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Canadian Science Advisory Secretariat
Newfoundland and Labrador Region **Science Advisory Report 2017/035**

STOCK ASSESSMENT OF NEWFOUNDLAND AND LABRADOR ATLANTIC SALMON – 2016

Image: Atlantic Salmon (Salmo salar).

Figure 1. Map of the Newfoundland and Labrador Region showing Salmon Fishing Areas (SFAs) 1-14B.

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, timing of return migration, 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 (SFAs 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 as either consecutive or alternate spawning fish. 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 (Fisheries and Oceans Canada [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 February 28 to March 1, 2017 Regional Peer Review Process "Assessment of Atlantic Salmon in NL." Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

SUMMARY

- Seventeen river populations of Atlantic Salmon were assessed in 2016. Adult salmon were enumerated on four rivers in Labrador and 13 rivers in Newfoundland. Three of the 13 assessed rivers in Newfoundland also enumerated juvenile salmon (smolt) migrating to sea.
- In 2016, Atlantic Salmon conservation egg requirements were achieved on one (25%) of the four assessed rivers in Labrador and seven (54%) of the 13 assessed rivers in Newfoundland.
- Seven of 14 (50%) monitored rivers recorded declines in total returns of greater than 30% in 2016 compared to their previous five-year mean. Declines of this magnitude over a wide geographic range are highly unusual for the NL Region warranting caution in managing stocks in 2017.
- Marine survival appears to be the major factor limiting the abundance of Atlantic Salmon within the region. Inter-annual variation in marine survival continues to fluctuate with survival in 2016 averaging 7.1% across three monitored rivers.
- Labrador Aboriginal and subsistence fisheries harvest was inferred from logbook returns (70% return rate) at 13,252 salmon (39 t) in 2016, which was 7% less, by number, than the previous six-year mean (2010-15) of 14,266 salmon (38 t).
- Recreational catch statistics for NL have been highly variable since 2005. Estimates of retained salmon in 2016 was 31,191 (55 t) and total catch (68,493 salmon, retained + 37,302 released) were 19% and 26% greater by number, respectively; than the previous five-year mean (2011-15).
- Genetic analysis of mixed stock Atlantic Salmon fisheries in coastal Labrador (2006-14), West Greenland (2011-14), and St. Pierre et Miquelon (2004, 2011-14), revealed significant differences in stock composition with Labrador exploiting 95.3% Labrador origin salmon. The other two fisheries exploited mixtures of migratory individuals.
- Total exploitation of the NL salmon populations by the three mixed stock fisheries (Labrador, West Greenland and St. Pierre et Miquelon) was less than 10% for large and 5% for small salmon.
- Genetic analysis of juvenile Atlantic Salmon from southern Newfoundland revealed that hybridization between wild and farmed salmon was extensive throughout Fortune Bay and Bay d'Espoir (17 of 18 locations), with one-third of all juvenile salmon sampled being of hybrid ancestry.
- The long-term consequences of continued farmed salmon escapes and subsequent interbreeding with wild Atlantic Salmon include a loss of genetic diversity.
- With respect to reference points it was proposed that the lower Limit Reference Point be set at the current conservation limit (100% CL) and the interim Upper Stock Reference point be set at 150% CL.

BACKGROUND

Recreational Fisheries

The recreational Atlantic Salmon fishery is managed according to a River Classification System, which is used to establish retention levels based on the health of individual salmon populations, without jeopardizing conservation goals. A five-year Integrated Atlantic Salmon Fisheries Management Plan was introduced for Newfoundland and Labrador (NL) in 2014 which was used to guide management decisions for 2016.

In 2016, the recreational salmon fishery for all Labrador rivers opened June 15 and closed September 15. Retention of large salmon has not been permitted in Labrador since 2011. In Salmon Fishing Area (SFA) 1 and some SFA 2 unclassified scheduled rivers, anglers could retain four small salmon for the season (Class 4); other scheduled salmon rivers in SFA 2 and all SFA 14B had a two fish retention (Class 2). 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). Recreational 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 2016 recreational salmon fishery for all Newfoundland rivers opened on June 1 and closed on September 7. A fall catch-and-release angling fishery occurred on Class 6 rivers from September 8 to October 7 (retention permitted on main stem of Gander River from August 1 to October 7). Retention of large salmon in Newfoundland has not been permitted since 1984.

The 2016 recreational catch statistics were derived from angler logs (Licence Stub Returns) and a phone survey of anglers that did not return their logs (non-respondents). While considered complete at this time, recreational catch and effort data may be adjusted if sufficient new information is received by DFO (e.g. additional vendor licences). Recreational catch for the NL Region from 1994 to 2016 is presented in Figure 2. Retained and released catches have been variable since 2005. The estimate of retained catch for 2016 was 31,191 salmon (55 t) and total catch was 68,493 salmon (retained + 37,302 released). Retained catch and total catch in 2016 were 19% and 26% greater by number, respectively, than the previous five-year mean (2011-15). Released catch in 2016 was 32% greater than the previous five-year mean (2011-15).

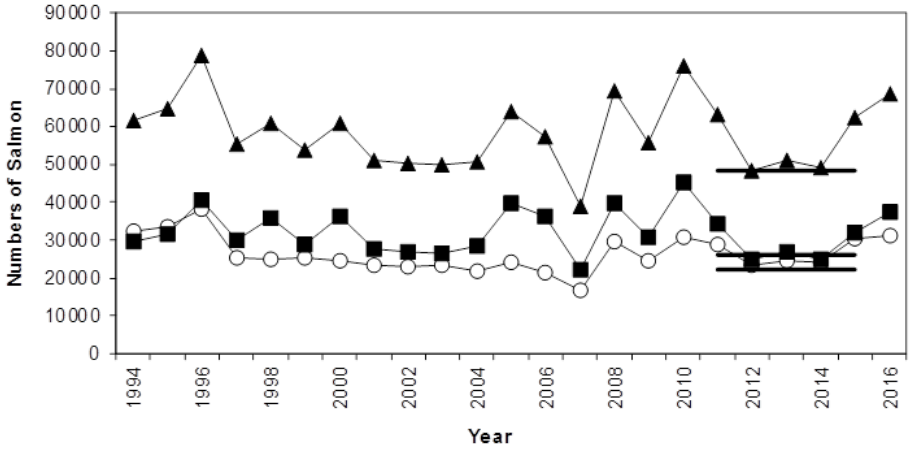

Figure 2. Recreational catch of Atlantic Salmon for NL (1994-2016): total retained (open circles), total released (black squares) and total catch (black triangles). Horizontal solid line represents the previous five-year mean (2011-15).

Aboriginal/Subsistence Fisheries

There has been no commercial salmon fishing in Newfoundland (SFAs 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 charr with a permitted retention of salmon by-catch (three salmon since 2011). In Newfoundland, Miawpukek First Nation hold a FSC communal salmon fishing licence, but have chosen not to harvest salmon under this licence since 1997 due to conservation concerns.

Labrador Aboriginal FSC and subsistence fisheries harvest was inferred from logbook returns (70% return rate) at 13,252 salmon (39 t) in 2016, which was 7% less than the previous six-year mean (2010-15) of 14,266 salmon (38 t) (Fig. 3, Appendix 1). Large salmon represented 43% (5,651) of the catch by number and 64% (25 t) by weight. Harvest estimates for 2016 are preliminary.

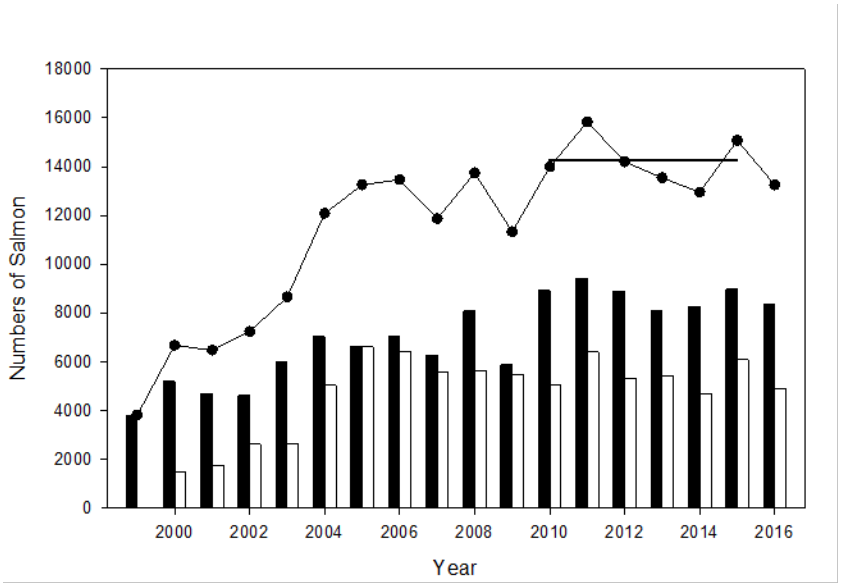

Figure 3. Atlantic Salmon harvested (number of fish) in Labrador Aboriginal and subsistence fisheries in SFA 1 (black bars), SFA 2 (white bars) and total harvest (black circles) from 1999 to 2016. Horizontal solid line represents the previous six-year mean of total harvest (2010-15). Harvest estimates for 2016 are preliminary.

ASSESSMENT

Seventeen NL river populations of Atlantic Salmon were assessed in 2016. Adult salmon were enumerated on four rivers in Labrador and 13 rivers in Newfoundland. Three rivers in Newfoundland also enumerated juvenile salmon (smolt) migrating to sea (Fig. 4). Two additional rivers (Garnish River and Conne River) attempted a smolt enumeration, but were unsuccessful as a result of unsuitable environmental conditions (high water).

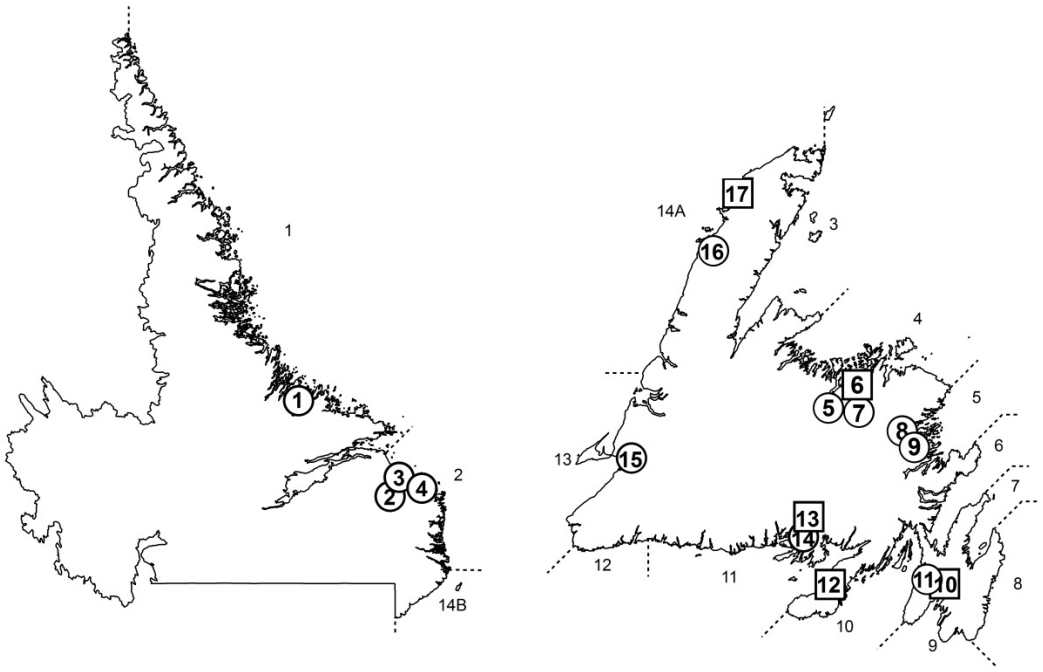

Figure 4. Map showing the locations of rivers in SFAs 1–14B where Atlantic Salmon populations were monitored in 2016: (1) English River, (2) Southwest Brook [Paradise River], (3) Muddy Bay Brook, (4) Sand Hill River, (5) Exploits River, (6) Campbellton River, (7) Salmon Brook [Gander River], (8) Middle Brook, (9) Terra Nova River, (10) Rocky River, (11) Northeast River, Placentia Bay, (12) Garnish River, (13) Conne River, (14) Little River, (15) Harry's River, (16) Torrent River, (17) Western Arm Brook. Adult counts (circles); Adult and smolt counts (squares); SFA boundary (dotted line).

Resource Status–Adult Salmon

Newfoundland and Labrador (SFAs 1 to14B)

In 2016, Atlantic Salmon conservation egg requirements were achieved on one (25%) of the four assessed rivers in Labrador and seven (54%) of the 13 assessed rivers in Newfoundland.

Seven of 14 (50%) monitored rivers, those with recent long-term monitoring records, recorded declines in total returns of greater than 30% in 2016 compared to the previous five-year mean. Declines of this magnitude over a wide geographic range are highly unusual for the NL Region and resulted in the triggering of a regional advisory process meeting.

Northern Labrador and Lake Melville (SFA 1)

There are nine scheduled salmon rivers in SFA 1. One river was assessed in 2016: English River, near Postville.

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

English River achieved 255% of its conservation egg requirement in 2016, which is greater than the previous six-year mean (2010-15) (Appendix 2). English River has achieved conservation in six of the last seven years.

Southern Labrador (SFA 2)

There are 16 scheduled salmon rivers in SFA 2. Three rivers were assessed in 2016: Sand Hill River, Muddy Bay Brook (Dykes River) and Southwest Brook (tributary of Paradise River).

In 2016, total returns of small salmon were less than the previous six-year mean (2010-15) on all three of the monitored rivers, whereas total returns of large salmon were greater than the six-year mean on Sand Hill River but less than the previous six-year mean on Muddy Bay Brook and Southwest Brook (Appendix 2).

Conservation egg requirements in 2016 were not met on any of the three assessed rivers: (Sand Hill River 60%; Muddy Bay Brook 93%; or Southwest Brook 38%). Conservation egg requirements were less than the previous six-year mean (2010-15) on all three rivers (Appendix 2). However, it should be noted that no data were collected in 2010 and 2012 for Muddy Bay Brook.

Labrador Straits (SFA 14B)

There are three scheduled salmon rivers in SFA 14B. No rivers were assessed in 2016.

Northeast and Eastern Newfoundland (SFAs 3-8)

There are 60 scheduled salmon rivers in SFAs 3-8. Five rivers were assessed in 2016: Exploits River, Campbellton River, and Salmon Brook (tributary of Gander River) in SFA 4, and Middle Brook and Terra Nova River in SFA 5. No rivers were assessed in SFAs 3, 6, 7, and 8 in 2016.

Compared to their previous five-year means (2011-15), total returns of small and large salmon in 2016 declined on Exploits River, Campbellton River, and Middle Brook. The number of small salmon also declined on Salmon Brook, whereas the number of large salmon was greater than the previous five-year mean. On Terra Nova River, the number of small salmon was greater than the previous five-year mean, while large salmon remained unchanged (<10% change) (Appendix 2).

In 2016, conservation egg requirements were achieved on Campbellton River (242%), Salmon Brook (117%), and Middle Brook (275%) (Appendix 2). These three rivers have achieved conservation in all of the previous six years. Exploits River (36%) and Terra Nova River (85%) have yet to achieve conservation. Large areas of rearing habitat were made accessible in the upper areas of Exploits River (above Red Indian Dam, 1989) and Terra Nova River (above Mollyguajeck Falls, 1985) which has not been fully colonized and hence influences the calculation of conservation achieved at the watershed level. Three adult salmon counts are conducted on the Exploits River: at Bishop's Falls, Grand Falls and Red Indian Lake dam. Assessing the Exploits River in three separate sections resulted in 36% of conservation egg requirements attained for the lower section (below Grand Falls), 44% for the middle section (Grand Falls to Red Indian Lake), and 3% for the upper section (above Red Indian Lake dam) (Appendix 2).

South Newfoundland (SFAs 9-11)

There are 48 scheduled salmon rivers in SFAs 9-11. Five rivers were assessed in 2016: Rocky River in SFA 9, Northeast River, Placentia Bay in SFA 10, Garnish River, Conne River and Little River in SFA 11.

Total returns of small salmon on Conne River in 2016 were below the previous five-year mean (2011-15) (Appendix 2) and the lowest recorded in the 31-year time series. Returns of large salmon were also lower than the previous five-year mean (Appendix 2). Only 56% of the conservation egg requirement was achieved.

Since monitoring began in 1986, returns of small salmon on Conne River have decreased by 74%, while large salmon have declined by 79%, whereas over the past 15 years (2002-16) abundance has fallen by 41% and 40%, for small and large salmon respectively, with no indication that salmon returns will improve.

Little River showed a similar trend as Conne River in 2016 with total returns less than the previous five-year mean and only 22% of the conservation egg requirement achieved (Appendix 2).

The fishway on Rocky River was undergoing reconstruction and therefore not operational in 2015. Fish were captured and transferred into Rocky River, but the 2015 returns likely do not reflect the number of fish that would have returned to the river had the fishway been operational. Although fishway construction was completed on Rocky River in 2016 prior to the upstream salmon migration, there were still some operational issues that likely prevented all returning fish from entering the river. Nevertheless total returns of small salmon were less than the previous five-year mean (which included the 2015 return year), while large salmon were similar to the five-year mean. If we exclude the 2015 returns, then total returns are 45% and 1% below the previous five-year mean for small and large fish, respectively. Only 29% of the conservation egg requirement was achieved on Rocky River in 2016. The low returns in both 2015 and 2016 could influence adult returns in subsequent years.

Historically, Northeast River in Placentia Bay was assessed from 1984 to 2002. After a period with no counts (2003-14), the river was assessed again in 2015 and 2016. Using the 10 years of returns from 1993-2002 for comparative purposes the counts have not changed significantly. In 2016, total returns of small salmon were 10% greater, while large salmon were 20% less than the 10-year mean (1993-2002). The conservation egg requirements were exceeded in both years (Appendix 2).

Garnish River was first assessed in 2015 and again in 2016. In 2016, returns of small and large salmon were 56% and 54% below the previous year and only 21% of the conservation egg requirement was achieved.

Southwest Newfoundland (SFAs 12-13)

There are 10 scheduled salmon rivers in SFA 12. No rivers were assessed in 2016.

There are 18 scheduled salmon rivers in SFA 13. One river was assessed in 2016: 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 2016 were greater than the previous five-year mean (2011-15) (Appendix 2).

The conservation egg requirement for Harry's River was calculated based on the proportion of large salmon, as determined from length measurements taken from the DIDSON sonar images, combined with the 2016 recreational harvest. Harry's River achieved conservation (125%) in 2016 and has achieved conservation in four of the previous six years.

Northwest Newfoundland (SFA 14A)

There are 22 scheduled salmon rivers in SFA 14A. Two rivers were assessed in 2016: Torrent River and Western Arm Brook. Returns of small salmon in 2016 were similar to the previous five-year mean (2011-15) on Torrent River and Western Arm Brook (Appendix 2), whereas large salmon returns were less than the previous five-year mean on Torrent River but greater on Western Arm Brook. Conservation egg requirements were exceeded on both rivers in 2016 (Torrent River 658% and Western Arm Brook 502%). Torrent River and Western Arm Brook have achieved conservation annually since 1984 and 1992, respectively.

Smolt Production and Marine Survival

Smolt and adult salmon counts were monitored on five rivers in 2016: Campbellton River (SFA 4), Rocky River (SFA 9), Garnish River (SFA 11), Conne River (SFA 11), and Western Arm Brook (SFA 14A). However, the smolt fences washed out on Garnish River and Conne River due to higher than normal water leverls, and conduit was removed from Rocky River for three days to prevent a washout. Therefore, no smolt estimate was available for Conne River and the smolt count on Garnish River of 2,751 should be considered a minimum estimate and hence an unreliable indicator of freshwater productivity for that year. It is not believed the smolt count on Rocky River was severely compromised by the removal of conduit.

Smolt are counted directly at monitoring facilities with the exception of Conne River, where a mark-recapture method is used to estimate smolt production. Smolt counts can be used to estimate smolt to adult small salmon survival, which provides insights into marine survival trends over time.

Smolt production

Smolt production in 2016 decreased on Western Arm Brook (SFA 14A) and Rocky River (SFA 9) but increased on Campbellton River in comparison with the previous five-year means (2011-15) (Fig. 5). Smolt production on Rocky River appears to be in a low production phase and is expected to continue as adult returns have been in decline. The low returns on Rocky River in 2015 and 2016 are, in part, a result of the fishway replacement and related operational challenges.

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 on Conne River and no significant trend on Western Arm Brook. The number of smolt on Campbellton River had declined following the moratorium but have increased since 2005.

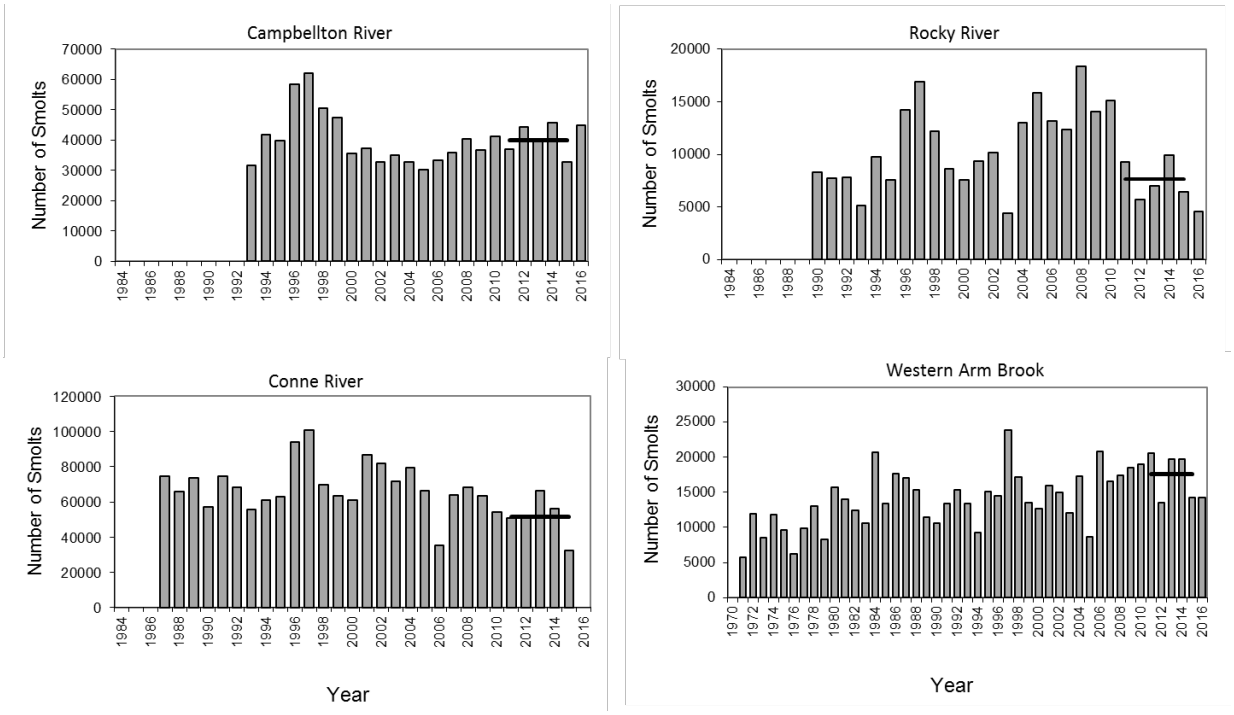

Figure 5. Smolt production on various Newfoundland and Labrador Atlantic Salmon rivers. Horizontal solid line illustrates the previous five-year mean (2011-15).

Marine survival

Marine survival, corresponding to adult small salmon returns in 2016, averaged 7.1% across the three monitored rivers (Campbellton River, Rocky River, Western Arm Brook) which had complete smolt counts (Fig. 6). Survival has been decreasing in recent years on Campbellton River and increasing on Western Arm Brook. However, the trends on either river are not outside the normal variation observed over the time series. Consistent with previous years, survival is generally higher at northern locations (Western Arm Brook and Campbellton River) by comparison with southern populations (Rocky River and Conne River). As returns of small salmon include a portion of repeat spawners, marine survival of smolt to maiden one-sea-winter salmon will be slightly less than the numbers reported here.

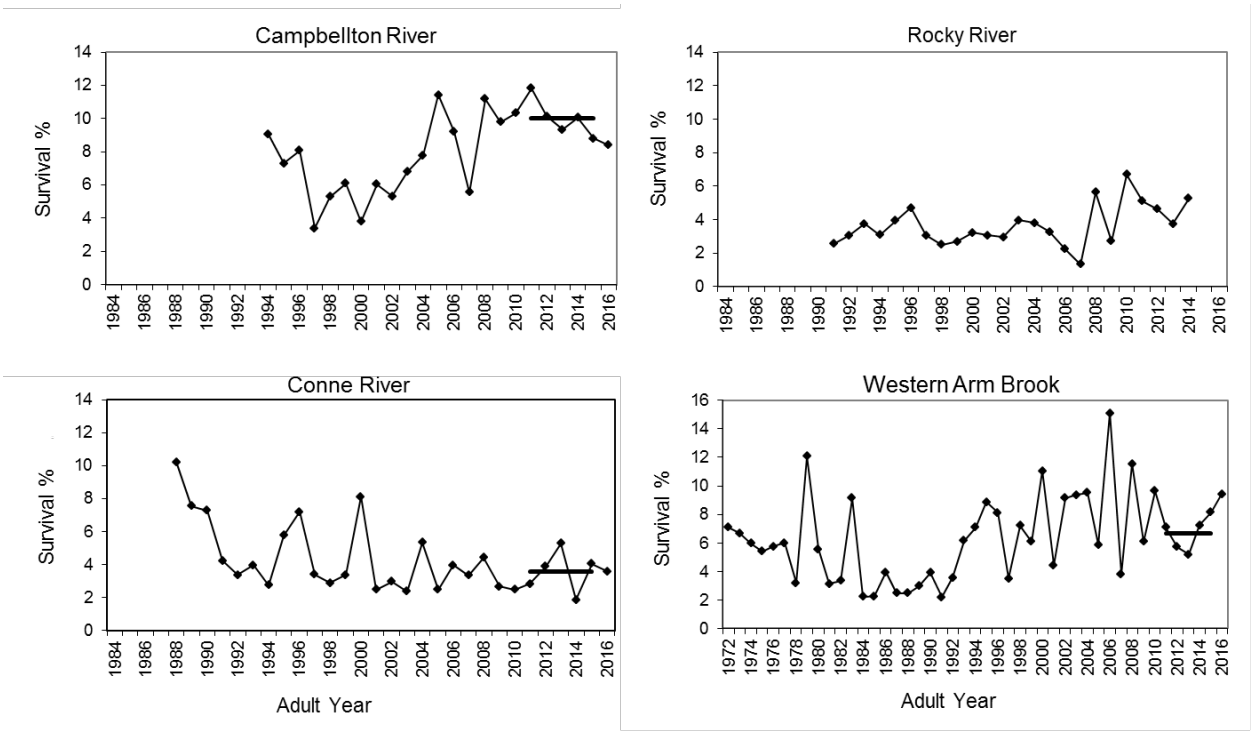

Figure 6. Marine survival rates of smolt to adult small salmon on various NL rivers. Survival rates have not been adjusted for marine exploitation during the commercial salmon fishery (prior to 1992) or for Labrador Aboriginal fisheries. Thus, values represent survival of salmon back to the river. Horizontal solid line illustrates the previous five-year mean (2011-15).

Sources of Uncertainty

No current assessments are available on salmon populations in SFAs 3, 6, 7, 8, 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.

Returns to Harry's River in 2016 were derived from abundance data collected using a DIDSON sonar unit and this makes it difficult to determine the exact numbers of small and large Atlantic Salmon. Hence, there is some uncertainty in the estimated number of eggs deposited for Harry's River as it was calculated based on the proportion of large salmon from average lengths obtained using sonar images.

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

Estimates of recreational catch and effort data are dependent on the number and accuracy of angler licence stubs completed and returned each year. Similarly, FSC and subsistence harvest estimates in Labrador are dependent on the number and accuracy of logbooks compiled and returned. For all salmon fisheries, uncertainty exists where either inaccurate or incomplete information is provided.

CONCLUSIONS AND ADVICE

Seventeen river populations of Atlantic Salmon were assessed in 2016. Seven of these populations recorded declines in total returns of greater than 30% by comparison with their previous five-year means.

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

There is genetic evidence that farmed salmon escapees are breeding with wild Atlantic Salmon in southern Newfoundland. The long-term consequences of continued farmed salmon escapes and subsequent interbreeding with wild Atlantic Salmon include a loss of genetic diversity.

Total exploitation of the NL salmon population by the three mixed stock fisheries (Labrador, West Greenland and St. Pierre et Miquelon) was less than 10% for large and 5% for small salmon.

The South Newfoundland (SFAs 9-12) Atlantic Salmon populations remain a concern, especially Conne River. COSEWIC (2010) designated South Newfoundland (Designatable Unit, DU 4) salmon populations as threatened in November 2010. The SARA listing process is ongoing.

Management Advice

Caution is warranted in the management of all stocks in 2017 owing to declines in total returns of greater than 30% on more than 50% of the monitored rivers in 2016.

There should be no increase in harvest/allocations on NL salmon populations in 2017.

There should be no human induced mortality on populations that are below the limit reference point (100% CL) except possibly for areas which have in-season reviews or special management plans.

Efforts should be made to increase returns to south coast rivers (DU 4), and known effects of finfish aquaculture escapees on wild salmon stocks should be mediated.

The proposed new lower Limit Reference Point of 100% conservation and Upper Stock Reference point of 150% conservation should be adopted as interim values while the evaluation of reference points continue.

OTHER CONSIDERATIONS

Indicators and procedure to trigger full assessment during interim years

In 2014, DFO began implementing a five-year management plan for Atlantic Salmon in the NL Region. Although management measures outlined in the plan were expected to remain the same over this five-year period, changes could be warranted if there was a dramatic change in

salmon stocks, particularly declines. To this end, DFO Science was asked by Resource Management to identify 'triggers/indicators' that would warrant revisiting the salmon management plan earlier than the planned five years. Thus, these triggers mainly reflect significant conservation concerns related to the health and abundance of salmon stocks within the NL Region.

There are two scenarios where DFO Science would recommend revisiting the five-year management plan earlier:

1) >30% **decline** in total returns on ≥50% of monitored rivers in any given year; or
2) >25% **decline** in total returns on ≥50% of monitored rivers in two consecutive years.

For both these scenarios, DFO Science will conduct an in-house review to consider other factors such as:

- River population size (i.e., <500 or >500 individuals as there is much more variability in rivers with smaller populations);
- Continuous decline on same rivers over two-year period; and
- Geographic patterns.

Also, all comparisons will be made using both the previous five-year mean (short-term trends) as well as the previous 10-year mean (long-term trends).

With respect to dramatic changes involving **increases** in stock abundance, rather than declines, it was felt five years was a reasonable timeframe when considering management changes that might result in increased harvests.

In 2016, seventeen salmon populations were assessed in NL. However, three of those populations (Rocky River, Garnish River and Northeast River, Placentia Bay) did not have recent reliable short-term or long-term trends for comparison to the 2016 total returns and were therefore not considered in the advice to Resource Management regarding the re-opening of the five-year Atlantic Salmon management plan. Of the 14 remaining assessed stocks, seven (50%) recorded declines in total returns of greater than 30% in 2016 compared to their previous five-year mean. Declines of this magnitude over a wide geographic range are highly unusual for the NL Region thus triggering a recommendation to Resource Management that the five-year management plan be re-opened.

Genetic analysis of mixed stock fisheries

Stock composition of Atlantic Salmon harvested in three fisheries in the northwest Atlantic was examined using genetic mixture analysis and individual assignment with a microsatellite baseline (15 loci, 12,409 individuals, 12 groups) encompassing the species western Atlantic range. Three hundred and fifty-three salmon collected from the St. Pierre et Miquelon fishery (2004, 2011-14) were analyzed and estimates of stock composition showed consistent dominance of three regions: Gulf of St. Lawrence, Gaspe Peninsula, and Newfoundland. In the West Greenland harvest (2011-14, n=2,336) North American contributions were largely from Labrador, Gulf of St. Lawrence, and Gaspe Peninsula. No evidence of spatial or temporal trends in mixture composition was apparent in the fishery. Finally, in the coastal Labrador fishery (2012-14, n=771), mixture estimates suggest the harvest is dominated by a single region, central Labrador (95.3%). Minor components were also allocated to Northern Labrador/Ungava and Newfoundland (<4%). In all three fisheries, estimates of stock composition appear stable over time and assigned individuals show the expected trend of increasing river age with latitude

of home region. Exploitation estimates of NL salmon across all three fisheries was generally low (<10% for large salmon and <5% for small salmon).

Aquaculture impacts

The consequences of a single large aquaculture escape event in 2013 for wild populations of Atlantic Salmon in a southern Newfoundland fiord were examined using targeted genomic tools. For the first time the unambiguous, widespread detection of first- and second-generation wild-aquaculture hybrid salmon and pure aquaculture offspring (i.e. 35% hybrids, 17/18 rivers within 75 km) has been reported. Results indicate that levels of hybridization were higher in smaller populations, hybridization had pre-dated the 2013 escape event, and some hybrids were reproductively viable. Four surveys for escapees were conducted each year in 2015 and 2016 in the Fortune Bay and Bay d'Espoir areas. In 2015, a total of 159 escapees were detected, compared to zero detected escapees in 2016 despite similar levels of effort. Monitoring of levels of hybridization and the presence and abundance of escapees will continue in southern Newfoundland in 2017.

Development of Reference Points that Comply with the Wild Atlantic Salmon Conservation Policy

The NL Region currently uses a single reference point (conservation egg requirement) to assess the status of its Atlantic Salmon populations; however, the use of a single reference point does not comply with the current Wild Atlantic Salmon Conservation Policy (WASCP). This policy requires that the status of salmon populations be assessed based on a lower and an upper reference point, which defines three status zones (Critical, Cautious and Healthy). Populations below the lower Limit Reference Point would be assessed as critical and according to the WASCP would require "*immediate consideration of ways to protect the fish, increase their abundance, and reduce the potential risk of loss.*" Biological considerations would be the main driver of any management actions. Cautious status would involve broader consideration of biological, social, and economic issues and more careful management actions. Populations above the Upper Stock Reference point would be assessed as healthy and available for exploitation at some predetermined maximum exploitation rate and the primary drivers for management could be social and economic considerations.

With respect to reference points, it was proposed that the lower Limit Reference Point be set at the current conservation limit (100% CL) and the interim Upper Stock Reference point be set at 150% CL.

Environmental Conditions – Freshwater Environment

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 2016 angling season, 65 out of 158 (41%) scheduled rivers in Newfoundland were closed for some part of the angling season. Closures affected all zones except SFAs 12, 13 and 14A on the west coast of the island. Closures generally occurred in late-July and early-August.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 28 to March 1, 2017 Regional Peer Review Process "Assessment of Atlantic Salmon in Newfoundland and 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: HARVESTS OF ATLANTIC SALMON IN ABORIGINAL AND SUBSISTENCE FISHERIES IN LABRADOR, 1999-2016

Table 1. Harvest of Atlantic Salmon in Aboriginal and Subsistence Fisheries in Labrador (SFAs 1 and 2), 1999-2016.

Year	Small salmon: Number	Small salmon: Weight (kg)	Large salmon: Number	Large salmon: Weight (kg)	Total Number	Total Weight (kg)
1999	2,739	5,580	1,084	4,220	3,824	9,800
2000	5,323	10,353	1,352	5,262	6,675	15,613
2001	4,789	9,789	1,673	6,499	6,478	16,288
2002	5,806	11,581	1,437	5,990	7,243	17,572
2003	6,477	13,196	2,175	8,912	8,653	22,108
2004	8,385	17,379	3,696	14,167	12,081	31,546
2005	10,436	21,038	2,817	10,876	13,253	31,914
2006	10,377	21,198	3,090	11,523	13,467	32,721
2007	9,208	17,070	2,652	9,386	11,860	26,456
2008	9,838	19,396	3,905	16,944	13,743	36,340
2009	7,988	16,130	3,344	13,681	11,332	29,810
2010	10,156	20,945	3,840	15,511	13,996	36,456
2011	11,301	23,442	4,533	18,535	15,834	41,978
2012	9,977	18,738	4,228	17,821	14,204	36,560
2013	7,164	14,674	6,374	25,299	13,539	39,973
2014	8,959	17,916	3,995	14,858	12,953	32,774
2015	8,923	17,500	6,146	24,935	15,069	42,435
2016	7,601	14,484	5,651	25,129	13,252	39,363
Previous six-year mean (2010-15)	9,413	18,869	4,853	19,493	14,266	38,363

APPENDIX 2: SUMMARY OF ATLANTIC SALMON STOCK STATUS IN NEWFOUNDLAND AND LABRADOR, 2016

Table 2. Summary of Atlantic Salmon Stock Status in Labrador (SFAs 1, 2 and 14B, 2016: Total Returns.

River	SFA	Method	2016 Small	2016 Large	2010-15 Mean Small	2010-15 Mean Large
English River	1	Fe	666	208	531	149
Sand Hill River	2	Fe	1,120	977	3,416	832
Muddy Bay Brook	2	Fe	239	18	338	30
Southwest Brook (Paradise River)	2	Fe	74	31	224	40

Table 3. Summary of Atlantic Salmon Stock Status in Labrador, 2016: Conservation Egg Requirement Achieved (%).

River	SFA	Method	2016	2010-15 Mean	Conservation Achieved Relative to 2010-15 Mean
English River	1	Fe	255	192	Increase
Sand Hill River	2	Fe	60	99	Decrease
Muddy Bay Brook	2	Fe	93	128	Decrease
Southwest Brook (Paradise River)	2	Fe	38	85	Decrease

Table 4. Summary of Atlantic Salmon Stock Status in Newfoundland-Northeast Coast (SFAs 3-8): Total Returns.

River	SFA	Method	2016 Small	2016 Large	2011-15 Mean Small	2011-15 Mean Large
Exploits River	4	Fw	21,886	2,325	28,594	4,901
Campbellton River	4	Fe	2,751	226	4,161	514
Salmon Brook (Gander River)	4	Fw	707	263	1,541	159
Middle Brook	5	Fw	2,240	320	2,932	383
Terra Nova River	5	Fw	5,154	483	4,103	513

Table 5. Summary of Atlantic Salmon Stock Status in Newfoundland-Northeast Coast (SFAs 3-8): Conservation Requirement Achieved (%).

River	SFA	Method	2016	2011-15 Mean	Conservation Achieved Relative to 2011-15 Mean
Exploits River	4	Fw	36	55	Decrease
Lower Exploits River	4	Fw	36	70	Decrease
Middle Exploits River	4	Fw	44	63	Decrease
Upper Exploits	4	Fw	3	8	Decrease
Campbellton River	4	Fe	242	419	Decrease
Salmon Brook (Gander River)	4	Fw	117	184	Decrease
Middle Brook	5	Fw	275	349	Decrease
Terra Nova River	5	Fw	85	70	Increase

Table 6. Summary of Atlantic Salmon Stock Status in Newfoundland-South Coast (SFAs 9-11): Total Returns.

River	SFA	Method	2016 Small	2016 Large	2011-15 Mean Small	2011-15 Mean Large
Rocky River	9	Fe	244*	35*	382	32
Northeast River (Placentia Bay)	10	Fe	855	101	-	-
Little River	11	Fe	51	1	135	3
Garnish River	11	Fe	289	18		
Conne River	11	Fe	1,166	66	1,946	84

*The low returns on Rocky River in 2015 and 2016 are, in part, a result of the fishway replacement and related operational challenges.

Table 7. Summary of Atlantic Salmon Stock Status in Newfoundland-South Coast (SFAs 9-11): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2016	2011-15 Mean	Conservation Achieved Relative to 2011-15 Mean
Rocky River	9	Fe	29	42	-
Northeast River (Placentia Bay)	10	Fe	512	-	-
Little River	11	Fe	22	60	Decrease
Garnish River	11	Fe	21	-	-
Conne River	11	Fe	56	80	Decrease

Table 8. Summary of Atlantic Salmon Stock Status in Newfoundland-Southwest Coast (SFAs 12-13): Total Returns.

River	SFA	Method	2016 Small	2016 Large	2011-15 Mean Small	2011-15 Mean Large
Harry's River[1]	13	D	3,578	817	3,071	506

Table 9. Summary of Atlantic Salmon Stock Status in Newfoundland-Southwest Coast (SFAs 12-13): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2016	2011-15 Mean	Conservation Achieved Relative to 2011-15 Mean
Harry's River	13	D	125	109	Increase

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

River	SFA	Method	2016 Small	2016 Large	2011-15 Mean Small	2011-15 Mean Large
Torrent River	14A	Fw	3,968	885	3,641	1,007
Western Arm Brook	14A	Fe	1,344	114	1,253	60

Table 11. Summary of Atlantic Salmon Stock Status in Newfoundland-Northwest Coast (SFA 14A): Conservation Egg Requirement Achieved (%).

River	SFA	Method	2016	2011-15 Mean	Conservation Achieved Relative to 2011-15 Mean
Torrent River	14A	Fw	658	793	Decrease
Western Arm Brook	14A	Fe	502	448	Increase

Table 12. Summary of Atlantic Salmon Stock Status in Newfoundland (SFAs 3-14A): Smolt Abundance.

River	SFA	Method	Smolts Relative to 2011-15 Mean	Marine Survival Relative to 2011-15 Mean
Campbellton River	4	Fe	Increase	Decrease
Rocky River	9	Fe	Decrease	-
Western Arm Brook	14A	Fe	Increase	Increase

Methods:

Fe = counting fence, Fw = 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.

[1]Based on proportion of large salmon from five-year mean (2006-10).

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