Fisheries and Oceans Canada / Pêches et Océans Canada
Ecosystems and Oceans Science / Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Research Document 2015/029

Newfoundland and Labrador Region

An Assessment Framework and Review of Newfoundland east and south coast Atlantic Herring (*Clupea harengus*) stocks to the spring of 2013

C. Bourne, F. Mowbray, B. Squires, J. Croft

Science Branch
Fisheries and Oceans Canada
PO Box 5667
St. John’s, NL A1C 5X1

May 2015

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1919-5044

Correct citation for this publication:

Bourne C, Mowbray F, Squires B, Croft J. 2015. An Assessment Framework and Review of Newfoundland east and south coast Atlantic Herring (*Clupea harengus*) stocks to the spring of 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/029. vi + 106

TABLE OF CONTENTS

ABSTRACT

The stock status of Newfoundland east and south coast Atlantic Herring (*Clupea harengus*) has been assessed since 2000 primarily using an abundance index derived from the fishery-independent spring research gillnet program, along with data from logbooks, telephone surveys and the commercial fishery. The methodology used to collect and analyze these data has been focused on the spring-spawning stock component, which historically comprised the majority of the population, with fall spawners composing the remainder. However, during the past decade the composition of the four assessed stock complexes (White Bay-Notre Dame Bay, Bonavista Bay-Trinity Bay, St. Mary's Bay-Placentia Bay and Fortune Bay) changed significantly, with the proportion of fall spawners in each area increasing to as high as 90%, largely due to declines in abundance of spring-spawning herring. During the 2011 stock assessment it was recommended that assessment methodology for the region should be reviewed and modified to reflect these stock composition changes; this document describes a special assessment framework meeting that was conducted in the fall of 2013 to address that recommendation. Components reviewed during the meeting included: stock structure, spawning stock composition, commercial and biological sampling procedures, aging protocols, indices of abundance, and models to assess stock status. The decline of spring-spawning herring, apparent shifts in distribution and spawning times, and the reductions to the research gillnet program in 2013 and its utility as an index were highlighted; abundance indices were also updated for each stock area. Numerous recommendations were made to improve assessments going forward, including splitting abundance indices by spawning group when possible, re-evaluating spawning group designations, examining the timing and gear selectivity in the research gillnet program and exploring the influence of environmental variables on the stock structure and recruitment of Newfoundland herring. These recommendations will be addressed in the next stock assessment to be held in 2015.

Réunion sur le cadre d'évaluation et examen des stocks de harengs de l'Atlantique (*Clupea harengus*) des côtes est et sud de Terre-Neuve-et-Labrador jusqu'au printemps 2013

RÉSUMÉ

L'état des stocks de harengs de l'Atlantique (*Clupea harengus*) des côtes est et sud de Terre-Neuve-et-Labrador a fait l'objet d'évaluations depuis 2000 principalement à l'aide d'un indice de l'abondance tiré du programme printanier de recherche au filet maillant indépendant de la pêche, ainsi qu'à l'aide des données tirées des journaux de bord, des sondages téléphoniques et de la pêche commerciale. La méthode utilisée pour recueillir et analyser ces données a été axée sur la composante des reproducteurs de printemps, qui par le passé constituait la majeure partie de la population, le reste étant constitué par les reproducteurs d'automne. Toutefois, au cours de la dernière décennie, la composition des quatre complexes de stocks évalués (baie Blanche – baie Notre Dame, baie de Bonavista – baie de la Trinité, baie St. Mary's – baie Placentia, et baie de Fortune) a changé de façon importante, la proportion des reproducteurs d'automne dans chaque zone augmentant jusqu'à constituer 90 % du stock, principalement en raison du déclin de l'abondance des reproducteurs de printemps. Lors de l'évaluation du stock de 2011, il avait été recommandé que la méthode d'évaluation pour la région soit revue et modifiée pour tenir compte de ces changements dans la composition des stocks. Le présent document fait le compte rendu de la réunion spéciale sur le cadre d'évaluation qui s'est tenue à l'automne 2013 pour répondre à cette recommandation. Les éléments examinés au cours de cette réunion étaient les suivants : structure du stock, composition des stocks de reproducteurs, procédures d'échantillonnage commercial et biologique, protocoles de détermination de l'âge, indices de l'abondance et modèles pour évaluer l'état du stock. Le déclin des reproducteurs de printemps, les modifications apparentes de la répartition et des périodes de frai et les réductions au programme de recherche au filet maillant en 2013 et son utilité en tant qu'indice ont été mis en évidence. Les indices d'abondance ont également été mis à jour pour chaque zone de stock. De nombreuses recommandations ont été formulées pour améliorer les évaluations à l'avenir, notamment le fractionnement des indices de l'abondance par groupe de reproducteurs, dans la mesure du possible, la réévaluation des désignations des groupes de reproducteurs, l'examen de la période des relevés et de la sélectivité des engins dans le programme de recherche au filet maillant et l'étude de l'influence des variables environnementales sur la structure du stock et le recrutement du hareng de Terre-Neuve-et-Labrador. Ces recommandations seront abordées lors de la prochaine évaluation du stock qui aura lieu en 2015.

INTRODUCTION

Atlantic herring (*Clupea harengus*) is an important forage species in the coastal waters of Newfoundland. Historically, stocks along the south and northeast coast of the island were composed predominantly of spring-spawning herring with a small fall-spawning population; consequently, both the commercial fishery and stock assessment methodology focused on the larger spring-spawning component. However, throughout the past decade there has been a shift in the spawning stock composition of Newfoundland herring as catch rates of spring spawners declined while those of fall spawners increased; following a trend that has also been observed in adjacent stock areas in the Northwest Atlantic in recent years (Melvin *et al.* 2009). During the 2011 Newfoundland south and northeast coast herring stock assessment (Bourne *et al*. 2013) it was recognized that this shift would necessitate a review and revision of stock assessment methods in the region; this assessment framework meeting was held to address those concerns.

Melvin *et al*. (2009) found that the recent changes in herring stock composition occurring throughout the northwest Atlantic are correlated with rising sea temperatures; however it is suspected that more complex environmental processes which have not yet been identified are responsible for the shift. Given the trend of ocean warming over the past decade and the strong influence of environmental conditions on Newfoundland herring recruitment (Winters and Wheeler 1987), it is likely that the changes observed in stock dynamics are largely attributable to environmental variables. Specifically, it is likely that conditions during the hatching and larval development have changed and impacted the differential survival of spring and fall spawned herring, though which variables are responsible for the changes and the nature of their influence on survival and recruitment is unknown.

The current assessment methods used for these stocks focus on spring-spawning herring, or make no distinction between spawning groups. Stock status updates are provided for the stock complexes as a whole with no segregation of spring and fall spawners. From a management perspective this has been adequate since the two spawning components never completely separate, remaining highly mixed throughout the year, even during spawning. However, it is important that trends in the abundance of both components be addressed, as having multiple spawning groups within a stock is thought to be an adaptive feature to ensure reproductive success, despite potential fluctuations in environmental conditions. It is therefore critical that mixed stocks are managed in a way that accounts for all spawning components present in order to preserve that resilience and ensure future recruitment and production (Bierman *et al*. 2010; Harma *et al*. 2012).

The most important abundance index for these stocks is the catch-at-age derived from the spring research gillnet program, which is undertaken by contracted fishers throughout the stock areas. Standardized gillnets are fished in the spring with the intention of intercepting schools of herring during their annual spawning migrations into shallow water when they are highly aggregated. A similar program was also conducted during the fall in various locations in the past, but currently the spring program is the sole source of fishery-independent data for these stocks. The timing of this program has come into question in recent years, given that herring appear to be arriving at their spring spawning grounds later than in the past, with active spawning now occurring in the summer months in many areas. This may have changed the meaning of the research gillnet index as it may no longer be capturing the most intense spawning aggregations and thus not providing a fully representative sample of the herring population, an issue which needs further investigation going forward.

In the past, stock assessments also included quantitative population estimates, which were derived from acoustic surveys. With the discontinuation of these surveys in 2001, modelling population dynamics for these stocks was no longer possible. During the 2009 assessment framework attempts were made to model herring populations with ADAPT and SURBA, however these were unsuccessful as reliable parameter estimates could not be obtained (Wheeler *et al.* 2010); no modelling has been attempted since as data has become more restricted and it was felt that quantitative modelling was not feasible for these stocks. Since the discontinuation of acoustic surveys, stock assessments have focused on relative abundance indices and providing stock status updates through performance reports, using a traffic light approach (Bourne *et al.* 2013).

This meeting focused on examining recent changes in herring stock composition, available data and abundance indices to discuss potential changes to assessment methodology going forward. The challenges of assessing multiple mixed stocks in a changing environment were acknowledged and recommendations were made for future assessments. The results of this meeting will be used to develop a new framework for assessments from 2014-18.

STOCK STRUCTURE AND DISTRIBUTION

Newfoundland east and south coast herring are divided into five stock complexes: White Bay-Notre Dame Bay (WBNDB), Bonavista Bay-Trinity Bay (BBTB), Conception Bay-Southern Shore (CBSS), St. Mary's Bay-Placentia Bay (SMBPB) and Fortune Bay (FB) (Fig. 1). In addition to these complexes, herring occur along the south coast of Newfoundland from Cape Ray to Pass Island; in the past these have been considered localized stocks that do not mix with the adjacent FB and the Northwest Atlantic Fisheries Organization (NAFO) Division 4R stocks. Herring also occur along the coast of Labrador, historically during the summer months and are considered to be migrants from WBNDB or potentially NAFO Division 4R. In recent years there have been reports of increasing numbers of herring along the Labrador coast and in 2013 an experimental fishery took place in NAFO Division 2J; samples from this fishery were not available at the time of this meeting and an update on the experimental fishery will be available during the next assessment.

The five herring stock complexes were defined based on results from tagging experiments conducted in the late 1970s and early 1980s (Wheeler & Winters 1984a). The results of these studies demonstrated clear north-south migratory patterns, with fish moving north in the summer to feed and then south in the fall to overwinter (Fig. 1). During these migrations local populations mixed substantially, but became more discrete in the spring as they aggregated and moved to shallow water spawning grounds. Tagging data also indicated a strong homing tendency, with the majority of fish returning to the same spawning area in successive years (Wheeler and Winters 1984b). For the purposes of fisheries management, stock complexes were defined based on these spawning aggregations; it was considered likely that smaller biological stocks existed within each complex.

While these stock complexes are still the basis for the assessment of Newfoundland herring, it is unknown if the same stock relationships observed during the tagging studies still exist. Herring biomass is substantially lower than when stock delineation took place and as noted by Winters and Wheeler (1984a), reductions in stock size can lead to changes in migration patterns. In addition, there has been a recent shift in spawning stock composition, potential changes in spring spawning times, more frequent occurrences of herring offshore in the spring, and reported changes in migration patterns and spawning locations. Given these observations, consideration should be given to re-examining stock relationships. Though fishers have called for an updated tagging study, this is currently not a viable option. During the late 1970s and early 1980s when the original studies were carried out, commercial herring landings and effort were much higher than they are today and allowed for a significant rate of return of tagged fish. With current catch numbers, there would need to be approximately three times as many tags deployed (over 300,000) to get a comparable rate of return. As an alternative to traditional tag and recapture studies, it has been recommended that more modern methods be used to study stock structure, such as the use of acoustic tags or molecular techniques (Wheeler *et al*. 2010). While this has not been undertaken by Fisheries and Oceans Canada (DFO) Science, research is currently being conducted at Dalhousie University to examine the genetic differences between spring and fall-spawning herring from a number of geographic regions, including Newfoundland, where samples have been collected for analysis in 2012 and 2013.

During recent years an increase in the occurrence of herring during the annual Science multispecies offshore surveys has been noted during the spring (Fig. 2), which may be indicative of changes in stock distribution and/or abundance. Herring sample collection from spring surveys was implemented in 2011 to examine the spawning type and age distribution of offshore herring; results from the 2011 and 2012 surveys were available at the time of this meeting.

SPAWNING STOCK COMPOSITION

Historically, all five of the stock complexes along the east and south coast of Newfoundland have been composed largely of spring-spawning herring, with a small (typically 25% or less) fall-spawning component. However, during the past decade there has been a shift in spawning stock composition, with the percentage of fall spawners matching or exceeding that of spring spawners in many areas and years (Fig. 3).

In addition to changes in the proportions of spring and fall spawners, there are also indications that the timing of spring spawning may be shifting. In the past the spring research gillnet program, which takes place from May to July each year, has captured the peak of spring spawning in each stock area. Though spawning times and duration can be highly variable, Winters and Wheeler (1996) found that the majority of herring had typically spawned by the time the program ended in July. However, in recent years research gillnet fishers have observed that fish often arrive and spawn later in the spring; similar reports have been made by fishers through logbooks and telephone surveys. This change raises concerns as spring-spawning fish have traditionally been considered those that spawn before July 1; if spawning is now occurring later in the summer then this designation may need to be reconsidered.

FISHERY DATA

FISHERY OVERVIEW

Herring are fished along the south and northeast coasts of Newfoundland both commercially and for bait (largely for the lobster fishery). After intensive exploitation and the introduction of purse seiners in the 1970s, all stocks were placed under quota regulation by the early 1980s. The combined total allowable catch (TAC) for all stock areas is currently 12,700 t, with total landings in recent years at 30% or less of the TAC (Fig. 4). The commercial fishery is carried out using fixed and mobile gear (gillnets, traps, and tuck, bar and purse seines), with seines landing the majority of herring (Fig. 5). The bait fishery is carried out with gillnets.

The commercial fishery takes place during both the spring and fall in most areas, the exception being FB where it is carried out exclusively in the spring. The spring fishery targets fish returning to spawning grounds after overwintering in more southerly areas, and fish landed in the fall fishery are typically at the end of their summer feeding period or undertaking migration to overwintering areas (Fig. 1). Because these stocks are mixed throughout the entire year, fisheries capture both spring and fall spawners, regardless of the month or location. In recent years there have been requests by fishers to open fisheries earlier (January and February) and to extend them into the summer months, as they have observed herring in their areas during these times and ice coverage has generally been low in the winter. There have also been anecdotal reports by bait fishers that herring are arriving earlier, later or not at all in their usual fishing areas.

POLICY AND ECONOMICS BRANCH DATA

Commercial fishery data are obtained from Policy and Economics Branch and sorted by bay, month and gear type (Tables 1-5, Figs. 4-6). Landings data are available by stock area since 1966. Data for the three most recent years are considered preliminary, as statistics may not have been finalized. This review includes partial landings for 2013 (as of November 4).

The Statistics Division of Policy and Economics Branch reports information obtained from Dockside Monitoring Program (DMP) reports, hails, logbooks and purchase slips. Bait fishery landings are not reported (see below).

ESTIMATION OF HERRING CAUGHT AND USED AS BAIT

Commercial statistics since 1996 do not include herring caught for bait purposes. In 2009 it was decided that estimates of bait landings should be included in commercial landings data, as the exclusion of these numbers represented a significant source of uncertainty (Wheeler *et al*. 2010).

Bait estimates are obtained from the annual herring fixed gear phone survey. This survey began in the fall of 2006 and has been conducted annually since then in September/October with the exception of 2010 when there was no survey. The objectives of the survey are to determine the number of active fishers per stock area, gather catch data to formulate bait estimates, and to obtain observations of herring abundance from active fishers.

Each year a list of herring fixed gear and/or bait permit holders in the assessed stock areas is obtained from Policy and Economics Branch. Names of fishers to be contacted are chosen randomly (using R statistical software) with the sample size calculated to give a 10% margin of error in all areas combined, assuming an 80% response rate (Gower and Kelly 1993), which has been achieved in most surveys. A 10% margin of error is considered to be acceptable as it indicates that the survey results are 90% accurate (for all areas combined).

By extrapolating the average bait caught per fisher interviewed to the number of estimated active fishers per stock area, total bait estimates for the survey year can be determined (Table 6). These estimates have been applied directly to commercial landings for the purposes of calculating catch-at-age from since 2007, with the exception of 2010 (for this year the mean of the 2009 and 2011 estimates was used). A bait estimate has also been calculated for 2013 and will be applied to the catch-at-age for the next assessment. These estimates made a significant difference to commercial landings in some cases, particularly in SMBPB where commercial landings have been low in recent years (Table 6). For the years prior to the 2009 assessment without bait statistics or phone surveys (1996-2006), bait estimates were back-calculated by averaging the estimates taken from the 2007 and 2008 surveys by stock area, and applying them to the numbers of active lobster fishers each year to estimate total bait catches, as described by Wheeler *et al*. (2010).

All bait estimates are applied to the month of May as this is when most bait is caught for the lobster fishery (Fig. 7). Bait landings are added to commercial landings for one bay per stock area. Up to 2010 these were White Bay, Bonavista Bay, St. Mary's Bay and Fortune Bay; however, recent survey results indicated that were few (if any) bait fishers active in White Bay or St. Mary's Bay (Figs. 8-9) so bait landings were applied to Notre Dame Bay and Placentia Bay in 2011 and 2012.

Bait estimates in recent years to not appear to reflect lobster landings (Table 7). This is likely due to availability issues; many fishers have reported that herring are arriving later (if at all) in their usual bait fishing areas meaning they have not been able to catch enough bait and have had to purchase it, potentially from other bays. Some fishers have also been using other species for bait (e.g. winter flounder).

ESTIMATION OF HERRING DISCARDED DEAD IN THE HERRING FISHERY

Herring can be discarded dead from all principal gear types used in the herring fishery: purse seines, tuck seines, bar seines, traps, and gillnets. In recent years the majority of discards have been due to size restrictions; if greater than 10% of the fish in a fishing set are under the minimum fork length, the catch must be released and survival can be poor when this occurs. In addition, herring may be discarded due to quota restrictions, safety issues (e.g. high winds, gear damage) or if a catch exceeds the capacity of the vessel.

Currently the only available estimates of dead discards from the fishery are obtained through the annual purse seine telephone survey, which has been conducted since 1996 (Table 7). Given that purse seines account for a large proportion of landings (Fig. 5), it is assumed that this survey accounts for the majority of discards.

During the survey, an attempt is made to contact all purse seine fishers who reported landings in the previous year. In 2013 tuck seiners were also included in this survey to obtain information about that growing sector of the fishery. Surveys are conducted in the winter after the fall fishery and again in early summer after the spring fishery. Response rates are high, typically 80-100%. As a part of the survey, each fisher is asked to provide an estimate of total landings, total discards and discard survival rate. From these data, a removal to landing ratio has been calculated; this ratio has ranged from 1.00-2.37, with a mean of 1.12 (Table 7).

Criticisms of this survey have been that it is subjective and that discard values are highly variable. While it is true that estimates of discards may be impacted by the amount of time since fishers were active (sometimes months prior to the survey), it is not unusual to see fluctuations in discard amounts due to the nature of the fishery and herring population dynamics. In particular, mixtures of small and large herring have been problematic in some years and have led to increased discards. Estimates of mortality are more likely to be problematic as it is difficult to determine survival rates upon release from a purse seine, which depend on a variety of factors (e.g. Olsen *et al*. 2012, Tenningen *et al*. 2012).

Despite these issues, the purse seine telephone survey remains the best source of discard data for the herring fishery at this point as at-sea observer coverage of the herring fleet is quite low, with an average of only 3 sets per year being observed over the past 5 years in the region. In addition, the telephone survey also allows fishers an opportunity to communicate observations of abundance and the fishery in general directly to Science personnel.

ESTIMATION OF HERRING CAUGHT AS BYCATCH IN OTHER FISHERIES

Herring bycatch occurs in other fisheries and is recoded by Policy and Economics Branch if it is provided on DMP forms or on other purchase slips. However, it is unclear what percentage of herring bycatch is recorded in this manner and it is therefore not compiled with commercial landings for assessment purposes.

Herring bycatch data is also available from the Observer Program, where fisheries observers record all set details while aboard commercial vessels, including bycatch by weight and species. Between 1995 and 2012 herring bycatch was recorded by observers in 15 fisheries (Table 8). The fisheries with the highest observed herring bycatch were those for other pelagic species, including billfish (Atlantic saury), capelin, mackerel and squid. Of these, the capelin fishery is of greatest concern as the billfish landings were part of a short experimental fishery taking place in 2011, the squid fishery has been very limited over the past decade, and in recent years the mackerel fishery has also seen low catch and effort.

Over the past 5 years (2008-12), the mean bycatch of herring per capelin fishing set was 21 kg, based on observer data; a portion of this herring is landed, but an estimated 4.2 kg/set is discarded. With a mean of 440 fishing sets of capelin per year, based on landings data, this gives a mean bycatch/year of 9 t, with 4 t discarded. Currently this bycatch mortality is not included in assessments.

ESTIMATION OF BYCATCH OF OTHER SPECIES IN THE HERRING FISHERY

Bycatch of other species in the herring fishery is generally low and occurs mainly in gillnets which are non-selective, fixed gear. An evaluation of bycatch in herring bait nets in 2001 found that there was a low incidence of bycatch of salmon and cod, with pollock being of potential concern (Reddin *et al*. 2002)

Fishers involved in the research gillnet program keep a detailed daily log which includes reports of bycatch. Since the 2001 study, which included data from this program, there have been 22 species other than herring caught in research gillnets, generally in very low numbers (Table 9). As with the previous findings, cod (both Atlantic and Greenland), Atlantic salmon and pollock were among the most prevalent bycatch, along with mackerel.

In 2013 questions were added to the annual fixed gear herring fixed gear phone survey which asked fishers to estimate the species and weight of any bycatch they had during the fishing season. As with the research gillnet program, results from the phone survey indicated that both Atlantic and Greenland cod are the most common bycatch in herring gillnets, however no Pollock was reported in this survey (Table 10).

While it is advisable to monitor bycatch in the herring fishery, the levels recorded in the research gillnet program and by gillnet fishers during the annual telephone survey (as of 2013) are not considered to be significant at this time.

BIOLOGICAL SAMPLING

COMMERCIAL SAMPLING PROTOCOLS

Samples from the commercial herring fishery are collected from fishers and processors, each consisting of a random sample of 55 fish. The sampling protocol is to take one sample per 500 t of landings by gear, by month, and by bay, whenever possible. These samples are then collected from fishers and processors by Science personnel and transported to the Northwest Atlantic Fisheries Centre (NAFC) in St. John’s for subsequent processing. Details of biological sampling procedures are described in detail in Wheeler *et al*. 2010.

During the 2011 assessment it was recommended that sample size should be reexamined to ensure that 55 fish per 500 t was adequate (Bourne *et al*. 2013). This has not yet been done as increasing the commercial sample size was not a viable option in the years since due to limited time and personnel for sample processing. In addition, obtaining enough samples to meet the current protocol has been a significant challenge. Because samples are procured at a cost to Science from commercial fishers (samples are paid for and travel expenses are incurred for collection) sample collection is rationalized when possible to minimize costs.

When there are not enough samples to meet the protocol (55 fish per 500 t by gear/month/bay) the following criteria are used:

1. Same gear, same season, same bay;
2. Similar gear (e.g. purse seine and tuck seine – both mobile, non-size selective gear), same season, same bay;
3. Same or similar gear, different season, same bay;
4. Same or similar gear, same season, different bay (within stock area); and
5. Same or similar gear, different season, different bay.

However, given the concern in recent years regarding the change in the proportion of spring and fall spawners, as well as potential changes in spawning times, criteria 3 and 4 were switched in 2012 to ensure that temporal patterns were not missed (i.e. consistently assigning samples to the same season in which they were collected).

When the above criteria are applied there are typically enough samples collected construct a catch-at-age vector for each stock area. In 2011, WBNDB presented a particular challenge as very few commercial samples were collected due to logistical issues. As a result criteria 1-3 were used, with samples collected in the winter from NDB being applied to fall landings from WB (same gear). In addition, no commercial gillnet samples were collected from WBNDB in that year; given that gillnets are a size-selective gear, mobile gear samples could not be applied to these landings. As a solution, samples collected during the same month and in the same bay via the research gillnet program were used in the commercial catch-at-age calculation.

Once samples have been processed and the above criteria used to apply the data to a portion of the commercial catch, the annual commercial catch numbers-at-age vector is calculated. This is done by converting the catch (t) for each portion (e.g. landings by gear, per bay, per month) to number of fish using the mean whole weight from the appropriate sample. Fish numbers are apportioned by age using the sample number-at-age, by spawning type. This process is repeated for all samples and the numbers are then summed to provide catch numbers-at-age for each stock area by spawning type.

Commercial catch-at-age data are available from 1970 to 2012 (Tables 11-14). From 1996 to 2012 bait estimates have been included in commercial landing numbers (see above) for the purposes of catch-at-age calculation. At the time of writing, the 2013 fishery is still ongoing in most areas and samples have not yet been collected and processed.

OFFSHORE SAMPLES

Given the increasing occurrence of offshore herring, DFO Science began collecting samples of herring caught in the multispecies surveys in 2011. If less than 55 herring were caught in a fishing set, they were all frozen, otherwise a random sample of 55 fish was collected. Frozen samples were transported back to NAFC to be processed by Pelagics personnel. As sampling time and resources are limited, not all samples were processed. The occurrence of herring in the spring survey was much higher than in the fall, therefore while samples were collected during both seasons, only those from the spring were processed. Of these samples, an effort was made to process at least one sample of 50 fish per each 20 square nautical mile area where herring were caught (Figs. 10-11). This was not always possible as there were cases where herring were not frozen despite being caught in fishing sets. There were 18 samples processed from the 2011 spring survey and 13 samples in 2012; samples collected in 2013 have not yet been processed.

OTHER SAMPLE SOURCES

During the 2011 assessment it was recognized that a gap exists in sampling during the summer months which needs to be addressed in order to fully evaluate potential shifts in spawning times and spawning stock composition (Bourne *et al*. 2013). The research gillnet program runs from April 1 to July 31, with many fishers finishing their 45 day fishing period early in the summer. The commercial herring fishery is generally concentrated in the spring and fall, and bait fishing is prohibited between July 1 and August 15 to minimize salmon bycatch. This has left Science with a general lack of samples in July and August. To address this issue, samples were collected in the summers of 2012 and 2013 from the commercial capelin fishery, where herring is regularly caught as bycatch. In both years, 9 capelin bycatch samples were collected; 2013 samples have not yet been processed. In addition, it was requested that contracted research gillnet fishers provide Science with samples from any gillnets they may have set personally for bait after the conclusion of the gillnet program when possible. This provided 3 samples in 2012 and 2013. There were also herring purse seine landings in August of 2012 in WBNDB which provided further samples to be used in spawning time analysis.

Over the past several years many fishers expressed concerns about the minimum size regulation in the commercial fishery, stating that large amounts of herring were being discarded dead in the purse seine fishery due to sets with high proportions of small fish which had to be released. The current minimum size of 26.5 cm (fork length) was selected during the late 1990s (J. Wheeler, pers. comm.) based on the size at maturity (L50). It was decided in 2013 to lower the minimum size to 24 cm temporarily to allow for the collection of samples of small herring by active purse seiners and to evaluate potential impacts on fishing mortality. Fishers provided Science with samples of 55 undersized fish when possible, or the smallest sized herring in the catch. These samples were still being collected at the time of this assessment and none have been processed. This pilot project will be extended for the 2014 fishing season to ensure an adequate sample size to reevaluate the L50 and minimum size regulation.

AGING PROTOCOLS AND SPAWNING TYPE DESIGNATION

All sampled herring are aged based on the examination of annulus formation on the otolith. Annuli are characterized by white, opaque, separate rings encircling the otolith center. After being removed from the specimen, otoliths are fixed into a depression on a black acrylic plate. Prior to 2012 this was done using 1, 2-dicholorethane, since then cytoseal has been used. Details of aging and spawning type designation are provided in Wheeler *et al*. 2010.

There have not been any age reading comparisons with other Regions since the early 1990s. In recent years possible changes in otolith characteristics have been noted, including centers which are not typical of either spring or fall spawners. It is suspected that this may be a result of shifting spawning times, specifically with spring spawning now occurring later in the summer. It is also possible that these changes could reflect shifts in diet, food availability or herring distribution. A retrospective study of otolith morphology would be beneficial in examining these potential changes. It is hoped that a digital system can be integrated for otolith reading to allow for archiving of images and more detailed analysis. It is also intended that a second reader be trained.

INDICES OF ABUNDANCE

Seven abundance indices have been documented for east and southeast NL herring:

- Spring research gillnet catch rates: area dependant; see below
- Fall research gillnet catch rates: 1980-1991
- Acoustic biomass estimates: 1983-2000
- Fixed gear logbook catch rates: 1996-2011
- Fixed gear logbook index: 1997-present
- Fixed gear fisher index (from telephone surveys): 2006-present
- Purse seine fisher index (from telephone surveys): 1996-present (excluding FB)

Of these indices, the spring and fall research gillnet catch rates are age-disaggregated by spawning type, all others are aggregated.

Acoustic biomass estimates were considered to be estimates of absolute biomass; all other indices are proportional to biomass. DFO Science conducted 32 acoustic herring surveys between 1983 and 2000; these surveys were discontinued after 2000 due to funding reductions in favor of continuing the research gillnet program, in part because of issues that had been encountered with data collection and associated costs. A consistent recommendation at assessment meetings since 2000 has been to reinstate acoustic surveys (Bourne *et al*. 2013), possibly as a joint survey with industry. This would provide data for quantitative population modelling, as well as potentially allow for biological sampling of young fish which are not recruited to the gillnet survey or retained in the commercial fishery.

RESEARCH GILLNET PROGRAM

The historical timing and distribution of the program among stock areas is as follows:

- WBNDB: spring 1988-2013 fall 1980- 1991
- BBTB: spring 1988-present
- CBSS: spring 1985-1997 fall 1983-1991
- SMBPB: spring 1982-2013
- FB: spring 1982-present

The program was initiated in the fall of 1980 to capture both spring and fall-spawning herring during their migrations to overwintering areas, then expanded to the spring in areas where there was no fall gillnet fishery. In 1991, when funding was reduced, the fall program was cut in all areas. This decision was made (versus cutting the spring program) as the fall gillnet fishery was declining and it was becoming more difficult to recruit fishers. The spring program was cut in 1997 in CBSS where the commercial fishery is quite small. In 2013 further funding reductions led to the cut of the spring program in WBNDB and SMBPB, along with a fisher from BBTB.

When the possibility of reductions to the research gillnet program was discussed at the 2011 assessment, it was agreed that reducing the number of fishers per stock area was not a viable option; it was also advised that cutting stock areas would compromise the ability of Science to provide advice regarding the commercial fishery (Bourne *et al*. 2013). However, this was ultimately the only possible option given program limitations and two stock areas had to be cut;

it was decided during the reduction process that one stock area should be kept on each coast (southeast and northeast).

On the southeast coast the decision was made to keep FB and cut SMBPB from the program. Historically FB has been an area of particular concern, with a stock that seems to be somewhat differentiated from others and an active commercial fishery. Science advice for this area is expected to be vital in the coming years as stock status has been declining and the stock area did not show the increasing proportion of fall spawners as other areas did which may compensate for a loss of spring-spawning fish (Bourne *et al*. 2013). On the northeast coast, the decision was made to keep BBTB as it is the stock area that seems to be showing the most dramatic shift in spawning stock composition, which is a major concern for the fishery. In addition, this requires less travel time for gear distribution and sample collection for Science personnel (therefore reducing costs) than WBNDB. Despite these reductions, a fisher still had to be cut from BBTB to meet budget restrictions.

The research gillnet program provides the only current source of fishery-independent data for herring assessments, providing a standardized age-disaggregated index of abundance. Contracted fishers in the program are provided with a fleet of 5 standardized gillnets of differing mesh size which, up to 2009, were fished for a 30 day period between May 1 and July 31; as of 2010 the fishing period was extended to 45 days to allow for suspected changes in spawning times. In 2012, 27 fishers were contracted throughout the four assessed stock areas; in 2013 there were 11 fishers (Fig. 12); however data from a fisher in FB was not used due to potential issues with sample collection. Details of the fishing and sampling procedures for the program are detailed in Wheeler *et al*. 2010.

The start of the program was delayed in both 2012 and 2013. In 2012 uncertainty about program funding and continuation led to a delay of nearly a month in issuing contracts and licenses, however most fishers had not intended to start fishing in early April and all completed their full 45 days of fishing, so the impact on the program was minimal. In 2013 issues with the provision of licenses led to a delay of about 10 days, again with minimal impact on the program.

After processing, age distribution by spawning type and mesh size is calculated for each sample. This is then apportioned to the catch numbers, by net (mesh size) for the sampling interval, to provide catch-at-age, by spawning type. This is repeated for all samples from each fisher and the catch-at-age, by sample, is summed to provide catch-at-age for the entire fishing period. Similarly, catch-at-age for all fishers within a stock area is summed to provide an annual research gillnet catch-at-age (by spawning type) vector for the stock area (Tables 15-18, Figs. 13-16). Research gillnet catch rates (catch numbers per days fished) are calculated by dividing the total catch by the total nights fished for all fishers within a stock area (Table 19, Fig. 17). This is also done for each spawning component (Fig. 18). Catch rates at age are calculated by apportioning the total catch rate by the percentage of spring and fall spawners and by the percentage at each age.

FIXED GEAR LOGBOOKS

The commercial fixed gear logbook program was initiated in 1996 as a means to provide a time series of standardized catch per unit effort (CPUE) data from the commercial fixed gear and bait fisheries (largely gillnet). Each year a logbook is sent to every fisher within the assessed stock areas who possesses a fixed gear commercial or bait license (currently approx. 1700); completion is voluntary. From 1996 to 2011, each fisher was asked to provide information regarding the number and dimensions of their gillnets by mesh size, and to complete a logbook entry for each day that a net or nets were hauled. Catch rates from these logbooks were standardized by panel area of nets fished (Table 20, Fig. 19). This facilitated comparison of inter-annual catch rates (kg/standard net/nights fished).

An issue with logbooks has consistently been a low rate of return. As of 2007, reminder letters were sent to fishers each summer in an effort to increase logbook returns. While there was a slight increase in some areas, the overall number of returns remained quite low (Table 20). It had been recommended in the past at both assessment and industry consultation meetings that logbooks be made mandatory in order to increase sample sizes, however this option was determined to be unfeasible due to issues with enforcement and potential misreporting.

The validity of the logbook CPUE index has been questioned in the past due to both the poor rate of logbook return and the fact that effort varies widely in the gillnet fishery, as fishers are often not aiming to maximize their catch (i.e. they are only removing enough fish to use as bait and not necessarily checking or cleaning their nets consistently). It was therefore decided during the 2011 assessment that given these issues, obtaining CPUE from logbooks was not a viable source of abundance data (Bourne *et al*. 2013).

Rather than eliminating logbooks entirely, changes were made in 2012 to simplify the format in hopes of recruiting more fishers to take part in the program; specifically, fishers were no longer required to provide details regarding the size of their nets/mesh or catch per net, they now simply had to provide the total weight of herring caught per day. Though CPUE could no longer be estimated it was hoped that if sample sizes improved, the catch data obtained could be used to validate phone survey results, and potentially provide temporal data on herring distribution. However, the logbook return rate did not show any significant increase in 2012 or 2013 (except in WBNDB) despite both reminder letters and a simplified format (Table 20).

When compared to telephone survey results, bait estimates calculated from logbooks show significant variation for many stock areas and years, with the mean sample size from the phone survey being at least three times as large as that from logbooks in all stock areas (Table 21). These results suggest that with the current return rates, bait estimates from logbooks are unreliable when compared to the telephone survey, particularly because the phone survey obtains a random sample whereas logbooks are voluntary.

FIXED GEAR FISHER ABUNDANCE INDICIES

In addition to providing data regarding catch, fishers who return logbooks and take part in fixed gear telephone surveys are also asked to answer the following three questions regarding the abundance of herring in their area:

Using a scale of 1 to 10, with 1 being the lowest, 5½ being average, and 10 being the highest:

1. how abundant (fish numbers) were herring in your fishing area in (the current year) compared to (the previous year)?
2. how abundant are herring in (the previous year) compared to the ten year period prior?
3. how abundant were herring in your fishing area in (current year) compared to the ten year period prior?

These answers are then included in a cumulative change index similar to that has been used in Div. 4t herring assessments (LeBlanc *et al*. 2012). The 1 to 10 scale of abundance is converted to a scale of -4.5 to +4.5, where 0 is average. A fisher’s observation of abundance from year “n-1” to year “n” is recorded as a “plus” or “minus” on the scale. An average is then derived for all fishers (by stock area); this is then added to or subtracted from the previous year’s estimate (Figs. 20-21). This index is intended to provide comparable results over time, despite a changing population of fishers.

PURSE SEINE FISHER ABUNDANCE INDEX

As with the logbook and fixed gear phone surveys, purse seine fishers contacted in the annual telephone survey are asked about herring abundance in their area and cumulative abundance change indices are calculated based on these observations (Fig. 22). The utility of this index is questionable given the small sample size in some areas/years and the nature of the mobile gear fishery, with purse seiners actively seeking out fish. This may give a different impression of abundance from the fixed gear fishery (particularly gillnet, from which the other indices are largely derived). In addition, most purse seine fishers are active in the fall, whereas gillnet fishers have historically been active in the spring-meaning that their abundance estimates could be reflective of different stock components (spring vs. fall spawners) or aggregations. While this means that the indices derived from the two fisheries are not directly comparable, there is potential for the purse seine index to provide insight on the abundance and movement of herring during the fall spawning period.

MODELS TO ASSESS STOCK STATUS

Biomass estimates were first produced for the stocks in 1985. The following methods have been used to assess biomass:

- acoustic survey data: 1985-1993;
- extended survivors analysis: 1994-95;
- research gillnet catchability analysis: 1996; and
- integrated catch-at-age (ICA): 1998, 2000.

Biomass estimation techniques from 1985 to 2000 have been fully described in the following research documents:

- acoustic survey biomass estimates: Wheeler *et al*. 1986, 1988, 1989, 1991, 1992, 1994; Wheeler and Chaulk 1987;
- extended survivors analysis: Wheeler *et al*. 1995; Wheeler and Winters 1996;
- research gillnet catchability analysis: Wheeler *et al*. 1997; and
- integrated catch-at-age analysis: Wheeler *et al*. 1999; Wheeler *et al*. 2001.

In the assessments since 2000 (2002, 2004, 2006, 2008, 2009 and 2011) current stock status and future prospects have been summarized for each stock complex in a performance report. Estimates of population numbers and biomass have not been available since 2001. Attempts were made to model stock status in 2009 using ADAPT and SURBA (Wheeler *et al*. 2010) but neither were found to provide reliable parameter estimates. No further modeling has been attempted since as data have become more limited with reductions to the research gillnet program and elimination of logbook CUPE.

PERFORMANCE REPORTS

Currently performance reports are used to update stock status and future prospects. Observations on abundance indices and biological characteristics are interpreted and then evaluated using the traffic light method (Caddy 1998). This method uses a system of red (-), yellow (?), or green (+) ‘lights’ to categorize indicators as ‘cause for concern’, ‘uncertain’ or ‘positive.’ Uncertain is defined as ‘uncertainty of an interpretation’ rather than precautionary uncertainty.

Current stock status is described based on a standardized (but arbitrary) evaluation of all abundance indices and the age composition of mature age groups. Abundance indices and age composition data are weighted based on their perceived importance and reliability in assessing current status, as decided by the assessment biologist(s). Since the implementation of this method, research gillnet catch rates have been given the most weight as they provide the only standardized, fishery-independent index. These are followed by research gillnet age compositions, commercial fixed gear logbook catch rates, and the cumulative abundance change index from the phone survey, purse seine survey and logbooks, with all three of the later getting equal weight.

These weightings were revised for the current update based on recent changes and the re-evaluation of indices (Table 22). Specifically, the research gillnet catch rates and age distributions were given slightly greater weightings, as these now represent the only quantitative indices in the reports (given the elimination of logbook CPUE). The weighting of the telephone survey abundance index remained the same while that of the fixed gear and purse seine abundance indices was reduced. This was done to reflect the larger sample size of the telephone survey; in addition, the nature and timing of the purse seine fishery, which uses mobile gear and actively seeks out fish in the fall, is suspected to make the abundance index from that survey less reliable. Logbook catch rate weighting was reduced as it was established that effort varies widely in that fishery and catch rates may not necessarily reflect abundance (Bourne *et al*. 2013). As of 2012, logbook CPUE was no longer collected and so was removed from the performance report entirely.

CURRENT DATA AND RECOMMENDATIONS

OVERVIEW

In addition to updating the commercial fishery data and indices of abundance, this section also includes results of analyses conducted to examine recent changes in herring stock composition and biology, as well as research recommendations for future assessments.

BIOLOGICAL AND ECOLOGICAL DATA

Environmental Changes

Observed shifts in herring stock composition have occurred concurrently with changes in ocean climate over the past decade (Colbourne *et al*. 2012). With the exception of 2002 and 2009, annual surface temperatures (0-55 m) at oceanographic Station 27 (off St. John’s, NL) have been above average (Fig. 24). Along with temperature, a range of other physical environmental indices have shown changes, with conditions in the late 1990’s and 2000’s being warmer and saltier in general than in the early 1990s, with less sea ice (Figure 24). Given that it is suspected that these environmental changes are driving herring spawning stock dynamics in the Northwest Atlantic (Melvin *et al*. 2009), but the exact drivers are not known, a research recommendation was made at this meeting to continue to explore the influence of environmental variables on herring stock structure and recruitment.

Spawning Components

The most dramatic changes in spawning stock composition during the past decade have occurred in WBNDB and BBTB, where fall spawners became more prevalent in the research gillnet catches in the early 2000s and more recently have accounted for more than 50% of the catch; samples obtained from the commercial fishery in both the spring and fall also reflect these trends with the percentage of fall spawners going as high as 90% in 2012 (Fig. 3). On the south coast the increase in the proportion of fall spawners has not been as dramatic. In SMBPB proportions of spawning types have historically fluctuated, but the percentage of fall spawners reached its highest level in the mid-2000s in the research gillnet program, and was even higher in the commercial catch. While there was an increase in fall spawners in FB during the 2000's in the research gillnet program, it was not as extreme as in the other stock areas, with spring spawners still comprising more than 80% of the catch most years; in the commercial catch the percentage of fall spawners was higher in the 1980s than it has been in recent years (Fig. 3).

Based on catch rates from the research gillnet program (Fig. 17), along with the relative year class sizes (Figs. 13-16) and recruitment trends (see below), it appears that the changing proportions of spawning components may be largely attributable to declining numbers of spring spawners and to a lesser extent, concurrent increases in the numbers of fall spawners – most likely due to differential survival of larvae. While this change in population numbers cannot be confirmed without biomass estimates, it is likely, given that this was the scenario that occurred recently in 4R where fall spawners have become dominant and the 2000 and 2002 year classes were also strong (Gregoire *et al*. 2012), indicating that recent trends in these stocks may be reflected in those along the rest of the NL coast.

Recruitment

Atlantic herring are characterized by highly variable recruitment and year class success, with fisheries often subsisting on a single strong year class. The cause of this variation has been an ongoing topic of study, with stock composition and environmental variables both being identified as drivers of recruitment success (e.g. Groger *et al*. 2010; Payne *et al*. 2009; Hufnagl and Peck 2011). With stocks in NL existing at the northern extent of the species' range in the northwest Atlantic and thus being exposed to harsher environmental conditions than more southerly regions, it is suspected that environment plays a particularly important role in their recruitment and survival (Winters and Wheeler 1987; Winters *et al*. 1993).

Recruitment in NL stocks is evaluated using the age 4 year class (the natural log of the age 4 research gillnet catch rate), which is considered to be fully recruited to the fishery. In 2012, the most recent year for which biological data is available, the recruiting 2008 year class was above average for fall spawners in WBNDB, BBTB and FB, and was average in SMBPB; the recruiting spring year class was average in WBNDB and FB, below average in BBTB and not detected in SMBPB (Fig. 26-29).

It is widely thought that herring recruitment and year class strength is determined by larval survival (e.g. Groger *et al*. 2010; Payne *et al*. 2013), and while it is possible that environmental variability can operate on any life stage (Harma *et al*. 2012), it is suspected that recent changes in NL spawning stock composition are largely due to differential larval success between spring and fall spawners, as seen in other areas (e.g. Johannessen *et al*. 2000; Hufnagl and Peck 2011). Spring-spawning herring lay eggs during the late spring and early summer, with larvae typically hatching and feeding during a time when zooplankton is abundant (following the annual spring bloom), which allows them to metamorphose into juveniles before the winter. In contrast, fall-spawner eggs hatch in mid to late-fall, when larvae experience cooler conditions with less abundant prey which limits their growth and development, delaying metamorphosis until the following year. Thus the growth and survival of spring and fall herring may be dependent on a variety of factors, including temperature, salinity, prey availability and overwintering conditions.

The idea of differential survival of spring and fall larvae is supported by the persistence of year classes through the research gillnet catch-at-age time series (Figs. 13-16) which generally shows no increase in adult mortality. Larval dynamics of Newfoundland herring have not extensively investigated; however, a study is currently being conducted by M.Sc. student Carissa Currie on the diet of larval herring using samples collected during annual Pelagic capelin larval surveys to examine the relationships between prey production and recruitment. It is hoped that further larval work will be done in the future.

While linking any single environmental or oceanographic variable to the changes in spawning stock composition is unlikely, Melvin *et al*. (2009) demonstrated that increases in ocean temperature are correlated with fall spawner recruitment and are likely indicative of more complex changes within the ecosystem (e.g. plankton/diet composition). Similar findings have been reported in other herring stocks, where broad scale ecological indices (e.g. NAO) have been used to explain the characteristic variation in recruitment seen in the species and changes in dominant spawning type (e.g. Groger *et al*. 2010; Harma *et al*. 2012).

The shift to fall spawner dominance has been most evident in WBNDB and BBTB, possibly due to the harsher environmental conditions than more southerly areas and the role of the Labrador current (Winters and Wheeler 1987). An analysis of these stock areas shows that the variability of spring spawner recruitment decreased through the 2000's to moderate levels, whereas fall spawner recruitment increased steadily (Fig. 30). The increase in fall spawners is correlated with increasing mean winter temperatures (Fig. 31), potentially due to higher survival of overwintering fall larvae in warmer conditions. There was no significant correlation between temperature and spring spawner recruitment, but the variation in recruitment did decrease as temperature increased, remaining stable at moderate to low levels (Fig. 31).

Spring Spawning Times and Spawning Group Assignment

Winters and Wheeler (1996) conducted an analysis of NL spawning times from 1970 to 1993 as part of a broader study of the NL herring reproductive cycle. The results showed that spring-spawning typically began in the 20^{th} week of the year (approximately the 3^{rd} week of May) and lasted an average of nine weeks, ending in mid-late July. Some exceptions were noted and it was found that annual variation in the onset and duration of spawning can be substantial, contrary to previous notions that it was a highly fixed aspect of life history. The results also demonstrated that spring-spawning had become progressively later starting in the early 1980s.

Using the same methods as Winters and Wheeler (1996) the time series was extended to 2012 to investigate current spawning times of spring spawners. Mean gonad weights at a common length were estimated for each week and then plotted, typically showing a gradual increase in weight during the pre-spawning holding phase, followed by the beginning of spawning and then a sharp decrease as spawning occurred (see Winters and Wheeler 1996). This pattern continued during the 1990's but changed during the 2000's, with gonad weights fluctuating and often not showing the steep decline indicative of active spawning (Fig. 32). It is suspected based on this analysis and communication with fishers that peak spawning is now occurring in July, often after the research gillnet program has ended; however there are currently very few samples obtained in July and August, making this is difficult to confirm. A recommendation was made at this meeting to obtain more samples from other sources during July and August to further explore this issue.

This potential change in spawning times, along with the shift in stock composition, also necessitates a re-examination of spawning group assignment of sampled herring. Otolith structure is the primary method to determine spawning groups for NL herring, with clear structural differences existing between spring and fall spawners. Maturity stage is also used to confirm spawning group, with July 1 often being considered the 'cut off' date for spring spawning. However in recent years there have been an increasing number of otoliths which have structural characteristics of both spring and fall spawners, making spawning group designation difficult. This, in conjunction with a high frequency of summer spawning fish has led to concerns regarding designation. It was recommended at this meeting that the criteria for spawning group assignment be re-evaluated, and research be conducted into otolith morphology.

Offshore Distribution

Data from samples collected during offshore surveys in 2011 and 2012 were grouped by NAFO division and catch-at-age was calculated for each. It should be noted that the timing and coverage of the survey likely has an effect on the abundance of herring caught per division, as the survey begins in April in 3Ps and progressively moves east during May and June; it is likely that during the course of the survey herring are migrating into coastal waters and thus their numbers decrease offshore as the season progresses. In addition, NAFO Divisions 3K and 2J are not surveyed in the spring so it is not possible to determine whether herring are offshore in these areas as well during that time.

In 2011 most herring were caught in 3Ps (Fig. 10), with samples consisting of 65% fall spawners representing a range of age groups; the majority of spring spawners in this area were immature age 2 fish. Samples from 3O consisted of approximately even numbers of spring and fall spawners; most fall spawners were age 3s and as with 3Ps, the majority of spring spawners were age 2s. In area 3L, two samples that were collected in June were processed and 82% of these fish were fall spawners from a range of age groups, almost all of the spring spawners were age 2 and 3 fish (Fig. 33).

The samples collected in 2012 (Fig. 11) reflect much the same age and spawning stock distribution as the previous year. In area 3Ps fall spawners composed 56% of the catch and represented a range of age groups; spring spawners were largely age 3s, the same prevalent 2009 year class seen offshore the previous year. In 3O samples consisted of 59% fall spawners, largely age 4s and 5s, whereas springs were almost entirely age 3s. In area 3L 68% of fish sampled were fall spawners from a range of year classes; the age 3 spring spawners also dominated the catch in this area (Fig. 34).

It is unknown how far offshore herring migrated in Newfoundland in the past as tagging experiments used recaptures from the inshore fishery (Wheeler and Winters 1984a, 1984b), but the data from the multispecies surveys indicate that in recent years there has been an increase in the presence of herring offshore in the spring (Fig. 2). The mean depth of fishing sets where herring occurred was 157 m in 2011 and 145 m in 2012, but the range of depths was extensive (43-460 m) in both years (Fig. 35). The mean fishing temperature of sets with herring in 2011 was 3.4°C and 2.52°C in 2012 (Fig. 36). There was no apparent relationship between the number of herring caught and either temperature or depth of fishing sets. However, the mean water temperature recorded at Station 27 has increased in recent years, the relationship between this increase and the occurrence of herring in offshore waters needs to be investigated further.

The age and spawning type distribution of herring collected in offshore samples was not surprising as it would be expected that most mature spring spawners would be moving inshore to shallow spawning areas during the time period of the spring survey, whereas some immature fish and fall spawners would likely migrate to inshore summer feeding grounds areas later, based on previous tagging study data (Wheeler and Winters 1984a, 1984b).

The consistency of age distributions between 2011 and 2012 demonstrates that offshore data may be valuable for the assessment of these stocks; in particular, the sampling of young fish can provide data on immature herring and recruitment. Currently, there are very few immature herring caught in the research gillnet program or commercial fishery, due to gear selectivity and size restrictions. This has led to a knowledge gap regarding the age and size at maturity of herring in recent years which may be addressed, at least in part, using offshore sample data. The potential to use offshore samples as an indicator of recruitment may also exist, as the trends seen in the 2011 samples are also reflected in the 2012 research gillnet catch-at-age in most areas. A research recommendation was made at this meeting to continue to explore other data sources, including offshore trawl surveys and vessel monitoring system (VMS) information.

THE 2011-2013 COMMERCIAL FISHERY

Landings

Prior to the 2010 fishery, Fisheries and Aquaculture Management Branch formulated a new Integrated Fisheries Management Plan (DFO 2010) for herring that set TACs for all stock areas for 2010 and 2011. These TAC's remained the same for the 2012 and 2013 fisheries with the exception of Fortune Bay, where there was a reduction in that TAC in 2013 from 288 t to 226 t. This reduction was implemented based on preliminary assessment results for the stock area which were presented at the Small Pelagic Advisory Committee meeting in April of that year, indicating potential issues with the recruitment and age structure of the stock (see below).

Total herring landings in the region were just 3900 t in 2011, representing 29% of the TAC; landings increased to 5200 t in 2012. At the time of this assessment, the 2013 fishery was ongoing and data presented are up to November 4, 2013 (Fig. 4, Tables 1-5). The majority of total landings in recent years were taken by purse, beach and bar seines (Fig. 5).

The only stock area to see an increase in landings in 2011 was WBNDB where purse seine landings in White Bay accounted for the majority of the catch, in part by fishers who had been looking for mackerel. Landings decreased slightly in 2012 (Fig. 6, Table 1). In recent years trap landings in WBNDB have increased, second only to purse seine landings. The fall fishery continues to be larger than the spring in the area, though the spring fishery has increased in recent years (Fig. 37).

In BBTB landings decreased in 2011 with just 17% of the TAC being landing, this increased to 46% (2255 t) in 2012 (Fig. 6, Table 2). The majority of landings have been in Bonavista Bay in recent years with the largest proportion of the catch being taken with purse and tuck seines. The fall fishery continues to have higher landings than the spring (Fig. 37).

Commercial landings in SMBPB have declined significantly in recent years, with only 42 t landed in 2011 and 56 t in 2012, representing 2% and 3% of the TAC respectively (Fig. 6). All of these landings have occurred in Placentia Bay, via gillnets and purse seines (Table 2). The fall fishery had been increasing in this area, but has declined along with the spring fishery (Fig. 37).

In FB 53% of the TAC was taken in 2011 and 59% in 2012 (1685 t). There is no purse seine fishery in FB, the majority of landings come from the bar seine fishery (Table 4). There have been persistent complaints during the fixed gear phone survey and via fixed gear logbooks about bar seine fishers in the Long Cove area of FB taking too many fish and straining the resource. The fishery in FB takes place in the spring.

Catch-at-age and Spawning Composition

The age distribution of commercial samples taken from WBNDB was extensive in both 2011 and 2012. The proportion of fall spawners remained higher than that of spring spawners in both years; the potentially strong 2009 spring year class that was detected in offshore samples (Figs. 33-34) was also evident in the age distributions (Table 11, Figs. 38 and 42).

In BBTB the commercial catch-at-age was skewed toward older fish in 2011 with an approximately even distribution of spring and fall spawners. In 2012 the percentage of fall spawners was 92%, the highest in the time series (Table 12, Figs. 39 and 43).

In SMBPB the age distribution of the commercial catch was well distributed between age classes in 2011, however in 2012 the catch was largely age 11+ fish (Table 13, Figs. 40 and 44); however it should be noted that the sample size for both years was quite low due to the small commercial fishery.

In FB spring spawners continued to dominate the commercial fishery at 98% in 2011 and 85% in 2012. The catch-at-age for both years was truncated, being composed almost entirely of older fish (Table 14, Fig. 41). As with other areas there have been no strong year classes in the area in recent years, with the 2002 year class comprising the majority of the catch in the past decade, a year class that is now exiting the fishery (Fig. 45). Concerns about this truncated age distribution have been raised with fisheries managers and a TAC reduction was implemented in 2013; this will be revisited in 2014 as more data becomes available about the FB age structure.

INDICES OF ABUNDANCE

Research Gillnet Program

In WBNDB combined (spring and fall spawner) catch rates were at an all-time low in 2011, but increased to a level slightly above the decadal mean in 2012 (Fig. 17). The proportion of spring spawners was approximately 65% in both years; catch numbers of fall spawners have decreased in recent years compared to the mid 2000’s, but the catch numbers of spring spawners remains low in comparison to the 1990s (Fig. 18). There have been no strong year classes recently, though fall spawners are relatively stronger than springs (Table 15, Fig. 13).

The combined catch rate in BBTB remained around the time series mean from 2011 to 2013 (Fig. 17). Though it has declined since a peak in 2007, the total catch of fall spawners is still above historical levels in the area, comprising more than 60% of the catch; total catches of spring spawners continue to decline (Fig. 18). The age distribution was extensive in 2011 and 2012 (Table 16, Fig. 14).

In SMBPB catch rates increased from a series low in 2011 to just below the decadal mean in 2012 (Fig. 17). Fall spawners constituted 31.8% of the catch in 2011 and 49.9% in 2012 (Fig. 18). The age distribution was skewed toward older spring spawners in 2011 and more than 25% of the catch in 2012 was age 3 spring spawners (Table 17, Fig. 15).

As with other areas, the combined catch rate in FB hit a series low in 2011 and was slightly higher in 2012 and 2013, but still well below both the long term and decadal mean (Fig. 17). A fisher was removed from the program in 2013 due to suspected data issues. When this fisher’s catch data was removed from the long term data series it had little impact on overall trends, particularly in recent years (Fig. 18). The total catch per year of spring spawners has declined steadily in FB over the past decade but unlike other areas, there has been no observed increase in fall spawners. The age distribution in 2011 was concerning, with 96% of the catch being comprised of spring spawners and over 90% of those fish aged 9 or 11+; in 2012 this improved slightly with most spring spawners being aged 9+ but slightly higher numbers of younger fish than the previous year (Table 18, Fig. 16). This truncated age distribution led to a precautionary TAC reduction in the area in 2012.

The reduction of this program is a major concern for stock assessments as the research gillnet program is currently the sole fishery-independent index of abundance. It is hoped that in time funding can be obtained to reinstitute the program in WBNDB and SMBPB, but in the meantime stock status will no longer be reported. It has been questioned whether it would be worthwhile to alternate the research gillnet program between stock areas every year, collecting data from WBNDB and SMBPB in one year, and BBTB and FB the next. This may be a possibility though the impact on the abundance index needs to be examined, as does the probability of retraining fishers in a bi-annual program.

The recent changes in stock composition and dynamics are also issues of concern this program and the validity of the index it provides. The spring research gillnet program was designed to intercept aggregated schools of herring as they moved onto spring spawning grounds. Historically fishers in the program have successfully obtained samples during peak spring spawning, as demonstrated by Winters and Wheeler (1996). However, with potential changes in spawning times this may no longer be the case. Despite a 15 day extension to the program in 2009, it still appears that potentially significant numbers of spawning herring are arriving after fishing has ended. Whether these are ‘late spring’ or summer spawners has yet to be determined, but they likely represent an important component of the population which is not currently being accounted for; as the program now covers only a fraction of the spawning migration, the index in turn only represents a fraction of the total abundance. It was suggested at this meeting that the timing and duration of the program be adjusted to better capture late spring spawning. However this would be difficult given restrictions on herring gillnets during the summer months due to salmon migrations, as well as the schedules of contracted fishers which would likely restrict them from participating in the program later in the summer.

The index of fall spawner abundance provided by this program is also a concern. Though all stock complexes contain a mix of spawning groups throughout the year, the presence of mature fall spawners in the spring offshore surveys may indicate that a proportion of the fall spawning population is not being accounted for in the spring research gillnet index. If this is the case, the proportion of fall spawners may be underestimated. Higher proportions of fall spawners in the commercial fall fishery suggest this may be the case (Fig. 3). A suggested solution to this problem is the reestablishment of a fall research gillnet program which would provide a comparable index of abundance during the fall spawning season, when all mature fish should be present inshore.

Fixed Gear Logbook Program

Overall logbook returns did not show significant increases in 2012, despite the reduction in required information from fishers (Table 20). The 2013 logbook data was not yet processed at the time of this assessment as logbooks were still being received. Because less detail was recorded in the 2012 logbooks, CPUE was no longer calculated; however total catch per stock area, average bait caught per fisher and fishing dates were compiled (Tables 20 and 21).

Fixed Gear Telephone Survey

The 2012 fixed gear phone survey had a response rate of 79%. Of those contacted, 41% were active and 88% of them fished for bait using gillnets. In 2013 the survey had a 75% response rate; this lower rate may be due to the fact that numerous phone numbers on the list obtained were no longer in service, it is hoped that with the implementation of the new licensing procedures in 2014 contact information will be adequately updated so this will not be an issue for the survey in the future. Of the fishers contacted 35% were active and 85% of those were bait fishers (Table 23).

The percentage of active fishers declined from 2012 to 2013 in all stock areas except BBTB, the stock area with the highest percentage of active fishers (Table 23).

The majority of fishers in WBNDB in 2012 remarked that herring were larger and more plentiful than previous years, but arriving later; in 2013 comments from the area were more varied, with some again remarking that fish were larger and later, but others complaining that stocks were low due to seiners and seals. In BBTB in 2012, fishers commented that there were a lot of big herring mixed with small, some remarked that seiners and commercial fisheries are having a negative impact on stocks; in 2013 many fishers commented that herring has been scarce and that they needed to buy lobster bait, there were also remarks that herring are arriving later each year. Fishers in FB in both 2012 and 2013 commented that overfishing by bar seiners in Long Harbour is having a negative impact on the stock and that herring are very scarce, some also blamed aquaculture operations.

The number of licences and percentage of active fishers has declined every year since the phone survey was implemented in 1996, as the mean age of fishers has increased to the current 58 years (Table 23). With reports of herring arriving later and fishers buying bait or using other species (Winter flounder) as bait, the herring bait fishery may be in decline.

Purse Seine Telephone Survey

Response rates in the purse seine telephone survey remained high in recent years, with all but 1 active fisher responding to the 2011 survey, and 87% responding in 2012 (Table 7). In both 2011 and 2012 almost all landings occurred in late summer and during the fall, so only a fall survey was conducted.

The removal to landing ratios were high in both WBNDB and BBTB in 2011 and 2012, particularly in BBTB where estimated discards surpassed landings in both years (Table 7). This was blamed on large numbers of undersized herring in fishing sets, which in turn had to be released.

Cumulative Change Index

Fishers who complete logbooks, the fixed gear telephone survey and the purse seine telephone survey are all asked to complete questions regarding herring abundance, the answers of which are used to calculate the cumulative change index and give a relative measure of changing herring abundance in their areas. Results from the 2013 logbooks and purse seine telephone surveys were not available at the time of this meeting.

In WBNDB and BBTB, fixed gear fishers who completed logbooks and purse seine fishers contacted via the telephone survey indicated that abundance in 2012 was higher than 2011 (Figs. 20 and 22). During the 2013 fixed gear telephone survey, the index showed that abundance had decreased in WBNDB but increased slightly in BBTB (Fig. 21).

Fishers from SMBPB who returned logbooks in 2012 reported no change in abundance (Fig. 20); the same was reported by the one active purse seine fisher that year (Fig. 22). During the 2013 fixed gear telephone survey fishers indicated that abundance in the area had decreased (Fig. 21).

For the 12th consecutive year, fishers who completed logbooks in 2012 reported a decrease in abundance (Fig. 20), the same was reported in the fixed gear telephone survey in 2013 (Fig. 21).

The validity of this index was questioned during this meeting, given that it is observational and that the timing and nature of the purse seine fishery differs from that of the fixed gear. There were also concerns about the scale of the index and whether it was giving an accurate representation of changes in abundance. A research recommendation was made that the reporting of information from these opinion surveys in stock status reports be re-evaluated. It was suggested that this index be removed from the calculation of stock status entirely and instead included in an ‘industry perspective’ section, or elsewhere, in assessments in the future.

Stock status and Performance reports

Performance reports (Tables 24-27) and stock statuses (Fig. 23) were updated for this meeting to provide an overview of current information and examine the impacts of revised stock status calculations, which were not substantial. These are preliminary results and may change if abundance indices are recalculated for the 2015 assessment, at which time a full update of stock status will be provided.

It was recommended at this meeting that reporting methods be revised for assessments going forward. The cumulative change index will be removed from performance reports, but included elsewhere in the assessment to provide an industry perspective. In TBBB and FB where the research gillnet program has continued, indices will be split between spring and fall spawners when possible. Stock status in these areas will be based on weighted values of research gillnet catch rates, cohorts above average, and the mean catch rate of older fish. The weighting scheme of these indices will be discussed at the next assessment. In addition, catch rates of age 4-6 fish will be used to report short term prospects (2-3 years).

In areas where the research gillnet program has been discontinued (WBNDB and SMBPB) a weighted stock status will no longer be provided. Instead the traffic light approach will be used and when appropriate, comments included on trends observed in adjacent stock areas.

It was also suggested that acoustic surveys be reintroduced to obtain biomass and exploitation estimates and that the fall research gillnet program be reinstated. Funding sources for these programs will be investigated but it is unlikely that these suggestions will be implemented in the near future. In addition, a research recommendation was made to explore the estimation of total mortality rates through population modelling (SURBA, etc.) using available data.

AREAS OF UNCERTAINTY

A major area of uncertainty in this assessment continues to be the inability to estimate current stock sizes and exploitation rates, and to place these estimates within an historical context using current data sources. Population modelling was attempted during the 2009 framework assessment meeting (Wheeler *et al*. 2010) where it was determined that models could not be calibrated using the available data; given that there has been reductions in the herring research gillnet program since that meeting, reducing the amount of data collected, this is still an issue. To estimate biomass and other population parameters for this stock, an absolute abundance index is needed (e.g. an acoustic survey).

Uncertainty about stock complex structure itself is also an issue for assessments, as tagging studies used to delineate stock complexes were conducted in the late 1970s and early 1980s when abundance was significantly higher. Since then population sizes have decreased and there have been changes in environmental conditions which may have impacted both herring distribution and behavior.

Assessment methods for these stocks were designed to target the historically predominant spring-spawning component, particularly through the spring research gillnet program. However, over the past decade there has been a widespread decline in spring spawners and most stocks are now composed of a large proportion of fall spawners, which are not adequately accounted for using the current assessment methods. Consideration should be given to adding a fall research gillnet program to better estimate the proportion of the fall-spawning component, which may not be fully represented during the spring research program-recent offshore data corroborates this, detecting fall-spawning herring offshore during the spring which are not recruited to the spring research gillnet program, the primary index of abundance.

There appears to have been a spatial/temporal shift in herring distribution and behavior in recent years, with greater offshore occurrences and later spring-spawning times. This may further confound the results of the spring research gillnet program, which may no longer be providing an index of abundance comparable to earlier in the time series.

The research gillnet program provides the only source of fishery independent data and its cancellation in two stock areas (WBNDB and SMBPB) in 2013 will severely limit assessment capabilities. Stock status will no longer be calculated in these areas.

The inability to estimate population sizes has precluded (to date) the calculation of stock status zones and reference points, which severely limits the implementation of the precautionary approach in fisheries management decisions.

SUMMARY AND RESEARCH RECOMMENDATIONS

During the meeting, herring data collection, assessment methods and stock composition changes were discussed in detail. The following key issues for stock assessments were identified:

1. there have been major changes in spawning stock composition (i.e. decreasing numbers of spring spawners, increasing proportion of fall spawners;
2. environmental change appears to be the main influence, but the exact drivers and mechanisms of change are not yet understood; and
3. stock assessments are based on a single index, the spring research gillnet program, which was reduced in 2013 and may not be adequately capturing trends in abundance of both spawning components.

The shift in spawning group composition within these stocks was the main reason that this framework meeting was held, as such a dramatic change necessitated a re-examination of stock assessment methods. The following suggestions were made to modify the assessment process and collect additional data to account for spawning component changes:

- split indices where possible from the research gillnet program. Advise fisheries managers that they should not be added;
- adjust timing/duration of research gillnet program to better capture spring-spawning;
- reinstate the fall research gillnet program;
- conduct research into otolith morphology;
- re-evaluate criteria for spawning group assignment; and
- obtain samples from other sources in July and August, if possible.

The primary index of abundance is currently derived from the spring research gillnet program. To improve this index and assessments in general, the following suggestions were made:

- evaluate the impact of changing the timing of the research gillnet program on the catch rate index; and
- reintroduce acoustic surveys to obtain biomass and exploitation rates.

The reporting methodology for stock assessments was also reviewed during this meeting, with discussions focusing on the loss of the research gillnet program in two stock areas, and the utility of the observational abundance index obtained through logbooks and phone surveys. The following changes to reporting methods were recommended for herring assessments:

- keep current summary format for areas that have a research gillnet program, except for fisher opinion surveys (cumulative change index), which will be removed from the calculation of stock status and included in industry perspective or elsewhere in the report;
- in areas with a research gillnet program, current stock status will be based on weighted values of catch rates, number of cohorts above average, and the mean catch rate of older fish. These indices should be presented separately and the weighting scheme will be discussed at the next stock assessment meeting;
- catch rates from the research gillnet program (mean ages 4-6) will be used to report short term stock prospects (2-3 years); and
- In stock areas without a research gillnet program, a traffic light approach will be used with no weighted stock status. Where appropriate, comments will be included on trends in adjacent stock area where stock status has been calculated.

Five research recommendations were produced as a result of this meeting which will be addressed if possible before the 2015 stock assessment:

1. examine implications of selectivity on the research gillnet index by comparing catches across mesh sizes;
2. continue to explore the estimation of total mortality rates through population modeling (SURBA, etc.);
3. explore other data sources such as offshore trawl surveys and vessel monitoring systems (VMS) data;
4. re-evaluate reporting information from opinion surveys (cumulative change indices); and
5. continue to explore the influence of environmental variables on herring stock structure and recruitment.

ACKNOWLEDGEMENTS

We would like to acknowledge the cooperation and information provided by fish harvesters and processors who contributed to the commercial sampling program, research gillnet program, logbook program and telephone surveys.

We would also like to thank the DFO Pelagics Section staff for their ongoing work and contributions to the herring research program, as well as those who attended the framework review meeting, in particular our colleague, Martin Castonguay.

REFERENCES CITED

Bierman, S. M., Dickey-Collas, M., van Damme, C.J.G., van Oversee, H.M.J., Pennock-Vos, M.G., Tribuhl, S. V. and Clausen, L.A.W. 2010. Between-year variability in the mixing of North Sea herring spawning components leads to pronounced variation in the composition of the catch.

Bourne, C.B., Mowbray, F., Squires, B. and Croft, C. 2013. An assessment of Newfoundland east and south cost herring stocks to the spring of 2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/039.

Caddy, J.F. 1988. A short review of precautionary reference points and some proposals for their use in data-poor situations. FAO Fisheries Technical Paper No. 379, 30 pp.

DFO. 2010. 2010/2011 Integrated management plan for herring on the east and south coasts of Newfoundland (NAFO Divisions 2J3KLPs).

Colbourne, E., Craig, J., Fitzpatrick, C., Senciall, D., Stead, P. and Bailey, W. 2012. An assessment of the physical oceanographic environment on the Newfoundland and Labrador Shelf during 2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/044.

Gower, A., and Kelly, K. 1993. How big should a sample be? Social Survey Methods Division, Statistics Canada. Mimeo. 14 p.

Groger, J.P., Kruse, G.H. and Rohlf, N. 2010. Slave to the rhythm: how large-scale climate cycles trigger herring (*Clupea harengus*) regeneration in the North Sea. ICES Journal of Marine Science. 67:454-465.

Grégoire, F., Beaulieu, J.L. and McQuinn, I.H. 2012. The Atlantic herring (C*lupea harengus harengus L*.) stocks of the west coast of Newfoundland (NAFO Division 4R) in 2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/121.

Harma, C., Brophy, D., Minto, C. and Clarke, M. 2012. The rise and fall of autumn-spawning herring (*Clupea harengus L.)* in the Celtic Sea between 1959 and 2009: Temporal trends in spawning component diversity. Fisheries Research. 121-122: 31-42.

Hufnagl, M. and Peck, M.A. 2011. Physiological individual-based modeling of larval Atlantic herring (*Clupea harengus*) foraging and growth: insights on climate-drive life-history scheduling. ICES Journal of Marine Science. 68: 1170-1188.

Johannessen, A., Blom, G. and Folkvord, A. 2000. Differences in growth pattern between spring and autumn spawned herring (*Clupea harengus L*.) larvae. Sarisa. 85:461-466.

LeBlanc, C.H., Mallet, A., MacDougall, C., Bourque, C. and Swain, D. 2012. Assessment of the NAFO Division 4T southern Gulf of St. Lawrence herring stocks in 2011. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/111.

Melvin, G.D., Stephenson, R.L. and Power, M.J. 2009. Oscillating reproductive strategies of herring in the western Atlantic in response to changing environmental conditions. ICES Journal of Marine Science. 66:1784-1792.

Olsen, R.E., Oppedal, F., Tenningen, M., and Vold, A. 2012. Physiological response and mortality caused by scale loss in Atlantic herring. Fish. Res. 129-130: 21-27.

Payne, M.R., Hatfield, E.M.C., Dickey-Collas, M., Falkenhaug, T., Gallego, A., Groger, J., Licandro, P., Llope, M., Munk, P., Rockmann, C., Schmidt, J.O. and Nash, R.D.M. 2009. Recruitment in a changing environment: the 2000s North Sea herring recruitment failure. ICES Journal of Marine Science. 66:272-277.

Payne, M.R., Ross, S.D., Clausen, L.W., Munk, P., Mosegaard, H. and Nash, R.D.M. 2013. Recruitment decline in North Sea herring is accompanied by reduced larval growth rates. Marine Ecology Prog. Ser. 489:197-211.

Reddin, D.G., Johnson, R., and Downton, P. 2002. A study of by-catches in herring bait nets in Newfoundland, 2001. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/031.

Tenningen, M., Vold. A. and Olsen, R.E. 2012. The response of herring to high crowding densities in purse seines: survival and stress reactions. ICES Jour. Mar. Sci. 69(8): 1523-1531.

Wheeler, J. P. and Chaulk, R. 1987. Newfoundland east and southeast coast herring-1986 assessment. CAFSAC Res. Doc. 87/60: 92 p.

Wheeler, J.P., and Winters, G.H. 1984a. Migrations and stock relationships of east and southeast Newfoundland herring (*Clupea harengus*) as shown by tagging studies. J. Northw. Atl. Fish. Sci. 5:121-129.

Wheeler, J.P., and Winters, G.H. 1984b. Homing of Atlantic Herring (Clupea harengus harengus) in Newfoundland waters as indicated by tagging data. Can. J. Fish. Aquati. Sci. 41:108-117.

Wheeler, J. P., Chaulk R., and Winters, G. H. 1986. East coast Newfoundland herring-1985 assessment. CAFSAC Res. Doc. 86/58: 63 p.

Wheeler, J. P., Winters, G. H. and Chaulk, R. 1988. Newfoundland east and southeast coast herring-1987 assessment. CAFSAC Res. Doc. 88/74. 62 p.

Wheeler, J. P., Winters, G. H. and Chaulk, R. 1989. Newfoundland east and southeast coast herring-1988 assessment. CAFSAC Res. Doc. 89/40: 86 p.

Wheeler, J. P., Winters, G. H., Stansbury, D. E., and R. Chaulk. 1991. Newfoundland east and southeast coast herring - 1990 assessment. CAFSAC Res. Doc. 91/2: 45 p.

Wheeler, J. P., Winters, G. H. and Chaulk, R. 1992. Newfoundland east and southeast coast herring-1991 assessment. CAFSAC Res. Doc. 92/49. 37 p.

Wheeler, J. P., G. H. Winters, and R. Chaulk. 1994. Newfoundland east and southeast coast herring-an assessment of stocks in 1992 and 1993. DFO Atl. Fish. Res. Doc. 94/53. 49 p.

Wheeler, J. P., Winters, G. H. and Chaulk R.. 1995. Newfoundland east and southeast coast herring-an assessment of stocks to the spring of 1994. DFO Atl. Fish. Res. Doc. 95/17. 60 p.

Wheeler, J. P. and Winters, G. H. 1996. Newfoundland east and southeast coast herring-an assessment of stocks to the spring of 1995. DFO Atl. Fish. Res. Doc. 96/63. 65 p.

Wheeler, J. P., Winters, G. H. and Squires, B. 1997. Newfoundland east and southeast coast herring-an assessment of stocks to the spring of 1996. DFO Atl. Fish. Res. Doc. 97/56. 67 p.

Wheeler, J.P., Squires, B., and Williams, P. 1999. Newfoundland east and southeast coast herring-an assessment to the spring of 1998. DFO Can. Stock Assess. Res. Doc. 1999/13, 171 p.

Wheeler, J.P., Squires, B., and Williams, P. 2001. Newfoundland east and southeast coast herring–an assessment of stocks to the spring of 2000. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/018, 129 p.

Wheeler, J.P., Squires, B., and Williams, P. 2010. An assessment framework and review of Newfoundland east and south coast herring stocks to the spring of 2009. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/20.

Winters, G.H., and Wheeler, J.P. 1987. Recruitment dynamics of spring-spawning herring in the Northwest Atlantic. Can. J. Fish. Aquat. Sci. 44: 882-900.

Winters, G. H. and Wheeler, J.P. 1996. Environmental and phenotypic factors affecting the reproductive cycle of Atlantic herring. ICES Journal of Marine Science. 53:73-88.

Winters, G.H., Wheeler, J.P. and Stansbury, D. 1993. Variablity in the reproductive output of spring-spawning herring in the north-west Atlantic. ICES Journal of Marine Science. 50:15-25.

APPENDIX I

Table 1: WB–NDB herring landings and TACs (t), by gear type, 1999-2013 (up to November 4, 2013). Landings are from Policy and Economics Branch and do not include herring discards or herring used as bait.

Year	Area	Purse Seine	Bar Seine	Tuck Seine	Gillnet	Trap	Total	TAC	% TAC Landed
1999	WB	0	0	-	4	30	34	-	-
1999	NDB	931	0	-	53	0	984	-	-
1999	Combined	931	0	-	57	30	1018	2500	41
2000	WB	74	0	-	3	2	79	-	-
2000	NDB	997	0	-	16	1	1014	-	-
2000	Combined	1071	0	-	19	3	1093	2500	44
2001	WB	13	0	-	7	5	25	-	-
2001	NDB	0	0	-	0	1	1	-	-
2001	Combined	13	0	-	7	6	26	1100	2
2002	WB	0	13	-	6	5	23	-	-
2002	NDB	303	0	-	7	23	333	-	-
2002	Combined	300	13	-	13	28	357	1100	32
2003	WB	0	0	-	22	0	22	-	-
2003	NDB	195	87	-	24	4	310	-	-
2003	Combined	195	87	-	46	4	332	1100	30
2004	WB	11	2	-	4	28	45	-	-
2004	NDB	152	48	-	8	13	220	-	-
2004	Combined	163	50	-	12	40	265	1100	24
2005	WB	39	174	115	2	174	505	-	-
2005	NDB	97	259	2	10	17	386	-	-
2005	Combined	136	433	117	12	190	891	1100	81
2006	WB	56	16	21	8	49	150	-	-
2006	NDB	83	58	0	19	0	159	-	-
2006	Combined	139	74	21	27	49	309	1100	28
2007	WB	13	8	0	0	9	31	-	-
2007	NDB	320	7	0	0	4	331	-	-
2007	Combined	333	15	0	0	13	362	1700	21
2008	WB	211	0	3	0	2	216	-	-
2009	NDB	228	246	19	4	1	498	-	-
2009	Combined	439	246	22	4	3	714	1700	42
2009	WB	4	0	0	0	6	10	-	-
2009	NDB	414	0	0	1	0	415	-	-
2009	Combined	418	0	0	1	6	425	2200	19
2010	WB	203	0	0	0	82	285	-	-
2010	NDB	210	22	0	2	7	239	-	-
2010	Combined	413	22	0	2	89	524	2640	20
2011*	WB	721	0	75	43	415	1255	-	-
2011*	NDB	43	0	0	0	1	44	-	-
2011*	Combined	764	0	75	43	416	1299	2640	49
2012*	WB	47	0	61	5	346	458	-	-
2012*	NDB	602	0	136	20	12	770	-	-
2012*	Combined	649	0	197	25	358	1228	2640	43
2013*	WB	0	0	17	13	214	244	-	-
2013*	NDB	307	0	0	1	0	308	-	-
2013*	Combined	307	0	17	14	214	552	2640	21

**provisional*

Table 2: BB- TB herring landings and TACs (t), by gear type, 1999-2013 (up to November 4, 2013). Landings are from Policy and Economics Branch and do not include herring discards or herring used as bait.

Year	Area	Purse Seine	Bar Seine	Tuck Seine	Gillnet	Trap	Total	TAC	% TAC Landed
1999	BB	563	222	-	94	0	879	-	-
1999	TB	245	208	-	100	0	553	-	-
1999	Combined	808	430	-	194	0	1432	2500	57
2000	BB	493	195	-	135	8	831	-	-
2000	TB	2	190	-	67	0	259	-	-
2000	Combined	495	385	-	202	0	1090	2500	44
2001	BB	241	16	-	37	0	294	-	-
2001	TB	18	155	-	19	0	192	-	-
2001	Combined	259	171	-	56	0	486	3500	14
2002	BB	0	297	-	25	7	329	-	-
2002	TB	200	4	-	13	20	237	-	-
2002	Combined	200	301	-	38	27	566	3500	16
2003	BB	343	1	-	48	90	482	-	-
2003	TB	0	0	-	8	0	8	-	-
2003	Combined	343		-	56	90	490	3000	16
2004	BB	188	139	-	3	2	322	-	-
2004	TB	134	19	-	21	2	177	-	-
2004	Combined	322	158	-	24	5	509	3000	17
2005	BB	910	456	21	154	82	1623	-	-
2005	TB	604	103	142	163	5	1017	-	-
2005	Combined	1515	559	162	317	87	2640	3000	88
2006	BB	703	467	63	33	4	1270	-	-
2006	TB	340	129	62	103	0	636	-	-
2006	Combined	1043	596	125	136	4	1906	3000	64
2007	BB	465	381	301	22	0	1169	-	-
2007	TB	784	197	473	132	23	1608	-	-
2007	Combined	1249	578	774	154	23	2777	4000	69
2008	BB	1138	197	405	10	0	1750	-	-
2008	TB	777	21	221	34	0	1079	-	-
2008	Combined	1915	218	626	44	0	2829	4000	71
2009	BB	1276	37	720	254	23	2310	-	-
2009	TB	452	182	215	24	0	873	-	-
2009	Combined	1728	219	935	278	23	3183	4500	71
2010	BB	1104	31	853	29	43	2060	-	-
2010	TB	40	0	25	5	0	70	-	-
2010	Combined	1144	31	878	34	43	2131	4950	43
2011*	BB	74	0	82	8	40	204	-	-
2011*	TB	4	0	56	63	0	123	-	-
2011*	Combined	78	0	138	71	40	327	4950	7
2012*	BB	1320	0	429	48	0	1797	-	-
2012*	TB	248	0	140	66	4	458	-	-
2012*	Combined	1568	0	559	114	4	2255	4950	46
2013*	BB	168	0	19	21	0	207	-	-
2013*	TB	0	0	69	59	8	136	-	-
2013*	Combined	168	0	88	80	8	343	4950	7

**provisional*

Table 3: CB and SS herring landings and TACs (t), by gear type, 1999-2013 (up to November 4, 2013). Landings are from Policy and Economics Branch and do not include herring discards or herring used as bait.

Year	Area	Purse Seine	Bar Seine	Tuck Seine	Gillnet	Trap	Total	TAC	% TAC Landed
1999	CB	0	0	-	0	0	0	-	-
1999	SS	0	0	-	0	0	0	-	-
1999	Combined	0	0	-	0	0	0	600	0
2000	CB	0	0	-	0	0	0	-	-
2000	SS	0	0	-	0	0	0	-	-
2000	Combined	0	0	-	0	0	0	600	0
2001	CB	0	0	-	0	0	0	-	-
2001	SS	0	0	-	0	0	0	-	-
2001	Combined	0	0	-	0	0	0	600	0
2002	CB	0	0	-	0	0	0	-	-
2002	SS	0	0	-	0	0	0	-	-
2002	Combined	0	0	-	0	0	0	600	0
2003	CB	0	0	-	0	0	0	-	-
2003	SS	0	0	-	0	0	0	-	-
2003	Combined	0	0	-	0	0	0	600	0
2004	CB	0	0	-	0	0	0	-	-
2004	SS	0	0	-	0	0	0	-	-
2004	Combined	0	0	-	0	0	0	600	0
2005	CB	1	3	0	3	1	8	-	-
2005	SS	0	0	0	0	3	3	-	-
2005	Combined	1	3	0	3	4	11	600	2
2006	CB	0	0	0	7	0	7	-	-
2006	SS	0	0	0	0	0	0	-	-
2006	Combined	0	0	0	7	0	7	600	1
2007	CB	94	0	0	0	0	94	-	-
2007	SS	0	0	0	0	0	0	-	-
2007	Combined	94	0	0	0	0	94	600	16
2008	CB	258	0	0	0	0	258	-	-
2008	SS	0	0	0	0	0	0	-	-
2008	Combined	258	0	0	0	0	258	600	43
2009	CB	29	0	0	0	0	29	-	-
2009	SS	0	0	0	0	0	0	-	-
2009	Combined	29	0	0	0	0	29	600	5
2010	CB	24	0	15	1	0	40	-	-
2010	SS	0	0	0	0	0	0	-	-
2010	Combined	24	0	15	1	0	40	600	7
2011*	CB	9	0	0	0	0	9	-	-
2011*	SS	0	0	0	0	0	0	-	-
2011*	Combined	9	0	0	0	0	9	600	2
2012*	CB	0	0	0	5	0	5	-	-
2012*	SS	0	0	0	0	0	0	-	-
2012*	Combined	0	0	0	5	0	5	600	1
2013*	CB	25	0	0	8	0	33	-	-
2013*	SS	0	0	0	0	0	0	-	-
2013*	Combined	25	0	0	8	0	33	600	6

**provisional*

Table 4: SMB- PB herring landings and TACs (t), by gear type, 1999-2013 (up to November 4, 2013). Landings are from Policy and Economics Branch and do not include herring discards or herring used as bait.

Year	Area	Purse Seine	Bar Seine	Tuck Seine	Gillnet	Trap	Total	TAC	% TAC Landed
1999	SMB	0	0	-	0	0	0	-	-
1999	PB	330	0	-	1	0	331	-	-
1999	Combined	330	0	-	1	0	331	2000	17
2000	SMB	0	0	-	0	0	0	-	-
2000	PB	447	41	-	4	0	492	-	-
2000	Combined	447	41	-	4	0	492	2000	25
2001	SMB	57	0	-	0	0	57	-	-
2001	PB	394	213	-	38	0	645	-	-
2001	Combined	451	213	-	38	0	702	2000	35
2002	SMB	100	0	-	0	0	100	-	-
2002	PB	1297	0	-	135	36	1468	-	-
2002	Combined	1398	0	-	135	36	1568	2000	78
2003	SMB	0	0	-	11	0	11	-	-
2003	PB	925	19	-	74	0	1018	-	-
2003	Combined	925	19	-	84	0	1029	2500	41
2004	SMB	342	0	-	79	0	421	-	-
2004	PB	897	71	-	1	0	968	-	-
2004	Combined	1240	71	-	179	0	1389	2500	56
2005	SMB	1101	43	0	0	2	1146	-	-
2005	PB	146	0	0	134	0	280	-	-
2005	Combined	1247	43	0	134	2	1426	2500	57
2006	SMB	729	0	0	0	0	729	-	-
2006	PB	649	0	0	150	0	799	-	-
2006	Combined	1378	0	0	150	0	1528	2500	61
2007	SMB	528	0	34	0	0	562	-	-
2007	PB	30	0	0	167	0	197	-	-
2007	Combined	558	0	34	167	0	759	2500	30
2008	SMB	236	0	0	0	0	236	-	-
2008	PB	831	0	0	79	2	912	-	-
2008	Combined	1067	0	0	79	2	1148	2500	46
2009	SMB	700	0	0	0	0	700	-	-
2009	PB	605	0	0	102	0	707	-	-
2009	Combined	1305	0	0	102	0	1407	2250	63
2010	SMB	264	0	0	0	0	264	-	-
2010	PB	740	0	0	2	0	742	-	-
2010	Combined	1004	0	0	2	0	1006	2250	45
2011*	SMB	0	0	0	0	0	0	-	-
2011*	PB	0	0	0	19	0	19	-	-
2011*	Combined	0	0	0	19	0	19	2250	1
2012*	SMB	0	0	0	0	0	0	-	-
2012*	PB	0	0	0	56	0	56	-	-
2012*	Combined	0	0	0	56	0	56	2250	2
2013*	SMB	0	0	0	0	0	0	-	-
2013*	PB	1	0	0	19	0	20	-	-
2013*	Combined	1	0	0	19	0	20	2250	1

**provisional*

Table 5: FB herring landings and TACs (t), by gear type, 1999-2013 (up to November 4, 2013). Landings are from Policy and Economics Branch and do not include herring discards or herring used as bait.

Year	Purse Seine	Bar Seine	Tuck Seine	Gillnet	Trap	Total	TAC	% TAC Landed
1999	0	337	-	30	88	455	5400	8
2000	0	791	-	16	35	842	5400	16
2001	0	1592	-	0	190	1782	2700	66
2002	0	1895	-	0	364	2259	2700	84
2003	0	2427	-	0	880	3307	3700	89
2004	0	1655	-	54	1221	2930	3700	79
2005	0	2084	0	4	564	2652	3700	72
2006	0	2027	0	4	310	2341	3700	63
2007	0	1987	0	2	459	2448	3200	77
2008	29	1760	133	2	626	2550	3200	80
2009	0	1857	0	6	498	2361	2880	82
2010	0	1708	0	7	909	2624	2880	91
2011*	0	1469	0	1	55	1525	2880	53
2012*	0	1509	0	15	161	1685	2880	58
2013*	0	778	174	15	0	968	2260	43

**provisional*

Table 6a: Herring bait estimates derived from the annual fixed gear telephone survey and total reported herring landings by stock area – WBNDB.

Bait estimates and commercial landings	**2008**	**2009**	**2010***	**2011**	**2012**	**2013****
Estimated bait landings (t)	*474*	*408*	*287*	*165*	*308*	*282*
Bait estimate (t) used by Fisheries Management	500	500	500	500	500	500
Total reported landings (t) without bait estimate	714	425	524	1299	1228	552
Commercial lobster landings (t)	134	107	96	61	66	70

Table 6b: Herring bait estimates derived from the annual fixed gear telephone survey and total reported herring landings by stock area – BBTB.

Bait estimates and commercial landings	**2008**	**2009**	**2010***	**2011**	**2012**	**2013****
Estimated bait landings (t)	*451*	*547*	*428*	*309*	*322*	*509*
Bait estimate (t) used by Fisheries Management	300	300	300	300	300	300
Total reported landings (t) without bait estimate	2829	3183	2131	327	2255	343
Commercial lobster landings (t)	102	90	101	65	71	62

Table 6c: Herring bait estimates derived from the annual fixed gear telephone survey and total reported herring landings by stock area – SMBPB.

Bait estimates and commercial landings	**2008**	**2009**	**2010***	**2011**	**2012**	**2013****
Estimated bait landings (t)	*127*	*138*	*155*	*172*	*142*	*112*
Bait estimate (t) used by Fisheries Management	150	150	150	150	150	150
Total reported landings (t) without bait estimate	1148	1407	1006	19	56	20
Commercial lobster landings (t)	44	53	60	35	35	101

Table 6d: Herring bait estimates derived from the annual fixed gear telephone survey and total reported herring landings by stock area – FB.

Bait estimates and commercial landings	**2008**	**2009**	**2010***	**2011**	**2012**	**2013****
Estimated bait landings (t)	*395*	*315*	*293*	*271*	*630*	*118*
Bait estimate (t) used by Fisheries Management	400	400	400	400	400	400
Total reported landings (t) without bait estimate	2550	2361	2624	1525	1685	968
Commercial lobster landings (t)	1090	1018	1168	882	925	891

**there was no telephone survey in 2010, bait estimates derived from 2009 and 2011 survey means*
***commercial landings to November 2013*

Table 7a: Parameters, landings data, discard data, and effort by stock area and year from annual purse seine telephone surveys – WBNDB.

Year	Number who Fished	% to Respond	Total Estimate of Landings (t)	Total Comm. Landings (t)	Total Estimate of Discards (t)	Estimate of Discard Survival (%)	Total Estimate of Removals (t)	Removal to Landing Ratio	Effort (total sets)
1996	18	94	392	435	446	49	620	1.58	26
1997	15	93	1801	2375	2045	97	1866	1.04	294
1998	6	100	302	606	540	93	338	1.12	108
1999	7	100	882	931	116	39	953	1.08	70
2000	12	75	651	1071	130	100	651	1.00	29
2001	0	-	-	-	-	-	-	-	-
2002	3	100	260	300	25	93	262	1.01	12
2003	4	100	201	195	193	40	317	1.58	8
2004	5	80	109	163	13	0	121	1.11	4
2005	4	100	84	136	12	35	92	1.10	4
2006	6	67	160	139	15	10	174	1.09	4
2007	2	100	325	333	0	-	325	1.00	17
2008	7	100	575	439	25	90	577.5	1.00	37
2009	4	100	545	417.9	215	45	663.3	1.22	26
2010	6	83	260	413.1	50	100	260	1.00	17
2011	10	90	1025	909.5	353	45	1219	1.19	63
2012	6	83	595	648.65	147.5	37.5	687	1.15	30

Table 7b: Parameters, landings data, discard data, and effort by stock area and year from annual purse seine telephone surveys – BBTB.

Year	Number who Fished	% to Respond	Total Estimate of Landings (t)	Total Comm. Landings (t)	Total Estimate of Discards (t)	Estimate of Discard Survival (%)	Total Estimate of Removals (t)	Removal to Landing Ratio	Effort (total sets)
1996	21	100	738	358	209	50	842	1.14	93
1997	16	94	736	650	47	60	755	1.03	136
1998	13	85	621	708	9	50	625	1.01	111
1999	14	100	894	808	219	69	962	1.08	123
2000	7	71	344	495	264	95	358	1.04	73
2001	5	80	260	259	2030	83	615	2.37	126
2002	5	80	200	200	225	100	200	1.00	15
2003	2	100	378	343	25	20	398	1.05	34
2004	4	25	100	322	0	-	100	1.00	8
2005	10	70	1315	1515	59	30	1356	1.03	59
2006	12	83	1100	1043	765	86	1209	1.10	74
2007	18	83	1474	1249	0	-	1474	1.00	83
2008	18	83	2077	1915	25	70	2084	1.00	109
2009	29	93	1822	1728.8	668	86	1918	1.05	127
2010	19	89	1242	1144.75	62.5	100	1242	1.00	104
2011	5	100	372.5	289	435	76	475	1.28	82
2012	22	91	1534	1568	1930	29	2890	1.88	140

Table 7c: Parameters, landings data, discard data, and effort by stock area and year from annual purse seine telephone surveys – SMBPB.

Year	Number who Fished	% to Respond	Total Estimate of Landings (t)	Total Comm. Landings (t)	Total Estimate of Discards (t)	Estimate of Discard Survival (%)	Total Estimate of Removals (t)	Removal to Landing Ratio	Effort (total sets)
1996	10	90	460	446	225	50	572	1.24	16
1997	15	100	4401	3836	403	82	4474	1.02	316
1998	15	87	1727	2281	790	99	1736	1.01	141
1999	3	67	186	330	0	-	186	1.00	26
2000	1	100	400	447	105	90	411	1.03	24
2001	2	100	430	451	105	95	435	1.01	11
2002	8	100	1440	1398	100	98	1458	1.01	55
2003	9	44	467	925	1050	98	471	1.01	30
2004	11	91	1272	1240	2	100	1272	1.00	87
2005	14	64	975	1247	572	98	984	1.01	73
2006	9	78	1005	1378	58	100	1005	1.00	47
2007	3	100	601	558	25	65	610	1.00	30
2008	6	67	1044	1067	50	95	1046	1.01	32
2009	6	100	1440	1305	16	92	1441	1.00	51
2010	6	83	704	1005	2.5	95	704	1.00	40
2011	1	90	3.5	24	0	-	3.5	1.00	0
2012	0	-	-	-	-	-	-	-	-

Table 8: Herring bycatch and discard estimates in observed fishing sets from 1995-2012.

Directed species	n observed sets with herring bycatch	Total Bycatch (kg)	Total Discard (kg)	% Discard	Mean bycatch/observed set (kg)	Mean discard/observed set (kg)
billfish	2	499	0	0	250	0
lobster	1	15	0	0	15	0
cod	165	1056	101	10	6	1
winter flounder	16	24	12	50	2	1
hake	3	3	3	100	1	1
yellowtail	2	2	2	100	1	1
turbot	9	10	10	100	1	1
redfish	54	261	77	30	5	1
lumpfish	8	17	15	88	2	2
skate	1	2	2	100	2	2
shrimp	4863	10532	10532	100	2	2
capelin	152	14505	3044	20.99	95	20
squid	12	532	520	98	44	43
mackerel	20	1228	937	76	61	47

Table 9: Composition of bycatch in the research gillnet program from 2002-12 by species and number.

Species	n caught	mean caught/year (number)
wolffish	1	0.44
grenadier	2	0.2
wolf eel	5	0.5
brook trout	6	0.6
American plaice	6	0.6
winter flounder	6	0.6
lumpfish	9	0.9
wrymouth	10	1.0
eelpout	12	1.2
brown trout	15	1.5
redfish	18	1.8
thorny skate	19	1.9
capelin	24	2.4
tomcod	37	3.7
sculpin	37	3.7
cunner	40	4.0
pollock	53	5.3
mackerel	77	7.7
Atlantic salmon	130	13.0
Greenland cod	438	43.8
Atlantic cod	908	90.8

Table 10: Summary of bycatch reported in the 2013 fixed gear phone survey by species, including number of fishers reporting bycatch and the estimated mean bycatch for 2013.

Species	n fishers	% total bait fishers	mean total weight caught (kg) 2013
Northern gannet	1	0.2	3
seal	1	0.2	25
shark	1	0.2	50
whale	1	0.2	(released)
brown trout	2	0.4	10
mackerel	3	0.6	5
salmon	4	0.8	10
sculpin	5	1	44
cunner	5	1	123
Greenland cod	12	2.4	215
Atlantic cod	24	4.8	361

Table 11a: Catch-at-age of spring-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1970-1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	10	1	5	1	1	2	56	50	1	1	115	445	76	1
3	1	129	290	727	4	128	24	1671	55	60	46	152	371	38
4	12	88	2396	1411	123	215	506	107	2034	50	1240	41	332	46
5	24	161	353	2825	3142	453	237	468	317	2928	92	1231	59	23
6	24	64	69	761	5446	5438	868	184	1034	323	1080	63	268	14
7	972	425	122	719	1193	7069	10893	793	517	1410	17	805	34	93
8	11	10184	403	654	697	1123	17145	7363	2509	767	496	64	258	1
9	83	233	1363	416	1506	838	1328	12675	10807	2222	179	344	19	26
10	159	254	205	1685	858	810	3364	1055	11756	14413	1450	194	192	4
11+	275	3105	808	794	2378	3999	8535	15707	14379	27508	14653	10908	4059	805
Total	1572	14645	6015	9994	15349	20076	42957	40074	43410	49683	19369	14248	5669	1052

Table 11b: Catch-at-age of spring-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	195	26	3113	1	1	2273	1	1	1	1	1	1
2	6	3	29	1105	407	23	1	29	940	1	1	1	252	106
3	12	187	975	324	1044	128	1936	386	207	96	1	96	0	3337
4	124	350	2945	7201	291	613	285	16183	942	31	1054	609	5	106
5	1218	240	308	25843	2984	124	637	1542	8940	263	121	2747	1559	65
6	73	1486	667	1651	11819	3106	240	553	483	3614	1674	129	3008	3558
7	114	108	1258	1067	1036	10566	2451	103	371	75	2199	701	163	3161
8	157	275	198	2088	1137	370	7360	2145	211	199	108	1513	727	54
9	37	94	162	399	1454	1081	532	4432	722	70	192	183	1215	217
10	122	81	179	442	315	844	1132	537	2796	544	49	127	1	687
11+	1938	2110	1973	4566	2943	2178	1148	2201	3509	861	441	337	599	2116
Total	3802	4935	8889	44712	26543	19034	15723	30384	19122	5755	5841	6444	7530	13406

Table 11c: Catch-at-age of spring-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	83	1	1	1	0	0	0	0
2	1	1	1	121	1	1	510	90	1	1	15	0	24	329	0
3	885	81	404	713	516	517	1045	1063	40	3	253	74	0	247	553
4	1128	1838	175	2127	298	5350	1794	1685	953	349	37	124	149	82	539
5	23	2272	3811	120	90	142	2956	819	513	1058	240	85	41	9	30
6	17	1	3103	2716	266	226	0	2465	302	563	582	71	42	35	162
7	1304	95	96	1	315	1	22	169	348	30	826	453	9	9	219
8	3440	1465	0	1	29	1	1	5	1	92	81	220	267	133	53
9	237	2021	151	1	1	1	1	1	1	1	1	70	0	797	0
10	160	95	28	1	1	1	1	89	47	27	22	20	55	0	105
11+	1354	285	55	1	376	1	4	10	1	1	1	114	32	389	456
Total	8550	8154	7825	5804	1894	6242	6334	6478	2207	2126	2059	1231	619	2030	2117

Table 11d: Catch-at-age of fall-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1970-1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	53	1	1	6	1	1	1	1	71	1	72	1
4	1	1	17	7	11	64	31	45	6	1	13	13	26	74
5	26	6	74	22	124	3	35	35	24	10	13	86	62	25
6	10	14	79	25	10	25	51	85	155	267	23	11	16	23
7	39	11	67	60	48	16	20	54	171	172	272	1	12	1
8	60	26	0	25	2	21	40	1	24	160	4	100	9	1
9	20	17	164	13	46	3	46	94	2	133	19	1	42	6
10	11	19	81	97	7	2	4	1	130	1	1	4	1	1
11+	172	291	562	298	346	302	329	182	238	298	450	65	23	1
Total	342	388	1099	550	597	444	559	500	753	1045	868	284	265	135

Table 11e: Catch-at-age of fall-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	11	1	1
3	1	1	10	2	1	1	1	1	1	1	1	1	30	1
4	60	29	67	297	92	65	130	188	109	1	7	11	0	163
5	409	94	69	469	115	12	65	450	187	48	70	37	0	284
6	66	333	79	156	45	5	52	98	172	78	80	2	1083	21
7	30	137	373	112	20	574	84	36	48	113	137	120	16	243
8	8	32	68	630	7	70	37	128	46	79	25	3	142	1
9	7	23	6	152	560	1	1	249	80	42	4	24	142	72
10	3	10	1	10	6	533	4	120	19	21	1	1	142	1
11+	24	74	42	108	306	29	577	2733	613	349	14	204	1	36
Total	610	735	717	1938	1154	1292	953	4005	1277	734	341	415	1558	824

Table 11f: Catch-at-age of fall-spawning herring from commercial samples collected in White Bay-Notre Dame Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
2	1	1	1	1	1	1	1	9	1	1	1	0	0	0	56
3	1	1	28	7	1	1	40	3	1	1	95	22	0	0	504
4	117	203	176	118	194	255	289	331	47	55	130	156	222	519	961
5	28	122	613	0	149	611	40	1635	852	178	179	123	497	326	357
6	1	162	263	119	720	36	134	130	1991	1224	359	229	302	925	267
7	1	41	139	1	1021	142	16	14	202	914	868	209	133	216	738
8	128	1	96	1	262	36	12	5	1	130	1232	377	107	367	97
9	23	1	28	1	59	36	1	37	6	1	1	324	170	93	167
10	1	1	1	1	61	1	1	8	6	1	1	28	230	514	135
11+	1	122	28	1	407	1	1	5	47	130	1	67	275	1413	702
Total	303	655	1373	251	2875	1121	535	2177	3154	2637	2866	1535	1936	4373	3984

Table 12a: Catch-at-age of spring-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1970 to 1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	1	1	1	1	5	10	1	1	1	1	1	1
2	1	1	1	1	1	1	14	16	22	6	15	136	1	1
3	1	690	10	1	1	392	77	248	26	286	13	246	8	4
4	1	311	1347	60	2	134	493	135	357	167	195	53	11	34
5	9	102	389	4887	235	163	123	759	122	765	43	256	2	7
6	55	64	91	126	4795	2564	166	227	251	19	293	26	30	2
7	808	361	75	96	424	14330	4897	50	112	436	52	288	5	15
8	35	1373	88	0	151	455	20697	6209	598	101	264	23	35	1
9	126	151	480	48	294	995	909	23206	4412	530	75	321	5	8
10	69	126	14	271	69	727	854	774	13394	5575	967	88	65	2
11+	212	522	213	1	1849	1679	4306	5890	5956	19994	12259	11762	1186	159
Total	1318	3702	2709	5492	7822	21441	32541	37524	25251	27880	14177	13200	1349	234

Table 12b: Catch-at-age of spring-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	151	296	717	1	1	115	1	1	1	4	1	0
2	4	13	207	1352	6612	563	58	689	499	354	1	1	1	79
3	22	175	443	413	9910	1043	3094	210	1056	621	394	107	31	310
4	35	70	4445	2845	267	3323	422	13551	271	160	819	2645	71	14
5	210	87	261	16208	3674	264	2350	2586	12612	344	303	349	5181	98
6	9	351	161	334	21739	1428	94	3859	2422	3779	1072	64	766	6169
7	5	37	262	359	782	8639	629	347	579	422	3878	152	115	616
8	12	27	38	126	713	13	4439	1550	194	385	479	978	162	7
9	2	13	10	33	8	216	235	7505	1394	132	471	172	518	1
10	2	22	31	6	55	100	325	447	2054	657	530	163	11	101
11+	154	797	657	956	1247	508	466	891	653	1092	2614	649	432	95
Total	456	1593	6666	22928	45724	16098	12113	31750	21735	7947	10562	5284	7288	7488

Table 12c: Catch-at-age of spring-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	51	1	1	1	1	1	1	1	1	0	0	0	0
2	58	50	367	446	1	1	260	47	1	1	88	0	0	0	42
3	538	48	212	531	596	401	406	3159	365	37	385	500	27	25	133
4	511	889	223	406	412	2403	237	2337	3003	530	359	612	138	62	105
5	94	701	909	64	250	267	848	678	489	2502	504	199	122	69	1
6	136	11	663	129	138	121	247	3209	315	2050	2430	262	175	96	72
7	3826	14	49	397	157	1	99	352	1686	559	1658	2974	37	34	14
8	272	3576	23	115	160	1	172	76	182	2145	573	234	487	64	38
9	4	1251	2259	1	2	1	118	63	48	256	234	261	620	701	37
10	4	63	112	5	1	1	8	87	1	93	193	238	252	159	43
11+	146	108	539	453	1149	7	45	139	318	204	325	944	499	667	490
Total	5590	6712	5407	2548	2867	3205	2442	10148	6408	8377	6752	6224	2357	1877	975

Table 12d: Catch-at-age of fall-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1970-1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	10	1	1	1	14	6	3	1
4	1	1	1	1	1	26	22	55	16	1	11	115	1	10
5	1	10	1	1	1	30	77	16	14	27	17	106	8	2
6	1	1	1	1	1	1	23	176	61	114	83	33	10	5
7	4	4	2	1	16	22	66	86	58	30	188	83	3	2
8	17	23	2	48	2	41	34	112	28	175	45	283	8	1
9	18	3	5	1	1	6	62	30	23	13	112	36	25	1
10	17	21	1	1	1	19	8	73	82	16	3	4	1	1
11+	738	406	33	1	1216	259	1069	1069	417	800	463	230	37	3
Total	800	472	49	58	1242	407	1373	1620	702	1179	938	898	98	28

Table 12e: Catch-at-age of fall-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	19	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	253	1	1	1	1	1	1	13	1	1
3	1	1	1	1	54	1	5	6	1	11	1	6	1	34
4	3	5	51	2	22	55	139	140	10	1	1	39	1	65
5	84	18	80	391	88	76	55	837	219	146	53	90	265	27
6	14	203	59	237	357	136	9	152	205	205	168	4	265	161
7	17	96	292	87	216	237	61	17	118	163	27	1	83	111
8	3	54	149	360	202	18	50	99	1	121	114	48	95	3
9	5	22	24	138	818	83	58	104	5	39	1	24	11	6
10	1	10	1	2	2	697	19	125	1	14	1	1	1	19
11+	9	29	30	156	237	193	89	481	167	376	79	206	21	76
Total	139	440	689	1394	2250	1498	487	1963	729	1078	446	433	744	503

Table 12f: Catch-at-age of fall-spawning herring from commercial samples collected in Bonavista Bay-Trinity Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
2	1	22	1	1	1	1	1	1	1	1	1	0	0	13	73
3	1	58	42	168	1	63	140	35	136	1	268	67	12	128	255
4	240	65	77	60	159	125	427	746	262	76	173	371	288	115	3441
5	326	193	137	119	153	454	123	1498	1776	146	271	469	1500	192	864
6	122	265	111	735	555	156	335	220	3010	1638	524	639	907	275	747
7	254	42	265	459	246	269	119	1047	99	2323	2406	738	242	296	1085
8	135	59	130	628	259	53	175	170	138	309	1815	1918	354	120	669
9	2	61	54	228	120	1	156	92	45	85	222	1922	1277	96	192
10	35	62	81	58	120	1	195	85	1	64	99	220	1414	320	228
11+	73	180	167	742	308	291	139	128	123	213	250	420	783	651	3528
Total	1191	1007	1067	3197	1923	1414	1810	4024	5593	4856	6031	6764	6777	2206	11082

Table 13a: Catch-at-age of spring-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1970-1983

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	3	1	1	1	3	1	1	1	1	1	1	1	1	1
2	476	1	1	76	995	74	365	52	30	87	133	1	1	1
3	109	557	207	326	280	2234	391	1423	175	663	332	193	1	5
4	4434	116	20375	77	234	471	1906	140	1817	279	133	42	2	2
5	59	2111	725	15470	126	147	208	736	123	2263	153	111	3	3
6	76	80	5154	566	14328	1591	267	87	596	96	1270	51	8	2
7	645	251	365	6757	436	13858	862	50	64	614	57	338	3	4
8	66	45	650	93	6049	146	5622	1039	106	85	470	28	14	1
9	72	13	352	224	138	3391	201	3830	512	66	38	80	4	9
10	37	22	73	193	238	350	2256	134	3827	501	237	6	4	1
11+	107	96	403	315	624	1323	1361	2448	2185	4785	2971	466	69	39
Total	6084	3293	28306	24098	23451	23586	13440	9940	9436	9440	5795	1317	110	68

Table 13b: Catch-at-age of spring-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	1	1	1	1	1	1	1	13	1	1	1
2	8	1	1	34	1	22	1	37	68	5	24	1	24	235
3	9	7	1	19	1	48	115	1	47	62	137	333	24	125
4	24	18	143	2	22	9	189	222	7	34	5	1418	276	1
5	36	27	19	502	163	1	64	160	363	11	36	37	1509	2055
6	6	21	28	29	2457	24	15	170	231	187	6	1	115	9606
7	3	15	9	47	119	463	30	12	55	118	225	1	52	636
8	24	3	4	9	213	34	494	110	53	74	60	63	40	134
9	1	25	1	3	16	100	45	493	74	63	98	1	69	76
10	10	5	5	1	36	5	172	88	383	56	172	16	20	50
11+	44	125	30	11	147	34	128	948	965	1174	1042	416	229	508
Total	166	248	242	658	3176	741	1254	2242	2247	1785	1818	2288	2358	13427

Table 13c: Catch-at-age of spring-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
2	204	1	1	1	1	1	6	379	136	1	1	23	0	62	0
3	535	63	11	1	299	74	72	587	31	3	10	68	0	1	0
4	186	63	594	29	90	657	67	4	1043	1	1	69	134	0	0
5	59	1	160	412	196	20	3039	96	153	104	17	161	0	15	0
6	1043	1	65	511	1444	75	943	3383	161	129	194	41	0	14	6
7	5036	253	62	169	274	1243	407	77	1201	38	228	1062	0	0	0
8	294	885	300	80	125	40	382	4	73	30	1	262	656	13	6
9	357	126	131	390	20	1	198	4	40	3	10	207	0	118	7
10	39	63	36	314	204	73	135	59	128	30	134	0	169	6	46
11+	110	190	403	1199	1441	481	245	69	297	51	134	350	231	33	259
Total	7864	1648	1764	3106	4093	2666	5495	4664	3265	390	729	2244	1190	262	324

Table 13d: Catch-at-age of fall-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1970-1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	1	1	1	1	1	1	1	1	1	1
3	0	0	24	5	2	1	11	1	1	1	1	1	1	1
4	0	9	61	150	2	7	4	47	23	11	96	139	1	18
5	2	2	175	52	96	68	214	52	435	143	35	116	7	6
6	0	53	15	71	146	182	67	209	92	598	52	10	1	12
7	71	31	61	10	80	89	32	81	244	73	419	11	1	4
8	112	43	37	54	95	206	17	69	122	216	79	50	1	1
9	19	84	101	17	93	6	94	26	38	21	126	7	1	1
10	28	35	71	68	51	37	11	22	52	2	25	1	1	1
11+	202	314	539	737	970	677	329	526	561	348	492	29	2	4
Total	434	571	1084	1164	1537	1275	781	1035	1570	1415	1327	366	18	50

Table 13e: Catch-at-age of fall-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	4	1	5	7	1	1	1	7	1	23	76
4	17	9	16	12	20	5	37	14	7	2	7	105	50	295
5	101	20	24	32	30	18	61	87	8	208	62	112	101	188
6	32	86	15	80	239	8	54	40	50	239	116	35	130	1403
7	21	46	97	30	90	56	24	23	33	173	182	106	12	1419
8	5	36	28	82	35	43	47	65	27	41	231	99	26	343
9	3	10	16	24	270	67	58	98	64	41	182	87	14	420
10	1	3	4	3	5	178	17	40	1	3	1	78	1	50
11+	8	24	15	12	53	164	173	495	479	863	411	282	111	958
Total	191	237	218	282	745	546	480	865	672	1573	1201	907	470	5153

Table 13f: Catch-at-age of fall-spawning herring from commercial samples collected in St. Mary's Bay-Placentia Bay (includes estimates of herring caught as bait) from 1998-2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0
3	59	1	12	1	1	1	1	1	92	3	10	0	0	40	0
4	233	1	59	20	327	37	54	616	193	3	36	69	56	7	0
5	544	1	201	118	90	727	230	1108	1222	43	168	71	369	28	0
6	268	126	89	211	277	148	1205	360	2085	317	322	24	262	142	0
7	933	190	858	187	752	906	460	369	170	1658	926	426	175	84	30
8	752	316	115	444	453	558	431	7	159	273	1928	963	153	21	12
9	605	190	321	42	157	36	374	110	236	124	46	946	819	32	12
10	20	316	136	47	113	112	209	53	125	182	67	279	594	51	36
11+	258	379	725	594	498	326	459	177	250	794	441	598	625	135	174
Total	3674	1522	2518	1665	2669	2851	3425	2804	4532	3397	3945	3376	3053	541	264

Table 14a: Catch-at-age of spring-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1970 to 1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	617	23	1	1	1	1	1	1	1	1	1	1
2	29475	167	1515	2210	389	2	82	27	1	1	25	1	1	1
3	5988	23223	256	925	1314	277	15	2103	42	1	16	144	1	2
4	11953	6086	19690	67	552	581	318	25	2677	183	3	16	3	2
5	133	23525	2896	5694	130	112	228	327	62	3833	69	4	3	1
6	281	1165	10767	475	4435	87	129	166	237	15	1122	3	1	1
7	7894	5747	351	1712	250	1490	11	26	43	165	7	21	2	1
8	233	3514	4432	73	1094	16	338	43	139	5	183	2	36	1
9	16	132	991	282	36	142	36	188	52	24	1	23	1	10
10	225	148	34	558	117	22	188	4	326	1	11	1	5	1
11+	257	537	366	173	255	201	140	244	302	167	50	12	5	18
Total	56456	64245	41915	12192	8573	2931	1486	3154	3882	4396	1488	228	59	39

Table 14b: Catch-at-age of spring-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1984 to 1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	54	1	1	1	1	1	1	1	2	6	1	1	1
4	4	3	145	1	1	1	1	23	1	1	1	1	232	1
5	3	39	4	304	1	1	2	8	3	1	2	14	12	1
6	2	12	69	11	219	18	2	1	1	327	1	14	49	1
7	1	2	20	49	7	274	12	1	1	2	24	24	1	1
8	2	1	6	18	26	1	155	6	1	3	9	569	1	1
9	1	1	1	4	6	17	17	274	2	8	23	36	741	1
10	2	1	2	1	1	11	20	1	75	10	8	36	100	68
11+	23	15	14	38	10	24	1	72	266	217	647	728	700	1638
Total	42	130	264	429	274	350	213	389	353	573	723	1425	1839	1715

Table 14c: Catch-at-age of spring-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
2	1	1	1	703	1	1	1	1	1	1	1	91	34	0	0
3	1	108	0	162	1	1	1	1125	1	1	39	127	160	58	0
4	1	27	544	192	1	882	1	143	1631	51	78	188	31	0	0
5	1	1	49	4907	1	0	750	214	38	2359	1	0	31	0	11
6	1	49	62	328	4029	76	20	1456	22	17	4922	50	0	0	0
7	1	864	99	195	157	7132	152	6	582	43	25	5026	362	0	0
8	1	176	1339	385	144	314	6506	58	199	193	78	301	4845	271	34
9	1	191	201	932	122	3	264	4925	1	156	158	183	62	6051	70
10	1	1	230	367	688	67	243	399	1963	829	53	77	127	217	243
11+	1337	1491	1450	1448	4456	3459	3815	1632	4928	6597	5229	4471	4924	2270	4966
Total	1347	2910	3976	9620	9601	11937	11754	9960	9367	10248	10583	10513	10576	8867	5324

Table 14d: Catch-at-age of fall-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1970-1983.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	7	1	7	1	1	1	1	5	1	1
4	1	598	1	48	9	22	9	23	1	7	4	64	1	1
5	334	1	84	50	87	12	38	19	36	5	3	16	7	1
6	1	136	25	79	65	39	26	19	6	50	3	1	2	2
7	443	175	185	8	12	19	13	1	25	1	3	1	1	1
8	816	769	44	32	27	20	1	1	12	17	1	1	1	1
9	412	626	310	15	5	11	27	1	6	12	1	1	1	1
10	1	470	125	27	1	7	1	1	1	1	1	1	1	1
11+	2201	1956	793	97	85	45	9	2	18	12	1	1	1	1
Total	4212	4734	1570	359	300	178	133	70	108	108	20	93	18	12

Table 14e: Catch-at-age of fall-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1984-1997.

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	17	3	1	2	3	10	1	1	1	1	1	1	1
5	9	4	8	4	1	6	5	1	4	1	1	1	1	1
6	4	26	16	7	5	1	12	8	5	3	1	1	1	1
7	6	12	38	11	5	6	17	1	3	11	1	25	1	1
8	1	7	12	25	1	31	7	3	1	1	1	31	1	1
9	1	4	5	10	13	3	54	1	1	1	1	10	65	1
10	1	1	1	5	1	17	1	3	1	1	1	1	1	1
11+	1	2	5	14	10	5	5	1	5	26	14	1	1	1
Total	27	76	91	80	41	75	114	22	24	48	24	74	75	11

Table 14f: Catch-at-age of fall-spawning herring from commercial samples collected in Fortune Bay (includes estimates of herring caught as bait) from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	1	1	1	1	1	1	1	11	1	1	1	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
3	1	1	1	29	1	1	1	1	1	1	88	0	0	0	11
4	1	1	10	1	1	38	1	249	1	77	88	140	15	168	148
5	1	1	26	109	1	1522	1	451	82	78	1	104	0	0	29
6	1	1	65	357	1	228	30	337	82	52	1	91	0	116	88
7	1	27	124	138	11	270	81	373	55	182	412	0	65	54	142
8	1	1	114	109	11	304	30	6	153	122	155	152	0	0	39
9	1	1	86	0	1	114	81	207	1	17	1	188	47	115	0
10	1	1	17	167	1	152	20	22	44	1	1	102	0	58	0
11+	1	25	148	409	135	193	101	611	437	164	78	331	66	0	472
Total	11	61	591	1320	165	2824	350	2270	859	697	827	1108	193	511	929

Table 15a: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in White Bay-Notre Dame Bay from 1988 to 2001.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	4.7	16.0	83.5	11.0	0.0	1.2	0.6	0.0	0.0	3.2	7.9	6.5	0.3	0.5
4	1.9	43.3	51.6	247.1	21.5	10.9	232.0	18.5	0.9	0.6	117.6	70.3	2.6	44.2
5	22.2	11.2	52.9	28.8	493.7	51.0	14.6	300.1	47.9	3.2	0.2	85.1	14.8	8.1
6	59.6	126.9	16.3	13.7	33.5	359.9	52.1	20.2	286.0	77.1	1.2	1.0	16.8	37.5
7	5.6	182.9	144.6	7.5	13.7	18.8	182.7	45.9	12.7	139.5	10.3	0.4	0.2	15.5
8	4.7	9.7	195.5	84.2	10.3	6.7	14.1	104.1	21.6	8.6	43.3	9.5	0.9	0.1
9	12.0	16.0	11.5	164.3	47.2	13.4	7.6	8.4	74.2	17.6	1.7	15.0	0.4	0.2
10	1.8	24.3	26.5	21.9	127.9	29.7	12.9	9.5	5.2	31.0	6.9	2.8	0.6	0.6
11+	34.1	56.4	97.1	106.1	110.8	115.9	69.1	52.1	21.1	39.4	56.8	18.0	12.1	0.1
Total	146.4	486.4	678.8	684.6	858.6	606.9	585.7	559.8	469.5	320.0	246.0	202.1	48.7	106.8

Table 15b: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in White Bay-Notre Dame Bay from 2002 to 2012.

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.1
3	11.0	3.6	5.5	7.0	0.3	0.2	32.8	2.4	1.1	1.2	28.4
4	3.0	65.9	11.3	30.6	69.4	6.9	6.7	7.1	16.6	6.1	41.3
5	4.7	2.7	43.9	41.5	10.0	137.1	1.3	5.1	8.4	1.7	7.1
6	3.6	9.5	2.8	85.3	8.3	17.0	54.2	15.7	23.3	0.9	1.7
7	2.1	1.3	2.0	1.4	36.5	7.3	2.4	52.5	12.9	1.5	2.5
8	0.7	4.6	1.7	0.8	2.3	17.4	2.9	5.0	25.5	1.3	1.7
9	0.2	1.5	1.5	6.8	0.0	0.0	2.5	4.5	4.6	4.6	3.2
10	0.5	1.2	0.6	3.3	1.1	5.3	2.3	4.4	3.0	0.0	12.3
11+	3.0	0.7	6.1	29.7	23.3	5.7	3.5	3.3	4.7	1.3	30.5
Total	28.9	91.1	75.6	206.6	151.5	197.6	108.6	58.9	64.7	19.0	129.0

Table 15c: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in White Bay-Notre Dame Bay from 1988 to 2001.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4	0.0	0.0	2.3	1.6	0.0	0.0	0.6	2.3	0.0	0.6	1.2	0.2	0.0	1.5
5	0.7	6.8	2.5	2.7	1.7	6.8	1.8	13.1	3.4	0.9	5.0	3.2	2.0	12.8
6	1.3	1.8	2.3	1.4	14.2	17.9	9.1	6.9	29.6	2.6	2.4	5.5	2.7	10.3
7	0.7	4.4	0.9	1.6	2.2	13.8	12.0	7.9	3.4	14.5	0.7	0.4	1.5	1.8
8	0.6	4.4	1.4	1.0	0.2	2.4	11.1	4.3	10.4	2.0	8.9	0.2	1.3	1.8
9	4.5	6.3	1.9	2.9	1.2	1.3	4.0	3.9	8.8	2.6	1.7	2.8	0.4	0.3
10	0.1	19.9	0.2	0.0	0.3	0.3	0.1	4.1	4.1	1.2	1.7	0.6	0.6	0.1
11+	1.4	17.1	16.0	13.6	8.6	25.0	33.8	10.9	11.7	8.1	4.5	1.1	0.8	0.6
Total	9.4	61.0	26.8	24.8	28.4	67.4	72.4	53.3	71.4	32.4	26.1	14.0	9.3	29.3

Table 15d: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in White Bay-Notre Dame Bay from 2002 to 2012.

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1
4	2.0	2.4	13.6	5.3	1.4	9.3	0.5	5.1	7.0	2.2	4.8
5	1.7	6.1	4.6	52.6	17.9	30.2	21.7	15.3	26.5	0.9	5.4
6	2.1	0.7	10.4	4.8	88.5	34.1	12.9	8.3	9.2	1.7	6.9
7	2.7	7.2	2.7	5.6	5.7	37.8	42.2	13.9	6.5	1.1	12.9
8	1.3	1.5	3.5	2.4	8.1	6.2	37.3	26.7	14.2	0.5	7.0
9	0.1	1.0	1.9	0.5	0.2	0.1	7.0	22.5	12.0	0.6	2.7
10	0.1	0.7	5.3	4.1	4.2	10.4	1.0	5.1	20.1	1.1	1.2
11+	0.4	0.6	3.3	19.5	29.2	14.7	1.7	3.2	4.4	2.3	28.2
Total	10.4	20.3	45.2	94.6	155.2	143.1	124.5	158.6	47.1	10.7	69.2

Table 16a: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in Bonavista Bay-Trinity Bay from 1988 to 2001.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2
3	5.6	2.3	8.8	0.9	0.3	2.6	0.7	0.0	0.0	2.8	1.2	0.1	0.1	3.4
4	0.3	21.8	8.2	50.1	1.2	1.7	16.6	34.3	0.9	0.0	5.7	17.6	2.6	3.3
5	2.3	0.9	27.7	12.0	46.2	8.2	9.6	8.2	140.9	3.3	0.2	7.2	11.9	2.0
6	29.2	5.5	4.5	27.9	8.1	50.6	12.6	1.7	20.8	181.9	1.7	0.4	5.8	10.0
7	0.5	57.7	12.2	3.2	10.3	6.4	65.0	4.6	5.3	23.7	62.3	0.8	0.4	3.0
8	0.4	0.9	60.8	19.8	2.3	7.0	6.5	19.9	5.5	5.6	4.6	29.8	0.2	0.5
9	0.6	0.6	0.8	62.3	17.6	3.7	8.9	2.6	20.8	7.0	2.1	1.4	12.7	0.9
10	0.0	0.7	3.2	3.8	34.8	13.1	7.5	3.0	3.7	16.7	1.3	0.3	4.1	3.8
11+	12.2	5.5	8.9	8.3	16.8	20.2	40.1	25.0	31.4	38.2	5.9	2.3	2.6	5.1
Total	51.2	96.1	135.1	188.2	137.6	113.5	167.6	99.2	229.1	278.9	83.0	59.9	40.5	32.1

Table 16b: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in Bonavista Bay-Trinity Bay from 2002 to 2012.

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2
3	11.0	2.5	1.1	11.6	1.1	2.2	4.6	0.0	0.2	1.0	9.1
4	5.8	47.3	9.3	4.6	53.5	6.8	4.1	4.6	7.0	1.0	4.4
5	2.3	12.2	68.3	6.3	11.1	69.6	1.7	2.8	10.4	4.2	2.9
6	0.6	2.9	13.1	40.6	8.0	14.1	37.3	14.7	5.9	23.1	2.3
7	1.5	0.4	2.5	5.1	52.4	9.5	4.4	36.7	21.1	1.7	0.7
8	0.5	1.5	0.8	2.5	2.8	38.9	2.5	6.7	28.8	2.6	0.3
9	0.1	0.6	0.3	0.1	1.7	1.5	13.3	8.8	5.9	19.8	0.7
10	0.0	0.9	0.8	1.5	1.9	0.9	5.5	13.0	12.4	5.5	0.9
11+	1.2	3.7	2.6	2.9	5.9	3.7	4.7	12.7	8.3	10.7	11.8
Total	23.0	72.1	98.6	75.1	138.2	146.9	78.0	56.6	61.3	48.6	33.0

Table 16c: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in Bonavista Bay-Trinity Bay from 1988 to 2001.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.1	0.0	0.1	0.0	0.1	0.2	0.6	0.0	0.7	0.8	0.6	0.2	0.1
5	0.3	0.3	0.4	3.8	0.5	1.7	1.9	2.1	2.7	0.2	3.6	4.0	2.4	3.7
6	0.2	0.3	0.2	2.1	2.5	5.0	3.7	1.3	12.3	5.1	0.7	5.9	2.9	5.5
7	0.2	1.9	0.9	1.1	1.0	3.9	5.4	1.6	1.7	13.3	2.9	1.4	4.3	2.1
8	0.0	1.3	1.2	0.7	0.5	0.8	3.2	2.0	3.6	2.7	7.1	2.5	2.7	1.5
9	0.5	0.5	1.2	2.2	0.7	0.4	0.8	0.2	3.0	2.2	0.7	4.3	0.5	0.6
10	0.0	3.3	0.1	0.7	0.4	0.1	0.4	0.1	1.9	2.0	0.8	1.0	1.3	1.5
11+	0.3	2.4	7.3	9.8	9.5	4.6	3.7	2.6	4.2	6.9	2.2	1.3	2.0	2.7
Total	1.5	10.1	11.3	20.5	15.1	16.7	19.2	10.4	29.5	33.1	18.7	20.9	16.2	17.7

Table 16d: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in Bonavista Bay-Trinity Bay from 2002 to 2012.

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
3	0.0	0.0	0.2	0.0	0.2	0.0	1.9	0.3	0.0	0.0	0.3
4	0.7	1.6	7.9	19.2	1.3	0.0	5.7	2.7	1.4	0.7	15.1
5	0.9	7.3	11.5	31.9	21.6	5.9	5.7	7.1	8.8	4.3	6.2
6	0.8	3.3	28.9	8.7	51.6	71.8	9.1	9.8	14.0	17.4	8.4
7	1.0	8.6	12.4	12.0	8.6	105.1	34.5	13.8	11.5	10.1	10.7
8	0.3	5.3	6.3	2.9	13.9	10.4	38.3	31.4	12.1	10.8	3.8
9	0.3	2.4	3.0	3.9	2.5	7.8	4.8	23.7	24.0	1.3	1.0
10	0.1	1.6	3.3	2.1	2.5	7.6	2.8	6.8	19.6	11.8	1.1
11+	0.1	5.3	8.9	6.4	12.8	8.7	5.1	4.4	8.6	18.5	16.7
Total	4.2	35.5	82.4	87.2	114.9	217.6	108.2	90.3	56.1	74.4	63.3

Table 17a: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in St. Mary's Bay-Placentia Bay from 1982 to 1997.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	1.6	0.7	0.0	0.0	0.0	0.4	0.2	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0
3	0.2	10.2	18.6	59.3	0.3	13.7	2.3	23.5	11.2	0.9	2.7	3.5	15.6	11.3	0.0	4.1
4	0.6	1.8	21.9	5.9	125.6	1.7	4.2	6.0	19.5	16.5	0.7	3.3	25.4	49.2	54.9	0.3
5	0.4	0.9	7.0	9.9	8.5	152.1	2.7	1.8	5.7	7.1	21.8	1.5	2.9	1.8	159.8	20.4
6	1.4	1.0	2.7	6.9	17.4	11.6	100.2	3.5	2.4	1.9	3.8	12.1	0.4	0.4	9.3	66.7
7	0.2	3.2	0.9	2.4	3.4	17.7	6.2	64.3	5.0	0.5	2.4	2.4	6.9	0.8	5.9	12.6
8	1.7	0.4	7.3	2.1	2.6	4.0	14.4	3.3	69.9	1.1	1.0	2.7	2.1	1.8	1.9	2.4
9	0.4	4.7	0.2	8.6	0.1	2.1	3.0	12.6	2.4	8.3	1.6	1.1	3.8	1.2	5.9	2.2
10	0.4	0.5	10.1	2.7	2.4	0.6	0.1	3.1	16.7	1.1	7.5	2.1	3.2	0.3	0.8	0.5
11+	6.5	19.4	47.0	45.4	12.1	7.4	7.2	4.9	6.8	4.8	13.1	17.2	45.6	3.5	28.0	26.8
Total	11.9	43.8	116.3	143.1	172.5	210.7	140.7	123.2	139.5	42.3	54.8	46.2	105.9	70.3	266.3	135.8

Table 17b: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in St. Mary's Bay-Placentia Bay from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
2	0.6	1.1	0.2	0.3	0.8	1.2	0.9	0.4	0.4	0.0	0.0	0.8	1.1	0.0	0.2
3	22.6	67.7	11.6	5.4	106.3	1.0	1.3	14.8	0.5	0.2	0.1	6.4	4.3	1.7	32.2
4	5.5	21.4	74.2	5.9	1.8	117.4	3.0	0.3	41.2	1.2	0.1	2.3	9.4	2.0	2.4
5	0.3	8.0	13.8	98.2	6.0	3.1	60.5	2.0	0.2	17.4	0.7	1.1	2.0	3.1	1.2
6	10.1	0.0	6.1	21.4	46.1	0.3	3.4	36.0	2.4	0.6	12.3	13.3	2.1	1.6	1.7
7	26.2	13.0	0.1	9.8	7.9	10.9	0.8	1.4	21.5	1.9	3.5	58.3	9.6	0.5	1.8
8	4.4	31.2	2.2	6.6	1.8	2.6	2.5	3.8	0.2	1.9	2.0	7.3	4.1	0.8	0.6
9	1.3	4.4	3.2	8.6	0.8	3.5	2.7	19.3	2.7	0.2	0.6	7.0	0.9	25.1	0.1
10	1.0	2.1	1.5	9.8	7.1	0.1	0.5	1.9	3.1	0.2	0.7	2.7	1.0	0.7	3.7
11+	7.9	15.1	11.6	2.5	83.3	6.8	0.9	4.3	4.7	0.0	0.0	0.8	0.3	8.4	17.2
Total	79.8	164.3	124.7	168.4	261.9	147.1	76.5	84.1	79.0	23.7	19.9	82.5	46.5	44.1	61.1

Table 17c: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in St. Mary's Bay-Placentia Bay from 1982 to 1997.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
3	0.6	0.4	6.2	0.9	0.7	2.0	0.0	0.1	0.1	0.3	0.0	0.1	0.3	0.3	0.0	4.3
4	0.6	9.3	10.9	36.8	8.0	4.6	1.1	1.8	1.0	2.3	1.1	1.4	5.4	5.6	0.9	3.5
5	2.0	1.7	53.6	14.2	16.6	8.2	1.2	3.8	4.5	8.1	3.7	3.8	2.2	2.6	13.8	2.7
6	0.2	4.8	16.0	39.0	10.2	14.9	2.9	1.5	2.8	2.3	5.4	3.8	2.0	0.1	17.8	8.9
7	0.0	0.9	22.9	14.4	42.2	8.5	5.2	3.8	2.9	0.9	1.6	3.8	2.8	0.8	3.6	13.7
8	0.2	0.4	1.6	12.2	10.4	20.6	5.0	2.8	3.3	2.3	0.8	1.4	4.1	1.4	5.8	2.1
9	0.1	0.7	4.1	1.5	3.6	7.5	8.3	2.0	6.7	1.5	1.9	0.6	1.9	0.6	5.8	4.0
10	0.0	0.4	0.8	2.5	1.5	0.7	1.2	5.0	2.0	0.9	1.0	0.6	0.7	0.1	2.6	3.0
11+	0.5	2.4	13.6	10.9	4.5	4.6	4.4	4.3	29.7	6.0	16.4	9.7	16.9	2.3	11.1	12.6
Total	4.1	21.0	129.4	132.5	97.8	71.6	29.2	24.9	52.9	24.6	31.9	25.3	36.4	13.8	61.3	54.7

Table 17d: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in St. Mary's Bay-Placentia Bay from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.8	3.6	1.1	0.1	0.3	0.5	0.4	0.1	0.1	0.5	2.1	0.0	0.7	0.2	0.0
4	12.0	10.8	22.4	3.6	3.3	1.5	5.3	9.5	2.0	6.7	2.7	20.1	10.8	3.8	1.0
5	4.7	15.6	20.2	11.0	6.0	13.7	2.6	11.0	7.6	8.0	5.9	11.3	24.0	8.4	1.6
6	2.6	19.8	22.8	12.9	47.7	2.0	15.1	5.1	9.3	13.8	5.3	8.0	17.0	5.9	4.2
7	5.2	5.1	25.2	12.4	54.7	7.2	2.8	7.3	1.1	15.2	15.8	18.0	9.5	3.3	1.8
8	7.9	4.5	8.5	18.7	11.9	11.7	3.0	4.3	4.8	3.0	12.2	23.9	11.3	3.9	0.8
9	2.1	6.9	3.3	2.3	9.7	2.6	2.3	5.8	0.5	0.1	0.2	14.1	10.3	3.6	2.0
10	1.3	1.8	1.4	2.0	8.4	0.3	0.5	25.0	1.3	0.3	0.8	4.1	15.9	5.6	2.4
11+	4.4	13.8	2.2	0.4	3.2	5.8	1.1	1.7	1.3	0.1	0.2	0.5	0.5	0.2	6.9
Total	40.9	82.0	107.1	63.3	145.4	45.2	33.1	70.0	27.9	47.8	45.1	44.1	34.9	34.9	20.7

Table 18a: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in Fortune Bay from 1982 to 1997.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.6	8.4	0.0	14.3	0.0	0.0	0.0	12.1	98.8	0.6	0.3	0.0	1.3	0.0	0.0	0.0
4	0.8	6.0	22.1	2.8	224	0.0	0.0	0.9	1.4	54.4	3.6	0.0	32.1	22.6	19.0	0.0
5	0.6	3.9	15.0	204.5	8.8	532	3.1	0.9	0.0	16.8	61.3	9.1	14.0	85.4	134	89.2
6	0.1	3.1	6.1	69.2	69.9	11.7	420	15.8	0.0	2.2	11.6	140	21.4	8.9	112	193
7	0.2	2.4	1.4	15.7	48.3	48.3	9.8	659	6.2	1.7	1.3	5.0	252	19.8	12.1	103
8	6.0	2.7	4.1	4.6	10.0	20.7	50.6	14.8	236	21.9	1.7	3.7	3.3	258	19.0	19.6
9	0.3	44.0	0.3	8.8	0.8	4.8	11.4	64.9	19.7	283	6.3	0.0	12.0	39.0	187	17.6
10	0.8	4.6	4.4	6.5	2.0	1.4	2.1	33.4	59.0	38.1	70.3	9.5	12.0	12.3	19.0	104
11+	0.8	53.7	102	135.3	35.9	71.8	19.6	124	56.1	141	175	245	319	237	360	451
Total	10.3	128	156	461.6	399	690	516	927	479	560	331	413	668	683	862	980

Table 18b: Spring research gillnet program catch rates at age (numbers per nights fished) of spring-spawning herring in Fortune Bay from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.4	82.8	0.0	0.0	8.1	0.0	2.9	44.6	3.4	0.5	0.0	0.2	0.5	0.0	2.8
4	3.7	36.7	124.2	1.1	0.9	19.0	3.1	0.7	167	2.9	0.0	0.0	10.5	0.6	14.9
5	0.0	21.3	40.7	235.2	4.9	0.9	44.8	2.1	9.0	102	0.0	11.1	30.6	0.5	3.8
6	514.2	15.4	8.7	49.7	194	5.6	7.0	40.1	2.9	2.2	108	15.2	34.6	0.3	5.2
7	144.5	245	10.9	65.6	23.3	246.2	2.3	3.1	15.6	3.4	9.0	41.4	25.1	0.1	8.4
8	161.6	161	124	75.8	6.3	16.7	62.1	3.8	1.8	4.2	15.5	15.9	73.5	1.2	3.3
9	19.6	40.1	109	122.1	5.8	3.7	3.9	107.0	6.9	1.4	1.8	4.1	22.5	34.1	14.7
10	28.2	21.3	55.9	117.6	11.6	0.9	2.3	9.8	16.1	0.9	3.2	10.4	40.4	1.2	35.4
11+	350.2	230	251	463.6	192.8	169.4	65.0	137.4	40.9	62.6	125.9	1.7	38.9	25.9	35.0
Total	1224.3	853	726	1130	447	462	194	348	264	180	263	309	276	63.2	122.4

Table 18c: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in Fortune Bay from 1982 to 1997.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	7.4	2.2	0.0	0.0	0.0	0.7	0.0	0.0	0.0
4	0.3	18.0	0.0	13.8	8.5	0.1	0.2	0.2	6.6	1.9	1.1	0.1	0.1	0.0	0.0	0.0
5	1.4	6.0	31.1	7.9	5.0	3.3	0.1	3.6	1.0	4.4	6.3	3.5	2.8	9.5	4.7	0.0
6	0.2	20.6	11.8	73.9	9.3	4.0	3.0	1.4	2.0	1.7	9.2	5.8	7.6	3.9	11.0	5.4
7	0.0	2.0	19.5	38.6	28.2	4.5	3.8	11.1	1.4	1.2	5.2	17.5	8.0	16.8	3.1	32.1
8	0.0	1.1	4.1	17.5	9.0	25.6	3.0	8.8	4.7	1.4	3.7	3.3	15.2	14.2	7.8	10.7
9	0.0	0.5	1.0	13.8	2.0	10.0	12.2	3.1	9.4	1.6	5.8	0.9	0.5	10.9	3.1	10.7
10	0.0	0.0	0.2	3.3	1.0	5.2	1.1	20.6	0.5	5.5	2.1	0.0	0.0	0.2	1.6	7.1
11+	0.1	0.7	3.5	5.9	1.7	17.3	13.9	24.6	19.6	18.5	17.9	18.4	11.5	18.7	26.6	25.0
Total	2.0	48.9	71.3	174.6	64.8	69.9	37.3	80.7	47.4	36.4	51.3	49.5	46.4	74.3	58.0	91.0

Table 18d: Spring research gillnet program catch rates at age (numbers per nights fished) of fall-spawning herring in Fortune Bay from 1998 to 2012.

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	2.8
4	4.2	0.0	11.2	0.0	7.4	0.4	14.8	15.9	4.7	2.8	0.7	7.9	10.5	0.6	6.1
5	2.1	7.7	8.1	5.3	3.4	12.6	12.1	27.3	13.9	3.3	7.8	2.0	15.6	0.0	1.4
6	12.8	26.9	2.1	12.8	24.5	0.5	43.6	21.7	28.4	11.0	1.2	3.8	10.3	0.0	1.5
7	4.2	28.8	53.9	9.3	23.2	19.1	1.9	15.4	9.9	10.7	9.9	5.9	13.5	0.0	1.1
8	17.0	53.8	5.4	13.2	1.9	11.5	5.5	2.6	5.9	4.2	36.3	46.4	69.3	0.6	0.2
9	2.1	34.6	14.4	34.6	7.5	5.5	10.1	5.9	2.7	1.0	2.1	13.6	9.4	34.0	14.1
10	0.0	15.4	3.3	10.8	1.9	4.0	3.2	1.9	5.8	1.1	3.0	15.7	21.3	0.6	33.3
11+	8.5	46.1	60.9	11.0	23.0	24.1	5.6	14.0	12.2	3.0	14.1	4.7	24.7	25.5	33.5
Total	51.0	213.4	159.5	97.0	92.9	78.5	96.9	104.7	83.4	37.1	75.1	65.6	175.0	60.7	93.1

Table 19a: Research gillnet program parameters, catch data, catch rates and effort by stock area and year-WBNDB.

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
1988	5	14 May	17 June	17759	9	146	156	570
1989	7	25 April	24 June	99614	61	486	547	910
1990	7	25 April	22 June	121218	27	679	706	859
1991	7	8 May	31 July	117333	25	685	709	827
1992	6	6 May	7 July	139253	28	859	887	785
1993	6	3 May	9 July	104251	67	607	674	773
1994	7	2 May	18 July	110697	72	586	658	841
1995	7	15 May	27 July	103011	53	560	613	840
1996	7	7 May	11 July	114465	71	470	541	1058
1997	7	13 May	11 July	70338	32	320	352	998
1998	7	5 May	10 July	53055	26	246	272	975
1999	7	5 May	16 July	46465	14	202	216	1075
2000	6	25 April	22 July	10681	9	49	58	920
2001	7	8 May	20 July	29934	29	107	136	1100
2002	9	21 April	31 July	10768	10	29	39	1372
2003	9	19 April	31 July	31444	20	91	111	1412
2004	8	23 April	31 July	30881	45	76	121	1278
2005	8	22 April	31 July	76674	95	207	301	1273
2006	8	24 April	31 July	75281	155	152	307	1227
2007	7	14 May	25 July	70388	143	198	341	1033
2008	8	5 May	31 July	57306	126	109	233	1229
2009	8	29 April	30 July	74184	116	101	218	1705
2010	8	16-Apr	29-Jul	41809	47	67	114	1825
2011	8	12-Apr	19-Jul	10474	11	19	30	1760
2012	8	18 Apr	23 Jul	64808	69	129	198	1635

Table 19b: Research gillnet program parameters, catch data, catch rates and effort by stock area and year-BBTB.

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
1988	7	9 May	17 June	6554	1	51	53	622
1989	8	18 April	12 June	25250	10	96	106	1189
1990	7	10 April	6 June	28748	11	135	146	982
1991	8	30 April	26 June	40320	20	188	209	966
1992	8	20 April	18 June	35196	15	138	153	1152
1993	8	23 April	15 June	28373	17	113	130	1090
1994	8	18 April	21 June	45863	19	168	187	1227
1995	7	9 May	27 June	20836	10	99	110	950
1996	7	11 April	18 June	58278	29	229	259	1127

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
1997	8	16 April	26 June	73135	33	279	312	1172
1998	8	21 April	29 June	25564	19	83	102	1257
1999	8	15 April	26 June	23290	21	60	81	1440
2000	8	3 April	26 June	15579	16	41	57	1373
2001	8	4 May	20 July	14303	18	32	50	1436
2002	10	15 April	18 July	9859	4	23	27	1814
2003	10	9 April	12 July	37597	36	72	108	1747
2004	9	14 April	17 July	54260	82	99	181	1499
2005	9	14 April	17 July	46422	87	75	162	1430
2006	9	5 April	15 July	78838	115	138	253	1557
2007	9	13 April	23 July	101092	218	147	364	1387
2008	8	18 April	14 July	52531	108	78	186	1411
2009	9	19 April	8 July	61376	85	62	147	2090
2010	9	03-Apr	16-Jul	47478	60	57	117	2020
2011	9	07-Apr	12-Jul	52446	74	49	123	2120
2012	9	28 Apr	20 Jul	66157	63	33	168	1714

Table 19c: Research gillnet program parameters, catch data, catch rates and effort by stock area and year-SMBPB.

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
1988	4	17 April	15 May	1905	4	12	16	595
1989	5	6 April	3 June	9174	21	44	65	708
1990	4	5 April	14 June	34405	129	116	246	700
1991	4	10 April	6 June	35835	133	143	276	650
1992	5	10 April	13 June	37840	98	172	270	700
1993	5	1 April	31 May	43693	72	211	282	774
1994	5	2 April	29 May	23140	29	141	170	681
1995	5	4 April	7 June	21634	25	123	148	730
1996	5	9 April	6 June	28591	53	139	192	743
1997	5	3 April	12 June	9971	25	42	67	745
1998	5	8 April	10 June	13264	32	55	87	765
1999	5	5 April	11 June	10727	25	46	72	750
2000	5	7 April	7 June	22350	36	106	142	785
2001	5	5 April	3 June	12861	14	70	84	765
2002	5	2 April	12 June	54047	61	266	328	825
2003	5	4 April	4 June	30290	55	136	191	795
2004	5	1 April	5 June	19392	41	80	121	803
2005	5	1 April	27 May	38665	82	164	246	785
2006	5	4 April	3 June	36152	107	125	232	780
2007	5	5 April	8 June	37536	63	168	232	810
2008	6	1 April	14 June	85521	145	262	407	1050

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
2009	6	4 April	12 June	37122	45	147	192	965
2010	6	5 April	18 June	22115	33	77	110	1009
2011	6	5 April	14 June	24036	70	84	154	780
2012	6	1 April	2 June	22020	28	79	107	1030

Table 19d: Research gillnet program parameters, catch data, catch rates and effort by stock area and year-FB.*

Year	n Fishers	Start of fishing period	End of fishing period	Total Catch numbers	Catch Rate (nos. per nights fished) *Fall Spawners*	Catch Rate (nos. per nights fished) *Spring Spawners*	Catch Rate (nos. per nights fished)- *Both*	Net Nights/ fisher
1988	2	16 April	22 May	799.0	2	10	23	125
1989	2	11 April	16 May	10653.0	49	129	30	125
1990	2	19 April	18 May	5908.0	71	156	227	75
1991	2	16 April	17 May	35774.0	175	462	1117	87
1992	2	15 April	6 June	57477.0	65	399	475	277
1993	2	8 April	22 May	41373.0	70	690	1133	145
1994	2	13 April	23 May	73317.0	37	517	665.	225
1995	2	11 April	23 May	39411.0	81	927	1550.	189
1996	2	17 April	24 May	38571.0	47	479	721	169
1997	2	9 April	28 May	24400.0	36	561	732.	175
1998	2	16 April	12 June	35375.0	51	331	496	185
1999	2	13 April	5 June	56695.0	49	413	721	165
2000	2	13 April	10 June	52257.0	46	668	1158	165
2001	2	18 April	23 June	90755.0	74	684	1202	135
2002	2	3 April	27 May	87665.0	58	862	1341	225
2003	2	7 April	31 May	101950.0	91	980	1610	189
2004	2	7 April	30 May	81576.0	51	1224	2124	175
2005	2	1 April	26 May	66829.0	213	854	1406	210
2006	2	1 April	30 May	101685.0	159	727	1241	210
2007	2	6 April	1 June	53783.0	97	1131	1891	205
2008	3	3 April	31 May	53483.0	93	447	781	291
2009	3	23 April	31 May	34244.0	78	463	685	342
2010	3	3 April	31 May	46558.0	97	194	366	385
2011	3	3 April	31 May	31478.0	105	349	579	301
2012	3	1 April	6 June	26195.0	83	264	349	400

**parameters adjusted in 2013 when fisher removed from program*

Table 20a: Parameters and catch/effort data from herring fixed gear logbooks – WBNDB.

Year	Number of Logbooks	Start of fishing activity	End of fishing activity	Total Logbook Catch (t)	Mean total catch/Fisher (t)	Catch / Std. Net / Night Fished (kg)	Effort (net nights per fisher)
1981	8	01-Apr	23-May	50.5	6.3	68.5	825
1983	38	18-Apr	14-Jul	68.0	1.8	41.8	2088
1996	16	01-Apr	18-Jun	68.5	4.3	38.4	2970
1997	9	10-May	30-Jun	9.2	1.0	36.7	1031
1998	13	15-Apr	30-Jun	8.7	0.7	14.9	1832
1999	5	20-Apr	30-Jun	9.7	1.9	17.3	1027
2000	8	15-Apr	10-Jul	6.8	0.9	22.5	727
2001	10	05-May	12-Jul	8.2	0.8	25.3	910
2002	8	30-Apr	05-Jul	0.8	0.1	2.2	719
2003	9	29-Apr	01-Jul	9.4	1.0	24.3	1405
2004	8	22-Apr	30-Jun	4.9	0.6	21.4	710
2005	8	30-Apr	18-Jun	6.5	0.8	34.3	731
2006	10	02-May	12-Jul	17.5	1.8	65.9	1361
2007	15	03-May	14-Jul	18.6	1.2	41.0	1515
2008	10	02-May	07-Jul	31.1	3.1	117.9	713
2009	14	02-May	10-Jul	34.1	2.4	108.9	677
2010	12	04-May	09-Jul	14.2	1.2	36.5	1223
2011	4	28-Apr	02-Jul	2.38	0.6	15.1	543
2012	9	11-Mar	13-Jul	15.5	1.7	-	-
2013*	25	-	-	-	-	-	-

Table 20b: Parameters and catch/effort data from herring fixed gear logbooks – BBTB.

Year	Number of Logbooks	Start of fishing activity	End of fishing activity	Total Logbook Catch (t)	Mean total catch/Fisher (t)	Catch / Std. Net / Night Fished (kg)	Effort (net nights per fisher)
1981	10	02-Apr	04-May	33.0	3.3	25.9	1291
1983	18	18-Apr	25-Jun	11.5	0.6	15.5	823
1996	11	02-Apr	05-Jun	51.5	4.7	52.6	2153
1997	6	07-Apr	27-Jun	39.4	6.6	27.9	1818
1998	6	02-Apr	21-Jun	16.3	2.7	13.5	1655
1999	5	02-Apr	29-Jun	28.7	5.7	27.8	657
2000	9	08-Apr	30-Jun	23.6	2.6	36.7	1018
2001	10	13-Apr	30-Jun	22.3	2.2	33.2	964
2002	10	20-Apr	21-Jun	6.0	0.6	10.2	574
2003	4	01-May	30-Jun	4.9	1.2	23.4	358
2004	5	21-Apr	30-Jun	6.8	1.4	16.6	608
2005	6	22-Apr	22-Jun	14.0	2.3	39.5	716
2006	12	11-Apr	30-Jun	31.6	2.6	46.4	890
2007	13	04-Apr	30-Jun	54.3	4.2	85.6	887
2008	5	26-Apr	30-Jun	11.1	2.2	29.4	270
2009	12	20-Apr	30-Jun	38.9	3.2	67.0	805
2010	12	01-Apr	01-Jul	22.8	1.9	31.4	972
2011	2	30-Apr	23-Jun	0.39	0.2	3.4	128
2012	17	10-Apr	03-Aug	22.5	1.3	-	-
2013*	17	-	-	-	-	-	-

Table 20c: Parameters and catch/effort data from herring fixed gear logbooks – SMBPB.

Year	Number of Logbooks	Start of fishing activity	End of fishing activity	Total Logbook Catch (t)	Mean total catch/Fisher (t)	Catch / Std. Net / Night Fished (kg)	Effort (net nights per fisher)
1983	6	18-Apr	29-Jun	1.2	0.2	3.4	320
1996	13	19-Mar	15-Jun	45.3	3.5	31.4	2073
1997	6	12-Feb	24-Jun	15.4	2.6	20.7	2171
1998	8	17-Mar	25-Jun	25.9	3.2	20.2	5361
1999	6	21-Feb	29-May	11.9	2.0	12.0	2981
2000	1	01-Apr	26-May	2.7	2.7	10.1	280
2001	3	28-Apr	23-Jun	2.0	0.7	10.2	235
2002	4	20-Feb	08-Jun	75.0	18.8	39.4	1692
2003	4	20-Mar	17-Jun	9.2	2.3	23.9	658
2004	2	08-Apr	15-Jun	1.1	0.6	5.4	332
2005	3	07-Apr	10-Jun	1.2	0.4	7.9	210
2006	5	03-Apr	05-Jun	3.2	0.6	9.1	432
2007	9	10-Mar	15-Jun	17.3	1.9	17.4	836
2008	7	15-Mar	13-Jun	53.4	7.6	36.8	1440
2009	3	04-Mar	10-Jun	16.7	5.6	42.7	537
2010	5	03-Mar	25-Jun	21.6	4.3	40.4	874
2011	5	24-Mar	05-Jun	10.1	2.0	33.6	418
2012	7	07-Apr	09-May	19.3	2.8	-	-
2013*	3	-	-	-	-	-	-

Table 20d: Parameters and catch/effort data from herring fixed gear logbooks – FB.

Year	Number of Logbooks	Start of fishing activity	End of fishing activity	Total Logbook Catch (t)	Mean total catch/Fisher (t)	Catch / Std. Net / Night Fished (kg)	Effort (net nights per fisher)
1996	11	08-Apr	10-Jun	60.0	5.5	37.5	3044
1997	13	29-Mar	28-Jun	68.9	5.3	39.4	5919
1998	11	01-Apr	17-Jun	41.3	3.8	54.7	2776
1999	8	21-Mar	15-Jun	36.1	4.5	37.9	1432
2000	11	25-Mar	12-Jun	96.5	8.8	83.5	2364
2001	8	28-Mar	21-Jun	54.6	6.8	38.2	1668
2002	7	28-Mar	29-Jun	35.7	5.1	50.6	1093
2003	7	08-Apr	18-Jun	16.3	2.3	36.6	581
2004	5	30-Mar	23-Jun	10.7	2.1	24.6	728
2005	6	06-Apr	19-Jun	8.6	1.4	16.0	552
2006	6	03-Apr	21-Jun	7.4	1.2	11.6	707
2007	15	09-Apr	22-Jun	27.7	1.8	30.3	1746
2008	13	02-Apr	20-Jun	28.8	2.2	49.3	1452
2009	12	02-Apr	19-Jun	30.2	2.5	35.8	1624
2010	14	04-Apr	21-Jun	33.5	2.4	22.6	1709
2011	10.0	07-Apr	15-Jun	14.6	1.5	28.6	1149.0
2012	6	22-Feb	08-May	5.5	0.9	-	-
2013*	10	-	-	-	-	-	-

**2013 logbooks were still being returned at the time of this assessment and had not been analyzed*

Table 21: Comparison of estimates of bait caught per fisher (t) derived from fixed gear logbooks vs telephone surveys.*

Survey	Bait estimate/fisher (t) 2007	Bait estimate/fisher (t) 2008	Bait estimate/fisher (t) 2009	Bait estimate/fisher (t) 2011	Bait estimate/fisher (t) 2012	mean sample size
WBNDB Logbooks	1.2	3.1	2.4	0.6	1.7	10
WBNDB Phone Survey	1.7	1.4	1.1	0.6	0.7	32
BBTB Logbooks	4.2	2.2	3.2	0.2	1.3	10
BBTB Phone Survey	2.1	1.7	2	1.3	1.5	37
SMBPB Logbooks	1.9	7.6	5.6	2	2.8	6
SMBPB Phone Survey	1.5	1.3	1.5	1.4	1.8	16
FB Logbooks	1.8	2.2	2.5	1.5	0.9	11
FB Phone Survey	2.9	2.1	1.7	1.5	3.8	44

**no telephone survey in 2010*

Table 22: Changes to abundance index weightings used in stock status calculations made in 2013

Index	Previous	Revised (1997-2011)	Revised (2012-onward)
Research Gillnet catch rate	2	2.5	2.5
Logbook catch rates	0.5	0.25	removed
Logbook cumulative abundance change index	0.5	0.25	0.25
Phone survey cumulative abundance change index	0.5	0.5	0.5
Purse seine survey cumulative abundance change index	0.5	0.25	0.25
Research Gillnet age composition	1	1.25	1.5

Table 23a: Results of the annual telephone survey of commercial fixed gear licence and or/herring bait permit holders by stock area - WBNDB.

Year*	# Licences and Bait Permits	% of total fishers - Licences and Bait Permits	# Fishers Phoned	% Fishers (stock area)	#	% of fishers phoned	# Active Fishers	% of fishers contacted	# Fished for Bait	% of active fisher - Fished for Bait	Mean Age
2006	989	42.5	113	11.4	84	74.3	40	47.6	39	97.5	52
2007	969	42.5	113	11.7	103	91.2	42	40.8	42	100.0	50
2008	959	42.3	113	11.8	92	81.4	32	34.8	32	100.0	52
2009	930	42.5	113	12.2	95	84.1	37	38.9	37	100.0	55
2011	876	42.6	83	9.5	59	71.1	19	32.2	19	100.0	55
2012	891	42.9	112	12.6	92	82.1	38	41.3	32	84.2	56

Table 23b: Results of the annual telephone survey of commercial fixed gear licence and or/herring bait permit holders by stock area - BBTB.

Year*	# Licences and Bait Permits	% of total fishers - Licences and Bait Permits	# Fishers Phoned	% Fishers (stock area)	#	% of fishers phoned	# Active Fishers	% of fishers contacted	# Fished for Bait	% of active fisher - Fished for Bait	Mean Age
2006	577	24.8	106	18.4	88	83.0	49	55.7	44	89.8	49
2007	562	24.6	106	18.9	88	83.0	50	56.8	44	88.0	50
2008	560	24.7	106	18.9	92	86.8	43	46.7	41	95.3	52
2009	547	25.0	106	19.4	89	84.0	44	49.4	41	93.2	53
2011	527	25.6	95	18.0	79	83.2	35	44.3	29	82.9	60
2012	533	25.7	105	19.7	88	83.8	36	40.9	32	88.9	58

Table 23c: Results of the annual telephone survey of commercial fixed gear licence and or/herring bait permit holders by stock area - SMBPB.

Year*	# Licences and Bait Permits	% of total fishers - Licences and Bait Permits	# Fishers Phoned	% Fishers (stock area)	#	% of fishers phoned	# Active Fishers	% of fishers contacted	# Fished for Bait	% of active fisher - Fished for Bait	Mean Age
2006	453	19.5	103	22.7	79	76.7	22	27.8	21	95.5	54
2007	445	19.5	102	22.9	83	81.4	19	22.9	17	89.5	57
2008	444	19.6	102	23.0	78	76.5	17	21.8	17	100.0	54
2009	415	18.9	101	24.3	86	85.1	19	22.1	17	89.5	56
2011	375	18.2	62	16.5	48	77.4	16	33.3	16	100.0	55
2012	378	18.2	98	25.9	72	73.5	15	20.8	15	100.0	58

Table 23d: Results of the annual telephone survey of commercial fixed gear licence and or/herring bait permit holders by stock area - FB

Year*	# Licences and Bait Permits	% of total fishers - Licences and Bait Permits	# Fishers Phoned	% Fishers (stock area)	#	% of fishers phoned	# Active Fishers	% of fishers contacted	# Fished for Bait	% of active fisher - Fished for Bait	Mean Age
2006	307	13.2	95	30.9	79	83.2	57	72.2	55	96.5	51
2007	304	13.3	94	30.9	81	86.2	52	64.2	51	98.1	49
2008	304	13.4	94	30.9	84	89.4	50	59.5	50	100.0	51
2009	298	13.6	94	31.5	76	80.9	47	61.8	45	95.7	53
2011	278	13.5	74	26.6	67	90.5	43	64.2	38	88.4	58
2012	275	13.2	91	33.1	70	76.9	42	60.0	36	85.7	60

Table 23e: Results of the annual telephone survey of commercial fixed gear licence and or/herring bait permit holders by stock area – all.

Year*	# Licences and Bait Permits	% of total fishers - Licences and Bait Permits	# Fishers Phoned	% Fishers (stock area)	#	% of fishers phoned	# Active Fishers	% of fishers contacted	# Fished for Bait	% of active fisher - Fished for Bait	Mean Age
2006	2326	100.0	417	17.9	330	79.1	168	50.9	159	94.6	52
2007	2280	100.0	415	18.2	355	85.5	163	45.9	154	94.5	52
2008	2267	100.0	415	18.3	346	83.4	142	41.0	140	98.6	52
2009	2190	100.0	414	18.9	346	83.6	147	42.5	140	95.2	54
2011	2056	100.0	314	15.3	253	80.6	113	44.7	102	90.3	57
2012	2077	100.0	406	19.5	322	79.3	131	40.7	115	87.8	58

** there was no telephone survey in 2010*

Table 24a: White Bay-Notre Dame Bay performance table to the spring of 2013 – summary of fishery.

The Fishery	***Observation***
Reported Landings: 2011-2012	Reported landings decreased slightly from 1474t in 2011 to 1226t in 2012 (representing 46% of the TAC). Average landings of 2800t during the 1990's and 480t in the 2000's, peak landings were 15700t in 1979. The proportion of autumn spawners in commercial landings has increased in the 2000's, dominating the catch since 2006.
Total Removals: 2011-2012	In addition to reported landings, 165 t were estimated to have been taken for bait in 2011 and 308t in 2012. Fishers estimated 55% discard mortality in the purse seine fishery in 2011 (194t) and 60% 2012 (89t).
Effort: 2011 and 2012	Documented purse seine effort (total sets) in 2011 was 60% lower than the peak year in 1997 and 90% lower in 2012; 32% of fishers contacted in the 2011 fixed gear phone survey were active and 41% were active in 2012
Geographic Distribution of Fishery	The 2011 purse seine fishery was largely in White Bay, the 2012 fishery occurred in both bays. The 2011 and 2012 gillnet fisheries were largely in Notre Dame Bay.

Table 24b: White Bay-Notre Dame Bay performance table to the spring of 2013 – indices and interpretations.

Abundance Indices and Biological Characteristics	***Observation***	***Interpretation***
Research Gillnet Catch Rates 1988-2012 (numbers / nights fished); rates by spawning type 1988-2012	Catch rates for both spawning types combined was the lowest in the time series in 2011 but improved in 2012. Catch rates of spring and autumn spawning components have been about equal since 2006.	Current abundance below average,
Gillnet Fisher Observations 1996-2012 from logbooks	9 observations in 2012; increasing trend from 2002-09, then decreasing in 2010 and 2011, increasing again in 2012.	Increasing trend in abundance.
Fixed Gear Fisher Observations 2006-2013 from telephone surveys (no survey in 2010)	42 observations in 2013; increasing trend in abundance from 2006-09, then a decrease in 2011, and an increase in 2012 with no change in 2013.	No recent change in abundance.
Purse Seine Fisher Observations 1996 - 2012	6 observations in 2012; increasing trend in abundance over past 7 years.	Increasing trend in abundance.
2012 Research Gillnet Age Compositions (ages 3+)	Age 11's accounted for over 20% of the catch, age 3, 4 and 7's were more than 5%.	Population age structure considered to be stable.
Current Year Classes: 2001 to 2007 Series: 1982 - 2008 year classes	Most mature fall year classes are above average, 3 of 7 mature spring year classes are above average.	Most mature year classes above average.
Recruitment: 2008 year class Series: 1982 to 2008 year classes	The 2008 year class is above average for both spring and fall spawners.	Recruitment is above average for both spring and fall spawners.

Table 24c: White Bay-Notre Dame Bay performance table to the spring of 2013 – stock status evaluation.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Recent	Uncertain. Stock status deteriorated since 2008 but improved in 2012.	**?**
Short Term Prospects	Positive. The recruiting year class is above average for spring and fall spawners, most mature fall-spawning year classes are above average. Most current year classes are average or above.	**+**

? = Uncertainty of Interpretation
+ = Positive Evaluation

The standardized performance index indicates that stock status declined steadily since 2009, following a period of improvement from 2002 to 2008, but showed improvement in 2012. The overall status is uncertain. Short term prospects are positive; the 2006 year class is average and most mature year classes are above average.

Table 25a: Bonavista Bay-Trinity Bay performance table to the spring of 2013 – summary of fishery.

The Fishery	***Observation***
Reported Landings: 2011-2012	Reported landings decreased in 2011 to 823t, then increased in in 2012 to 2255t (representing 46% of the TAC). Average landings of 2800t during the 1990's and 480t in the 2000's, peak landings were 15700t in 1979. The proportion of autumn spawners in commercial landings has increased in the 2000's, dominating the catch since 2006 and comprising over 90% in 2012.
Total Removals: 2011-2012	In addition to reported landings, 309 t were estimated to have been taken for bait in 2011 and 322t in 2012. Fishers estimated 24% discard mortality in the purse seine fishery in 2011 (108t) and 70% 2012 (1351t).
Effort: 2011 and 2012	Documented purse seine effort (total sets) in 2012 reached the highest point in the time series at 140, in 2011 it was 82; 40% of fishers contacted in the 2012 fixed gear phone survey were active and 51% were active in 2013
Geographic Distribution of Fishery	The 2011 and 2012 purse seine fisheries occurred in both bays. The 2012 and 2013 gillnet fishery was distributed throughout both bays.

Table 25b: Bonavista Bay-Trinity Bay performance table to the spring of 2013 – indices and interpretations.

Abundance Indices and Biological Characteristics	***Observation***	***Interpretation***
Research Gillnet Catch Rates 1988-2012 (numbers / nights fished); rates by spawning type 1988-2012	Catch rates for both spawning types combined were below average in 2011 and average in 2012. Catch rates of spring and fall-spawning components have been about equal since 2007, with fall catches slightly higher.	Current abundance average.
Gillnet Fisher Observations 1996-2012 from logbooks	17 observations in 2012; Increasing trend through 2000's to 2007, decrease to 2011 (sharply from 2010-2011), increase in 2012	Increasing trend in abundance.
Fixed Gear Fisher Observations 2006-2013 from telephone surveys (no survey in 2010)	22 observations in 2013; increasing trend in abundance throughout survey	Increasing trend in abundance.
Purse Seine Fisher Observations 1996 - 2012	8 observations in 2012; increasing trend in abundance.	Increasing trend in abundance.
2012 Research Gillnet Age Compositions (ages 3+)	Age 11's accounted for over 20% of the catch, 3 other mature age groups accounted for more than 5% each	Population age structure considered to be stable.
Current Year Classes: 2001 to 2007 Series: 1982 - 2008 year classes	Most mature fall year classes are above average, 3 mature year classes are average, the rest are below.	Most mature year classes above average or below.
Recruitment: 2008 year class Series: 1982 to 2008 year classes	The 2008 year class above average for fall spawners but below for springs.	Recruitment is below average for springs but above for falls.

Table 25c: Bonavista Bay-Trinity Bay performance table to the spring of 2013 – stock status evaluation.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Recent	Stock status improved from 2002-2007, declined to 2010 and then improved in 2011 and 2012.	**+**
Short Term Prospects	Uncertain; recruitment of the 2008 year class is above average for falls but below for springs.	**?**

+ = Positive Evaluation
? = Uncertainty of Interpretation

The standardized performance index indicates that stock status improved slightly in 2011 and 2012, after declining from 2008 to 2010, and a period of improvement from 2002 to 2007. Current stock status is positive, where short term prospects are uncertain; the 2006 year class is average and all mature year classes are near or above average.

Table 26a: St. Mary's Bay- Placentia Bay performance table to the spring of 2013 – summary of fishery.

The Fishery	***Observation***
Reported Landings: 2011-2012	Reported landings decreased in 2011 to only 42t, then increased slightly in in 2012 to 56t (representing 3% of the TAC). Average landings of 2800t during the 1990's and 480t in the 2000's, peak landings were 15700t in 1979. The proportion of autumn spawners in commercial landings has increased in the 2000's.
Total Removals: 2011-2012	In addition to reported landings, 172 t were estimated to have been taken for bait in 2011 and 142t in 2012.
Effort: 2011 and 2012	There was only one purse seine fisher in 2011 and none in 2012; 21% of fishers contacted in the 2012 fixed gear phone survey were active and 17% were active in 2013
Geographic Distribution of Fishery	The only purse seine fisher in 2011 was active in Placentia Bay, there was no fishery in 2012. Gillnet landings in both 2012 and 2013 were in Placentia Bay.

Table 26b: St. Mary's Bay- Placentia Bay performance table to the spring of 2013 –indices and interpretations.

Abundance Indices and Biological Characteristics	***Observation***	***Interpretation***
Research Gillnet Catch Rates 1988-2012 (numbers / nights fished); rates by spawning type 1988-2012	Catch rates for both spawning types combined were well below average in 2011 and improved in 2012, but remained below average. Catch rates of spring and autumn spawning components have been about equal since 2005.	Current abundance below average,
Gillnet Fisher Observations 1996-2012 from logbooks	7 observations in 2012; decreasing trend from 2005-2009, slight increase in 2010, decrease in 2011 and stable in 2012	Decreasing trend in abundance.
Fixed Gear Fisher Observations 2006-2013 from telephone surveys (no survey in 2010)	12 observations in 2013; increasing trend in abundance from 2006-2009, slight decrease since.	No recent change in abundance.
Purse Seine Fisher Observations 1996 - 2012	No purse seine fishery in 2012.	-
2012 Research Gillnet Age Compositions (ages 3+)	Age 11+ fish accounted for more than 25% of the fish caught, 2 other mature year classes are above 5%.	Population age structure skewed by age 11+ fish
Current Year Classes: 2001 to 2007 Series: 1982 - 2008 year classes	Most mature fall year classes are at or above average while most spring are below.	Most falls above average, most springs below.
Recruitment: 2008 year class Series: 1982 to 2008 year classes	The 2008 year class is slightly below average for falls and springs.	Recruitment is below average.

Table 26c: St. Mary's Bay- Placentia Bay performance table to the spring of 2013 – stock status evaluation.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Recent	Stock status improved declined from 2001 to 2003, then improved slightly in 2005 and has remained slowly declined since, with the exception of a slight increase in 2011.	-
Short Term Prospects	Uncertain. Most fall year classes are above average but most springs are below, recruitment is below average.	?

- = Negative Evaluation
? = Uncertainty of Interpretation

The standardized performance index indicates that stock status improved slightly in 2011, after decline from since 2005, however it declined again in 2012; the current stock status is negative. Short term prospects are uncertain; the 2008 year class is slightly below average and mature fall year classes are above average where springs are below average.

Table 27a: Fortune Bay performance table to the spring of 2013 – summary of fishery.

The Fishery	***Observation***
Reported Landings: 2011-2012	Reported landings decreased in 2011 to 1524t, then increased in in 2012 to 1658t (representing 59% of the TAC). Average landings of 2800t during the 1990's and 480t in the 2000's, peak landings were 15700t in 1979. The proportion of autumn spawners in commercial landings has increased slightly in recent years.
Total Removals: 2011-2012	In addition to reported landings, 271 t were estimated to have been taken for bait in 2011 and 630t in 2012.
Effort: 2011 and 2012	60% of fishers contacted in the 2012 fixed gear phone survey were active and 47% were active in 2013
Geographic Distribution of Fishery	The 2012 gillnet fishery was distributed throughout FB whereas the 2013 fishery was more concentrated at the top of the bay/Long Harbour area

Table 27b: Fortune Bay performance table to the spring of 2013 – indices and interpretations.

Abundance Indices and Biological Characteristics	***Observation***	***Interpretation***
Research Gillnet Catch Rates 1988-2011 (numbers / nights fished); rates by spawning type 1988-2010	Catch rates for both spawning types combined were extremely low in both 2011 and 2012, below both the long term and decadal mean. The catch of spring spawners is declining.	Current abundance below average,
Gillnet Fisher Observations 1996-2012 from logbooks	6 observations in 2012; decreasing trend for the past decade.	Decreasing trend in abundance.
Fixed Gear Fisher Observations 2006-2013 from telephone surveys (no survey in 2010)	22 observations in 2013; decreasing trend in abundance for entire time series.	Decreasing trend in abundance.
Research Gillnet Catch Rates 1988-2011 (numbers / nights fished); rates by spawning type 1988-2010	Catch rates for both spawning types combined were extremely low in both 2011 and 2012, below both the long term and decadal mean. The catch of spring spawners is declining.	Current abundance below average,
2012 Research Gillnet Age Compositions (ages 3+)	Age 10 and 11+ fish accounted for more than 25% of the catch each, only two other year classes accounted for more than 5%.	Population age structure is skewed toward older fish.
Current Year Classes: 2001 to 2007 Series: 1982 - 2008 year classes	Most mature spring year classes are above average and 3 mature fall year classes are above.	Most mature year classes above average.
Recruitment: 2008 year class Series: 1982 to 2008 year classes	The 2008 year class is average for spring spawners and above average for falls.	Recruitment is about average.

Table 27c: Fortune Bay performance table to the spring of 2013 – stock status evaluation.

Stock Status	***Interpretation***	***Evaluation***
Current vs. Recent	Stock status declined from 2001 to 2005 when it improved slightly, it has declined since.	**-**
Short Term Prospects	Uncertain; average recruitment of 2006 year class; all current mature year classes are average or above but catch numbers low.	**?**

- = Negative Evaluation
? = Uncertainty of Interpretation

The standardized performance index indicates that stock status declined for most of the decade and current status is negative. Short term prospects are uncertain; the 2008 year class is average and all mature year classes are near or above average.

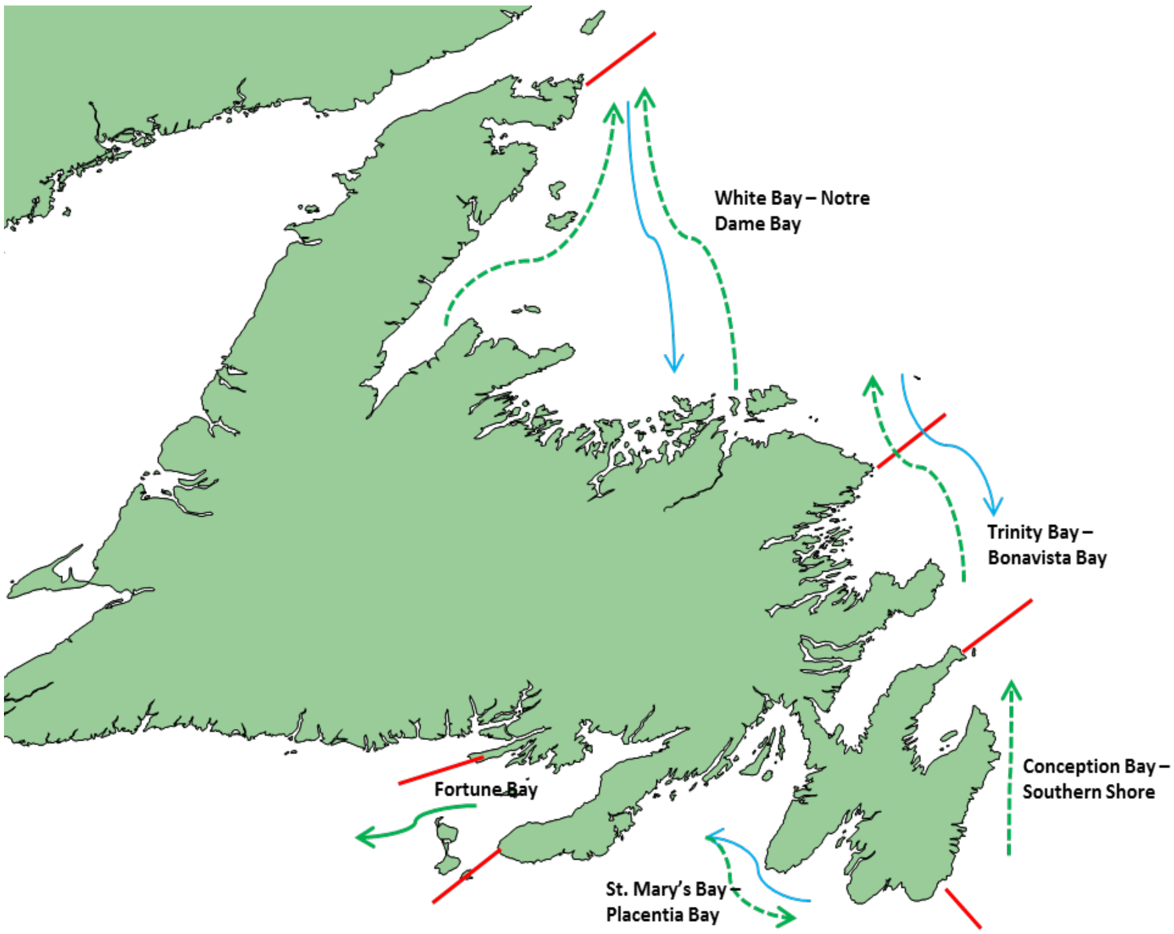

Figure 1: Map indicating herring stock complexes and migration patterns (solid line to overwintering areas; broken line from spring spawning locations to summer feeding grounds) within the Newfoundland and Labrador Region.

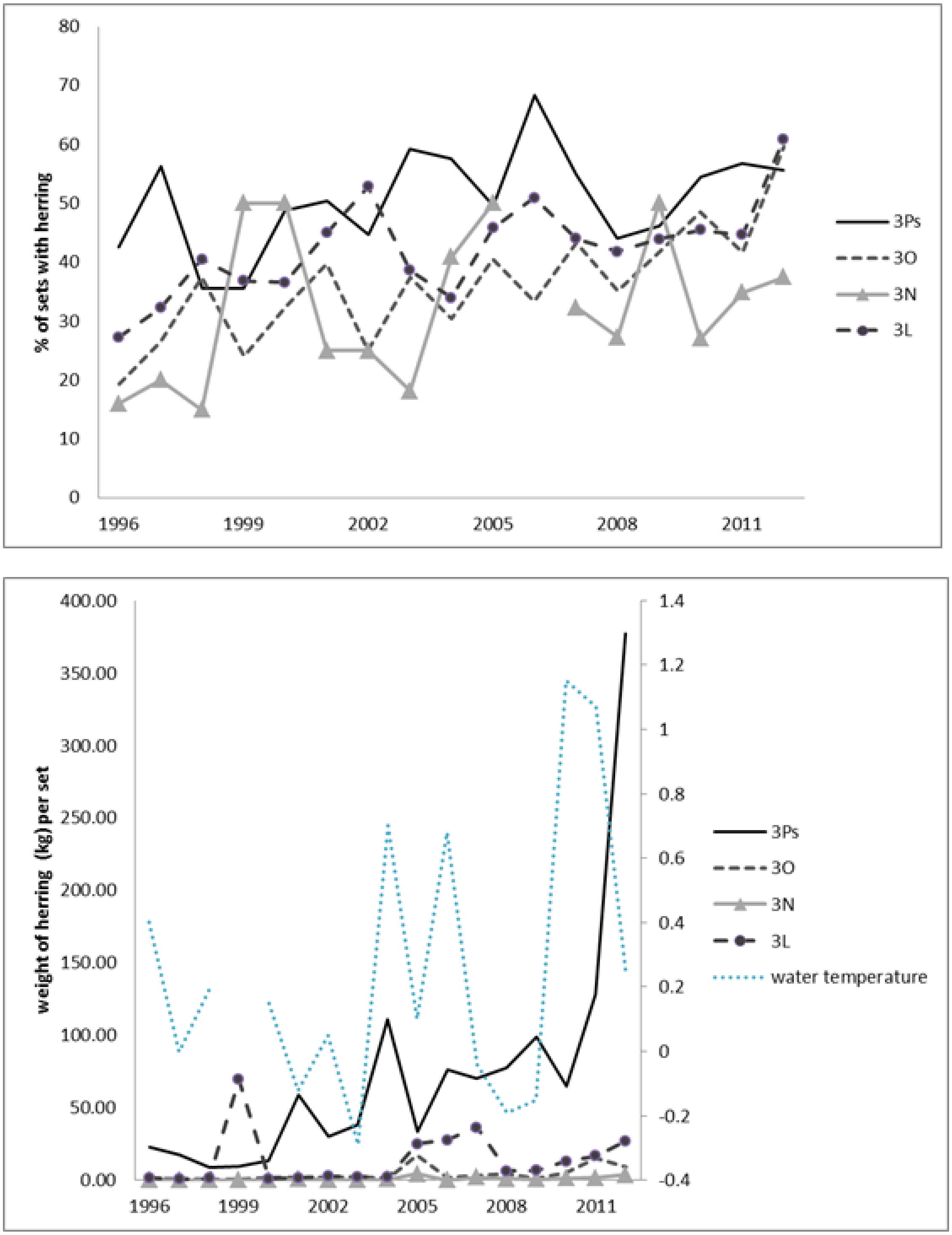

Figure 2: Percentage of fishing sets on annual DFO spring multispecies bottom trawl surveys where herring were present by year and NAFO division (top) ; total weight of herring caught per fishing set where they were encountered and annual mean spring water temperature (0-175 m) at Station 27(bottom).

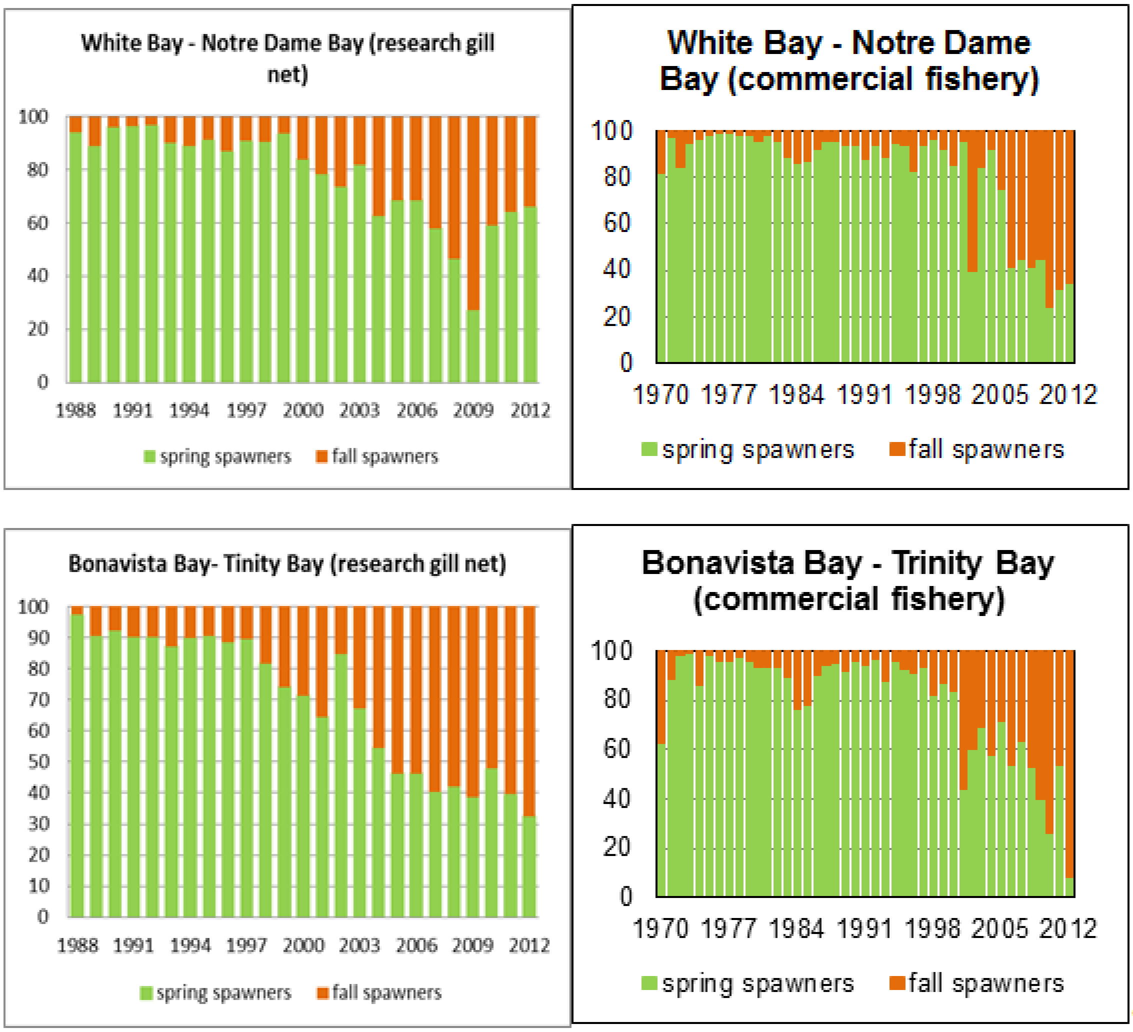

Figure 3: Proportion of spring and fall-spawning herring in the research gillnet program (left panels) and commercial fishery (right panels) by stock area.

Figure 3: Cont'd.

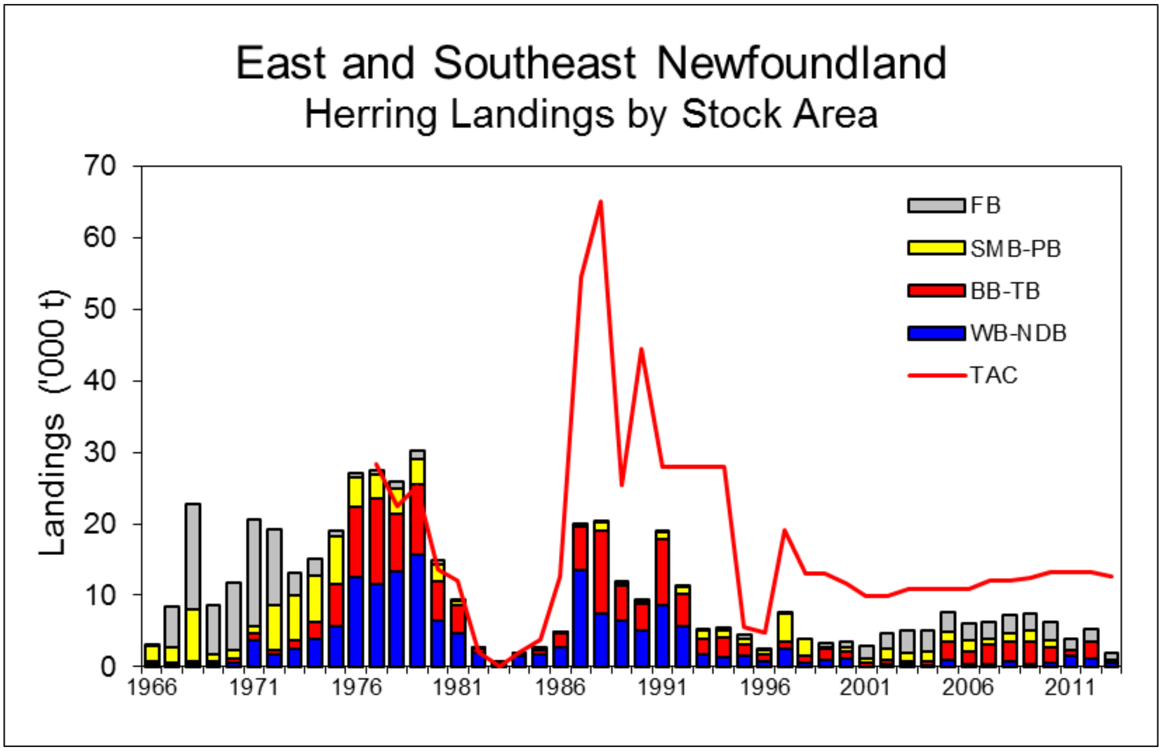

Figure 4: Herring landings and TAC for the Newfoundland north and southeast coast.

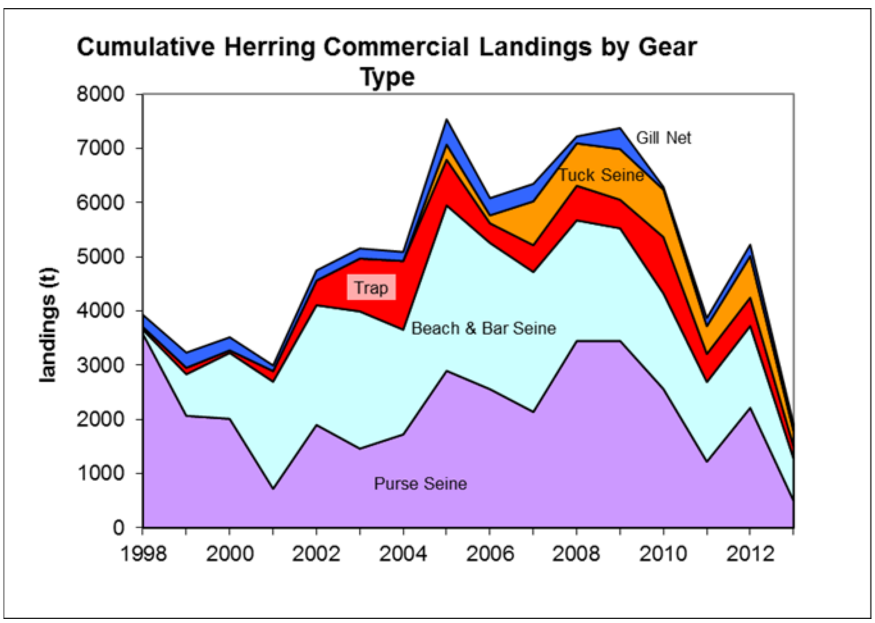

Figure 5: Herring landings for the Newfoundland north and southeast coast by gear type.

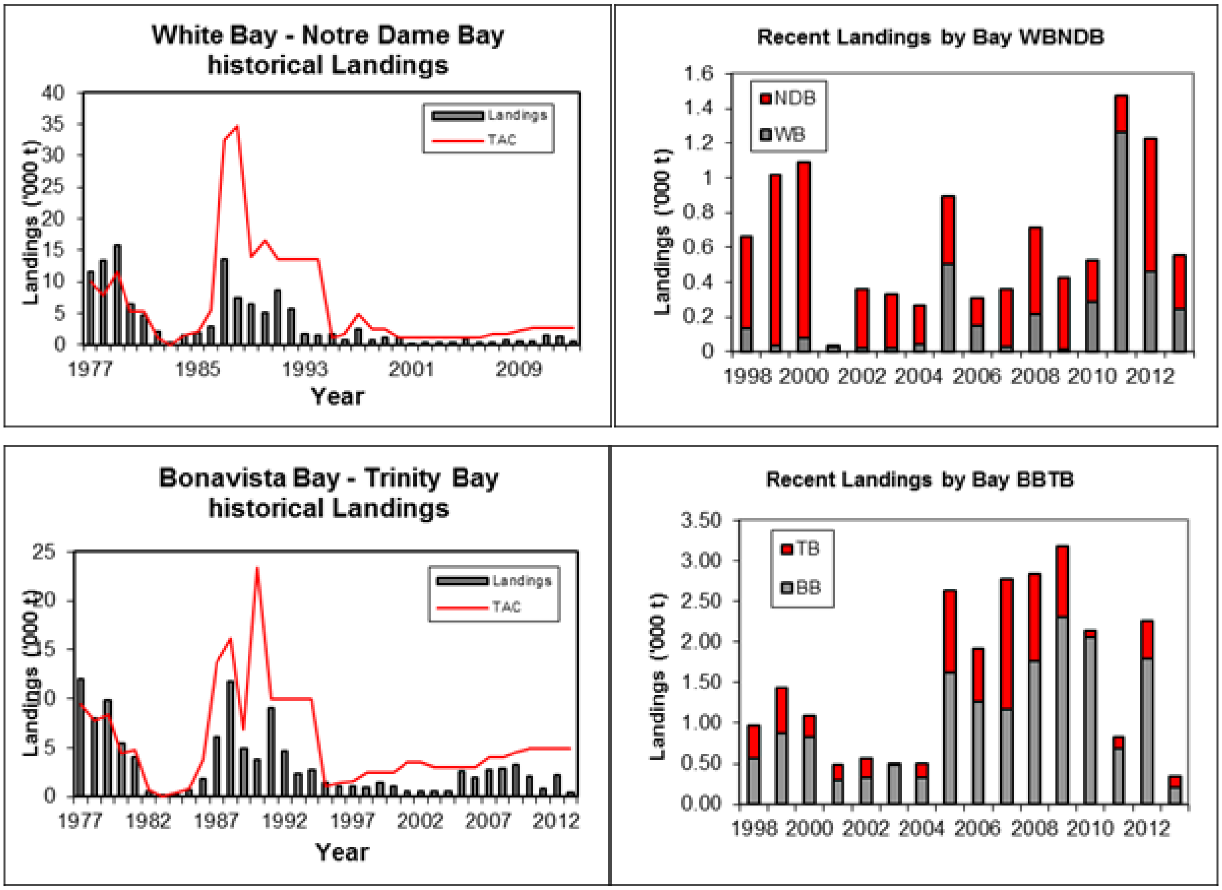

Figure 6: Commercial herring landings by stock area for entire time series (left) and by bay for past 15 years (right); note that 2013 landings are preliminary.

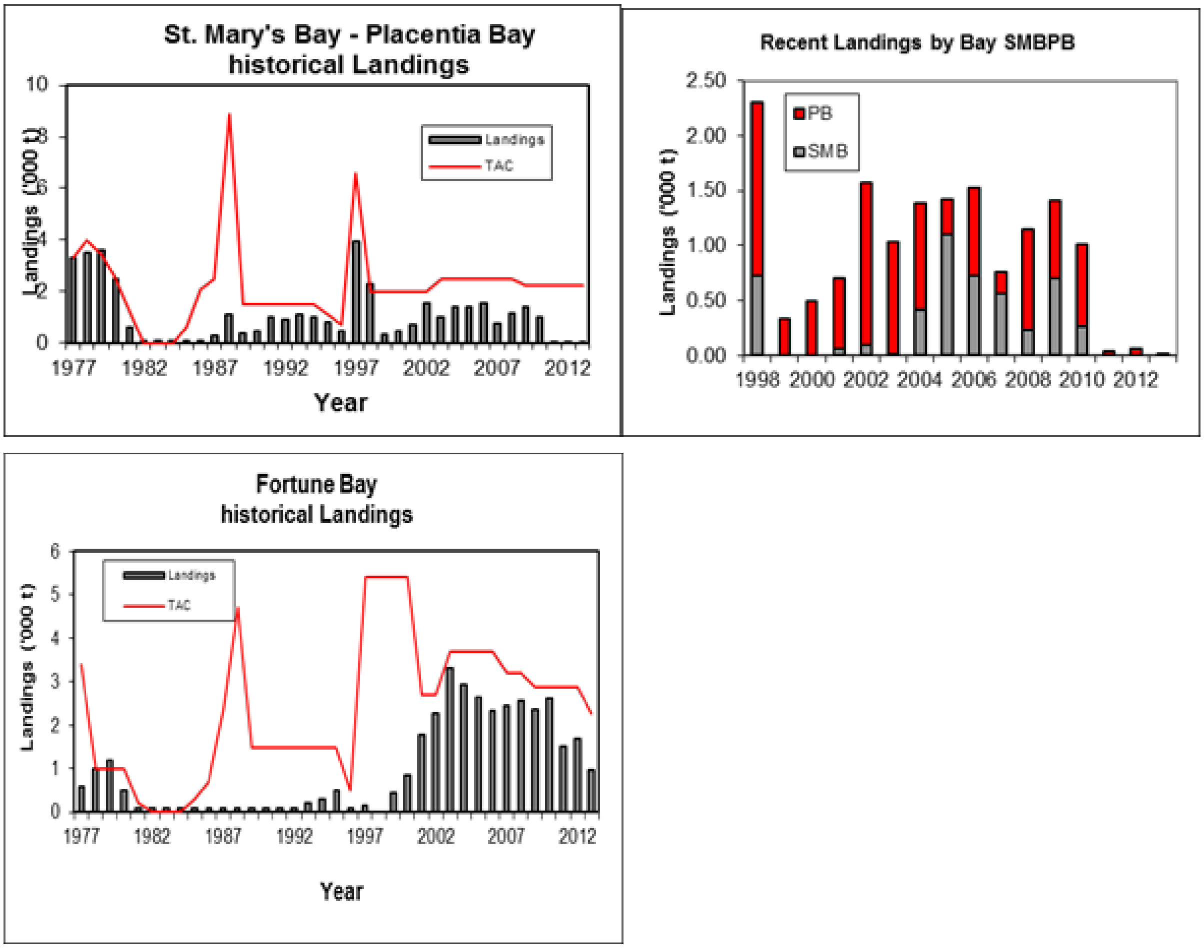

Figure 6: Cont'd.

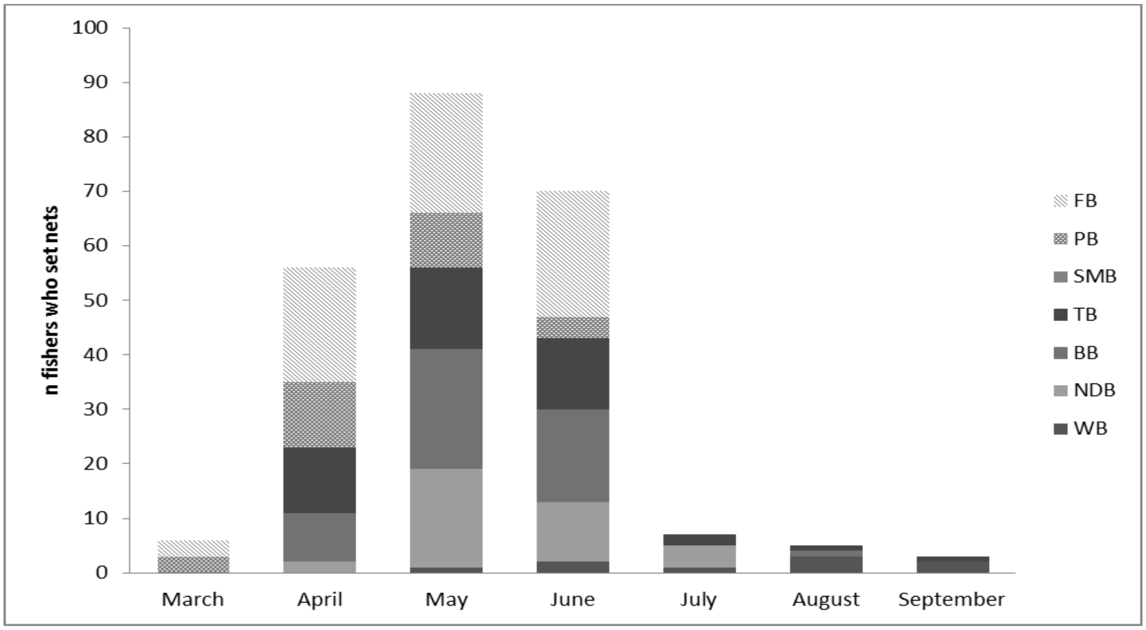

Figure 7: Number of fishers who reported setting herring nets for bait by month and bay during the 2013 fixed gear phone survey (conducted in September).

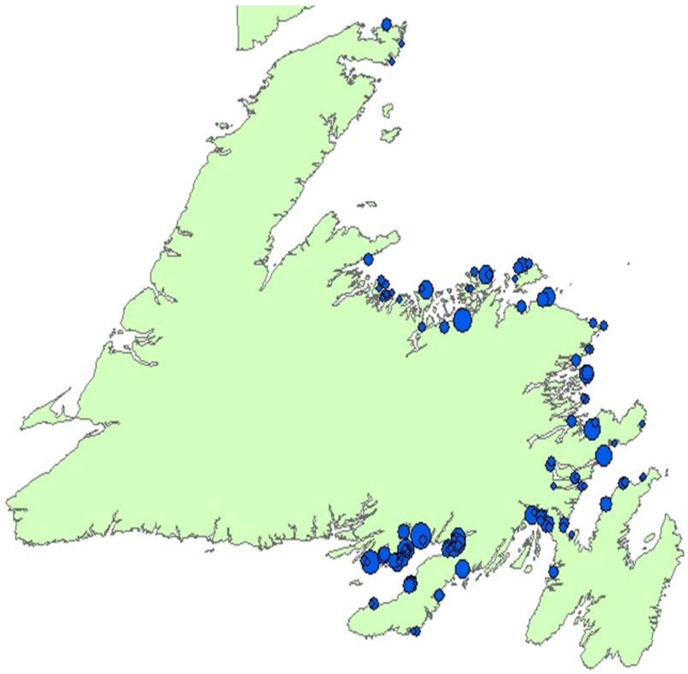

Figure 8: Locations and proportionate landings of fishers contacted in the 2012 herring fixed gear telephone survey.

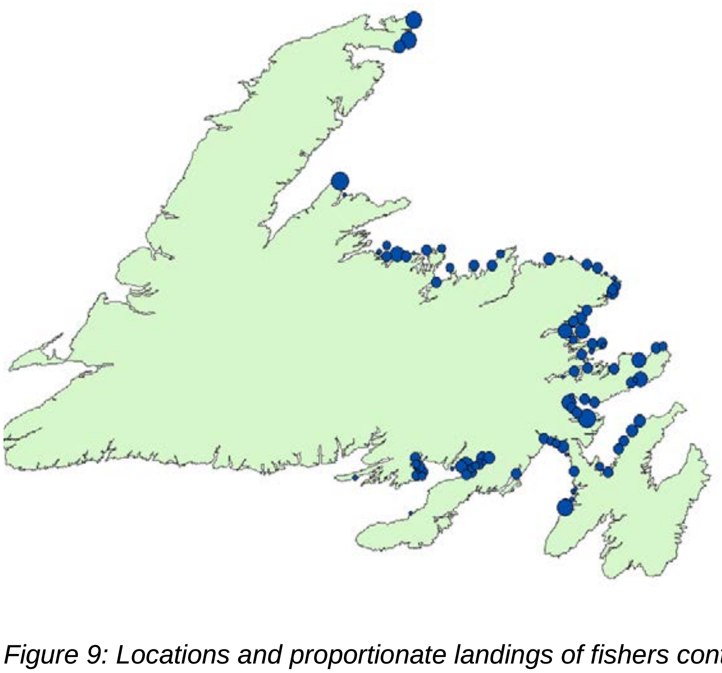

Figure 9: Locations and proportionate landings of fishers contacted in the 2013 herring fixed gear telephone survey.

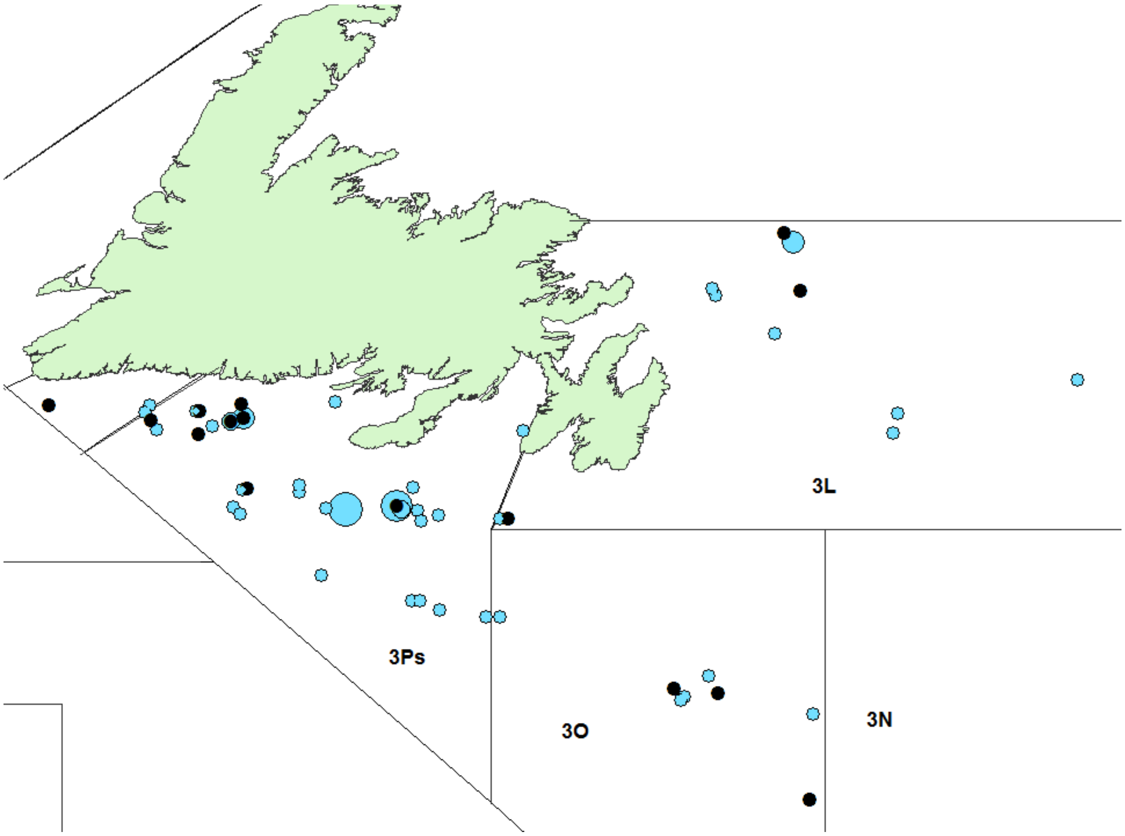

Figure 10: Distribution of fishing sets with herring catches in the 2011 DFO Science spring multispecies bottom trawl survey; size of points are proportional to number of herring in the fishing set and black points represent sets where herring were sampled in detail.

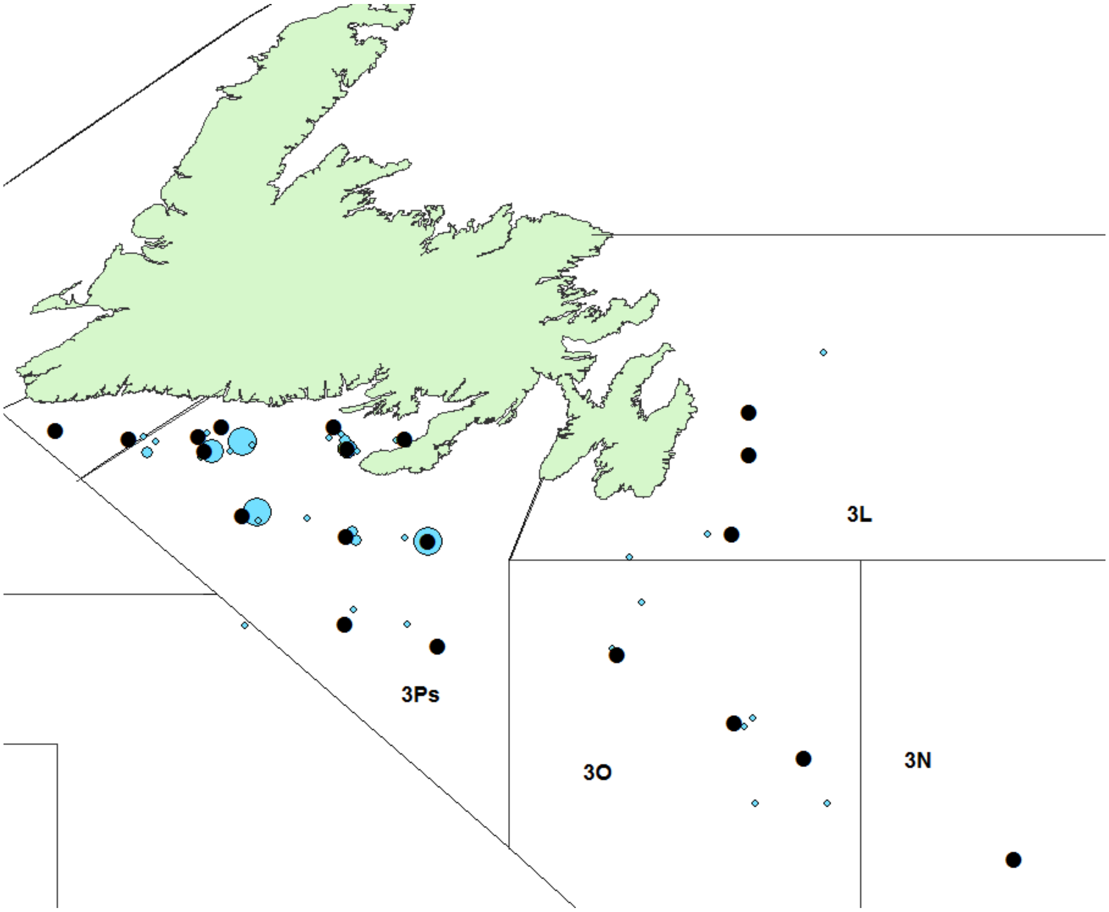

Figure 11: Distribution of fishing sets with herring catches in the 2012 DFO Science spring multispecies bottom trawl survey; size of points are proportional to number of herring in the fishing set and black points represent sets where herring were sampled in detail.

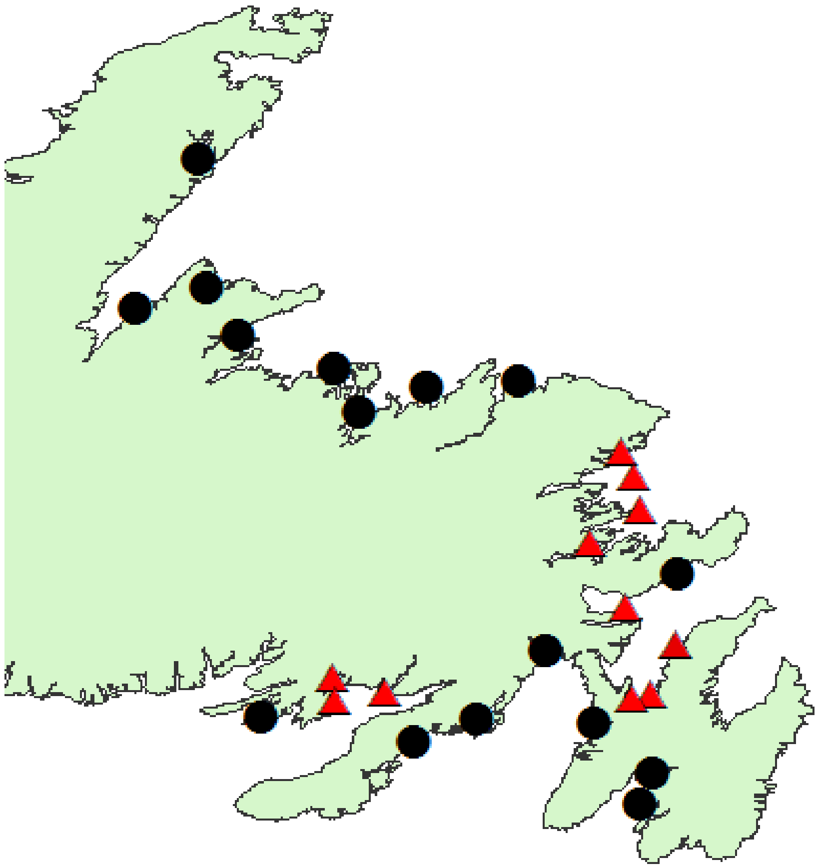

Figure 12: Locations of research gillnet fishers in 2012 (all points) and 2013 (red triangles only).

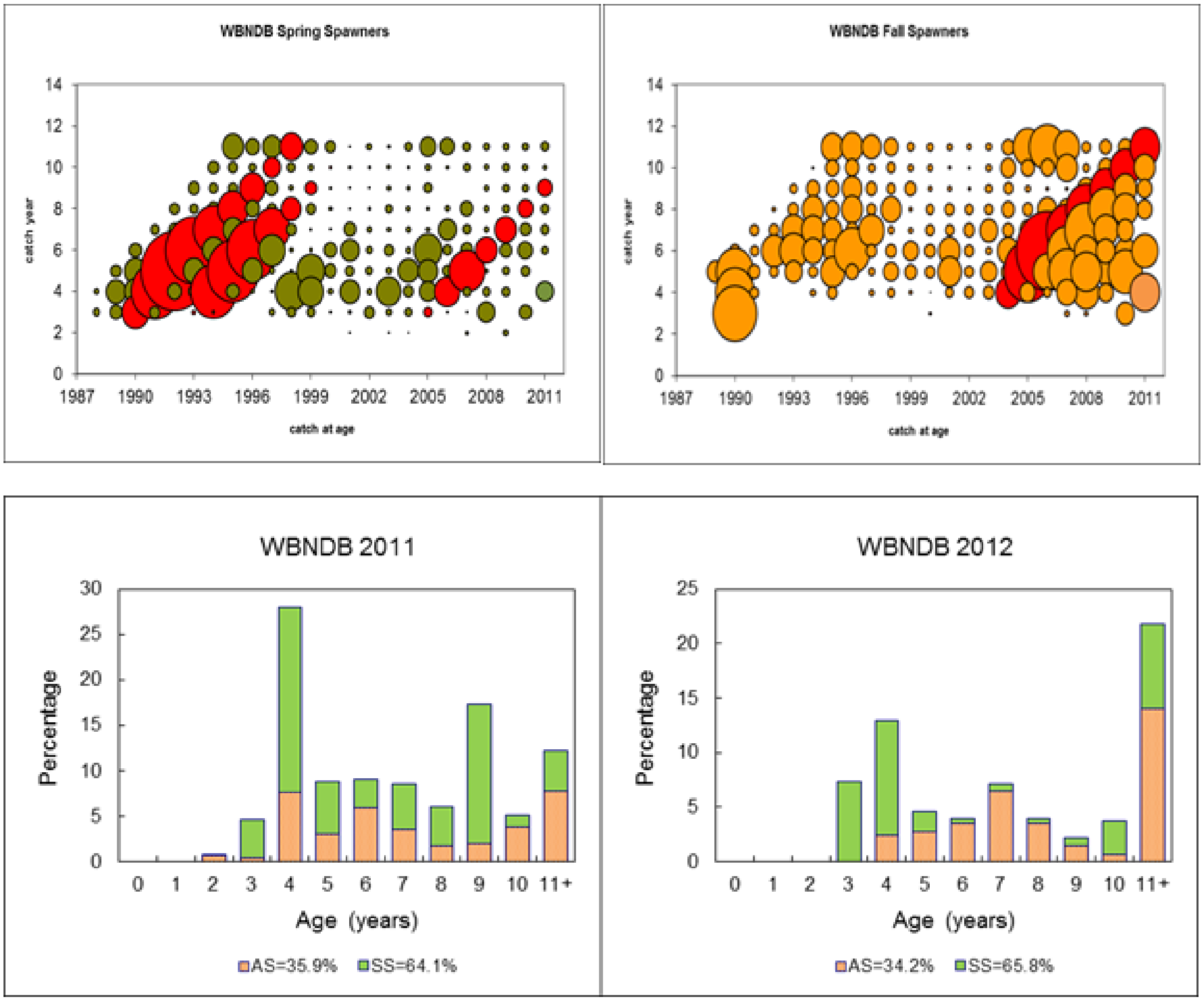

Figure 13: WBNDB herring catch-at-age (normalized by age) from the research gillnet program time series (top) and age distribution (bottom) for 2011 and 2012.

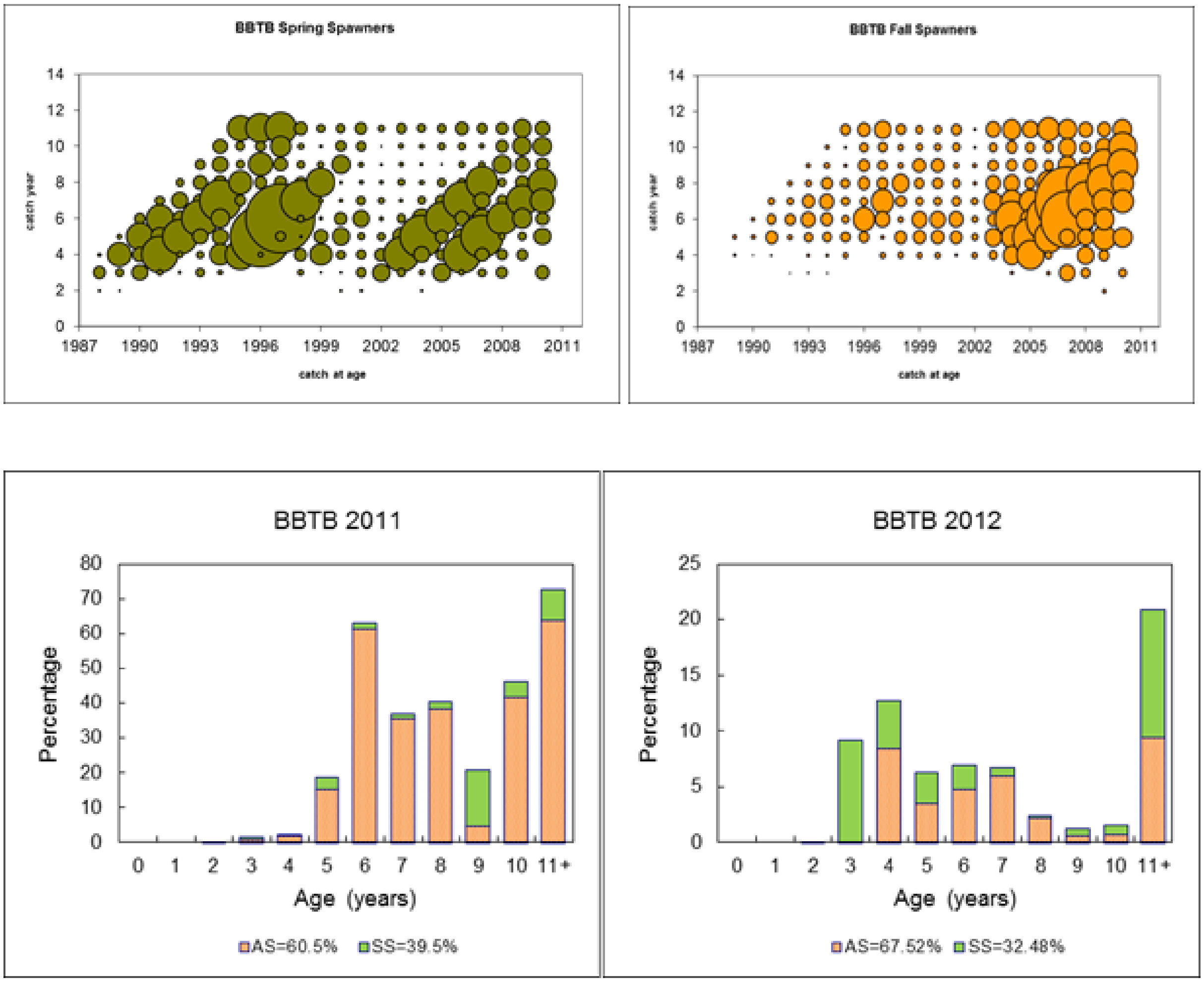

Figure 14: BBTB herring catch-at-age (normalized by age) from the research gillnet program time series (top) and age distribution (bottom) for 2011 and 2012.

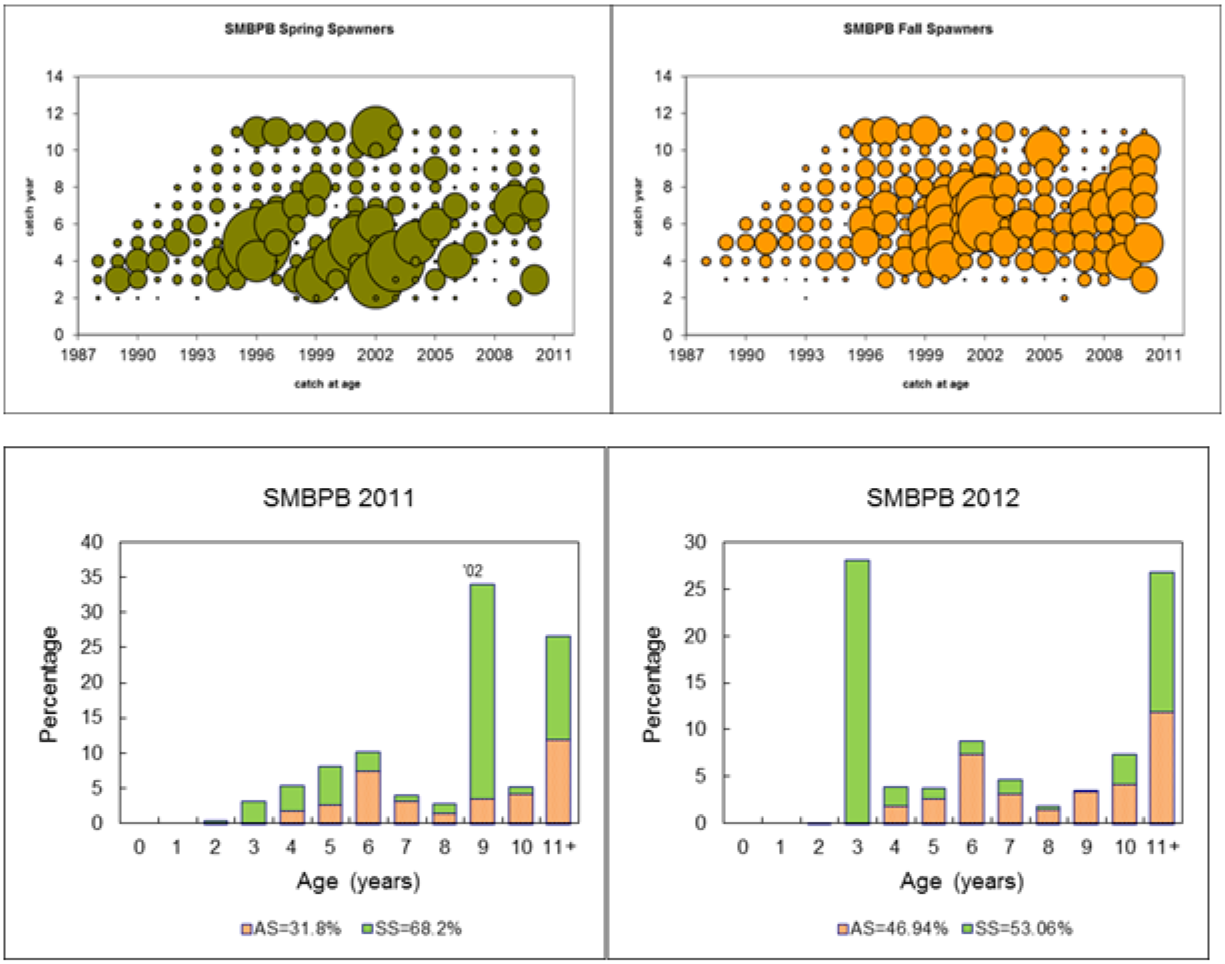

Figure 15: SMBPB herring catch-at-age (normalized by age) from the research gillnet program time series (top) and age distribution (bottom) for 2011 and 2012.

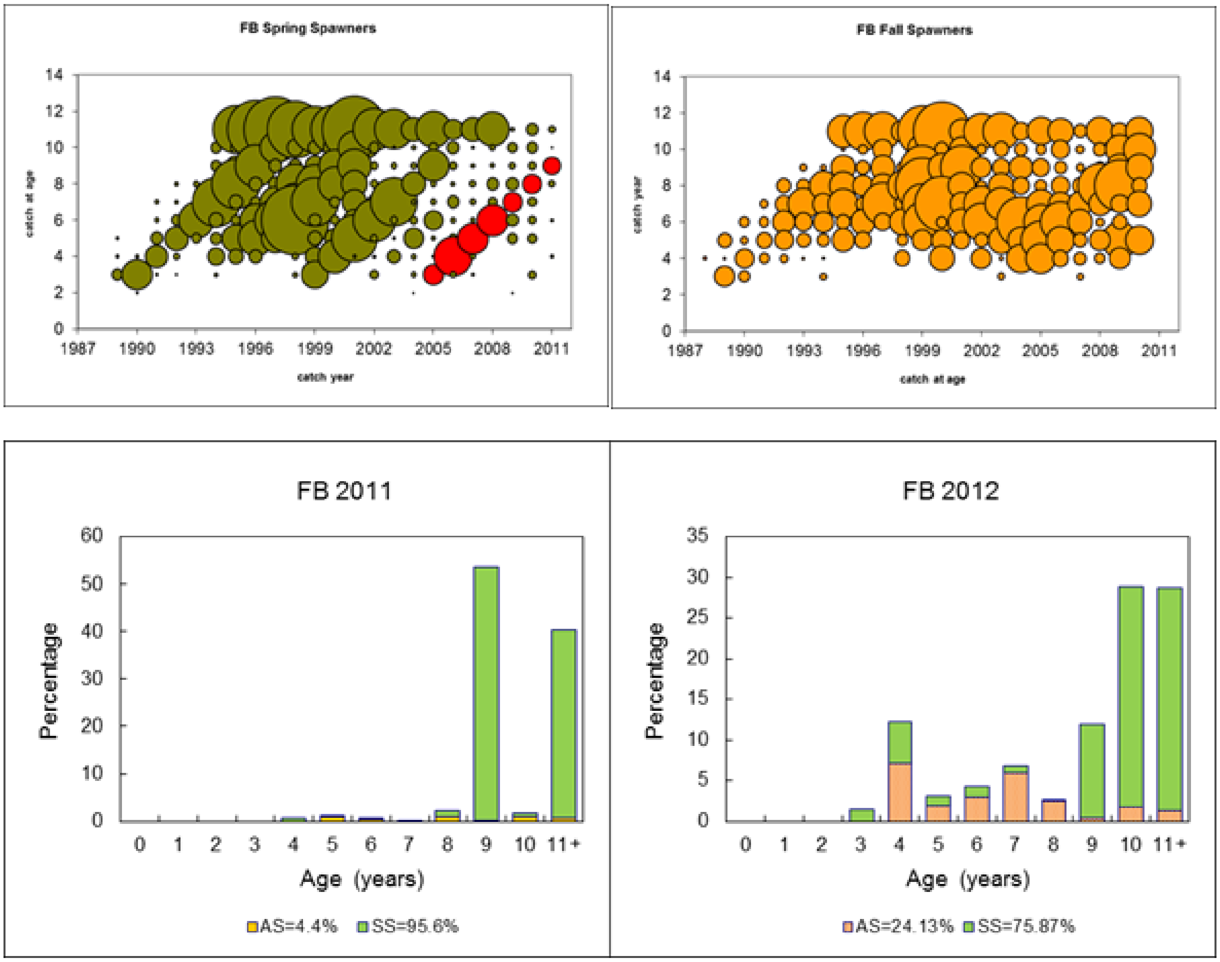

Figure 16: FB herring catch-at-age (normalized by age) from the research gillnet program time series (top) and age distribution (bottom) for 2011 and 2012.

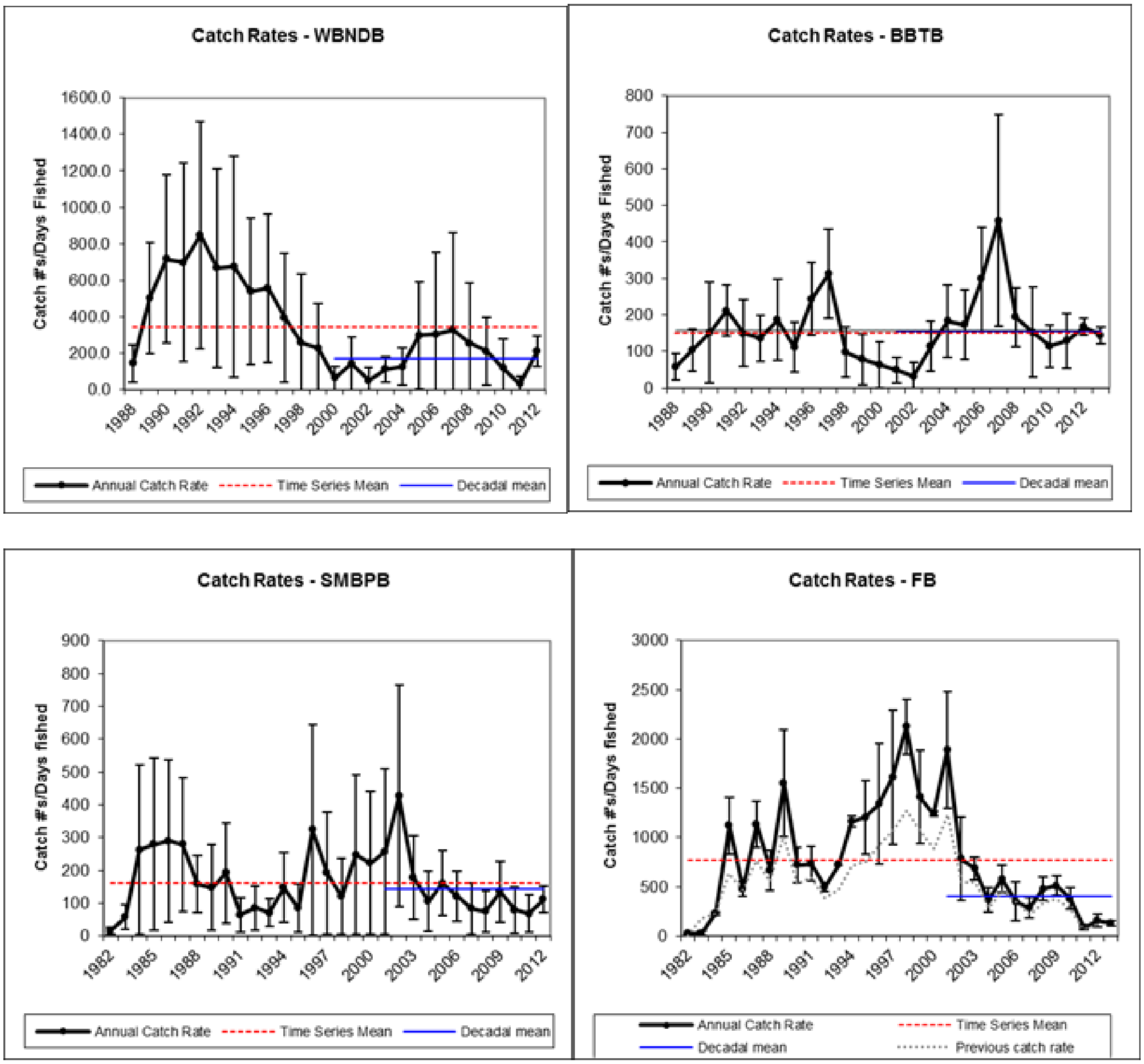

Figure 17: Research gillnet catch rates (numbers per nights fished) by stock area and year, spring and fall spawners combined (with 95% confidence limits), decadal means based on 2000-13. Green/dotted time series line in FB represents previous catch rates before removal of 1 fisher.

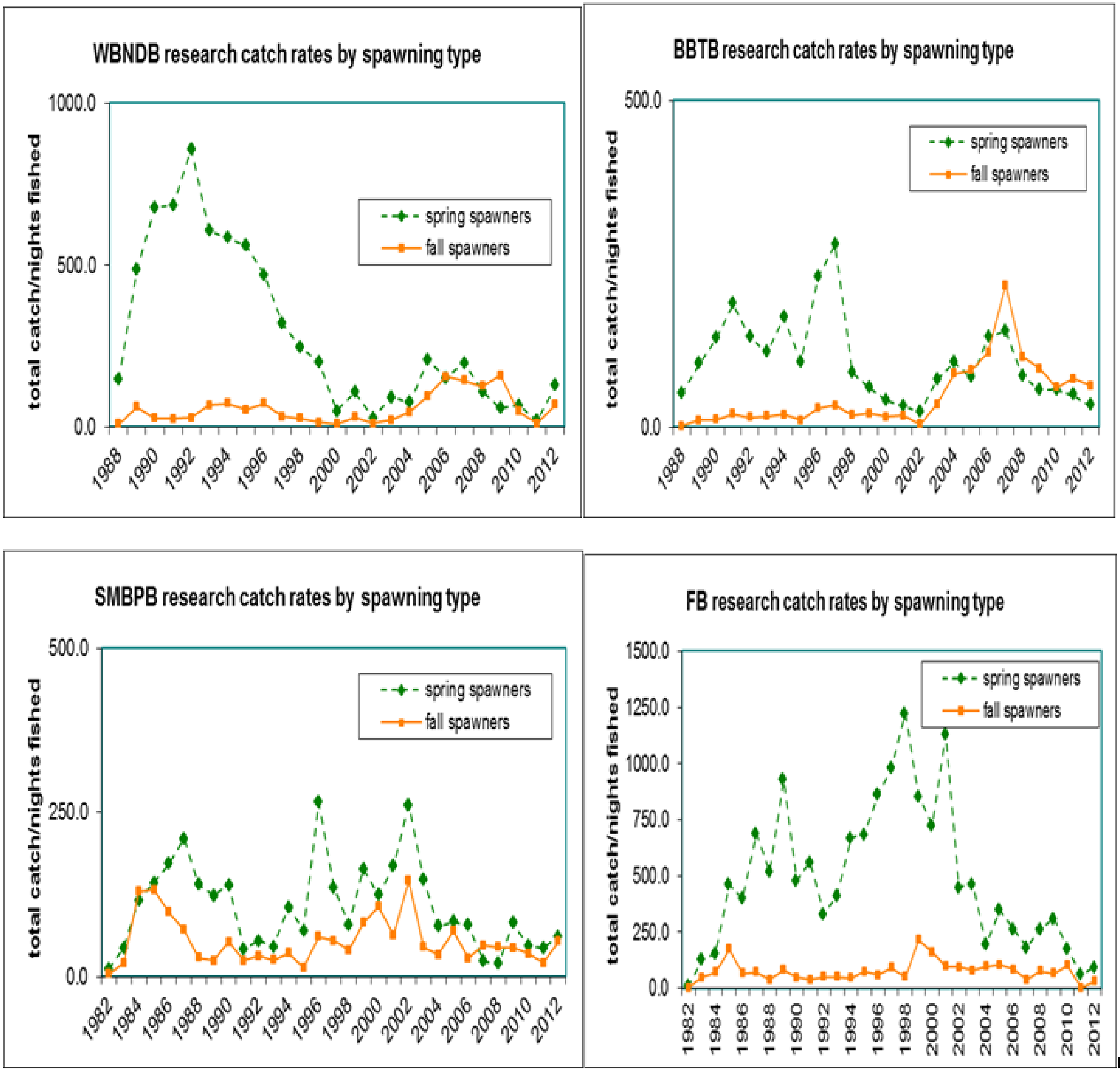

Figure 18: Research gillnet program catch rates (numbers per nights fished) by stock area, year and spawning type.

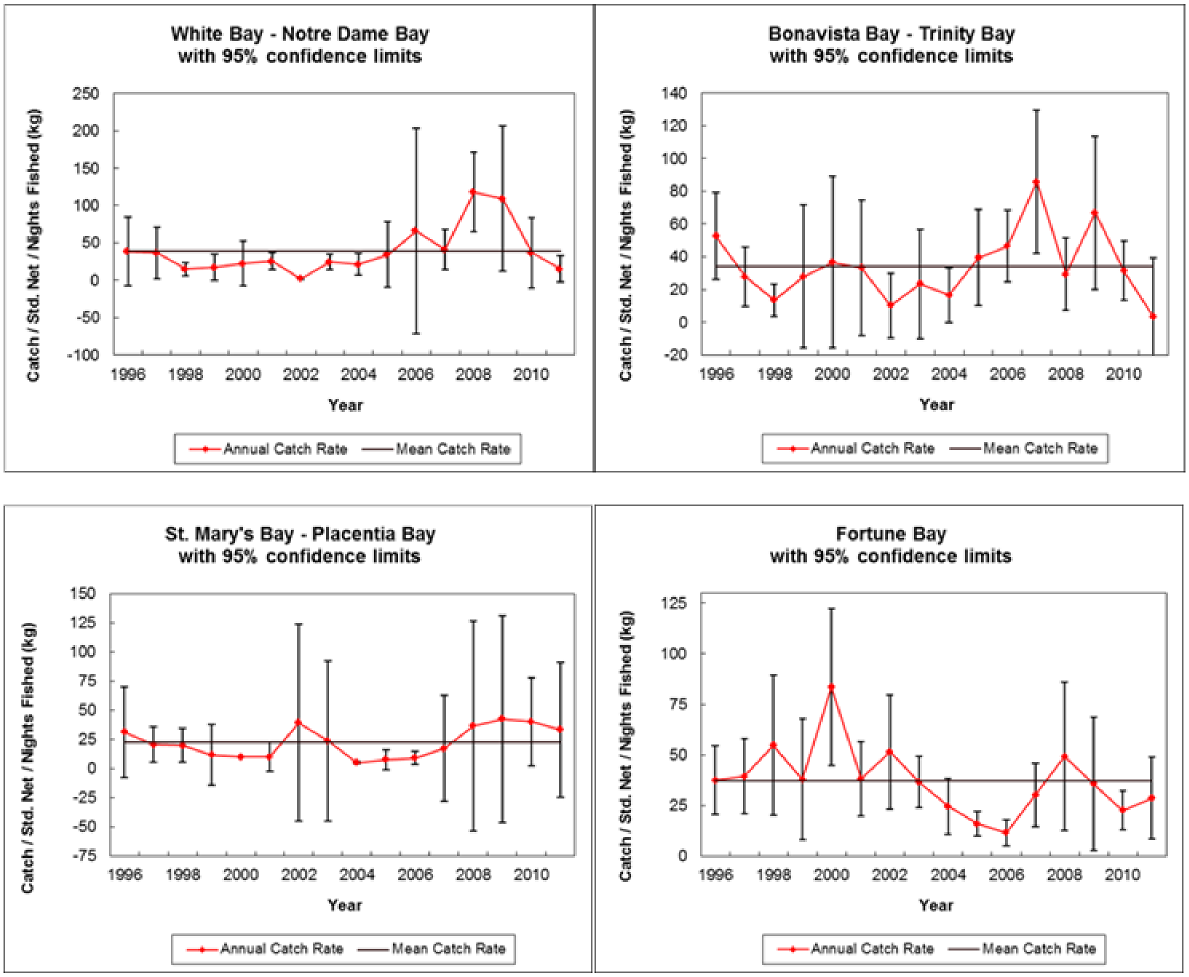

Figure 19: Catch rates from voluntary herring fixed gear logbooks 1996-2011.

Figure 20: Cumulative index of abundance change from herring fixed gear logbooks 1997-2012.

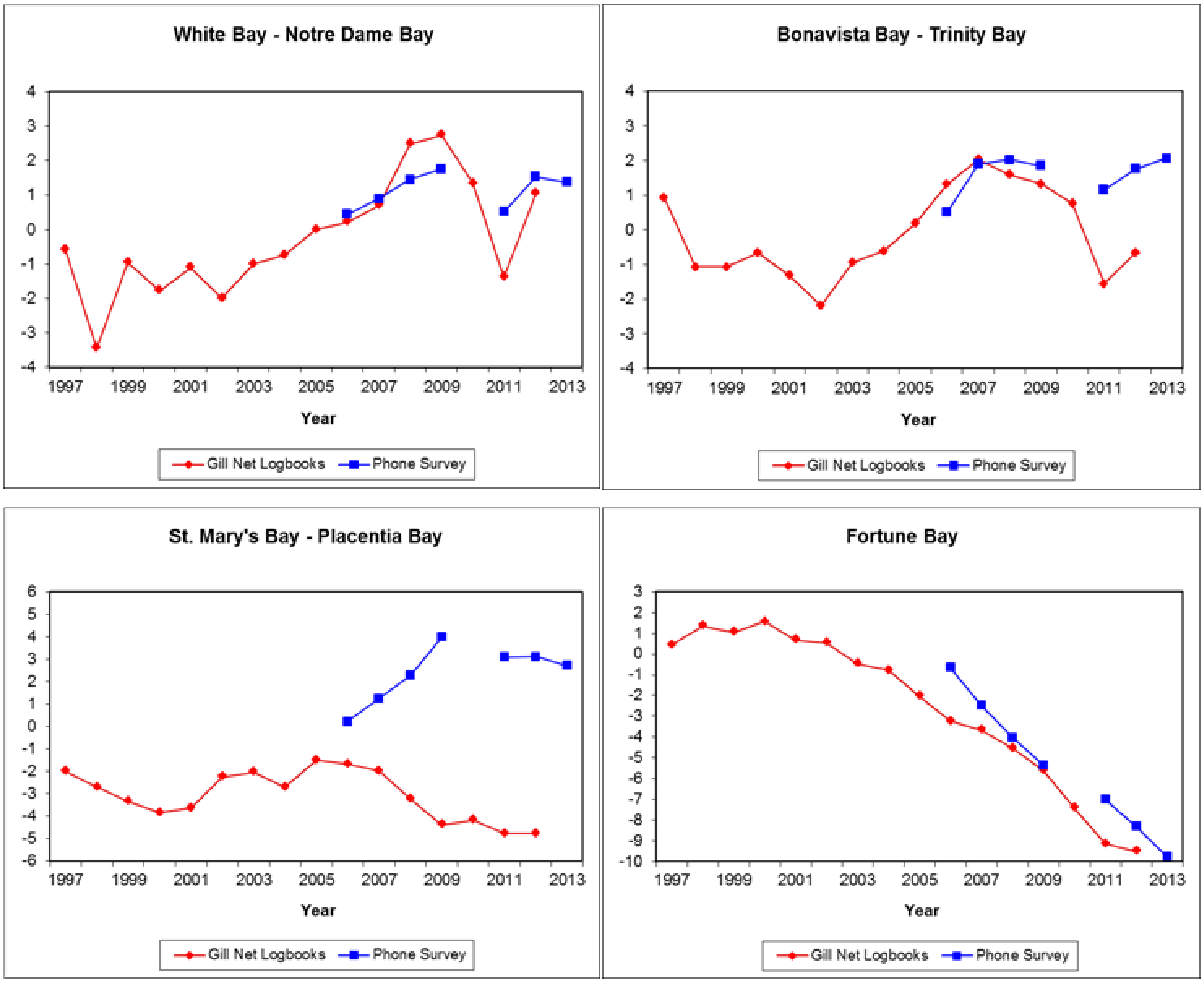

Figure 21: Cumulative abundance change index from herring fixed gear logbooks and telephone surveys 1997-2013.

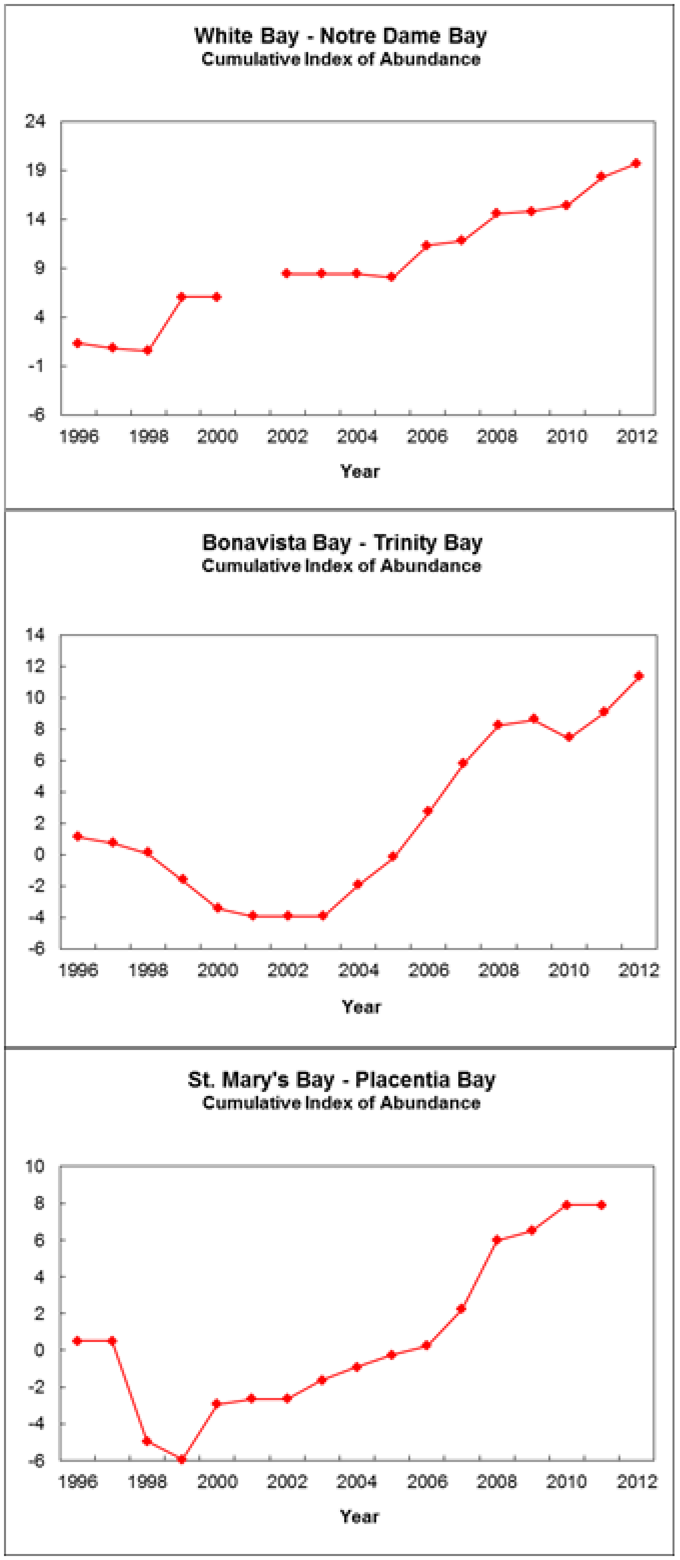

Figure 22: Cumulative abundance change index from herring purse seine telephone survey 1996-2012.

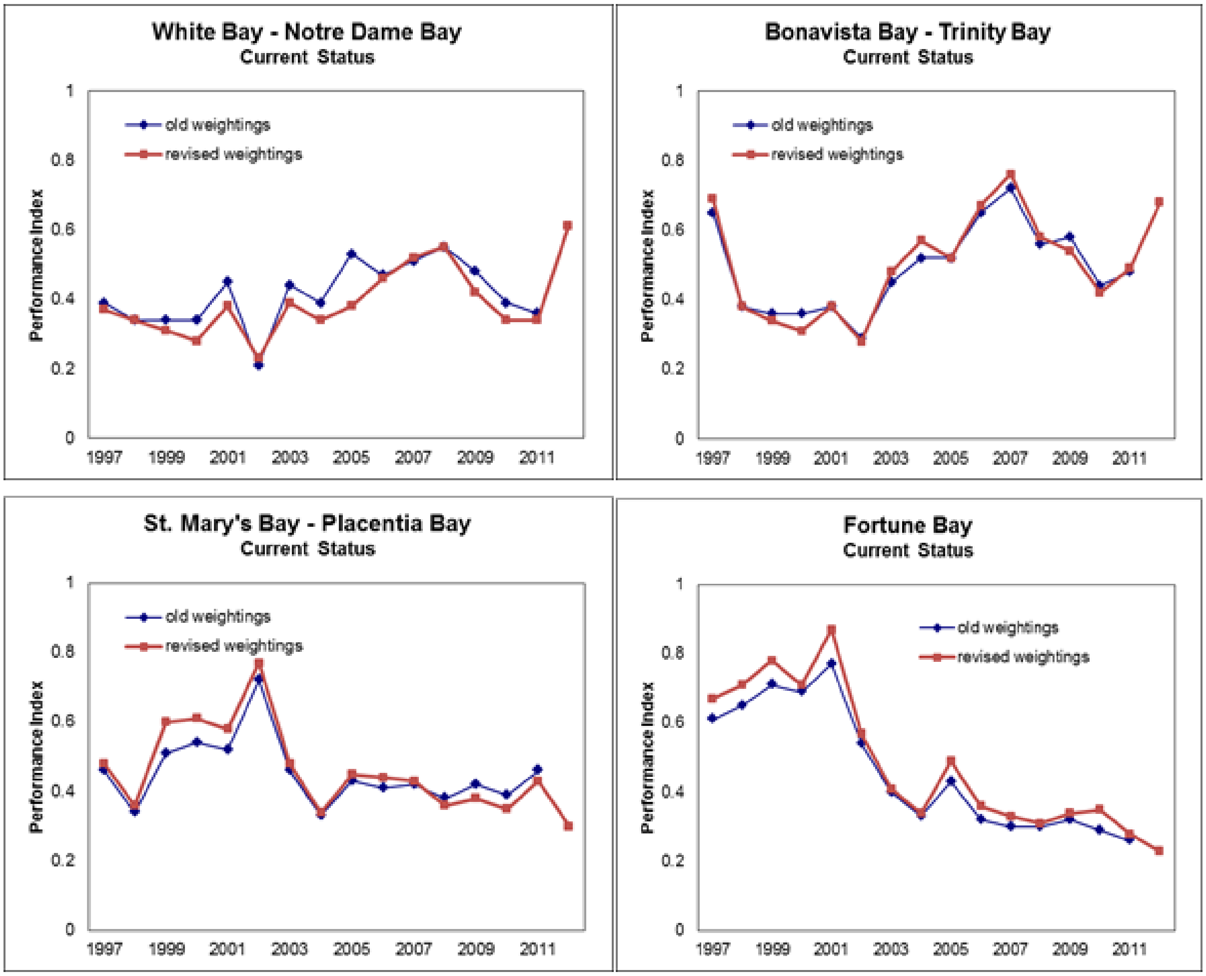

Figure 23: Performance report indices of current stock status derived using previous index weightings and revised weightings (revised in 2013).

INDEX	LOCATION	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SLP (NAO)	ICELAND-AZORES	1.1	0.4	0.3	0.9	0.4	1.3	-1.4	-0.6	-0.3	1.2	1.1	-0.9	-0.3	-0.3	-1.0	0.5	-0.3	0.3	0.5	0.2	-2.9	-1.2
	NUUK (WINTER)	-0.6	-0.2	-0.8	-1.8	-0.4	-0.9	0.7	-0.2	0.0	-0.2	0.0	0.5	-0.2	0.9	0.7	1.2	0.9	1.0	-0.7	0.6	1.8	0.3
	NUUK (ANNUAL)	-0.7	-0.4	-1.4	-1.6	-0.6	-0.2	0.4	0.1	0.2	-0.2	0.4	0.8	0.2	1.3	0.6	1.1	0.7	0.5	0.2	0.5	2.6	-0.3
	IQALUIT (WINTER)	-0.8	-1.4	-0.6	-1.7	-0.5	0.0	0.3	0.2	-0.5	0.0	0.3	0.5	0.0	0.5	0.9	-0.3	0.6	1.2	-0.7	0.1	2.2	2.1
AIR	IQALUIT (ANNUAL)	-1.2	-0.5	-1.7	-1.7	-0.4	0.5	0.5	0.3	0.2	0.1	0.4	0.6	-0.1	0.8	0.1	0.9	1.4	0.2	-0.1	0.5	2.7	0.5
TEMPERATURES	CARTWRIGHT (WINTER)	-1.2	-1.4	-1.5	-1.5	-1.0	-0.8	0.6	0.2	0.8	0.4	0.3	0.0	0.4	0.2	1.7	0.0	0.7	0.9	-0.8	0.2	2.8	2.1
	CARTWRIGHT (ANNUAL)	-1.3	-1.6	-1.4	-1.3	-0.6	-0.3	0.5	-0.3	0.6	1.1	0.5	0.6	-0.3	0.4	1.1	0.9	1.8	0.1	0.1	0.4	2.5	0.7
	BONAVISTA (WINTER)	-1.7	-0.8	-1.1	-1.7	-1.7	-0.4	1.0	-0.8	0.6	1.9	1.2	0.3	0.1	-1.1	0.8	0.3	1.5	0.2	-0.1	0.4	1.5	1.2
	BONAVISTA (ANNUAL)	-0.6	-1.8	-1.8	-1.8	-0.7	-0.7	0.6	-0.9	0.6	1.5	0.8	0.6	-0.1	0.5	1.0	1.2	1.7	0.0	0.7	0.5	1.6	0.8
	ST. JOHN'S (WINTER)	-2.1	-1.1	-1.7	-1.5	-1.2	-0.8	0.4	0.2	0.2	1.2	1.4	-0.6	0.2	-0.6	0.9	0.7	1.6	0.2	-0.1	1.1	1.2	2.4
	ST. JOHN'S (ANNUAL)	-0.5	-1.4	-1.7	-1.5	-0.5	-0.7	0.3	-1.1	0.6	1.9	1.0	0.3	-0.4	0.4	0.6	0.7	1.6	-0.1	0.8	0.9	1.7	0.6
SEA ICE	NL SEA-ICE EXTENT (Annual)	1.2	1.6	1.3	1.6	1.1	0.1	-0.9	-0.2	-0.5	-0.7	-0.4	-0.9	-0.5	-0.2	-1.4	-0.9	-1.4	-0.6	-0.3	-0.1	-1.6	-1.8
COVERAGE	NL SEA-ICE EXTENT (Winter)	1.1	1.1	1.3	1.7	1.3	0.4	-0.5	0.1	-0.7	-0.5	-0.3	-0.9	-0.6	-0.2	-1.7	-0.7	-1.3	-0.9	-0.1	-0.4	-1.9	-1.9
	NL SEA-ICE EXTENT (Spring)	0.9	1.9	1.2	1.5	1.0	-0.2	-1.2	-0.4	-0.1	-0.9	-0.6	-0.8	-0.5	0.0	-0.9	-1.2	-1.5	-0.1	-0.6	0.5	-1.1	-1.4
ICEBERG COUNT	GRAND BANKS	0.0	1.9	0.2	1.5	1.5	1.0	-0.2	0.4	1.0	-1.1	0.1	-1.0	0.2	0.2	-0.8	-1.2	-1.2	-0.7	0.3	0.7	-1.2	-1.2

Figure 24: Standardized anomalies from atmospheric and ice data in the Northwest Atlantic from 1990-2011; anomalies normalized with respect to their standard deviations over the 1981-2010 base period (Colbourne et al. 2011)

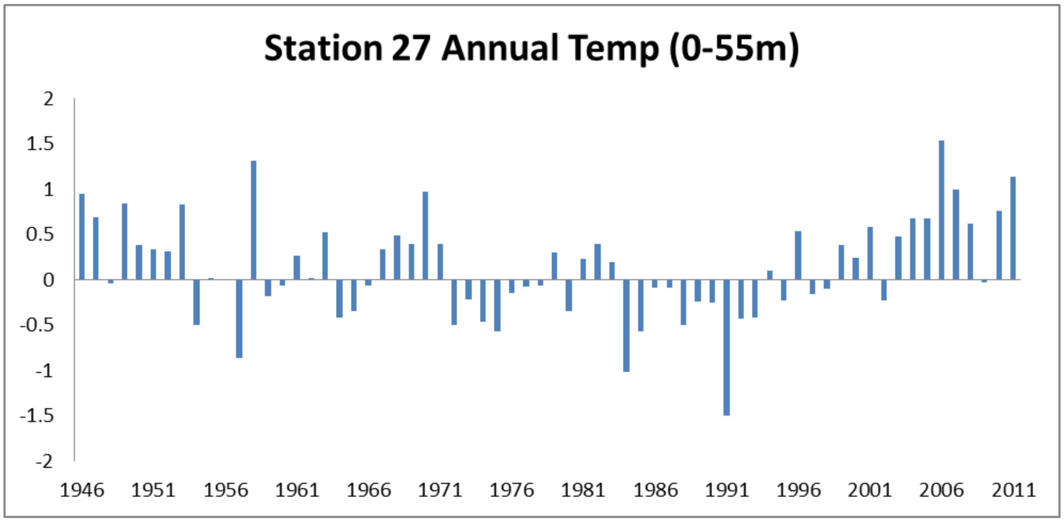

Figure 25: Mean annual ocean surface temperature anomalies at Station 27, 0-55 m.

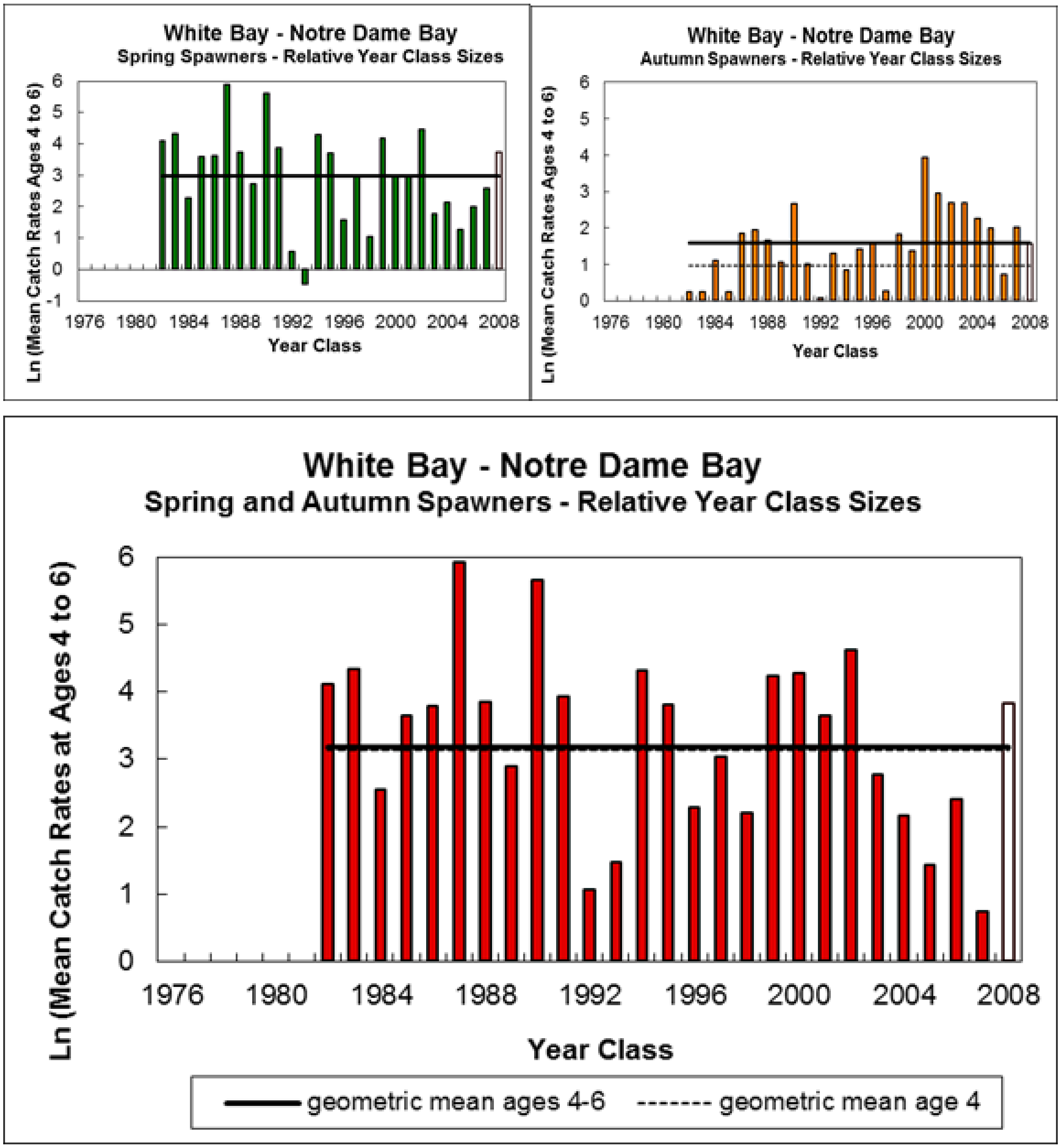

Figure 26: Relative year class sizes from research gillnet catch rates at ages 4-6 and age 4 recruiting 2008 year class (white bar) for spring spawners (top right), autumn spawners (top left) and both spawning components combined (bottom) for WBNDB.

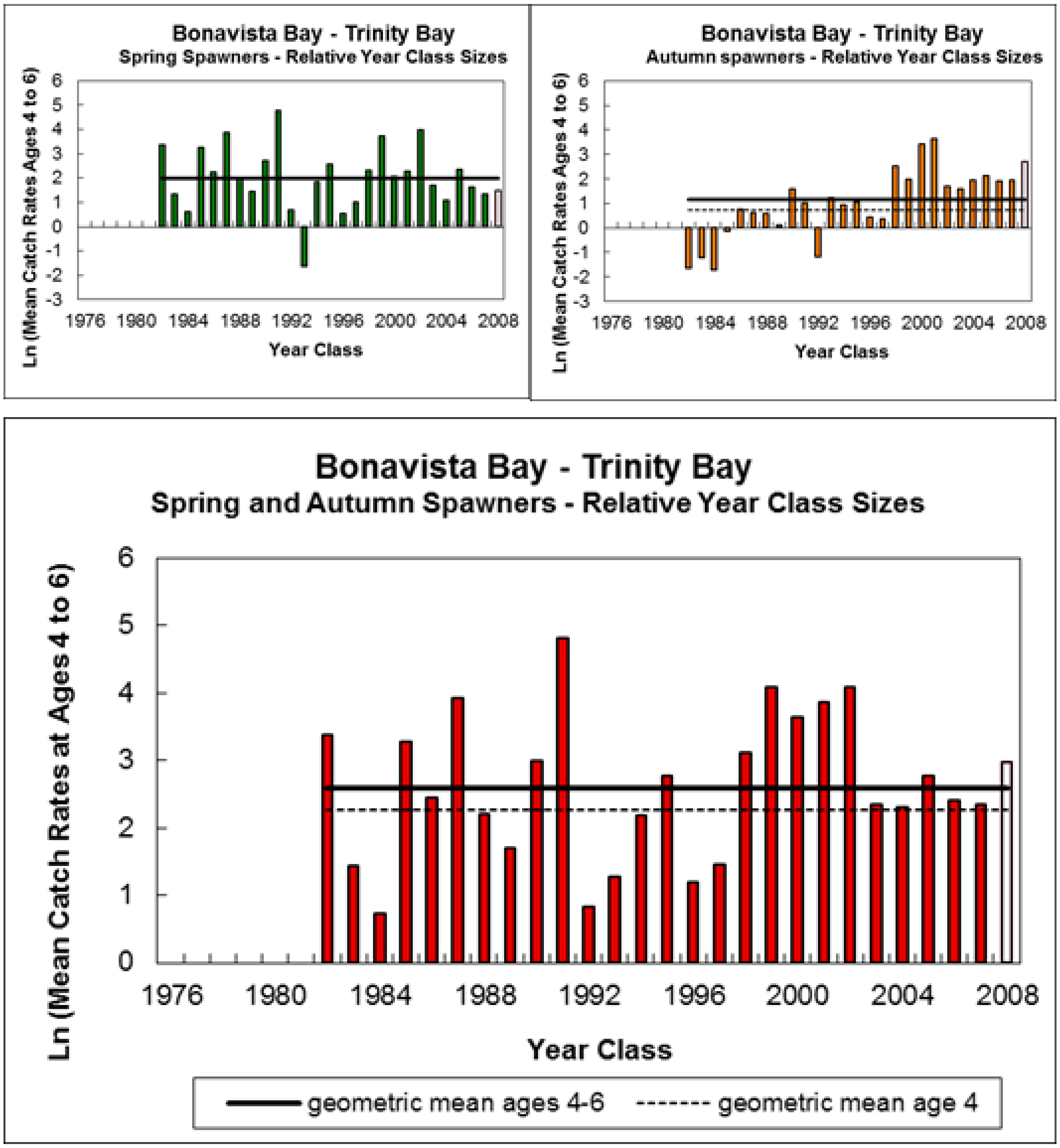

Figure 27: Relative year class sizes from research gillnet catch rates at ages 4-6 and age 4 recruiting 2008 year class (white bar) for spring spawners (top right), autumn spawners (top left) and both spawning components combined (bottom) for BBTB.

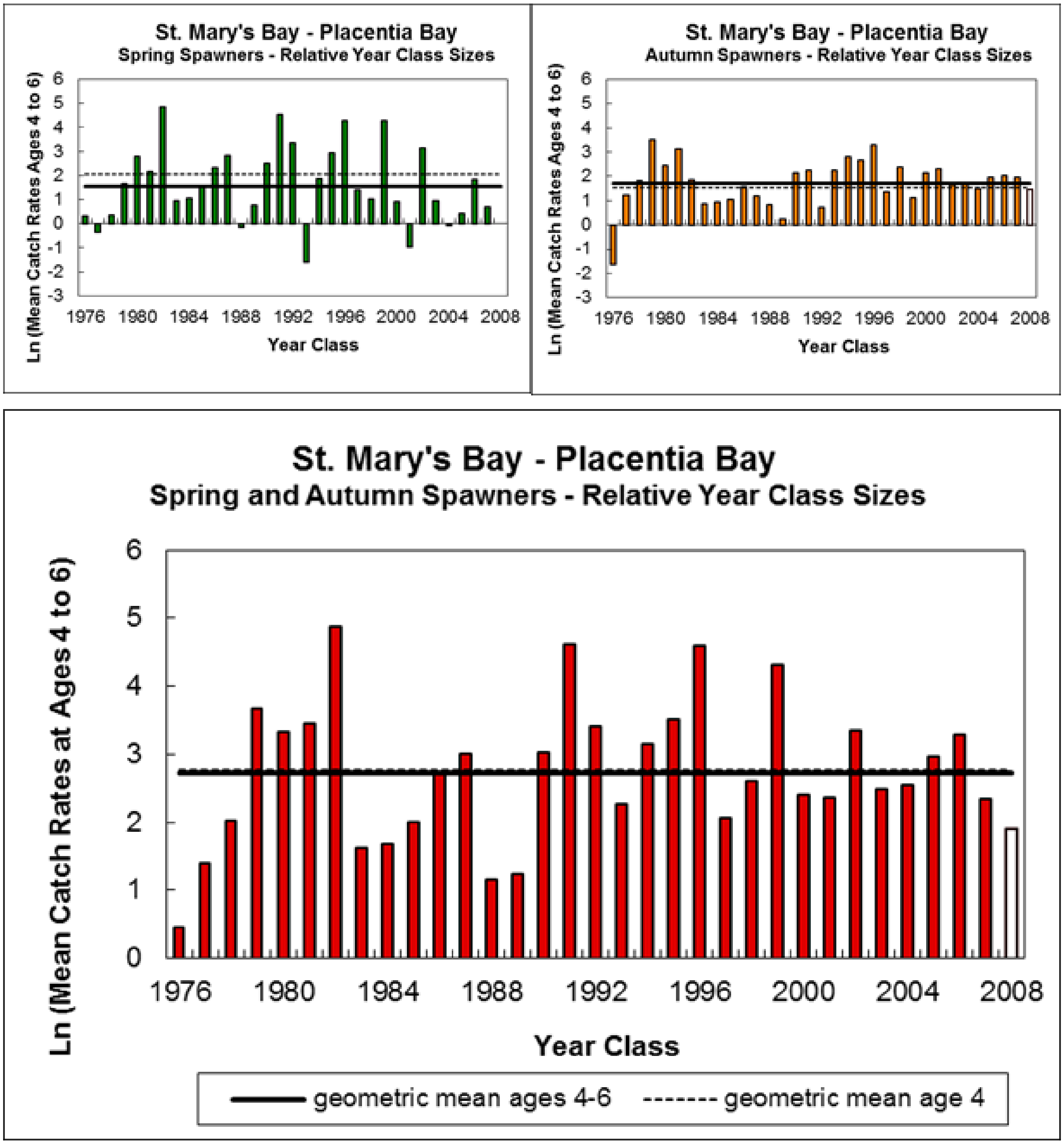

Figure 28: Relative year class sizes from research gillnet catch rates at ages 4-6 and age 4 recruiting 2008 year class (white bar) for spring spawners (top right), autumn spawners (top left) and both spawning components combined (bottom) for SMBPB.

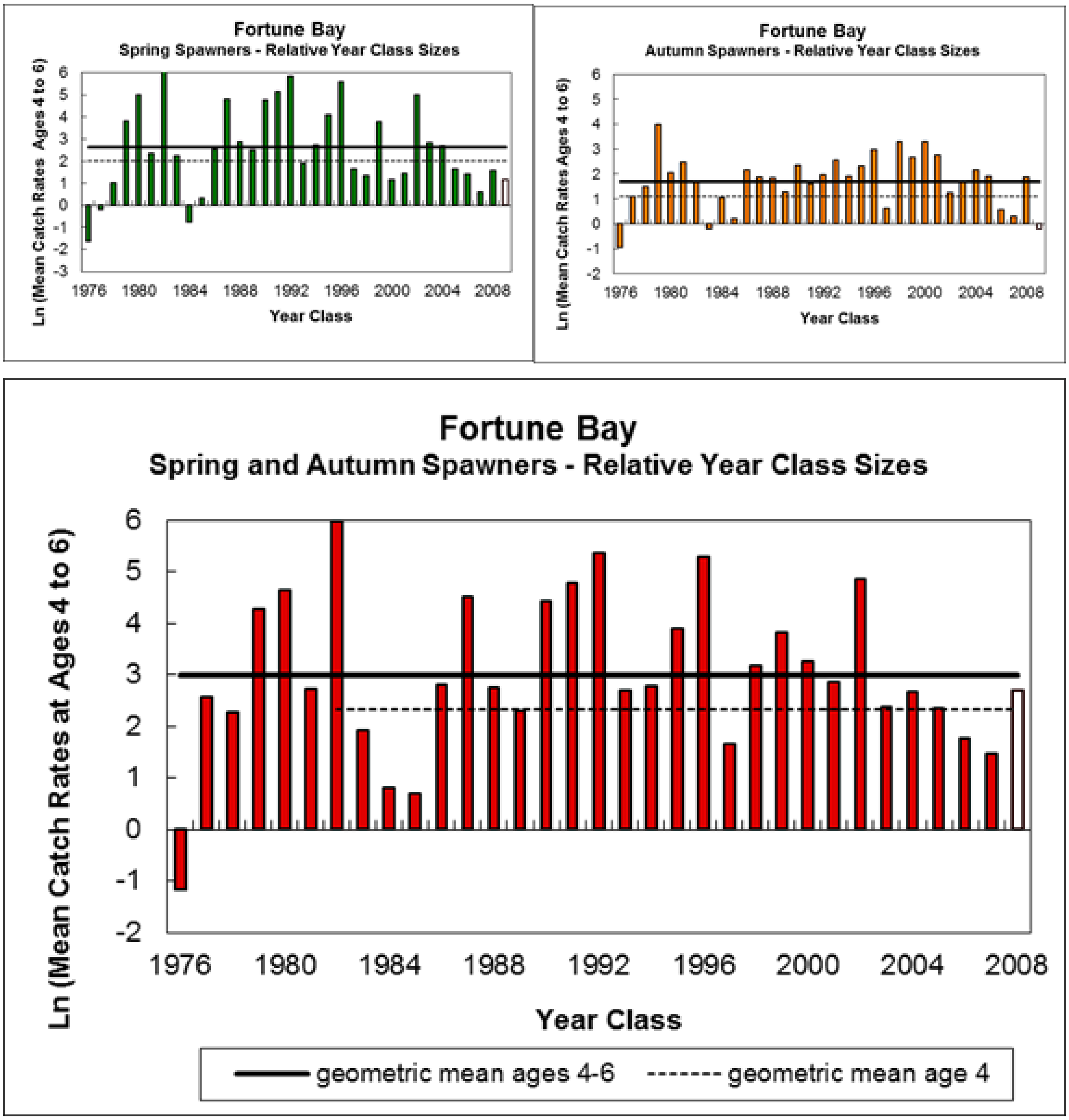

Figure 29: Relative year class sizes from research gillnet catch rates at ages 4-6 and age 4 recruiting 2008 year class (white bar) for spring spawners (top right), autumn spawners (top left) and both spawning components combined (bottom) for FB.

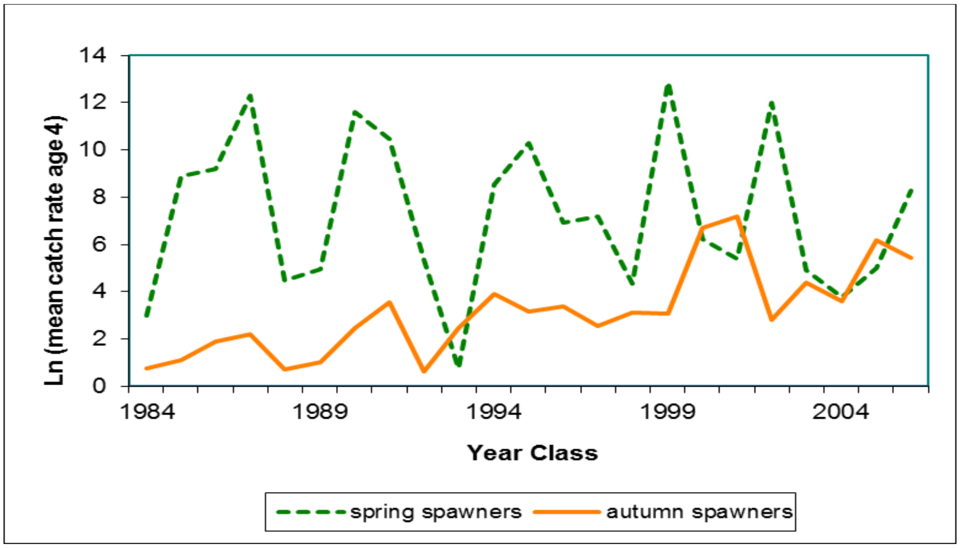

Figure 30: Trends in recruitment of spring and fall spawners on northeast NL coast from 1984 to 2008.

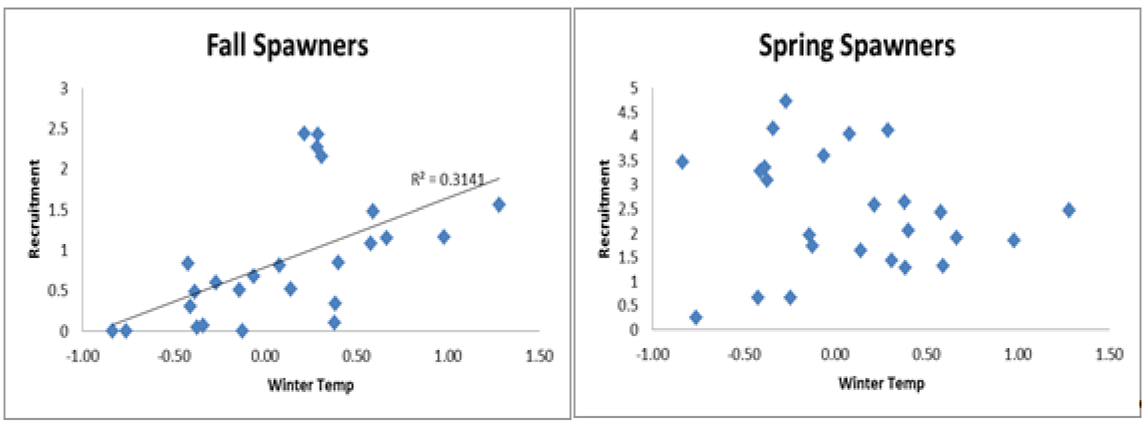

Figure 31: Relationship between annual winter sea temperatures (Station 27, Dec-Feb) and herring recruitment on the northeast coast of Newfoundland by spawning component.

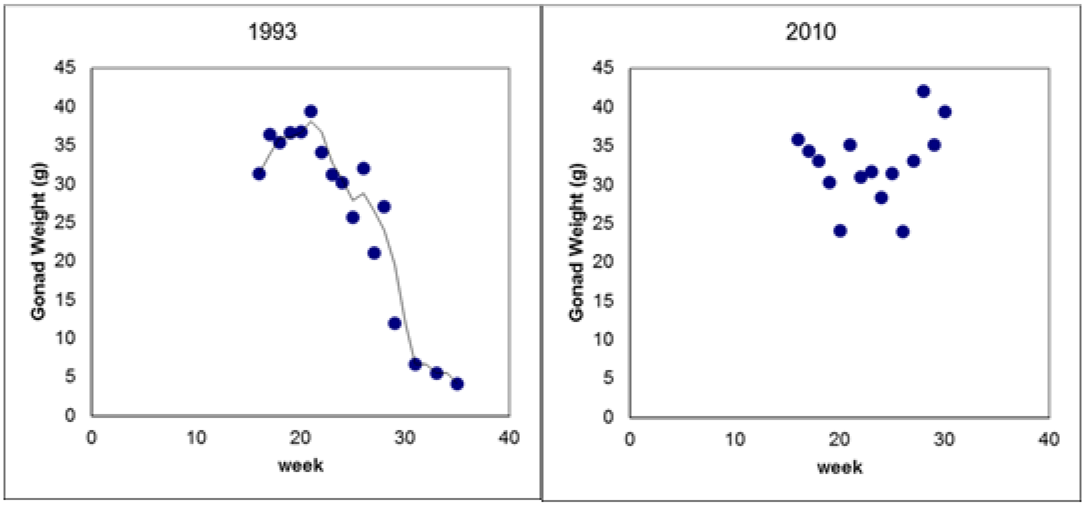

Figure 32: Mean gonad weight at a common length for spring-spawning herring plotted by week for 1993 and 2010.

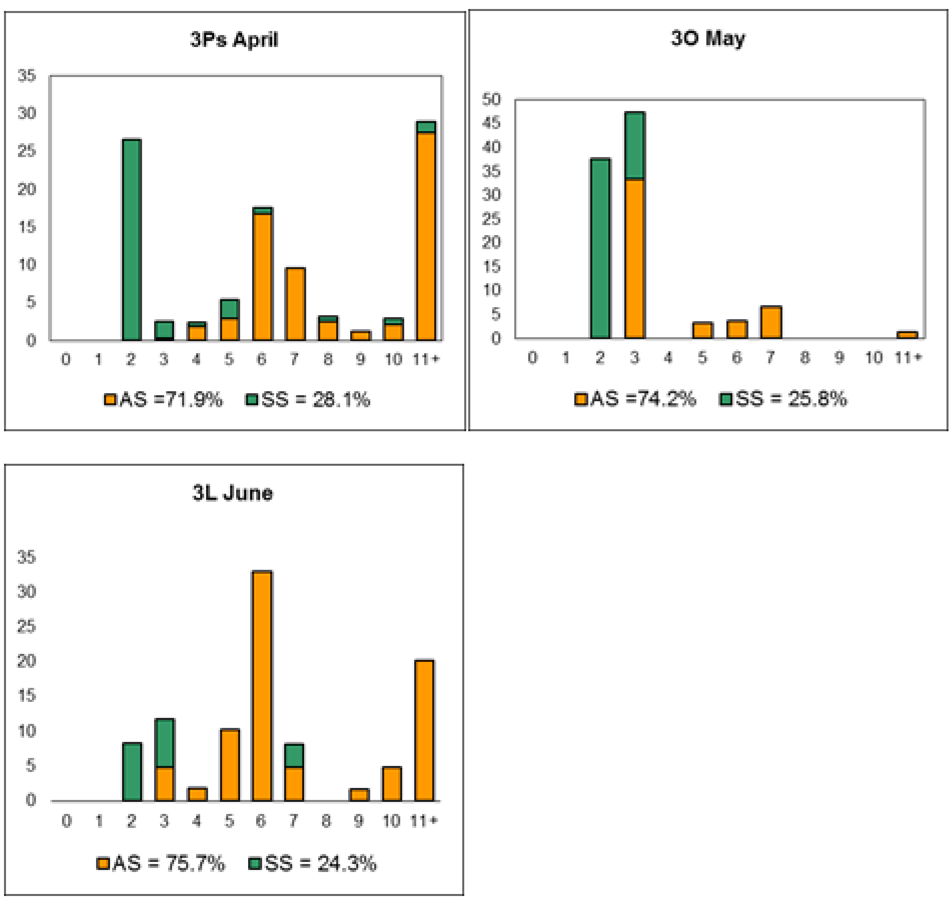

Figure 33: Age distribution (by numbers caught) of offshore herring samples collected during the 2011 DFO Science multispecies survey by spawning type, NAFO division and month.

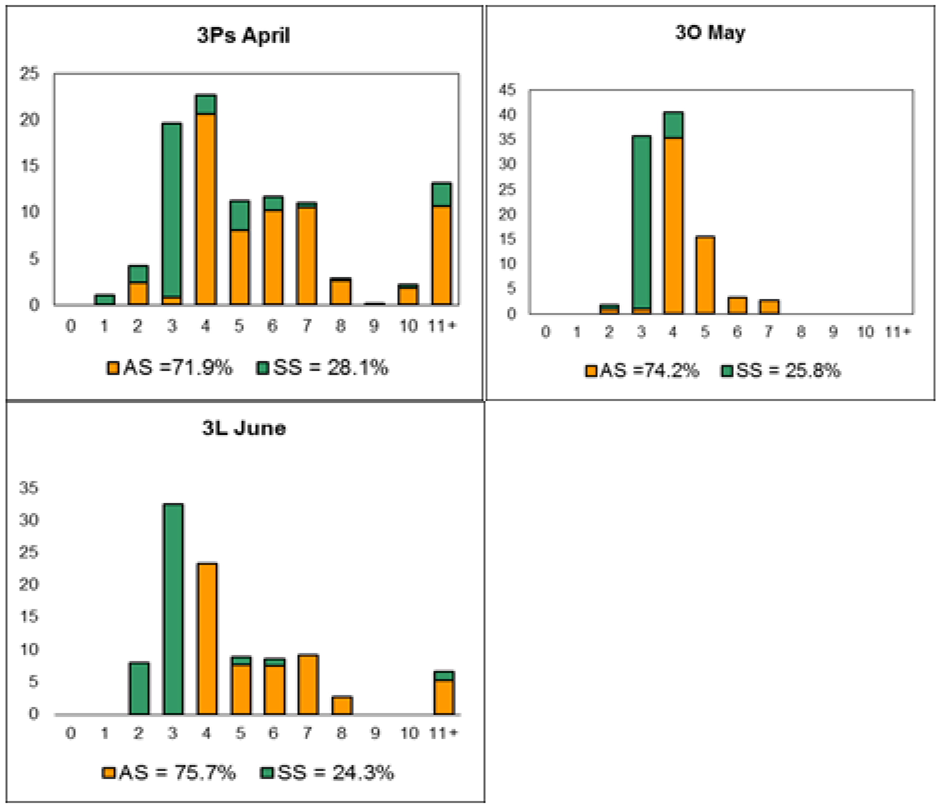

Figure 34: Age distribution (by numbers caught) of offshore herring samples collected during the 2012 DFO Science multispecies survey by spawning type, NAFO division and month caught.

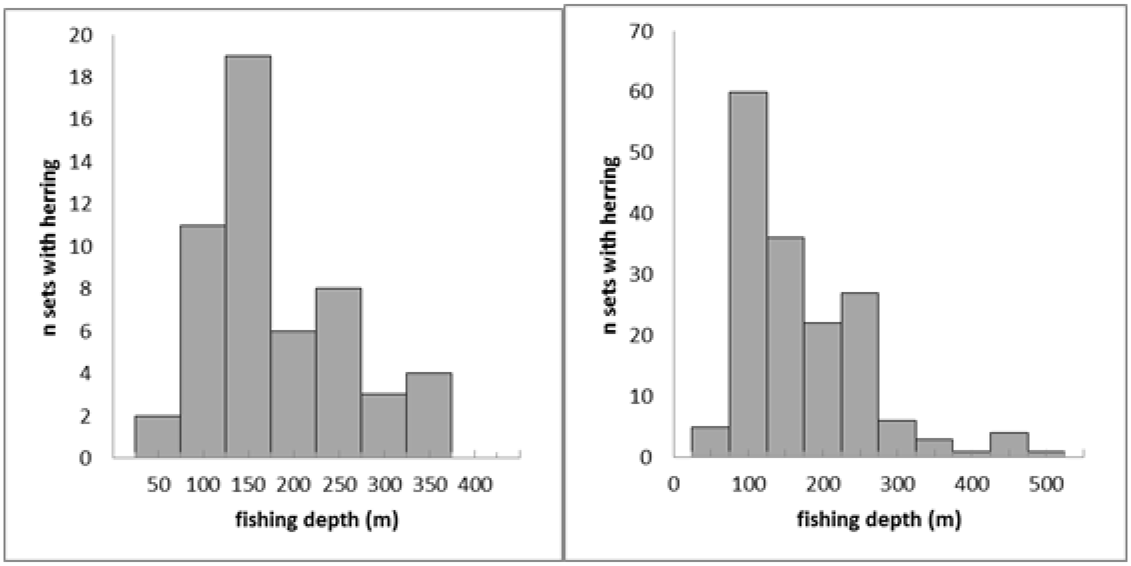

Figure 35: Distribution of depths at which herring were caught during the 2011 (left) and 2012 (right) DFO spring multispecies bottom trawl survey.

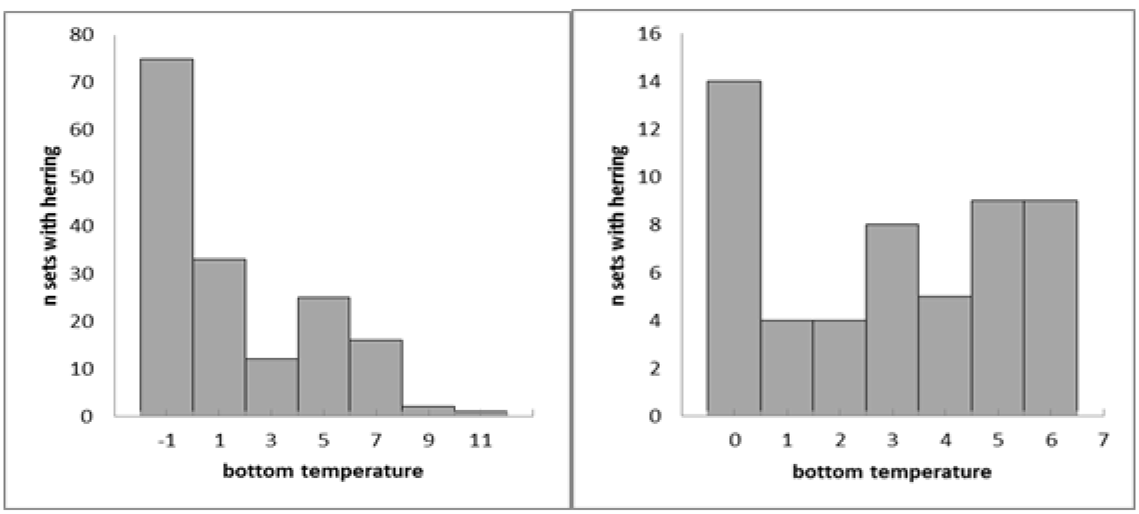

Figure 36: Distribution of bottom temperatures at which herring were caught during the 2011 (left) and 2012 (right) DFO spring multispecies bottom trawl survey.

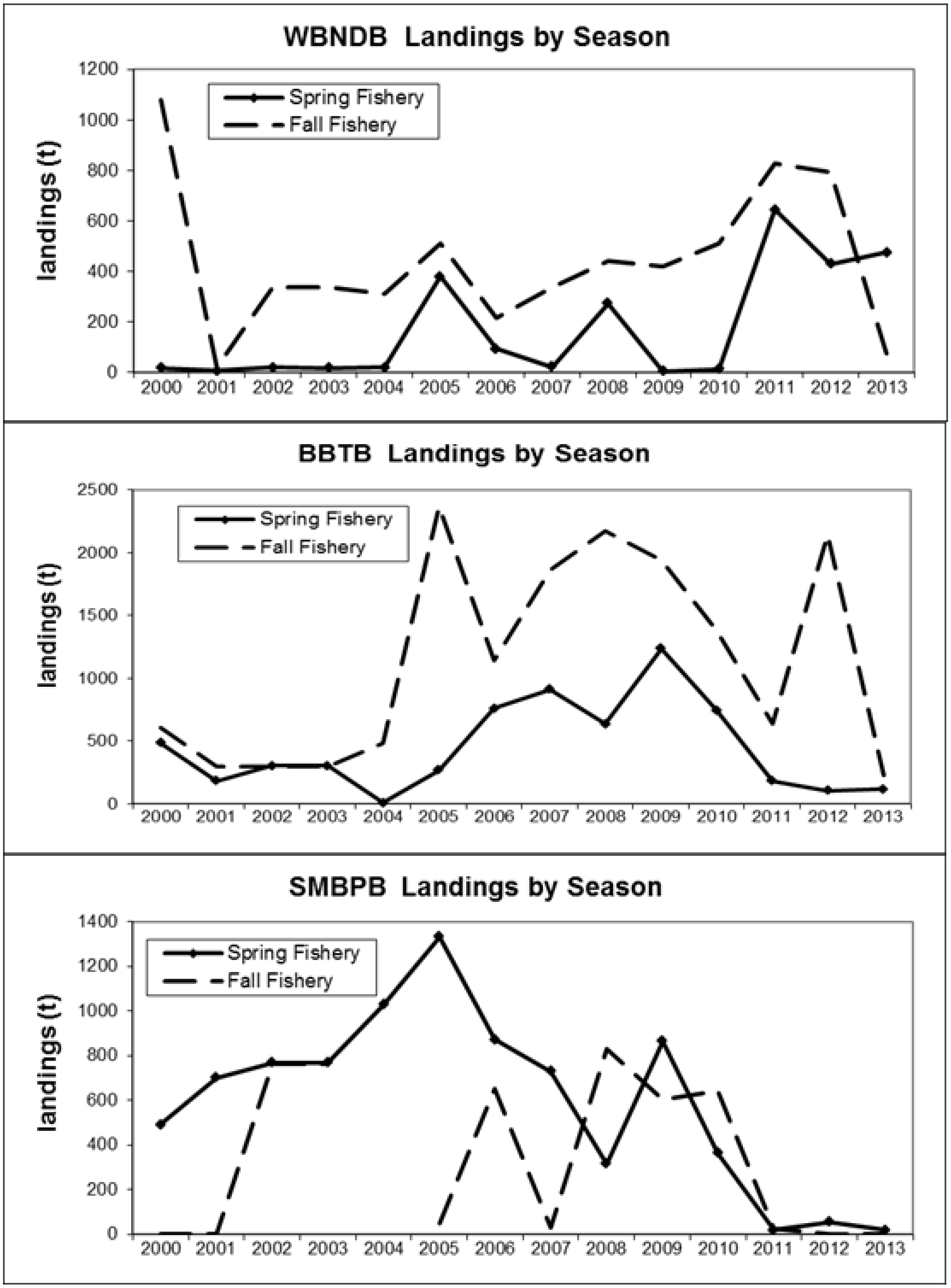

Figure 37: Commercial herring landings by stock area and fishing season (both spawning components combined).

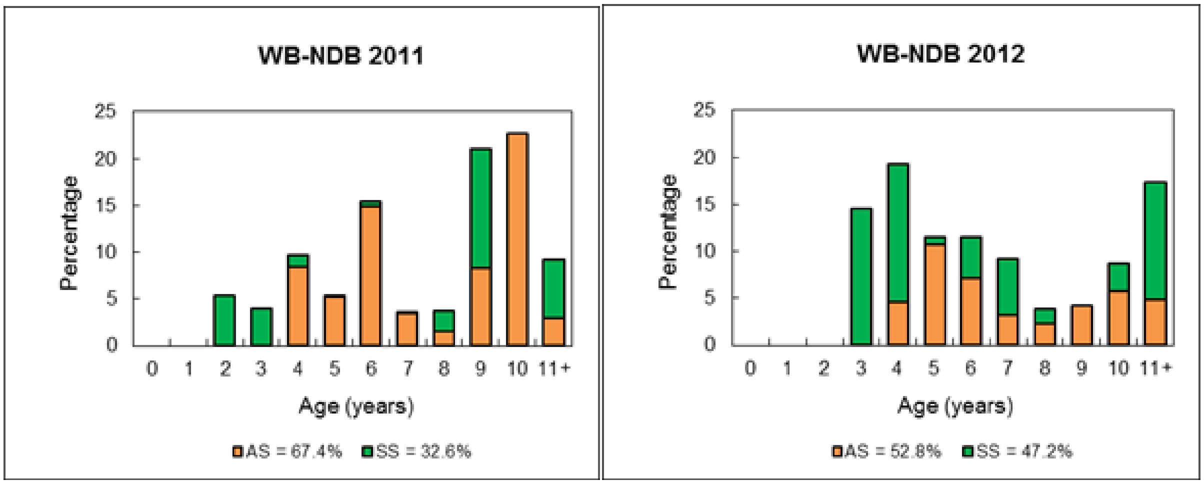

Figure 38: Age distribution of herring in the commercial fishery by spawning type (AS = autumn spawners, SS = spring spawners) in WBNDB in 2011 and 2012.

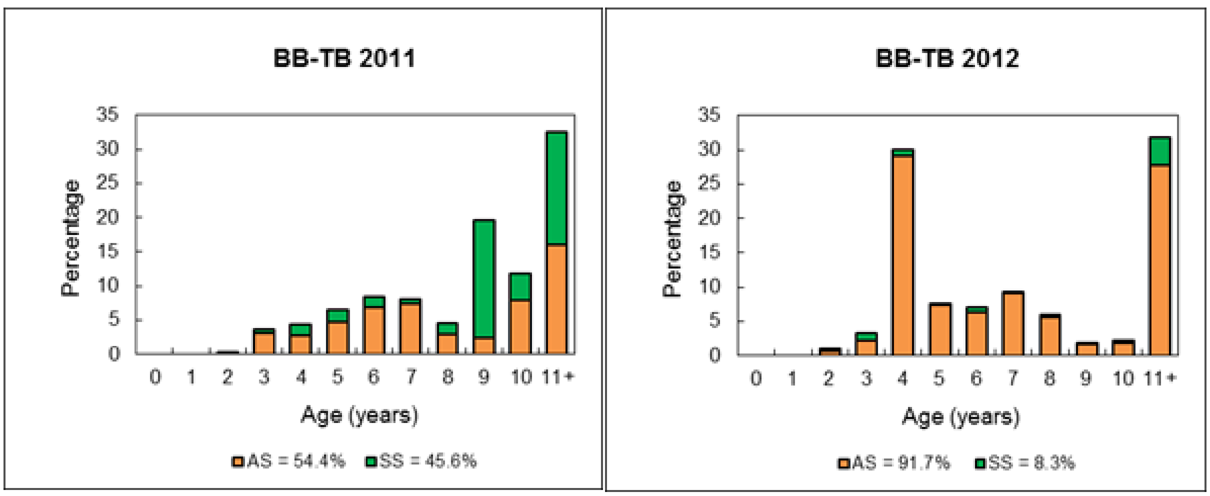

Figure 39: Age distribution of herring in the commercial fishery by spawning type (AS = autumn spawners, SS = spring spawners) in BBTB in 2011 and 2012.

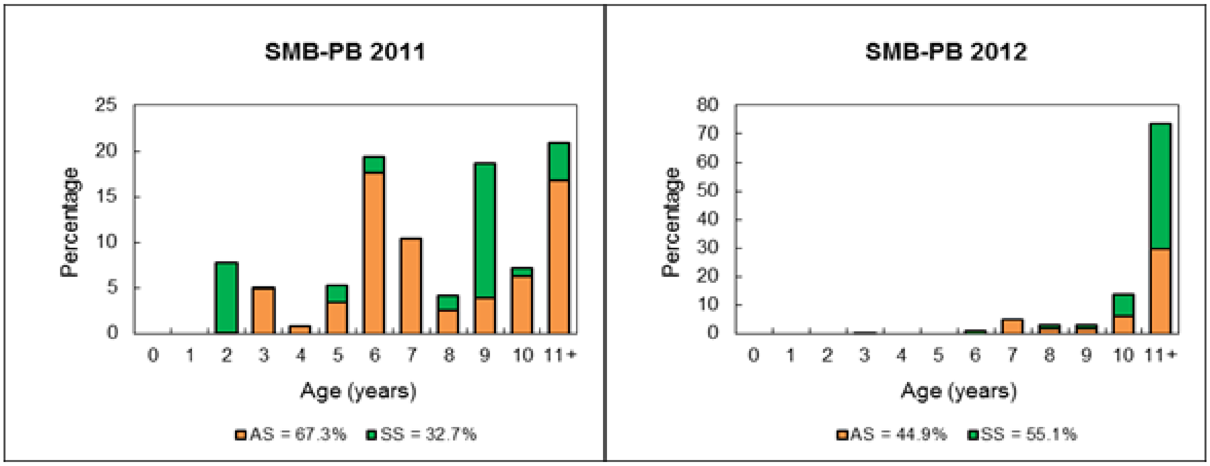

Figure 40: Age distribution of herring in the commercial fishery by spawning type (AS = autumn spawners, SS = spring spawners) in SMBPB in 2011 and 2012 (note that sample sizes have been small in this area due to a small fishery in recent years).

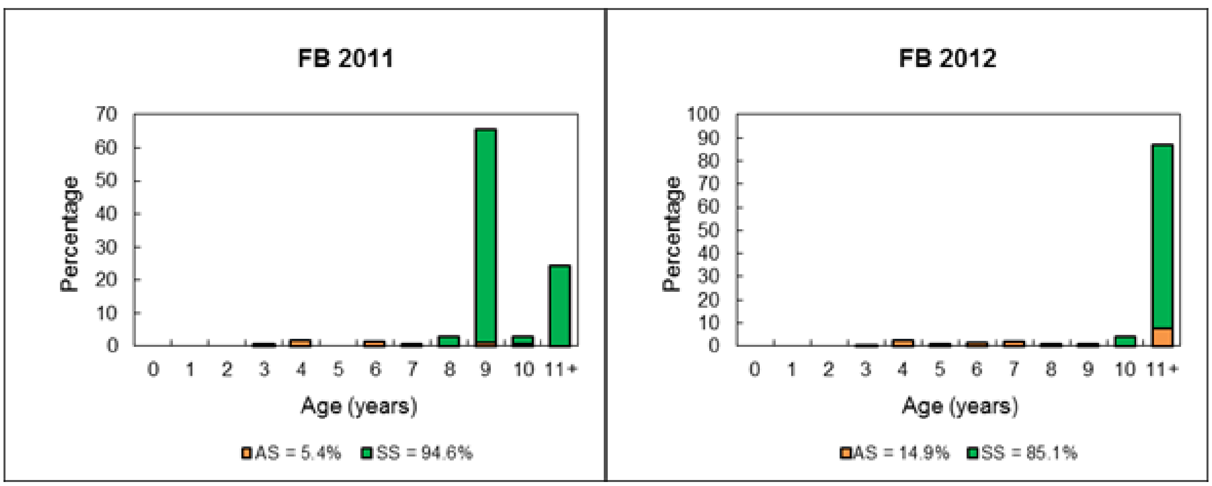

Figure 41: Age distribution of herring in the commercial fishery by spawning type (AS =autumn spawners, SS spring spawners) in FB in 2011 and 2012.

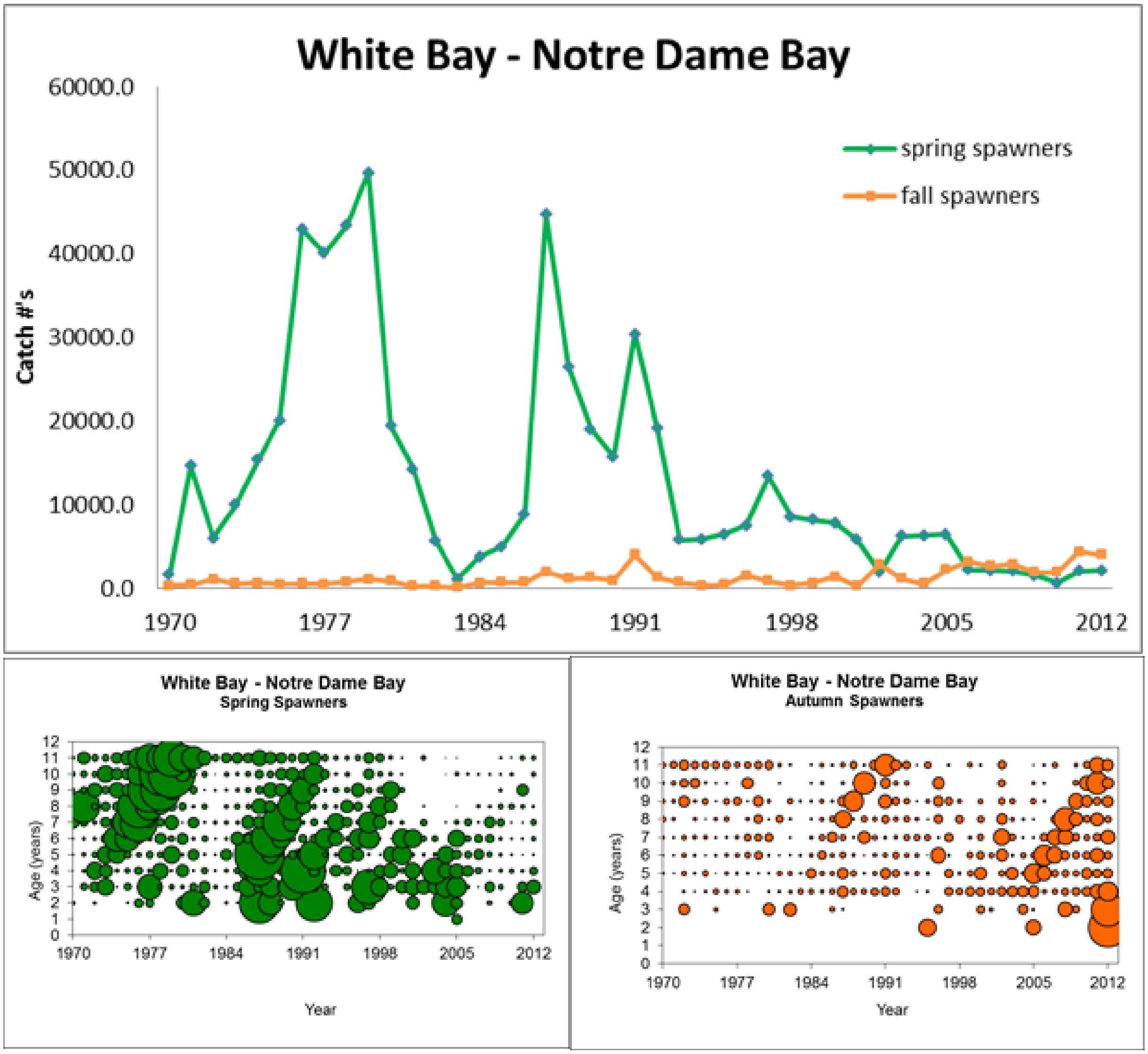

Figure 42: Commercial catch numbers and numbers at age normalized by age of spring and fall spawners in WBNDB. Catch numbers include estimates of bait landings.

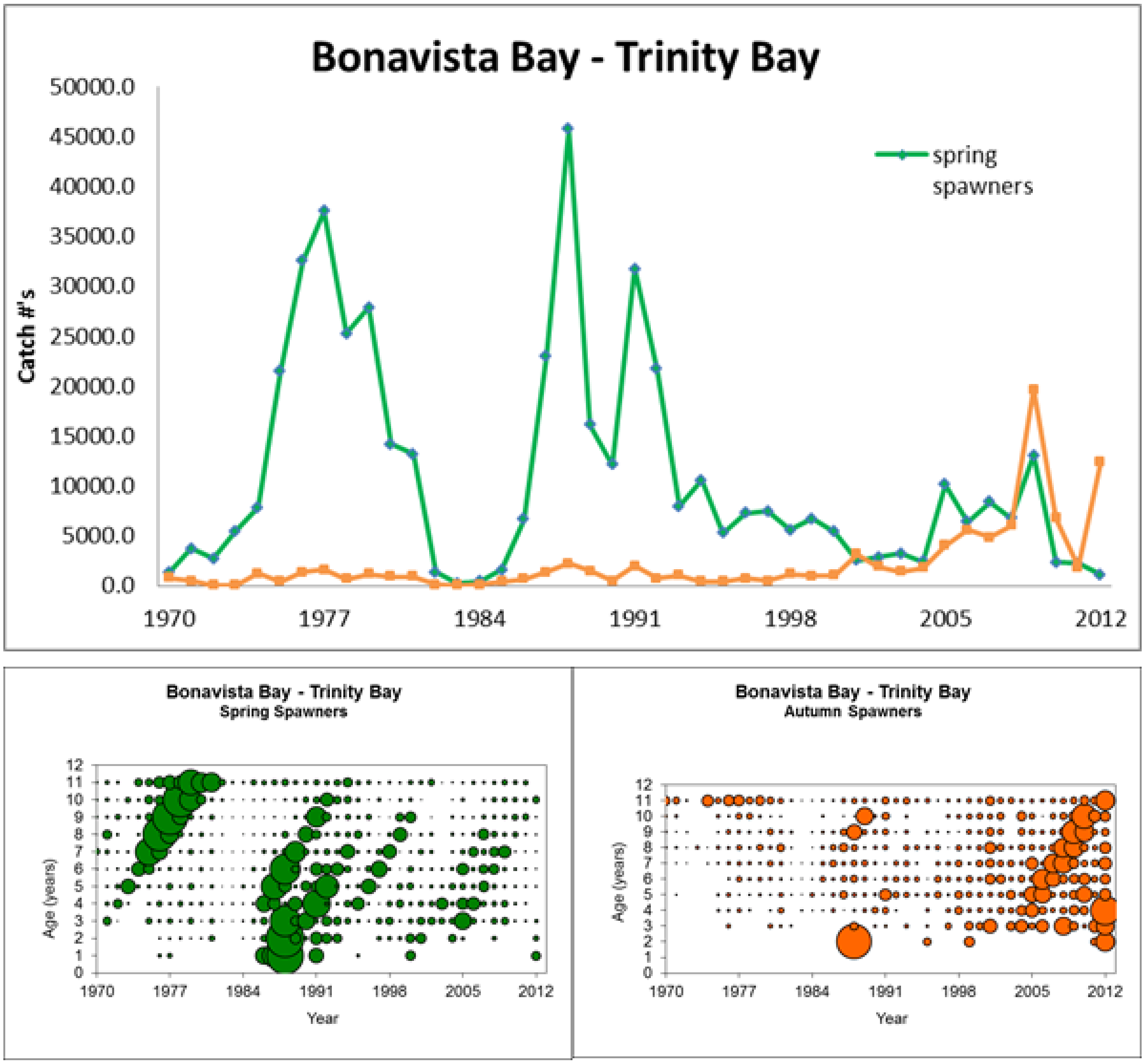

Figure 43: Commercial catch numbers and numbers at age normalized by age of spring and fall spawners in BBTB. Catch numbers include estimates of bait landings.

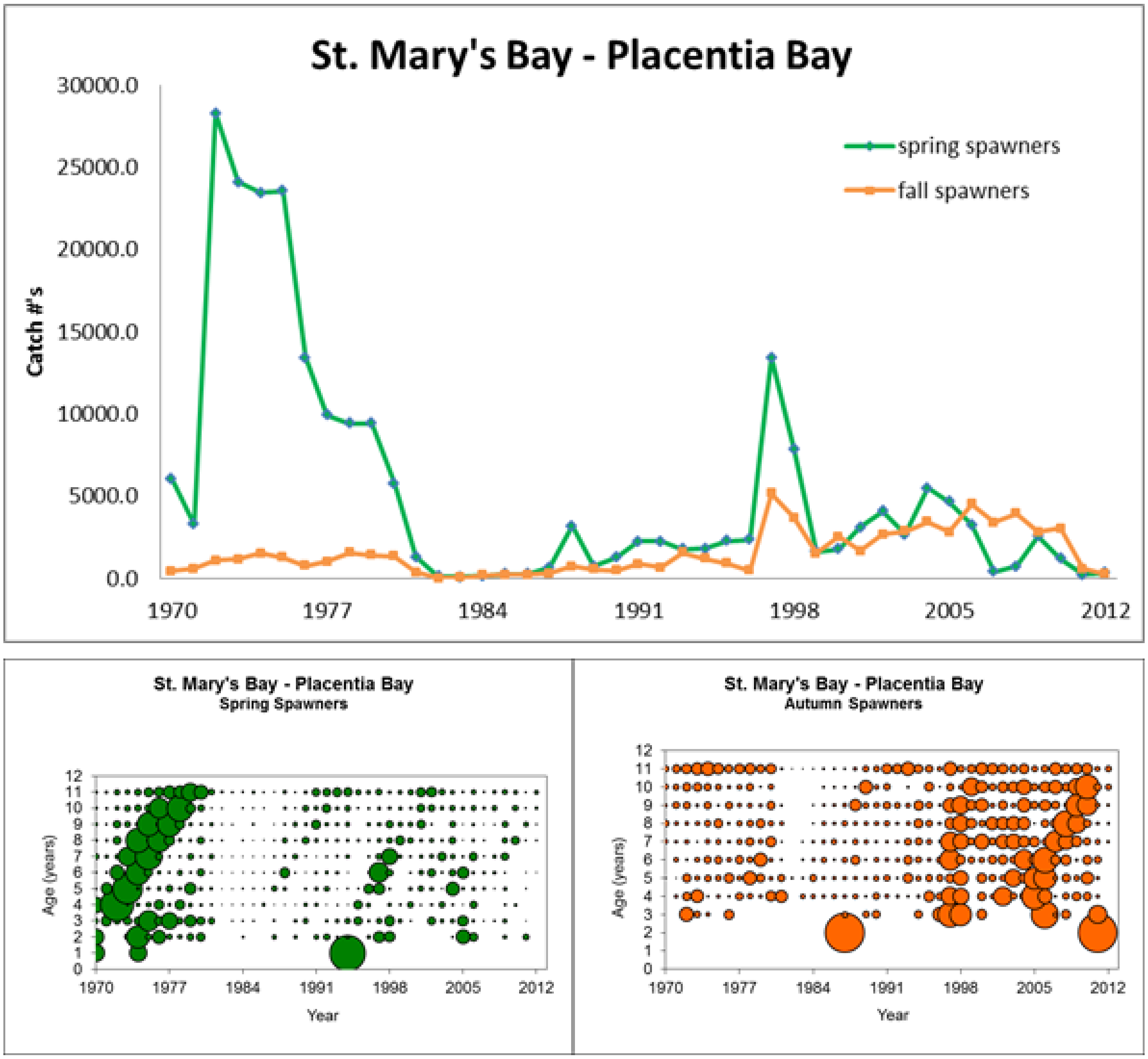

Figure 44: Commercial catch numbers and numbers at age normalized by age of spring and fall spawners in SMBPB. Catch numbers include estimates of bait landings.

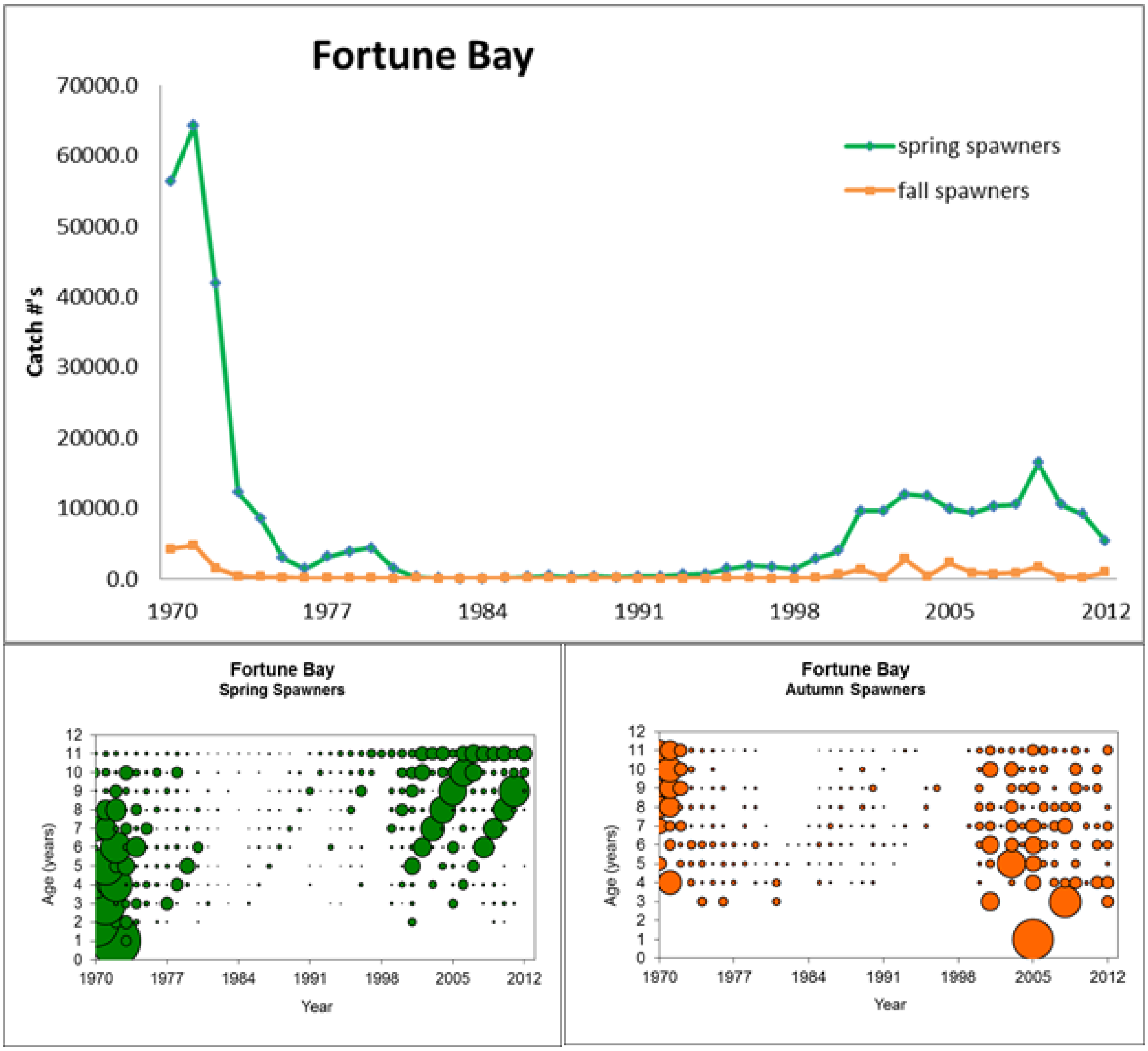

Figure 45: Commercial catch numbers and numbers at age normalized by age of spring and fall spawners in FB. Catch numbers include estimates of bait landings.