



## ASSESSMENT OF NEWFOUNDLAND EAST AND SOUTH COAST HERRING TO THE SPRING OF 2016



*Atlantic Herring (Clupea harengus)*

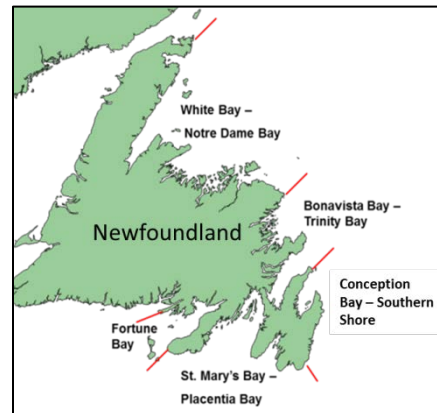


Figure 1: Map of Newfoundland east and south coast Atlantic Herring stock complexes.

### Context:

*Atlantic Herring (Clupea harengus)* occurring on the east and south coasts of Newfoundland are managed by five stock complexes: White Bay-Notre Dame Bay (WBNDNB); Bonavista Bay-Trinity Bay (BBTB); Conception Bay-Southern Shore (CBSS); St. Mary's Bay-Placentia Bay (SMBPB); and Fortune Bay (FB). Herring also occur on the south coast of Labrador and along the southwest coast of Newfoundland, however, the stock affiliation of these herring is currently unknown. All stock complexes are composed of both spring and fall spawners. Prior to the 2000s, spring spawners comprised greater than 90% of all stocks, however stock composition has changed over the past two decades and fall spawners are now dominant in all areas except Fortune Bay. This shift is thought to be correlated with changing environmental conditions. Herring are caught in a commercial fishery during both the spring and fall, primarily through purse and tuck seines; there is also a spring gillnet bait fishery. The 2016 combined Total Allowable Catch (TAC) for all stock areas was 14,291 t and an average of 6,200 t was landed over the past five years. Estimated bait removals over the same period were 702 t.

A Regional Peer Review meeting for the assessment of Atlantic herring stock complexes on the east and south coasts of Newfoundland (Northwest Atlantic Fisheries Organization [NAFO] Divisions 3KL and Subdivision 3Ps) was held January 31-February 1, 2017 in St. John's, Newfoundland and Labrador (NL). Participants included Fisheries and Oceans Canada (DFO) scientists and technicians, fisheries managers, the Fish, Food and Allied Workers Union, the provincial government, and harvesters. The Terms of Reference included updates on the 2015 and 2016 commercial fishery, the 2014 and 2015 herring research gillnet program, the cumulative change index, telephone surveys and logbooks, a 2016 acoustic survey in Placentia Bay, environmental, biological and ecological data, and stock status updates. The last assessment of these stocks took place in 2015. Stock status since 2002 has been updated using performance reports, based on the spring research gillnet program; this method was used to update the stock status for BBTB and FB, the only stock areas where the program has continued. The results of an opportunistic acoustic survey were used to provide a stock status for SMBPB. Biological updates only were provided for WBNDNB and CBSS.

## SUMMARY

### Overview

- The spring research gillnet program was used to update the stock status index in Bonavista Bay-Trinity Bay and Fortune Bay. The group was only able to provide advice for St. Mary's Bay-Placentia Bay because of an opportunistic acoustic survey in 2016.
- Given the absence of a quantitative indicator to evaluate stock trajectory, the group was unable to provide advice on stock status for White Bay-Notre Dame Bay or Conception Bay-Southern Shore.

### Biological and Ecological Information

- Since 2010, large-scale ocean colour imagery over the northwest Atlantic, from the southern Grand Bank to northern Labrador, indicates later onset in peak timing and reduced duration of the spring phytoplankton bloom compared to normal conditions.
- Following a period of above average values, a composite index of climate conditions throughout the region fell below average in 2014-15, returning to above average in 2016.
- Herring spawning stock composition changed in the early 2000s from spring spawner to fall spawner dominance in all stock areas except Fortune Bay. These changes are potentially correlated with environmental indicators.
- In 2015 a broad age distribution with multiple year classes above the long term mean was observed in all stock areas except Fortune Bay.
- The length at 50% maturity (L50) decreased through the late 1980s and 1990s, but showed a general increasing trend since 1996. The average L50 of spring spawners in the commercial fishery from 2010 to 2015 was 246 mm and for fall spawners was 255 mm (fork length).
- The size at age decreased in all stock areas in the 1990s but has remained stable since the 2000s.
- While Harp Seal abundance has been stable at a high level since the mid-late 2000s, total finfish biomass in the Newfoundland and Labrador shelves bioregion increased from the mid-2000s to early 2010s, then leveled off, and over the last couple of years is showing signs of decline, especially in southern areas (3LNO and 3Ps). This coincides with a joint reduced availability of capelin and shrimp in the offshore since 2014. Consequently there is a potential for increased predation pressure on herring, particularly if predators increase their foraging/residence in inshore waters.

### White Bay – Notre Dame Bay

- Without a fishery-independent index of abundance (i.e. acoustic survey or research gillnet program), the status of this stock could not be assessed. Biological updates were provided based on samples collected from the commercial fishery.
- Landings increased over the past three years and industry reports that effort has been consistent over that time period. Preliminary data indicate that at least 65% of the TAC was taken in 2016, the highest landings since the mid-1990s.

- The 2008 year class continued to dominate the 2014 catch; in 2015 age 2 spring spawners comprised an unusually large proportion of the catch - however this is based on a small sample size. Fall spawners comprised 68% of the 2015 catch.
- Purse and tuck seine fishers indicated increasing abundance in 2015, gillnet fishers indicated increasing abundance from 2011 to 2014 but a decrease in 2015.

### **Bonavista Bay – Trinity Bay**

- The stock status index derived from the research gillnet program had an increasing trend over the past five years and the 2014 and 2015 values are among the highest in the time series. The evaluation of current stock status is positive.
- Short term prospects for the stock are positive, with mean catch rates of age 4-6 herring of both spawning components increasing over the past several years.
- Landings in 2015 were at the highest level since 1990s, and 73% of TAC was taken. Preliminary data indicates landings were down slightly in 2016.
- Overall there was a broad age distribution in the commercial catch, however the 2008 fall year class continued to dominate in 2014 and 2015. Fall spawners comprised 80% of landings in both years.
- Purse and tuck seine fishers indicated increasing abundance from 2010 to 2015, gillnet fishers indicated increasing abundance from 2011 to 2015.
- Combined catch rates in the spring research gillnet program generally increased from 2010 to 2015, reaching the second highest level in the time series. Catch rates declined dramatically in 2016, and fishers indicated this was due to the late arrival of herring in the spring. There is a broad age structure in the research gillnet program, however the 2008 fall year class dominates the catch.
- Recruitment of age 4 fish in the research gillnet program in 2015 was high for fall spawners and average for spring spawners.

### **Conception Bay – Southern Shore**

- Without a fishery-independent index of abundance (i.e. acoustic survey or research gillnet program), the status of this stock could not be assessed. Biological updates were provided based on samples collected from the commercial fishery.
- After a period of low fishing activity, participation and landings have generally increased in this stock area over the past four years; 20% of the TAC was taken in 2015 and preliminary data indicates landings were higher in 2016. All commercial landings were in Conception Bay.
- The age distribution in the commercial fishery was dominated by the 2008 fall year class with a broad distribution in 2015; fall spawners accounted for 73% of the catch.
- All fleets indicated that abundance in the area increased from 2014 to 2015.

### **St. Mary's Bay – Placentia Bay**

- An opportunistic acoustic survey was conducted in February 2016 in Placentia Bay, providing an estimate of relative abundance; however without acoustic surveys or the research gillnet program, it will not be possible to update the status of this stock going forward.

- The acoustic survey indicated that biomass in Placentia Bay was slightly below the mean of the acoustic surveys conducted between 1986 and 2000. Based on these results the overall evaluation of the current stock status is positive.
- After a period of no purse seine fishing activity, landings in Placentia Bay have increased over the past five years. In 2015, 16% of the TAC was taken and preliminary data indicates 25% was landed in 2016.
- In 2015, commercial samples were largely composed of age 11+ fish with 95% fall spawners, however this was based on a small sample size. The age distribution of bait samples taken at the same time was broader, with 59% fall spawners.
- Purse seine fishers indicated an increase in abundance from 2013 to 2015. Gillnet fishers indicated a decrease in abundance from 2012 to 2015.

### Fortune Bay

- Spring spawners comprise over 85% of the catch in Fortune Bay. Fall spawners do not occur in adequate numbers to allow evaluation of this spawning component.
- The stock status index derived from the spring research gillnet program has had a declining trend since 2010. The evaluation of current stock status is negative.
- Future prospects based on the catch rate of age 4-6 herring are poor.
- Landings and TAC have been decreasing since 2006, and only 11% of the TAC was landed in 2016.
- The age distribution of the commercial catch continued to be highly skewed toward older fish, with over 80% of the catch consisting of age 11+ spring spawners in 2014 and 2015.
- Gillnet fishers indicated declining abundance from 2001 to 2015. Bar seiners indicated increasing abundance since being included in the survey in 2013.
- Combined catch rates in the spring research gillnet program have been well below the time series average since 2011. The age distribution has been highly skewed toward age 11+ spring spawners since 2013. In 2016, age 4 and 11+ spring spawners each accounted for 40% of the catch.
- Recruitment of age 4 herring was extremely poor from 2003-15; recruitment in 2016 was above average.

## BACKGROUND

### Stock Structure and Composition

Atlantic Herring (*Clupea harengus*) found along the south and east coasts of Newfoundland are divided into 5 stock complexes: White Bay-Notre Dame Bay (WBNDDB), Bonavista Bay-Trinity Bay (BBTB), Conception Bay-Southern Shore (CBSS), St. Mary's Bay-Placentia Bay (SMBPB), and Fortune Bay (FB). These complexes were determined through tagging experiments in the early 1980s, based on spawning locations that herring were found to return to annually; during summer feeding there is substantial mixing between stock complexes.

Both spring and fall spawning herring are present within all five stock complexes. Historically spring spawners dominated, typically comprising 90% or more of the catch. However, during the late 1990s and early 2000s, spring spawners declined and fall spawner recruitment increased. Currently, fall spawners dominate the catch in all areas except Fortune Bay. A shift in spring

spawning times to early/mid-summer on the northeast coast has also been observed during the 2000s.

Increasing occurrence of herring during spring multispecies bottom trawl surveys in NAFO Subdivision 3Ps indicates that distribution may have changed through the 2000s. As it is no longer feasible to conduct a tagging study to investigate these types of changes due to low relative abundance and fishing activity, other methods are being explored. Samples from Newfoundland herring are being tested as part of a larger study through Dalhousie University examining the genetic difference between stocks and spawning components. In addition, otolith shape is being explored as a potential method to differentiate between stocks. This work is ongoing.

### **Ecosystem Considerations**

Herring found in the waters of NL are at the northern extent of their range in the northwest Atlantic and are subject to environmental extremes, which are thought to drive the highly variable recruitment of these stocks. In the past, overwintering conditions and salinity were correlated with spring spawning dynamics (Winters and Wheeler 1987), but those relationships have not persisted during the 2000s. It is suspected that plankton dynamics play a key role in the recruitment of strong spring-spawner year classes and an initial analysis showed a potential positive correlation between spring-spawner recruitment in BBTB and the duration of the spring bloom between 1999, when the Atlantic Zonal Monitoring Program (AZMP) began, and 2011, the most recent year for which recruitment could be evaluated. Large-scale ocean color imagery over the northwest Atlantic indicated later onset in peak timing and reduced duration of the spring phytoplankton bloom since 2010, compared to normal conditions. This could potentially have a negative impact on spring herring recruitment, but it is likely that various factors influence year class success and predictions cannot be made without a more robust model of recruitment dynamics, which is currently being investigated.

Fall spawner recruitment has been correlated with rising sea temperatures in the northwest Atlantic, but it is likely that temperature is a proxy for other environmental drivers (Melvin et al. 2009). A physical environment composite climate index for the region, comprised of standardized anomalies of 28 oceanographic time series, increased during the late 1990s and remained above average during the 2000s, coinciding with the increased recruitment of fall spawning herring. This index fell below average in 2014 and 2015, and returned to above average in 2016 (Fig. 2).

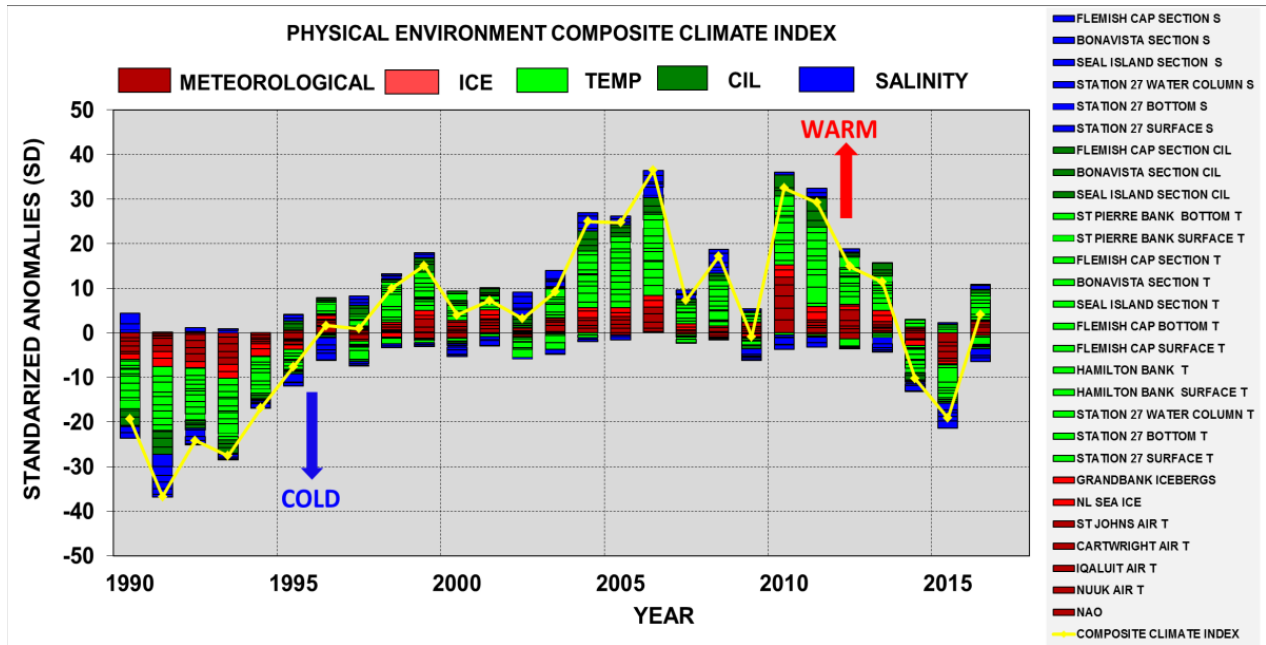


Figure 2: Composite climate index derived by summing the standardized anomalies of North Atlantic Oscillation (NAO), air temperature, ice, water temperature and salinity and cold-intermediate-layer (CIL) areas from several locations in the Northwest Atlantic. The standardized anomalies for each series are computed based on the 1981-2010 reference period.

Ecosystem data analysis indicates that total finfish biomass in the NL shelves bioregion increased from the mid-2000s to early 2010s, then leveled off, and over the last couple of years is showing signals of decline (Fig. 3). These signals are not homogeneous across all ecosystem units; they appear stronger in the southern regions (3LNO and 3Ps) (Fig. 3). These signals could be associated with the joint reduced availability of key forage species like capelin and shrimp in the offshore since 2014, as well as other changes in ecosystem conditions (e.g. declines in zooplankton levels in recent years). Among marine mammals, Harp Seals have rebuilt from the very low levels observed in the 1970s, but their numbers have been relatively stable since the mid-late 2000s.

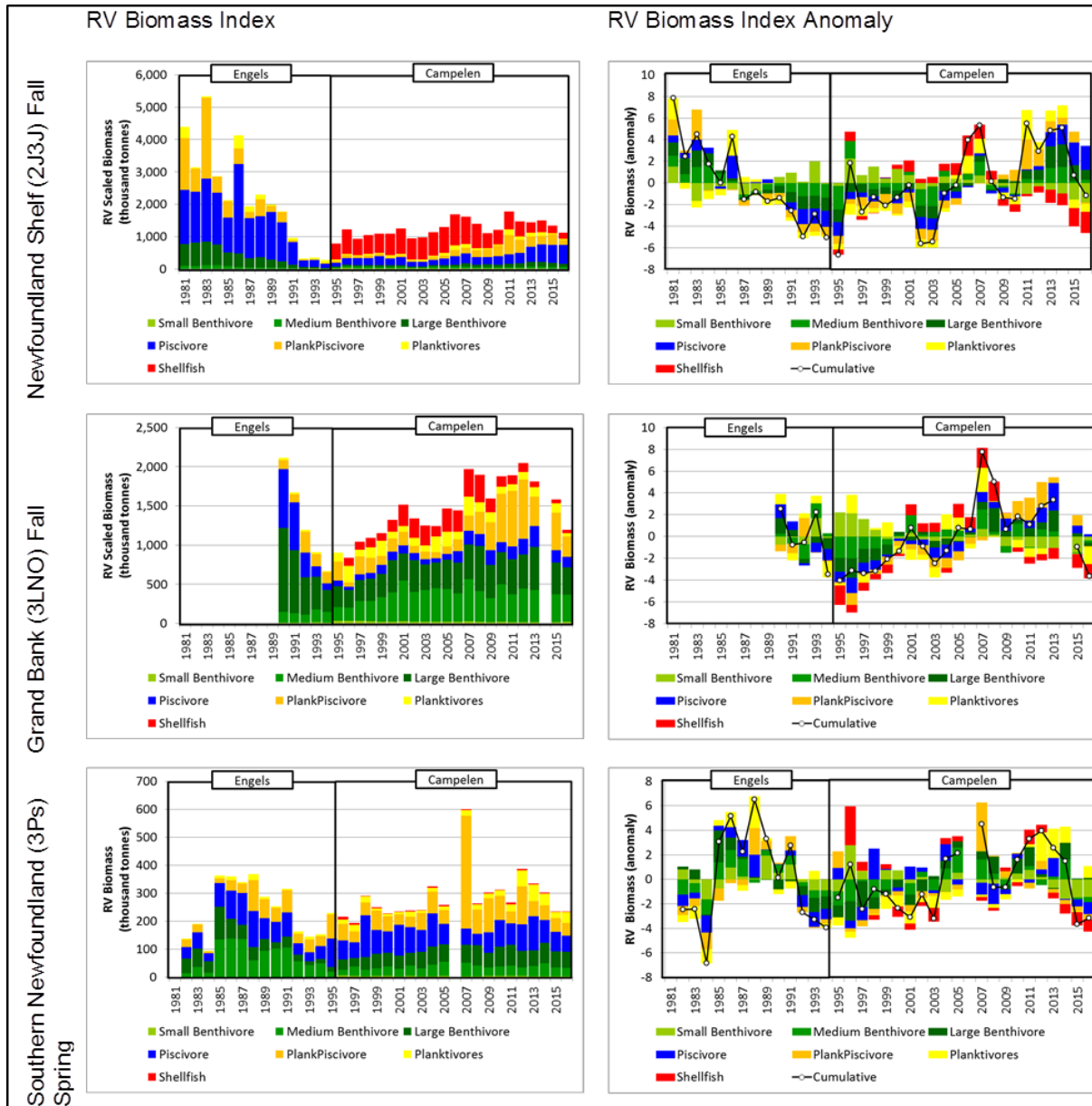


Figure 3: Trends in the Research Vessel (RV) Biomass Index by fish functional groups in core strata of the Newfoundland Shelf (2J3K), Grand Bank (3LNO) and Southern Newfoundland (3Ps) Ecosystem Production Units (EPUs). The black boxes indicates a change in survey gear from Engels to Campelen. The shellfish functional group includes *Pandalus* shrimp and Snow Crab, but its signal is heavily dominated by shrimp; reliable RV survey data for these species are only available since the introduction of the Campelen gear in the survey. Conversion factors between gears are only available for a handful of groundfish species; the scaling factors used here for 2J3K and 3LNO were applied at the fish functional group level and provide a general approximation for comparing across gears. Standardized anomalies were calculated within each gear-specific portion of the time series.

In terms of predation, diet compositions of predators like cod and Harp Seals indicate that herring has been an important prey for Harp Seals in inshore areas in the past, and only occasionally appears in the Atlantic Cod diet, most notably in southern Newfoundland (3Ps). This low importance in the diet of cod has been interpreted, in part to the more inshore distribution of herring in the NL bioregion, but also to timing of the surveys. Under current

conditions of reduced availability of capelin and shrimp in the offshore, there is potential for an increase in predation pressure on herring if predators like cod increase their foraging/residence in inshore waters.

## Biology

The size at age of both spring and fall spawners decreased significantly in the 1990s and has remained relatively stable since in all stock areas. Length at 50% maturity (L50) of spring spawner cohorts generally decreased through the 1980s to the late 1990s, but has increased since. Fall spawner numbers were too low to conduct L50 analysis until recently; cohorts over the past several years have shown a general increase in L50. The current minimum size for herring in the seiner fishery is 270 mm (total length); the mean L50 over the past four years for spring spawners is 267.2 mm and 278 mm for fall spawners (Fig. 4).

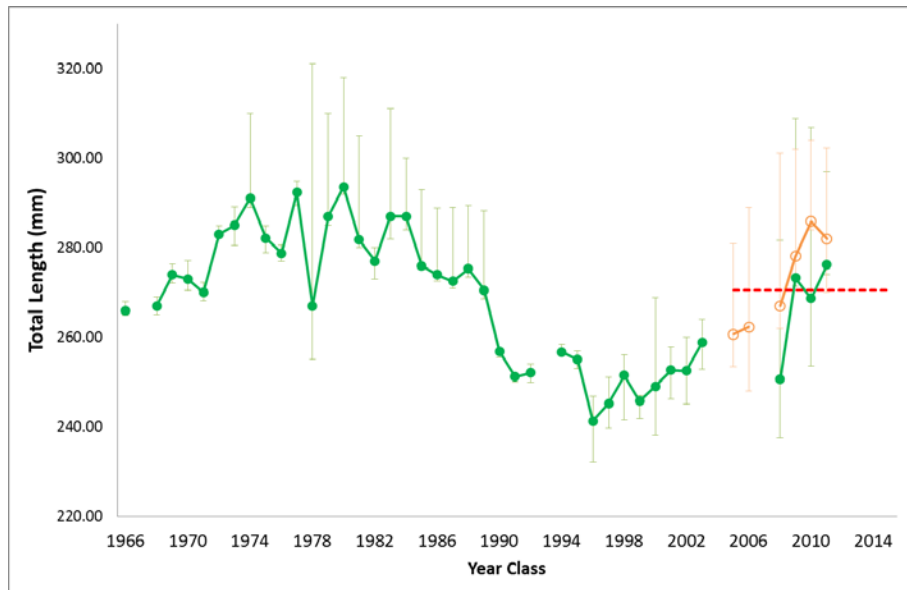


Figure 4: Length at 50% maturity (L50) of spring spawner (green line/solid markers) and fall spawner (orange line/hollow markers) year classes, and current minimum size limit in commercial fishery (red/broken line).

## Fishery

The combined TAC for all areas from southern Labrador to Cinq Cerf Bay has been set at 14,291 t, approximately 50% of which was landed in 2015 and 2016 (Table 1, Fig. 5); landings presented for 2016 are considered preliminary. The commercial fishery is largely carried out by purse and tuck seines, with bar seines, gillnets, and traps comprising a small percentage of landings (Fig. 5). The fishery takes place entirely during the spring in FB, and during the spring and fall in all other stock areas.



Table 1: Landings (t) and TAC (t) by stock area 2014-2016 (\*2016 data is preliminary).

Year	Labrador Landings	Labrador TAC	WBND B Landings	WBND B TAC	BBTB Landings	BBTB TAC	CBSS Landings	CBSS TAC	SMBPB Landings	SMBPB TAC	FB Landings	FB TAC	Total Landings
2014	49	500	367	2,640	3,862	4,950	408	600	338	2,250	796	2,260	5,822
2015	111	500	616	2,640	4,445	6,110	150	700	351	2,250	802	1,200	6,475
2016*	11	500	1,709	2,640	3,670	6,110	480	700	539	2,250	137	1,200	6,546

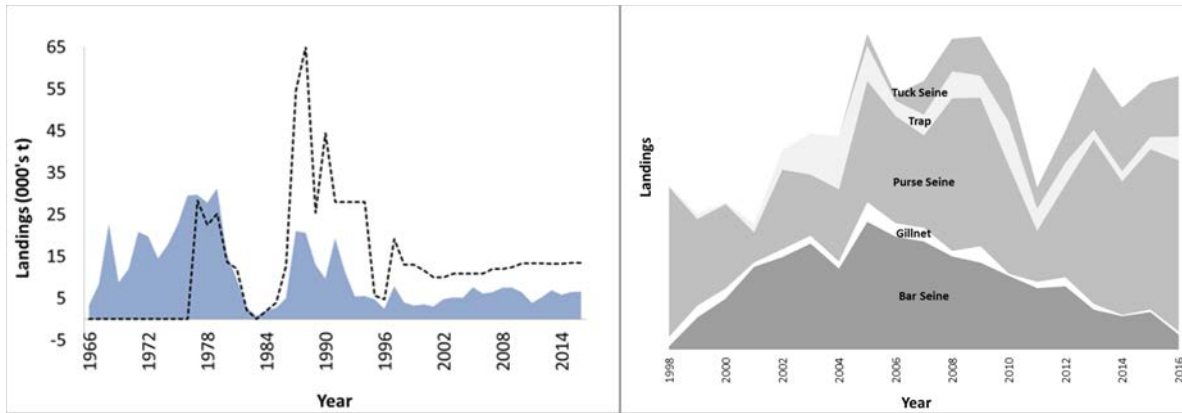


Figure 5: Left Panel: Commercial landings (000's t) and total TAC (dashed line) for all stock areas combined from 1966-2016; Right Panel: Proportion of landings by gear type for all stock areas combined from 1998-2016 (note 2016 landings data are preliminary).

The gillnet bait fishery occurs primarily during the spring. Because bait removals are not required to be reported, an annual telephone survey is conducted by DFO Science each fall to estimate the percentage of active fishers and bait removals for each stock area. Voluntary logbooks are also distributed to fixed gear fishers to help obtain data about this fishery; due to consistently poor return rates these logbooks will be required as a licence condition as of 2017. Both the logbooks and telephone surveys are also used to ask fishers about their perception of abundance in the current year compared to the previous. Fishers in WBNDDB and BBTB indicated an increasing perception of abundance from 2011 to 2014, with a decline in WBNDDB in 2015 but a continued increase in BBTB; fishers in SMBPB and FB indicated decreasing abundance (Fig. 6). CBSS was added to this survey in 2016. Results of the 2016 survey are not presented as the configuration of bait gillnets changed with licence conditions as of that year, requiring nets be set parallel to land. This change in gear configuration likely impacted the index by altering fishers' perception of abundance, an issue which will be considered in the next assessment.

An additional DFO Science telephone survey is conducted each spring and fall to obtain estimates of unsuccessful fishing sets (discards) and the estimated mortality rates of the fish that are released during those sets by purse and tuck seiners. Discard levels have varied over the past several years from 5% to over 50%. High discards have been attributed to high proportions of small (undersized) herring. The minimum size limit for this fishery is set at the estimated L50 and is currently 270 mm, total length (Fig. 4). Fishers in this survey are also asked about their perceptions of abundance; bar seiners in FB were added to the survey in 2014 to provide a broader industry perspective. Purse, tuck, and bar seine fishers in all areas reported increasing abundance in recent years (Fig. 6).

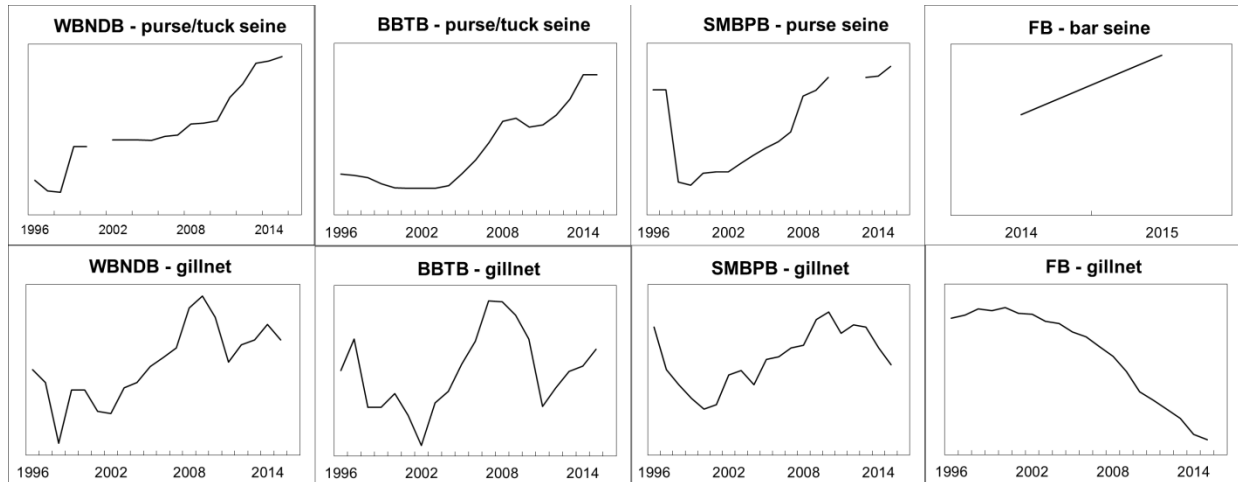


Figure 6: Cumulative change index derived from fishers' perception of abundance for fixed gear (bait gillnets) and purse/tuck seines, by stock area from 1996-2015 and FB bar seines from 2014-15.

There has been a small fishery in Southern Labrador since 2013, with a 500 t exploratory fixed gear TAC. 111 t were landed in 2015 and 11 t in 2016 (Table 1). Most herring in this area are caught via traps during August and September. The 2008 fall spawner year class currently dominates the catch in this area; the age structure is generally well distributed. In 2015, all fish collected in this fishery were fall spawners (Fig. 7). It is not currently known to which stock complex these herring belong.

In WBNDDB, 616 t were landed in 2015 and 1,709 t in 2016 (Table 1), representing 65% of the TAC and the highest landings in nearly 20 years. The bait fishery accounted for an additional estimated 189 t in 2016 and 166 t in 2015. The majority of herring in the commercial fishery were caught via purse seines and traps. In 2014, the strong 2008 year class accounted for over 50% of the catch, with a mix of age 4s, 5s, and 11 + herring comprising a further 35%. In 2015, there was a broad age distribution, with signs of a potentially strong 2013 spring year class that accounted for almost 20% of the catch - however this was based on a small sample size. Fall spawners continue to comprise over 50% of the catch in this area: 58% in 2014 and 68% in 2015 (Fig. 7).

In BBTB landings remained near the same levels as previous years, with 4,445 t in 2015 and 3,670 t in 2016, 73% and 60% of the TAC respectively (Table 1). Estimated bait removals were 283 t in 2015 and 272 t in 2016. The majority of commercial landings are attributable to purse and tuck seines. The 2008 fall year class dominated the catch in 2014, accounting for over 50% of landings. In 2015, this year class remained strong while ages 3-6 also accounted for over 10% of the catch each. Fall spawners also continue to dominate the commercial catch in BBTB, comprising 80% of landings in 2014 and 2015 (Fig. 7).

Commercial landings in CBSS have increased over the last 4 years; 150 t were landed in 2015 and 480 t in 2016, 22% and 70% of the TAC respectively (Table 1). An additional estimated 81 t were removed in the bait fishery in 2016. Most commercial landings in this area are by purse and tuck seines, all occurring in Conception Bay. The catch at age in 2014 and 2015 was similar to that seen to the north, with a strong 2008 fall year class dominating the catch and signs of a potentially strong 2013 spring year class in 2015. Fall spawners comprised 95% of the 2014 catch, and 73% of the 2015 catch (Fig. 7).

In SMBPB landings increased in 2015 and 2016, with 351 t and 539 t landed respectively, representing 16% and 24% of the TAC. Bait removal estimates increased from 18 t in 2015 to

180 t in 2016. Commercial landings are largely via purse seine, with a small percentage attributable to gillnets; all landings occurred in Placentia Bay. There was a broad age distribution in 2014, with the 2008 year class comprising 25% of the catch, followed by age 11 + and age 5s. In 2015, the age distribution was truncated with no fish under age 6, and again the 2008 year class and age 11 + dominating the catch. Fall spawners accounted for 49% of the commercial catch in 2014 and 95% in 2015. Sample size was small for this area, additional bait samples were collected in 2015 and the age distribution was somewhat less truncated than that of the purse seine samples, with 41% spring spawners (Fig. 7).

Commercial landings in FB have been in decline since 2009; the TAC has not been taken in recent years despite being reduced from 2,880 t to 2,260 t in 2013, and again to 1,200 t in 2015. Commercial landings were 802 t in 2015 and 137 t in 2016 (Table 1). Bait removals were estimated to be 64 t in 2015 and 128 t in 2016. The catch at age is extremely truncated, with age 11 + fish comprising over 90% of landings in both 2014 and 2015. FB is the only stock area where fall spawner recruitment did not increase during the 2000s and spring spawners still consistently comprise the majority of the catch: 99% in 2014 and 85% in 2015 (Fig. 7).

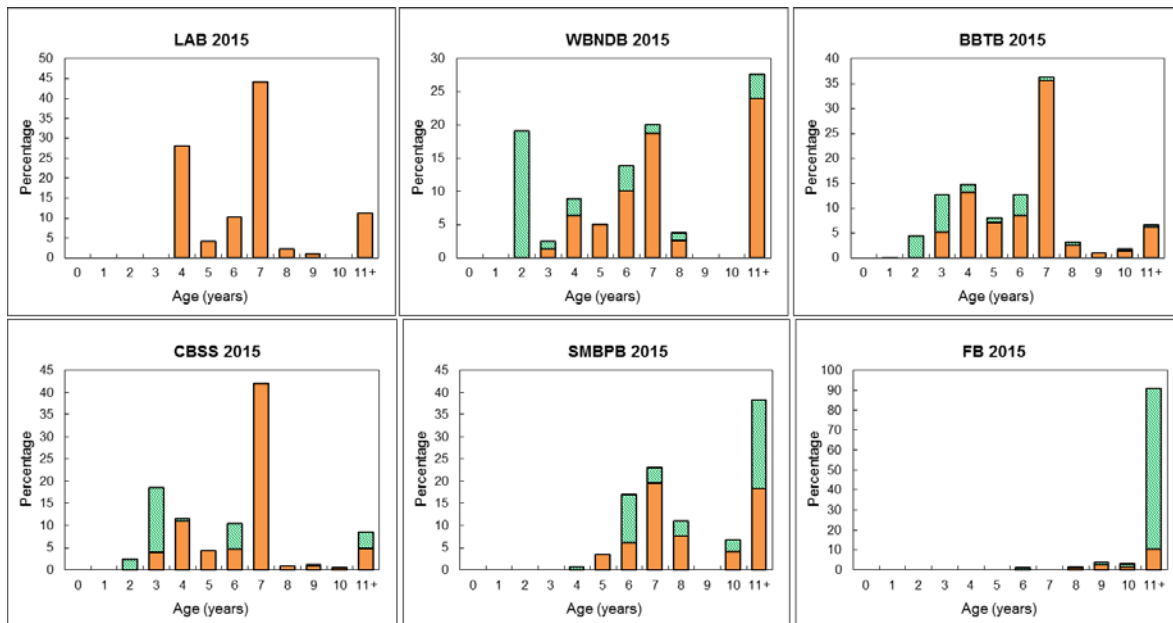


Figure 7: 2015 catch at age of commercial catch by stock area and spawning component (upper/green bars = spring spawners; lower/orange bars = fall spawners); note, SMBPB includes samples from the bait fishery.

## ASSESSMENT AND BIOLOGICAL UPDATES

### White Bay – Notre Dame Bay: Biological Update

It was determined that without a fishery-independent index of abundance (i.e. acoustic surveys or a research gillnet program) the status of this stock could not be assessed and only a biological update could be provided, based on data and samples collected from the commercial fishery. Landings in this area have increased over the past three years (Table 1) and industry reports that effort has been consistent over that time period. Preliminary fishery data for 2016 indicate that landings were at the highest point since the 1990s. The commercial catch at age was dominated by the 2008 year class in 2014, which remained strong in 2015, along with the 2013 spring year class (Fig. 7). While the prevalence of age 2 fish in 2015 may be a sign of

recruitment, it should be noted that this age distribution was based on a small sample size. Fall spawners continue to dominate the catch, composing 68% in 2015. Purse and tuck seine fishers indicated increasing abundance in 2015, gillnet fishers indicated an increase from 2011 to 2014, but decrease in 2015 (Fig. 6).

### Bonavista Bay – Trinity Bay: Stock Status

The stock status index for BBTB is derived from the overall catch rates, catch rates of older/fully recruited year classes (ages 7 - 11+), and year class strength observed in the spring research gillnet program. Combined catch rates generally increased from 2010 to 2015, reaching the second highest level in the time series. There was a steep decline in 2016; fishers indicated this was due to the late arrival of herring in the spring. Fall spawners continue to dominate in this catch area, comprising 69% of the catch in 2015 (Fig. 8).

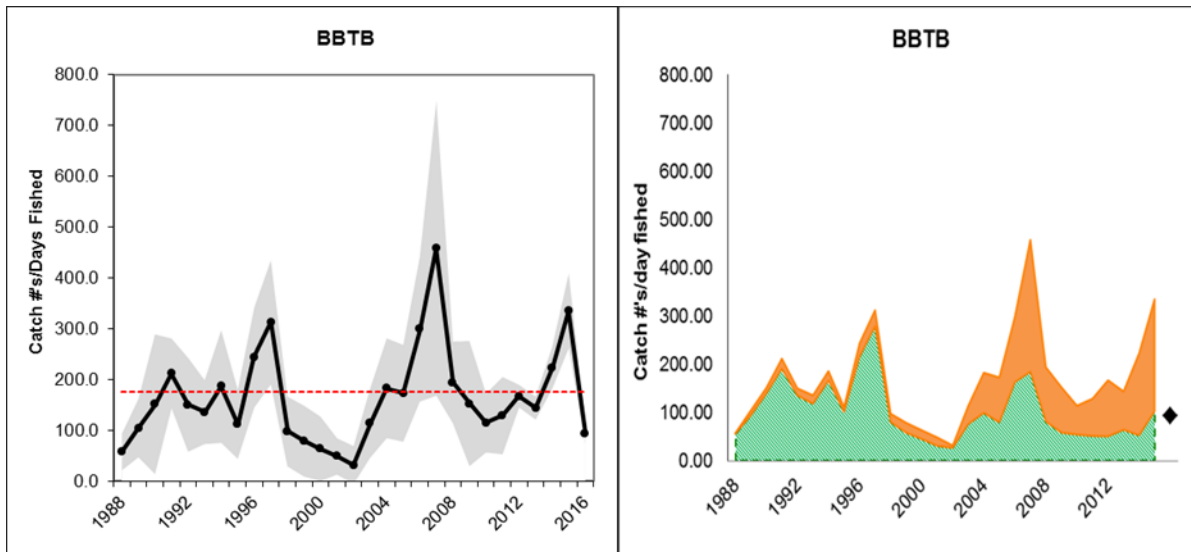


Figure 8: Combined catch rate of spring and fall spawners in the spring research gillnet program (left panel; dashed line = time series mean) and catch rate by spawning type (right panel: lower/green area = spring spawners, upper/orange area = fall spawners, black point = 2016 combined catch rate) in BBTB.

The age structure of samples taken from the research gillnet program was broad, but the 2008 fall year class dominated the catch in 2015. The recruitment of age 4 fish was high in 2015 for fall spawners and average for spring spawners; most fall year classes are of above average relative strength (Fig. 9, Table 2). In the past the stock status index was based entirely on spring spawning herring but given the increase in fall spawners, for this assessment it was calculated for both spawning components, and weighted according to the percentage of the catch each composed. The index had an increasing trend over the past 5 years and the 2014 and 2015 values are among the highest in the time series (Fig. 10).

Table 2a: BBTB performance table to the spring of 2016 – summary of fishery.

<b>The Fishery</b>	<b>Observation</b>
Reported Landings: 2015/2016	Landings in 2015 were the highest since the early 1990's, 73% of the TAC was taken. Initial data indicates landings were down in 2016 but still high relative to the time series.
Bait Removals: 2015/2016	Estimated bait removals of 283 t in 2015 and 272 t in 2016, near the bait allocation of 300 t.
Estimated Discards: 2015	Fishers estimated that 98 t were discarded in the purse seine fishery in 2015, representing 3% of total estimated removals.

Table 2b: BBTB performance table to the spring of 2016 – indices and interpretations.

<b>Cumulative Indices and Biological Characteristics</b>	<b>Observation</b>	<b>Interpretation</b>
Gillnet Fisher Observations 1996-2015 from telephone surveys and logbooks	Gillnet fishers reported increasing abundance from 2011 to 2015.	Increasing trend in abundance.
Purse and Tuck Seine Fisher Observations 1996 - 2015	Purse seine fishers reported a general increasing trend in abundance since 2010.	Increasing trend in abundance.
Commercial catch at age 2015	The strong 2008 fall year class (age 7) continued to dominate the catch, accounting for over 35% of landings. Other younger year classes accounted for 10-15% each. Fall spawners compose approximately 80% of landings.	Age structure is stable. Fall spawners dominate the catch.
Length and weight at age	Lengths and weights at age have remained stable through the 2000's for both spawning components.	Size at age is stable.

Table 2c: BBTB performance table to the spring of 2016 – research gillnet program.

<b>Research Gillnet Program</b>	<b>Observation</b>	<b>Interpretation</b>
Research gillnet catch rates	Catch rates increased in 2014 and again in 2015, reaching the second highest point in the time series. Catch rates declined sharply in 2016, below the decadal and time series mean.	Increasing trend in abundance, but sharp decrease in 2016.
Research gillnet age composition and recruitment	The 2008 fall cohort dominates the catch but the age distribution is widespread. Recruitment of fall spawners remains high. Recruitment of spring spawners was average for the most recent year class assessed.	Population structure stable, good recruitment.

Table 2d: BBTB performance table to the spring of 2016 – stock status evaluation.

<b>Stock Status Index</b>	<b>Evaluation</b>
The age distribution is stable with several strong year classes. Recruitment of fall spawners is above average, and average for spring spawners. The stock status index has shown an increasing trend over the past 5 years. Current stock status is positive.	+

+ = Positive Evaluation

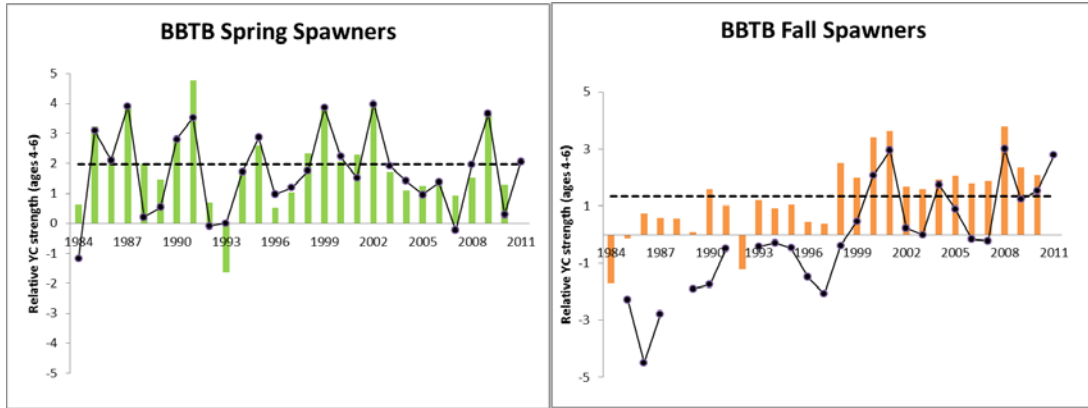


Figure 9: Year class strength (ages 4-6) and recruitment (age 4) by spawning component (bars = year class strength, solid line = recruitment, dashed line = series mean).

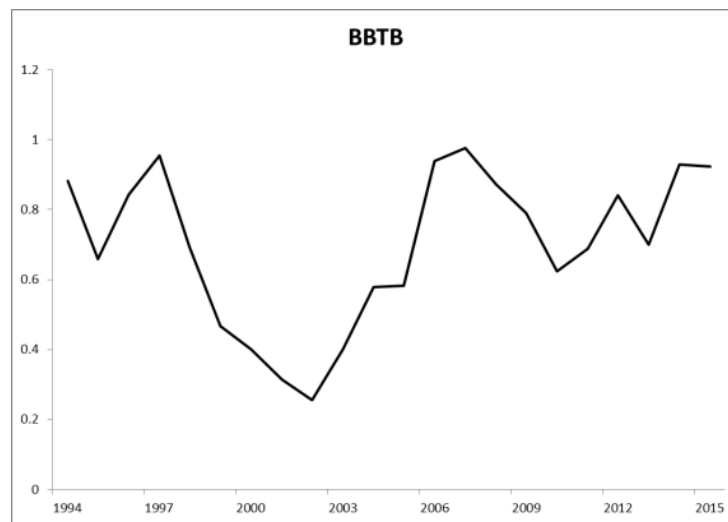


Figure 10: Stock status index for spring and fall spawners combined in Bonavista Bay-Trinity Bay.

**Conception Bay – Southern Shore: Biological Update**

This stock area has not been assessed in recent years. Without a fishery-independent index of abundance (i.e. acoustic surveys or a research gillnet program) only a biological update could be provided based on limited fisheries data. Participation in the fishery and landings have generally increased in this stock area over the past four years. In 2015, 20% of the TAC was taken and preliminary data indicates that landings were higher in 2016 (Table 1). All commercial landings are in Conception Bay, the only fishing activity on the Southern Shore in recent years has been a low number of gillnet bait fishers. The age distribution of samples collected from the commercial fishery was stable but dominated by the 2008 fall year class; fall spawners comprised 73% of the catch in 2015 (Fig. 7). As this is a small fishery, sample size for this age distribution was low. All fleets indicated an increase in abundance in this stock area from 2014 to 2015.

**St. Mary’s Bay – Placentia Bay: Stock Status**

The calculated stock status index for this area could not be updated for this area as it no longer has a research gillnet program, however an estimate of relative abundance was derived from an opportunistic acoustic survey which took place in Placentia Bay in February 2016. This survey

was conducted using a chartered purse seine vessel which was outfitted with a Simrad EK60 echosounder with a towed 120 kHz transducer. The survey design was similar to those conducted in the area between 1986 and 2000 as part of the regular herring monitoring activities that took place during that time period, which were used to derive abundance estimates for stock assessments. A total of 130 inshore transects were conducted in 12 strata (Fig. 11). Though the area covered was reduced from previous surveys due to time restraints, key strata which have historically contained the highest concentrations of herring in Placentia Bay were covered. During the survey, two fishing sets were completed and samples collected. Using the data collected, surveyed abundance was calculated using the same methods as previous assessments which included acoustic surveys. The biomass of herring in the inner portion of Placentia Bay was estimated at 19,834 t, slightly below the mean of the past surveys (Fig. 12).

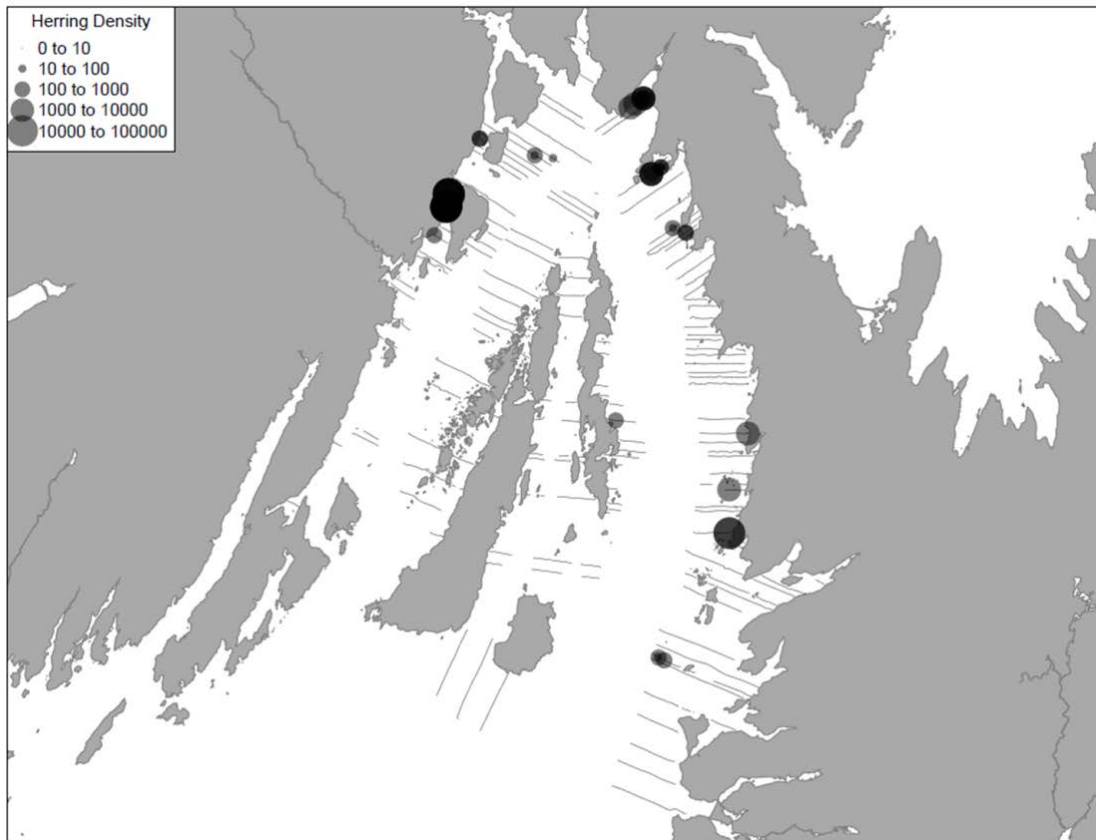


Figure 11: Surveyed transect lines and estimated herring density in Placentia Bay during 2016 inshore acoustic survey.



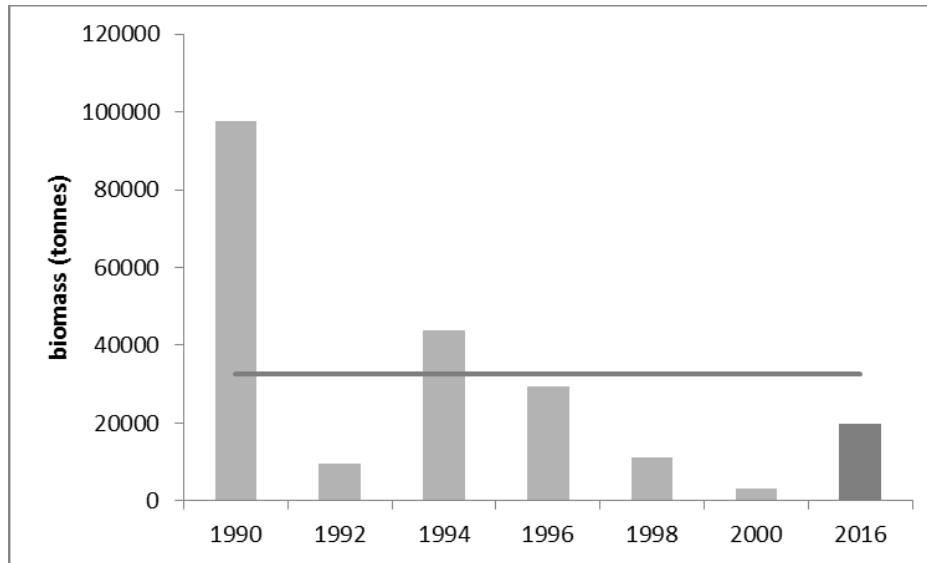


Figure 12: Historical biomass estimates (1990-2000) and 2016 biomass estimate from acoustic surveys of Placentia Bay (solid line is historical biomass estimate mean).

### Fortune Bay: Stock Status

The stock status index for FB is derived from the combined catch rates and year class strength of spring spawners observed in the spring research gillnet program. Combined catch rates have been well below the time series average since 2011; unlike other areas, spring spawners continue to dominate in FB and accounted for 81% of the catch in 2016 (Fig. 13).

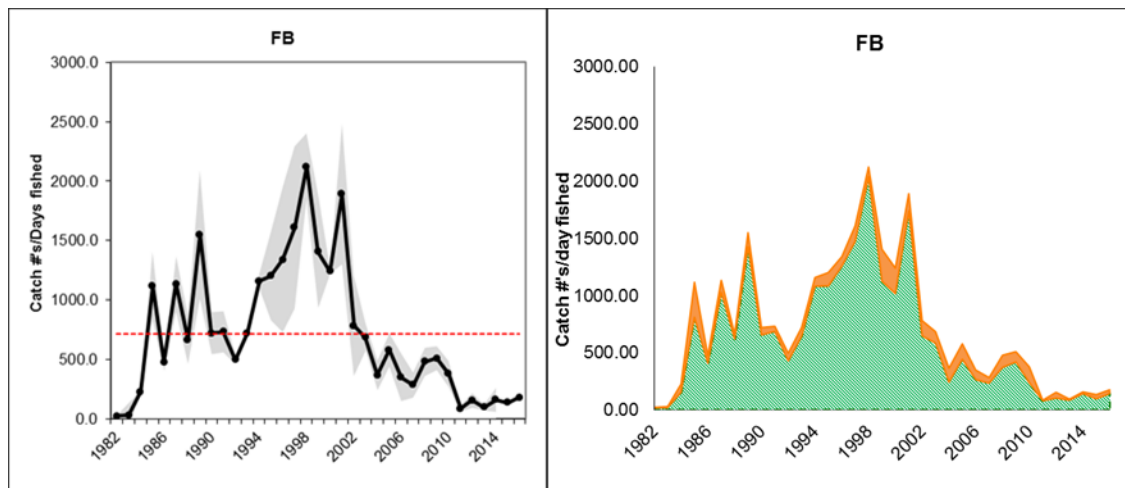


Figure 13: Combined catch rate of spring and fall spawners in the spring research gillnet program (left panel: dashed line = time series mean) and catch rate by spawning type (right panel: lower/green area = spring spawners; upper/orange area = fall spawners) in FB to 2016.

The age structure of herring caught in the research gillnet program was highly skewed from 2013 to 2015, when the strong 2002 year class entered the age 11 + group. In 2016 age 4 and age 11 + spring spawners each accounted for 40% of the catch. Recruitment of age 4 spring spawners was extremely poor from 2003 to 2015 and the strength of all mature year classes is below average; however, recruitment of the incoming 2016 year class is above average

(Fig. 13, Table 3). The stock status index for this area has had a declining trend since 2010 (Fig. 14).

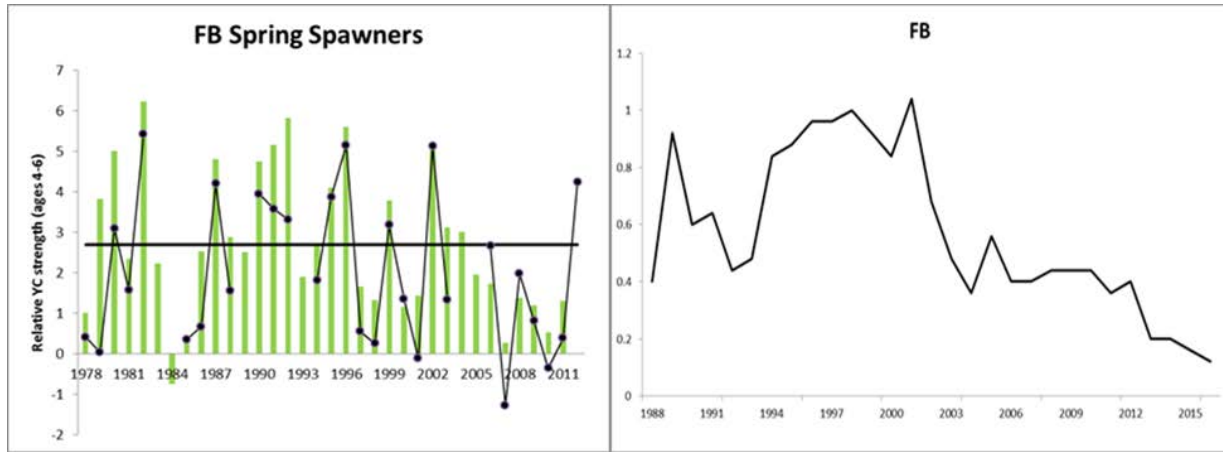


Figure 14: Year class strength (ages 4-6) and recruitment (age 4) of spring spawners (left: bars = year class strength, solid line = recruitment, straight line = series mean); and stock status index (right) for Fortune Bay.

Table 3a: FB performance table to the spring of 2016 – summary of fishery.

The Fishery	Observation
Reported Landings: 2015/2016	Landings increased slightly in 2015 but only 65% of a reduced TAC was taken. In 2016 there was a steep decline with only 11% of the reduced TAC landed.
Bait Removals: 2015/2016	Estimated bait removals were 64 t in 2015 and increased to 128 t in 2016, still well below the bait allocation of 400 t.

Table 3b: FB performance table to the spring of 2016 – indices and interpretations.

Cumulative Indices and Biological Characteristics	Observation	Interpretation
Gillnet Fisher Observations 1996-2015 from telephone surveys and logbooks	Gillnet fishers have reported decreasing abundance since 2000.	Decreasing trend in abundance.
Bar Seine Fisher Observations 2014-2015	Bar seine fishers indicated increasing abundance from 2014 to 2015.	Increasing abundance.
Commercial catch at age	The age distribution is extremely skewed, with age 11+ herring comprising over 90% of the catch. Spring spawners account for 85% of landings.	Age distribution is highly skewed toward older fish; not stable. Spring spawners dominate the catch.
Length and weight at age	Lengths and weights have remained stable through the 2000s.	Size at age is stable.

Table 3c: FB performance table to the spring of 2016 – research gillnet program.

<b>Research Gillnet Program</b>	<b>Observation</b>	<b>Interpretation</b>
Research gillnet catch rates	Catch rates declined sharply between 2010 and 2012 and though there was a slight increase in 2016, still remain well below decadal and time series mean.	No change in abundance/abundance low.
Research gillnet age composition and recruitment	The age composition has been highly skewed toward age 11+ spring spawners. Recruitment of age 4 spring spawners was above average in 2016.	Age distribution is unstable. Recruitment increased in 2016 but year class strength is below average overall.

Table 3d: FB performance table to the spring of 2016 – research gillnet program.

<b>Stock Status Interpretation</b>	<b>Evaluation</b>
The age distribution is unstable, with strong age 4 and 11 + year classes. Recruitment was above average in 2016. The stock status index has shown a decreasing trend since 2010. Current stock status is negative.	-

- = Negative Evaluation

## Sources of Uncertainty

The inability to estimate spawning stock biomass and exploitation rates continues to be a major source of uncertainty for this stock assessment.

The lack of a fishery-independent abundance index in three of five stock areas makes it impossible to update the standardized stock status index unless an acoustic survey is completed, otherwise only biological updates could be provided, based on limited data from the commercial fishery.

There has been an apparent change in spring spawning time on the northeast coast, shifting toward mid/late-summer. This may have implications on the designation of spawning component and subsequently age structure calculated from biological samples.

Distribution of herring has likely changed since stock complexes were delineated in the 1980s; it is currently not known how migration patterns may have changed and what impact this could have on stock structure.

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

As of 2016 gillnet bait fishers were required to set their nets parallel to shore as a licence condition. This likely impacted their perceptions of abundance provided for the cumulative change index.

## CONCLUSION

### White Bay – Notre Dame Bay

Without a fishery-independent index the status of this stock could not be assessed. Commercial landings have increased over the last three years and the age structure of the catch is stable.

### Bonavista Bay – Trinity Bay

There are several strong year classes present in this stock area and recruitment in 2015 was above average for fall spawners and average for spring spawners. Based on the catch rate of

age 4-6 fish, short term prospects are positive. The stock status index, based on catch rates and year class strength from the research gillnet program, had an increasing trend over the last five years and the 2015 value is among the highest in the time series. The evaluation of current stock status is therefore positive (Table 2).

### **Conception Bay – Southern Shore**

Without a fishery-independent index the status of this stock could not be assessed. Commercial landings have increased over the past four years after a period of low fishing activity. The age distribution of the catch is stable, but based on a small sample size.

### **St. Mary's Bay – Placentia Bay**

The commercial age distribution appears to be stable, but is based on a small sample size. An opportunistic acoustic survey was conducted in February 2016 in Placentia Bay, which provided an estimate of relative abundance that was just below the mean of the acoustic surveys conducted between 1986 and 2000. Based on these results the overall evaluation of current stock status is positive.

### **Fortune Bay**

The relative strength of all mature year classes in this stock area is below average and the age distribution is not well distributed. Recruitment of the dominant spring spawning component was above average in 2016, however the stock status index has been declining since 2010 and continued to do so in 2016. The evaluation of current stock status is therefore negative (Table 3).

## **SOURCES OF INFORMATION**

This Science Advisory Report is from the January 31 to February 1, 2017 Status of Divisions 3KL and Subdivision 3Ps Herring meeting in St. John's, NL. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

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 Jour. Mar. Sci.* 66: 1784-1792.

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.

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*MPO. 2017. Évaluation des stocks de hareng des côtes est et sud de Terre-Neuve jusqu'au printemps 2016. Secr. can. de consult. sci. du MPO. Avis sci. 2017/028.*