Northwest Atlantic Fisheries Organization

Serial No. N6953 **NAFO SCS Doc. 19/13**

SCIENTIFIC COUNCIL MEETING - JUNE 2019

Canadian Research Report for 2018 Newfoundland and Labrador Region

Submitted by
B. Healey and E. Parrill [1]

SUBAREA 2

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2018 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Atlantic Salmon–Subarea 2

The commercial fishery for Atlantic Salmon in Subarea 2 has remained closed since 1998. Estimates of recreational catches for Newfoundland and Labrador have been highly variable since 2005 (total catch range of 38,681 to 76,121 salmon). The 2018 preliminary recreational catch for Subarea 2, including retained and hooked-and-released fish was 6,580 salmon, 13% less than the previous 6 year mean (2012-17). Estimated Labrador Aboriginal and subsistence fisheries harvest was inferred from logbook returns (56% return rate) at 11,866 salmon in 2018 (7,935 small, 3,931 large), which was 14% less than the previous six year mean (2012 17) of 13,850 salmon (8,100 small, 5,750 large).

Two of the four rivers assessed in Subarea 2 were below their lower stock reference point in 2018. The most northerly river was the only one above its upper stock reference point in 2018.

b) Arctic Charr–Subarea 2

Commercial landings of Arctic Charr from north Labrador in 2018 were approximately 27 t and more than 65% higher than 2017. This is equivalent to about 16,000 Arctic Charr caught in terms of numbers of fish. Commercial landings have been sporadic over the past decade, driven largely by effort directed towards the commercial fishery, and in some years a fixed amount of charr that the local fish plant was able to process (~25 t). In addition to the commercial fishery, estimates of subsistence fishery harvests of Arctic Charr have averaged about 9,800 fish annually during the past 10 years (2008–17), ranging from a low of 8,400 charr in 2010 to 13,000 reported caught in 2012.

[1] Following the submission of updated stock information from the designated species experts, this document was compiled by the Centre for Science Advice (CSA) Office, Newfoundland and Labrador Region. Refer to the end of the document – Acknowledgement Section - for a complete list of contributing authors.

c) Cod–Divisions 2GH, Divisions 2J3KL

Although the cod stock in Div. 2GH has been under a moratorium on directed fishing since 1996, there was no reported catch since 1993. Bycatch of cod occurs in shrimp fisheries in 2GH and from 2004-09 estimates of bycatch have ranged between 250 kg to 5,200 kg annually (Orr et al. 2010). More recent data have not been compiled.

The northern cod stock (Div. 2J3KL) was closed to directed commercial fishing in 1992 but has been subjected to ongoing stewardship (weekly landings) and recreational fisheries in the inshore since 2006. Beginning in 2016, the 2J3KL Northern cod Stewardship Fishery has been managed using variable weekly catch limits. For the 2018 season, a maximum authorized harvest amount of 9,500 t was introduced. This corresponded to a 25% reduction from the 2017 removals. The Recreational Groundfish Fishery season was open for 39 days in 2018. This was a reduction of 7 days from the 2017 season. Recreational fishers were limited to five (5) groundfish per day (including cod). The maximum boat limit when three or more people were fishing was 15 groundfish.

Reported landings in 2018 were 9, 269 t from the stewardship fishery, 148 t in the sentinel surveys, and 63 t taken as by-catch (mostly from the redfish (Sebastes) and turbot (Reinhardtius hippoglossoides) fisheries). The Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) reported that the annual catches of cod by non-Canadian fleets outside the 200 nautical mile limit on the Nose of the Grand Bank (Div. 3L) were <300 t or less during 2000 18 (provisional value of 16 t in 2018).

There are no direct estimates of recreational landings for eight of the past 10 years; therefore reported landings are less than total catch in those years. Evidence from tagging data shows that although removals by the recreational fishery have been substantial in some years since 1997, they have been about 25% of the commercial catch in the last three years (2016-18).

d) American Plaice–Subarea 2 + Division 3K

This stock has been under moratorium since 1994. The status of the stock was updated in 2012 and a limit reference point (LRP) established. Total mortality due to all causes, including fishing, has been decreasing on more recent cohorts. An empirical biological LRP was determined from examining stock recruit data from the Research Vessel (RV) surveys. Generally recruitment has been impaired when the survey spawning stock biomass (SSB) index is below 70,000 t and therefore this was chosen as the LRP. It may be necessary to re-evaluate the LRP once more data are available at higher SSB (as SSB approaches the LRP). The 2009 estimate of survey SSB indicates that the stock is at 24 % of the LRP. This is the most recent SSB estimate for this stock as ageing data has not been completed for 2010-18. It was not possible to determine an upper reference point or a removals (F-based) reference point for this stock. The main source of bycatch of American Plaice in SA 2+3K since 2000 has been in the Greenland Halibut (GHL) gillnet and otter trawl fisheries. From 2007 to 2018, the total reported landings of American Plaice were between 3-23 t annually with the exception of a 100 t catch in 2013 resulting from bycatch from otter trawl fisheries in Div. 2J.

Based on observer data, estimates of American Plaice bycatch discarded from Canadian shrimp fisheries in the Div. 2G to Div. 3K area have ranged from 27 t to 34 t from 2007-2009 (Orr et al. 2010). More recent data have not been compiled.

e) Redfish–Subarea 2 + Division 3K

Redfish in Subarea 2 + Division 3K underwent a full assessment in 2016. Results indicated that redfish biomass in Subarea 2 + 3K increased from 2003-2011. Biomass during 2011-2015 declined to approximately half of the pre-collapse (1978-1990) levels. Recruitment (abundance of redfish <15cm) since 2000 was above the long term average with a time-series high in 2014. Fishing mortality has been low (<1%) since 2006. The fishery remains under moratorium and average annual removals from bycatch landings and discards in the shrimp and Greenland Halibut fisheries since 2006 has been 500 t. In the absence of a limit reference point (LRP) it was not possible to determine the zone within the Precautionary Approach (PA) framework that SA2 +3K redfish currently reside in. Due to marginal increases in both abundance and biomass RV survey indices from 2004 – 2011 and a subsequent period of declining indices from 2011-2015 it was recommended that an adaptive and cautious management approach be applied to any reopened fishery.

From 1978 to present, redfish removals were comprised of reported landings by Canada and non-Canadian fleets, and reported bycatch landings and discards by Canadian and non-Canadian fleets. Discards in the shrimp and Greenland halibut fisheries, which emerged in the 1980s, were estimated from catch rates derived from the fishery observer data scaled to the total landings. From 1980 to 1996, discards ranged between 14 t to 700 t annually, averaging 240 t per year. Since the moratorium in 1997, estimates of discards ranged between 20 t and 600 t annually, averaging 300 t per year. During 2017, discards were estimated at 104 t.

Reported landings from other countries fishing in NAFO's Regulatory Area (NRA) with large midwater trawls increased rapidly from 1,800 t in 2001 to a peak of 5,400 t in 2005. The catch declined to 1,100 t in 2006 and rose again to 3,100 t in 2007. The fishery has been virtually non-existent from 2008 to 2016 (<10 t) except for 74 t reported by Lithuania in 2011 and 39 t by Russia in 2015. It is assumed a portion of increased catches in the NRA were from the pelagic stock of redfish that resides primarily in the Irminger Sea between Greenland and Iceland. In 2018, landings were 9 t.

f) Witch Flounder-Divisions 2J3KL

There has been no directed fishing on this stock since 1994. In 2018, bycatch in other fisheries from the Newfoundland and Labrador Region was 131 t. Canadian fall surveys since the late 1970s indicated that Witch Flounder were widely distributed throughout the shelf area in deeper channels around the fishing banks primarily in Div. 3K. By the mid-1980s, they were rapidly disappearing and by the early 1990s had virtually disappeared from the area entirely except for some very small catches along the slope in Div. 3L. In the mid-2000s, the survey distribution expanded somewhat, and has continued to be found in broader areas in Div. 3L and 3K. For the three divisions combined, the biomass index declined from about 65,000 t in 1984 to 1,100 t in 1995, the lowest in the time series. Mean weight per tow decreased from a maximum of near 6 kg/tow in 1984 to a low of 0.23 kg/tow in 1995. The small increase in biomass index and mean weight per tow observed between 1995 and 1996 was almost exclusively a result of inclusion of the deeper strata surveyed in Div. 3L. Estimates of biomass and abundance have increased since 2003, with the stock estimated to be at 68% of B_{LIM} under the Canadian Precautionary Approach Framework.

g) Greenland Halibut-Subarea 2 + Divisions 3KLMNO

The Canadian (NL) catch of Greenland Halibut in 2018 in Subarea 2 and Div. 3KLMNO was approximately 6,202 t. Length frequency and otoliths were collected for calculation of catch-at-age.

h) Shrimp–Subarea 2 + Division 3K

The Northern Shrimp (*Pandalus borealis*) fishery in Subarea 2 and the northern portion of Subarea 3 is divided into three management areas, each referred to as a shrimp fishing area (SFA): 2G (SFA 4), Hopedale and Cartwright Channels in 2HJ (SFA 5), and Hawke Channel in 2J3K (SFA 6). The resource within these SFAs was usually assessed on a biennial basis, with updates provided in interim years. However, significant reductions in resource status in SFA 6 have triggered annual stock assessments since 2015. The last formal assessment was completed during February, 2019 and the next formal assessment is scheduled to be completed during February 2020.

Ecosystem conditions on the Newfoundland Shelf (2J3K) are indicative of an overall low productivity state, with both total shellfish and total finfish biomass showing declines since the early to mid-2010s. Current total (shellfish + finfish) biomass is at similar levels to those observed in the mid-1990s. However, shellfish make up a much lower proportion of the biomass.

Predation, fishing and environmental forcing are correlated with subsequent shrimp production, although the precise linkage with environmental variables remains unclear. The build-up of shrimp until the mid-2000s occurred during a period of favourable environmental conditions and reduced predation. Shrimp per-capita net production has declined since the mid-1990s, and is expected to remain around current low values for the next 2-3 years. Shrimp is an important forage species, particularly when there is scarcity of high energy prey such as capelin. Shrimp predation mortality in the near future is expected to remain relatively high unless abundance of alternative prey increases. Given current predation pressure on shrimp, fishing pressure could now be more influential on stock declines in SFA 6 than it was in the past.

The Labrador Current runs southward from SFA 4, through SFAs 5 and 6. Research on larval dispersal modeling within SFAs 4–6 indicated strong downstream larval connectivity and that a majority of recruits in a particular SFA may come from SFAs farther north; Northern Shrimp larvae may travel several hundreds of kilometers before settlement. Further research has demonstrated that larvae originating in the Arctic also show high settlement in SFAs 4–6. This research also indicates low larval shrimp retention in SFAs 4 and 5, and higher larval retention in SFA 6. Release location, ocean circulation, and larval behaviour were identified as important variables affecting larval dispersal in the study area. Simulations on larval dispersal indicated that larvae released from inshore populations showed higher potential settlement success than larvae released from offshore sites (shelf edge).

Studies of genetics between Northern Shrimp populations in SFAs 4–6 have demonstrated that Northern Shrimp in these areas are largely homogenous genetically. This is most likely due to larval and pelagic transport by the Labrador Current. Despite the relationships between SFAs 4–6, the Northern Shrimp resources in these areas are managed (and hence assessed) on an individual SFA basis rather than as a whole.

SFA 4 (NAFO Division 2G)

Biomass indices in SFA 4 have been declining since 2012. The fishable biomass index decreased by 46% and the female SSB decreased by 39% from 2017 to 2018 and are both at the lowest levels in the survey time series. The total allowable catch (TAC) is typically taken in this area and commercial catch per unit effort (CPUE) has varied without trend. Exploitation rate indices have been increasing since 2012/13. Female SSB index in 2018 was in the Cautious Zone with a 7% probability of having been in the Critical Zone.

SFA 5 (Hopedale and Cartwright Channels)

Biomass indices in SFA 5 have been declining since 2010, although with some annual variability. The fishable biomass index decreased by 43% and the female SSB index decreased by 31% between 2017

and 2018, both are at the second lowest levels of the survey time series. The TAC is typically taken in this area and CPUE has varied without trend. Female SSB index is in the Cautious Zone within the PA Framework with 51% probability. If the 25,630 t TAC is maintained and taken in 2019/20, then the exploitation rate index will be 32%..

SFA 6 (Hawke Channel + NAFO Division 3K)

There is concern for the current status of this resource. The female SSB index declined by 19% from 2016 to 2017 and returned to near-2016 levels in 2018. It is currently in the Critical Zone for the third consecutive year, based on the PA Framework. This follows three consecutive years of the female SSB index declining while in the Cautious Zone. The IFMP states that the exploitation rate should not exceed 10% while the female SSB index is in the Critical Zone. The TAC is typically taken in this area and CPUE has been at record low levels in recent years.

Fishery removal effects may become relatively high given the low level of net shrimp production after predator removals of shrimp in recent years. Thus, fishing mortality can be very important for determining whether gains (production) exceed losses (predation and fishing) and hence whether the stock increases or decreases. Recent environmental and ecosystem conditions along with harvest rates have not permitted the stock to increase.

i) Snow Crab–Divisions 2HJ

Most of the landings are derived from Div. 2J in all years. Landings have remained at 1,700 t for the past four years while effort has remained at its lowest level in two decades. CPUE has remained near the decadal average in recent years, reflecting trends throughout the division. The exploitable biomass index has changed little during the past 15 years. Recruitment into the exploitable biomass has changed little during the past 15 years. The 2018 trawl and trap surveys suggest recruitment will remain unchanged in 2019. The exploitable biomass has consisted largely of incoming recruits with few old-shelled crab in the population over the past decade. This suggests high mortality of large adult male crab. Total mortality in exploitable crab has been at or near its highest level in recent years but declined slightly in 2018. The exploitation rate index has been above the long-term average for the past three years. Status quo removals in 2019 would decrease the exploitation rate index, but it would remain at a relatively high level. Following the proposed Precautionary Approach the stock status would be in the provisional cautious zone in 2019. Size-at-terminal molt in males has precipitously declined in recent years, suggesting potentially dampened short-term recruitment prospects into the exploitable biomass. Poor monitoring and coverage levels of the CPS trap survey in recent years compromises the integrity of biomass estimation. Efforts should be made to ensure the survey is fully complete with protocols followed moving forward.

j) Iceland Scallop–Divisions 2HJ

Inshore aggregations were fished in 2009, 2010, 2011, 2012, 2013, 2014 ,2015, with nominal catches estimated at 17 t , 16 t, 19 t, 16 t, 20 t, 6 t , and 8 t round, respectively and 5 t round in 2016 and 2017 and 6 t round in 2018. The fishery for these years was prosecuted in 2J only, by inshore vessels, typically under 45 ft (14 m), L.O.A. Except for exploratory surveys for presence/absence, there have been no directed scientific missions into Scallop aggregations along the Labrador coast.

B. SPECIAL RESEARCH STUDIES

1. Biological Studies

a) Multispecies Trawl Surveys

Biological and oceanographic data from spring (Divs. 3LNOP) and fall (Divs. 2HJ3KLNO) multi-species research vessel surveys were collected in 2018 to support stock assessment, distribution and abundance studies, and detailed biological sampling were conducted on important commercial species (e.g. Atlantic Cod, American Plaice, Greenland Halibut, redfish, Yellowtail Flounder, White Hake, Thorny Skate, shrimp, crab) as well as a suite of indicator species under the Ecosystem Research Initiative of the NL Region. In 2018, the annual spring survey completed a total of 268 successful sets in Divs. 3LNO (Div. 3L was not fully completed) and 171 in Subdiv. 3Ps (Subdiv. 3Pn was not surveyed). During the fall survey, a total of 588 successful sets were conducted in Divs. 2HJ3KLNO. Depending upon the species, sampling occurs for length, age, growth, maturity stage, condition, stomach contents analyses. In addition, sampling for lengths and weights were conducted on a suite of other species to support ecosystem monitoring.

Analysis of maturity and growth data are conducted regularly on a variety of groundfish species and are presented to the annual meeting of NAFO Scientific Council during assessments.

b) Arctic Charr

Biological information obtained from sampling commercial landings in the north Labrador Arctic Charr fishery terminated following the 2014 season along with other research programs. While this ended a long-term program focused on Arctic Charr that began in the early-1970s in recent years genetic studies have been carried out with the aim of determining the contribution of local stocks to the nearshore mixed stock fishery and better understand climate change impacts on charr in this region. Discussions have also occurred to consider options to resume a Science program on charr in this area. Studies have also examined diel activity and winter movement patterns of overwintering Arctic charr in two southern Labrador lakes.

c) Snow Crab

A trap survey for Snow Crab was conducted in the northern portion of Div. 2J and Div. 2H in the summers of 2013-2018. The surveys, conducted by the Torngat Joint Fisheries Secretariat with in-kind support from DFO, were performed to quantify the distribution and abundance of commercial-sized males in the Nunatsiavut Settlement Area. The fixed-station survey covered areas to the north, west, and south of the Makkovik Bank. Small-meshed pots were also incorporated into the study to capture females and small males.

d) Atlantic Salmon

The stock composition of Atlantic salmon harvested in three fisheries in the northwest Atlantic (Labrador Subsistence, Saint Pierre and Miquelon and mixed stock West Greenland fisheries) was evaluated using the Single Nucleotide Polymorphism (SNP) panel. Estimates of stock composition and individual assignment were derived using Bayesian mixture analysis with samples spanning 2015-18. From 2017 and 2018, a total of 994 individuals from the Labrador subsistence salmon fisheries were analysed using the SNP panel with 31 range-wide regional reporting groups. As in past years, estimates are dominated by the Labrador group >98%. Although two individuals of USA origin were detected in 2017, none were detected in 2018. The dominance of the Labrador reporting group is consistent with previous analysis conducted for the period 2006–14 which estimated >95% of the

harvest was attributable to Labrador stocks. Regional contributions within Labrador suggest largely local harvest within each of the regions. A total of 193 individuals collected from the Saint Pierre and Miquelon fishery between 2017 and 2018 were analyzed using the SNP panel range wide baseline, and showed consistent dominance of three regional groups with little differences between the two years (83–89%: Southern Gulf of St Lawrence, Gaspe Peninsula, and Newfoundland). The largest contributor in both years were individuals from Newfoundland reporting groups totaling >60% in each year. Region of origin analyses for the mixed stock Atlantic Salmon fishery at West Greenland harvests indicated that Labrador origin salmon comprised approximately 20% of the total salmon originating from eastern North America with Newfoundland origin salmon representing a smaller proportion at <4% (Bradbury et al. 2016). This work illustrates how genetic analysis of these mixed stock Atlantic salmon fisheries in the northwest Atlantic can directly inform assessment and management efforts. Analysis of these three fisheries will continue in 2018.

SUBAREA 3

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2018 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Atlantic Salmon-Subarea 3

The commercial fishery for Atlantic Salmon in Subarea 3 has remained closed since 1992. The 2018 preliminary recreational harvest estimate for Subarea 3, including retained and caught-and-released fish, was 19,016 salmon, 32% below the previous 5 year mean (2013-2017). Five of the ten assessed rivers in Subarea 3 were below their limit reference point in 2018. Of the other five assessed rivers, three exceeded the upper stock reference point and two were between the limit reference point and upper stock reference point.

b) Capelin–Subarea 2 + Divisions 3KL

Inshore Capelin catches in Subarea 2 + Div. 3KL are taken primarily by purse seines, tuck seines, and Capelin traps during the inshore spawning migration. Landings in 2017 and 2018 were 19,777 t and 19,755 t, respectively, against TAC in Divs. 2J3KL of 30,496 t in 2017 and 19,823 t in 2018. The Capelin assessment was held in March 2019 and included survey and biological data to December, including updates for the two main indices of Capelin abundance – the spring acoustic survey index and larval index 2018, and a new forecast model for predicted abundance in the annual spring survey. The acoustic abundance index, generated from the annual spring (May) Div. 3L acoustic survey of the immature portion of the stock, has fluctuated markedly over time from a peak of 6 million t in the late 1980s to a low of 25,000 t in 2010. From 2013-15, the acoustic abundance index showed some improvement peaking in 2014 at nearly 20% of the 1980s levels, but has since declined to levels similar to those seen in the late 2000s. The acoustic abundance index in 2018 was 50% lower than the 2014 acoustic index. The larval index has been low for the past five years (2014-18), reaching a time series low in 2018. The fall distribution of capelin in 2016 to 2018were similar to the distribution patterns in the period of low capelin abundance in the 1990s and 2000s with the center of mass located in northern Div. 3L and few Capelin present in Div. 2J; Capelin were also concentrated inshore in 2018. A new statistical forecast model was introduced at the 2019 assessment which combined the larval index, fall Capelin condition, and environmental data (timing of sea ice retreat) to forecast the acoustic biomass index for the following two years. The model predicted a slight increase in 2019 but decrease in 2020.

Fisheries productivity on the Newfoundland Shelf has declined since the early to mid-2010s. This decline was initially associated with a loss of shellfish and in the last two years includes declines in piscivores.

c) Cod–Divisions 3NO and Subdivision 3Ps

The 3NO cod stock has been under moratorium to all directed fishing, both inside and outside the NAFO Regulatory Area, since February 1994 and this continued into 2019. Canada (NL) landings ranged from 444 t to 818 t between 2002-2005, and from 26 t to 247 t between 2006-2018. Canadian catches in 2017 totalled 64 t, taken primarily in the 3NO yellowtail fishery.

The 2018 assessment of 3NO cod reported that the spawning biomass has declined since 2015 and the 2018 estimate (19,000 t) represents only 31% of Blim (60,000 t).

For the 3Ps cod stock, after the extension of jurisdiction in 1977 catches averaged around 30,000 t until the mid-1980s when fishing effort by France increased and total landings reached about 59,000 t in 1987. Catches then declined gradually to 36,000 t in 1992. A moratorium was imposed in August 1993 after only 15,000 t had been landed. Although offshore landings fluctuated, the inshore fixed gear fishery reported landings around 20,000 t each year up until the moratorium. Since the moratorium, TACs are established bilaterally shared between Canada (84.4 %) and France (St. Pierre and Miquelon, 15.6 %). The fishery reopened in May 1997 with a TAC of 10,000 t. In 2000 the management year was changed to begin on 1 April. The TAC for 2017/18 was set at 6500 t. Total landings for 2017/18 totalled 5,031 t.. The majority of recent catches are taken by fixed gear (gillnet and line-trawl).

The 2018 assessment of 3Ps Cod indicated that the stock has increased since 2015. Spawning stock biomass (SSB) is currently estimated to be 49% above the limit reference point (BRecovery). The probability of being below the LRP in 2018 is 0.04. Projections with total mortality assumed to remain at or above current levels indicate that SSB in 2020 and 2021 to be at or below Blim.

d) American Plaice-Subdivision 3Ps

Canadian landings declined in 2018 to 144 t. This stock has not been assessed since 2014.

e) Witch Flounder-Subdivision 3Ps

A TAC was first established for this stock in 1974 at 3,000 t, which remained in effect until 1988 when it was reduced to 1,000 t. It was further reduced to 500 t in 1996 and 1997 but was increased again to 650 t for 1998 and has remained at that level since then. Landings from this stock over the last 20 years have fluctuated between about 200 t and 1,000 t annually. The Can (NL) catch averaged 377 t in the past 4 years with the 2018 catch at 276 t. The directed fishery is prosecuted by offshore otter trawlers and a nearshore Danish seine fleet. Survey stock size indices are highly variable, but have shown no overall trend. In recent years (2016, 2017), survey abundance and biomass have increased to values at or among the highest in the time series. The age and size structure observed in this stock since the early 1980s also appeared to have remained stable with little change in growth pattern. Aging has not been conducted on Witch Flounder in this region since the mid-1990s. Geographic distribution has not changed appreciably since 1983 except during the early to mid-1990s when fish

disappeared from the 51-100 fathom depth zone, coincident with extremely cold sea bottom water temperatures. In recent years the distribution appears to be returning to a more normal pattern. An interim limit reference point was adopted in 2017, with a proxy for BMSY adopted based on average survey biomass observed from 1983-1993, and Blim set at 40% of BMSY. The stock is currently above the LRP, and has been in most years of the time series (1983-2017).

f) Yellowtail Flounder–Divisions 3LNO

Since the fishery for this stock reopened in 1998, stock size steadily increased and in 2018 (the last full assessment of this stock) was estimated to be 1.5 times B_{msy}, well above the level of the mid-1980s. Annual spring and fall multi-species bottom trawl surveys have been conducted since 1971 and 1990 respectively. Evidence from the commercial fishery and various surveys indicates that the range of this stock has increased along with stock size since the mid-1990s. Fishing mortality was estimated to be relatively low and the stock biomass relatively high. In 2006, the majority of the Canadian directed fishery for Yellowtail Flounder did not take place due to a dispute in the industry. Since then, Canadian catch has ranged from 4,000 t to 11,400 t, well below the TAC in each year and in 2018 was 6,774 t. Scientific Council noted that this stock is well above B_{msy}, and recommended any TAC option up to 85 % F_{msy} for 2019 to 2021 (24.9 t, 22.5 t and 21.1 t respectively). The TAC for 2018 was 17,000 t. Scientific Council also noted that bycatch of cod and American Plaice in the Yellowtail fishery needs to be considered in determining the TAC for yellowtail flounder.

g) American Plaice– Divisions 3LNO

Catches from this stock were generally in the range of 40,000 to 50,000 t per year throughout the 1970s and 1980s, before declining to low levels in the early 1990s. There has been no directed fishing on this stock since 1993 and the TAC has been set at 0 since 1995. Bycatch of American plaice has been generally less than 3,500 t since 2007. Since the moratorium, the majority of bycatch is taken in the Canadian yellowtail fishery within Canada's 200-mile limit and in the skate, redfish and Greenland halibut fisheries in the NAFO regulatory area (NRA). In 2018, Canadian landings of American Plaice (as bycatch) were 463 t.

h) Redfish–Unit 2 (3Ps4Vs, 3Pn4Vn-June to December, 4Wfgi)

Redfish in the Canadian Atlantic within Divs. 3P4RSTVWX were redefined into three management units in 1993 (Unit 1-3). Further work continued on the biological basis for management units for two species (*Sebastes fasciatus and S. mentella*) and a final Canadian workshop in 2010 concluded that a review based on genetics, morphometrics and otolith chemical signature suggests that Unit 1 and Unit 2 corresponds to a single biological population of each species and recommended these Units should be combined for assessment purposes. The 2018 assessment for these stocks evaluated Sebastes mentella and S. fasciatus separately in the area covered by the combined management units of Unit 1 and Unit 2. The fishery management year was changed in 1999 from a calendar year basis to an April 1 – March 31 (following year) basis.

In the past two years, Can (NL) removals from this stock were 1,062 t and 1,508 t. Industry reports that limitations in market conditions and management measures had a major effect on catches. Current management regulations include a closure related to peak spawning in May and June, and a minimum landing size restriction at 22 cm.

i) Redfish – Division 3O

Canada has had limited interest in a fishery in Div. 3O because of small sizes of redfish encountered in areas where otter trawling is feasible regarding bottom topography. Canadian landings were less than 200 t annually from 1983 to 1991 but increased in the early 1990s. Between 1996 and 2000 Canadian catches alternated between levels of about 8,000 t and 2,500 t based on market acceptability for redfish near the Canadian 22 cm size limit. From 2001-2004, the Canadian catch averaged about 3,400 t, increased to 5,400 t in 2005 but has declined steadily to about 75 t in 2013. Canada (NL) has generally accounted for more than 95 % of the Canadian catch since 2001 but reported less than 35 t annually during 2012 to 2016. In 2017, landings increased to 247 t. In 2018, landings increased further to 411 t with most of the landings reported by Canada (MAR).

j) Redfish – Divisions 3LN

The directed fishery in 3LN was under moratorium from 1998 to 2009 then re-opened in 2010 with a TAC of 3,500 t which has progressively increased to 10,400 t for 2015-2016. Canada is allocated about 43 % of the TAC. The total catch averaged 21,000 t from 1960-1985 then escalated rapidly to 79,000 t in 1987 then fell steadily to a minimum of 450 t in 1996. Catches were generally low, fluctuating between 450 t and 3,000 t during the moratorium years to 2009. Canada has generally increased its harvest since the reopening of the fishery. Landings in 2018 were 4533 t.

k) Witch Flounder-Divisions 3NO

There was no directed fishing on this stock from 1994 to 2014. The fishery reopened in 2015. Canadian catch in 2018 was approximately 507 t.

l) White Hake–Divisions 3NO and Subdivision 3Ps (Divisions 3NO in NRA)

Prior to 1995, White Hake was taken as bycatch in other demersal fisheries on the Grand Banks. Average estimated catch during 1985-90 was approximately 5,000 t. Annual catches in a new directed (Canadian) fishery on the Grand Banks, starting in 1995 and encompassing Divs. 3NO and Subdiv. 3Ps, averaged 460 t. However, in 2001 and 2002, a >10-fold increase in the catch of White Hake Div. 3NO was attributable to EU-Spain, EU–Portugal and Russia in the NAFO Regulatory Area. STATLANT average annual reported landings for NAFO Divs. 3NO were 284 t during the period 2012-16. Preliminary 2018 Canadian landings for NAFO Divs. 3NO and Subdiv. 3Ps are 55 t and 319 t, respectively. The current TAC for White Hake in 3NO for 2018 is 1,000 t and in Subdivision 3Ps is 500 t.

The dominant feature of the White Hake abundance indices was the peak abundance observed over 1999-2001. Following the very large 1999 year class, the stock declined to a lower level comparable to levels observed prior to the recruitment pulse. The survey indices for this stock remain at low levels relative to the 1999-2002 peak period.

m) Thorny Skate–Divisions 3LNO and Subdivision 3Ps

Before the mid-1980s, non-Canadian fleets landed several thousand metric tonnes (t) of skate (mainly Thorny Skate) annually. An average of about 5,000 t was discarded annually by the Canadian fleet during the 1980s and early-1990s, while only a few hundred tonnes per year were recorded in Canada's landings statistics during that period. Although often kept by non-Canadian fleets, skates were taken only as bycatch until the mid-1980s. In 1985, EU-Spain targeted skate in a non-regulated fishery in the NRA. Bycatches of Thorny Skate in other fisheries outside 200 miles (primarily Greenland Halibut, *Reinhardtius hippoglossoides*) have also contributed significantly to skate catches. In 1993 and 1994, experimental fishing resulted in the first significant directed skate landings appearing in Canadian statistics. In 1995, Canada established a regulated skate fishery inside its 200-mile-limit with gear and

bycatch policies, a licensing system, and TAC. A TAC of 5,000 t for Divs. 3LNO and 1,000 t for Subdivision 3Ps were adopted by Canada in 1995. In 1996, the TAC was raised to 6,000 t for Divs. 3LNO and 2,000 t for Subdiv. 3Ps. In 1997, the TAC was reduced to 1,950 t for Divs. 3LNO and 1,050 t for Subdivision 3Ps. The Canadian fishery includes otter trawl, gillnet and longline gear while the non-Canadian catches are taken by otter trawl.

Outside Canada's 200-mile limit, catch was unregulated until September 2004, when the Fisheries Commission of the NAFO set a TAC of 13,500 t for 2005-09 in Divs. 3LNO. This quota was lowered by NAFO to 12,000 t for 2010-11; then to 8,500 t for 2012. The TAC was further reduced to 7,000 t for 2013-18. The TAC for Subdiv. 3Ps in the EEZ was maintained at 1,050 t by Canada.

Average STATLANT landings for 2012-16 were 3,406 t in NAFO Divs. 3LNO, and 476 t in Subdivision 3Ps. Preliminary Canadian landings for 2018 are 208 t in NAFO Divisions 3LNO, and 940 t in Subdivision 3Ps.

Thorny Skate underwent a decline in the late 1980s to early 1990s followed by a slight increase in the late-1990s. Since then, abundance indices have been slowly increasing.

n) Shrimp–Divisions 3LNO

This shrimp stock is distributed around the edge of the Grand Bank, mainly in Div. 3L. The fishery began in 1993 and came under TAC control in 2000 with a 6,000 t TAC. Annual TACs were raised several times between 2000 and 2009 reaching a level of 30,000 t for 2009 and 2010. The TAC was then reduced annually until no directed fishing (ndf) was implemented in 2015 to 2018. Preliminary catch records, as of February 2019, confirm that no fishing had taken place in 2018. As per NAFO agreements, Canadian vessels took most of the catch during each year prior to 2015.

There is reason for concern about the status of the Northern Shrimp resource within NAFO Divs. 3LNO. In Canadian surveys, there was an overall increase in both the spring and autumn biomass indices to 2007 after which they decreased by over 90% to the lowest levels in the time series in 2017. EU-Spain survey biomass indices for Div. 3LNO, within the NRA only, increased from 2003 to 2008 followed by a 93% decrease by 2012 and remaining near that level through 2017. The Canadian research vessel spring Div. 3LNO SSB index decreased by 97% between 2007 and 2016. The Canadian RV autumn SSB index showed an increasing trend to 2007 but decreased 93% by 2015 and has remained at a low level. SSB indices remain below B_{lim} for the fifth consecutive year.

Exploitation and mortality rate indices were increasing from 2007 to 2013, despite decreasing catches during that period, but dropped drastically in 2014. In 2018 the risk of the stock being below B_{lim} is greater than 95%. Given prospects of poor recruitment in recent years, the stock is not expected to increase in the near future.

o) Snow Crab–Divisions 3KLNO and Subdivision 3Ps

In Div. 3K, landings have remained relatively low for the past three years (6,000 t in 2018). Effort has been maintained near a two-decade low for the past six years. Standardized CPUE increased in 2018 from a time-series low in 2017, but remains below the times-series average. Despite localized improvements, the post-season trawl and trap survey exploitable biomass indices have remained near time-series lows for the past five years. Despite localized improvements, the post-season trawl and trap survey indices of recruitment into the exploitable biomass have remained near time-series lows for the past five years. Total mortality in exploitable crab has remained at its highest level during the past four years. The exploitation rate index declined from a decadal high to near time-series average levels in 2018. Under status quo removals in 2019 the exploitation rate index would be unchanged. Following the proposed Precautionary Approach the stock status would be in the provisional cautious zone in

2019. Size-at-terminal molt in males has precipitously declined in recent years, suggesting potentially dampened short-term recruitment prospects into the exploitable biomass.

In Div. 3LNO Offshore, landings declined by 43% from 2016 to 14,000 t in 2018 because of reductions in the TAC, to the lowest level in two decades. Effort expanded rapidly from 1992 to the mid-2000s and has oscillated at a similar level since. Standardized CPUE most recently peaked near a time-series high in 2013 and has since declined by 49% to its lowest level since 1992. The trawl-derived exploitable biomass index showed a modest increase in 2018, but both it and the trap-derived exploitable biomass index remain at or near time-series' lows. Recruitment into the exploitable biomass has been at or near time-series lows in both the trawl and trap surveys in the past three years, but increased slightly in 2018. Total mortality declined from its highest observed level in 2016 to a relatively low level in 2018. The exploitation rate index increased by a factor of five from 2014 to 2017, and remained high in 2018. The exploitation rate index would decline to near the long-term average with status quo removals in 2019. Following the proposed Precautionary Approach the stock status would be in the provisional cautious zone in 2019. Size-at-terminal molt in males has precipitously declined in recent years, suggesting potentially dampened short-term recruitment prospects into the exploitable biomass.

In Div. 3L Inshore, landings declined by 56% from a time series high in 2015 to 3,700 t in 2018. In 2018, the landings were 16% below the TAC. Effort remained at a time series high in 2018. Standardized CPUE has declined by 68% since 2013 to below 5 kg/trap, its lowest level in the time series. The exploitable biomass is severely depleted. The post-season trap survey exploitable biomass index remained near a time-series low in 2018. Crab Management Areas (CMAs) 6B and 6C had total catch rates of approximately 1 kg/trap in the 2018 surveys. Recruitment into the exploitable biomass steadily declined to a time-series low in 2017. In 2018, recruitment indices from DFO and CPS trap surveys remained near their lowest levels. Localized improvements in overall biomass available to the fishery could occur within the next two years. The overall trap survey-derived exploitation rate index has increased since 2013 and remained at its highest observed level in 2018. Status quo removals would maintain the exploitation rate at a time series high in 2019. Size-at-terminal molt in males has precipitously declined in recent years, suggesting potentially dampened short-term recruitment prospects into the exploitable biomass. Following the proposed Precautionary Approach, the stock status would be in the critical zone in 2019.

In Subdiv. 3Ps, landings increased from decadal lows to 1,900 t in 2018. The landings exceeded the TAC, which was set at 1,792 t. Effort has declined by 60% since 2014 to be near its lowest level in two decades. Standardized CPUE increased from time-series low levels in 2016 and 2017 to more than 5 kg/trap in 2018. The in-season trawl survey exploitable biomass index was at a time-series low in 2016, but has improved during the past 2 years. The post-season trap survey index suggests an increase in the exploitable biomass throughout the major fishing grounds. Recruitment into the exploitable biomass was near a decadal high in 2018, with the exception of Fortune Bay. Despite a small decline in recruitment available to the 2019 fishery, survey data of pre-recruit abundance suggest short-term prospects are positive relative to the recent 2013-16 low period. The distribution of pre-recruit crab appears concentrated on the major fishing grounds of the division. Total mortality in exploitable crab has varied considerably throughout the time series, but was low in 2018. The exploitation rate index was near its lowest observed level in the time series in 2018 and status quo removals would result in the exploitation rate index being near a time series low in 2019. Following the proposed Precautionary Approach, the stock status would be in the provisional cautious zone in 2019. Discards declined sharply in 2018 to be near the long-term average. A continuation of current measures is recommended to re-establish a strong residual biomass to help minimize discards.

p) Iceland Scallop–Divisions 3LNO and Subdivision 3Ps

The Divs. 3LN Iceland Scallop fishery commenced in 1992. Aggregations over the eastern Grand Bank (Div. 3L) were first commercialized. In 1994, the fishery expanded into the Lilly and Carson Canyons (LCC) and subsequently (1995) into the northeast of LCC between 45°30' N and 46°30' N. In 1996 a new aggregation was located and rapidly fished down. Nominal landings have declined throughout, partially because of effort diversion into shrimp and crab.

There was no fishery for Iceland Scallop in Div. 3LNO from 2009-11. In 2012 there was a removal of 11 t in 3LN. There were again no removals in 3LNO between 2013 and 2018. Resource status was updated for the LCC based on a survey in August 2008.

The Iceland Scallop fishery on Subdiv. 3Ps commenced in 1989. It encompasses the trans-boundary stock, along the northern edge of St. Pierre Bank. Since 1992 it has been co-managed by France (70% of annual TAC) and Canada (30% of TAC), and the remainder of Subdiv. 3Ps remains entirely under Canadian jurisdiction.

Total removals from the Canadian zone have decreased from 5,367 t (round), in 1997 to 40 t in 2004. In 2015, 2016, 2017, and 2018 removals were 45 t , 375 t ,527 t and 53 t respectively. From 2012 to 2014 removals averaged 3 t, then in 2010 and 2011 there were no removals, in 2009, only 2 t of a total 3,500 t TAC were removed, less than the 5 t taken in 2008. There has been no directed effort for Iceland Scallops in the trans-boundary area since 1998. The resource status of Iceland Scallops in the trans-boundary area was last updated based on a DFO survey in September 2017.

q) Sea Scallop–Subdivision 3Ps

The Sea Scallop fishery on St. Pierre Bank commenced soon after its discovery in 1953. The area has been fished by both Newfoundland inshore vessels and larger Maritimes (Nova Scotian) based offshore vessels. Occurring as they do towards the northern extreme of its distribution, Sea Scallops here have not been able to withstand continued heavy exploitation. The fishery is typically characterized by a disproportionate dependence on sporadic recruitment of a single or a few intermittent and sometimes, well-spaced year-classes. Figures shown in Table 1 represent only landings in Newfoundland ports and do not include removals from the area landed in Nova Scotia.

There had been very little effort by offshore vessels from 1997 to 2003 with most of the landings coming from inshore beds. In 2003 there was sign of a large recruited year-class, with 647 t (round) removed. In the following two years, there was a significant increase in effort and landings by both inshore and offshore fleets. Landings decreased in 2006 and 2007. Landings almost doubled in 2010 to 842 t (round) from 432 t in 2009 which was an increase from the 293 t landed in 2008. Landings increased again in 2011 and 2012 to 920 t and 1,190 t (round) respectively then decreased to 1,071 t in 2013. In 2014 and 2015, landings remained relatively the same at 1,158 t and 1,126 t respectively and have since decreased in 2016, 2017 and 2018 to 883 t , 846 t and 414 t respectively. The resource status of this area was last updated based on DFO resource survey in September 2015.

r) Squid–Subarea 3

Following a peak catch in 1979 of about 88,800 t, the Subarea 3 catch declined regularly to 5 t in 1983. Catches remained lower than 5,000 t during the 13-year period 1983-1995. They increased from 1995 to approximately 12,700 t in 1997 before declining sharply to about 800 t in 1998 and 20 t in 1999. They remained low (approximately 300 t) in 2000, decreased to only about 20 t in 2001 and increased to about 2,500 t in 2004. Catches decreased to about 550 t in 2005 and then increased to about 7,000 t in 2006. High catches in 1996-97 and 2006 were associated with environmental warming and increase in squid abundance at the northern extreme of their range. The catch decreased sharply to only 230 t

in 2007 and has since remained low, declining steadily from about 520-640 t in 2008-09 to about 100 t in 2010 and only about 20 t in 2012. There were no reported landings from 2013 to 2015, but approximately100 t were landed in 2016 and 313 t were landed in 2017. In 2018, squid landings increased to 1,322 t.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Physical oceanographic observations are routinely collected during marine resource assessments and research surveys in the Newfoundland and Labrador Region. The Atlantic Zonal monitoring program (AZMP) initiated in 1998 continued during 2018 with three physical and biological oceanographic offshore surveys carried out along several cross-shelf NAFO and AZMP sections from the Southwest St. Pierre Bank to Beachy Island on the mid-Labrador Shelf. The spring survey was conducted on the CCGS Teleost from April 6 to 24, 2018. The summer survey took place on the chartered vessel Coriolis II between July 15 and August 3rd, 2018, and the fall survey on the CCGS Hudson between November 10 and December 2nd, 2018. This program was established to include biological and chemical oceanographic sampling at a fixed coastal site (Station 27) at biweekly intervals and along offshore sections at seasonal time scales. The main objectives are to establish the seasonal temporal and spatial distribution and abundance of plant pigments, nutrients, microzooplankton and mesozooplankton in relation to the physical environment. Physical, biological and chemical variables being monitored include temperature, salinity, dissolved oxygen, ocean currents as well as measures of primary and secondary production and biomass, species composition of phytoplankton and zooplankton and nutrients. The oceanographic monitoring program currently conducted on the Newfoundland and Labrador Shelf should allow an understanding of changes in ecosystem productivity and changes in ecosystem structure over time. Data from this effort are used to produce annual physical, chemical and biological state of the ocean reports and in studies relating environmental conditions to marine resources.

a) Physical Environment

Physical oceanographic studies were conducted on the Newfoundland and Labrador Shelf during 2018 in NAFO Div. 2J and 3KLNMOP. The results were based on physical observations collected on the NL Shelf from Nain Bank to the Southern Grand Bank and on St. Pierre Bank from the AZMP and fisheries assessment surveys.

Annual sea-surface temperature (SST based on infrared satellite imagery) were below normal during 2018, except in coastal areas (e.g., inshore bays).. In 2018, the vertically-averaged (0-176 m) temperature/salinity at the inshore monitoring site (Station 27) was warmer and fresher by 0.8/-3.1 standard deviations (SD), respectively. Observations from the summer AZMP oceanographic survey indicated that the area of cold-intermediate-layer (CIL <0°C) water overlying the northeast Newfoundland and southern Labrador shelf decreased over 2017 to -0.6 and -1.9 SD, respectively, The spatially averaged bottom temperature during the spring in 3Ps was 1.4 SD above normal in 2018, the second warmest year after the 33-year record high in 2016 (+1.8 SD). In Divs. 3LNO spring bottom temperatures were slightly above normal at +0.7 SD. Bottom fall temperature in 2J, 3K and 3LNO were respectively 1.1 SD, 0.9 SD and 0.4 SD above normal in 2018. This is in line with recent years that are closer to normal temperature following a warming trend that took place from the early 1990s to the early 2010s (they peaked in 2011 with respectively 1.8 SD, 2.3 SD and 3.1 SD above normal in 2011) .

b) Nutrients and plankton studies

In general, shallow (0-50 m) inventories of nitrate, a limiting nutrient in ocean primary production, were near or below the 1999-2015 average across Newfoundland and Labrador AZMP oceanographic sections in 2018, with the exception of higher concentration on the northeast Newfoundland Shelf. The deep (50-150 m) inventories of nitrate, an index of nutrient availability to fuel the base of the marine food chain in the subsequent spring bloom, were below normal everywhere except along the Bonavista Bay section (northeast Newfoundland Shelf) where concentration were near normal, which represents a decline from 2017. The chlorophyll a (0-100 m) inventories inferred from the seasonal oceanographic surveys, which provide an index of phytoplankton biomass in the water-column, were above or near normal across the NL Shelf and the Grand Banks.

Satellite ocean colour observations from 11 subregions off Newfoundland and Labrador indicated that total production (magnitude) of surface phytoplankton spring blooms was below or near normal in all subregions in 2018 except in the St. Anthony Basin, on the northeast Newfoundland Shelf, and in the Flemish Pass where positive anomalies were observed. Spring bloom timing was delayed in the Labrador Sea and on the NL Shelf but near normal on the Grand Banks. Bloom duration was near normal across the area.

Total copepod abundance stayed above normal in all regions in 2018, but declined on the NL Shelf relative to 2017. Although non-copepod zooplankton abundance remained above normal in most areas, it showed a significant decrease on the Labrador Shelf compared to 2017. The abundance of *Pseudocalanus spp.*, a small key functional copepod group, declined on the NL Shelf but remained near or above normal on the Grand Banks. The abundance of the large grazing copepod *Calanus finmarchicus*, an important prey to a variety of different life stages of fish, shifted from below to above normal on the Labrador Shelf in 2018, and remained slightly below normal on the northeast Newfoundland Shelf and near normal on the Grand Banks. Zooplankton biomass, which seemed to be primarily driven by *C. finmarchicus* abundance, increased across the region 2018 except on the Southeast Grand Banks where the second lowest anomaly of the 20-y time series was recorded. Although biomass shifted from below to above normal on the Labrador Shelf, it remained below the long-term average everywhere on the Grand Banks.

2. Biological Studies

a) Multispecies Trawl Surveys

The surveys detailed in Section 1. a) also provide data for the majority of resources in this area.

b) Capelin

In 2018, there was a spring (May) offshore acoustic survey in Div. 3L. This survey targets the immature, non-migratory portion of the Capelin stock and produces an abundance index. In 2017 and 2018, acoustic data was collected during the fall multispecies bottom trawl survey in Divs. 2J3KL, along with enhanced sampling of the biology and feeding of forage fishes. Analyses of these fall acoustic data are ongoing. In 2017 and 2018, recently emerged larvae into the Bellevue Beach inshore area of Trinity Bay were monitored. In 2017 and 2018, inshore larval surveys were conducted in August and September to map capelin larval abundance and dispersal in Trinity Bay, Div. 3L.

c) Atlantic Salmon

Stock composition of Atlantic Salmon harvested in three fisheries in the northwest Atlantic was examined using genetic mixture analysis and individual assignment with a single nucleotide polymorphism baseline (96 loci, 9,369 individuals, 31 groups) encompassing the species native range. 193 individuals collected from the St. Pierre et Miquelon fishery (2017, 2018) were analyzed and estimates of stock composition showed consistent dominance of three regions, Gulf of St. Lawrence, Gaspe Peninsula, and Newfoundland, with Newfoundland contributions representing the largest component at 61%. One European individual from the British reporting group was detected in this fishery in 2018. In the West Greenland harvest (2017-18, n=1985), North American contributions were largely from Labrador, the Gulf of St. Lawrence, and the Gaspe Peninsula. European contributions (~20% of total) were almost entirely from the British reporting group. Finally, in the coastal Labrador fishery (2017-18, n=994) mixture estimates suggest the harvest is dominated by the three Labrador reporting groups, together accounting for >98% of the harvest. In all three fisheries, estimates of stock composition appear stable over the two years analyzed. Estimation of stock composition in all three fisheries will continue in 2019.

d) Shrimp

A population model is under development, with a framework meeting to review the model and a proposed precautionary approach framework scheduled for May 2019. This model incorporates some available environmental and ecosystem data.

Research on larval drift and dispersal has been completed for SFAs 4-6, NAFO Divs. 3LMNO and North of SFA 4. While the results for SFAs 4-6 and Divisions 3LMON have been published, the results including North and Northeastern areas of the Northwest Atlantic Ocean are unpublished. The research includes a simulated release of 100 larvae from 100 sites in a biophysical model. The larvae are then permitted to drift and disperse for 85 days, approximately the period it takes for larvae to settle, and vertically behave as larval shrimp in the water column. Two subsamples of the results were presented; one demonstrated that most larvae hatched in Div. 3L end up in Div. 3M and the other demonstrated that most larvae that settle in Div. 3L originate in areas north of that division.

Preliminary research from a study on estimating age from eye stalks of shrimp is ongoing. More information is to follow once the study is concluded and results become final. There does not appear to be a strong relationship between number of growth rings and length of shrimp in NAFO Divs. 2J3KLNO.

e) Snow Crab

Long-term trap surveys in White Bay (3K), Notre Dame Bay (3K), Bonavista Bay (3L), and Conception Bay (3L) were continued in 2018. These surveys collect information on biological and population parameters and are used in annual assessments of Snow Crab. The surveys have also been used for past and on-going research into the incidence and impacts of Bitter Crab Disease (BCD) in NL Snow Crab. A similar survey was initiated in Fortune Bay (3Ps) in 2007 and was continued in 2018. Similar surveys were initiated in Fortune Bay in 2007, and Trinity Bay and St. Mary's Bay in 2013. These continued in 2018.

A post-season trap survey, conducted by Snow Crab harvesters, which began throughout most of 2J3KLNOPs in 2004 was continued in 2018.

A sperm limitation study, extracting and examining female sperm plugs, was conducted in Divisions 3K, 3LNO, and 3Ps in 2018 and will be continued in 2019.

f) Cod

The utility of using 0-year old and 1-year old cod abundance at a site on the northeast coast of Newfoundland in calculating a pre-recruit index of year-class strength shows some promise and continues to be evaluated. After experiencing low abundances during the 2004-2007 period, annual abundances of age 1 in this cod nursery/rearing area have increased substantially in the subsequent 9-year period (2008-2017). The degree to which these observations reflect broader coast-wide phenomena and offshore stock biomass are being investigated.

Genetic and genomic analysis of Atlantic cod in the region continued in 2018. Recent work has suggested a coastal population in Gilbert Bay Labrador is highly discrete, genetically isolated, adaptively unique and genetic tools were developed to identify the presence of this stock in coastal fisheries. Analysis in 2018 is targeting genomic diversity within Northern cod primarily associated with the genomic basis of differences in migratory behaviour and resolving genetic impacts of population decline and selective harvest.

SUBAREA 4

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2018 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Atlantic Salmon–Subarea 4

The commercial fishery for Atlantic Salmon in Subarea 4 has remained closed since 1992. The preliminary estimate of the 2018 recreational harvest, including retained and hooked-and-released fish, was 16,912 salmon, 14% less than the previous 5 year mean (2013-17).

In 2018, four of the seven assessed rivers in Subarea 4 were above their upper stock reference point while two rivers were below the lower limit reference point and one river fell in the cautious zone between the two reference points.

b) Snow Crab–Div. 4R

In Divs. 4R3Pn, landings have steadily declined since a recent peak in 2013 and were 250 t in 2018. Meanwhile, effort has remained at a low level. Standardized CPUE has declined since 2013 to below the long-term average. The exploitable biomass is severely depleted, with few residual crab in the population. The trap survey exploitable biomass index most recently peaked in 2012 and declined to a time series low in 2017. The index increased slightly in 2018, reflecting localized improvements in CMA 12EF. Recruitment into the exploitable biomass was low from 2014 to 2017, but survey data from 2018 suggest localized improvements may occur in 2019, particularly in CMA 12EF. The overall exploitation rate index declined to below the long-term average in 2018. Status quo removals in 2019 would result in little change to the exploitation rate index. Poor monitoring coverage throughout this division results in large uncertainty in the biomass estimates provided in 2018 and predictions for 2019. Caution is warranted when developing conclusions from these estimates. This division was not included in the scientific proposed PA due to data deficiencies.

c) Iceland Scallops–Div. 4R

In 2013 removals from the Strait of Belle Isle (Div. 4R) increased to 378 t from 295 t (round) in 2012 against a TAC of 1,000 t then decreased slightly in 2014 to 310 t. In 2016,2017 and 2018, landings

decreased, to 192 t ,115 t, and 140 t respectively. The TAC remains at 1,000 t (round). Landings in 2011 almost doubled to 431 t (round), from the 2010 removals estimated at 244 t (round). The fishery here continues to be driven by the exploitation of an accumulated biomass consisting largely of cohorts of old, possibly well separated year classes with little potential for further growth. No significant larval settlement or recruitment has been detected in recent years. Resource status was last updated for the Strait based on research surveys from September 2011, and 2018.

d) Sea Scallops–Div. 4R

The Sea Scallop removals in 4R increased between 2010 and 2012 from 27 t to 66 t (round), but has since decreased in the last few years to 10 t and 6 t (round) in 2017 and 2018 respectively.

SUBAREA 2 + 3 + 4

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2018 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Lobster

Total reported landings for Newfoundland (Div. 3KLP4R) have remained relatively stable since the 1960s and in recent years have increased to a decadal high of 3,400 t. Reported landings declined through the 1990s to 1,800 t in 2000, from a peak of 3,200 t in 1992. They increased to 2,300 t in 2003, and then decreased to 1,900 t in 2004. Landings averaged about 2,600 t from 2005 to 2010, with little variability, but declined by 27 % in 2011 to 1,900 t before increasing to approximately 3,400 t in 2018. In Subdiv. 3Ps landings increased up to 2010 to 1,228 t but had a sharp decline in 2011 to 916 t and have averaged close to 1200 t in the last few years. Landings in Div. 4R peaked in 2008 at 1,400 t and continued to increase to a high of approximately 1,700 t in 2018. In Div. 3K and 3L landings in 2018 were 82 t and 102 t respectively.

The Lobster fishery is monitored at several localized sites through at-sea sampling programs and co-operative arrangements with harvesters who complete index logbooks on commercial catch and effort. In addition, mandatory DFO logbooks were implemented in 2010. At-sea sampling data which has been collected from at least one Lobster Fishing Area (LFA) in each Division clearly show a sharp drop in captured lobsters at minimum legal size (MLS) and few large lobsters surviving beyond MLS, indicating that most of the exploitable biomass is caught in the year of recruitment to the fishery. Based on the index (2004-15) and mandatory DFO logbooks (2010-15) CPUE (number of lobster caught/number of traps hauled) has increased gradually over the last decade. Resource status was last updated for the Newfoundland Lobster stock (LFAs 3-14) in 2016.

b) Marine Mammals

2018 Research Projects:

1. Grey seal tagging (Stenson, Lawson, Hammill, Sheppard, Goulet)

In July 2017, satellite transmitters were deployed on 15 adult grey seals live-captured on Miquelon , France to study the movements of seals in southeast Newfoundland and the French territories of St. Pierre and Miquelon. The transmitters collected data on seasonal distribution and diving behaviour of seals that summer along the south coast of Newfoundland, the Scotian Shelf, and

potentially, on the Grand Banks. They also collected oceanographic data to improve climate models in this area. This work is part of a DFO-led collaboration with CEBC –CNRS/Université de La Rochelle, SPM DTAM (Agriculture, Food, Water and Biodiversity Service) and the SPM ONCFS (National Office of Hunting and Wildlife). All tagged seals departed the St. Pierre Bank between 2 September and 19 December and eventually went to Sable Island where they remained during the whelping and breeding period. Three females were sighted ashore on Sable Island in January 2018. All three gave birth and successfully weaned their pups. Tags remained active until 28 March to 30 May, with two tags still collecting location data on 15 October, 2018.

2. Data Layers (Lawson, Goulet)

To assess and monitoring cetacean Species at Risk, and other marine mammals, baseline data on the occurrence and distribution of cetaceans in potential development areas are required urgently to facilitate the design of industrial monitoring programmes and impact assessments. DFO developed geo-referenced databases on human activities and biological and environmental features in Canada that will be amalgamated as complimentary data-layers. We are now creating a reference document that will provide users with metadata concerning each database that can be used to search, access, and work with each of the data layers. The geo-referenced databases and corresponding GIS maps created will be available for use by DFO, Environment Canada, and other internal government users via a web-based interface to be developed this year. These existing biological and physical data will be used to model the distribution, and when possible, the seasonal density of marine mammals and sea turtles in Canada's three oceans. Results will be used to delineate areas of seasonal aggregation and to visualize and to quantify the degree of geographic and seasonal overlap between human activities and areas of aggregation for marine mammals. This will highlight areas of particular conservation concern. This analysis will also be used to evaluate the performance of habitat suitability analysis to address the paucity of seasonal density data for mammals, sea turtles, and their prey; the primary focus will be on obtaining data for Species at Risk. The project has compiled data for the Atlantic, Arctic, and Pacific Canadian waters.

3. Acoustic monitoring (Lawson, Sheppard)

To assess and monitoring cetacean Species at Risk, other marine mammals, and anthropogenic noise, DFO NL has been deploying long-term, autonomous underwater acoustic recorders around Newfoundland and Labrador. These recorders collect data across a broad frequency spectrum, and for periods up to one year in both nearshore and offshore locations. In addition to the data layers project and DFO's visual surveys, these acoustic data will facilitate DFO's efforts to understand habitat use by marine mammals throughout the year, as well as the potential manmade stressors arising from underwater noise exposure from seismic exploration and commercial shipping. To reduce analysis time and costs DFO is currently implementing the LFDCS autodetection/classification software in-house in Newfoundland and in the Maritimes.

4. **Harp and hooded seal pup production survey (Stenson, Lawson, Gosselin, Buren, Sheppard, Goulet, Hammill, Mosnier, Lang, den Heyer)**

Visual and photographic surveys were carried out off Newfoundland and Labrador, and in the Gulf of St. Lawrence, during February and March 2017 in order to assess the pup production of the Northwest Atlantic populations of hooded and harp seals. Fixed wing and helicopter reconnaissance surveys identified the locations of multiple whelping concentrations in the southern and northern Gulf, as well as off southern Labrador (referred to as the 'Front'). Fixed-wing aircrafts carried out systematic strip-transect photographic surveys of each whelping areas. Approximately 35,000 photographs were taken. Visual survey and staging data were collected from ship and land-based helicopters. Preliminary results indicate that harp seal pup production in the southern Gulf during 2017 was much lower than previous surveys although there it appears that some of these animals may have moved to the Front. The photos were analysed during 2018 and will be integrated with information on annual reproductive rates, estimates of ice related mortality and harvest information to estimate total abundance of these populations. The scientific review of these data will occur in 2019.

5. **Ocean Productivity (Buren, Stenson, Lawson)**

A project aimed at characterizing spatial and temporal variability, long-term trends, and the influence of environmental conditions (e.g., ice cover, SST, etc.) on energy content of key forage species in the northwest Atlantic was continued. In collaboration with University partners we are determining energy contents of important prey species through bomb calorimetry, proximal compositional analyses, and lipid profiles. This project is ongoing.

6. **A Predictive Model of the Environmental Regulation of Capelin (Buren, Lewis)**

A study of the factors that influence the population dynamics of capelin was continued in 2018. The goal is to develop statistical models to provide short- and long- term forecasting models of capelin abundance. Results from this project will improve the provision of advice for the management of capelin, and predators that rely on them as an important food source (e.g.,. northern cod and harp seals). This project will be completed in 2019.

7. **Can we detect changes in Arctic ecosystems? (Stenson, Buren, Ferguson)**

The Arctic Ocean is being heavily impacted by climate change; it is warming faster than any other ocean region and is gradually acidifying. To understand how Arctic ecosystems will evolve in response to multiple stressors, it is crucial to evaluate the effects of ongoing change. To effectively monitor changes to pan-Arctic ecosystems requires tracers that focus on key ecosystem components and provide quantitative information on ecosystem structure, providing information for management and conservation of ecosystem services. As part of a collaborative project between scientists in Canada, UK, and Norway, this study uses stable isotopes to focus simultaneously on the base of the food chain, controlled by the activity of marine phytoplankton, and key Arctic predators, harp and ringed seals. Using historical samples of seal teeth, this project will provide information on past changes to Arctic ecosystems, and develop an approach that can be used to monitor future

changes and aid in the management and conservation of ecosystem services. This project is ongoing and will continue until July 2020.

8. Biological sampling of Marine Mammals (Stenson, Lawson, Buren, Sheppard, Goulet)

Multi-disciplinary studies on the population dynamics, fisheries interactions, and the impact of climate change on marine mammals were continued in 2018. The ongoing programme of collections involving sealers, fishermen and DFO personnel from Newfoundland, Labrador and the Gulf of St. Lawrence continues to provide annual biological samples of seals (Harp, Hood, Ringed, Bearded, and Grey) and stranded or by-caught cetaceans in the region. These data facilitate the long-term monitoring of distribution, reproductive status, diets, and the growth and condition of marine mammals during a period of significant ecological change.

B. SPECIAL RESEARCH STUDIES

1. Miscellaneous Studies

a) Atlantic Salmon population genetics in Atlantic Canada

Resolving population structure of Atlantic salmon in threatened or understudied regions remains a priority. Several recent genetic and genomic studies in Atlantic Canada have revealed both river-scale and regional population structure of Atlantic salmon, which are directly informing the design of conservation units and allowing the estimation of river and region-specific exploitation. Genetic analysis of mixed stock Atlantic Salmon fisheries in coastal Labrador (2017-18), West Greenland (2017-18) and St. Pierre et Miquelon (2015, 2017-18) revealed significant differences in stock composition, with Labrador exploiting 98-99% Labrador origin salmon. The other two fisheries exploited mixtures of North American migratory stocks. In West Greenland, there was also a significant contribution from United Kingdom and Iceland stocks. At the regional scale, recent analysis has revealed new evidence of climate associated structure within Labrador with evidence that populations within Lake Melville are discrete from coastal populations. Ongoing work is using a large genomic database to refine conservation units (i.e. COSEWIC) throughout Atlantic Canada.

The consequences of aquaculture escape events for wild populations are also being examined within Atlantic Canada. Monitoring for escaped farmed salmon as well as hybridization between wild and farmed salmon continued in 2018. Examination of the relative survival of wild, hybrid, and feral juveniles in the wild suggests decreased survival of aquaculture salmon offspring and simulation modeling suggests possible impacts on the character and size of wild populations experiencing hybridization. Escapees were detected both at Garnish River counting fence (n=5) and as part of a directed escapee survey following an escape event in late July 2018 (n=400). Regular monitoring for aquaculture escapees was conducted during the fall of 2018 using angling and tended gill nets in Fortune Bay and Bay d'Espoir and detected no escapees. Ongoing work will continue to monitor for levels of hybridization and in developing baseline genetic data for Placentia Bay salmon populations.

b) Sentinel Studies

The Sentinel Survey of Atlantic Cod (*Gadus morhua*) has been conducted in NAFO Divs. 2J3KL, Subdivision 3Ps and Divs. 3Pn4Rs since October 1994, and currently there are twenty-four years of

catch and effort data and biological information. Data collected were tabled at the Regional Stock Assessment in the fall 2018 for Subdiv. 3Ps cod, and in the spring 2019 for Divs. 2J3KL cod. Control and experimental fishing sites were sampled by inshore fish harvesters using traditional fishing gears (i.e. linetrawl and gillnet) based on historic fishing patterns. The objectives of the program are: the use of Atlantic Cod catch rates to develop indices of relative abundance for resource assessments; to incorporate knowledge of inshore fish harvesters in the resource assessment process; to evaluate inter-annual variability in resource distribution over inshore areas; and to collect information on key biological parameters used in assessments (e.g. fish length, sex, and otoliths to determine fish age), as well as biological samples used for genetic, physiological, and toxicological analyses, along with stomach contents for food and feeding studies. Temporal trend in standardized catch rate for gillnet and linetrawl in Subdiv. 3Ps (both age disaggregated and age aggregated models) were similar with the highest values observed at the beginning of the time-series and then declined sharply after 1997 and remained near or below the historical mean catch rate thereafter. Standardized catch rate for gillnet in Divs. 2J3KL (Northern area) was stable at low levels in 1995-2004, then increased rapidly and peaked in 2015 before declining over 2016-18; catch rates in the Central area were higher at the beginning of the time-series, declined rapidly to their lowest values in 2002, and then followed a pattern similar to that of the Northern area; catch rates in the Southern area declined rapidly over 1998-2002, then remained stable at low levels. The model fit for linetrawl catch rate was questionable and not considered in further analyses .

c) Cod Tagging and Telemetry

Ongoing tagging and telemetry studies on cod in Div. 2J3KL were continued in 2018. There were 2,307 cod tagged and released with Floy tags and 30 tagged with acoustic transmitters in Div. 3KL. Recoveries of cod with Floy tags and detections of acoustically tagged cod aid the study of movement patterns and mortality rates. An independent Brownie analysis of the tagging data indicated that trends in estimates of fishing and natural mortality were similar to those estimated by NCAM.

Information from tagging was also used in the integrated state-space assessment model for cod in Div. 2J3KL.

d) Hydrographic Surveys

The Canadian Hydrographic Service (CHS) conducted surveys, both internal CHS surveys and contracted private sector surveys, in several areas on the west coast of the island to update charts as part of the Ocean Protection Program. Chart production is nearly complete for the Lake Melville area incorporating new data collected from CHS surveys and data from external sources collected in recent years. These charts will be released this year.

Annual Sailing Directions Revisory Survey

A New Edition of ATL 120, Labrador, Camp Islands to Hamilton Inlet (including Lake Melville) was nearing completion with publishing projected for 2019. A New Edition of Sailing Directions ATL 109, Gulf of St. Lawrence (Northeast Portion) was commenced with publishing projected for 2020.

All Canadian Hydrographic Service Sailing Directions publications are available in Print on Demand (POD) format.

REFERENCES

Bradbury, I.R., Hamilton, L.C., Sheehan, T.F., Chaput, G., Robertson, M.J., Dempson, J.B., Reddin, D., Morris, V., King, T., and Bernatchez, L. 2016. Genetic mixed-stock analysis disentangles spatial and temporal variation in composition of the West Greenland Atlantic Salmon fishery. ICES J. Mar. Sci. 73(9): 2,311-2,321.

Orr, D., P. Veitch, D. Sullivan, J. Firth, C. Peters and T. Inkpen. 2010. Groundfish by-catch within the northern shrimp fishery off the eastern coasts of Newfoundland and Labrador over the years 2007-2009. NAFO SCR Doc. 2010/045 Serial No. N5813 53 p.

Rideout, R.M. and D.W. Ings. 2018. Temporal And Spatial Coverage Of Canadian (Newfoundland And Labrador Region) Spring And Autumn Multi-Species RV Bottom Trawl Surveys, With An Emphasis On Surveys Conducted In 2017 18/17, Ser. No. N6801.

Table 1. Summary of preliminary catches (t) for stocks within the DFO, Newfoundland and Labrador Region, 2008-2018. Note that unless otherwise specified, this table presents Newfoundland and Labrador landings only.

Subarea	Species	Division	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
2	Cod	2GH		0	0	0	0	0	0	0	0	0	0
	Shrimp*	2G (SFA 4)	15,033	16,739	14,677	15,050	14,958	14,969	13,847	10,441	11,134	10,656	9,682
		2HJ (SFA 5)	17,000	26,102	22,552	21,530	21,850	22,317	23,645	25,264	21,425	25,094	20,503
		2J3K (SFA 6)	7,280	10,065	25,143	48,722	46,340	59,032	58,327	59,685	61,501	45,099	75,080
	Snow Crab	2HJ	1,753	1,758	1,700	1,769	1736	1392	1606	1933	2131	2387	2549
	Iceland Scallop	2HJ	6	5	5	8	6	20	16	19	16	17	13
	Arctic Charr	2J3KLPs+4R	27	16	29	25	22	25	11	24	11	16	18
	Atlantic Salmon****	2GHJ	32	39	39	42	38	37	54	41	36	30	36
2+3	Redfish	2+3K	9	104	16	5	48	66	103	74	61	28	20
	Greenland halibut	2+3KLMNO	6,067	5359	6089	6524	7223	6410	6176	6166	6529	5744	4701
	American plaice	2+3K	11	3	1	4	9	100	11	18	22	10	10
	Witch	2J+3KL	131	97	53	187	178	182	94	143	160	45	5
	Cod*****	2J3KL	9,354	12,778	9911	4314	4583	4299	3305	3139	2902	3098	3343
	Grenadier	2+3		2	0	1	5	11	28	113	41	13	10
	Capelin	2J3KL (offshore)	0	0	0	0	0	0	0	0	0	0	0
	Squid	2+3	1322	313	104	0	0	0	17	90	100	643	516
3	Redfish	3LN	4,266	4177	3005	4139	1446	2730	920	1960	113	6	1
		3M	0	0	0	0	0	0	0	2	0		0
		3O	54	36	21	31	34	0	0	97	42	255	202
	Yellowtail	3LNO	6,774	6,508	6248	5442	6800	7920	1795	3947	8056	5414	10216
	American plaice	3LNO	513	223	750	436	748	1041	267	450	1154	1077	878
		3Ps	276	206	168	100	46	96	140	279	402	509	456

	Witch flounder	3NO	355	349	798	222	9	62	3	11	39	41	46
		3Ps	129	391	479	343	144	226	235	175	446	454	298
	Atlantic halibut	3	451	499	519	361	570	400	364	270	321	289	287
	Cod	3NO	64	58	136	130	187	223	25	39	103	158	231
		3Ps	4,553	5796	4964	4961	4378	3058	4254	5424	6737	7491	9636
	Haddock	3LNO	17	228	186	62	10	13	4	42	27	104	60
		3Ps	200	329	224	167	189	69	101	88	129	173	288
	Pollock	3Ps	292	582	357	190	305	148	335	186	319	287	616
	White hake***	3NOPs	374	294	363	205	397	301	264	239	559	748	1383
	Thorny skate***	3LNOPs	1,148	418	192	169	388	294	531	467	604	1334	1452
	Capelin	3L	10,749	16,155	8890	11,380	9,808	12,423	11,645	12,023	11,927	13,326	15,176
		3K	9,006	3,662	16,619	13,640	13,365	11,332	10,672	8,081	3,544	9,853	13,043
	Shrimp*	3M	0	0	0	0	0	0	0	0	0	0	0
		3L	0	0	0	0	1,769	6,119	8,019	9,276	13,535	20,494	21,187
	Sea scallop	3KLNO	1	0	3	0	0	0	0	0	27	0	0
		3Ps	414	846	883	1,126	1158	1071	1,190	920	842	432	293
	Iceland scallop	3LNO	0	0			0	0	11	0	0	0	1
		3Ps	53	527	368	45	1	4	2	0	0	2	5
	Snow Crab	3K	5,984	5,509	5550	7182	7828	8519	8390	10,744	12,420	16,184	15,068
		3LNO	17,787	23,230	32,316	37,159	34,499	33,892	33,511	32,914	31,419	29,033	30,248
		3Psn	2,082	1,173	1188	2540	4904	6047	6225	6716	6026	5559	4523
	Lobster	3K	82	77	76	121	50	63	66	61	96	107	134
		3L	102	95	92	113	81	81	84	75	111	98	109
		3Ps	1,263	1,088	1199	1100	940	1048	952	917	1228	1071	1171
		3Pn	216	162	157	150	161	138	164	112	139	127	153
	Atlantic salmon**	2J3KLPs+4R		30	49	46	37	48	39	48	51	41	50
3+4	Redfish	3P+4V	1,508	1,062	372	71	533	192	295	907	2275	2265	1217
4	Iceland scallop	4R	140	115	192	200	310	378	295	431	244	246	121
	Sea scallop	4R	6	10	7	4	6	42	66	48	27	15	0
	Lobster	4R	1,756	1,488	1354	1260	906	873	857	769	1022	1096	1404

	Snow Crab	4R	302	524	694	776	850	891	742	596	188	268	365

Note: Table indicates Newfoundland and Labrador landings only unless otherwise specified.
*Shrimp catches are for Eastern Canada (i.e. taken by vessels from Newfoundland and Labrador, Quebec, and Nova Scotia).
Shrimp catches for shrimp fishing areas 4, 5 and 6 are as February 7, 2019, and represent an Apr 1 – Mar 31 fishing year.
Please note that the values shown for 2003 - present will not agree with past values shown because in the past values were converted to calendar year catches.
The 3L shrimp catches are taken according to a calendar year (Jan. 1 - Dec. 31) and are recorded accordingly.
**Recreational catch (retained only)
***Canadian catches only
**** Subsistence Fisheries
***** Excludes recreational catch for 2007 and 2009-2019

ACKNOWLEDGEMENTS

The following staff of Fisheries and Oceans Canada have contributed to the completion of this report:

J. Ladell	C. Burke	
B. Dempson	E. Coughlan	
B. Rogers	D. Mullowney	
L. Mello	L. Wheeland	
J. Bartlett	M.J. Morgan	
C. Bourne	D. Ings	
K. Baker	D. Belanger	
I. Bradbury	G. Stenson	
D. Maddock-Parsons	B. Rogers	
K. Skanes	P. Regular	
M. Simpson		

APPENDIX I: RESEARCH PROJECTS OF INTEREST TO NAFO CONDUCTED UNDER THE INTERNATIONAL GOVERNANCE STRATEGY

The objectives of the International Governance Strategy (IGS) are to strengthen international governance of fisheries, support healthy ocean ecosystems and to protect Canada's economic and environmental interests. The IGS is now funded on an ongoing basis at $22 million per year for the overall Strategy which includes $4 million for Science in the NAFO Regulatory Area.

The IGS Science Program conducts scientific research to acquire, synthesize and interpret scientific data to better understand fisheries and their supporting ecosystems in support of decision-making (e.g. understanding fishing interactions with sensitive marine areas and species, reducing bycatch of non-target species, improving selectivity of fishing operations, conducting deep-sea fisheries responsibly). The outcomes of the IGS Science program will support objective international policy debates and standard-setting; and, to leverage science into relevant international studies (e.g., contribute to international scientific cooperation that informs RFMO decision-making).

The three main components of the science program include:

1) Science in support of straddling stocks and highly migratory species,
2) Science in support of understanding ocean variability and marine ecosystems,
3) Science in support of protecting high seas marine habitat and communities (e.g., impacts of fishing, identification and characterization of Vulnerable Marine Ecosystems, including seamounts and unfished frontier areas, etc.), and,

The following tables outline those IGS activities of interest to NAFO that were completed 2018/19.

Project Leader(s)	Title
I. Bradbury	Population genomic analysis of Atlantic Halibut stock structure to inform trans-boundary management in eastern North America
I. Bradbury	Genomic based mixed stock analysis of Atlantic salmon fisheries in the North Atlantic
Koen-Alonso/Pepin	Making the NAFO Roadmap for an Ecosystem Approach to Fisheries (EAF) operational: Incorporating ecosystem and multispecies information into fisheries management advice
M. Finley/ M. Barrett	Reproductive strategies of Eastern Georges Bank Haddock and its implications on stock dynamics