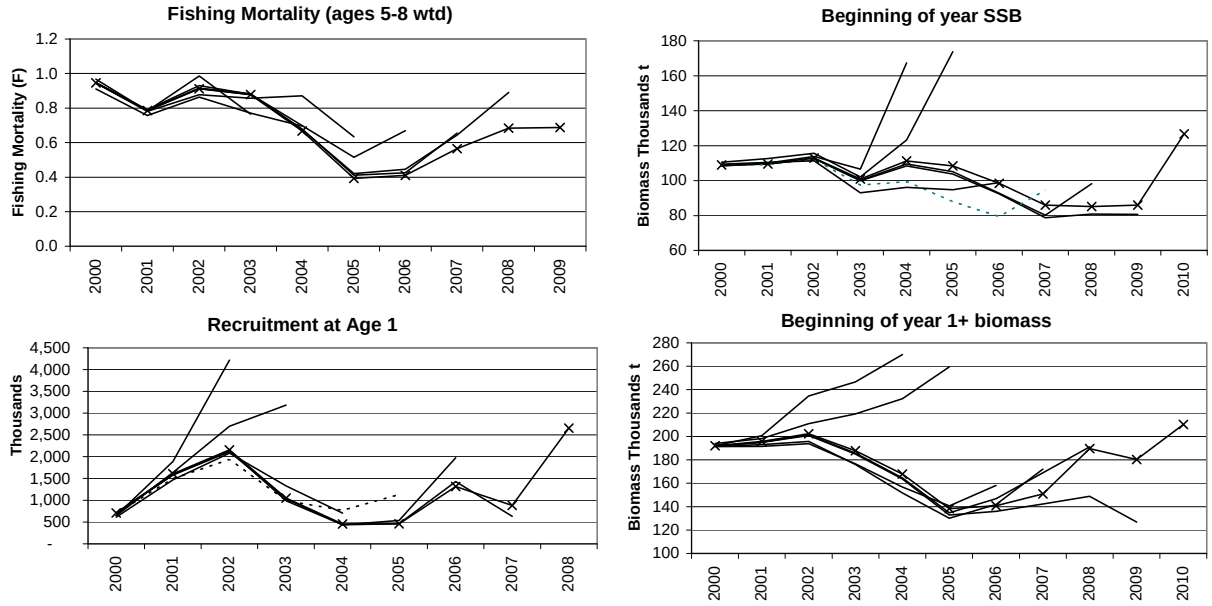


Figure 42. Retrospective estimates of the SW Nova Scotia / Bay of Fundy herring stock component from the VPA, as successive years of data were removed, for fishing mortality (F), recruitment at age 1, beginning of year SSB and beginning of year total biomass.

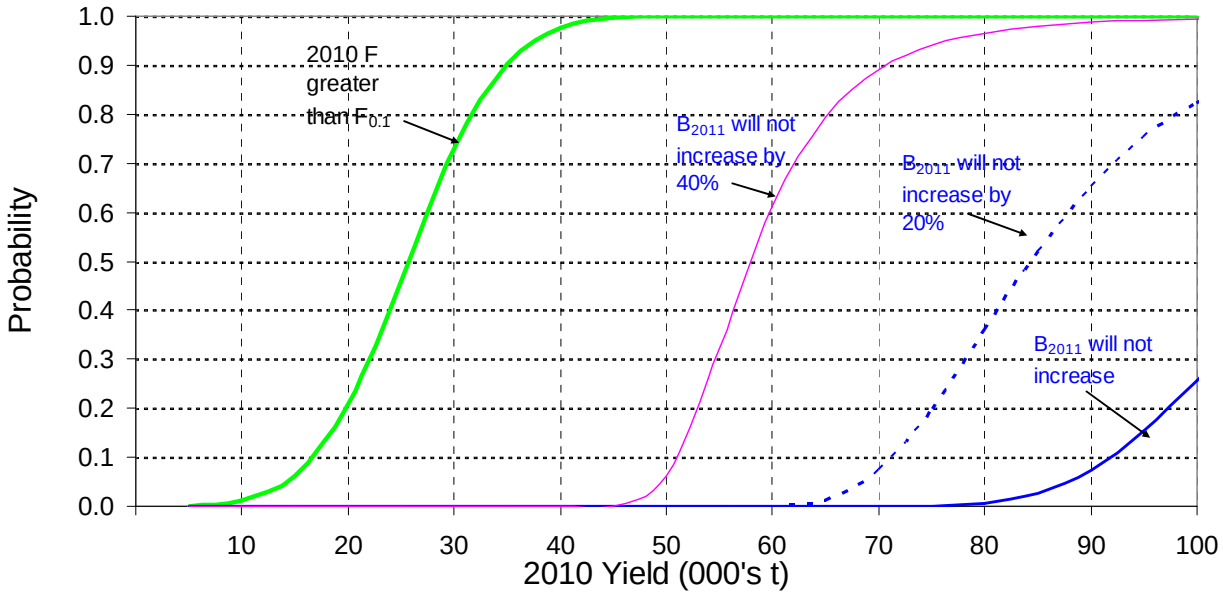


Figure 43. Probability (risk) of the 2010 fishing mortality exceeding F=0.228 and for 2011 total biomass not increasing more than the 2010 biomass by 0%, 20% and 40% at various yield (quota) levels for the VPA model with German Bank acoustic.

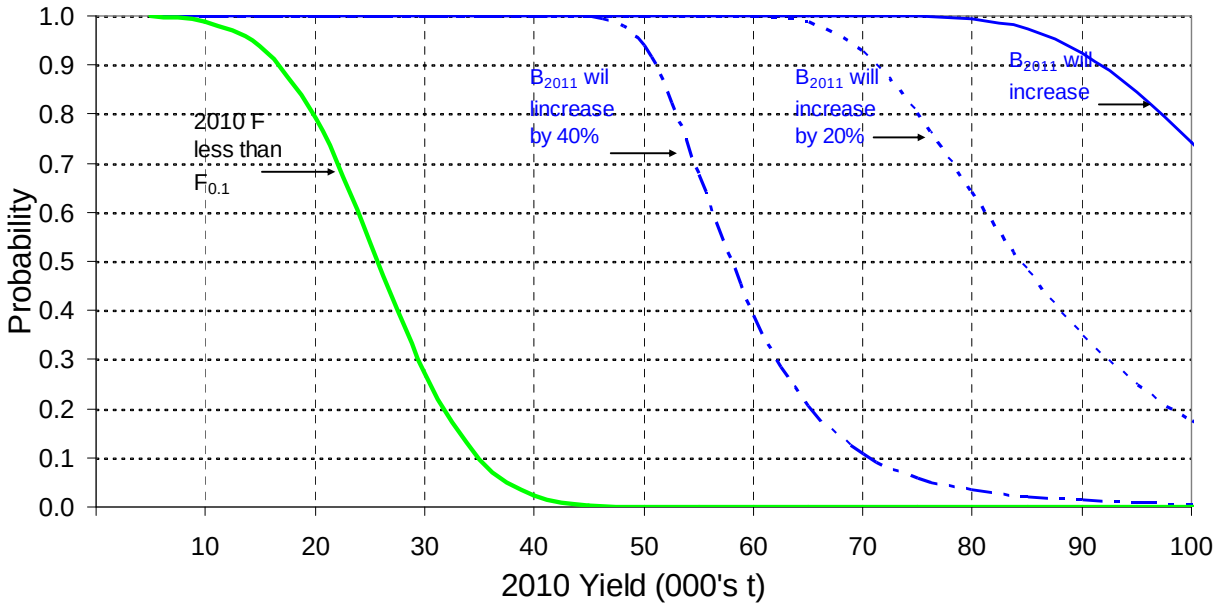


Figure 44. Probability (risk) of the 2010 fishing mortality exceeding F=0.228 and for 2010 total biomass increasing more than the 2010 biomass by 0%, 20% and 20% at various yield (quota) levels for the VPA model with German Bank acoustic.

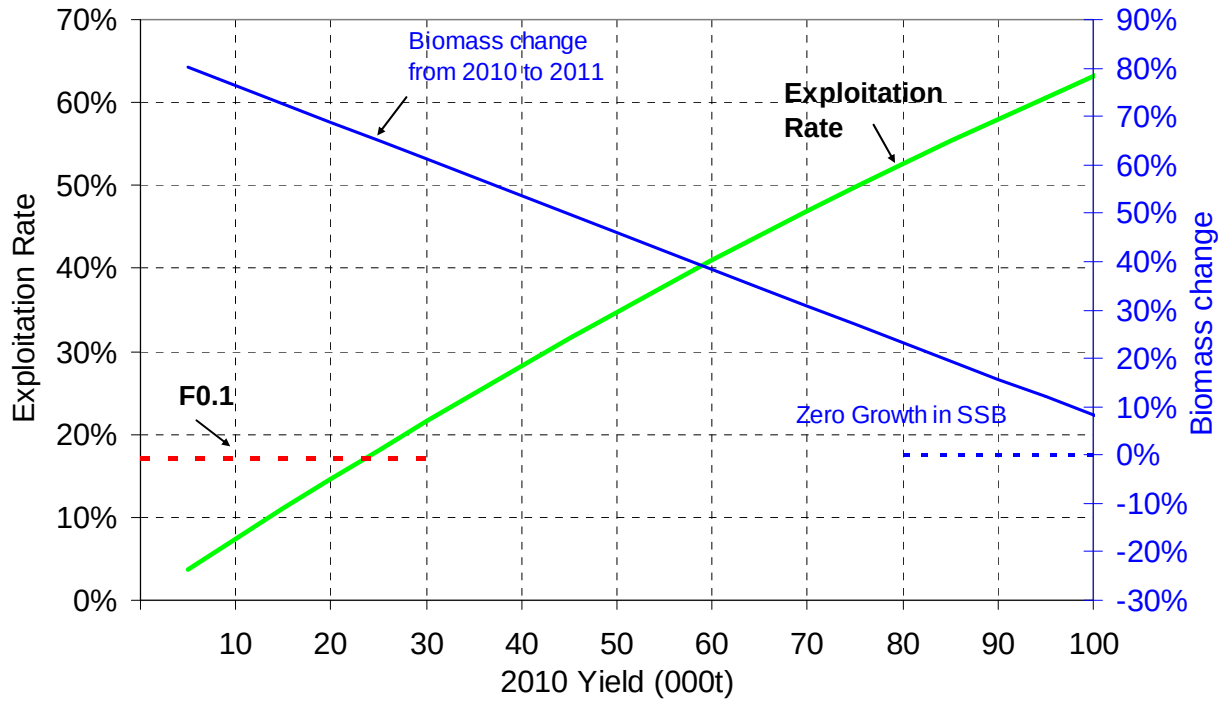


Figure 45. Exploitation rates (%) and total biomass change from 2010 to 2011for various quotas (yield) in 2010 for the VPA model with German Bank acoustic index (ages 4 to 8). The $F_{0.1}$ reference level (F=0.228 or 17% exploitation) and zero growth levels are also indicated.

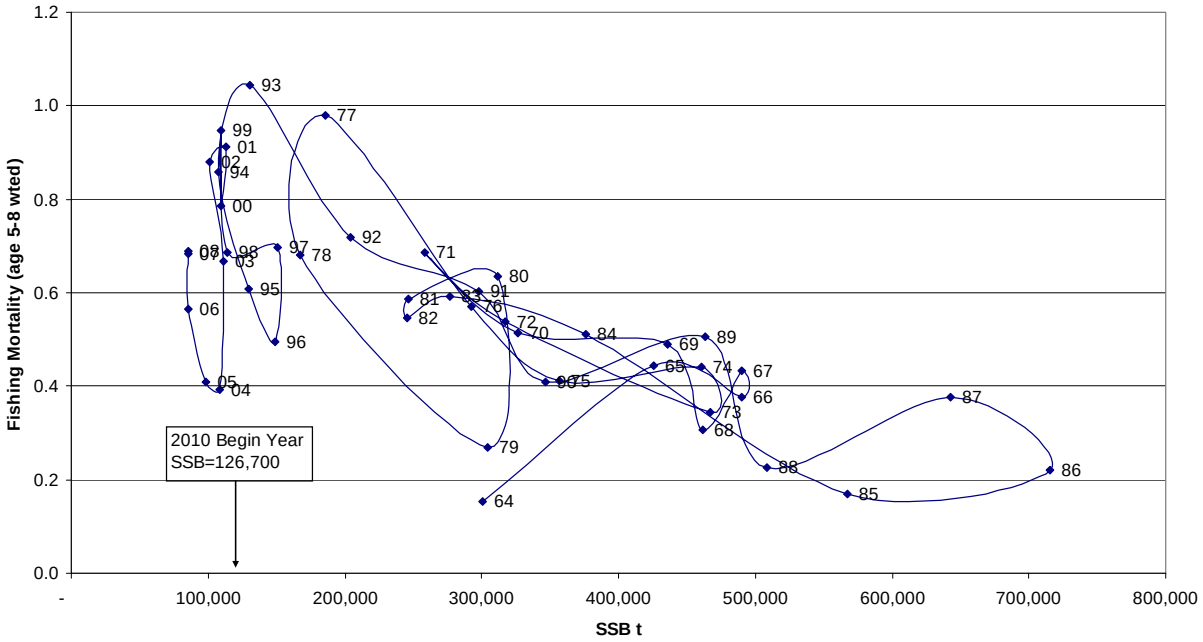


Figure 46. Annual trends in spawning stock biomass and fishing mortality from the VPA calibrated with German Bank acoustic index (ages 4 to 8). Year labels are shown for each data point and the total beginning of year biomass for 2010 is shown along scale.

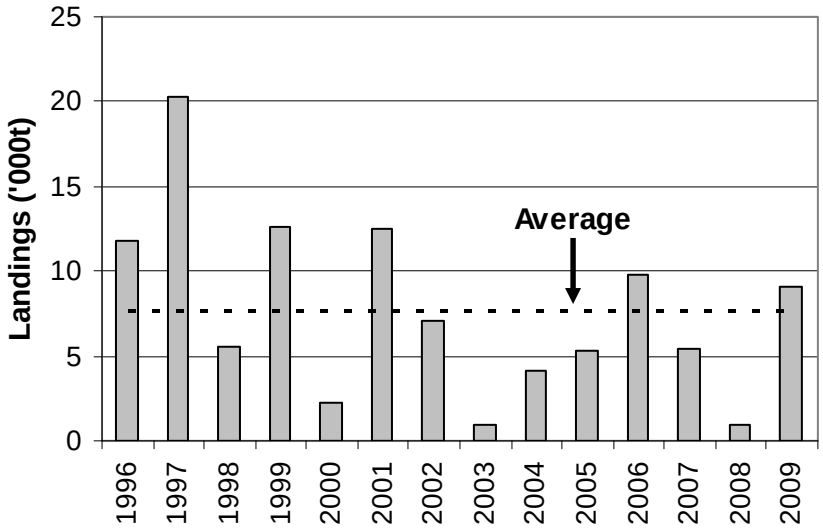


Figure 47. Scotian Shelf Banks herring landings from all gears for 1996 to 2009 with the overall average for the period.

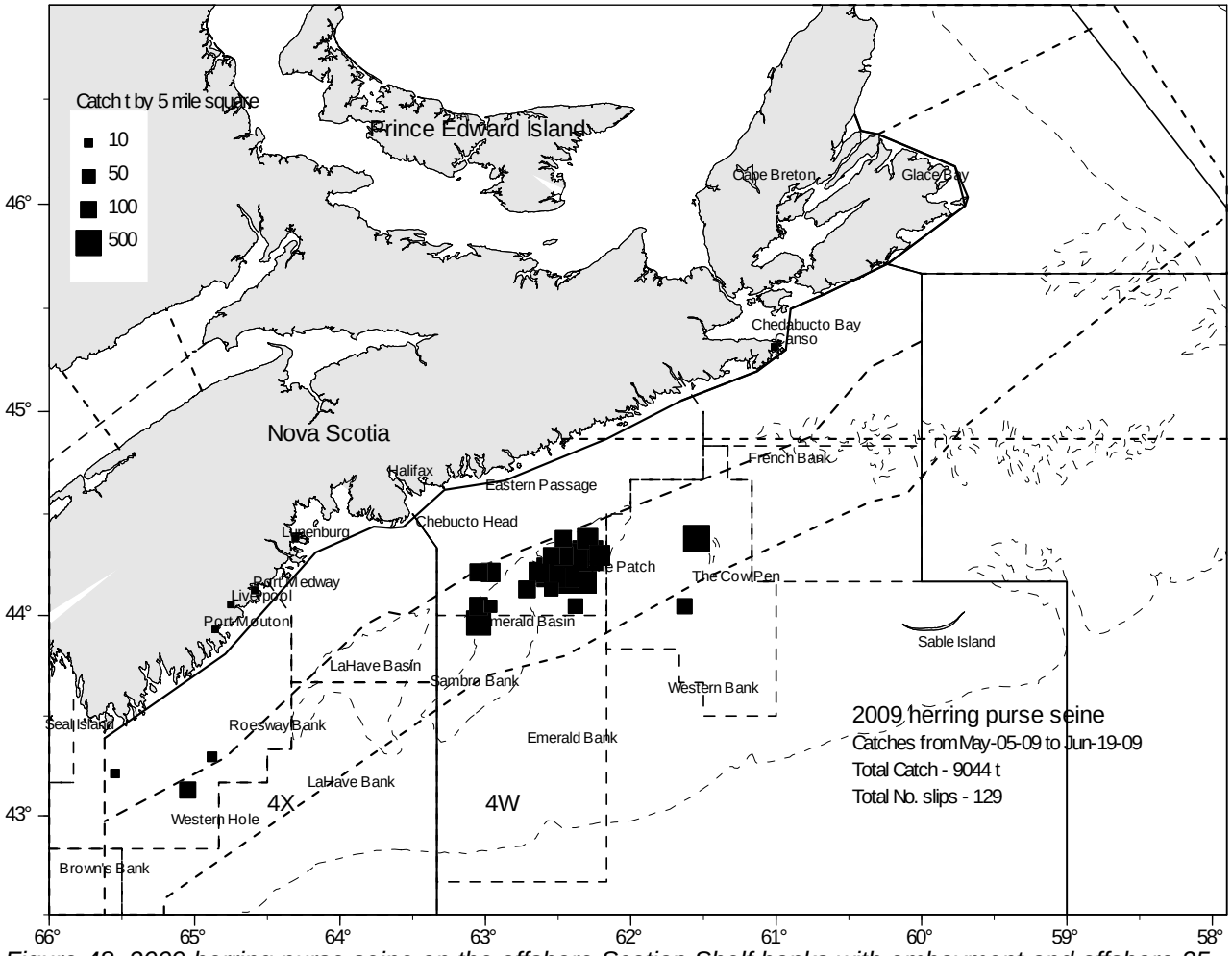


Figure 48. 2009 herring purse seine on the offshore Scotian Shelf banks with embayment and offshore 25 and 50 mile lines shown.

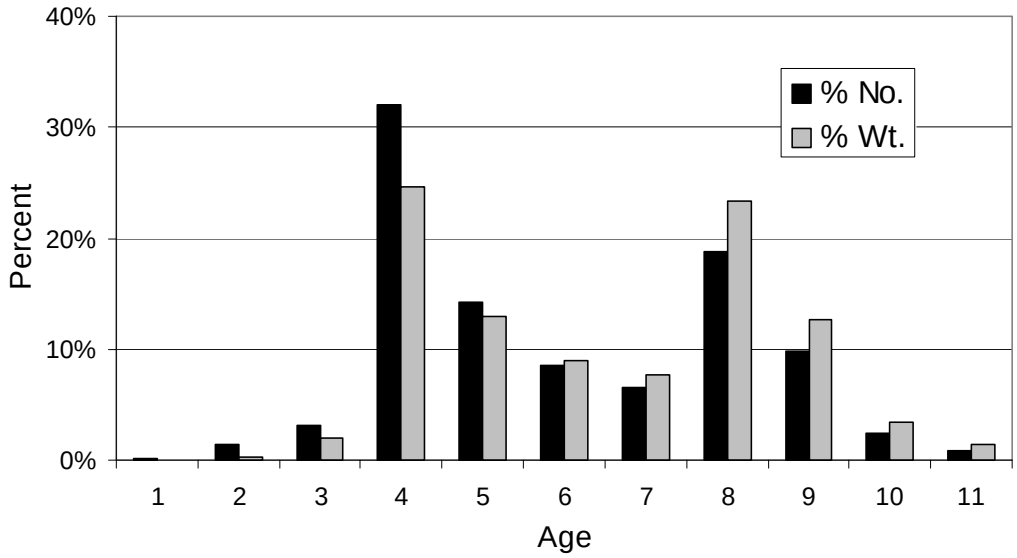


Figure 49. Fishery catch at age (% numbers and % weight) for the 2009 Offshore Scotian Shelf herring component.

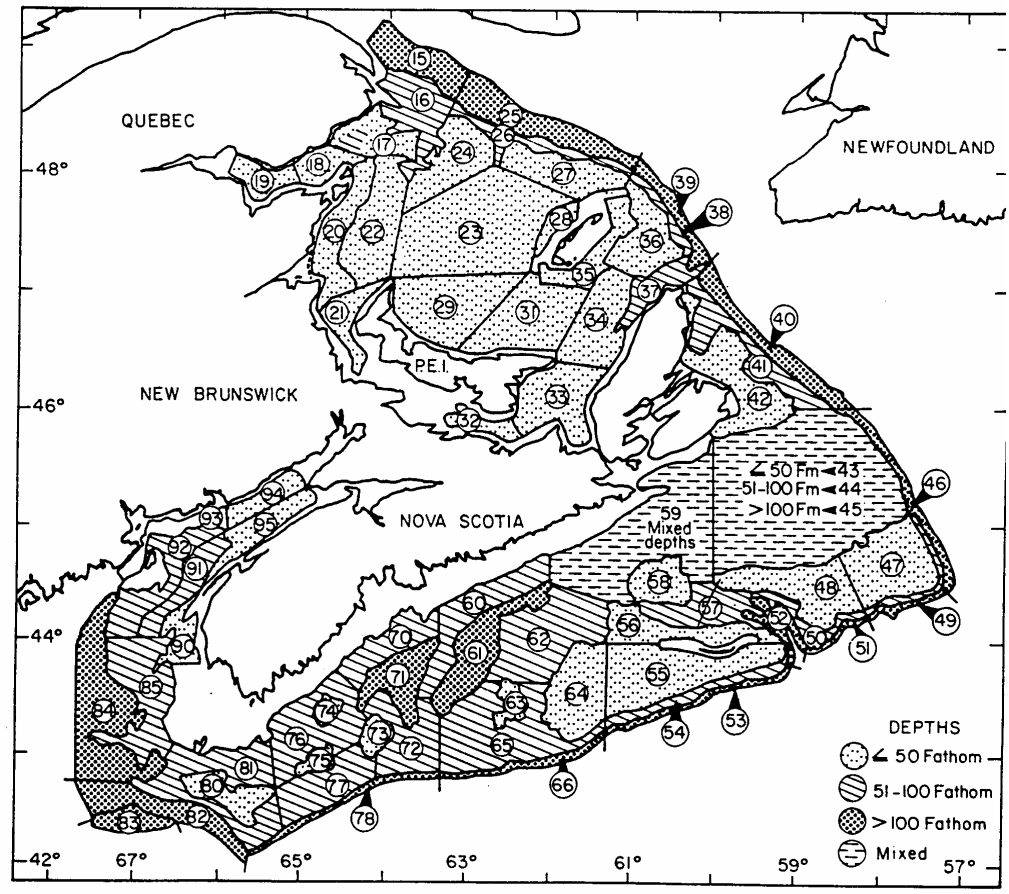


Figure 50. Research bottom trawl survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday 1981).

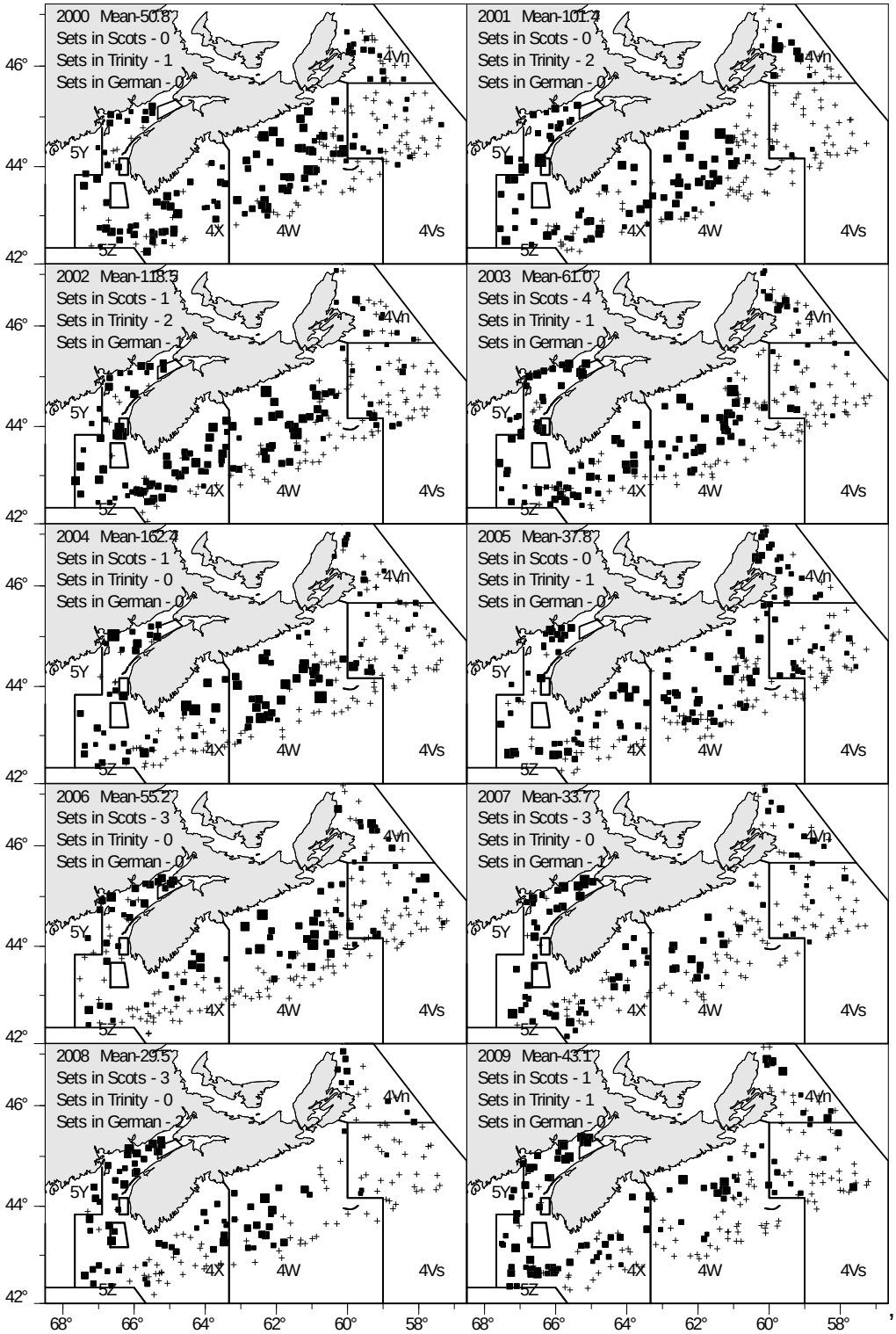


Figure 51. Herring catches from the DFO summer bottom trawl research survey for 2000-2009 (2005 using Alfred Needler data only). Mean numbers per standard tow and count of sets in Scots, Trinity and German spawning areas.

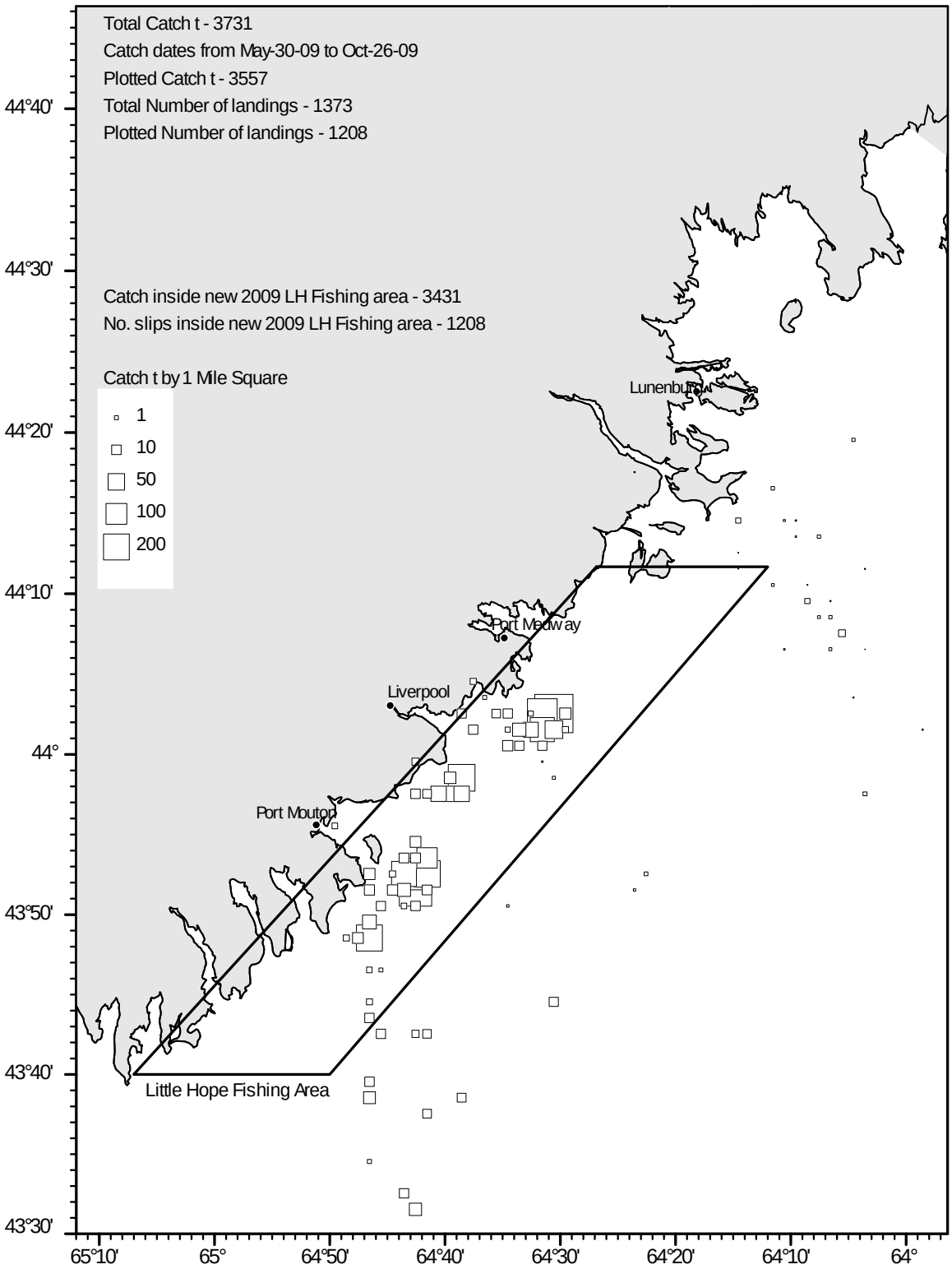


Figure 52. 2009 herring gillnet catch locations for landings in statistical districts 23-31 with amount caught within the Little Hope Fishing Area.

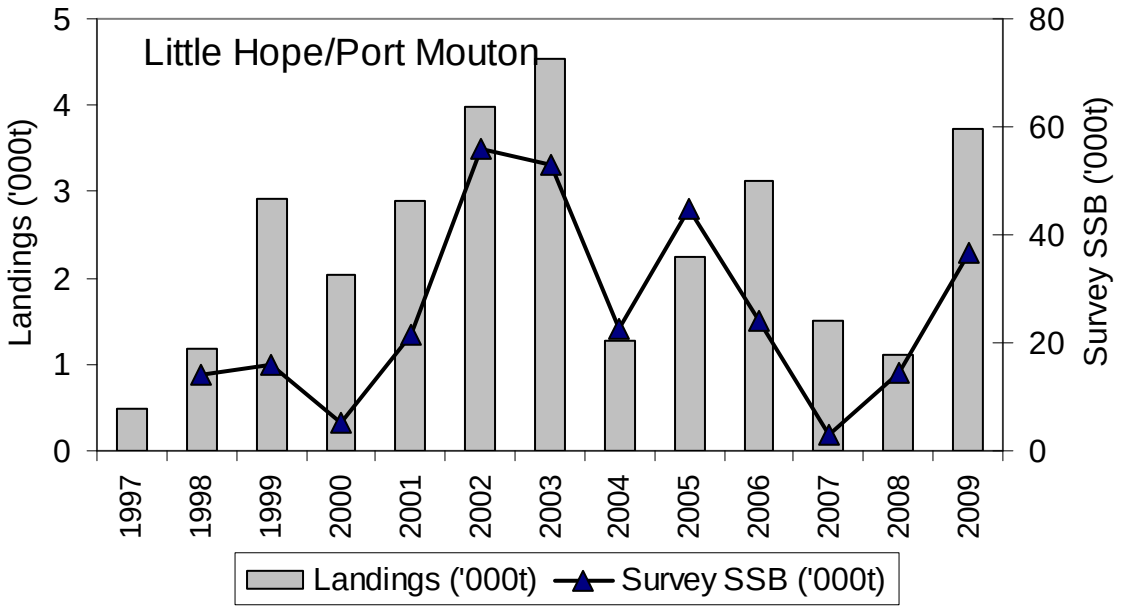


Figure 53. Herring landings and acoustic survey biomass ('000t) for the Little Hope/Port Mouton gillnet fishery from 1997-2009.

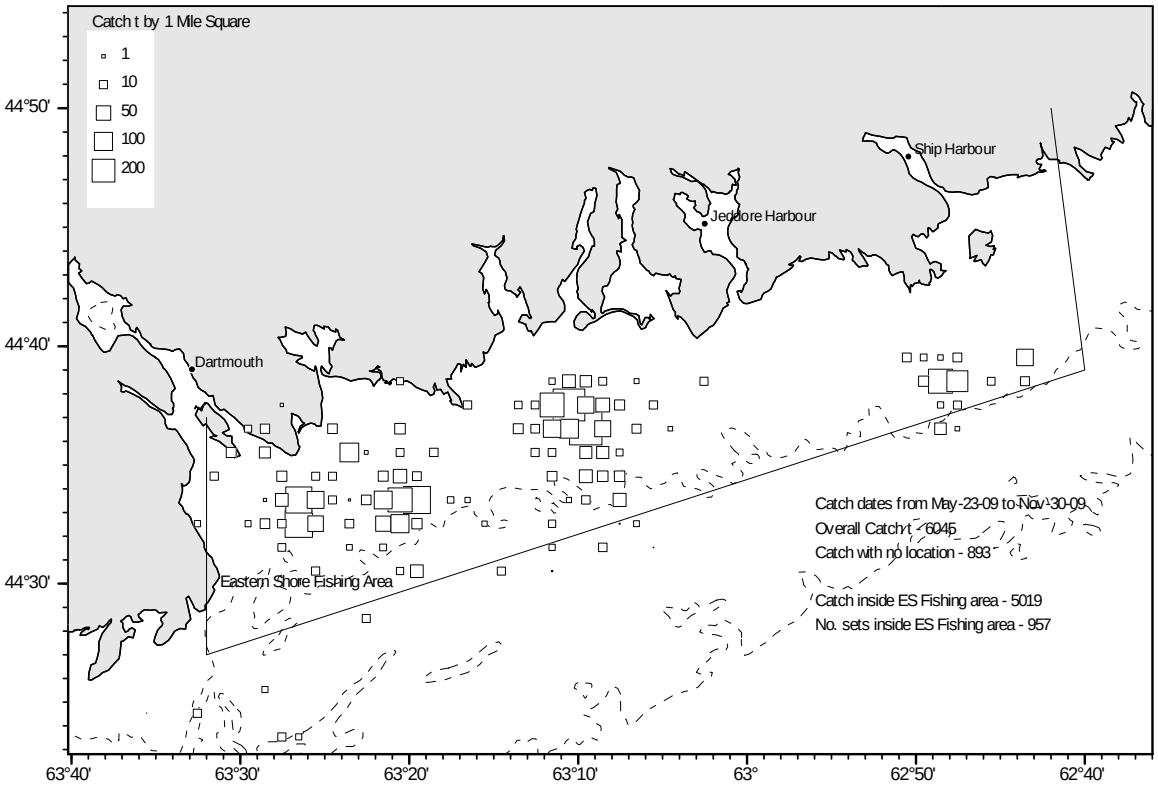


Figure 54. Gillnet herring catches for the 2009 fall fishery along the Eastern Shore Fishing Area (catches by 1 mile squares).

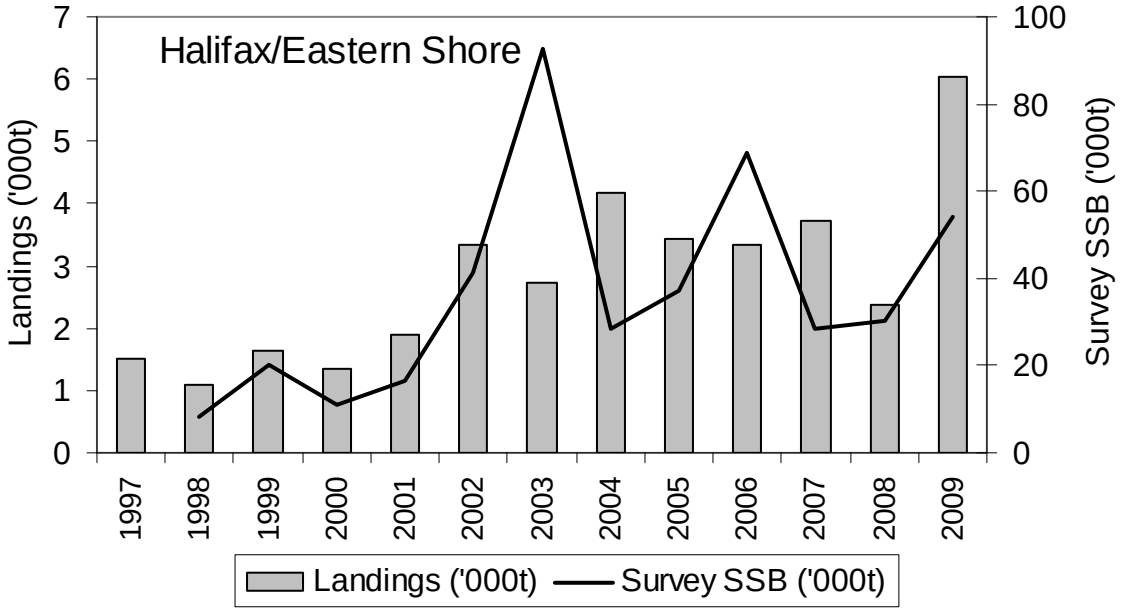


Figure 55. Herring landings and acoustic survey biomass ('000t) for the Halifax/Eastern Shore gillnet fishery from 1997-2009.

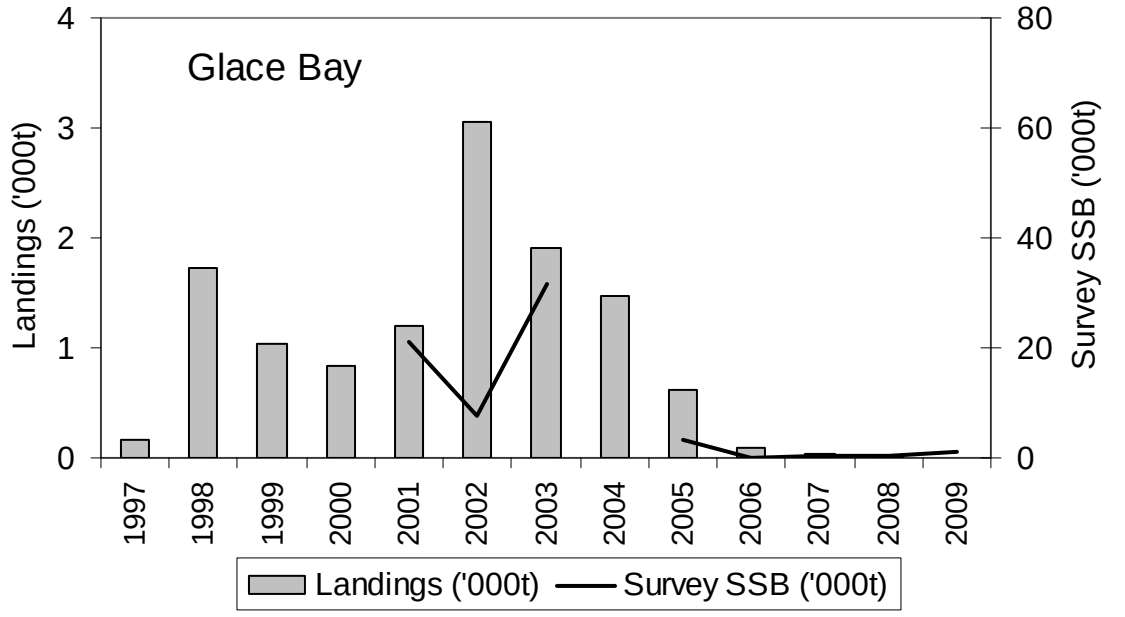


Figure 56. Herring landings and acoustic survey biomass ('000t) for the Glace Bay gillnet fishery from 1997-2009.

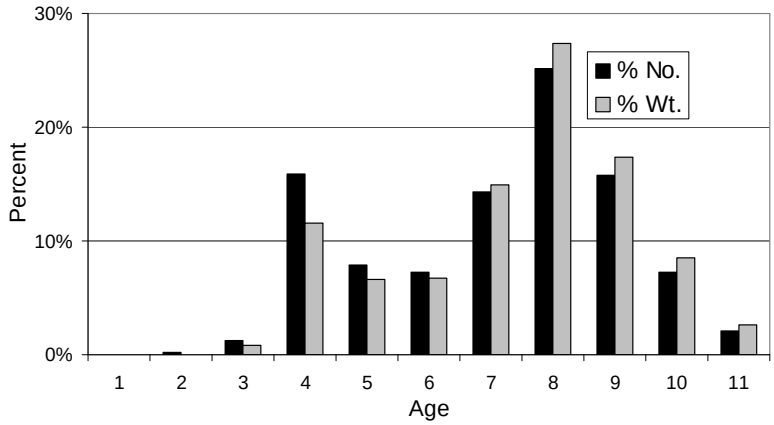


Figure 57. Fishery catch at age (% numbers and % weight) for the 2009 Coastal Nova Scotia herring component.

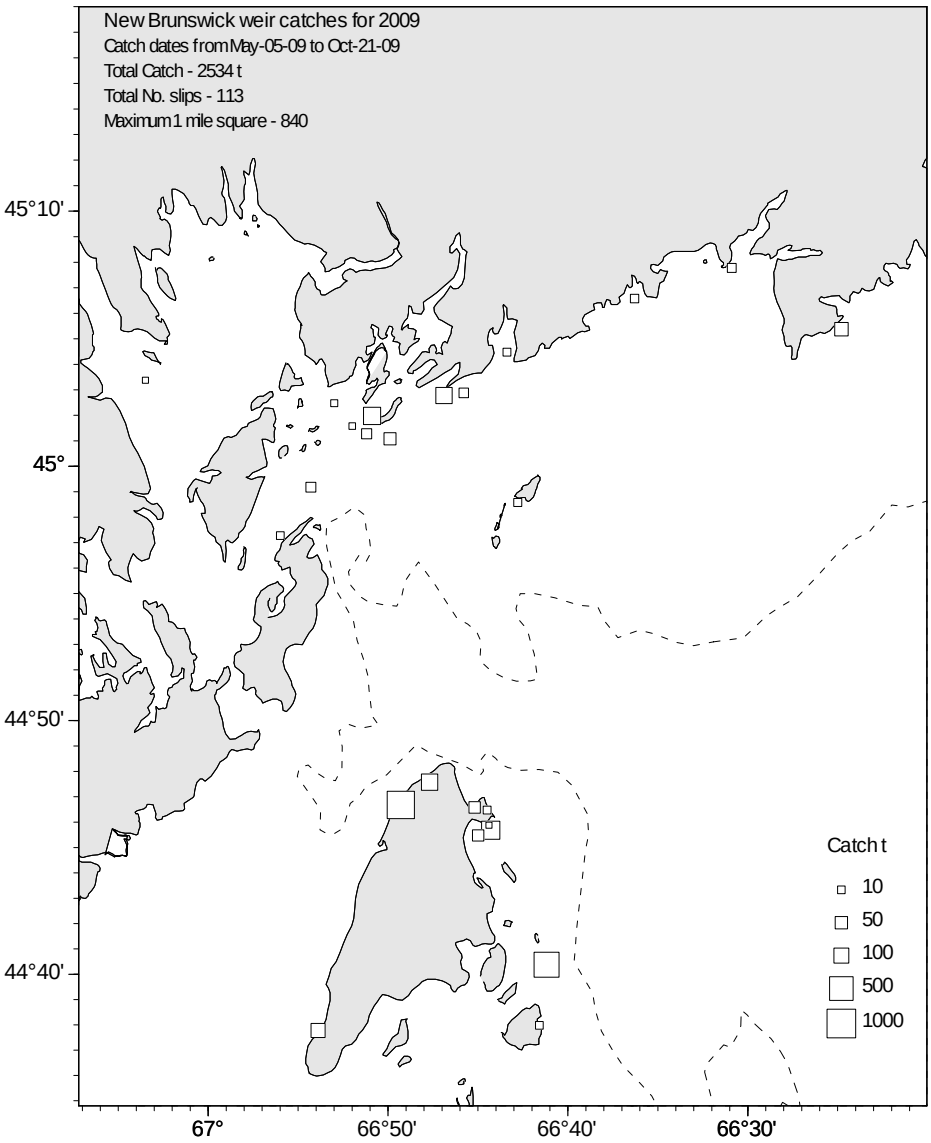


Figure 58. New Brunswick herring weir catches by location for the 2009 fishing season

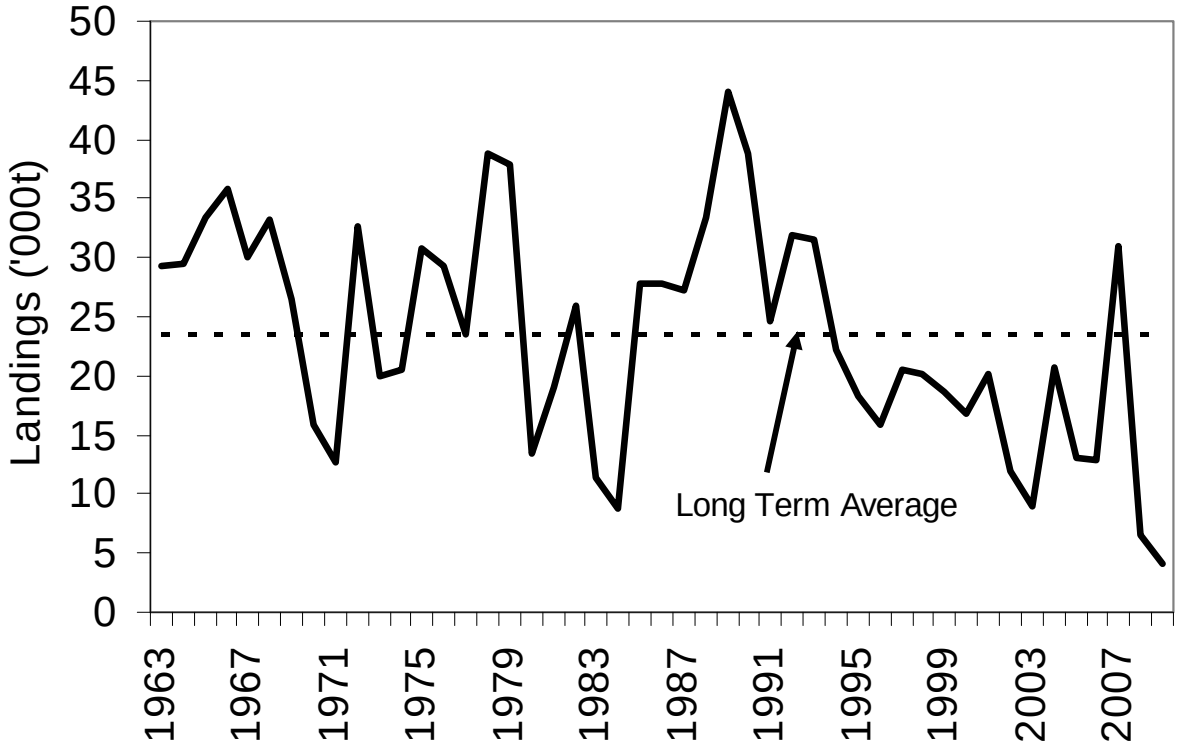


Figure 59. Herring landings from the southwest New Brunswick weir and shutoff fishery for 1963-2009 with the overall long term average.

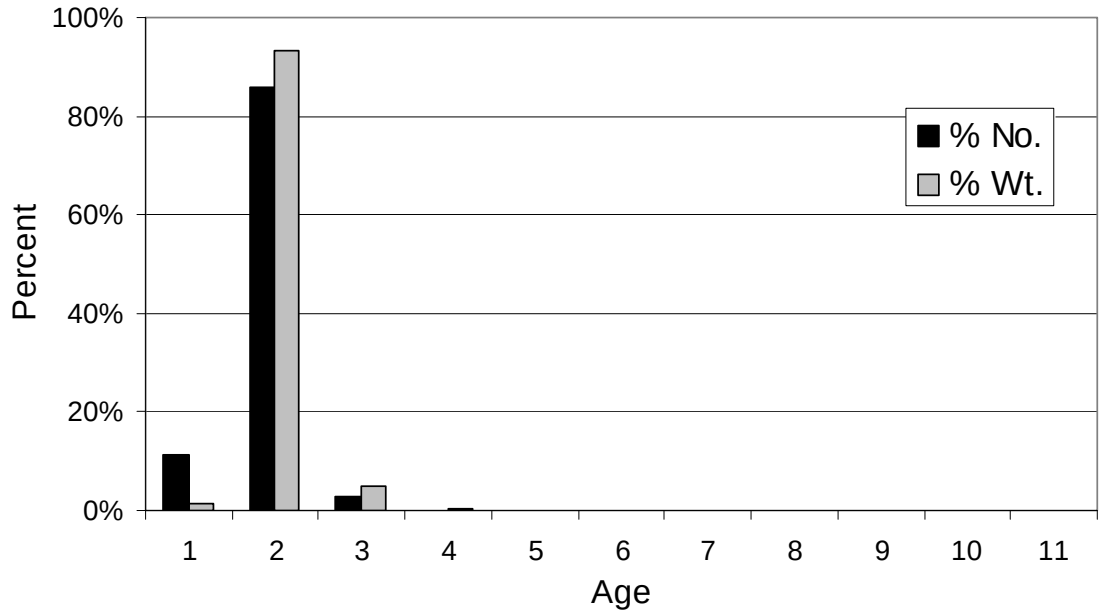


Figure 60. Fishery catch at age (% numbers and % weight) for the 2009 SW New Brunswick migrant juvenile herring component.

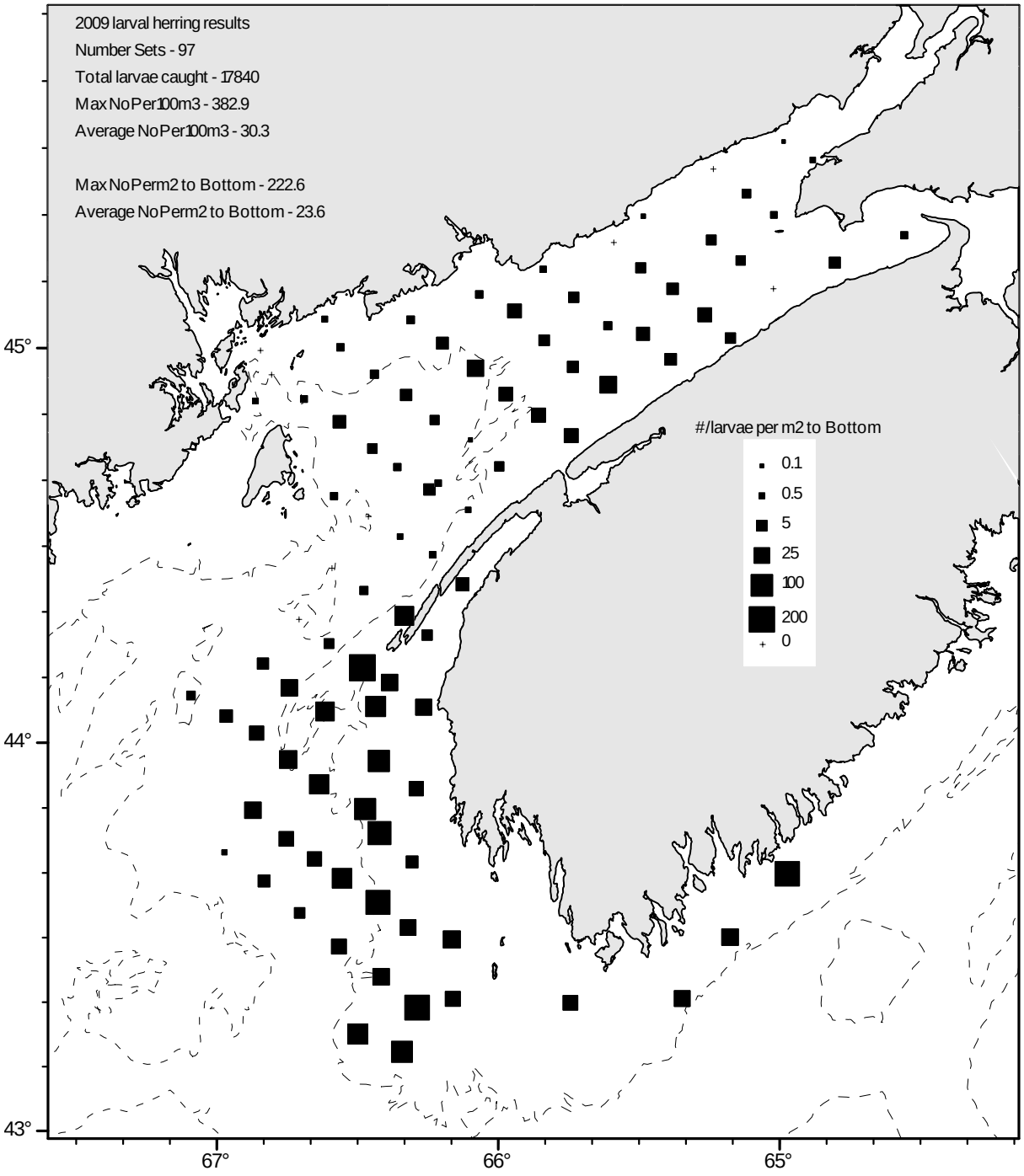


Figure 61. Larval herring abundance for the 2009 bongo survey (number of larvae per m^2 to bottom).

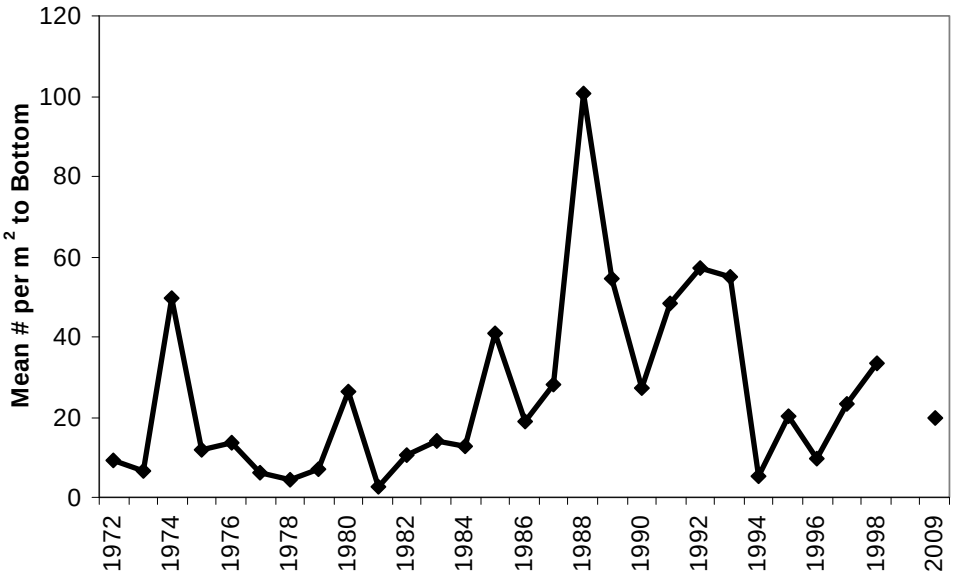


Figure 62. Herring larval abundance index from autumn Bay of Fundy / southwest Nova Scotia plankton surveys (average number of larvae per m^2 to bottom from 79 index stations) for 1972 to 1998 and 2009. Note there were no larval surveys in this area from 1999 to 2008.

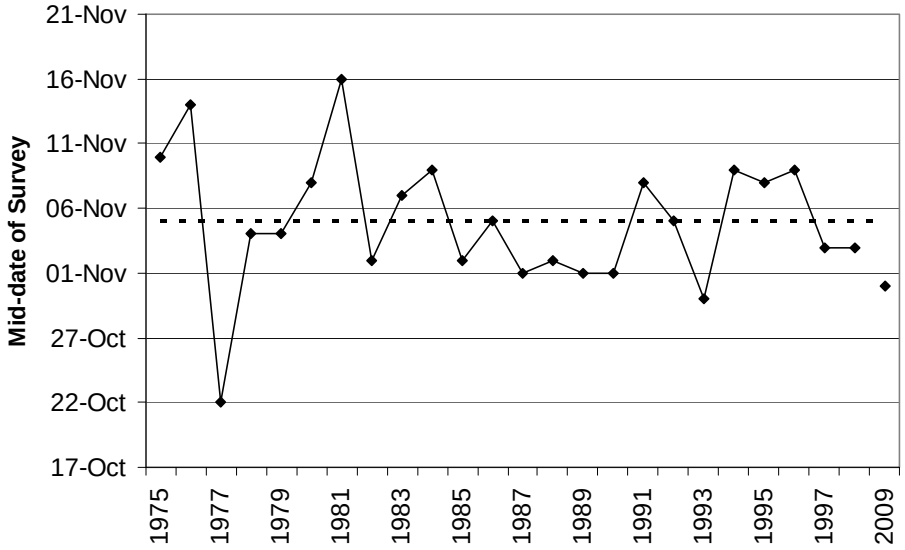
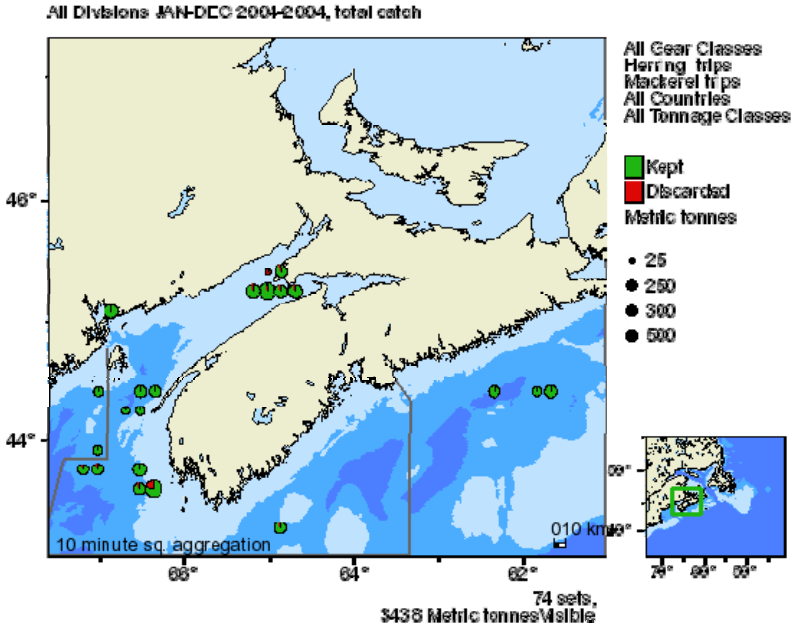


Figure 63. Larval survey timing from autumn Bay of Fundy / southwest Nova Scotia plankton surveys for 1975 to 2009 with mid-date of survey and overall average mid-date (of Nov. 5). Note there were no larval surveys in this area from 1999 to 2008.

Appendix A. Observer reports for herring directed trips from 2004-2009.

2004 Observer data

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

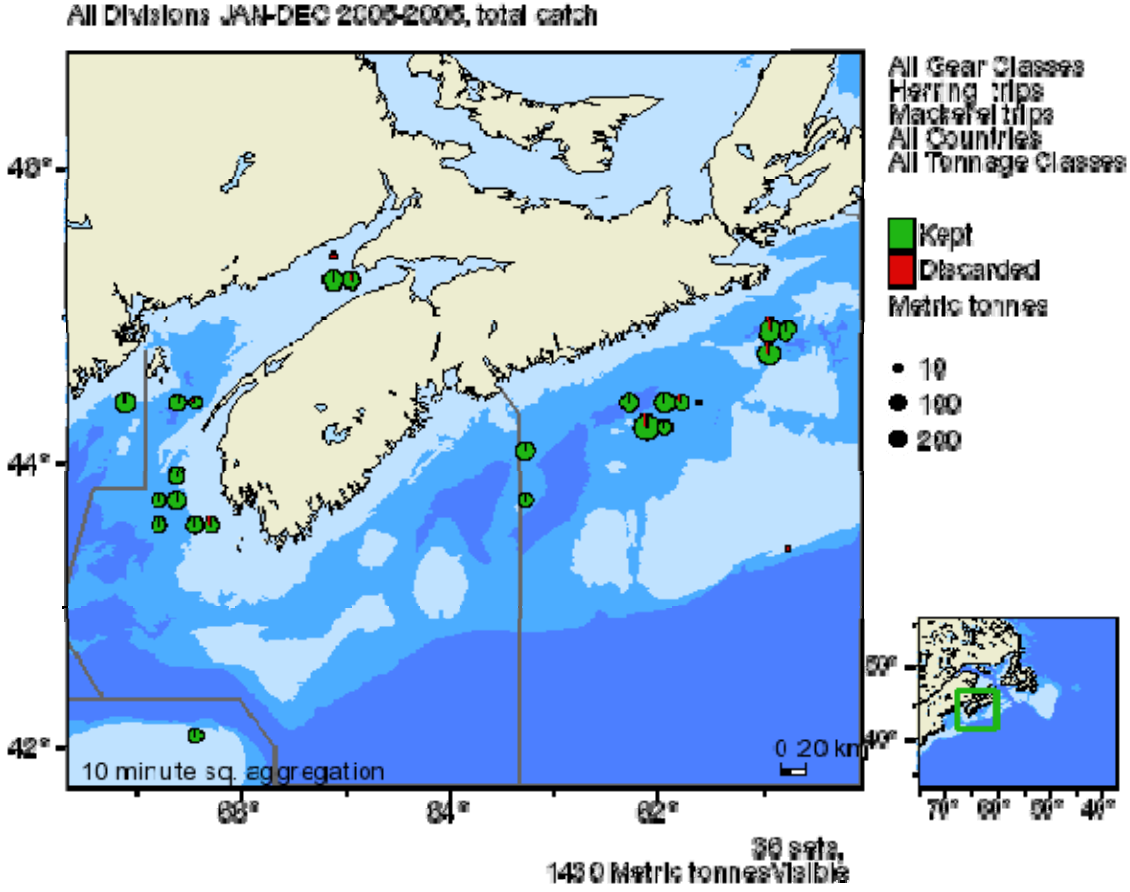


2004 Catch Composition (Metric tonnes)

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

2005 Observer data

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

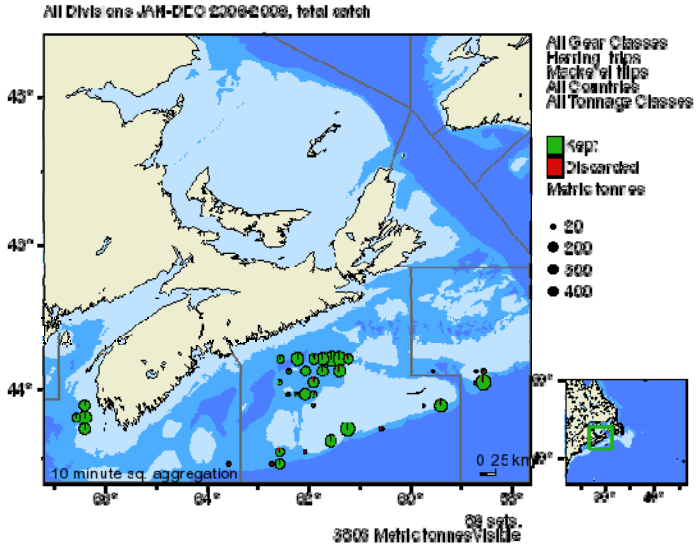


2005 Catch Composition (Metric tonnes)

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

2006 Observer data

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

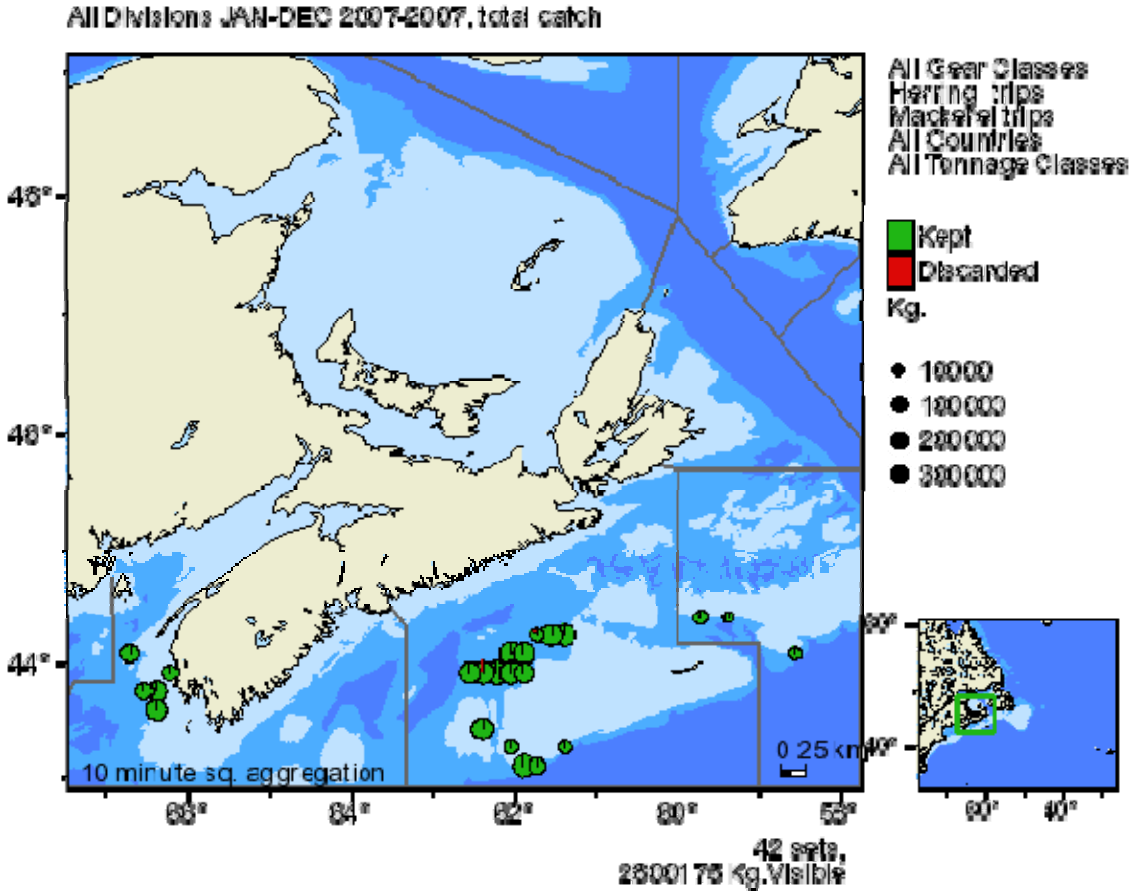


2006 Catch Composition (Metric tonnes)

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

2007 Observer data

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

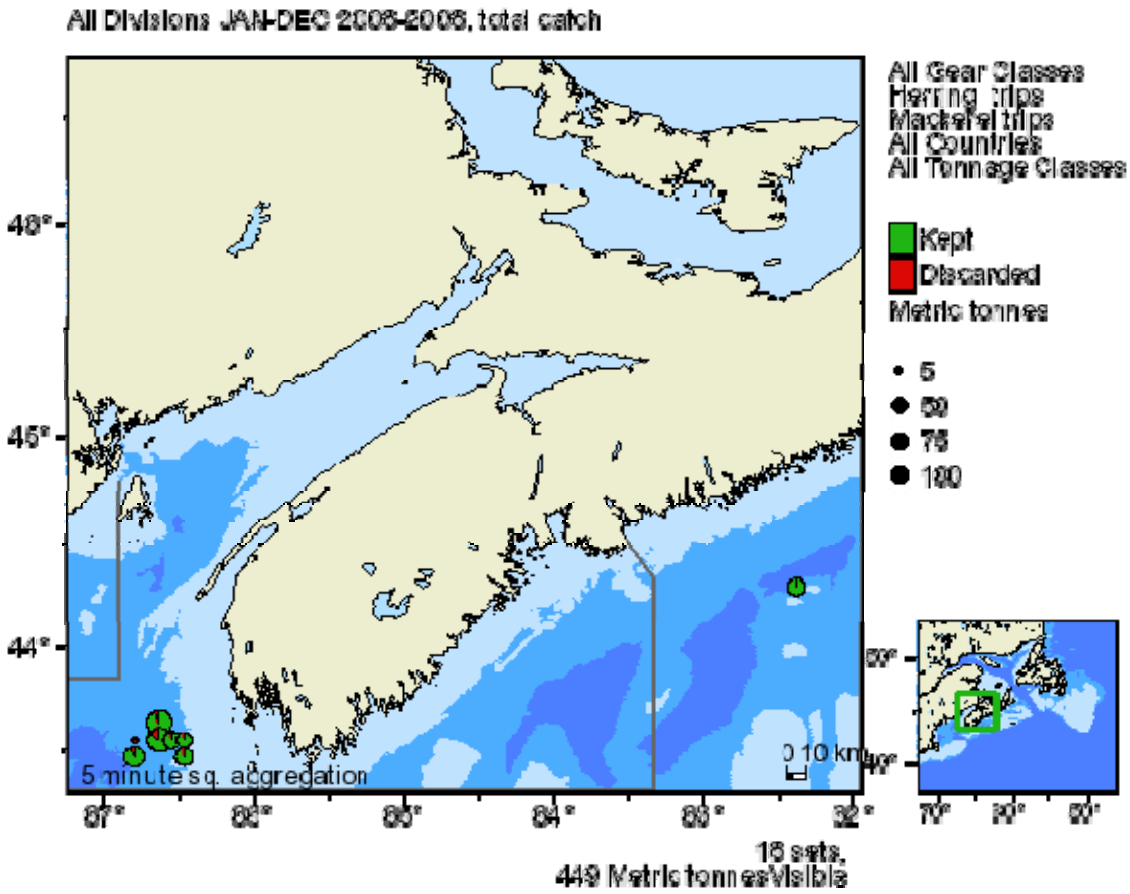


2007 Catch Composition (Metric tonnes)

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

2008 Observer data

- 11 trips, 30 sets monitored, purse seine gear only
- 1 trip in area 4W (Patch area) in June and rest in 4X during July and August
- only herring and dogfish observed; protocols checked and observers will be monitoring catch more closely in 2010 with more trips planned through FAM

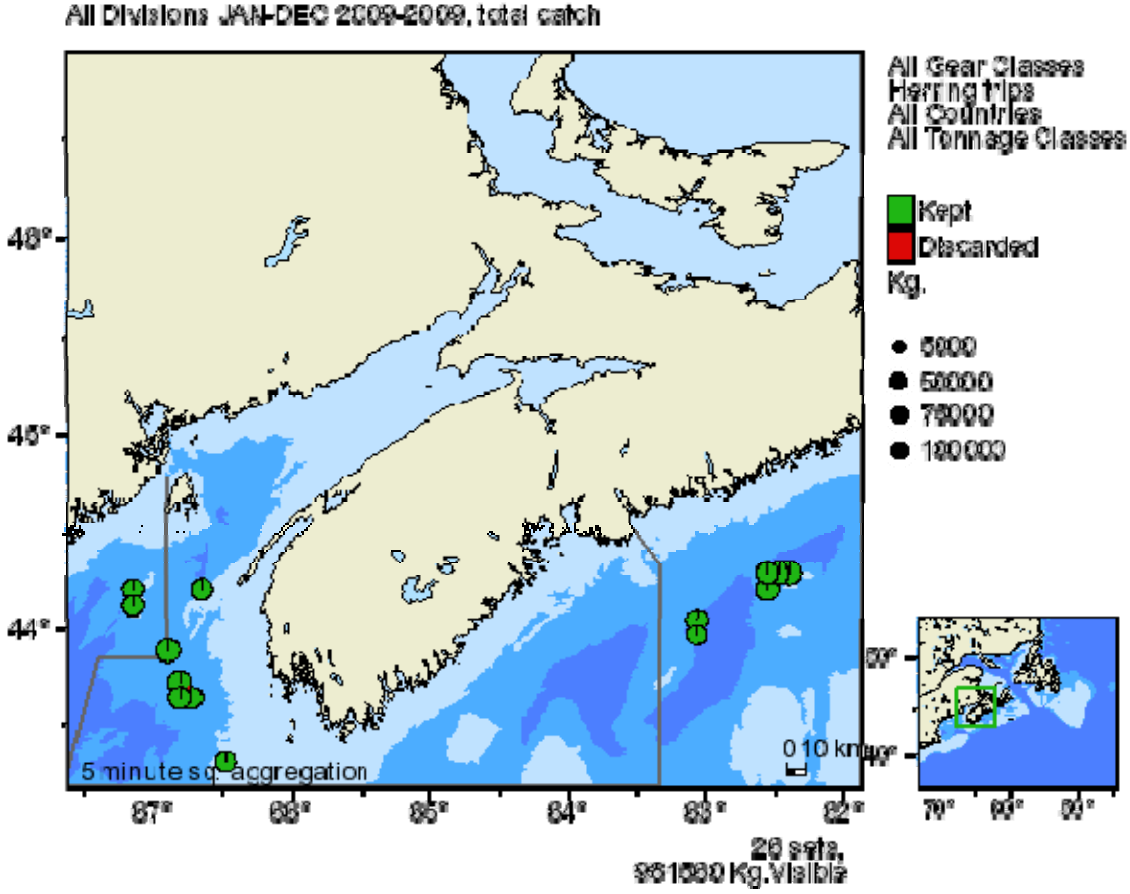


2008 Catch Composition (Metric tonnes)

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

2009 Observer data:

- 14 trips, 28 sets monitored, purse seine gear only
- 5 trip in area 4W (Patch area) in June and rest in 4X/5Y during July and Sept
- by-catch of only small amounts of mackerel and dogfish; protocols checked for observers



Catch Composition (Metric tonnes)

Species	Kept 2009	Discarded 2009
HERRING(ATLANTIC)	981.545	0
MACKEREL(ATLANTIC)	0.01	0
SPINY DOGFISH	0	0.005

Appendix B. ADAPT formulation and model output using German Bank acoustic index (ages 4-8).

```
TUESDAY, APRIL 13, 2010  10:00:51.542 AM
Portions of this program are copyrighted works of APL2000, Inc.
Copyright 1996 APL2000, Inc.
APL  Ver. 6.0.10

ADAPT-W  Ver. 3.1
Workspace size = 1449590784

Catch (with revised 1999-2009)
             1       2       3       4       5       6       7       8       9      10      11
1965.00  270378 1084719   34835  234383   49925   10592    1693     561      54      37       1
1966.00  154323  914093  448940   73382  321857   45916   13970    7722    1690     215       1
1967.00  722208  613970  153626  266454  110051  159203   57948    4497     409     296     148
1968.00  164703 2389061  224956   83109  290285   73087   90617   31977   15441    5668    1175
1969.00  108875  290329  531812  132319  162439  112631   62506   22595    6345    2693     722
1970.00  699720  576896   76532  286278  201215  120280  111937   41257   21271    7039    2674
1971.00   87570  404224  183896  106630  113566   75593   93620   50022   36618    7536    5695
1972.00       0  649254   71984  148516   77207   75384   49065   48700   26055   13792   11679
1973.00    1018  167454  781061  130851   40128   30334   22046   20249   23871   11630   13386
1974.00   18411  766064   93606  803651   68276   19093   10232    6565   12786    7102    9031
1975.00    3199  317641  239827  124599  514605   66302   12298    4409    4778    3847    6225
1976.00     240   55596  206535  153782   68804  268839   21460    5571    3951    2059    3446
1977.00    1170  153921   31572  218478  119234   51173  177247   13977    3170    1415    3894
1978.00   35381  383611   40887   12906  122108   68410   31088  108975   11082    2425    1676
1979.00     342  183982  250393   54620    5430   23142   18255   11836   41389    4527    2411
1980.00    2339   12503   80518  474091   27930    4373    4692    6560    2985   10641    2739
1981.00       0  103051   50883  102743  451482   32978    2418    2767    1917     538    2149
1982.00    3589  102133  150764   22640   98206  211043   14627    2080    1354    1250    1014
1983.00    5488  191682  150328  244007   24483   60678   89982   10352    1728     642    1324
1984.00       0   88433  243542  224354  146096   22716   21654   28299    9515    2183    9000
1985.00    9022  216740  337591  302782  147670   42404   14075   18178    7997    1201     470
1986.00      63  125300  275903  292792   56937   31599   10770    4320    2942    1356     349
1987.00    2300   82940  126436  527443  242597   45933   19481    7292    3361    3120     650
1988.00     151  148399  113208  195096  434192  236089   42533   21208    4186    3797    2845
1989.00       8  101788  114095   61842   79451  169023   76684   18303    8270    3814    3057
1990.00       0  178532  130176  171560   89922  101066  201901  116788   31466   10572    6848
1991.00       0   96960  179463  183647   88431   41352   50380   80732   45516   18291   13524
1992.00       9  168561  132642  286923  126510   75473   34458   35369   59136   34558   20653
1993.00     166   76405   43766  194198  130713   67708   33820   21481   21893   20684   11175
1994.00     151  103885  142260   53700  118015   72512   36059   14889    8706   10447   15533
1995.00    1831  113457  219777  112245   36784   36402   22127    6474    4217    2957    3566
1996.00       0   37496   37715  256063   54534   16862    9151    3300    1782    1310    1605
1997.00     356   56561   87395   78098  131062   18917    5131    3636     894     620     874
1998.00     137  264901   62322  138751   97065   97464   20679    3856    1730    1288     398
1999.00    8851  151039  252738   71618  103543   62952   26311    6226    2085     388     664
2000.00     458  377737   53091  123143  109079   56447   30188   11736    1459     642     255
2001.00      79   80842  310871   53995   64106   30769   17119    4620    3363     237     191
2002.00   15637  310284  106948  189078   84275   24536    9430    5885    3011    2438    1815
2003.00      91  478583  254757   80673  108638   18949    9942    3108    2871    1815    1156
2004.00    3590  321791  315227  161333   39533   36688   10713    1908    3175    1249    1663
2005.00     510   66456  130574  173597   59342   12273    8654    4208    1009     102     538
2006.00    2649  111810  102318   68387   81548   34414   16298    3859     419     216     136
2007.00      14  185513   55970   33654   38506   70868   25268    7346    1289     467     230
2008.00    1152   78374  219897   52978   24831   32050   31086   11402    4225     481      77
2009.00     702  263298  117708  138589   22198   11954   11487   13084    6008    1418     314
2010.00

German Only Acoustic-newages
               4       5       6       7       8
1999.65*********************************57062.00
2000.65****************************************
2001.65************************63690.0012901.00
2002.65************************69343.0043173.00
2003.65************************63515.0018151.00
2004.65************************53172.0019343.00
2005.65****************92400.0079193.0034675.00
2006.65*********************************32351.00
2007.65*********************************29818.00
```

```
 2008.65********93175.00************************
 2009.65****************79524.0084240.0096383.00

Index Type and Model Form
ID# þ Label þ  Age Group(s) þ Index Type þ Model Form
 1 German Only Acoustic-newages 4 Abundance Proportional
 2 German Only Acoustic-newages 5 Abundance Proportional
 3 German Only Acoustic-newages 6 Abundance Proportional
 4 German Only Acoustic-newages 7 Abundance Proportional
 5 German Only Acoustic-newages 8 Abundance Proportional

Index Inclusion
ID# on same line have common catchability
 1
 2
 3
 4
 5

VPA setup
Plus Group : Yes, using FIRST method

Population
            1       2       3       4       5       6       7       8       9      10      11+
 1965.00                                                                              (500)
 2009.00********
 2010.00********                                            5000
F ratios
            1       2       3       4       5       6       7       8       9      10      11+
 1965.00                                            1.00    1.00    1.00    1.00  **wtd**
 1966.00                                            1.00    1.00    1.00    1.00  **wtd**
 1967.00                                            1.00    1.00    1.00    1.00  **wtd**
 1968.00                                            1.00    1.00    1.00    1.00  **wtd**
 1969.00                                            1.00    1.00    1.00    1.00  **wtd**
 1970.00                                            1.00    1.00    1.00    1.00  **wtd**
 1971.00                                            1.00    1.00    1.00    1.00  **wtd**
 1972.00                                            1.00    1.00    1.00    1.00  **wtd**
 1973.00                                            1.00    1.00    1.00    1.00  **wtd**
 1974.00                                            1.00    1.00    1.00    1.00  **wtd**
 1975.00                                            1.00    1.00    1.00    1.00  **wtd**
 1976.00                                            1.00    1.00    1.00    1.00  **wtd**
 1977.00                                            1.00    1.00    1.00    1.00  **wtd**
 1978.00                                            1.00    1.00    1.00    1.00  **wtd**
 1979.00                                            1.00    1.00    1.00    1.00  **wtd**
 1980.00                                            1.00    1.00    1.00    1.00  **wtd**
 1981.00                                            1.00    1.00    1.00    1.00  **wtd**
 1982.00                                            1.00    1.00    1.00    1.00  **wtd**
 1983.00                                            1.00    1.00    1.00    1.00  **wtd**
 1984.00                                            1.00    1.00    1.00    1.00  **wtd**
 1985.00                                            1.00    1.00    1.00    1.00  **wtd**
 1986.00                                            1.00    1.00    1.00    1.00  **wtd**
 1987.00                                            1.00    1.00    1.00    1.00  **wtd**
 1988.00                                            1.00    1.00    1.00    1.00  **wtd**
 1989.00                                            1.00    1.00    1.00    1.00  **wtd**
 1990.00                                            1.00    1.00    1.00    1.00  **wtd**
 1991.00                                            1.00    1.00    1.00    1.00  **wtd**
 1992.00                                            1.00    1.00    1.00    1.00  **wtd**
 1993.00                                            1.00    1.00    1.00    1.00  **wtd**
 1994.00                                            1.00    1.00    1.00    1.00  **wtd**
 1995.00                                            1.00    1.00    1.00    1.00  **wtd**
 1996.00                                            1.00    1.00    1.00    1.00  **wtd**
 1997.00                                            1.00    1.00    1.00    1.00  **wtd**
 1998.00                                            1.00    1.00    1.00    1.00  **wtd**
 1999.00                                            1.00    1.00    1.00    1.00  **wtd**
 2000.00                                            1.00    1.00    1.00    1.00  **wtd**
 2001.00                                            1.00    1.00    1.00    1.00  **wtd**
 2002.00                                            1.00    1.00    1.00    1.00  **wtd**
 2003.00                                            1.00    1.00    1.00    1.00  **wtd**
 2004.00                                            1.00    1.00    1.00    1.00  **wtd**
 2005.00                                            1.00    1.00    1.00    1.00  **wtd**
```

2006.00					1.00	1.00	1.00	1.00	**wtd**	
2007.00					1.00	1.00	1.00	1.00	**wtd**	
2008.00					1.00	1.00	1.00	1.00	**wtd**	
2009.00	********				0.20					
2009.00		********			0.40					
2009.00			********		0.70					
2009.00				********	0.90					
2009.00					1.00	********				
2009.00					1.00		********			
2009.00					1.00			********		
2009.00					1.00				********	

Natural Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1966.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1967.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1968.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1969.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1970.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1971.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1972.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1973.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1974.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1975.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1976.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1977.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1978.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1979.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1980.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1981.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1982.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1983.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1984.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1985.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1986.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1987.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1988.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1989.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1990.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1991.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1992.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1993.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1994.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1995.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1996.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1997.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1998.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1999.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2000.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2001.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2002.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2003.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2004.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2005.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2006.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2007.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2008.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2009.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)

Virtual Population Analysis using initial values

Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503535	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	35035	2855	1060	707
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	41661	21740	836	1253
1968.00	1286168	4325977	1170158	950143	889042	372334	200109	75150	30056	17430	1311
1969.00	1754254	904620	1415817	755635	702962	467578	239085	82892	32938	10845	9244
1970.00	2304088	1338028	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460432	1258575	579796	324285	303152	228973	243661	130382	77266	19947	19640
1972.00	1138008	6028997	667900	309749	169890	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350865	481941	121064	70133	52761	54102	51165	27434	19153
1974.00	1625831	1912064	612116	2859204	277070	63139	30305	23481	26162	20577	15921
1975.00	247160	1314490	880009	416859	1619379	165492	34562	15639	13330	10013	15485
1976.00	721831	199468	790743	505120	229480	864261	76168	17278	8846	6633	11863
1977.00	4140114	590768	113392	461879	275573	126138	466418	43094	9150	3713	10203
1978.00	1346660	3388582	345413	64490	183137	119042	57492	223174	22748	4650	6640
1979.00	449237	1070607	2428575	245952	41189	41881	36645	19393	85500	8737	5577
1980.00	1572744	367495	710920	1762615	152257	28831	13695	13722	5372	33071	5530
1981.00	1669838	1285541	289592	509479	1017323	99522	19666	7007	5380	1742	19618
1982.00	2303788	1367148	959566	191298	324700	429503	51913	13922	3261	2688	15069
1983.00	4080696	1882940	1027198	649865	136217	177720	163392	29370	9525	1459	12507
1984.00	5029406	3336034	1368811	705598	313564	89490	91116	53695	14770	6243	9667
1985.00	1833037	4117729	2651469	901483	376462	126284	52859	55136	18753	3662	3342
1986.00	1060823	1492614	3175718	1866647	466629	176055	65377	30635	28842	8204	4234
1987.00	1399834	868471	1109045	2351243	1264625	330733	115701	43830	21191	20962	8648
1988.00	1404777	1144009	636260	794050	1450813	817103	229403	77190	29320	14323	20846
1989.00	1749310	1149998	802925	419031	474794	798182	457064	149543	44154	20234	22821
1990.00	1190310	1432207	849747	554605	287374	317200	501483	305176	105942	28708	29064
1991.00	597766	974544	1011714	578483	300156	154616	169053	229934	145299	58499	31676
1992.00	860590	489409	710471	666790	308898	166380	89449	93196	115909	78131	45329
1993.00	1813509	704583	249616	462321	289434	139738	68806	42388	44635	42185	51754
1994.00	962499	1484626	507991	164974	204860	120204	53995	26165	15554	17014	48410
1995.00	1007654	787891	1121792	288180	86913	62813	34034	12299	8182	4989	30363
1996.00	742833	823343	542875	720712	135472	38269	19072	8266	4303	2941	23103
1997.00	1293745	608180	640254	410445	360637	62123	16264	7448	3814	1929	18705
1998.00	723167	1058907	446934	445463	265770	177861	33888	8713	2854	2319	15549
1999.00	1831523	591955	628938	309777	240240	130649	58872	9391	3688	801	13124
2000.00	706078	1491529	348956	288795	189243	104134	50792	24694	2178	1165	10455
2001.00	1590451	577674	881779	237888	126351	57972	35005	14771	9742	492	8712
2002.00	2125706	1302079	400135	443376	146222	46297	20059	13388	7949	4962	7152
2003.00	1029013	1726257	787171	231548	193963	44800	16051	8004	5702	3812	6113
2004.00	438910	842403	983613	416014	117278	62160	19736	4321	3771	2109	5466
2005.00	430436	356107	401604	522593	196189	60579	18299	6621	1833	317	3600
2006.00	1111407	351950	231752	211711	272217	107377	38558	7257	1691	603	2631
2007.00	631194	907550	187865	98312	112004	149692	57048	16996	2504	1008	2331
2008.00	1737946	516765	576166	103581	50326	57188	59300	24129	7348	902	2109
2009.00	1000000	1421869	352509	274851	37583	19055	18311	20856	9577	2260	1967
2010.00	1000000	818097	927181	183079	101464	11050	5000	4805	5473	2513	1921

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.250	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.766	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.709	0.326	0.302	0.852	1.195	0.482	3.748
1985.00	0.005	0.060	0.151	0.459	0.560	0.458	0.345	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.189	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.086
1988.00	0.000	0.154	0.218	0.314	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.203	0.265	0.204	0.145	0.230	0.232	0.159
1990.00	0.000	0.148	0.185	0.414	0.420	0.429	0.580	0.542	0.394	0.516	0.299
1991.00	0.000	0.116	0.217	0.427	0.390	0.347	0.396	0.485	0.420	0.419	0.628
1992.00	0.000	0.473	0.230	0.635	0.593	0.683	0.547	0.536	0.811	0.659	0.687
1993.00	0.000	0.127	0.214	0.614	0.679	0.751	0.767	0.803	0.764	0.764	0.271
1994.00	0.000	0.080	0.367	0.441	0.982	1.062	1.279	0.962	0.937	1.095	0.433
1995.00	0.002	0.172	0.242	0.555	0.620	0.992	1.215	0.850	0.823	1.030	0.138
1996.00	0.000	0.052	0.080	0.492	0.580	0.656	0.740	0.573	0.602	0.666	0.080
1997.00	0.000	0.108	0.163	0.235	0.507	0.406	0.424	0.759	0.297	0.434	0.053
1998.00	0.000	0.321	0.167	0.417	0.510	0.906	1.083	0.660	1.071	0.925	0.029
1999.00	0.005	0.328	0.578	0.293	0.636	0.745	0.669	1.261	0.952	0.750	0.057
2000.00	0.001	0.326	0.183	0.627	0.983	0.890	1.035	0.730	1.287	0.914	0.027
2001.00	0.000	0.167	0.488	0.287	0.804	0.861	0.761	0.420	0.475	0.744	0.024
2002.00	0.008	0.303	0.347	0.627	0.983	0.859	0.719	0.654	0.535	0.766	0.326
2003.00	0.000	0.362	0.438	0.480	0.938	0.620	1.112	0.553	0.795	0.732	0.233
2004.00	0.009	0.541	0.432	0.552	0.461	1.023	0.892	0.658	2.275	1.029	0.406
2005.00	0.001	0.230	0.440	0.452	0.403	0.252	0.725	1.165	0.912	0.434	0.180
2006.00	0.003	0.428	0.658	0.437	0.398	0.432	0.619	0.864	0.317	0.498	0.059
2007.00	0.000	0.254	0.395	0.470	0.472	0.726	0.660	0.638	0.822	0.704	0.115
2008.00	0.001	0.183	0.540	0.814	0.771	0.939	0.845	0.724	0.979	0.868	0.041
2009.00	0.001	0.228	0.455	0.797	1.024	1.138	1.138	1.138	1.138	1.138	0.193

(iterations)

LAMBDA 1.00000E-3
RSS 1.22359E1
NPHI 1.22359E1

Parameters
9.26257E0 9.83072E-1 1.40042E0 1.58033E0 1.88741E0
1.76097E0

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001
RELATIVE CHANGE IN EACH PARAMETER LESS THAN 0.00001

Estimated VPA (biased)

Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503535	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	35035	2855	1060	707
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	41661	21740	836	1253
1968.00	1286168	4325977	1170158	950143	889042	372334	200109	75150	30056	17430	1311
1969.00	1754254	904620	1415817	755635	702962	467578	239085	82892	32938	10845	9244
1970.00	2304088	1338028	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460432	1258575	579796	324285	303152	228973	243661	130382	77266	19947	19640
1972.00	1138008	6028997	667900	309749	169890	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350865	481941	121064	70133	52761	54102	51165	27434	19153
1974.00	1625831	1912064	612116	2859204	277070	63139	30305	23481	26162	20577	15921
1975.00	247160	1314490	880009	416859	1619379	165492	34562	15639	13330	10013	15485
1976.00	721831	199468	790743	505120	229480	864261	76168	17278	8846	6633	11863
1977.00	4140114	590768	113392	461879	275573	126138	466418	43094	9150	3713	10203
1978.00	1346661	3388582	345413	64490	183137	119042	57492	223174	22748	4650	6640
1979.00	449237	1070607	2428575	245952	41189	41881	36645	19393	85500	8737	5577
1980.00	1572744	367495	710920	1762615	152257	28831	13695	13722	5372	33071	5530
1981.00	1669838	1285541	289592	509479	1017323	99522	19666	7007	5380	1742	19618
1982.00	2303789	1367148	959566	191298	324700	429503	51913	13922	3261	2688	15069
1983.00	4080696	1882941	1027198	649865	136217	177720	163392	29370	9525	1459	12507
1984.00	5029406	3336034	1368811	705598	313564	89490	91116	53695	14770	6243	9667
1985.00	1833037	4117730	2651469	901483	376462	126284	52859	55136	18753	3662	3342
1986.00	1060823	1492615	3175719	1866648	466629	176055	65377	30635	28842	8204	4234
1987.00	1399834	868471	1109045	2351244	1264625	330734	115701	43830	21191	20962	8648
1988.00	1404778	1144010	636260	794050	1450813	817103	229403	77190	29320	14323	20846
1989.00	1749312	1149998	802926	419031	474794	798182	457064	149543	44154	20234	22821
1990.00	1190311	1432208	849747	554605	287374	317200	501483	305176	105942	28708	29064
1991.00	597768	974545	1011715	578483	300157	154616	169053	229934	145300	58499	31676
1992.00	860592	489411	710472	666791	308898	166380	89449	93196	115909	78131	45329
1993.00	1813556	704585	249618	462322	289434	139738	68806	42388	44635	42185	51754
1994.00	962592	1484664	507992	164975	204860	120205	53995	26165	15554	17014	48410
1995.00	1007733	787967	1121823	288181	86914	62813	34034	12299	8182	4989	30363
1996.00	742892	823408	542937	720738	135473	38270	19072	8266	4303	2941	23104
1997.00	1293952	608229	640308	410495	360657	62123	16264	7448	3815	1929	18705
1998.00	723683	1059077	446974	445506	265811	177877	33889	8714	2855	2320	15549
1999.00	1832421	592378	629077	309810	240276	130683	58886	9392	3689	801	13124
2000.00	711175	1492265	349301	288908	189270	104163	50819	24705	2178	1166	10456
2001.00	1607998	581847	882380	238170	126443	57994	35029	14793	9752	493	8713
2002.00	2156994	1316446	403550	443867	146453	46372	20076	13407	7967	4970	7153
2003.00	1051450	1751873	798916	234339	194362	44986	16111	8019	5717	3827	6120
2004.00	457886	860772	1004541	425600	119554	62482	19887	4369	3783	2121	5483
2005.00	462682	371643	416573	539675	203999	62436	18557	6744	1872	326	3624
2006.00	1325246	378351	244462	223929	286158	113755	40077	7467	1789	634	2658
2007.00	895360	1082627	209420	108649	121978	161078	62254	18232	2674	1088	2379
2008.00	2712043	733046	719381	121189	58761	65327	68549	28364	8354	1039	2214
2009.00	1000000	2219393	529517	391678	51874	25907	24895	28356	13021	3073	2164
2010.00	1000000	818097	1579793	327696	196498	22626	10536	10125	11532	5295	2739

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.250	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.766	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.709	0.326	0.302	0.852	1.195	0.482	3.748
1985.00	0.005	0.060	0.151	0.459	0.560	0.458	0.345	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.189	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.086
1988.00	0.000	0.154	0.218	0.314	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.203	0.265	0.204	0.145	0.230	0.232	0.159
1990.00	0.000	0.148	0.185	0.414	0.420	0.429	0.580	0.542	0.394	0.516	0.299
1991.00	0.000	0.116	0.217	0.427	0.390	0.347	0.396	0.485	0.420	0.419	0.628
1992.00	0.000	0.473	0.230	0.635	0.593	0.683	0.547	0.536	0.811	0.659	0.687
1993.00	0.000	0.127	0.214	0.614	0.679	0.751	0.767	0.803	0.764	0.764	0.271
1994.00	0.000	0.080	0.367	0.441	0.982	1.062	1.279	0.962	0.937	1.095	0.433
1995.00	0.002	0.172	0.242	0.555	0.620	0.992	1.215	0.850	0.823	1.030	0.138
1996.00	0.000	0.052	0.080	0.492	0.580	0.656	0.740	0.573	0.602	0.666	0.080
1997.00	0.000	0.108	0.163	0.235	0.507	0.406	0.424	0.759	0.297	0.434	0.053
1998.00	0.000	0.321	0.167	0.417	0.510	0.905	1.083	0.660	1.070	0.925	0.029
1999.00	0.005	0.328	0.578	0.293	0.636	0.744	0.669	1.261	0.952	0.750	0.057
2000.00	0.001	0.325	0.183	0.626	0.983	0.890	1.034	0.730	1.287	0.913	0.027
2001.00	0.000	0.166	0.487	0.286	0.803	0.861	0.760	0.419	0.474	0.743	0.024
2002.00	0.008	0.299	0.344	0.626	0.980	0.857	0.718	0.652	0.533	0.765	0.326
2003.00	0.000	0.356	0.430	0.473	0.935	0.616	1.105	0.551	0.792	0.728	0.233
2004.00	0.009	0.526	0.421	0.535	0.450	1.014	0.881	0.648	2.252	1.019	0.404
2005.00	0.001	0.219	0.421	0.434	0.384	0.243	0.710	1.127	0.882	0.420	0.178
2006.00	0.002	0.391	0.611	0.407	0.375	0.403	0.588	0.827	0.297	0.466	0.058
2007.00	0.000	0.209	0.347	0.415	0.424	0.654	0.586	0.580	0.745	0.632	0.113
2008.00	0.000	0.125	0.408	0.649	0.619	0.765	0.683	0.579	0.800	0.703	0.039
2009.00	0.001	0.140	0.280	0.490	0.630	0.700	0.700	0.700	0.700	0.700	0.174

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000116
MEAN SQUARE RESIDUALS 0.249712

Parameter	Est.	Std. Err.	Rel. Err.	Bias	Rel. Bias
N[2010 7]	1.05E4	2.93E3	0.278	3.35E2	0.032
q ID#[1]	2.67E0	4.20E-1	0.157	2.86E-2	0.011
q ID#[2]	4.06E0	6.36E-1	0.157	4.39E-2	0.011
q ID#[3]	4.86E0	7.61E-1	0.157	5.31E-2	0.011
q ID#[4]	6.60E0	1.03E0	0.157	7.24E-2	0.011
q ID#[5]	5.82E0	9.10E-1	0.156	6.37E-2	0.011

VPA using analytical bias adjusted parameters (linear scale)
Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	3503535	3848688	995990	1312007	348049	92556	44658	4104	1354	406	500
1966.00	2737874	2624572	2177169	784001	863223	239988	66231	35035	2855	1060	707
1967.00	6078739	2102325	1329624	1378701	575717	418512	155171	41661	21740	836	1253
1968.00	1286168	4325977	1170158	950143	889042	372334	200109	75150	30056	17430	1311
1969.00	1754254	904620	1415817	755635	702962	467578	239085	82892	32938	10845	9244
1970.00	2304088	1338028	480252	682955	499558	429512	281595	139599	47575	21258	13377
1971.00	7460432	1258575	579796	324285	303152	228973	243661	130382	77266	19947	19640
1972.00	1138008	6028997	667900	309749	169890	146502	119687	115682	61966	30575	20551
1973.00	2336523	931722	4350865	481941	121064	70133	52761	54102	51165	27434	19153
1974.00	1625831	1912064	612116	2859204	277070	63139	30305	23481	26162	20577	15921
1975.00	247160	1314490	880009	416859	1619379	165492	34562	15639	13330	10013	15485
1976.00	721831	199468	790743	505120	229480	864261	76168	17278	8846	6633	11863
1977.00	4140114	590768	113392	461879	275573	126138	466418	43094	9150	3713	10203
1978.00	1346661	3388582	345413	64490	183137	119042	57492	223174	22748	4650	6640
1979.00	449237	1070607	2428575	245952	41189	41881	36645	19393	85500	8737	5577
1980.00	1572744	367495	710920	1762615	152257	28831	13695	13722	5372	33071	5530
1981.00	1669838	1285541	289592	509479	1017323	99522	19666	7007	5380	1742	19618
1982.00	2303789	1367148	959566	191298	324700	429503	51913	13922	3261	2688	15069
1983.00	4080696	1882941	1027198	649865	136217	177720	163392	29370	9525	1459	12507
1984.00	5029406	3336034	1368811	705598	313564	89490	91116	53695	14770	6243	9667
1985.00	1833037	4117730	2651469	901483	376462	126284	52859	55136	18753	3662	3342
1986.00	1060823	1492615	3175719	1866648	466629	176055	65377	30635	28842	8204	4234
1987.00	1399834	868471	1109045	2351244	1264625	330734	115701	43830	21191	20962	8648
1988.00	1404778	1144010	636260	794050	1450813	817103	229403	77190	29320	14323	20846
1989.00	1749312	1149998	802926	419031	474794	798182	457064	149543	44154	20234	22821
1990.00	1190311	1432208	849747	554605	287374	317200	501483	305176	105942	28708	29064
1991.00	597768	974544	1011715	578483	300157	154616	169053	229934	145300	58499	31676
1992.00	860592	489411	710472	666791	308898	166380	89449	93196	115909	78131	45329
1993.00	1813553	704585	249618	462322	289434	139738	68806	42388	44635	42185	51754
1994.00	962586	1484662	507992	164975	204860	120204	53995	26165	15554	17014	48410
1995.00	1007729	787962	1121821	288181	86914	62813	34034	12299	8182	4989	30363
1996.00	742889	823405	542933	720736	135473	38270	19072	8266	4303	2941	23104
1997.00	1293940	608226	640304	410492	360656	62123	16264	7448	3815	1929	18705
1998.00	723652	1059067	446972	445504	265809	177876	33889	8714	2854	2320	15549
1999.00	1832367	592353	629069	309808	240274	130681	58885	9392	3689	801	13124
2000.00	710869	1492221	349280	288901	189268	104161	50818	24704	2178	1166	10456
2001.00	1606945	581597	882344	238153	126437	57993	35027	14792	9751	493	8713
2002.00	2155117	1315584	403345	443837	146440	46367	20075	13406	7966	4969	7153
2003.00	1050105	1750337	798211	234171	194338	44975	16107	8018	5716	3826	6119
2004.00	456748	859671	1003286	425025	119418	62462	19878	4366	3782	2120	5482
2005.00	460754	370711	415676	538651	203530	62325	18542	6736	1870	325	3622
2006.00	1312530	376773	243699	223196	285322	113372	39986	7454	1783	632	2656
2007.00	879748	1072216	208131	108028	121379	160395	61942	18158	2664	1083	2376
2008.00	2654619	720264	710864	120136	58255	64838	67994	28110	8294	1031	2207
2009.00	1000000	2172377	519055	384724	51017	25495	24499	27905	12814	3024	2153
2010.00	1000000	818097	1541313	319142	190828	21929	10202	9803	11166	5127	2690

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
1965.00	0.089	0.370	0.039	0.219	0.172	0.135	0.043	0.163	0.045	0.106	0.002
1966.00	0.064	0.480	0.257	0.109	0.524	0.236	0.264	0.277	1.028	0.252	0.002
1967.00	0.140	0.386	0.136	0.239	0.236	0.538	0.525	0.127	0.021	0.490	0.139
1968.00	0.152	0.917	0.237	0.101	0.443	0.243	0.681	0.625	0.819	0.440	2.943
1969.00	0.071	0.433	0.529	0.214	0.293	0.307	0.338	0.355	0.238	0.318	0.090
1970.00	0.405	0.636	0.193	0.612	0.580	0.367	0.570	0.392	0.669	0.450	0.248
1971.00	0.013	0.434	0.427	0.446	0.527	0.449	0.545	0.544	0.727	0.533	0.383
1972.00	0.000	0.126	0.126	0.739	0.685	0.821	0.594	0.616	0.615	0.678	0.960
1973.00	0.000	0.220	0.220	0.354	0.451	0.639	0.610	0.527	0.711	0.622	1.402
1974.00	0.013	0.576	0.184	0.369	0.315	0.403	0.462	0.366	0.760	0.475	0.958
1975.00	0.014	0.308	0.355	0.397	0.428	0.576	0.493	0.370	0.498	0.545	0.579
1976.00	0.000	0.365	0.338	0.406	0.398	0.417	0.370	0.436	0.668	0.416	0.383
1977.00	0.000	0.337	0.364	0.725	0.639	0.586	0.537	0.439	0.477	0.539	0.540
1978.00	0.029	0.133	0.140	0.248	1.275	0.978	0.887	0.759	0.757	0.838	0.324
1979.00	0.001	0.209	0.121	0.280	0.157	0.918	0.782	1.084	0.750	0.830	0.639
1980.00	0.002	0.038	0.133	0.350	0.225	0.183	0.470	0.736	0.926	0.435	0.776
1981.00	0.000	0.092	0.215	0.250	0.662	0.451	0.145	0.565	0.494	0.413	0.129
1982.00	0.002	0.086	0.190	0.140	0.403	0.766	0.370	0.180	0.604	0.708	0.077
1983.00	0.001	0.119	0.176	0.529	0.220	0.468	0.913	0.487	0.222	0.655	0.124
1984.00	0.000	0.030	0.218	0.428	0.709	0.326	0.302	0.852	1.195	0.482	3.748
1985.00	0.005	0.060	0.151	0.459	0.560	0.458	0.345	0.448	0.627	0.445	0.168
1986.00	0.000	0.097	0.101	0.189	0.144	0.220	0.200	0.169	0.119	0.201	0.095
1987.00	0.002	0.111	0.134	0.283	0.237	0.166	0.205	0.202	0.192	0.179	0.086
1988.00	0.000	0.154	0.218	0.314	0.398	0.381	0.228	0.359	0.171	0.344	0.163
1989.00	0.000	0.103	0.170	0.177	0.203	0.265	0.204	0.145	0.230	0.232	0.159
1990.00	0.000	0.148	0.185	0.414	0.420	0.429	0.580	0.542	0.394	0.516	0.299
1991.00	0.000	0.116	0.217	0.427	0.390	0.347	0.396	0.485	0.420	0.419	0.628
1992.00	0.000	0.473	0.230	0.635	0.593	0.683	0.547	0.536	0.811	0.659	0.687
1993.00	0.000	0.127	0.214	0.614	0.679	0.751	0.767	0.803	0.764	0.764	0.271
1994.00	0.000	0.080	0.367	0.441	0.982	1.062	1.279	0.962	0.937	1.095	0.433
1995.00	0.002	0.172	0.242	0.555	0.620	0.992	1.215	0.850	0.823	1.030	0.138
1996.00	0.000	0.052	0.080	0.492	0.580	0.656	0.740	0.573	0.602	0.666	0.080
1997.00	0.000	0.108	0.163	0.235	0.507	0.406	0.424	0.759	0.297	0.434	0.053
1998.00	0.000	0.321	0.167	0.417	0.510	0.905	1.083	0.660	1.070	0.925	0.029
1999.00	0.005	0.328	0.578	0.293	0.636	0.745	0.669	1.261	0.952	0.750	0.057
2000.00	0.001	0.325	0.183	0.626	0.983	0.890	1.034	0.730	1.287	0.913	0.027
2001.00	0.000	0.166	0.487	0.286	0.803	0.861	0.760	0.419	0.474	0.743	0.024
2002.00	0.008	0.300	0.344	0.626	0.981	0.857	0.718	0.652	0.533	0.765	0.326
2003.00	0.000	0.357	0.430	0.473	0.935	0.616	1.105	0.551	0.792	0.728	0.233
2004.00	0.009	0.527	0.422	0.536	0.450	1.015	0.882	0.648	2.253	1.020	0.404
2005.00	0.001	0.219	0.422	0.435	0.385	0.244	0.711	1.129	0.884	0.421	0.178
2006.00	0.002	0.393	0.614	0.409	0.376	0.404	0.589	0.829	0.298	0.468	0.058
2007.00	0.000	0.211	0.350	0.418	0.427	0.658	0.590	0.584	0.749	0.636	0.113
2008.00	0.000	0.128	0.414	0.656	0.626	0.773	0.691	0.586	0.809	0.711	0.039
2009.00	0.001	0.143	0.286	0.501	0.644	0.716	0.716	0.716	0.716	0.716	0.175

German Only Acoustic-newages
Age : 4
Ln calibration constant : 0.98307

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	12.90814	13.30648	-0.39833	12.32340
2000.65	13.29570	13.01983	0.27587	12.03676
2001.65	11.96155	13.04773	-1.08618	12.06466
2002.65	13.91288	13.44958	0.46330	12.46651
2003.65	13.07601	12.91014	0.16587	11.92707
2004.65	13.99593	13.46632	0.52962	12.48324
2005.65	13.43489	13.76940	-0.33451	12.78633
2006.65	12.68530	12.90726	-0.22196	11.92419
2007.65	12.50204	12.17939	0.32265	11.19632
2008.65	11.96151	12.13655	-0.17503	11.15347
2009.65	13.87180	13.41276	0.45904	12.42969

Average squared residual : 0.22217

German Only Acoustic-newages
Age : 5
Ln calibration constant : 1.40042

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	13.68446	13.24667	0.43779	11.84625
2000.65	13.23268	12.78250	0.45018	11.38209
2001.65	12.15655	12.49595	-0.33940	11.09553
2002.65	13.10848	12.52764	0.58083	11.12723
2003.65	13.26855	12.84024	0.42831	11.43982
2004.65	12.64678	12.66968	-0.02290	11.26926
2005.65	12.46392	13.24663	-0.78271	11.84621
2006.65	13.16744	13.59117	-0.42373	12.19075
2007.65	12.64286	12.70609	-0.06323	11.30567
2008.65	11.44223	11.84925	-0.40702	10.44883
2009.65	11.85972	11.71751	0.14221	10.31709

Average squared residual : 0.18299

German Only Acoustic-newages
Age : 6
Ln calibration constant : 1.58033

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	13.40663	12.74694	0.65969	11.16661
2000.65	12.62049	12.42568	0.19481	10.84535
2001.65	11.63916	11.85890	-0.21974	10.27857
2002.65	11.81281	11.63761	0.17520	10.05727
2003.65	11.87492	11.76386	0.11106	10.18352
2004.65	12.12068	11.83386	0.28682	10.25353
2005.65	11.43388	12.33404	-0.90016	10.75371
2006.65	12.38557	12.83028	-0.44471	11.24995
2007.65	13.34025	13.01461	0.32564	11.43428
2008.65	11.72588	12.04034	-0.31446	10.46001
2009.65	11.28381	11.15765	0.12617	9.57732

Average squared residual : 0.17051

German Only Acoustic-newages
Age : 7
Ln calibration constant : 1.88741

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	12.36044	12.30618	0.05427	10.41876
2000.65	12.43556	11.92127	0.51429	10.03385
2001.65	11.06178	11.72708	-0.66529	9.83966
2002.65	11.14682	11.19815	-0.05133	9.31073
2003.65	11.05903	10.72650	0.33253	8.83908
2004.65	10.88129	11.08227	-0.20099	9.19486
2005.65	11.27964	11.12429	0.15535	9.23688
2006.65	11.80680	11.97398	-0.16719	10.08657
2007.65	12.70685	12.41539	0.29146	10.52797
2008.65	12.26954	12.44888	-0.17935	10.56147
2009.65	11.34143	11.42488	-0.08345	9.53747

Average squared residual : 0.09453

German Only Acoustic-newages
Age : 8
Ln calibration constant : 1.76097

Year	Observed	Predicted	Residual	Ln Pop.
1999.65	10.95189	9.95874	0.99316	8.19777
2000.65	11.56515	11.27150	0.29365	9.51053
2001.65	9.46506	10.96062	-1.49556	9.19965
2002.65	10.67297	10.71053	-0.03756	8.94956
2003.65	9.80648	10.26217	-0.45569	8.50120
2004.65	9.87009	9.59243	0.27766	7.83146
2005.65	10.45377	9.71473	0.73905	7.95376
2006.65	10.38440	10.01182	0.37258	8.25085
2007.65	10.30287	11.06460	-0.76173	9.30363
2008.65	11.53498	11.50769	0.02729	9.74672
2009.65	11.47609	11.42861	0.04747	9.66764

Average squared residual : 0.44215

1.00	-0.29	-0.28	-0.27	-0.27	-0.27
-0.29	1.00	0.08	0.08	0.08	0.08
-0.28	0.08	1.00	0.08	0.08	0.07
-0.27	0.08	0.08	1.00	0.07	0.07
-0.27	0.08	0.08	0.07	1.00	0.07
-0.27	0.08	0.07	0.07	0.07	1.00

Projection run using status quo quota of 55,000t in 2010.

Projection results using analytical bias adjusted point estimates

Projected Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
2010.00	1000000	818097	1541313	319142	190828	21929	10202	9803	11166	5127	2690
2011.00	1000000	818731	602447	1020890	180315	96976	10569	4917	4725	5382	3767

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
2010.00	0.000	0.106	0.212	0.371	0.477	0.530	0.530	0.530	0.530	0.530	0.530

M

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

PR

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.20	0.40	0.70	0.90	1.00	1.00	1.00	1.00	1.00	1.00

Beg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30
2011.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30

Projected Population Biomass

	1	2	3	4	5	6	7	8	9	10	11	1+	2+	3+	4+
2010.00	3686	26121	100118	36532	30194	4135	2232	2322	2772	1369	794	210274	206588	180467	80349
2011.00	3686	26142	39133	116859	28531	18285	2312	1165	1173	1437	1112	239834	236148	210006	170874

Projected Catch Numbers

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0	74693	267766	90195	66122	8247	3837	3687	4199	1928	1012
2011.00											

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.01	0.04	0.08	0.14	0.17	0.20	0.23	0.25	0.26	0.28	0.30

Projected Catch Biomass

	1	2	3	4	5	6	7	8	9	10	11	1+	2+	3+	4+
2010.00	0	3077	22725	12435	11369	1676	888	908	1080	542	301	55000	55000	51923	29198
2011.00															

Projection run using $F_{0.1}$ fishing mortality at F=0.228 in 2010.

Projection results using analytical bias adjusted point estimates

Projected Population Numbers

	1	2	3	4	5	6	7	8	9	10	11+
2010.00	1000000	818097	1541313	319142	190828	21929	10202	9803	11166	5127	2690
2011.00	1000000	818731	639944	1151925	222747	127252	14294	6650	6390	7278	5095

Fishing Mortality

	1	2	3	4	5	6	7	8	9	10	11+
2010.00	0.000	0.046	0.091	0.160	0.205	0.228	0.228	0.228	0.228	0.228	0.228

M

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

PR

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.20	0.40	0.70	0.90	1.00	1.00	1.00	1.00	1.00	1.00

Beg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30
2011.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30

Projected Population Biomass

	1	2	3	4	5	6	7	8	9	10	11	1+	2+	3+	4+
2010.00	3686	26121	100118	36532	30194	4135	2232	2322	2772	1369	794	210274	206588	180467	80349
2011.00	3686	26142	41568	131859	35245	23993	3127	1575	1586	1943	1504	272228	268542	242401	200833

Projected Catch Numbers

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0	33077	121951	42783	32196	4068	1892	1818	2071	951	499
2011.00											

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.01	0.04	0.08	0.14	0.17	0.20	0.23	0.25	0.26	0.28	0.30

Projected Catch Biomass

	1	2	3	4	5	6	7	8	9	10	11	1+	2+	3+	4+
2010.00	0	1363	10350	5898	5536	826	438	448	533	267	148	25807	25807	24444	14094
2011.00															

Input for Analytical risk analysis of projection results

M

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

PR

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.20	0.40	0.70	0.90	1.00	1.00	1.00	1.00	1.00	1.00

Beg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30
2011.00	0.00	0.03	0.06	0.11	0.16	0.19	0.22	0.24	0.25	0.27	0.30

Avg wt

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.01	0.04	0.08	0.14	0.17	0.20	0.23	0.25	0.26	0.28	0.30

Maturity

	1	2	3	4	5	6	7	8	9	10	11
2010.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2011.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Risk analysis for probability of $F_{0.1}$, decrease in SSB and Biomass at 150,000t

Inverse Exploitation Rate (Reference = 5.39)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	27.638	7.093	0.808	26.830	0.001
10000	13.920	3.573	0.407	13.513	0.011
15000	9.349	2.400	0.273	9.076	0.062
20000	7.065	1.813	0.206	6.859	0.209
25000	5.696	1.462	0.166	5.529	0.462
30000	4.784	1.228	0.140	4.644	0.728
35000	4.133	1.061	0.121	4.013	0.903
40000	3.646	0.936	0.107	3.540	0.976
45000	3.268	0.839	0.096	3.173	0.996
50000	2.967	0.761	0.087	2.880	1.000
55000	2.720	0.698	0.080	2.641	1.000
60000	2.516	0.646	0.074	2.442	1.000
65000	2.343	0.601	0.068	2.275	1.000
70000	2.196	0.564	0.064	2.132	1.000
75000	2.069	0.531	0.060	2.009	1.000
80000	1.959	0.503	0.057	1.901	1.000
85000	1.862	0.478	0.054	1.807	1.000
90000	1.776	0.456	0.052	1.724	1.000
95000	1.700	0.436	0.050	1.650	1.000

% Biomass Change (Reference = 0)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	81	4	0	80	0.000
10000	77	3	0	76	0.000
15000	73	2	0	73	0.000
20000	69	2	0	69	0.000
25000	65	1	0	65	0.000
30000	61	0	0	61	0.000
35000	57	1	0	57	0.000
40000	53	2	0	54	0.000
45000	49	3	0	50	0.000
50000	45	4	-1	46	0.000
55000	42	5	-1	42	0.000
60000	38	6	-1	38	0.000
65000	34	7	-1	35	0.000
70000	30	7	-1	31	0.000
75000	26	8	-1	27	0.001
80000	22	9	-1	23	0.006
85000	18	10	-1	20	0.026
90000	14	11	-1	16	0.075
95000	11	12	-1	12	0.155

Biomass (Reference = 150000)

Quota	Mean	Std. Err.	Bias	Adj. Mean	Prob
5000	235290	49150	5272	230018	0.052
10000	230177	49148	5272	224905	0.064
15000	225068	49145	5272	219796	0.078
20000	219962	49141	5273	214690	0.094
25000	214861	49136	5274	209587	0.113
30000	209764	49129	5275	204489	0.134
35000	204670	49120	5276	199394	0.157
40000	199582	49110	5278	194304	0.183
45000	194498	49098	5280	189218	0.212
50000	189419	49084	5283	184136	0.243
55000	184345	49067	5287	179059	0.277
60000	179277	49049	5291	173986	0.312
65000	174214	49027	5296	168918	0.350
70000	169157	49003	5302	163856	0.389
75000	164107	48975	5309	158798	0.429
80000	159063	48944	5317	153746	0.469
85000	154027	48909	5327	148699	0.511
90000	148998	48870	5339	143658	0.552
95000	143976	48826	5354	138623	0.592