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2021 STOCK STATUS UPDATE OF ATLANTIC SALMON IN NEWFOUNDLAND AND LABRADOR

Context

In 2021, Fisheries and Oceans Canada (DFO) began a two-year stock assessment cycle for Atlantic Salmon (*Salmo salar*) in the Newfoundland and Labrador (NL) Region. Although management measures outlined in the 2021 and 2022 Atlantic Salmon management plans were expected to remain the same in those years, adjustments could have been warranted if there was a dramatic decline in salmon abundance (see Appendix II). The last full stock assessment for Atlantic Salmon occurred in March 2021 for 2020 returns. Atlantic Salmon returns in 2021 did not trigger a full stock assessment; therefore, the next detailed assessment for Atlantic Salmon will occur as scheduled in winter 2023 for 2022 returns.

This Science Response Report (SRR) presents results from the March 1–2, 2022 Regional Science Response Process (SRP) on the Stock Status Update of Atlantic Salmon in Newfoundland and Labrador with data from 2021 for Salmon Fishing Areas (SFAs) 1, 2 and 14B (Labrador) and 3 to 14A (Newfoundland) (Fig. 1). Fisheries Management will use advice from this SRP to inform the 2023 Atlantic Salmon management plan.

Background

Juvenile Atlantic Salmon predominantly remain in freshwater habitats for three to four years in Newfoundland (>95% of samples taken since 2000) and four to five years in Labrador (>83% of samples taken since 2000) prior to undergoing smoltification and migrating to sea as smolts (DFO 2020a). Spawning populations in NL consist of varying proportions of small (fork length <63 cm) and large (fork length ≥63 cm) adult salmon (Fig. 2). For the majority of rivers in Newfoundland (SFAs 3–12 and 14A), the small adult salmon population is predominantly grilse (one-sea-winter [1SW] salmon) that have spent one year at sea before returning to spawn for the first time. For most monitored rivers in NL, small salmon are predominantly female (range of 60–92% across rivers). The large adult salmon population in Newfoundland rivers is composed mainly of repeat-spawning grilse which are either a consecutive or alternate spawning fish. In contrast, populations in Labrador (SFAs 1, 2, and 14B) and southwestern Newfoundland (SFA 13) consist of 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 returning to spawn. Run timing for returning salmon is influenced by climate conditions on the NL Shelf, occurring earlier in warmer years and later in colder years with low water temperatures and high amounts of inshore sea ice (Dempson et al. 2017).

Since 2017, the status of Atlantic Salmon populations has been assessed relative to two reference points, defined on the basis of egg depositions, as per the Fishery Decision-Making Framework Incorporating the Precautionary Approach (DFO 2015). For each monitored river, the Limit Reference Point (LRP) is set at 100% of the previously defined conservation egg requirement (O'Connell and Dempson 1995, O'Connell et al. 1997, Reddin et al. 2006). Populations below the LRP fall in the Critical Zone, where management actions should both promote stock growth and minimize fisheries-related mortality. The interim Upper Stock

Reference Point (USR) is set at 150% of the previously defined conservation egg requirement. Populations above the USR are considered to be in the Healthy Zone and are therefore available for exploitation at some predetermined maximum exploitation rate. Populations with a status between the LRP and USR fall within the Cautious Zone, in which management actions should promote stock rebuilding to the Healthy Zone.

Analysis and Response

Stock Assessment

Atlantic Salmon stocks within the NL Region (SFAs 1–14B) were assessed using data collected from salmon monitoring facilities (fish counting fences and fishways; Fig. 1), in-river snorkel surveys, and the recreational fishery (catch and effort data). The Licence Stub Return System (O'Connell et al. 1998, Dempson et al. 2012, Veinott and Cochrane 2015) provided river-specific estimates of recreational catch and effort for SFAs 1–14B, except for Eagle River and Sand Hill River in SFA 2 where data were provided annually by private fishing camps. DFO Science assumed a catch-and-release mortality rate of 10% when calculating estimates of total returns and total spawners on monitored rivers where angling was permitted. This was consistent with low to average mortality estimates from a review of several catch-and-release studies on Atlantic Salmon (Van Leeuwen et al. 2020) and similar to the mean mortality probability observed in a study on Western Arm Brook (SFA 14A; Keefe et al. 2022). For each monitored river, preliminary estimates of total returns and egg depositions in 2021 were calculated using the average catch data over the previous generation (2015–20 for most Newfoundland rivers and 2014–20 for Labrador rivers), excluding 2020 because preliminary estimates of river-specific harvest and catch-and-release angling were unavailable for the 2020 and 2021 recreational angling season. Accordingly, results presented in this report for monitored rivers in 2020 and 2021 are considered preliminary and will be updated once river-specific recreational angling estimates are finalized for those years. Changes to estimates of total returns, spawners and % LRP achieved once recreational angling estimates are finalized are often negligible.

DFO Science also examined trends over time in salmon abundance on each monitored river. In each year, the estimated number of returns on a given river were compared to the average returns over the previous generation and three generation time periods. For all comparisons, DFO Science used a minimum difference threshold of 10% between an annual abundance and a multi-year average to determine whether the abundance of a monitored population increased or decreased. For assessments prior to 2021, the previous generation referred to the previous five years for Newfoundland populations and six years for Labrador populations (DFO 2020a, 2020b). After examination of scale age data from rivers throughout the NL Region in preparation for the 2021 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) review of Atlantic Salmon populations in Canada, these generation times were updated to six years for most Newfoundland rivers and seven years for most Labrador rivers. Three generations corresponds to 16–18 years for most Newfoundland rivers and 19–22 years for most Labrador rivers.

In addition to river-specific comparisons, regional trends in adult Atlantic Salmon abundance on monitored rivers were assessed using a Salmon Abundance Index. This index was used to examine temporal patterns in the relative abundance of adult Atlantic Salmon on monitored rivers simultaneously within Newfoundland and Labrador, as opposed to providing an actual estimate of total adult Atlantic Salmon abundance for each of the two primary areas in the NL Region. For the assessment of 2020 Atlantic Salmon stocks in the NL Region (DFO 2022), time series of total return estimates for monitored Atlantic Salmon rivers were combined and

modelled with a negative binomial generalized linear model (GLM) with a log link function and year as a factor. For this report, the modeling approach was adjusted to include both year and river as factors to align with similar Atlantic Salmon abundance indices used in previous analyses (Dempson et al. 2004). Abundance estimates for some years changed slightly but the overall patterns remained similar. Returns were modelled separately for Newfoundland since 1992 and Labrador since 1998, the years that commercial moratoriums began in each area. The estimated marginal mean log abundances (+/- standard errors) were presented for each year for Newfoundland and Labrador. The error bars represent variability in counts across monitored rivers which differed by one to two orders of magnitude (returns ranged from 100s or 1,000s of salmon on some rivers to 10,000s on Exploits River).

Counts of returning adult Atlantic Salmon were impacted by environmental conditions and methodological challenges on several rivers in 2021. Due to high water conditions, some counting fences were not operational during various periods of the season including Come By Chance River (SFA 10, July 31–Aug 6), Little Barachois Brook (SFA 13, June 28–July 2), Harrys River (SFA 13, June 28–July 6 and July 23 onward), Trout River (SFA 14A, July 23–August 16) and Parkers River (SFA 14A, July 10–15). Counting fences were partially removed to assist migrating salmon to move upstream during persistent low water conditions on Come By Chance River (SFA 10, July 15–19) and Northwest River (SFA 5, July 26 onward). Similar to 2020, the Torrent River (SFA 14A) salmon run was video recorded in the fishway from mid-June until mid-October. Unfortunately, technical issues resulted in no Atlantic Salmon counts from August 1–31. Applying a nonparametric bootstrap (1,000 iterations) to the proportion of the Torrent River salmon run counted in August over the previous two generations (2009–20) suggested that, on average, 19.8% (95% confidence intervals [CIs]: 13.5%, 26.0%) of the small salmon run and 11.3% (95% CIs: 6.7%, 16.3%) of the large salmon run is counted during this period annually. Finally, the 2021 snorkel survey on Robinsons River only covered one of four sections of the river historically surveyed. Applying a nonparametric bootstrap (1,000 iterations) to the proportion of the salmon counted in section four of Robinsons River in previous snorkel surveys (2001–05, 2018 and 2019) suggested that, on average, 69.5% (95% CIs: 62.5%, 76.0%) of the small salmon and 69.5% (95% CIs: 54.5%, 81.6%) of the large salmon were counted in that section of the river. Estimates of adult Atlantic Salmon returns and % LRP in 2021, presented below in figures and tables for these eight rivers, were not adjusted to account for periods where fences were not in operation or there were issues with the snorkel survey or camera system. Therefore, abundance estimates presented for these rivers in 2021 are considered minimum estimates.

Overall, in 2021, 25 Atlantic Salmon populations were monitored in the NL Region (Fig. 1): four rivers in Labrador and 21 in Newfoundland. Due to the issues outlined above, total return estimates were provided for 17 rivers, with estimates for eight additional rivers deemed incomplete. Abundance information for three of these eight rivers (Little Barachois Brook and Robinsons River in SFA 13 and Torrent River in SFA 14A) was sufficient to estimate 2021 stock status, but for the other rivers (Northwest River in SFA 5, Come By Chance River in SFA 10, Harrys River in SFA 13, and Trout River and Parkers River in SFA 14A), estimates of 2021 egg depositions, % LRP achieved, and stock status were not provided. This was due to high uncertainty regarding the actual total returns and spawners to these rivers in 2021, resulting from the timing and/or duration of when the counting fences were not operational. In addition, although total returns were reported for Rattling Brook (SFA 4), egg depositions, % LRP achieved, and stock status were not estimated due to recent enhancement activities. Therefore, out of 25 monitored Atlantic Salmon populations in the NL Region in 2021, estimates of % LRP achieved in 2021 (and stock status zone) are provided for 19 rivers.

The abundance of out-migrating Atlantic Salmon smolts was monitored on five rivers in Newfoundland in 2021 (Campbellton River in SFA 4, Rocky River in SFA 9, Conne River and Garnish River in SFA 11, and Western Arm Brook in SFA 14A). From 1987–2018, the number of migrating smolts on Conne River was estimated annually using partial counting fences and mark-recapture methods (Dempson and Stansbury 1991). In 2019 and 2021, DFO Science counted the number of migrating smolts on this river using a full counting fence. Smolt abundance was counted annually on the other four rivers using an upstream-oriented counting fence. A significant majority of smolts from Newfoundland rivers spend only one year at sea; therefore, marine survival was estimated annually by comparing the smolt count in one year to the number of returning small salmon (<63 cm) the following year.

Recreational Fishery Regulations

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 (Veinott et al. 2013). Consistent with the previous two years, the 2021 recreational angling season involved a seasonal retention limit of one fish on Class 2 rivers and two fish on Class 4, 6, and unclassified rivers, and daily catch and release limits of three fish on Class 2, 4, 6, and unclassified rivers. Preliminary estimates of river-specific angling effort and number of salmon retained and released were unavailable for 2021.

Indigenous/Subsistence Fishery

Indigenous Food, Social, and Ceremonial (FSC) fisheries for Atlantic Salmon occur in Labrador under communal licences. Labrador also has a resident fishery for Brook Trout (*Salvelinus fontinalis*) and Arctic Charr (*Salvelinus alpinus*) with a permitted retention of three salmon bycatch. In Newfoundland, Miawpukek First Nation (MFN) holds a FSC communal salmon fishing licence but has chosen not to harvest salmon under this licence since 1997 due to conservation concerns.

Labrador FSC and subsistence fisheries harvests were inferred from logbook returns (62% overall tag return rate) and were estimated at 14,041 salmon in 2021 (8,797 small, 5,244 large), which was 5% higher than the previous generation (2014–20) average (13,350 salmon, 7,954 small and 5,396 large) and 13% higher than the previous three generation (2001–20) average (12,457 salmon, 8,379 small and 4,078 large) (Fig. 3, Table 1). Large salmon represented 37% of the harvest by number in 2021. The total Atlantic Salmon harvest by weight in 2021 was 37,649 kg, 6% above the previous generation average and 21% above the previous three generation average (Fig. 3, Table 1). Estimates for 2021 are considered preliminary and will be updated upon the receipt and analysis of additional logbooks.

Total Returns

Time series of small and large salmon returns to monitored rivers, including preliminary estimates for 2021, are presented in Figures 6–13 (see Appendix I).

Total returns of adult Atlantic Salmon in 2021 were lower on five of 17 (29%) assessed rivers relative to the previous generation average (2015–20 and 2014–20 for Newfoundland and Labrador rivers, respectively), and total returns on three of these rivers (18%) declined by >30% (Fig. 4, Table 2). Total returns in 2021 were higher on nine rivers (53%) relative to the previous generation average and three rivers showed no change (different of less than 10%). In comparison to the previous three generation average, total returns declined on five of 13 rivers

(38%), three of which (23%) declined by 30% or more (Fig. 5, Table 2). Total returns to six monitored rivers (46%) were higher than the previous three generation average in 2021 and two rivers showed no change (Table 2).

Total returns of adult Atlantic Salmon to assessed rivers in SFA 11 declined in recent years (DFO 2020a, DFO 2020b, DFO 2022). Atlantic Salmon returns to Little River averaged 235 salmon annually (range: 47–801) from 1987–2016 but did not exceed ten fish annually from 2017–20 (DFO 2020b, DFO 2022). Total returns to Conne River ranged from 8,047–10,671 salmon from 1986–88 and have been on a declining trajectory ever since (Fig. 10). Consecutive record low adult Atlantic Salmon returns to Conne River were recorded from 2017–20 (DFO 2022) and did not exceed 710 salmon each year. In 2021, total returns to Conne River were the second lowest in the time series, were 71% below the previous generation average (2015–20), and 85% below the previous three generation average (2004–20) (Fig. 3 and 4, Table 2). Significant declines in total returns were also observed on Terra Nova River and Middle Brook (both in SFA 5); however, Atlantic Salmon returns to these rivers may have been negatively impacted by persistent low water conditions throughout much of the summer in 2021. In addition, large salmon abundance was below the previous generation average on eight of 17 rivers (47%) monitored in 2021 (Table 3).

Despite these declines, several monitored rivers showed improved total returns in 2021 compared to recent years. Total returns to Garnish River set a record high in 2021 (monitored since 2015) and total returns (based on a partial count of returning salmon) to Torrent River suggest a near record high in 2021, with a record high for small salmon returns (Table 4). Total returns to Sand Hill River in 2021 were the highest since 2011. Estimated total returns to Exploits River increased significantly to 37,683 salmon in 2021, 86% above the previous generation average (Table 2). This contrasted recent years, where total returns declined to fewer than 21,000 salmon per year from 2017–20 from 46,477 salmon in 2010. Record numbers of large salmon returns were observed on both Campbellton River (since 1993) and Muddy Bay Brook (since 2002).

Salmon Abundance Index

The Atlantic Salmon abundance index was calculated by modeling total returns from monitored rivers combined using a negative binomial GLM with log link function and year and river as factors (Fig. 14). This was compiled for Newfoundland (since 1992) and for Labrador (since 1998) separately and included data since the commercial moratoriums. This index was used to examine temporal patterns in adult Atlantic Salmon abundance on monitored rivers simultaneously, as opposed to providing an actual estimate of total adult Atlantic Salmon abundance within each of the two primary areas.

In Newfoundland, estimated marginal mean log salmon abundance declined after 2015, reflective of relatively poor returns observed on several monitored Atlantic Salmon rivers in recent years, particularly 2017–19 (DFO 2020a, 2020b). In 2021, total returns to several monitored rivers in Newfoundland increased above the previous generation average and particularly recent years (2017–20). As a result, the estimated marginal mean log abundance in 2021 was slightly higher as well (Fig. 14). Overall, the salmon abundance index suggested that 2021 adult Atlantic Salmon returns to monitored rivers in Newfoundland had not rebounded to pre-2016 levels but had improved in comparison to 2017–20 returns.

In Labrador, the estimated marginal mean log salmon abundance in 2021 was slightly below that of 2020, but much higher than in 2019 when declines in returns were observed on English River, Sand Hill River, and Southwest Brook (DFO 2020b). Estimated salmon abundance for

2021 was on par with some of the highest years over the previous generation (2014–20) (Fig. 14). This was likely driven by increased total returns to Sand Hill River and Muddy Bay Brook in 2021 compared to the previous generation averages for those rivers (Table 2).

Indicators of Stock Status (% LRP Achieved)

Adult Atlantic Salmon abundance estimates on eight monitored rivers were incomplete due to counting fence washouts, low water levels, and issues with camera or snorkel survey; however, three of these rivers had sufficient data to estimate the 2021 stock status. The counting fence on Little Barachois Brook (SFA 13) was not operational from June 28 to July 2 due to high water levels. However, the number of salmon counted at the fence, combined with the estimated number of salmon counted below the fence in a late summer snorkel survey, provided a minimum egg deposition estimate of 99% of the river-specific LRP in 2021. Therefore, it was highly likely that this population was in the Cautious Zone in 2021. Torrent River counts from August 1–31, 2021 were unavailable due to technical issues with the camera system that recorded the adult Atlantic Salmon run in the fishway. However, counts from June 12 to July 31 and September 1 to October 12, 2021, suggested that the number of returning Atlantic Salmon to this river in 2021 was near a record high (Fig. 13). A minimum egg deposition estimate using the data available for this river suggested it was in the Healthy Zone in 2021 (999% of the river-specific LRP). The 2021 snorkel survey on Robinsons River covered only one of four river sections historically sampled. The small and large spawner abundance estimates from the late summer snorkel survey in 2021 suggested a minimum egg deposition estimate of 53% of the LRP. Applying a nonparametric bootstrap (1,000 iterations) to the proportion of the salmon counted in section four of Robinsons River in previous snorkel surveys (2001–05, 2018 and 2019) suggests that, on average, 69.5% (95% CIs: 62.5%, 76.0%) of the small salmon and 69.5% (95% CIs: 54.5%, 81.6%) of the large salmon are counted in this section of the river. Adjusting the small and large spawner estimates from the 2021 snorkel survey (740 small salmon and 180 large salmon) by these average proportions results in estimates of 1,065 (95% CIs: 974, 1,184) small salmon and 259 (95% CIs: 221, 330) large salmon spawners, which would achieve 76% (95% CIs: 67%, 90%) of the river-specific LRP. Therefore, it is highly likely that this population was in the Critical Zone in 2021.

In 2021, the % LRP attained (based on egg depositions) and stock status zone was estimated for 19 monitored Atlantic Salmon populations. Estimated Atlantic Salmon egg depositions were in the Healthy Zone on eight of 19 monitored rivers (42%): two in Labrador and six in Newfoundland (Fig. 15, Table 5). Estimated egg depositions were in the Cautious Zone on one Labrador river (Sand Hill River) and two Newfoundland rivers (Salmon Brook [SFA 4] and Little Barachois Brook [SFA 13]). Estimated egg depositions were in the Critical Zone on one Labrador river (Southwest Brook) and seven Newfoundland rivers (Fig. 15, Table 5). Overall, 42% of all assessed rivers were below the LRP in 2021 (Table 5). However, due to an increase in total returns to several monitored rivers in 2021, only four of the 16 rivers (25%) assessed during the previous generation showed relative declines in estimated egg depositions in 2021 (Table 5). Five of 13 monitored rivers (38%) showed a decline in estimated egg depositions in 2021 relative to the previous three generation average (Table 5). Estimated egg depositions were particularly low on Conne River in SFA 11 (12% of LRP in 2021) and have now been below 20% of the river-specific LRP since 2019. In contrast, estimated egg depositions in 2021 set a record high on Garnish River, and were the highest since 2011 on Sand Hill River and Exploits River.

Smolt Production and Marine Survival

Smolt abundance is counted annually on five monitored rivers in Newfoundland (Fig. 1, Fig. 16, Table 6). Smolt production in 2021 was below the river-specific previous generation average on Conne River (-42%), Campbellton River (-46%), and Western Arm Brook (-19%), but was above the average on Rocky River (+26%). Rocky River had consecutive low smolt counts in 2018 and 2019 (Fig. 16), potentially due to fishway problems and repairs in 2015 and 2016 which negatively impacted the number of salmon that were able to return to the river and spawn in those years (DFO 2020a; DFO 2022). Smolt production in 2021 was below the river-specific three generation average on Conne River (-59%), Campbellton River (-44%), Western Arm Brook (-30%), and Rocky River (-45%). Smolt production on Garnish River in 2021 was 34% below the 2017–19 average (Fig. 16, Table 6). Below-average smolt abundance observed on monitored rivers in 2021 may have been partially explained by poor adult Atlantic Salmon returns to several monitored rivers in 2017 (DFO 2020a; Fig. 14). Juvenile Atlantic Salmon predominantly remain in freshwater habitats for three to four years in Newfoundland, and three-year-old smolts from the 2017 spawning year class would have left those rivers in 2021.

Migrating Atlantic Salmon from rivers in Newfoundland predominantly spend one winter at sea; thus, marine survival is estimated annually on these five rivers by comparing the return of small adult salmon in one year to the smolt count the year before. In 2020, no smolt counts were conducted due to COVID-19 impacts on field operations. As a result, there were no marine survival estimates available for monitored Newfoundland Atlantic Salmon rivers for 2021 (adult return year).

Marine survival is the primary driver of Atlantic Salmon returns. Predation in estuarine and marine habitats can negatively impact Atlantic Salmon post-smolt survival (Daniels et al. 2019, Strøm et al. 2019). However, our understanding of predation impacts on marine survival of NL Region populations is poor and the effect of prey distribution and abundance on Atlantic Salmon migration and survival at sea requires more attention. The zooplankton community has shifted in recent years towards fewer large energy-rich copepods and more small copepods (DFO 2020c), but it is difficult to ascertain how these changes influence post-smolt survival annually. In southern Newfoundland (SFA 11), recent work has documented extensive hybridization with aquaculture escapees (Keyser et al. 2018, Sylvester et al. 2018, Wringe et al. 2018), as well as reduced survival of these offspring (Sylvester et al. 2019). Research has also predicted negative impacts on wild population size at existing levels of aquaculture production (Bradbury et al. 2020a). Recent evidence of European introgression into farmed salmon used in the region has increased the potential of negative impacts due to hybridization. In addition to genetic interactions, aquaculture associated factors such as disease or parasite transfer and ecological interactions (i.e., competition or predation) have been implicated as contributing to declines of wild salmon populations in Norway, Scotland, and Ireland (Bradbury et al. 2020b). Marine survival of monitored Atlantic Salmon populations in SFA 11 has been particularly poor in recent years (<1% on Conne River and Garnish River in 2020 compared to >5% for three other Newfoundland populations) (DFO 2022). Updated information on the presence of escapees and genetic interactions, disease and parasite transfer to wild populations from aquaculture salmon, predation of wild salmon in the region, the residency of Atlantic Salmon post-smolts near aquaculture operations, and/or sea lice infestations rates would improve our understanding of poor marine survival and declining abundance of returning Atlantic Salmon to rivers in that region in recent years.

Sources of Uncertainty

At the time of the SRP, angler log and phone survey data for 2020 and 2021 had not yet been processed. Calculations of total returns, and egg depositions on monitored rivers where angling was permitted included estimates of recreational harvest and catch-and-release mortality. Values presented in this report will be updated once all angler log and phone survey data are processed. Therefore, some values herein may change slightly once data are finalized, although changes are typically negligible.

Returns of angling logs by recreational anglers have been low in recent years, averaging 20% from 2014–19. The preliminary estimates of 2021 total returns and egg depositions in this report for assessed rivers where angling was permitted used river-specific angling estimates (harvested and released salmon) averaged over the previous generation. The relatively low return rate of angler logs in recent years will add uncertainty for 2020 and 2021 values for these rivers.

Estimates of recreational catch and effort data were dependent on the quantity and accuracy of angler licence stubs that were completed and returned. Similarly, the Indigenous FSC and resident trout/char harvest bycatch estimates in Labrador were dependent on the quantity and accuracy of logbooks compiled and returned. For all salmon fisheries, uncertainty existed where inaccurate and/or incomplete information was provided.

Historical or estimated biological characteristic data (e.g., fecundity, sex ratio, female size) and estimated catch data used in the assessment added uncertainty to the estimates of egg depositions and % LRP attained.

Atlantic Salmon smolt abundance was not monitored in 2020 due to COVID-19 impacts on DFO Science field operations. As a result, marine survival estimates for returning adult small salmon in 2021 were not available.

No current assessments were available for salmon populations in SFAs 3, 6, 7, 8, 12, and 14B, or in the Lake Melville area of SFA 1.

Salmon populations in assessed rivers may have not been representative of all rivers in a given SFA.

Conclusions

- Adult returns of Atlantic Salmon were monitored for 25 populations in 2021: four rivers in Labrador and 21 rivers in Newfoundland. Due to incomplete data, estimates of 2021 stock status were presented for 19 rivers. Five of the 21 monitored rivers in Newfoundland also counted juvenile salmon (smolt) migrating to sea.
- Of the 17 monitored rivers with sufficient abundance data to compare 2021 returns to river-specific previous generation time periods, total returns of adult Atlantic Salmon were above average on nine rivers, below average on five rivers, and average on three rivers.
- Of the 13 monitored rivers with sufficient abundance data to compare 2021 returns to river-specific previous three generation time periods, total returns of adult Atlantic Salmon were above average on six rivers, below average on five rivers, and average on two rivers.
- In 2021, eight of 19 assessed rivers were in the Critical Zone (one in Labrador and seven in Newfoundland); three rivers were in the Cautious Zone (one in Labrador and two in Newfoundland); and eight rivers were in the Healthy Zone (two in Labrador and six in

Newfoundland). The DFO Precautionary Approach Framework requires that removals from all sources be kept at the lowest possible level until the stock clears the Critical Zone.

- Returns to Conne River in 2021 were the second lowest on record (since 1986), and this stock is still deep in the Critical Zone (12% of the river-specific LRP in 2021). Below-average smolt production in 2021 and continuing low spawning escapements could negatively impact returns and smolt production in 2022 and beyond, while continuing low spawning escapements since 2019 will result in much lower smolt production and likely lower adult returns in subsequent years.
- Smolt production in 2021 was below the previous generation average on four of five rivers and below the previous three generation average on all rivers where smolt abundance is monitored annually.
- Marine survival is the major factor limiting the abundance of adult Atlantic Salmon in the NL Region. Inter-annual estimates of marine survival were unavailable for the 2021 adult return year.
- Returns improved in 2021 for several monitored rivers. However, given the annual variability in adult Atlantic Salmon returns combined with below-average smolt abundance on monitored rivers in 2021, concerns remain for the status of these stocks for 2022 and 2023.

Contributors

Name	Affiliation
Blair Adams	Dept. of Fisheries, Forestry and Agriculture
Roanne Collins	DFO-NCR – Science
Hilary Rockwood	DFO-NL – Centre for Science Advice
Connie Dobbin-Vincent	DFO-NL – Resource Management
Jackie Kean	DFO-NL – Resource Management
Mark Simms	DFO-NL – Resource Management
Amber Messmer	DFO-NL – Science
Brian Dempson	DFO-NL – Science
Chantelle Burke	DFO-NL – Science
Corey Morris	DFO-NL – Science
Curtis Pennell	DFO-NL – Science
Hannah Murphy	DFO-NL – Science
Ian Bradbury	DFO-NL – Science
Kim Marshall	DFO-NL – Science
Kristin Loughlin	DFO-NL – Science
Martha Robertson	DFO-NL – Science
Michelle Fitzsimmons	DFO-NL – Science
Nick Kelly	DFO-NL – Science
Rebecca Poole	DFO-NL – Science
Sarah Lehnert	DFO-NL – Science
Steve Duffy	DFO-NL – Science
Travis Van Leeuwen	DFO-NL – Science

Approved by

B. Healey
A/Regional Director Science
Newfoundland and Labrador Region
Fisheries and Oceans Canada
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Appendix I – Figures and Tables

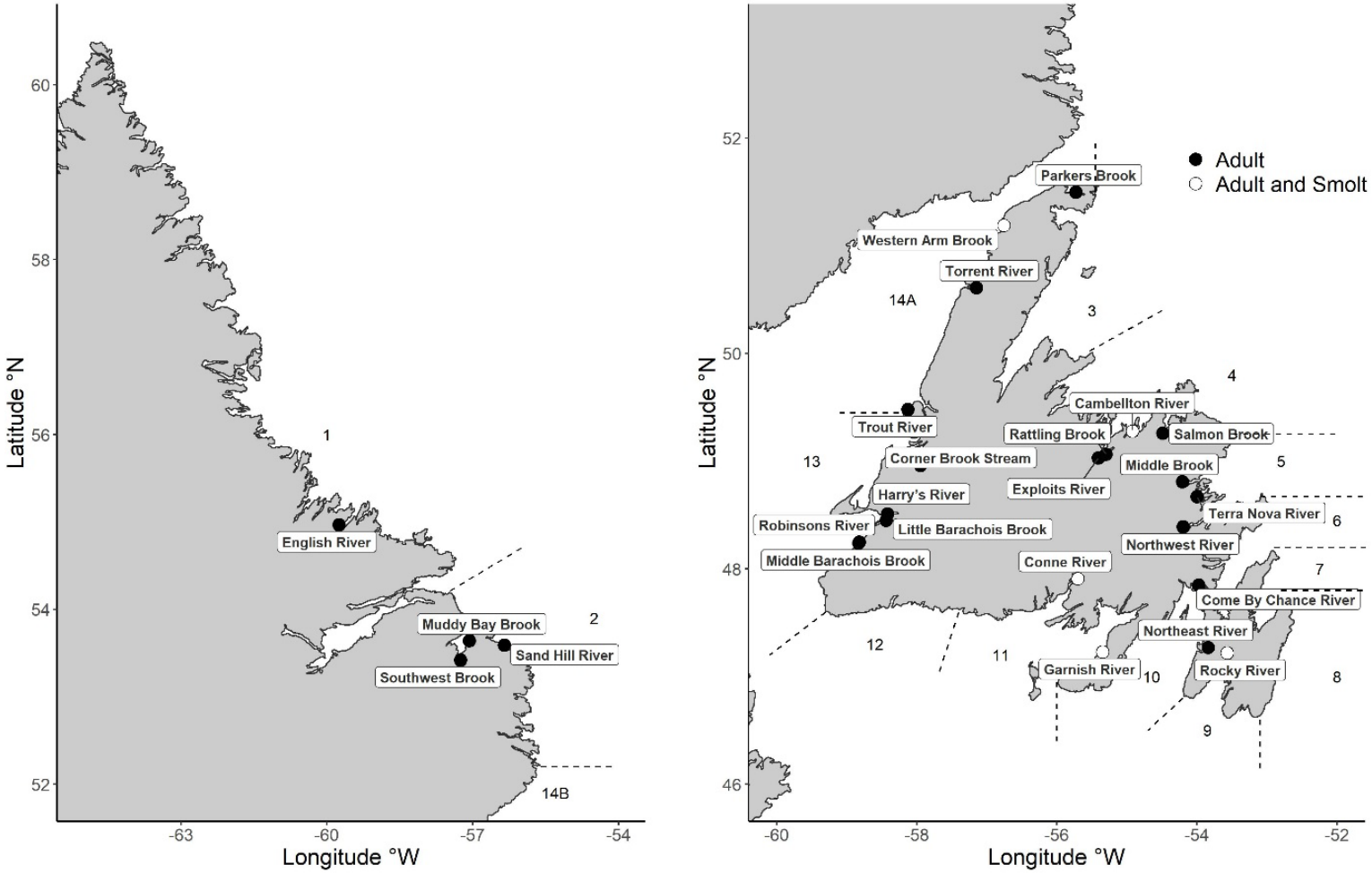

Figure 1. Map of the NL Region showing SFAs 1–14B and rivers where the number of out-migrating Atlantic Salmon smolts and/or returning adults were counted in 2021.

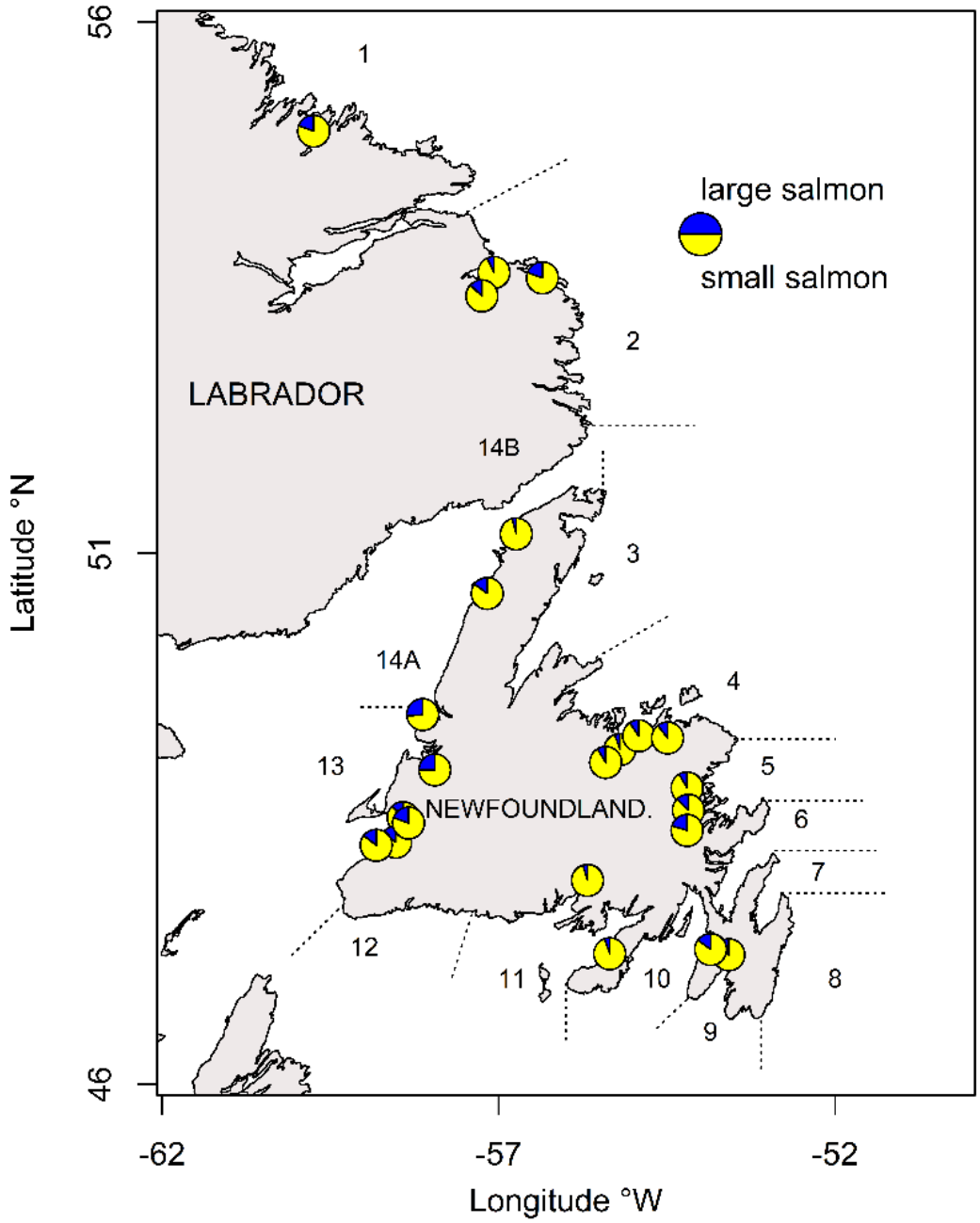

Figure 2. Average proportion of small (fork length <63 cm) and large (fork length ≥63 cm) Atlantic Salmon for available data from 1992–2021 for Newfoundland and Labrador rivers monitored in 2021. The approximate boundary of each SFA is indicated by dotted lines.

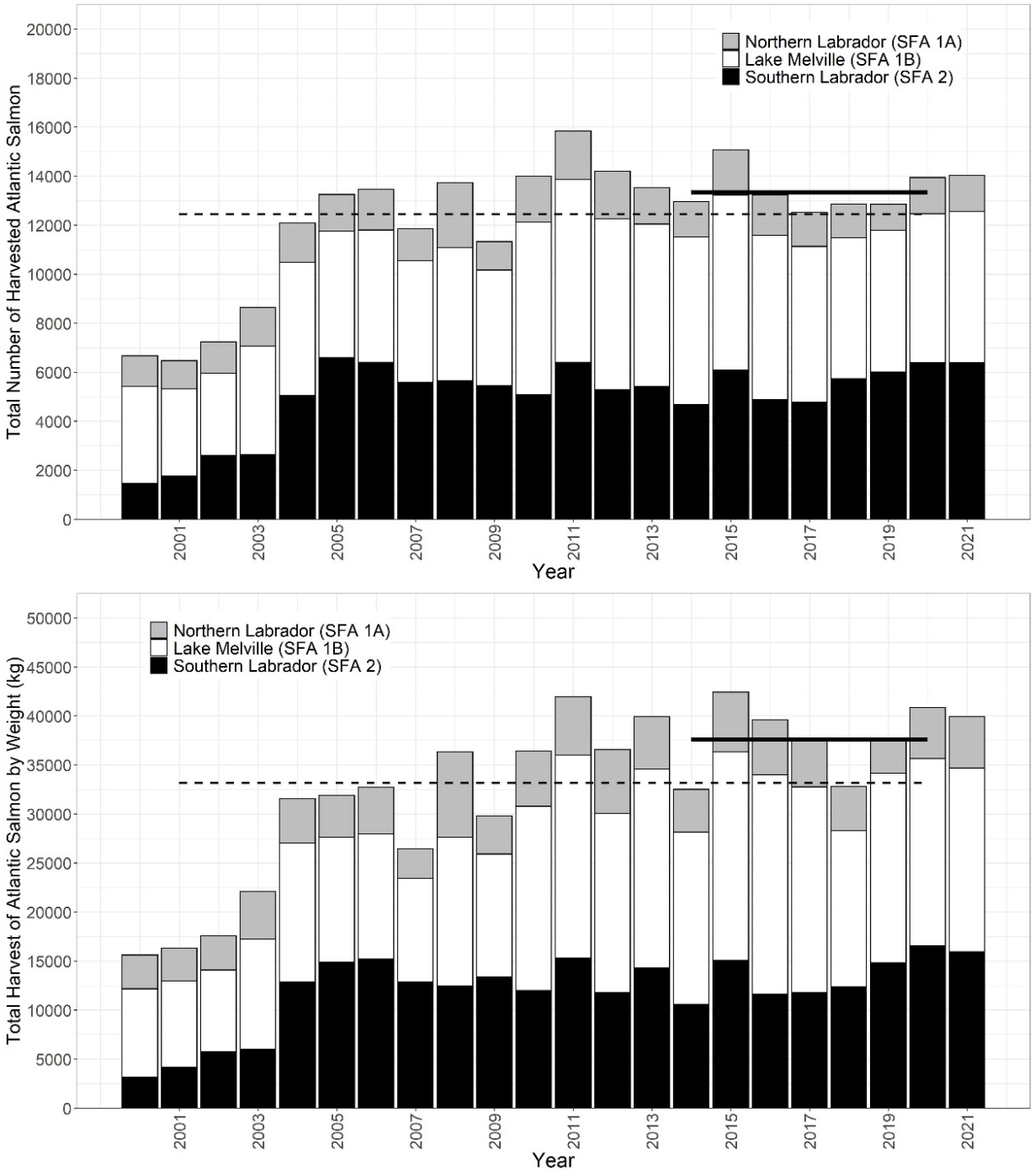

Figure 3. Estimated number (top panel) and weight (bottom panel) of Atlantic Salmon harvested in Labrador Indigenous and subsistence fisheries in SFAs 1A, 1B and 2 from 2000–21. Horizontal solid line represents the previous generation average (2014–20). Horizontal dashed line represents the previous three generation average (2001–20). Harvest estimates for 2021 are preliminary and will be updated upon the receipt and analysis of additional logbooks.

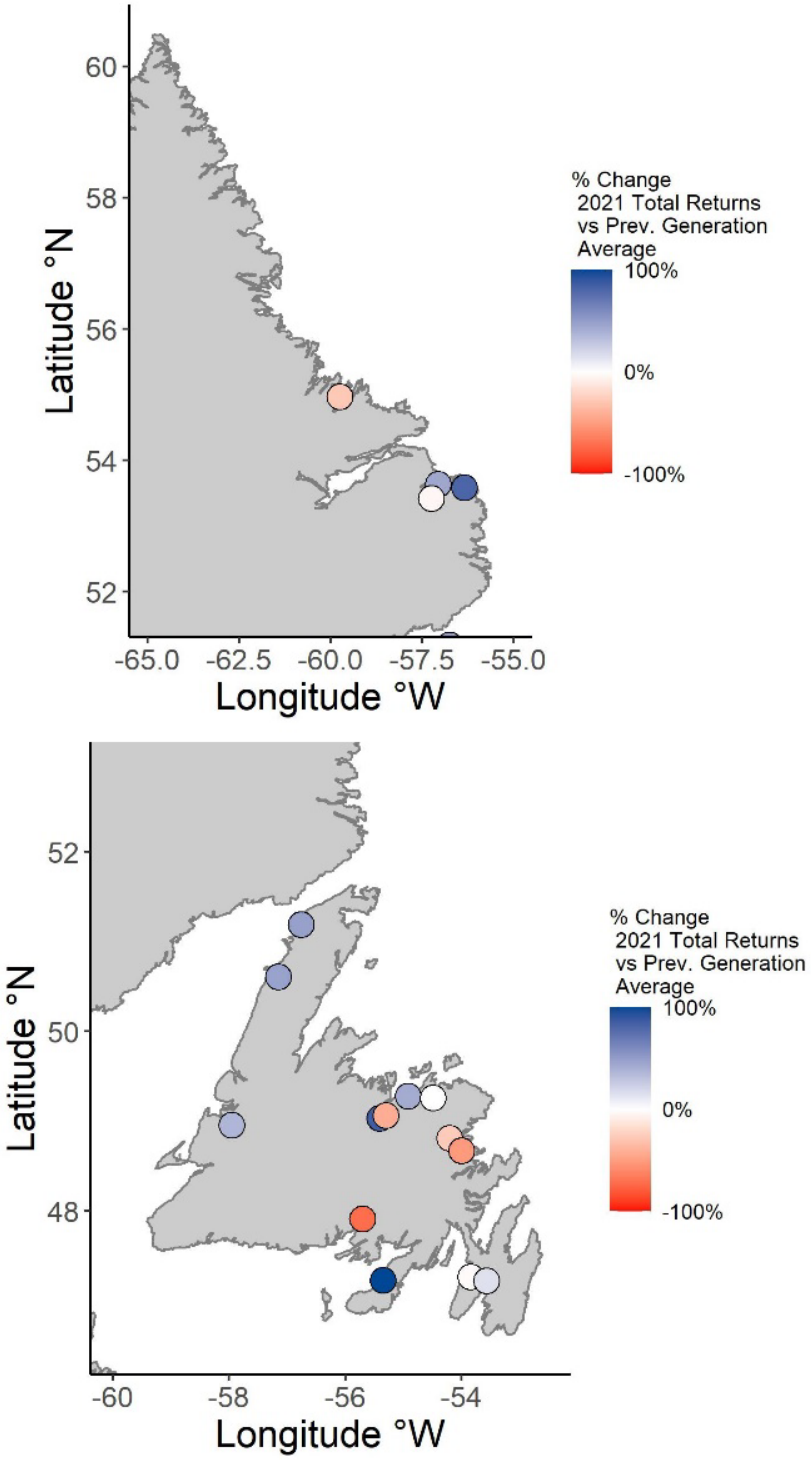

Figure 4. The percent change in 2021 total returns compared to the average returns over the previous generation for 17 monitored Atlantic Salmon populations in Newfoundland (bottom) and Labrador (top). Total returns in 2021 on each river are compared to average returns over the previous generation time period specific to each river (six years for most Newfoundland rivers and seven years for Labrador rivers). Percent change estimates are scaled between +100% (blue) and -100% (red).

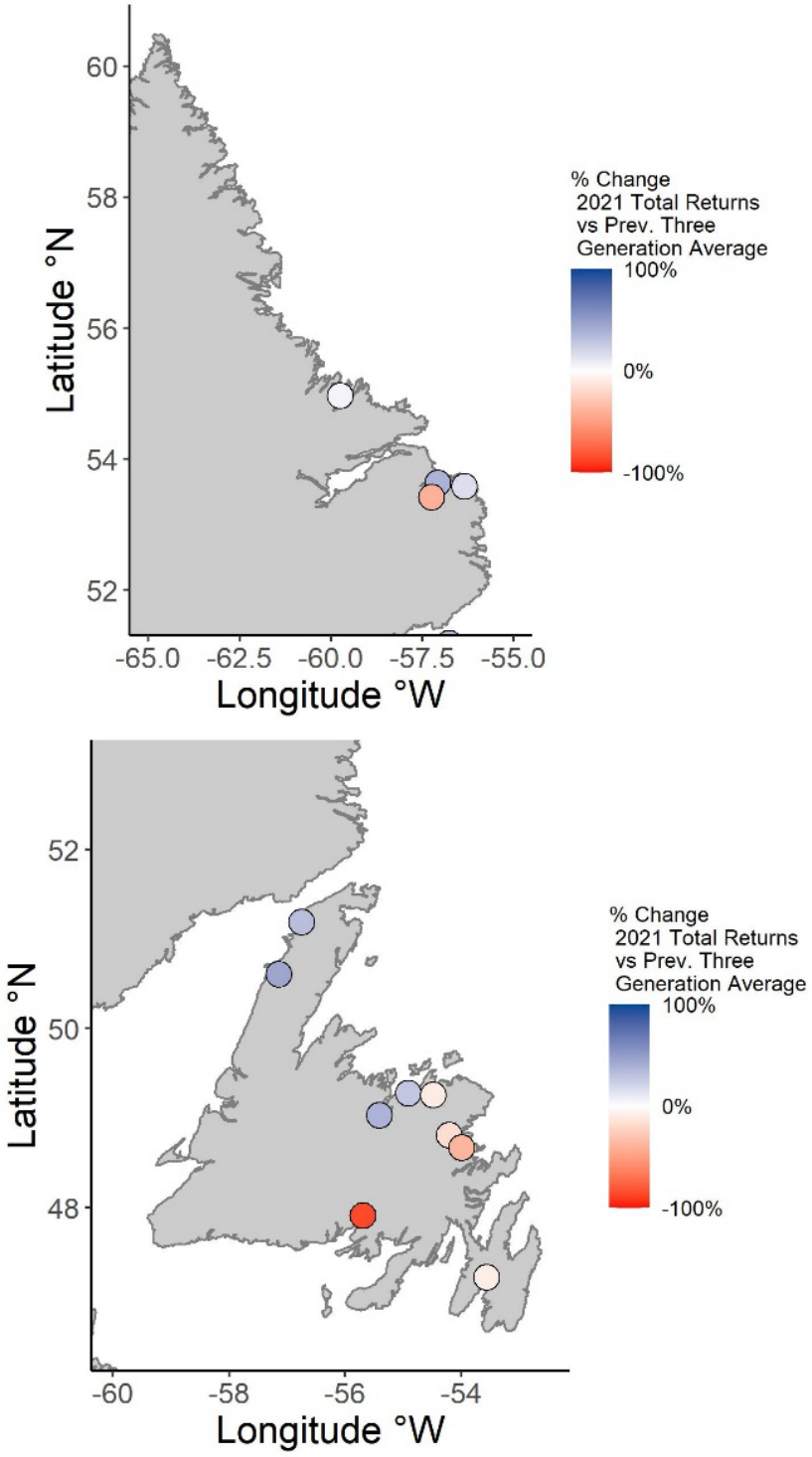

Figure 5. The percent change in 2021 total returns compared to the average returns over the previous three generations for 13 monitored Atlantic Salmon populations in Newfoundland (bottom) and Labrador (top). The previous three generation time period is specific to each river (16–18 years for most Newfoundland rivers and 19–20 years for most Labrador rivers). Percent change estimates are scaled between +100% (blue) and -100% (red).

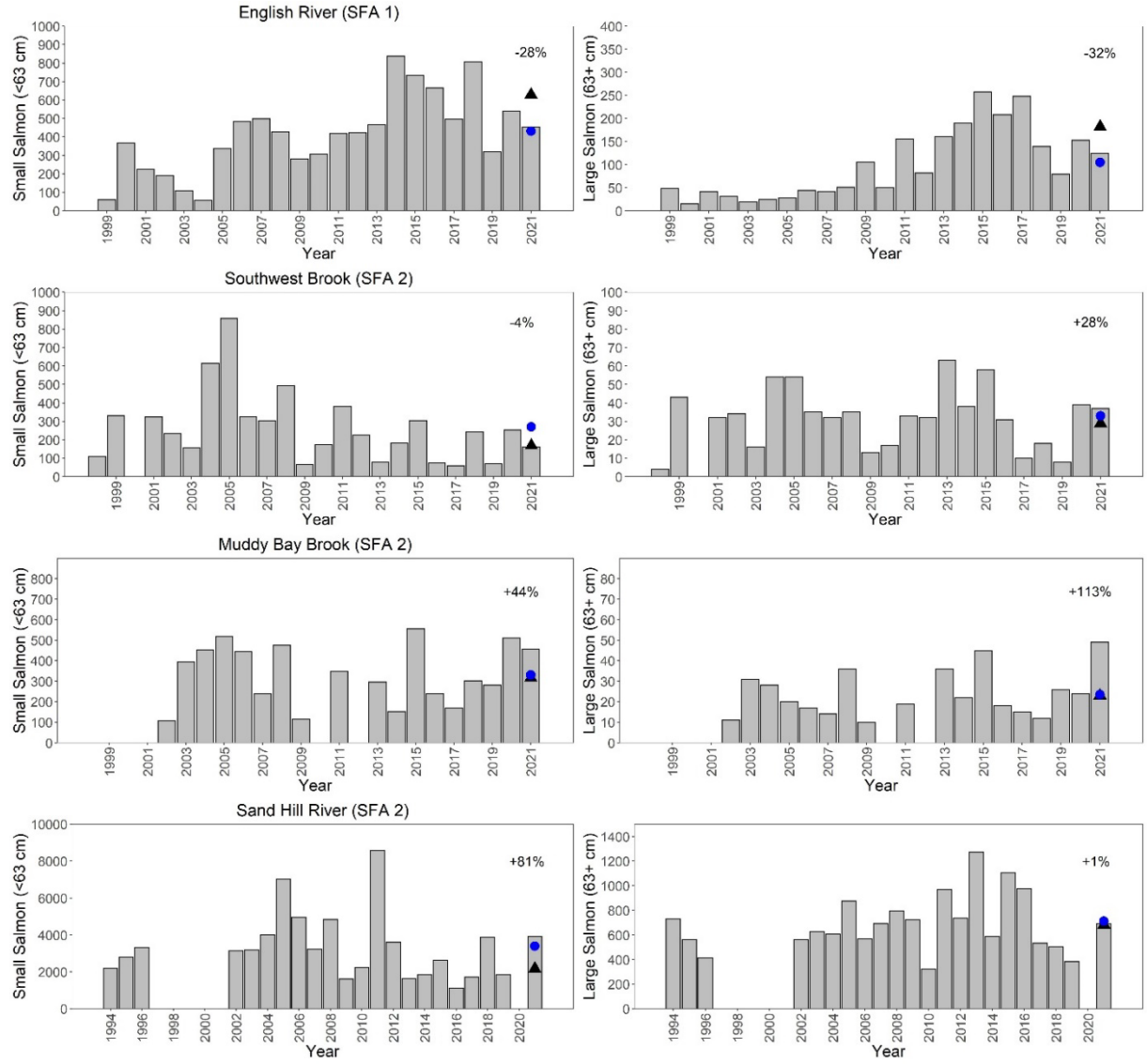

Figure 6. Total returns of small and large salmon to monitored rivers in Labrador: English River (SFA 1) and Southwest Brook, Muddy Bay Brook, and Sand Hill River (SFA 2), 1994–2021. The black triangles and blue circles represent the previous generation average (2014–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. For comparisons to previous three generation averages, see Tables 2–4.

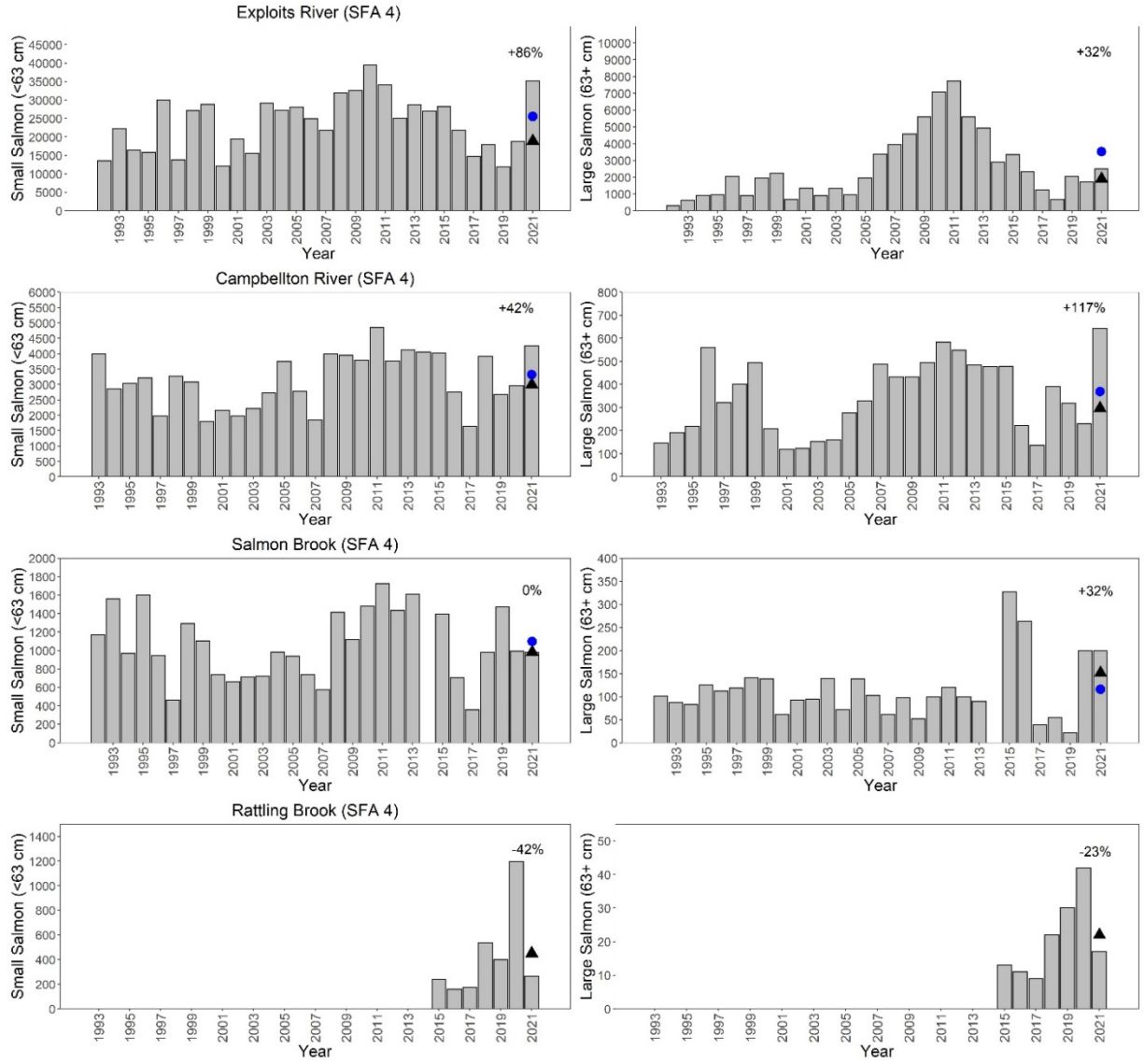

Figure 7. Total returns of small and large salmon to monitored rivers in SFA 4 on the northeast coast of Newfoundland, 1992–2019. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. For comparisons to previous three generation averages, see Tables 2–4.

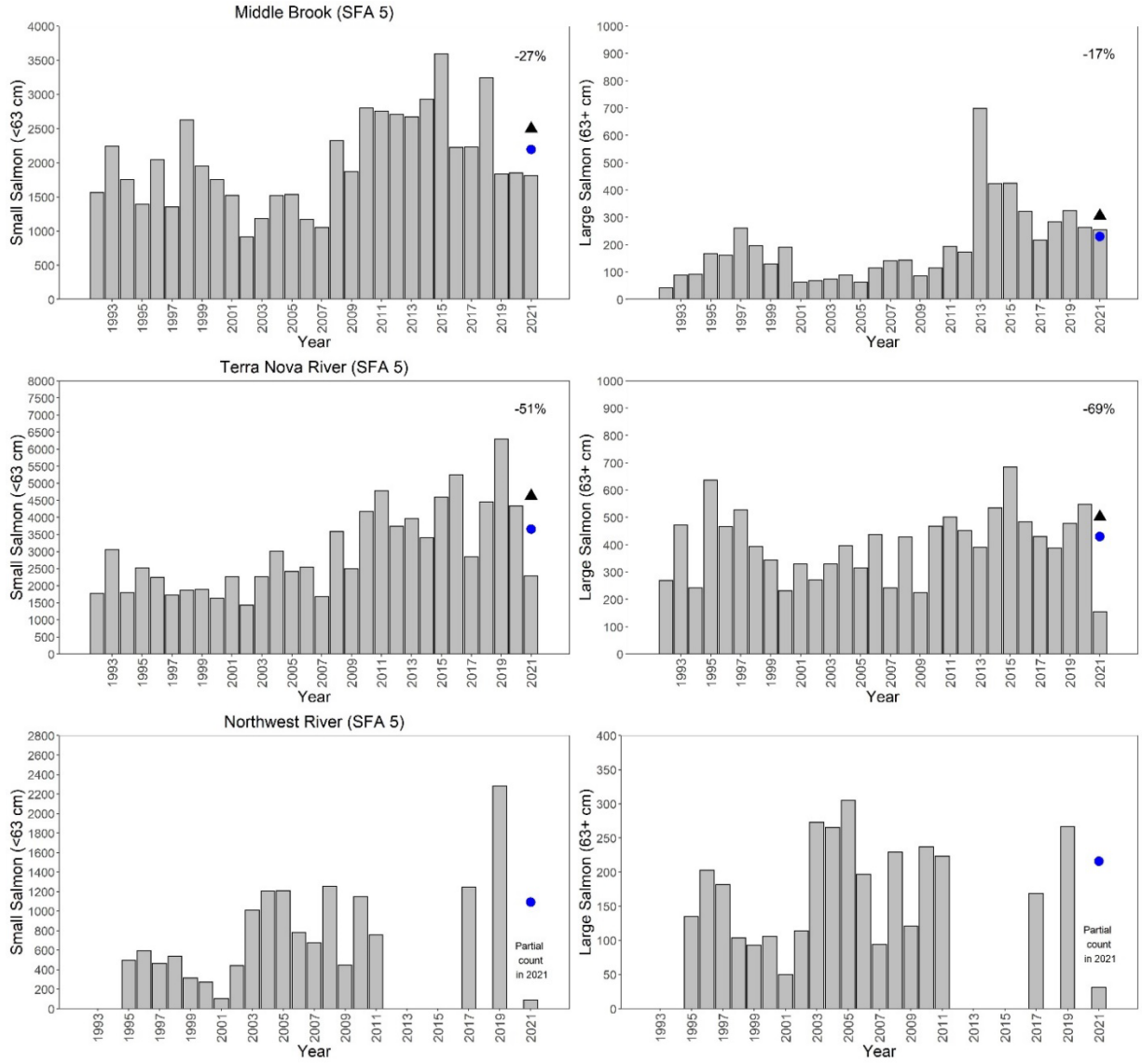

Figure 8. Total returns of small and large salmon to monitored rivers in SFA 5 on the northeast coast of Newfoundland, 1992–2021. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. The 2021 Atlantic Salmon count on Northwest River was incomplete. For comparisons to previous three generation averages, see Tables 2–4.

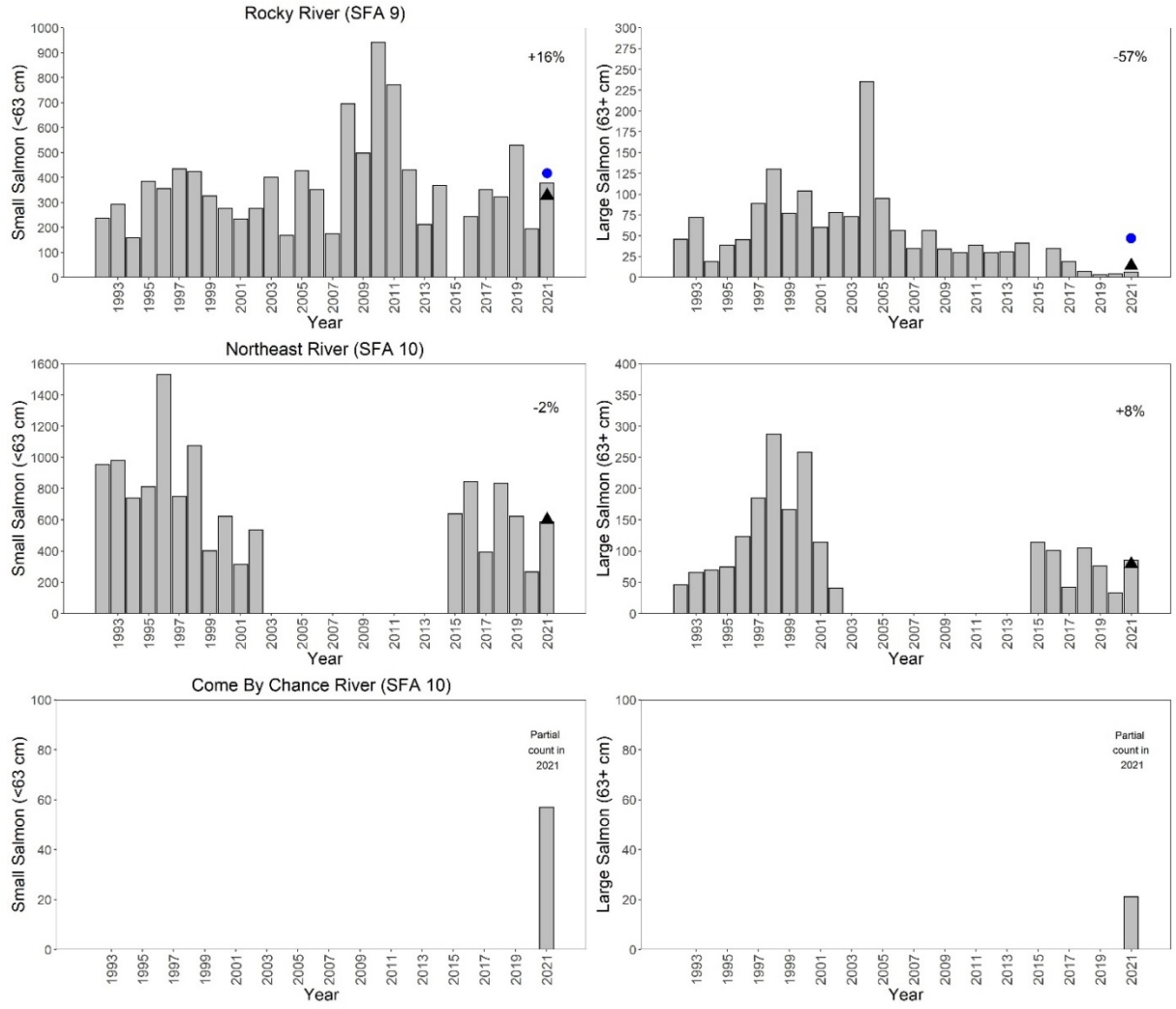

Figure 9. Total returns of small and large salmon to monitored rivers on the southeast coast of Newfoundland, 1992–2021: Rocky River (SFA 9) and Northeast River (Placentia Bay) and Come By Chance River (SFA 10). The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. The 2021 Atlantic Salmon count on Come By Chance River was incomplete. For comparisons to previous three generation averages, see Tables 2–4.

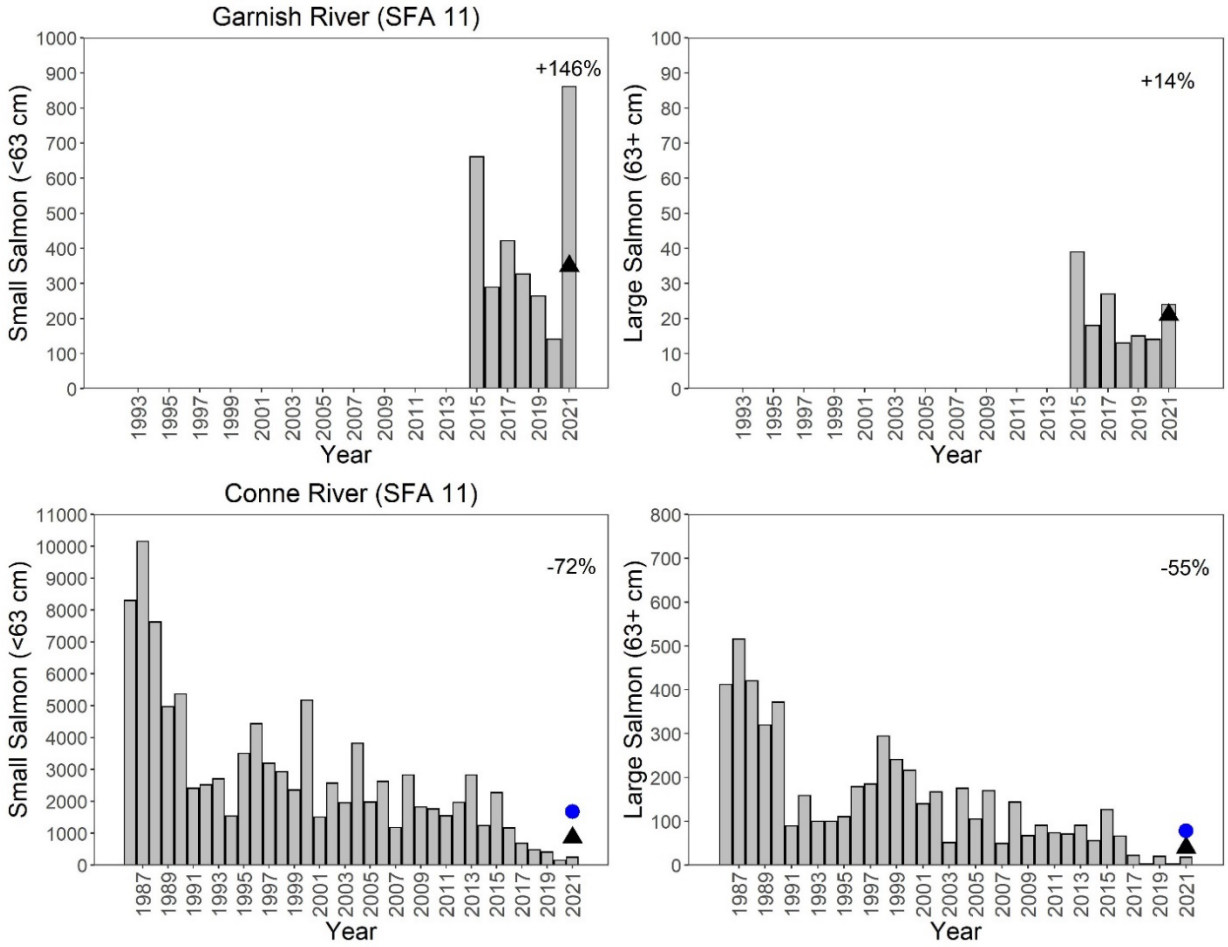

Figure 10. Total returns of small and large salmon to monitored rivers in SFA 11 on the south coast of Newfoundland, 1987–2021. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. For comparisons to previous three generation averages, see Tables 2–4.

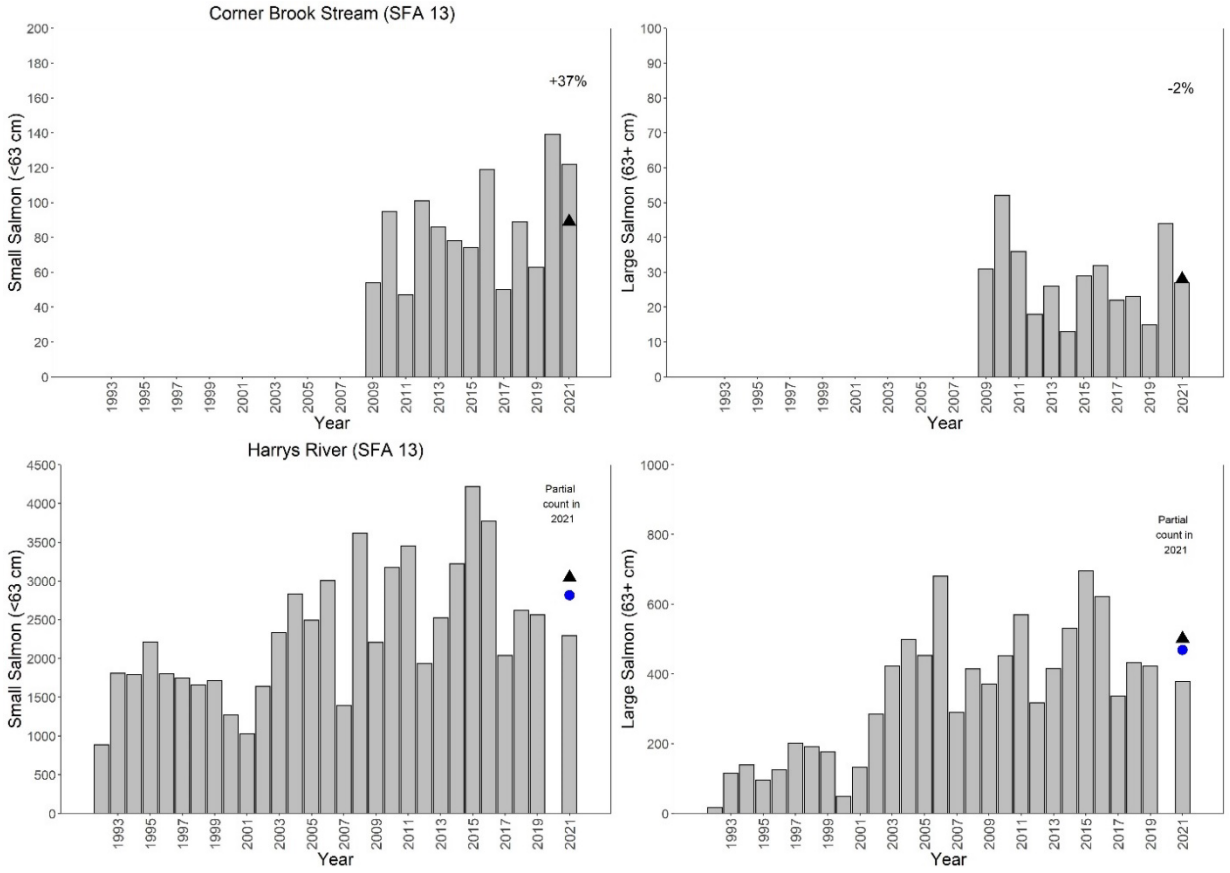

Figure 11. Total returns of small and large salmon to Corner Brook Stream and Harrys River in SFA 13 on the west coast of Newfoundland, 1992–2021. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. The 2021 Atlantic Salmon count on Harrys River was incomplete. For comparisons to previous three generation averages, see Tables 2–4.

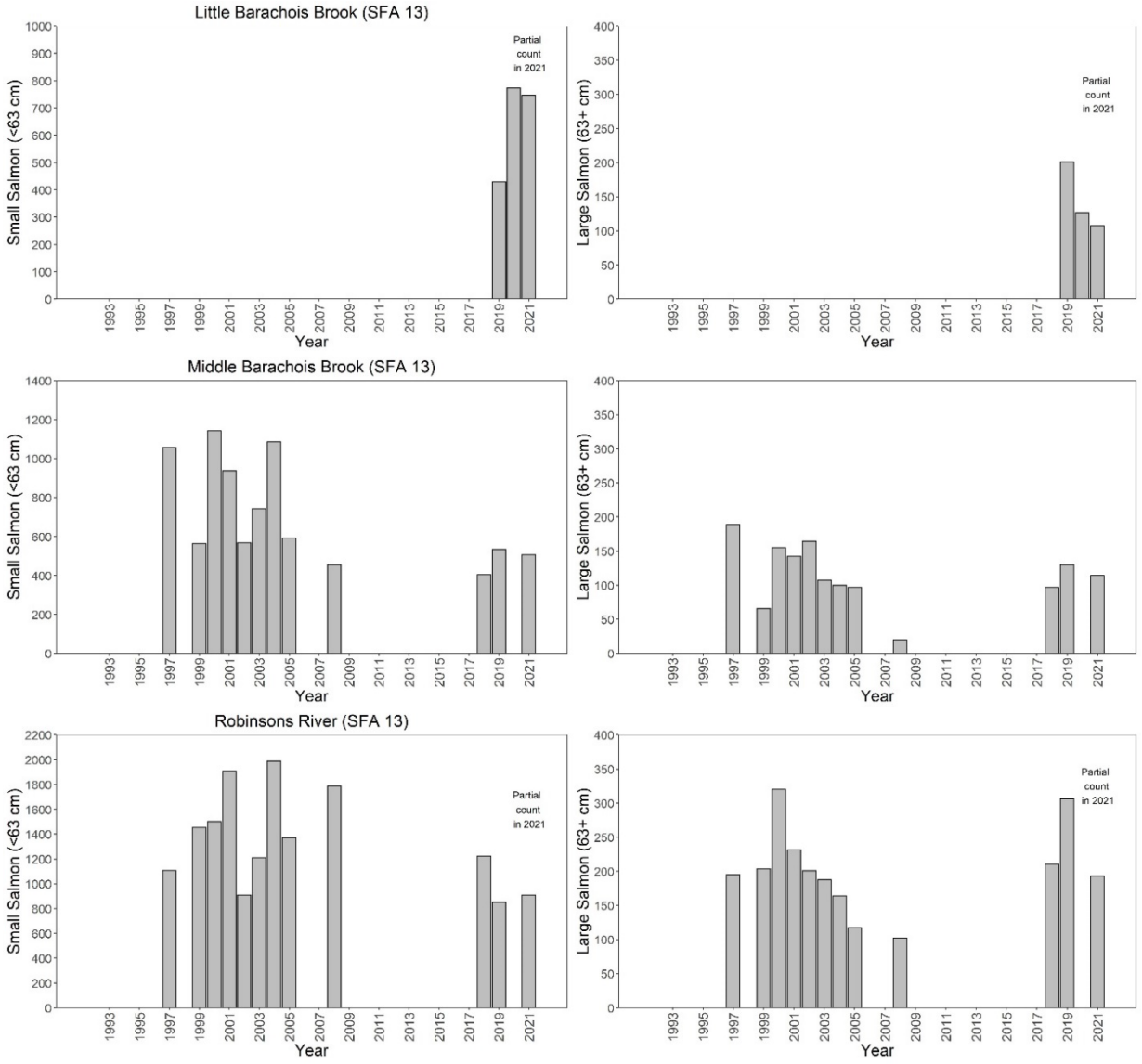

Figure 12. Estimated total returns of small and large salmon based on in-river snorkel surveys in SFA 13 on the southwest coast of Newfoundland, 1993–2021. Previous generation and three generation averages are unavailable for these three rivers. Total return estimates for Little Barachois Brook are based on the combination of a counting fence that ran throughout the Atlantic Salmon migration and an in-river snorkel survey conducted in late August from the counting fence down to the river mouth (≈9 km distance). The 2021 Atlantic Salmon counts on Little Barachois Brook and Robinsons River were incomplete.

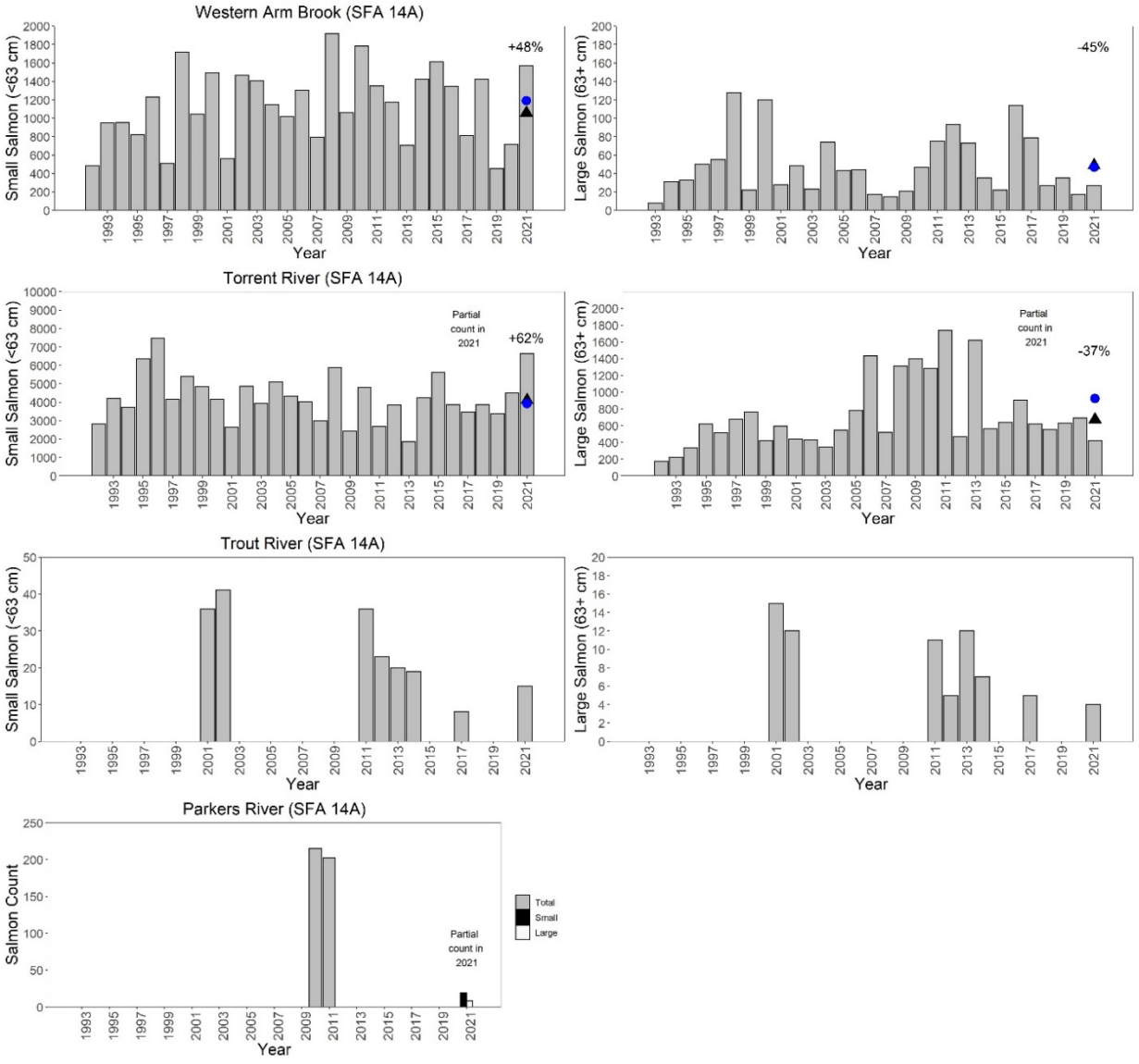

Figure 13. Total returns of small and large salmon to monitored rivers in SFA 14A on the west coast of Newfoundland, 1992–2021. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Percent change values (inset) reflect comparisons of 2021 small and large salmon returns to the previous generation average. For comparisons to previous three generation averages, see Tables 2–4. Total returns shown for Torrent River in 2021 are minimum estimates (incomplete count in 2021, see text). Parkers River counts in 2010 and 2011 are only available as total salmon counts (small and large salmon combined). The 2021 Atlantic Salmon count on Parkers River was incomplete.

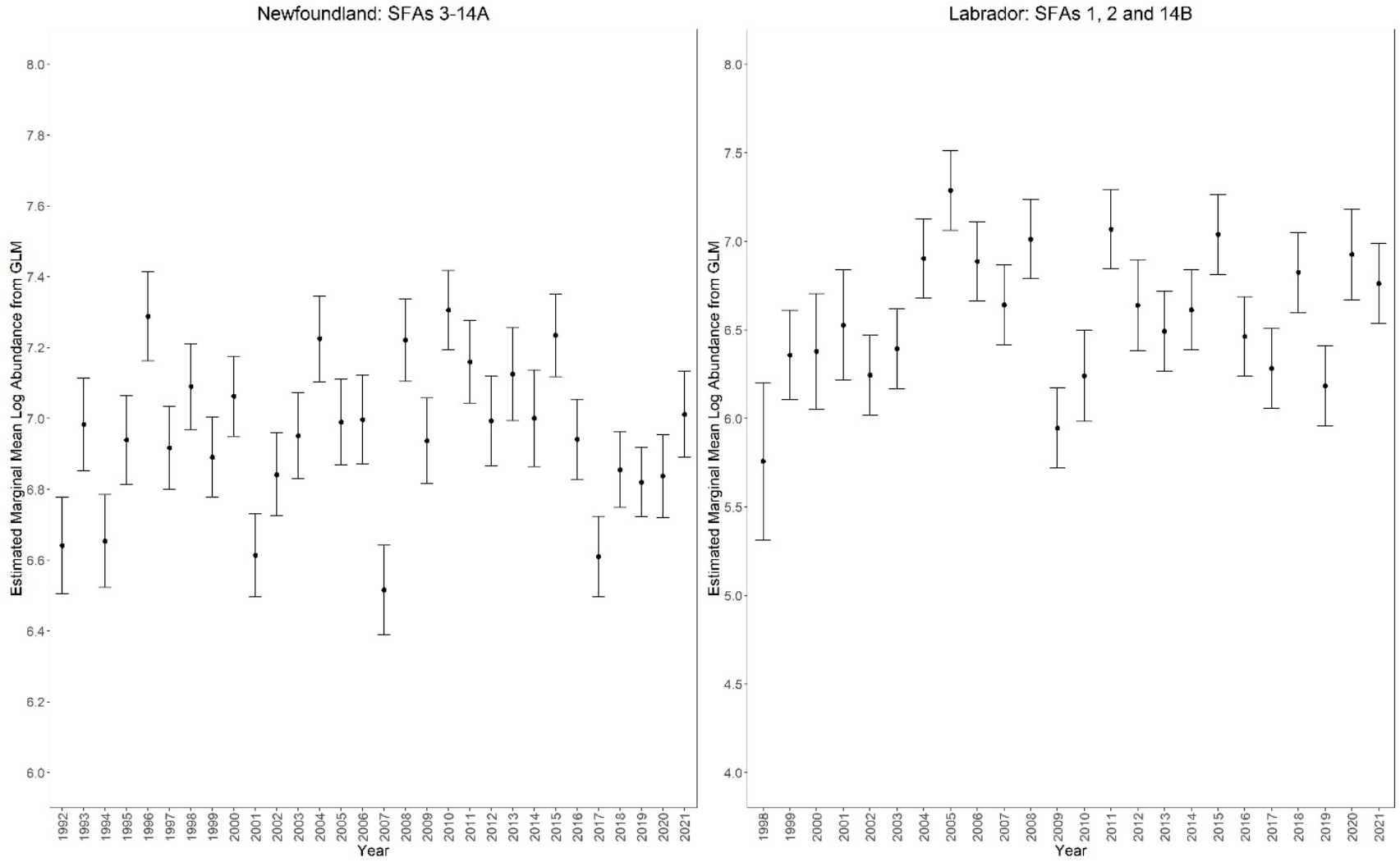

Figure 14. Estimated marginal mean log Atlantic Salmon abundance from negative binomial GLMs (log link function and year as a factor) applied to data from monitored rivers in Newfoundland (left) and in Labrador (right). Vertical lines represent ± one standard error. Each model only includes data since the commercial moratorium (1992 for Newfoundland and 1998 for Labrador).

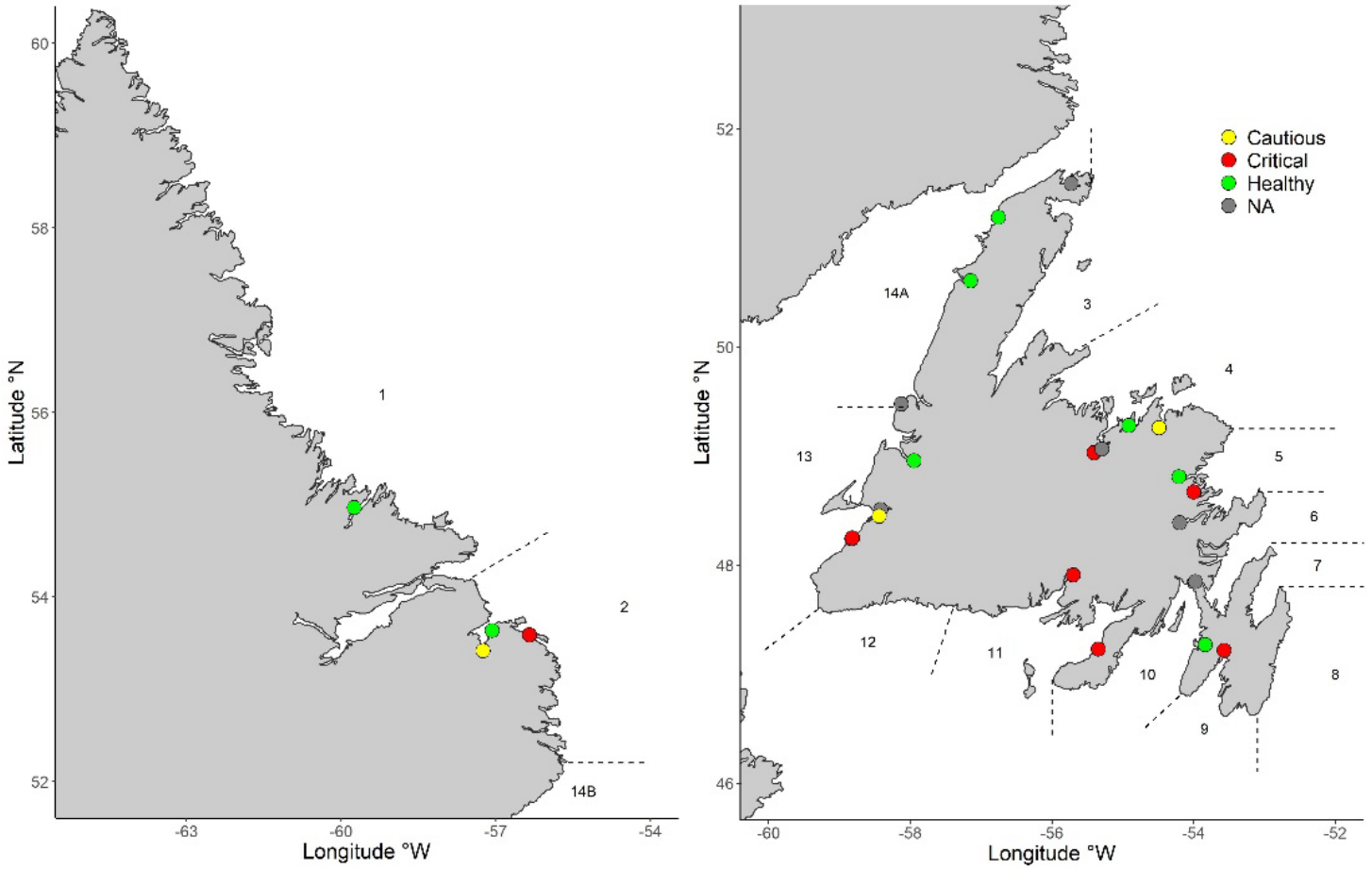

Figure 15. Map of Atlantic Salmon rivers monitored in 2021 in Newfoundland (right) and Labrador (left). Rivers are coloured by their estimated stock status zone as per the Precautionary Approach (DFO 2015). Designation of a population within a stock status zone is based on comparing the estimated egg depositions in 2021 to the river-specific Limit Reference Point (LRP): Critical Zone (0–99% of LRP), Cautious Zone (100–149% of LRP), and Healthy Zone (≥150% of LRP). Due to incomplete salmon counts in 2021, estimates of egg depositions and stock status zone are unavailable for five monitored rivers (see Table 5). One additional river (Rattling Brook in SFA 4) is not assessed due to recent enhancement activity on that river. Numbers and dashed lines represent SFAs and their approximate boundaries.

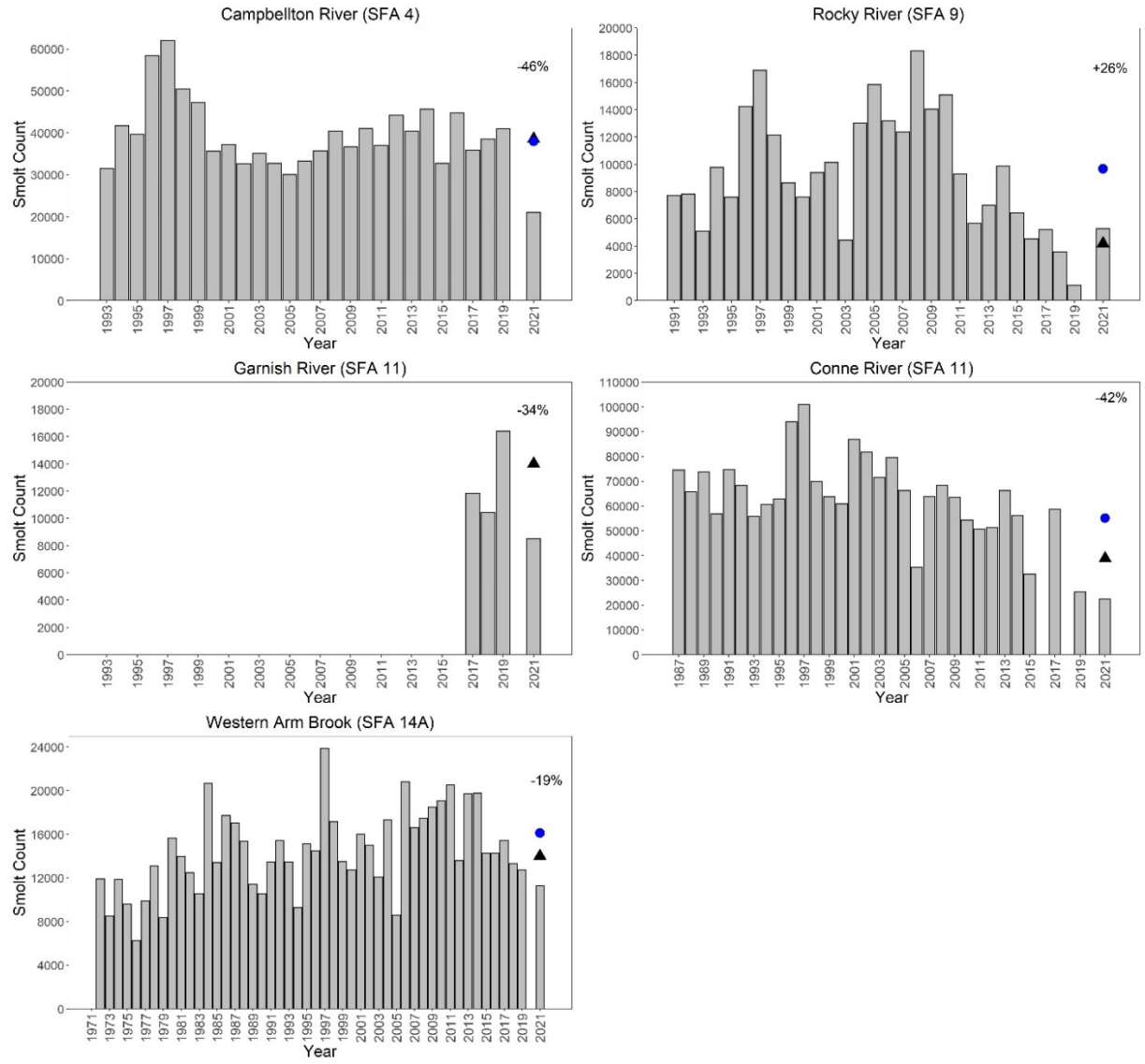

Figure 16. Smolt production on monitored Newfoundland Atlantic Salmon rivers in 2021. The black triangles and blue circles represent the previous generation average (2015–20) and previous three generation average, respectively. Smolt counts are not available for 2020 due to COVID-19 impacts on field operations. Percent change values (inset) reflect comparisons of 2021 smolt abundance to the previous generation average. For comparisons to previous three generation averages, see Table 6.

Table 1. Harvests of Atlantic Salmon in the subsistence and FSC Fisheries in Labrador (SFA 1 and 2 combined), 1999–2021. Estimates for 2021 are compared to the previous generation average (2014–20) and previous three generation average (2001–20). Estimates for 2021 are preliminary.

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	23,439	4,535	18,541	15,834	41,979
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	8,960	17,663	4,000	14,876	12,959	32,539
2015	8,923	17,500	6,146	24,935	15,069	42,435
2016	7,645	14,579	5,595	25,022	13,240	39,601
2017	6,701	12,952	5,818	24,523	12,518	37,475
2018	8,780	16,536	4,077	16,270	12,858	32,807
2019	7,062	13,249	5,793	24,543	12,855	37,791
2020	7,607	14,366	6,345	26,529	13,952	40,895
2021	8,797	17,881	5,244	22,089	14,041	39,970
2014–20	7,954	15,264	5,396	22,385	13,350	37,649
% Change	+11	+17	-3	-1	+5	+6
2001–20	8,379	16,571	4,078	16,596	12,457	33,167
% Change	+5	+8	+29	+33	+13	+21

Table 2. Total returns (small [<63 cm] and large [≥63 cm] size groups combined) of Atlantic Salmon to monitored NL rivers in 2021 in comparison to the average returns (and percent change) during the previous generation and previous three generations. One generation corresponds to five or six years in Newfoundland and seven years in Labrador. Percent change of <10% is considered no change. Rivers where counts of returning salmon are considered incomplete in 2021, due to washout events or issues with monitoring, are bolded.

River Name	SFA	2021 Total Returns	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
Exploits River	4	37,683	20,795	+81%	29,065	+30%
Campbellton River	4	4,904	3,293	+49%	3,692	+33%
Salmon Brook	4	1,182	1,134	+4%	1,213	-3%
Rattling Brook	4	280	471	-41%	NA	NA
Middle Brook	5	2,067	2,802	-26%	2,425	-15%
Terra Nova River	5	2,437	5,132	-53%	4,090	-40%
Northwest River	**5**	**121**	**NA**	**NA**	**NA**	**NA**
Rocky River	9	385	342	+13%	464	-17%
Northeast River	10	674	678	-1%	NA	NA
Come By Chance River	**10**	**78**	**NA**	**NA**	**NA**	**NA**
Garnish River	11	885	371	+138%	NA	NA

River Name	SFA	2021 Total Returns	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
Conne River	11	260	901	-71%	1,769	-85%
Middle Barachois Brook	13	619	NA	NA	NA	NA
Robinsons River	**13**	**1,101**	**NA**	**NA**	**NA**	**NA**
Little Barachois Brook	**13**	**854**	**NA**	**NA**	**NA**	**NA**
Harry's River	**13**	**2,673**	**3,545**	**NA**	**3,286**	**NA**
Corner Brook Stream	13	149	117	+28%	NA	NA
Torrent River	**14A**	**7,063**	**4,785**	**+≥48%**	**4,855**	**+≥45%**
Western Arm Brook	14A	1,598	1,111	+44%	1,240	+29%
Trout River	**14A**	**19**	**NA**	**NA**	**NA**	**NA**
Parkers River	**14A**	**27**	**NA**	**NA**	**NA**	**NA**
English River	1	578	811	-29%	537	+8%
Southwest Brook	2	199	198	0%	304	-34%
Muddy Bay Brook	2	505	339	+49%	352	+43%
Sand Hill River	2	4612	2,849	+62%	4,102	+12%
Summary		N = 25	N = 17	Declines ≥30% 3/17 (18%)	N = 13	Declines ≥30% 3/13 (23%)

Table 3. Total returns of large (≥63 cm) Atlantic Salmon to monitored NL rivers in 2021 in comparison to the average returns (and percent change) during the previous generation and previous three generations. One generation corresponds to five or six years in Newfoundland and seven years in Labrador. Percent change of <10% is considered no change. Rivers where counts of returning salmon are considered incomplete in 2021, due to washout events or issues with monitoring, are bolded.

River Name	SFA	2021 Large Returns	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
Exploits River	4	2,500	1,891	+32%	3,525	-29%
Campbellton River	4	644	297	+117%	369	+75%
Salmon Brook	4	200	151	+32%	116	+72%
Rattling Brook	4	17	21	-20%	NA	NA
Middle Brook	5	255	306	-17%	230	+11%
Terra Nova River	5	155	502	-69%	430	-64%
Northwest River	**5**	**31**	**NA**	**NA**	**NA**	**NA**
Rocky River	9	6	14	-56%	47	-87%
Northeast River	10	85	79	+8%	NA	NA
Come By Chance River	**10**	**21**	**NA**	**NA**	**NA**	**NA**
Garnish River	11	24	21	+14%	NA	NA
Conne River	11	18	40	-55%	78	-77%
Middle Barachois Brook	13	114	NA	NA	NA	NA
Robinsons River	**13**	**193**	**NA**	**NA**	**NA**	**NA**
Little Barachois Brook	**13**	**108**	**NA**	**NA**	**NA**	**NA**
Harry's River	**13**	**422**	**501**	**NA**	**469**	**NA**
Corner Brook Stream	13	27	28	-2%	NA	NA
Torrent River	**14A**	**423**	**674**	**-≤37%**	**924**	**-≤54%**
Western Arm Brook	14A	27	49	-45%	47	-43%
Trout River	**14A**	**4**	**NA**	**NA**	**NA**	**NA**
Parkers River	**14A**	**8**	**NA**	**NA**	**NA**	**NA**
English River	1	124	182	-32%	105	+18%
Southwest Brook	2	37	29	+28%	33	+13%
Muddy Bay Brook	2	49	23	+113%	23	+113%
Sand Hill River	2	692	682	+1%	713	-3%

River Name	SFA	2021 Large Returns	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
Summary		N = 25	N = 17	Declines ≥30% 5/17 (29%)	N = 13	Declines ≥30% 4/13 (31%)

Table 4. Total returns of small (<63 cm) Atlantic Salmon to monitored NL rivers in 2021 in comparison to the average returns (and percent change) during the previous generation and previous three generations. One generation corresponds to five or six years in Newfoundland and seven years in Labrador. Percent change of <10% is considered no change. Rivers where counts of returning salmon are considered incomplete in 2021, due to washout events or issues with monitoring, are bolded.

River Name	SFA	2021 Returns	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
Exploits River	4	35,183	18,904	+86%	25,540	+38%
Campbellton River	4	4,260	2,996	+42%	3,323	+28%
Salmon Brook	4	982	983	0%	1,097	-10%
Rattling Brook	4	263	450	-42%	NA	NA
Middle Brook	5	1,812	2,497	-27%	2,195	-17%
Terra Nova River	5	2,282	4,630	-51%	3,660	-38%
Northwest River	**5**	**90**	**NA**	**NA**	**NA**	**NA**
Rocky River	9	379	328	+15%	417	-9%
Northeast River	10	589	600	-2%	NA	NA
Come By Chance River	**10**	**57**	**NA**	**NA**	**NA**	**NA**
Garnish River	11	861	350	+146%	NA	NA
Conne River	11	242	861	-72%	1,691	-86%
Middle Barachois Brook	13	505	NA	NA	NA	NA
Robinsons River	**13**	**908**	**NA**	**NA**	**NA**	**NA**
Little Barachois Brook	**13**	**746**	**NA**	**NA**	**NA**	**NA**
Harry's River	**13**	**2,295**	**3,043**	**NA**	**2,817**	**NA**
Corner Brook Stream	13	122	89	+37%	NA	NA
Torrent River	**14A**	**6,640**	**4,111**	**+62%**	**3,931**	**+69%**
Western Arm Brook	14A	1,571	1,062	+48%	1,192	+32%
Trout River	**14A**	**15**	**NA**	**NA**	**NA**	**NA**
Parkers River	**14A**	**19**	**NA**	**NA**	**NA**	**NA**
English River	1	454	629	-28%	431	+5%
Southwest Brook	2	162	169	-4%	271	-40%
Muddy Bay Brook	2	456	316	+44%	330	+38%
Sand Hill River	2	3,920	2,167	+81%	3,389	+16%
Summary		N = 25	N = 17	Declines ≥30% 3/17 (18%)	N = 13	Declines ≥30% 3/13 (23%)

Table 5. Summary of Atlantic Salmon stock status in Newfoundland and Labrador (SFAs 1–14B). The Limit Reference Point (LRP) and Upper Stock Reference point (USR) correspond to 100% and 150% of the previously defined conservation egg requirement, respectively. One generation corresponds to five to six years in Newfoundland and seven years in Labrador. Asterisks indicate rivers that have undergone enhancement activities. River names in bold type had an incomplete count of returning salmon in 2021 and those with NA for % LRP achieved had insufficient abundance data to estimate 2021 stock status.

River Name	SFA	LRP Achieved (%)	2021 Status	Previous Generation Average	% Change vs. Previous Generation	Previous 3 Generation Average	% Change vs. Previous 3 Generations
* Exploits River	4	64%	Critical	31%	+104%	47%	+36%
Campbellton River	4	467%	Healthy	291%	+61%	319%	+46%
Salmon Brook	4	137%	Cautious	128%	+7%	136%	+1%
Middle Brook	5	221%	Healthy	292%	-24%	248%	-11%
* Terra Nova River	5	34%	Critical	78%	-56%	62%	-45%
Northwest River	**5**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
* Rocky River	9	38%	Critical	34%	+12%	47%	-20%
Northeast River	10	305%	Healthy	308%	-1%	NA	NA
Come By Chance River	**10**	**25%**	**NA**	**NA**	**NA**	**NA**	**NA**
Garnish River	11	80%	Critical	33%	+145%	NA	NA
* Conne River	11	12%	Critical	41%	-71%	72%	-83%
Middle Barachois Brook	13	48%	Critical	NA	NA	NA	NA
Robinsons River	**13**	**53%**	**Critical**	**NA**	**NA**	**NA**	**NA**
Little Barachois Brook	**13**	**≥100%**	**Cautious**	**NA**	**NA**	**NA**	**NA**
Harry's River	**13**	**NA**	**NA**	**106%**	**NA**	**100%**	**NA**
Corner Brook Stream	13	260%	Healthy	217%	+20%	NA	NA
Torrent River	**14A**	**≥999%**	**Healthy**	**719%**	**+ ≥38%**	**768%**	**+ ≥29%**
Western Arm Brook	14A	437%	Healthy	330%	+32%	394%	+11%
Trout River	**14A**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Parkers River	**14A**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
English River	1	162%	Healthy	231%	-30%	145%	+12%
Southwest Brook	2	66%	Critical	63%	+5%	93%	-29%
Muddy Bay Brook	2	218%	Healthy	136%	+60%	132%	+65%
Sand Hill River	2	106%	Cautious	67%	+59%	92%	+15%
Summary		Rivers with estimated stock status: N = 19	8 Healthy 3 Cautious 8 Critical	-	Declines ≥30% 3/16 (19%)	-	Declines ≥30% 2/13 (15%)

Table 6. Summary of Atlantic Salmon smolt production in 2021 compared to the previous generation average (2015–20) and previous three generation average for each river.

River Name	SFA	2021 Smolt Production	Previous Generation Average	% Change Previous Generation Average	Previous 3 Generation Average	% Change Previous 3 Generation Average
Campbellton River	4	21,015	38,584	-46	37,961	-44
Rocky River	9	5,290	4,196	+26	9,674	-45
Conne River	11	22,397	38,867	-42	55,136	-59
Garnish River	11	8,494	12,888	-34	NA	NA
Western Arm Brook	14A	11,288	14,004	-19	16,121	-30

Appendix II – Assessment Triggers

There are two scenarios where DFO Science would trigger an assessment (outside of current two-year schedule).

1. ≥30% decline in total returns on ≥50% of rivers in a given year, relative to two reference periods:
   a. previous generation average (river-specific generation times, typically six years for Newfoundland rivers and seven years for Labrador rivers)
   b. previous two generation average
2. ≥25% decline in total returns on ≥50% of rivers over two consecutive years, relative to two reference periods:
   a. previous generation average (river-specific generation times, typically six years for Newfoundland rivers and seven years for Labrador rivers)
   b. previous two generation average

Analysis of 2021 returns indicate no trigger for either of the above criteria.

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Center for Science Advice (CSA)
Newfoundland and Labrador Region
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

E-Mail: DFONLCentreforScienceAdvice@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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