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Science | Sciences

Newfoundland and Labrador Region

Canadian Science Advisory Secretariat
Science Advisory Report 2014/023

STOCK ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SALMON - 2013

Image: Atlantic Salmon (Salmo salar)

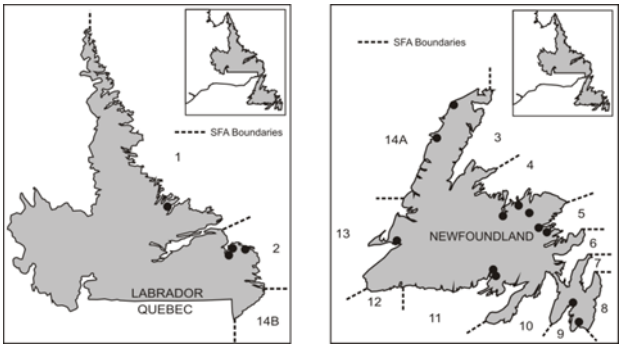

Figure 1. Assessment locations in Newfoundland and Labrador Region.

Context:

There are 15 Atlantic Salmon (Salmo salar) management areas, known as Salmon Fishing Areas (SFAs) 1-14B, in Newfoundland and Labrador (NL) (Fig. 1). Within these areas there are 394 rivers known to contain wild Atlantic Salmon populations that are characterized by differences in life history traits, including freshwater residence time, age at first spawning, and the extent of ocean migration. Spawning populations consist of varying proportions of small (fork length < 63 cm) and large (fork length ≥ 63 cm) salmon. The majority of rivers in Newfoundland (SFA 3-12) contain populations of small salmon which are predominantly maiden fish (never spawned before) that have spent one-year at sea before returning to spawn (grilse, one-sea-winter, 1SW). The large salmon component in this area consists mainly of repeat spawners (repeat-spawning grilse) which are returning for a second or subsequent spawning. In Labrador (SFAs 1, 2 and 14B) and western Newfoundland (SFAs 13 and 14A), there are important large salmon components that contain maiden fish that have spent two (two-sea-winter, 2SW) or more years (multi-sea-winter, MSW) at sea before spawning.

Conservation egg requirements for Atlantic Salmon have been established for individual rivers in Labrador (SFAs 1-2) based on 1.9 eggs per m^2 of river rearing habitat, the Straits Area of Labrador (SFAs 14A-14B) based on 2.4 eggs per m^2 of river rearing habitat and 105 eggs per hectare of lake habitat, and Newfoundland (SFAs 3-13) based on 2.4 eggs per m^2 of river rearing habitat and 368 eggs per hectare of lake habitat. Conservation egg requirements are considered to be threshold reference points. The level to which egg depositions can fall below conservation before threatening the long term sustainability of the population needs to be determined. According to the Wild Atlantic Salmon Conservation Policy (DFO 2009), at some level below conservation "the population is at a level of abundance at which further mortalities will lead to continued decline in the spawner abundance and an increasing risk of serious harm." Atlantic Salmon stock status is currently assessed based on the proportion of the conservation egg requirement achieved in a given year and trends in abundance of various life stages. Annual comparisons are generally made to the previous five-year mean for Newfoundland and six-year mean for Labrador, which correspond to the average Atlantic Salmon generation time in those areas.

This Science Advisory Report is from the December 3-4, 2013, Update on the Status of Atlantic Salmon in Newfoundland & Labrador. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

Newfoundland and Labrador Region (SFAs 1-14B)

- Sixteen river populations of Atlantic Salmon were assessed in 2013. Adult salmon were enumerated at four rivers in Labrador and 12 rivers in Newfoundland. Five of the 12 assessed rivers in Newfoundland also enumerated juvenile salmon (smolt) migrating to sea.
- In 2013, Atlantic Salmon conservation egg requirements were achieved on two (50 %) of the four assessed rivers in Labrador and eight (67 %) of the 12 assessed rivers in Newfoundland.
- Marine survival appears to be the major factor limiting the abundance of Atlantic Salmon within the region. Inter-annual variation in the Newfoundland index of marine survival continues to fluctuate with survival in 2013 averaging 5.6% across all five monitored rivers. The overall index of marine survival for 2013 was below the previous five-year mean (2008-12). One of the five monitored rivers (Conne River) in 2013 had survival rates greater than the previous five-year mean.
- Marine survival of smolts to adult small salmon returning to Sand Hill River in 2013 was 2 %. Marine mortality of smolts in Labrador includes both natural and fishing mortality at sea (i.e. Aboriginal and subsistence fisheries).
- Labrador Aboriginal and subsistence fisheries harvested approximately 14,204 salmon (36 t) in 2012, which was 7 % greater than the previous six-year mean (2006-11) of 13,264 salmon (35 t).
- Genetic analysis of Labrador Atlantic Salmon Aboriginal and subsistence fisheries indicated that the majority of individuals harvested over the period 2006-2011 are of Labrador origin (85-98 %), and that the rate of fishery interception of southern stocks (e.g., Maritime, USA) is low.
- Recreational catch statistics for Newfoundland and Labrador have been highly variable since 2005. Estimates of retained salmon in 2012 (27,863) and total catch (61,251 salmon, retained + 33,388 released) were 7 % and 1 % greater, respectively, than the previous five-year mean (2007-11).
- Salmon returning to monitored Labrador rivers are not adjusted for marine exploitation (i.e. Labrador Aboriginal and subsistence fisheries, West Greenland fishery). The abundance index of small salmon is variable and 2013 returns were 37 % below the previous six-year mean (2007-12). There has been an increasing trend in the abundance of large salmon since 2010. A notable increase of large salmon in 2013 is well above (107 %) the previous six-year mean.
- The abundance index of small salmon returning to Newfoundland continues to fluctuate and, when adjusted to correct for marine exploitation, has generally remained lower than pre-moratorium levels (1984-1991). Returns of small salmon in 2013 were 6 % lower than the previous five-year mean (2008-12). Returns of large salmon in 2013 were 21 % greater than the previous five-year mean.
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated South Newfoundland (SFAs 9-12) Atlantic Salmon populations as threatened in 2010. In 2012, a Recovery Potential Assessment was conducted for South Newfoundland Atlantic

Salmon. Recent genetic analysis suggests this region may be composed of two significant populations and future subdivision of this Designatable Unit (DU) may be warranted.

- The Licence Stub Return Program produced accurate estimates (± 5 %) of variables such as total catch, mean catch per angler, and total effort using all recreational angling data. For individual rivers, the accuracy of the stub program is highly dependent on the number of anglers returning stubs from specific rivers (± 12 % to 48 %).

BACKGROUND

Recreational Fisheries

The recreational salmon fishery is managed according to a River Classification System which is used to develop retention levels based on the health of individual salmon populations, without jeopardizing conservation goals. An Integrated Atlantic Salmon Fisheries Management Plan was introduced for Newfoundland and Labrador in 2012 and a five-year management plan will be implemented in 2014.

In 2013, the recreational salmon fishery for all Labrador rivers opened June 15 and closed September 15. Retention of large salmon has not been permitted since 2011. In SFA 1 and some SFA 2 unclassified scheduled rivers, anglers could retain four small salmon for the season; other scheduled salmon rivers in SFA 2 and all SFA 14B had a two fish retention (Class III). The lower retention limit in these rivers was implemented as a precautionary measure to address increased fishing pressure expected due to the construction of the Trans-Labrador Highway (TLH). Angling catch data were derived from outfitting camp logbooks for SFA 1, a combination of logbook and Licence Stub Return data for SFA 2, and Licence Stub Return data for SFA 14B.

The 2013 recreational salmon fishery for all insular Newfoundland rivers opened on 1 June and closed on September 7. A fall catch-and-release angling fishery occurred on Class I rivers from September 8 to October 7 (retention permitted on main stem of Gander River from August 1to October 7). Retention of large salmon has not been permitted since 1984.

The 2012 angling catch statistics from Licence Stub Returns are preliminary and 2013 data are not yet available as stubs are still being returned to DFO. Recreational catch for the Newfoundland and Labrador Region from 1994 to 2012 is presented in Fig. 2. Retained and released catches have been variable since 2005. The estimate of retained catch for 2012 was 27,863 salmon and total catch was 61,251 salmon (retained + 33,388 released). Retained catch and total catch in 2012 were 7 % and 1 % greater, respectively, than the previous five-year mean (2006-11). Released catch in 2012 was 3 % less than the previous five-year mean (2006-11). It should be noted that in 2012, 14 % of the potential number of recreational fishing days available in insular Newfoundland were closed for environmental reasons (i.e., low water levels and/or high water temperatures) (Fig. 12).

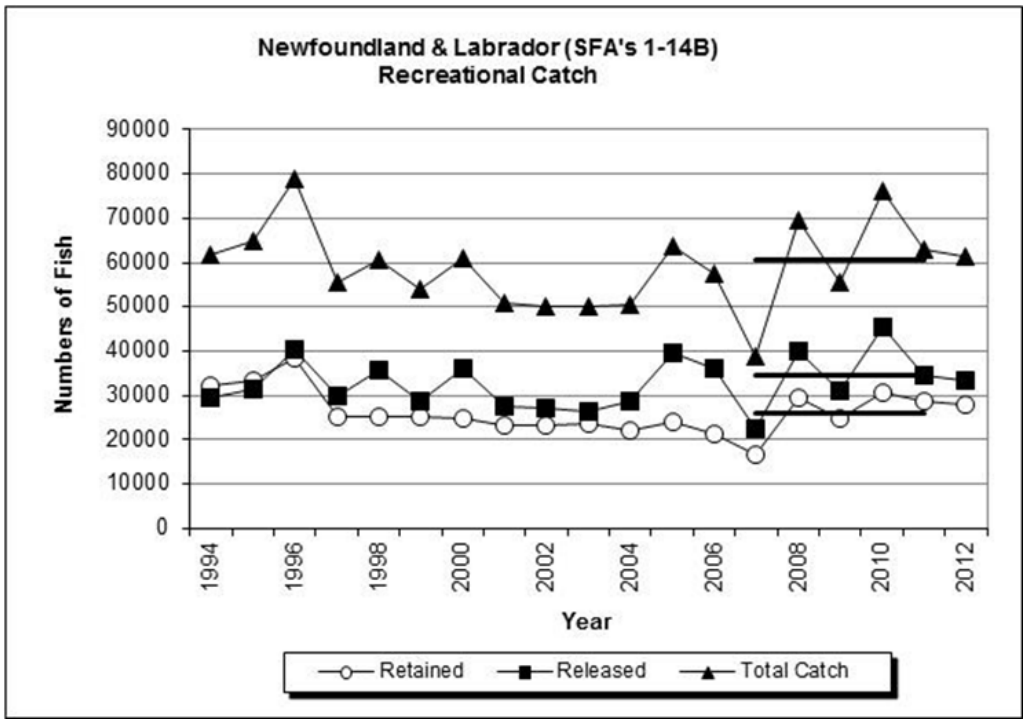

Figure 2. Angled catch of Atlantic Salmon for the Newfoundland and Labrador Region (1994-2012). Horizontal solid line represents the previous five-year mean (2007-11).

Aboriginal/Subsistence Fisheries

There has been no commercial salmon fishing in Newfoundland (SFA 3-14A) since 1992, the Straits area of Labrador (SFA 14B) since 1997, and the rest of Labrador (SFAs 1-2) since 1998.

Aboriginal food, social and ceremonial (FSC) fisheries for Atlantic Salmon, Arctic Charr and Brook Trout occur in Labrador under communal licences. Labrador also has a Resident Subsistence Fishery for trout and char with a permitted retention of salmon by-catch (three salmon since 2011). In insular Newfoundland, Miawpukek First Nations hold a FSC communal salmon fishing licence, but have chosen not to harvest salmon under this licence since 1997 due to conservation concerns.

Labrador FSC and subsistence fisheries harvested approximately 14,204 salmon (36 t) in 2012, which was 7 % greater than the previous six-year mean (2006-2011) of 13,264 salmon (36 t) (Fig. 3, Appendix 1). Large salmon represented 49 % (18 t) of the catch by weight and 30 % (4,198) by number. Harvest data for 2013 are currently unavailable.

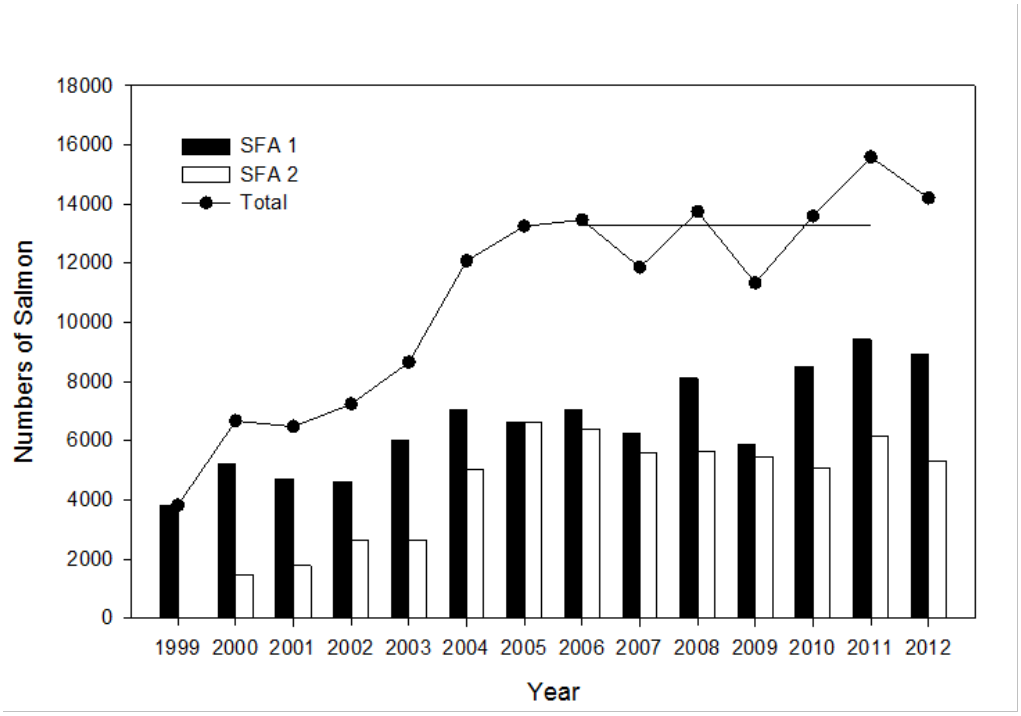

Figure 3. Atlantic Salmon harvested (number of fish) in the Aboriginal and subsistence fisheries in Labrador from 1999 to 2012. Horizontal solid line represents the previous six-year mean of total harvest (2006-11).

ASSESSMENT

Sixteen Newfoundland and Labrador river populations of Atlantic Salmon were assessed in 2013. Adult salmon were enumerated at four rivers in Labrador and 12 rivers in Newfoundland. Five of the 12 assessed rivers in Newfoundland also enumerated juvenile salmon (smolt) migrating to sea (Fig. 4).

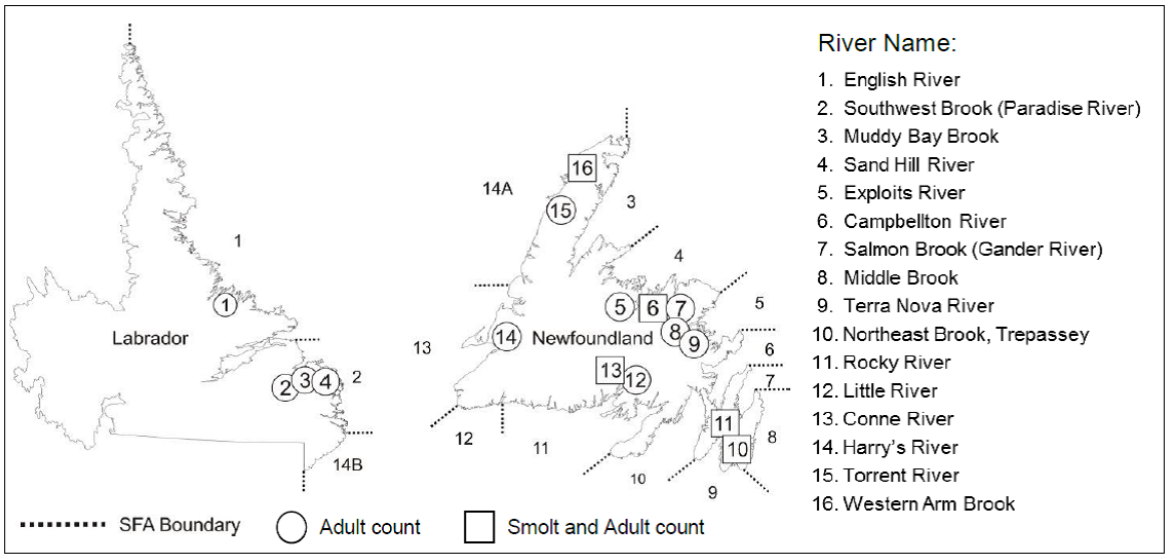

Figure 4. Map showing the name and location of Atlantic Salmon monitoring facilities in Newfoundland and Labrador operated in 2013.

Resource Status–Adult Salmon

Labrador (SFAs 1, 2, and 14B)

Salmon abundance can be tracked by examining trends of individual populations or in a collective manner where information on salmon returns to all monitored rivers is combined to derive composite indices of abundance (Dempson *et al*. 2004). In the latter case, the variability inherent in each individual river is accounted for in the modelling process.

The abundance index of small salmon returning to Labrador is variable and 2013 returns were below the previous six-year mean (2007-12) (Fig. 5). There has been an increasing trend in the abundance of large salmon since 2010. A significant increase of large salmon was observed in 2013, which is well above the previous six-year mean (Fig. 6).

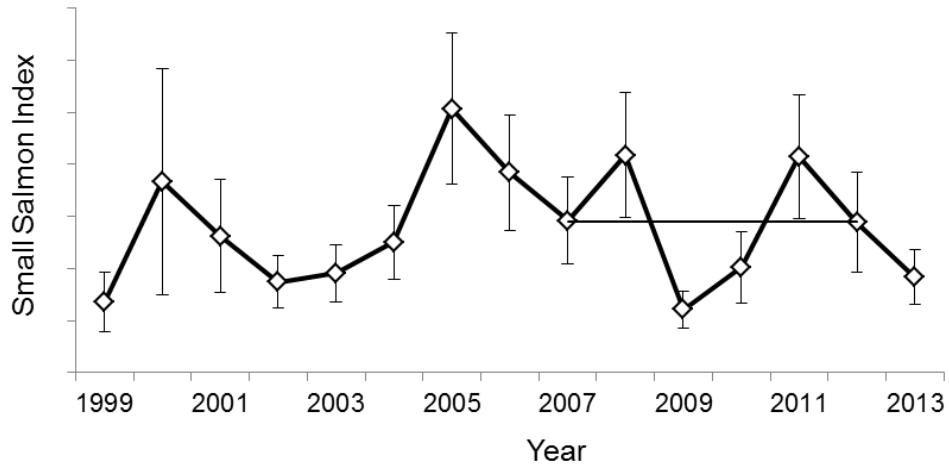

Figure 5. Trends in abundance of small Atlantic Salmon in Labrador, 1999 to 2013. Horizontal lines illustrate the previous six-year mean 2007-12. Vertical lines represent ± 1 standard error.

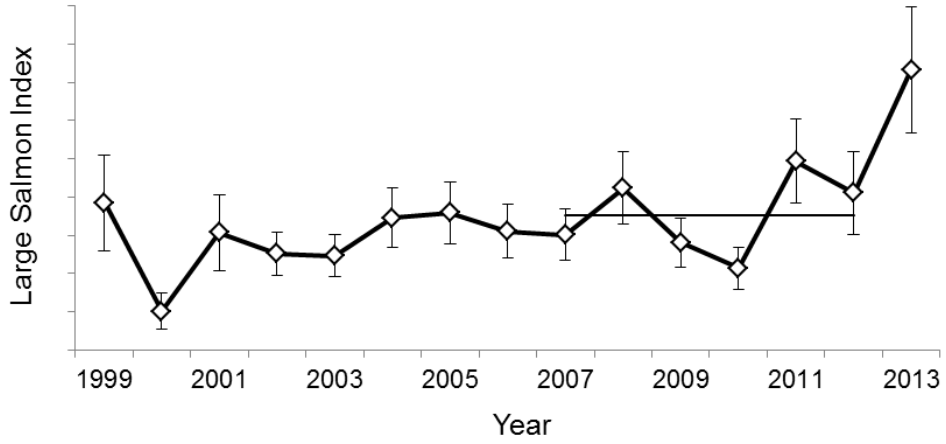

Figure 6. Trends in abundance of large Atlantic Salmon in Labrador, 1999 to 2013. Horizontal lines illustrate the previous six-year mean 2007-12. Vertical lines represent ± 1 standard error.

Northern Labrador and Lake Melville (SFA 1)

There are nine scheduled salmon rivers in SFA 1. One river was assessed in 2013: English River, near Postville.

Total returns of small and large salmon were greater than the previous six-year mean (Appendix 2).

English River achieved 188 % of its conservation egg requirement in 2013, which is greater than the previous six-year mean (2007-12). English River has achieved conservation in six of the last seven years (Appendix 2).

Southern Labrador (SFA 2)

There are 16 scheduled salmon rivers in SFA 2. Three rivers were assessed in 2013: Sand Hill River, Muddy Bay Brook (Dykes River) and Southwest Brook (tributary of Paradise River).

In 2013, total returns of small salmon were less than the previous six-year mean (2007-12) on Sand Hill River and Southwest Brook and remained the same on Muddy Bay Brook. Returns of large salmon were significantly greater than the 2007-2012 means on all assessed rivers in SFA 2 (Appendix 2).

Conservation egg requirements in 2013 were not met on Sand Hill River (82 %) and Southwest Brook (57 %), and were less than the previous six-year mean (2007-12) (Appendix 2). Muddy Bay Brook achieved conservation in 2013 and the percent achieved (125 %) was greater than the previous six-year mean (2007-12) (no data collected in 2010 and 2012) (Appendix 2).

Labrador Straits (SFA 14B)

There are three scheduled salmon rivers in SFA 14B. No rivers were assessed in 2013.

Newfoundland (SFAs 3-14A)

The abundance index of small salmon returning to Newfoundland continues to fluctuate and has generally remained lower than pre-moratorium levels (1984-1991) where adjustments to correct

for marine exploitation have been made (Fig. 7). Abundance decreased dramatically from 2004 to 2007, with the latter being a record low year. Over the next three years abundance increased such that 2010 was the highest recorded since 1988. Following two years of decline in 2011 and 2012, abundance of small salmon increased in 2013, but is below the previous five-year mean (2008-12) (Fig. 7).

Trends in large salmon returns to Newfoundland are similar to that of small salmon (Fig. 8). There was a precipitous decline in abundance of large salmon from the mid-1980s until the early 1990s. Following the closure of the Newfoundland commercial salmon fishery in 1992, abundance of large salmon increased consistently until 1998. Since then there was a general declining trend to 2009. Large salmon abundance increased in 2010 and has been relatively stable with 2013 returns greater than the previous five-year mean (Fig. 8).

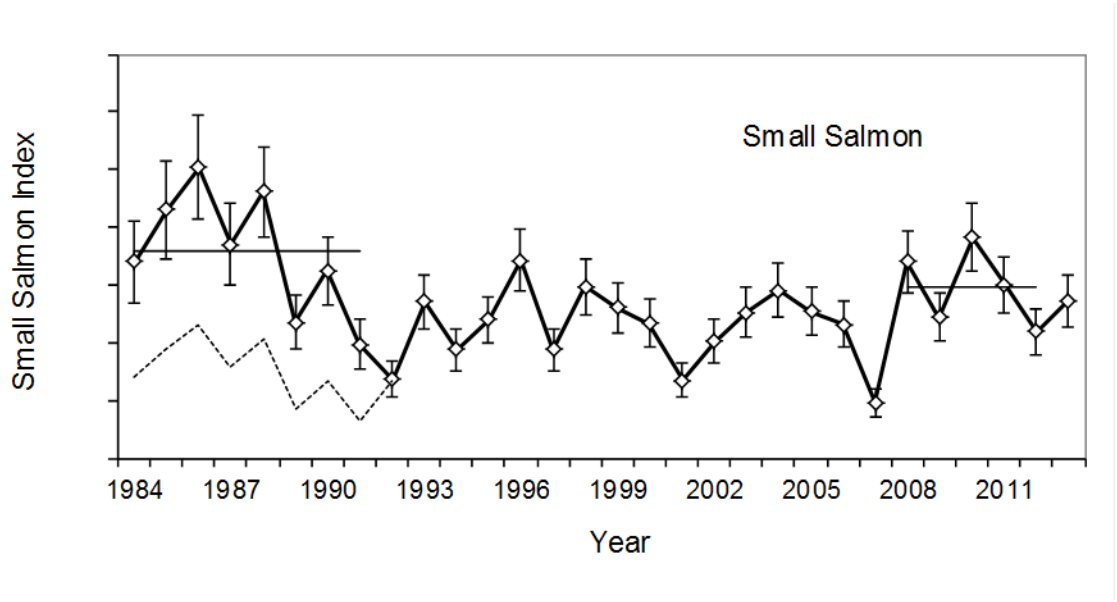

Figure 7. Trends in abundance of small Atlantic Salmon in Newfoundland, 1984-2013. Returns from 1984 to 1991 have been corrected to account for marine exploitation. Horizontal lines illustrate the mean abundance index for the periods 1984-1991 and 2008-12. Vertical lines represent ± 1 standard error. The fine dashed line represents returns unadjusted for exploitation for the period 1984-1991.

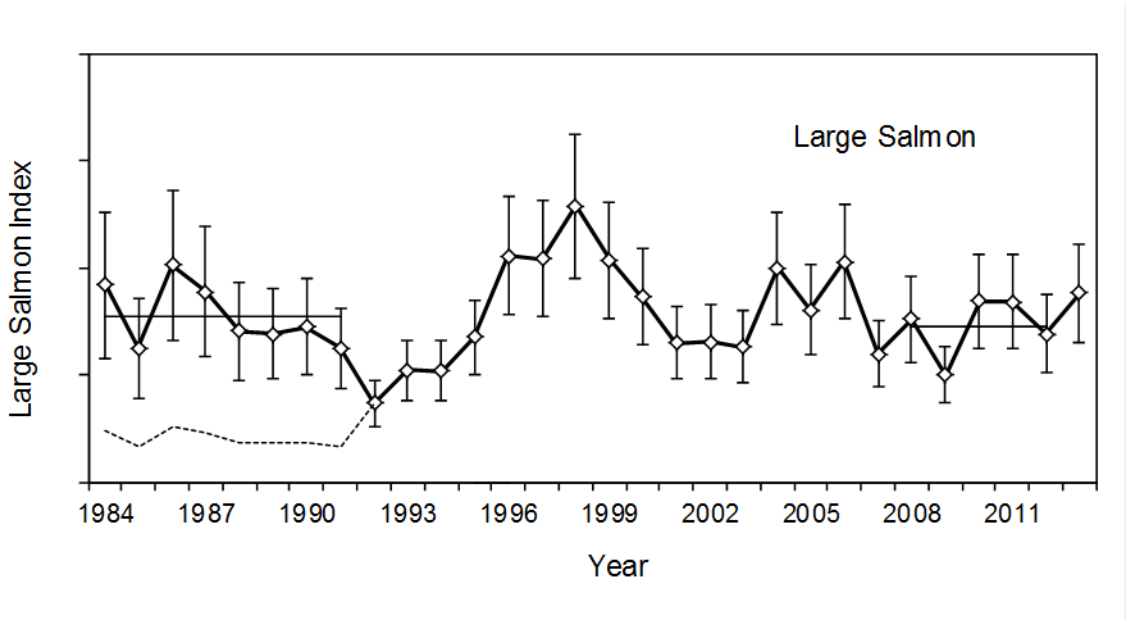

Figure 8. Trends in abundance of large Atlantic Salmon in Newfoundland, 1984-2013. Returns from 1984 to 1991 have been corrected to account for marine exploitation. Horizontal lines illustrate the mean abundance index for the periods 1984-1991 and 2008-12. Vertical lines represent ± 1 standard error. The fine dashed line represents returns unadjusted for exploitation for the period 1984-1991.

Northeast and Eastern Newfoundland (SFAs 3-8)

There are 60 scheduled salmon rivers in SFAs 3-8. Five rivers were assessed in 2013: Exploits River, Campbellton River, and Salmon Brook (tributary of Gander River) in SFA 4, and Middle Brook and Terra Nova River in SFA 5. With the exception of Gander River, all populations were assessed directly from salmon returning to fish counting facilities. The status of Gander River has been inferred from salmon returning to a fishway on Salmon Brook tributary since 2000. No rivers were assessed in SFAs 3, 6, 7, and 8 in 2013.

Compared to their previous five-year means (2008-12), total returns of small and large salmon in 2013 declined on Exploits River and increased on Middle Brook. All other monitored rivers remained similar to the previous five-year means (Appendix 2).

In 2013, conservation egg requirements were achieved at Salmon Brook (184 %) (Gander River estimate was 133 %), Campbellton River (405 %) and Middle Brook (325 %) (Appendix 2). Salmon Brook (Gander River), Campbellton River and Middle Brook have achieved conservation in all of the previous six years. Exploits River (54 %) and Terra Nova River (64 %) have yet to achieve conservation. Large areas of rearing habitat were made accessible in the upper areas of Exploits River (above Red Indian Lake Dam, 1989) and Terra Nova River (above Mollyguajeck Falls, 1985) which influences the calculation of conservation achieved at the watershed level. Three adult salmon counts are conducted on the Exploits River. Assessing these sections separately result in 86 % of conservation requirements attained for the lower section (below Grand Falls), 57 % for the middle section (Grand Falls to Red Indian Lake), and 7 % for the upper section (above Red Indian Lake Dam) (Appendix 2). Data are not available to assess different sections of Terra Nova River.

South Newfoundland (SFAs 9-11)

There are 48 scheduled salmon rivers in SFAs 9-11. Four rivers were assessed in 2013: Northeast Brook (Trepassey) and Rocky River in SFA 9, Conne River and Little River in SFA 11. No rivers were assessed in SFA 10 in 2013.

Total returns in 2013 were similar to or higher than the previous five-year mean (2008-12) at three of the four assessed rivers, with substantive increases occurring at Little River by comparison with 2012 (highest return of small salmon since 2004). Total returns to Rocky River was one of the lowest on record, which can in part be attributed to low smolt production in 2012.

Returns of large salmon were similar to the previous five-year mean on Northeast Brook, Conne River and Rocky River, while they were higher on Little River. As noted in past years, large salmon at rivers such as Conne are predominately alternate spawning grilse.

Despite increased returns at both Conne River and Northeast Brook (Trepassey) in 2013, both rivers have had significant long-term declines in salmon abundance. At Conne River, small salmon have declined by 72 %, while large salmon have decreased by 78 % (1986 to 2013). When examined over the past 15-years (1999-2013) small and large salmon have declined by 33 % and 35 %, respectively. A similar situation has occurred at Northeast Brook (Trepassey). Over the entire period of record (1984-2013), total returns of small salmon have decreased by 50 % with large salmon declining by 94 %. During the past 15 years (1999-2013), returns of small and large salmon have declined by 48 % and 88 %, respectively.

Conservation egg requirements in 2013 were achieved in three of four rivers, with only 25 % attained at Rocky River, the lowest since 2007. Rocky River was made accessible to anadromous salmon following the construction of a fishway at the river mouth. Extensive enhancement activities occurred from 1984-1996. This river has yet to achieve conservation. In contrast, Conne River and Little River have achieved 90 % or more of their conservation requirements in 5 of the past 10 years, while only once, in 2012, has Northeast Brook (Trepassey) failed to achieve conservation.

Environmental conditions in 2013, specifically low water levels at Rocky River, may have contributed to lower returns by delaying or preventing some salmon from entering the river. In addition, the low spawning escapements in 2007 may have impacted the returns of 1SW salmon (River Age 4) in 2013.

Southwest Newfoundland (SFAs 12-13)

There are 10 scheduled salmon rivers in SFA 12. No rivers were assessed in 2013.

There are 18 scheduled salmon rivers in SFA 13. One river was assessed in 2013: Harry's River. Atlantic Salmon were monitored on Harry's River at a location approximately 3 km upstream from the river mouth using a DIDSON sonar system. Total returns of salmon in 2013 were less than the previous five year mean (2008-12) (Appendix 2).

The conservation egg requirement for Harry's River was calculated based on the proportion of large salmon from a five year mean (2006-10) and average angling harvest from the years 2005-07, 2009, and 2012 when the river remained Class III. Harry's River did not achieve conservation (86 %) in 2013. However, Harry's River has achieved conservation in three of the previous six years.

Northwest Newfoundland (SFA 14A)

There are 22 scheduled salmon rivers in SFA 14A. Two rivers were assessed in 2013: Torrent River and Western Arm Brook. Returns of small salmon in 2013 were less than the previous five-year means (2008-12) at Torrent River and Western Arm Brook (Appendix 2), whereas large salmon returns were greater than the previous five-year means at both rivers (2008-12). Lower returns of small salmon on Western Arm Brook in 2013, can in part be attributed to the low smolt count in 2012.

Conservation egg requirements in 2013 were achieved at Torrent River (799 %) and Western Arm Brook (266 %), however these values are less than the previous five-year mean (Appendix 2). Torrent River and Western Arm Brook have achieved conservation annually since 1984 and 1992, respectively.

Smolt Production and Marine Survival

Information on smolt and adult salmon counts are routinely monitored at five rivers: Campbellton River (SFA 4), Northeast Brook (Trepassey) and Rocky River (SFA 9), Conne River (SFA 11), and Western Arm Brook (SFA 14A). Occasionally smolts are also monitored at Sand Hill River, Labrador (SFA 2). With the exception of Conne River smolts, fish are counted directly at monitoring facilities. A mark-recapture method is used to estimate smolt production at Conne River. Estimates of marine survival from smolts to adult small salmon can be derived and examined in relation to trends over time or in view of changes in fisheries management plans.

Smolt production

Smolt production in 2013 decreased at two south coast rivers (SFA 9 and 11) by comparison with the previous five-year means (2008-12) (Fig. 9). Smolt production declined by more than 40 % at Rocky River and was the third year in succession with below average smolt production. There were 62 % fewer smolts recorded at Northeast Brook (Trepassey) with 2013 the lowest number on record. Numbers of smolts produced at Western Arm Brook and Conne River were above their previous five year means, while production at Campbellton River was similar to the mean. Smolts were not monitored at Sand Hill River in 2013. Given the size of Sand Hill River and often unpredictable environmental conditions (i.e. high spring flow), a smolt monitoring fence is not suitable for this site and alternate approaches such as mark-recapture will need to be considered.

Since 1996, the first year of expected increase in smolt production resulting from the commercial salmon moratorium, there has been a general declining trend of smolt numbers at Conne River and Northeast Brook (Trepassey), while there has been no significant trend at Rocky River and Western Arm Brook. Smolts at Campbellton River had declined following the moratorium, but have increased since 2005.

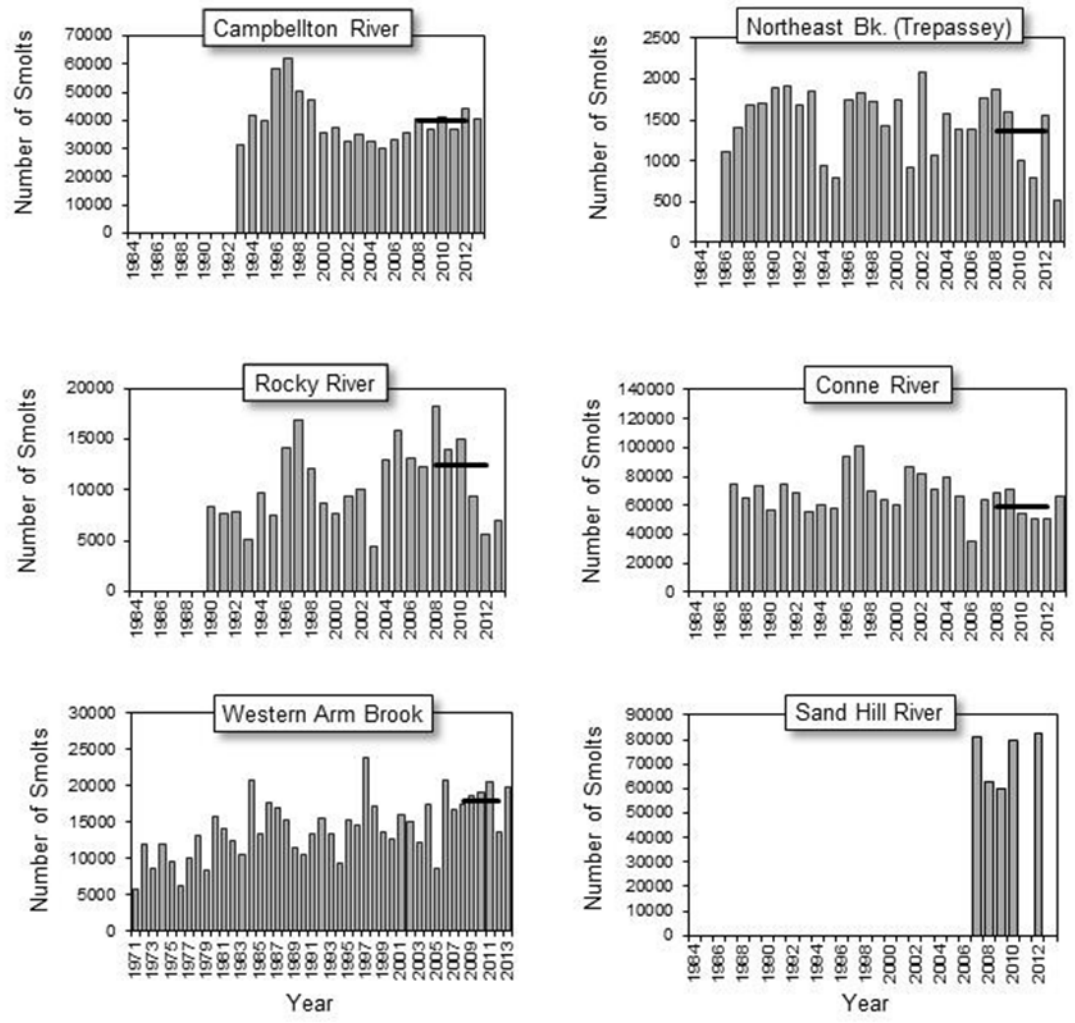

Figure 9. Trends in smolt production at various Newfoundland and Labrador Atlantic Salmon rivers. Horizontal solid line illustrates the mean for the previous five years (2008-12).

Marine survival

Marine survival, corresponding to adult small salmon returns in 2013, averaged 5.5 % across all five insular Newfoundland rivers (Fig. 10). Survival decreased at three of five rivers compared with 2012, while survival increased at Conne River and Northeast Brook (Trepassey). By comparison with the previous five-year mean (2008-12), survival was lower in all rivers except Conne River. Consistent with previous years, survival is generally higher at northern locations (Western Arm Brook and Campbellton River) in comparison with southern populations (Rocky, Conne, and Northeast Trepassey). As returns of small salmon include a portion of repeat spawners, marine survival of smolts to maiden one-sea-winter salmon will be slightly less than the numbers reported here.

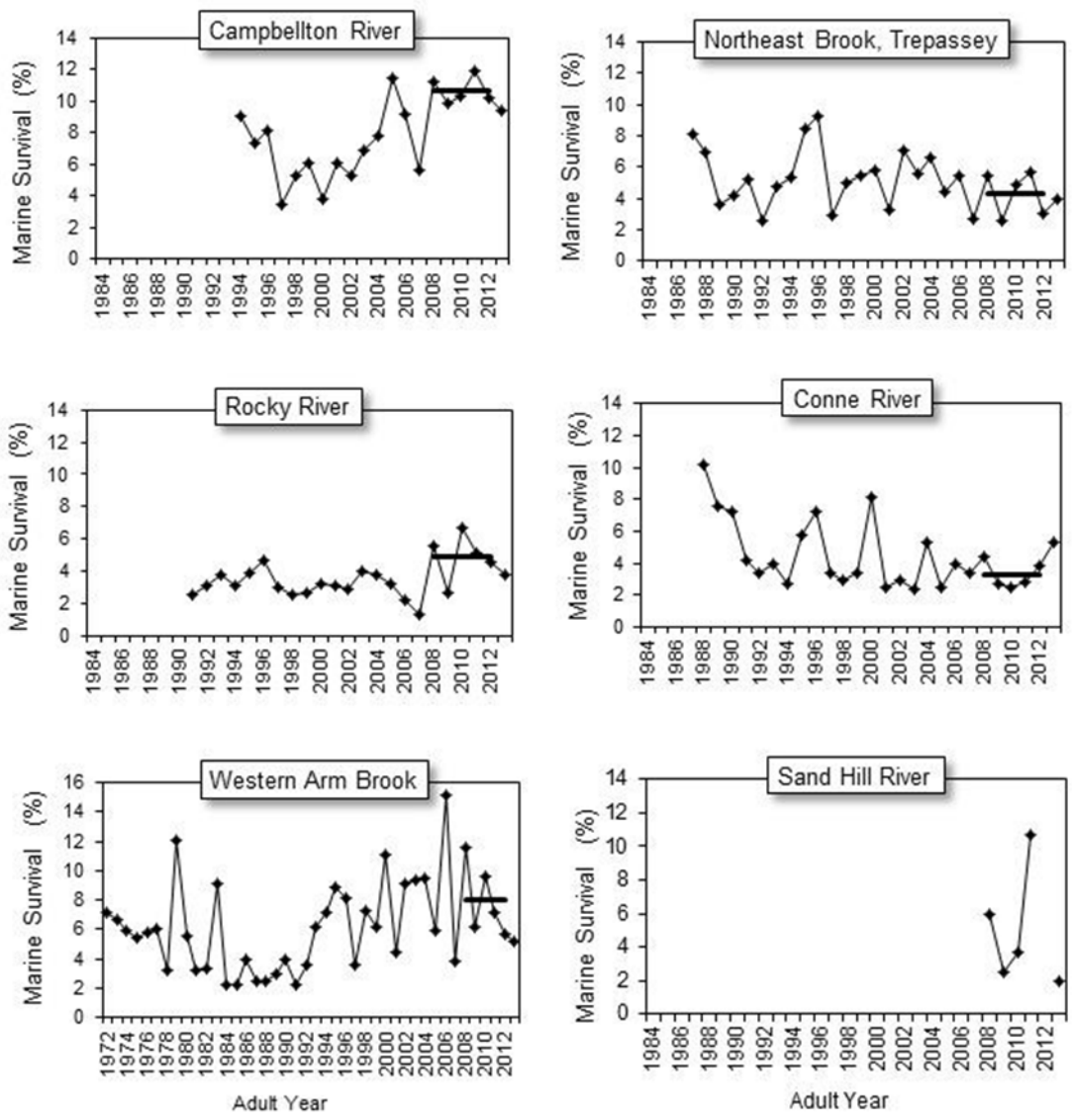

Figure 10. Marine survival rates of smolts to adult small salmon at various Newfoundland and Labrador rivers. Survival rates have not been adjusted for marine exploitation during the commercial salmon fishery (prior to 1992) or for Labrador Aboriginal fisheries. Thus, values represent survival of salmon back to the river. Horizontal solid line illustrates the mean for the previous five years (2007-11).

Marine survival of smolts to adult small salmon was also examined in a collective manner using data from the five assessed rivers in Newfoundland to derive a composite index. The standardized mean survival of smolts in 2012 to adult small salmon returns in 2013 was 5.6 % and is similar to the previous five-year mean (Fig. 11). Over the entire period of record (1986-2013) there is no significant trend in survival. However, survival does fluctuate considerably over the time period of record.

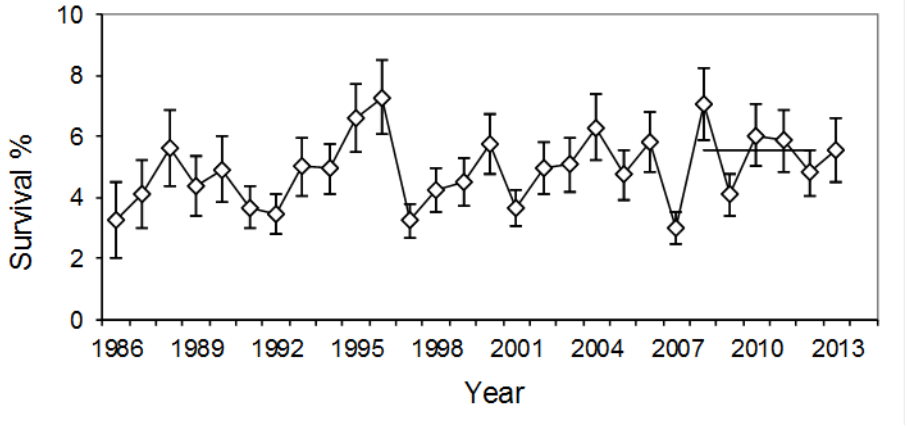

Figure 11. Standardized mean survival of smolts to adult small salmon derived from a general linear model analysis of monitored Newfoundland rivers. X-axis is the year of adult small salmon return. Vertical lines represent one standard error about the mean. Horizontal solid line illustrates the mean for the previous five years (2008-12).

Sources of Uncertainty

No current assessments are available on salmon populations in SFAs 3, 6, 7, 10, 12 and 14B and the Lake Melville area of SFA 1.

Salmon populations in assessed rivers may be unique and not representative of other rivers in the SFA.

Given that the 2013 recreational fishery data are not yet available; the previous five year mean of recreational catch data is used to determine the number of salmon spawners in assessed rivers. Therefore, there is uncertainty in the conservation egg requirements calculated.

Returns to Harry's River in 2013 were derived from abundance data collected using a DIDSON sonar and this makes it difficult to determine the numbers of small and large Atlantic Salmon. Hence, there is some uncertainty in the estimated conservation egg requirement for Harry's River as it was calculated based on the proportion of large salmon from a five-year mean (2006-10) and average angling harvest from the years 2005-07, 2009, and 2012 when the river remained Class III.

Historical or estimated biological characteristic data (e.g. fecundity, sex ratio, female size) are generally used in the assessment process. Given that these values will vary annually, there is uncertainty in the conservation egg requirement values reported where data are limited or not up to date.

The precision of the harvest estimates on a river by river basis is dependent on the number of anglers fishing in a given river. Therefore, uncertainty in the harvest estimate increases on smaller rivers with fewer anglers.

For the genetic analysis of stock composition in the Labrador Aboriginal and subsistence fisheries, the existing reporting groups include a grouping for southern Labrador, which includes a region of the Quebec north shore. As a result of this inability to differentiate some Labrador and Quebec salmon, there is uncertainty regarding the identity of fish assigned to this group, and it is possible that a small proportion of Quebec north shore salmon are exploited in the adjacent marine harvest.

The scaling up of the genetic estimates of stock composition in the samples of the Labrador Aboriginal and subsistence fisheries to the levels of fishery exploitation are dependent on how representative the samples are of the harvest, estimates of total harvest from catch logs, and estimates of total population size for the region, all of which are subject to uncertainty.

There is uncertainty and a lack of information regarding the extent to which escapees (farmed fish) show up in the rivers and the impacts they may have on wild populations.

CONCLUSIONS AND ADVICE

In general, low marine survival continues to be an area of concern and the limiting factor affecting abundance of Newfoundland and Labrador salmon.

The South Newfoundland (SFAs 9-12) Atlantic Salmon populations remain a concern, especially Conne River. COSEWIC (2010) designated South Newfoundland (DU 4) salmon populations as threatened in November 2010. The listing process is ongoing and public consultations are currently underway.

There is a knowledge gap regarding the potential impact the expanding aquaculture industry along the south coast may have on wild Atlantic Salmon populations.

Management Advice

There should be no increase in harvest/allocations on Newfoundland and Labrador salmon populations in 2014, except for areas which have in-season special management plans and where conservation requirements are being met.

There should be no angling or other human induced mortality on populations that are below 100 % conservation egg requirement.

Efforts should be made to improve the number of spawners in South Newfoundland (DU 4) populations and to understand the reasons for the decline.

OTHER CONSIDERATIONS

Wild-farmed Atlantic Salmon interactions

The Atlantic Salmon aquaculture industry has been growing steadily in Newfoundland during the past decade, increasing from a production level of just under 3000 t in 2001 to 16,831 t in 2012. Accompanying this increase is concern about the biological and genetic risks to declining wild populations of Atlantic Salmon and general biodiversity of aquatic ecosystems. Little is known about the behaviour and distribution of escaped Atlantic Salmon from marine cage aquaculture sites on the south coast of Newfoundland, and the extent of their interactions with wild Atlantic Salmon and other species.

Opportunistic sampling was carried out in 2012 (October) and 2013 (May and October) at seven locations (coastal waters and rivers) in proximity to salmon aquaculture sites on the South Coast of Newfoundland. Biological characteristics data were collected from 113 farm-origin Atlantic Salmon, including fork length, whole weight, sexual maturity, and stomach contents and gross visual observations were also noted. Scale samples and adipose fin clips were obtained for later confirmation of farm-origin and genetic analysis, respectively. Results suggest that some escapes can forage for food, survive for many months in freshwater, sexually mature, and cohabitate with wild Atlantic Salmon. This information can help initiate further scientific research

into the biology and behaviour of escaped farmed Atlantic Salmon and provide insights into escape management.

Genetic analysis of food, social and ceremonial Atlantic Salmon fisheries in coastal Labrador

The stock composition and exploitation of Atlantic Salmon in food, social and ceremonial fisheries in coastal Labrador was evaluated using genetic mixture analysis and individual assignment with a microsatellite baseline (15 loci, 11,575 individuals) encompassing the species western Atlantic range. Mixture analysis accuracy to regional reporting groups was >90 %. Together, fishery samples (2006-11; 1,772 individuals) clustered tightly with neighbouring populations, and both Bayesian and maximum likelihood mixture analyses indicate that 85-98 % of the harvest are of Labrador origin. Estimates of fishery associated exploitation were highest for Labrador salmon (4.3-9.4 % per year) and generally < 1 % for other regions. Individual assignment of fishery samples indicates that non-local contributions to the fishery (e.g., Maritimes, Gaspé Peninsula) were rare and occurred primarily in southern Labrador, consistent with discrete migration pathways through the Strait of Belle Isle.

Atlantic Salmon population genetics along southern Newfoundland: the identification of designatable units (DUs) and farmed escapees

In 2010, COSEWIC designated Atlantic salmon populations along southern Newfoundland (DU 4) as threatened. As previous work had shown unusually high genetic differentiation throughout southern Newfoundland, the population structuring in the region was re-examined with extensive parr sampling (2008-12) and both genetic and genomic analysis. Multivariate and Bayesian clustering support a hypothesis of two discrete groups with the dividing boundary located near the Burin Peninsula. Genomic analysis confirms that the groups represent populations that are both discrete and differ adaptively (relevant genes) and represent deep divergent lineages (mtDNA). This analysis is consistent with the presence of two DU's in southern Newfoundland and suggests that a re-assessment for the region is warranted.

Given recent reports of escaped farmed salmon along the south coast of Newfoundland, the potential to use both genetic and genomic tools for identifying farmed escaped Atlantic Salmon and subsequent hybridization was also evaluated. Using an existing baseline of regional wild populations and farmed salmon (i.e. Saint John River strain), accurate identification (>99 %) was possible both with a microsatellite panel (n=15) and targeted SNP (n=96) panels. The ability of both marker types to quantify the presence of hybridization using simulated hybrids was explored. The microsatellite panel was unable to successfully identify or classify hybrid individuals; however, accurate identification of various hybrid classes (F1, F2, etc.) was possible with the targeted SNP panels examined. To further demonstrate the application of genetic approaches for the identification of farmed escapees in southern Newfoundland, tissue samples from 64 suspected farmed escapees sampled from the wild following escapes in 2012 and 2013 were also analyzed. Individual assignment confirmed an aquaculture origin for 97 % of these individuals. Individuals not of aquaculture origin were assigned to wild stocks either in, or adjacent to, their capture location. This work suggests that highly accurate escape and hybrid identification is possible using genetic and genomic tools for Atlantic Salmon in this region.

Accuracy and utility of the Licence Stub Angling Program

The licence stub angling program began in 1994 and was developed to obtain catch and effort data on anglers fishing for Atlantic Salmon in Newfoundland and Labrador. The data collected

from salmon anglers is used annually in DFO's salmon stock assessments as well as in estimates of the total salmon population for the region presented to ICES annually. For data analyses purposes the salmon angling population is split into two groups. Those that return their angling logs (licence stubs) to DFO, either voluntarily or after being prompted by DFO, make up the portion of the angling population that is referred to as Respondents. Approximately 20 % to 25 % of the total angling population, annually, falls into this category. The remaining 75 % to 80 % of the angling population are labeled Non-Respondents. To collect catch and effort data on Non-Respondents, DFO conducts a phone survey of a random sample of the Non-Respondents.

By definition Respondents are a complete population and as such there is no sampling error in the data provided because the entire population has been sampled. That is not to say there is no variability in the data (i.e. not all anglers catch the same number of fish), but the average catch for Respondents, for example, is the true value for that population. Measures of dispersion such as the variance and standard deviation can provide information on the range of values in the catch and effort data, but they are not measures of uncertainty in the population parameter. The same cannot be said for the data collected on the Non-Respondents because only a sample of the Non-Respondents is surveyed. Therefore, there is always uncertainty around how representative a sample of a population is of the entire population. In this case the population is anglers that did not submit an angler log. Estimates of how closely the sample represents the population, or in other words, how accurate the sample is, can be calculated based on sampling statistics. The estimates of accuracy presented in this document, therefore, only apply to the Non-Respondent phone survey data.

Accuracy of surveys, represented by the margin of error (MOE) and the confidence interval (CI), is determined by the population size and the survey sample size. Given that the size of the Non-Respondents population is around 15,000 and the survey sample size averages approximately 1,500, then, at the population level, the survey of Non-Respondents would be considered accurate to within 5 %, 95 % of the time (i.e. MOE ±5 %, CI 95 %). At the river level, because the survey only captures a small number of anglers on any given river, the MOE is much greater for a given CI (Table 1).

Table 1. Estimates of errors in average catch per angler and confidence intervals associated with polling different numbers of anglers (n) in the licence stub phone survey.

River	n	Catch/Angler	Margin of Error ± catch	Margin of Error ± %	CI%
Exploits R.	256	1.61	0.19	12	95
Exploits R.	256	1.61	0.10	10	90
Salmon R.	57	1.38	0.37	27	95
Salmon R.	57	1.38	0.30	22	90
Flat Bay Bk.	28	0.61	0.29	48	95
Flat Bay Bk.	28	0.61	0.24	40	90

Environmental Conditions

Freshwater Environment

In past years, freshwater environmental conditions were inferred by examining the frequency and extent that scheduled salmon rivers were closed for environmental reasons, specifically, low water levels and warm water temperatures. During the 2013 angling season, 33 out of 158 (21 %) scheduled rivers in insular Newfoundland were closed. Closures primarily affected SFAs 3 and 4 on the northeast and east coast and SFAs 9 and 10 on the south coast. Closures generally occurred in mid-to-late July. Overall, 2.3 % of all potential fishing days were affected by environmental closures (Fig. 12).

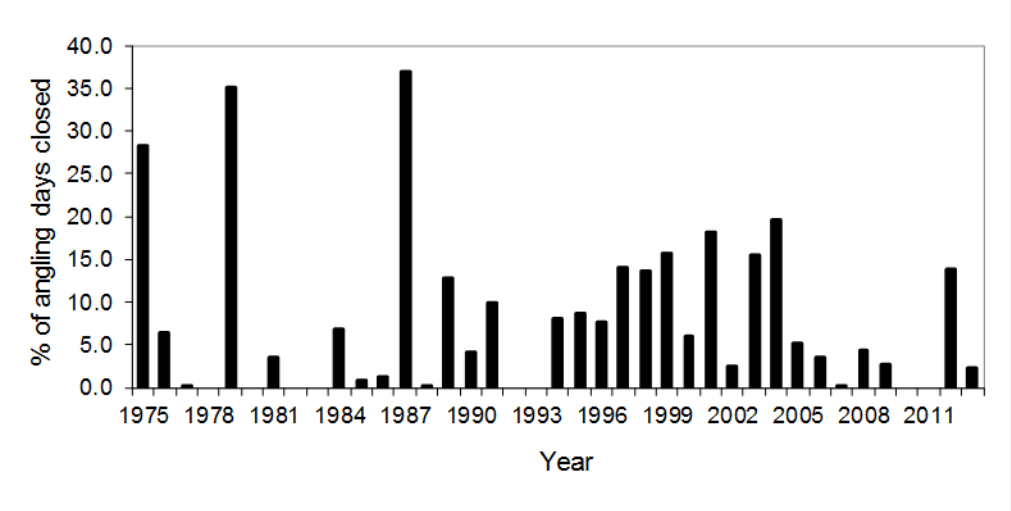

Figure 12. Percentage of potential angling days in insular Newfoundland that were closed for environmental reasons, 1975-2013.

SOURCES OF INFORMATION

This Science Advisory Report is from the December 3-4, 2013, Update on the Status of Atlantic Salmon in Newfoundland & Labrador. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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APPENDIX 1: SUBSISTENCE ATLANTIC SALMON FISHERIES LANDINGS IN LABRADOR AS OF NOVEMBER 1999-2012

Table 2. Subsistence Atlantic Salmon Fisheries Landings in Labrador as of November 1999-2012 – SFA 1.

Year	Number - small salmon	Weight (kg) – small salmon	Number – large salmon	Weight (kg) – large salmon	Total - Number	Total - Weight (kg)
1999	2739	5580	1084	4220	3824	9800
2000	4111	8111	1092	4365	5203	12474
2001	3394	6995	1299	5121	4708	12117
2002	3609	7386	1015	4441	4624	11827
2003	4382	9094	1639	7026	6021	16120
2004	4822	10038	2210	8656	7032	18694
2005	4958	10116	1687	6930	6644	17046
2006	5422	11189	1639	6330	7061	17519
2007	4700	8306	1560	5314	6261	13619
2008	5154	10342	2955	13627	8109	23968
2009	3964	8173	1907	8232	5871	16405
2010	5904	12630	2606	11004	8510	23634
2011	6477	13844	2947	12816	9424	26660
2012	5744	10629	3132	14122	8901	24750

Table 3. Subsistence Atlantic Salmon Fisheries Landings in Labrador as of November 1999-2012 – SFA 2.

Year	Number – small salmon	Weight (kg) – small salmon	Number – large salmon	Weight (kg) – large salmon	Total - Number	Total - Weight (kg)
1999	-	-	-	-	-	-
2000	1212	2242	260	897	1472	3139
2001	1396	2793	374	1378	1770	4172
2002	2197	4196	422	1549	2619	5745
2003	2095	4102	536	1885	2632	5987
2004	3480	7166	1450	5480	5050	12852
2005	5479	10922	1130	3946	6609	14868
2006	4955	10008	1451	5193	6406	15201
2007	4507	8764	1092	4073	5599	12837
2008	4680	9044	954	3349	5634	12393
2009	4024	7956	1437	5449	5461	13405
2010	3963	7893	1119	4066	5081	11959
2011	4665	9285	1501	5409	6165	14694
2012	4237	8110	1066	3699	5303	11809

APPENDIX 2: SUMMARY OF ATLANTIC SALMON STOCK STATUS IN NEWFOUNDLAND AND LABRADOR, 2013

Table 4. Summary of Atlantic Salmon Stock Status in Labrador, 2013: Total Returns.

River	SFA	Method	2013 Small	2013 Large	2007-12 Mean Small	2007-12 Mean Large
English River	1	Fe	467	160	392	81
Sand Hill River	2	Fe	1,646	1,271	4,010	707
Muddy Bay Brook	2	Fe	296	36	294	20
Southwest Bk. (Paradise River)	2	Fe	79	63	272	27

Table 5. Summary of Atlantic Salmon Stock Status in Labrador, 2013: Conservation Egg Requirement Achieved (%).

River	SFA	Method	2013	2007-12 Mean	2007-12	Conservation Achieved Relative to 2007-12 Mean
English River	1	Fe	188	122	6 of 7 yrs	Increase
Sand Hill River	2	Fe	82	105	2 of 7 yrs	Decrease
Muddy Bay Brook	2	Fe	125	113	3 of 5 yrs	Increase
Southwest Bk. (Paradise River)	2	Fe	57	90	3 of 7 yrs	Decrease

Table 6. Summary of Atlantic Salmon Stock Status in Newfoundland-Northeast Coast (SFAs 3-8): Total Returns.

River	SFA	Method	2013 Small	2013 Large	2008-12 Mean Small	2008-12 Mean Large
Exploits River	4	Fw	29,041	4,923	32,685	6,104
Campbellton River	4	Fe	4,119	484	4,072	496
Gander River[1]	4	EFw	24,691	1,379	22,625	1,475
Salmon Brook (Gander River)	4	Fw	1,612	90	1,435	94
Middle Brook	5	Fw	3,136	182	2,526	142
Terra Nova River	5	Fw	3,923	390	3,762	415

Table 7. Summary of Atlantic Salmon Stock Status in Newfoundland-Northeast Coast (SFAs 3-8): Conservation Requirement Achieved (%).

River	SFA	Method	2013	2008-12 Mean	2008-13	Conservation Achieved Relat2ve to 2008-11 Mean
Exploits River	4	Fw	54	64	0 of 6 yrs	Decrease
Lower Exploits River	4	Fw	86	128	4 of 6 yrs	Decrease
Middle Exploits River	4	Fw	57	61	0 of 6 yrs	No change
Upper Exploits	4	Fw	7	7	0 of 6 yrs	No change
Campbellton River	4	Fe	405	400	6 of 6 yrs	No change
Gander River[1]	4	EFw	133	121	6 of 6 yrs	No change
Salmon Brook (Gander River)	4	Fw	184	162	6 of 6 yrs	Increase
Middle Brook	5	Fw	325	249	6 of 6 yrs	Increase
Terra Nova River	5	Fw	64	63	0 of 6 yrs	No change

Table 8. Summary of Atlantic Salmon Stock Status in Newfoundland-South Coast (SFAs 9-11): Total Returns.

River	SFA	Method	2013 Small	2013 Large	2008-12 Mean Small	2008-12 Mean Large
Northeast Brook (Trepassey)	9	Fe	62	3	61	2
Rocky River	9	Fe	212	31	667	38
Little River	11	Fe	385	9	145	3
Conne River	11	Fe	2,710	91	1,984	89

Table 9. Summary of Atlantic Salmon Stock Status in Newfoundland-Southwest Coast (SFAs 12-13): Total Returns.

River	SFA	Method	2013 Small/Large	2008-12 Mean Small/Large
Harry's River[2]	13	D	2,943	3,301

Table 10. Summary of Atlantic Salmon Stock Status in Newfoundland-Northwest Coast (SFA 14A): Total Returns.

River	SFA	Method	2013 Small	2013 Large	2008-12 Mean Small	2008-12 Mean Large
Torrent River	14A	Fw	2,106	1,623	3,914	1,240
Western Arm Bk.	14A	Fe	705	73	1,458	50

Table 11. Summary of Atlantic Salmon Stock Status in Newfoundland-South Coast (SFAs 9-11): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2013	2008-12 Mean	2008-13	Conservation Achieved Relat2ve to 2008-11 Mean
Northeast Brook (Trepassey)	9	Fe	148	139	5 of 6 yrs	No change
Rocky River	9	Fe	25	70	0 of 6 yrs	Decrease
Little River	11	Fe	169	63	2 of 6 yrs	Increase
Conne River	11	Fe	101	80	2 of 6 yrs	Increase

Table 12. Summary of Atlantic Salmon Stock Status in Newfoundland-Southwest Coast (SFAs 12-13): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2013	2008-12 Mean	2008-13	Conservation Achieved Relat2ve to 2008-11 Mean
Harry's River[2]	13	D	86[3]	96	3 of 6 yrs	Decrease

Table 13. Summary of Atlantic Salmon Stock Status in Newfoundland-Northwest Coast (SFA 14A): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2013	2008-12 Mean	2008-13	Conservation Achieved Relat2ve to 2008-11 Mean
Torrent River	14A	Fw	799	912	6 of 6 yrs	Decrease
Western Arm Bk.	14A	Fe	266	513	6 of 6 yrs	Decrease

Table 14. Summary of Atlantic Salmon Stock Status in Newfoundland (SFAs 3-14A): Smolt Abundance.

River	SFA	Method	Smolts Relative to 2008-12 Mean	Marine Survival Relative to 2008-12 Mean
Campbellton River	4	Fe	No change	Decrease
Northeast Brook (Trepassey)	9	Fe	Decrease	No change
Rocky River	9	Fe	Decrease	Decrease
Conne River	11	CMR	Increase	Increase
Western Arm Bk.	14A	Fe	Increase	Decrease

Methods:

Fe = counting fence, Fw = fishway, EFw = estimated from tributary fishway, D = DIDSON (Dual-Frequency IDentification SONar), CMR = estimate from Capture-Mark-Recapture

Trends:

No Change = ± 10%, Increased = > 10% increase, Decreased = > 10% decrease

Marine survival is from smolts in year i to small salmon in year i +1.

190 eggs/100 m^2 was used to determine the conservation levels for Labrador rivers.

[1] Gander River was assessed using a counting fence 1989-99, and has since been estimated from a tributary count on Salmon Brook.

[2] Harry's River shows total returns of salmon (small + large).

[3] Based on proportion of large from 5 year average (2006-10).

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