Northwest Atlantic Fisheries Organization

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Canadian Research Report for 2016 Newfoundland and Labrador Region

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SUBAREAS 0 AND 1

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2016 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Greenland Halibut–Subarea 0 + 1 (except Division 1A inshore)

The Greenland Halibut resource within Subarea 0+1 is considered to be part of a common stock distributed in Davis Strait and south to Subarea 3. The resource within the Subarea 0+1 area, with the exception of Div. 1A inshore, is managed jointly by Canada and Denmark (Greenland), with the TAC being split equally. Since 2000, NAFO Scientific Council has provided separate TAC advice for offshore areas of Div. 0A+1A based on the unresolved relationship with the remaining areas and in 2003, Div. 1B has been included in the management area with Div. 0A and Div. 1A. In 2015, Scientific Council advised to maintain the TAC from at 16,000 t for 2016 in Div. 0A+1AB and at 14,000 t for Div. 0B and 1C-1F.

The Canadian Greenland Halibut fishery occurs in Division 0A in the north (Baffin Bay) and Division 0B in the south (Davis Strait). Catches in offshore 0+1 have been at the TAC levels since 2000. The Canadian (NL) fishery only occurs in Div. 0B and since 2007 catch has fluctuated between 3,300 t to 4,000 t. Overall, catch by gear and by month remained about the same in 2016 as it was in the previous 3 years. The catch was 3,589 t in 2016 and about equally split between otter trawlers (1,257 t with single trawls and 675 t with twin trawls) and gillnets (1,657 t).The fisheries occurred from June to October with about a third of the catch being taken in July-August.

SUBAREA 2

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2016 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

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[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.

a) Atlantic Salmon–Subarea 2

The commercial fishery for Atlantic Salmon in Subarea 2 has remained closed since 1998. The 2016 preliminary recreational catch, including retained and hooked-and-released fish, was 8,930 salmon, 20% greater than the previous 6 year mean (2010-2015). Preliminary subsistence fisheries catches of Atlantic Salmon for 2016 were 39 t, which was similar by weight to the previous 6 year mean (2010-2015). There has been a general increasing trend in subsistence fishery harvests since 2000 from an average of 26 t from 2000-2009 to an average of 38 t from 2010-2016.

b) Arctic Charr–Subarea 2

Commercial landings of Arctic Charr from north Labrador in 2016 were approximately 29 t and about 16% higher than 2015 and were the highest reported landings since 2006. This is equivalent to almost 17 thousand Arctic Charr caught in terms of numbers of fish. Commercial landings have been sporadic in recent years driven largely by effort directed towards the commercial fishery, and a fixed amount of charr that the local fish plant was willing to process (~25 t). In addition to the commercial fishery, estimates of subsistence fishery harvests of Arctic charr have averaged about 9,400 fish annually during the past 10 years (2007 – 2016), ranging from a low of 5,400 charr in 2007 to 13,000 reported caught in 2012.

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 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 and recreational fisheries in the inshore since 2006. The previous multi-year management plan (2013-2015) for the stewardship fishery was an individual quota (IQ) based plan, whereby each harvester was permitted an annual allowance of 2.3 t (= 5,000 lb). The management approach changed in 2016 from an IQ for the stewardship fishery to weekly landing limits per fisher (2,000 lbs from Aug. 15 – Sept. 4 then 3,000 lbs from Sept. 4 – Dec. 16), and the requirement that fish could be caught only within fisher's home bay was removed.

The recreational fishing season was extended in 2016, with recreational fishers being allowed to fish on weekends, including both Canada Day and Labour Day, in addition to the two week season in summer and fall. This was an increase of 14 days from 2015 to 2016. Recreational fishers were permitted a maximum catch of 5 fish per day or person, or 15 fish per boat per trip when 3 of more people were fishing together.

Total reported landings in 2016 were 10,164 t compared with 4,435 t in 2015 (most of this was from the stewardship fishery). There are no requirements to report recreational landings. However, tagging data were also used to provide information on the magnitude of the recreational fishery. Recreational catch based on tagging returns has been estimated at 30% of the stewardship fishery landings during 2006-2016; therefore, catch in 2016 was estimated at about 13, 164 t.

In 2016, there was 19 t of cod bycatch mainly in redfish fisheries, but also small amounts in other fisheries as well. Bycatch of cod occurs in shrimp fisheries in 2J3KL and from 2007-09 estimates have ranged between 1.3 t to 16.2 t annually (Orr et al. 2010). More recent data have not been compiled, but shrimp landings have been declining.

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 2010-16. 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 2016, 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. 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 50 t and 600 t annually, averaging 300 t per year. During 2015, discards were estimated at 100 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. 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.

f) Witch Flounder-Divisions 2J3KL

There has been no directed fishing on this stock since 1994. In 2016, bycatch in other fisheries from the Newfoundland and Labrador Region was 53 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, but the stock size remains low.

g) Greenland Halibut-Subarea 2 + Divisions 3KLMNO

The Canadian (NL) catch of Greenland Halibut in 2016 in Subarea 2 and Div. 3KLMNO was approximately 6,040 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 2J + 3K (SFA 6). The resource within these SFAs is normally assessed on a biennial basis, with updates provided in interim years. However, significant reductions in resource status in SFA 6 have led to more frequent stock assessments. The last formal assessment was completed during February, 2017 and the next formal assessment is scheduled to be completed during February 2018.

The regional Composite Climate Index recovered in 2016 to above 1981–2010 average (normal) conditions after declining for several years in a row to among the lowest in the time series. Fall bottom temperatures were above normal in 2016, resulting in above normal areas of potential thermal (2 °C to 4 °C) habitat. Consistent with below normal sea ice extent, the phytoplankton bloom in 2016 was earlier than in the past three years. This could lead to a further reduction in shrimp productivity in the short term.

Environmental forcing, predation and fishing are correlated with subsequent shrimp production. The build-up of shrimp until the mid-2000s occurred during a period of favourable environmental conditions and reduced predation. Shrimp per-capita production has declined since the mid-2000s. Environmental conditions and increasing predation pressure appear as important drivers for the decline. Recent environmental conditions may lead to improved shrimp per-capita production but are unlikely to trigger rebuilding of the resource in SFA 6 (at a rate similar to the build-up period) over the medium term when considered in combination with high predation pressure. 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 high unless abundance of alternative prey increases. Given declining production of shrimp, fishing pressure could now be influencing stock declines in SFA 6 more than it did in the past.

SFA 4 (NAFO DIVISION 2G)

A very small fishery took place in SFA 4, with a TAC of 500 t that was never taken, in the late 1970s and expanded greatly in the late 1980s. The TAC increased from 2,580 t in 1989 to 5,200 t in 1995 and 9,320 t in 1998. From 1998 until 2008/09 a portion of the TAC was allocated to the area south of 60°N to promote spatial expansion of the fishery, during which time the TAC was increased about every four years. The TAC has remained the same, at 14,971 t, since 2013/14. Commercial catch increased from approximately 10,000 t from 2005/06–2011/12 to about 15,000 t in the past four years.

Large-vessel standardized CPUE fluctuated without trend near the long term mean. Between 2005 and 2012 the fishable biomass index ranged between 76,600 t and 164,000 t and in 2016 was 95,300 t. Between 2005 and 2012 the female SSB index ranged between 39,700 t and 115,000 t and in 2016 was 55,500 t. The exploitation rate index has been about 15% for the past three years. Female SSB index in 2016 was in the Healthy Zone within the IFMP PA Framework with a 45% probability of having been in the Cautious Zone.

SFA 5 (Hopedale and Cartwright Channels)

The TAC doubled from 7,650 t in 1994 96 to 15,300 t over the 1997 2002 period. In 2003, the TAC increased to 23,300 t, the management year changed from January 1 December 31 to April 1 March 31, and an additional interim quota of 9,787 t was set for the fifteen month 2003/04 management year; hence 2003/04 had a 33,087 t TAC. The TAC of 23,300 t was maintained through to 2013/14. In 2013 the resource status appeared to decline and the TAC was set at 20,970 t for 2014/15, however it was set at 23,300 t again in 2015/16. TAC was increased by 10%, to 25,630 t, from 2015/16 to 2016/17. It is expected that the 2016/17 TAC will be taken.

Standardized large-vessel CPUE over the last five years has been stable at relatively high levels. Fishable biomass index has decreased, by 27%, from 149,000 t in 2015 to 110,000 t in 2016. Female SSB index has decreased, by 35%, from 83,200 t in 2015 to 54,300 t in 2016. The exploitation rate index has varied without trend around 15% from 1997–2016/17. Female SSB index is in the Healthy Zone within the IFMP PA Framework, with a 6% chance of being in the Cautious Zone. If the 25,630 t TAC is maintained and taken in 2017/18, then the exploitation rate index will be 23.3%.

SFA 6 (HAWKE CHANNEL + NAFO DIVISION 3K)

The TAC was set at 11,050 t in 1994 and increased to 23,100 t in 1997 as a first step towards increasing the exploitation of an abundant resource. Most of the TAC increases from 1997 onwards were allocated to the small-vessel fleet. The TACs, and subsequently the catches, increased significantly to a maximum of 85,725 t in 2008/09–2009/10 after which TAC reductions were applied periodically. TAC was reduced by 42%, to 27,825 t, from 2015/16 to 2016/17; however it is uncertain if the TAC will be fully taken based on the portion of the catch taken as of the assessment and on verbal communication with harvesters. As of the February 8, 2017 CAQR, 79% of the TAC had been taken.

The annual commercial CPUE has demonstrated a declining trend for about the last ten years. Commercial and survey data demonstrate a contraction of the resource within recent years. Fishable biomass index declined from 785,000 t in 2006 to 104,000 t in 2016, which is the lowest in the time series. There was a 25% decline between 2015 and 2016. Female spawning stock biomass (SSB) index declined from 466,000 t in 2006 to 65,000 t in 2016 which is the lowest in the time series. There was a 27% decline between 2015 and 2016. The exploitation rate index ranged between 5.5% and 21.4% from 1997 to 2016/17, and has averaged 17.8% in the last five years. The 2016/17 exploitation rate index will be 20.2% if the TAC is taken. The female SSB index is currently in the Critical Zone, of the Integrated Fisheries Management Plan (IFMP) Precautionary Approach (PA)

Framework, with greater than 99% probability. If the 27,825 t TAC is maintained and taken in the 2017/18 season, the exploitation rate index will be 26.8%. The IFMP states that the exploitation rate should not exceed 10% while the female SSB index is in the Critical Zone.

i) Snow Crab–Divisions 2HJ

Most of the landings are derived from Div. 2J in all years. Snow Crab landings have remained relatively low at less than 2,000 t since 2011. Meanwhile, effort has been substantially reduced and remained at or near its lowest level during the past four years. CPUE increased steadily from 2011 to 2015, but decreased to a relatively low level in 2016. No improvements are anticipated in 2017. The trawl and collaborative post-season (CPS) trap survey-based exploitable biomass indices both increased sharply in 2014 and since declined by about half to relatively low levels. Recruitment was relatively low throughout the 2000s. It spiked to a recent high in 2014 but subsequently decreased to more typical levels in both the trap and trawl surveys in the past two years. Short-term recruitment prospects appear poor; the pre-recruit biomass index was at or near its lowest level in the past two years. Despite abrupt annual fluctuations, the pre-recruit fishing mortality index has been increasing since 2005. It was at its highest level in a decade in 2016. Total mortality in exploitable crabs was at its highest observed level in 2016. Although below historic peaks, the exploitation rate index doubled to 60% in 2016. Exploitation rates above 50% are associated with high levels of soft-shell discards. Status quo removals in 2017 would increase the exploitation rate index to 67%.

j) Iceland Scallop–Divisions 2HJ

Inshore aggregations were fished in 2009, 2010, 2011, 2012, 2013, 2014 ,2015 and 2016 with nominal catches estimated at 17 t , 16 t, 19 t, 16 t, 20 t, 6 t , 8 t and 5 t round, respectively. 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 fall (Div. 2HJ) multi-species research vessel surveys were collected in 2016 to support stock assessment, distribution and abundance studies, and detailed biological sampling were conducted on important commercial species (eg. cod, American Plaice, Greenland Halibut, redfish, Thorny Skate, shrimp, crab) as well as a suite of indicator species under the Ecosystem Research Initiative of the NL Region. A total of 77 successful sets were conducted in Div. 2H between 93m-1354m and 115 sets in 2J between 108m – 1451m. 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.

Analyses of maturity data is conducted regularly on Greenland Halibut and other species and are presented as required 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. This ended a long-term program focused on Arctic charr that began in the early 1970s. Discussions are currently underway to consider options to resume a Science program on Charr in this area.

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 2013-2016. 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. In addition, large terminally molted males were tagged during the surveys with the intent of tracking movements.

d) 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 microsatellite baseline (15 loci, 12,409 individuals, 12 groups) encompassing the species western Atlantic range. Three hundred and fifty-three salmon collected from the Saint Pierre et Miquelon fishery (2004, 2011-14) were analyzed and estimates of stock composition showed consistent dominance of three regions: Gulf of St. Lawrence, Gaspe Peninsula, and Newfoundland. In the West Greenland harvest (2011-14, n=2,336) North American contributions were largely from Labrador, the Gulf of St. Lawrence, and the Gaspe Peninsula. No evidence of spatial or temporal trends in mixture composition was apparent in the fishery. Finally in the coastal Labrador fishery (2012-14, n=771) mixture estimates suggest the harvest is dominated by a single region, central Labrador (95.3%). Minor components were also allocated to Northern Labrador/Ungava and Newfoundland (<4%). In all three fisheries, estimates of stock composition appear stable over time and assigned individuals show the expected trend of increasing river age with latitude of home region. Exploitation estimates of Newfoundland and Labrador salmon across all three fisheries was generally low (<10% for large salmon and <5% for small salmon).

SUBAREA 3

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2016 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 2016 preliminary recreational harvest, including retained and hooked-and-released fish, was 34,638 salmon, 18 % greater than the previous 5 year mean (2011-2015).

Four of the ten assessed rivers in Subarea 3 achieved conservation spawning requirement in 2016. Three of the rivers that did not achieve conservation have had large areas of habitat made accessible and the area of habitat utilized by Salmon is unknown.

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. Preliminary landings in 2015 and 2016 were

25,020 t and 30,297 t, respectively, against a Total Allowable Catch (TAC) in Div. 2J3KL of 28,464 t. The last full Capelin assessment was held in February 2015 and included survey data and biological data to May 2014. During this assessment several biological indicators were shown to be returning to levels last recorded prior to the collapse of the stock in the early 1990s. In April 2017 a Capelin update was provided as information to industry. This update included only data from the 3L acoustic survey (1985-2015), Trinity Bay larval indices (1991-2016) and 2J3KLNO fall bottom trawl surveys. The acoustic survey abundance index has fluctuated markedly over time from a peak of 6 million t in the late 1990s to a low of 25,000 t in 2010. From 2013-2015 the index showed some improvement peaking in 2014 at near 20% of the 1980s levels. However abundance in 2015, while still superior to 1991-2012 period, showed larger than usual declines in the 2012 and 2013 year classes. No survey was conducted in 2016 so the abundance of the incoming year class is uncertain. The poor survival of this 2013 cohort was coincident with delayed gonad development with gonad weights in the survey the lowest since 1996 when weighing of gonads at sea commenced. Changes in abundance were paralleled with changes in capelin distribution. Capelin surveyed in May 2015 tended to be found in deeper water and further offshore than the previous two years, similar to patterns common in the 2000s. The fall distribution of capelin also changed in 2015 and 2016 reverting to a pattern common during the periods of low abundance in the 1990s and 2000s with the center of mass located in northern Div 3L and few Capelin present in Div 2J. Larval indices for the 2014 and 2015 cohorts are at the lowest levels in the series (2003-2015). These observed declines in larval production in combination with the poor survival of the 2013 cohort suggest that overall Capelin abundance in 2016-2017 is likely to decline.

Ecosystem estimates of consumption of Capelin by fish increased during 2014-2015, probably as a result of improvements in Capelin abundance. However Capelin consumption in 2016 has declined, likely as a result of reduced Capelin availability.

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 2017. Total catch since 1994 increased from 170 t in 1995 to 4,900 t in 2003, and ranged between 500 t and 1,100 t for 2004-2016. The provisional 2016 value reported to NAFO based on monthly catch reports is 666 t. Canada (NL) landings ranged from 444 t to 818 t between 2002-2005, and from 26 t to 247 t between 2006-2017. Canadian catches in 2017 totalled 147 t, taken primarily in the 3NO yellowtail fishery.

The 2015 assessment of 3NO cod (i.e. the last full assessment of this stock) reported that the spawning biomass has increased considerably over the past five years but the 2015 estimate of 38,454 t still represents only 64% 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 2015/16 was set at 13,043 t. Total landings for 2015/16 totalled 6,427 t. Reasons given for not taking the complete TAC included economic factors and reduced cod availability. The majority of recent catches are taken by fixed gear (gillnet and line-trawl).

The 2016 assessment of 3Ps Cod indicated that the stock has declined since 2012 and is currently estimated to be 18% above the limit reference point (BRecovery). The probability of being below the LRP in 2016 is 0.22, which is a concern.

d) American Plaice-Subdivision 3Ps

Canadian (NL) landings have generally declined over the past 10 years. Catches ranged between 450 t - 510 t from 2006-2009 then declined to 46 t in 2014. The 2015 catch was 100 t and 168 t in 2016.

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 238 t in the past 4 years with the 2016 catch at 479 t. The directed fishery is prosecuted by offshore otter trawlers and a nearshore Danish seine fleet. However, in recent years it appears to be a mixed American Plaice and Witch Flounder fishery by otter trawlers. Although survey stock size indices since 1983 have been highly variable, the survey biomass index during recent years suggests that the biomass is on average about 75 % of the 1983-90 average when catches were around 800 t. 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.

f) Yellowtail Flounder–Divisions 3LNO

Since the fishery for this stock reopened in 1998, stock size has steadily increased and in 2015 (the last full assessment of this stock) was estimated to be 1.8 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 2016 was 6,248 t. Scientific Council noted that this stock is well above B_{msy}, and recommended any TAC option up to 85 % Fmsy for 2016 and 2017 (26.3 t and 23.6 t respectively). The TAC for 2016 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). Catch for this stock is not known precisely. In 2015, the catch estimate was 1,149 t and in 2016 was 1,741 t, based on Daily Catch Records (DCR).

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

Redfish in the Canadian Atlantic within Div. 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 2016 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.

For the UNIT 2 portion (primarily Div. 3P4V) of the combined stock UNIT1&2, total Canadian catches have declined steadily from 27,000 t in 1993 to 8,000 t in 2002, matching reductions in TACs. From 2002-05 the TAC has been stable at 8,000 t while catches declined from about 7,500 t in 2003 to 6,100 t in 2005. In 2006 the TAC was increased to 8,500 t and maintained at that level to 2016, whereas Canadian catches have averaged 3,775 t from 2010-2015 and was 2,235 t in 2016 with Canada (NL) taking 372 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 2015 and only 21 t in 2016. From 1974-2004, Div. 3O was under TAC regulation set by Canada within its jurisdiction, while catches were unrestricted in the NAFO Regulatory area of Div. 3O. Since 2004, NAFO Fisheries Commission has set the TAC for Div. 3O redfish at 20,000 t.

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 increased its harvest since the reopening of the fishery from 113 t in 2010 to 4,139t in 2015 then declined to 3,005 t in 2016.

k) Witch Flounder-Divisions 3NO

There was no directed fishing on this stock from 1994 to 2014. A 1,000 t TAC was adopted for 3NO Witch Flounder beginning in 2015 with a TAC increase to 2,172 t in 2016. The 2016 Canadian catch was 798 t from a Canadian TAC of 1,303 t. Non-Canadian catch in 2016 was 217 t for a total estimated catch of 1015 t of an available 2172 t quota. There were indications of improvement in stock status based on the increases in the Canadian survey biomass and abundance indices from 2010 to 2013. Survey indices trended downwards in 2014 and 2015 with a slight improvement in 2016.

This stock underwent full assessment in 2014 based on survey indices and in 2015 utilizing a surplus production model in a Bayesian framework. The 2015 assessment indicated that the stock steadily increased since 1999 and was at 81% *Bmsy*. In 2015 the risk of the stock being below *Blim* or above *Flim* was concluded to be less than 1%. Based upon this information, the NAFO Fisheries Commission in 2015 set a TAC for 2016 and 2017 at 2,172 t and 2,225 t respectively.

Witch flounder in Divs. 3NO is due for a full assessment in 2017.

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 Div. 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 Div. 3NO were 252 t during the period 2011-2015. Preliminary 2015 Canadian landings for NAFO Div. 3NO and Subdiv. 3Ps are 94 t and 267 t respectively. The current TAC for White Hake in 3NO for 2017 is 1,000 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 Divisions 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 Div. 3LNO and 2,000 t for Subdiv. 3Ps. In 1997, the TAC was reduced to 1,950 t for Div. 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 Northwest Atlantic Fisheries Organization (NAFO) set a TAC of 13,500 t for 2005-2009 in Div. 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 2013-17. The TAC for Subdiv. 3Ps in the EEZ was maintained at 1,050 t by Canada.

Average STATLANT landings for 20011-15 were 4,403 t in NAFO Divisions 3LNO, and 493 t in Subdivision 3Ps. Preliminary Canadian landings for 2016 are 2.8 t in NAFO Divisions 3LNO, and 189 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 remained relatively constant at low levels.

n) Shrimp–Divisions 3LMNO

Catches increased dramatically beginning in 1999, with the beginning of a regulated fishery. Over the period 2004-09, catches increased from 13,200 t to 26,000 t. Due to declines in resource indices, the TACs have been steadily decreasing. During 2013-2016 annual Fishery Commission meetings, the 2014 TAC was at 4,300 t, and no directed fishing was permitted for 2015-2017. Preliminary catch records, as of February, 2017, confirm that no fishing had taken place in 2016. As per NAFO agreements, Canadian vessels took most of the catch during each year prior to 2015. Canadian catches increased from 10,300 t in 2004 to 18,900 t in 2008 before declining with reduced TACs. Catches by other contracting parties (outside the 200 mile limit) increased from 2,900 t in 2004 to 7,700 t in 2006 and between 2007 and 2012 ranged between 2,100 and 7,600 t.

There is reason for concern about the status of the Northern Shrimp resource within NAFO Divisions 3LNO. The spring female spawning stock biomass (SSB) index decreased by 97% from 2007 to 2016 while the autumn SSB index decreased by 92% from 2007 to 2015. The autumn 2015 SSB was below the $B_{lim.}$ Both the spring and autumn 3LNO total biomass indices dropped drastically, by over 90%, from 2007 to 2013. The autumn index decreased further in 2014, however there was a slight increase during spring 2014 and little change in 2015. It is important to note that the spring 2014 indices of biomass and abundance have increased slightly, however these levels are still near the lowest indices over the time series. Exploitation and mortality rate indices were increasing from 2007 to 2013, despite decreasing catches during that period, but dropped drastically in 2014. Given expectations of poor recruitment, with recruitment indices at the lowest in the time series, the resource is not predicted to increase in the near future.

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

In Div. 3K, landings declined by 63% since 2009 to 5,600 t in 2016, a time series low. Effort has remained near its lowest level for the past five years. CPUE has been low for the past six years reflecting recent lows in most management areas. It is expected to remain low in 2017. The post-season trawl and trap survey exploitable biomass indices both declined since 2008 to their lowest observed level in the past two years. Recruitment is at or near time series' lows throughout most of the division. Recruitment is expected to remain low in the short term because trawl and trap pre-recruit indices are near time series' lows throughout the division. Maintaining current removals would leave the overall exploitation rate index unchanged in 2017, reflecting slight changes throughout most of the division. However, the exploitation rate index in White Bay (CMA 3B) would double to a historical high.

In Div. 3LNO offshore, landings have remained at 22,000-29,000 t since 1999. Effort has gradually increased over this period to a historical high in 2016. CPUE declined by a third from near a time series' high in 2013 to a two-decade low in 2016. Substantial declines have occurred in all but management area MSex in recent years and further declines are anticipated in 2017. Both the trawl and trap surveys show considerable spatial contraction in high catch rates of exploitable crabs in recent years. The trawl survey exploitable biomass index, which covers the entire division, has precipitously declined since 2013 to a historic low. Both indices declined by about 50% in 2016, with the CPS trap survey index declining between 27-74% in the various management areas. Overall recruitment was at a historic low in 2016, reflecting low levels throughout most of the division. Recruitment prospects are very poor. The pre-recruit biomass index has been at its lowest level for the past three years. The pre-recruit fishing mortality index has been at or near the time series' high in the past two years. The exploitation rate index doubled to 60%, a historic high, in 2016. Status quo removals would double the index again in 2017, with increases occurring in all management areas

In Div. 3L inshore, landings increased throughout the 2000s and have remained at about 8,000 t since 2013. Effort had oscillated without trend from 2005-2016 but increased by 40% in 2016 to a time series' high. Overall CPUE was near its highest observed level during 2014-2015 but abruptly declined by about 40% in 2016 to its lowest level in a decade. This reflected decreases ranging from 20-48% in the various management areas. The post season trap survey exploitable biomass index changed little from 2004 to 2015 but declined by a third in 2016. This reflected decreases ranging from 12-46% in the various management areas. Overall recruitment into the exploitable biomass has steadily declined since 2010 to a time series low. Recruitment indices from DFO and CPS trap surveys in all management areas were at or near their lowest levels in 2016. Recruitment is expected to remain low in most management areas in the short-term as inferred from pre-recruit indices from DFO and CPS trap surveys. However, improvements appear likely for Bonavista Bay (CMA 5A). The overall trap survey-based exploitation rate index increased gradually from 2006-2016 to a time series' high. Maintaining status quo removals would increase the exploitation rate by 52% in 2017. This reflects projected increases of 14-85% in all management areas, which would each remain near or achieve new time series' highs.

In Subdiv. 3Ps, landings declined from a recent peak of 6,700 t in 2011 to a time series low of 1,200 t in 2016. Effort reached a historic high in 2014 and has since decreased by half; only 40-60% of the TAC was taken in the past two years. CPUE has steadily declined since 2009 to a record low in 2016, reflecting precipitous declines throughout most of the Subdivision in recent years. The exploitable biomass index declined by 88% since 2010 to a time series low in 2016. Overall recruitment has declined since 2009 to its lowest observed level. Recruitment is expected to remain low in the short term (2-3 years) as the pre-recruit biomass index has remained at its lowest level for four consecutive years. Total mortality in exploitable crabs declined from its highest level in 2013 to near average in 2016. Coincidentally, the exploitation rate index has also declined by more than half since its 2013 peak due to the substantial decline in fishing. The impact of maintaining the current level of fishery removals on the exploitation rate is unknown. Concern is expressed that discards comprised half the catch in 2016. The four highest levels in the pre-recruit fishing mortality index have occurred during the past four years. Continuing to fish under elevated mortality levels on sub-legal-sized crabs could potentially impair reproductive capacity.

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

The Div. 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 2016. 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, and 2016 removals were 45 t and 368 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 this area was last updated based on DFO resource survey in September 2009.

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 slightly to 883 t in 2016. 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 thirteen-year period 1983 to 1995. They increased since 1995 to about 12,700 t in 1997 before declining sharply to about 800 t in 1998 and about 20 t in 1999. They remained low, at about 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 had been no reported landings from 2013 – 2015 but about 100 t were landed in 2016.

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 2016 with three (both spring and fall surveys were impacted by vessel availability and technical issues) physical and biological oceanographic offshore surveys carried out along several cross-shelf NAFO and AZMP sections from the Southeast Grand Bank to Seal Island on the southern Labrador Shelf. The spring mission was separated into two legs with the first was conducted on the CCGS Teleost from April 1 to 6, 2016 and the second on May 11 to 17, 2016. The summer survey on CCGS Teleost took place from July 8-28, 2016 and the last on CCGS Hudson from November 13 to 22, 2016. 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 2016 in NAFO Div. 2J and 3KLNMOP. The results were based on physical observations collected on the NL Shelf from Hamilton 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) trends on the northeast Newfoundland Shelf while showing an increase of about 1ºC since the early 1980s were mostly below normal during 2016. The annual bottom (176 m) temperature/salinity at the inshore monitoring site (Station 27) was below normal by -0.7/-1.4 SD, respectively in 2016. The cold-intermediate layer (CIL; volume of <0ºC) during 2016 was below normal off southern Labrador (2J) but near normal on the northeast Newfoundland Shelf and Grand Bank (3KL). The volume of CIL water during the fall in NAFO Divisions 2J3KL from multi-species net-mounted CTD deployments was below normal. The spatially averaged spring bottom temperature in 3Ps was about 1ºC (2 SD) above normal, a 33-year record, while in 3LNO it was about normal. The spatially averaged bottom temperature during the fall in 2J and 3K show an increasing trend since the early 1990s of about 1ºC, reaching a peak of >2 SD above normal in 2011 and remaining above normal in 2016 by 0.5ºC and 0.3ºC, respectively.

b) Nutrients and plankton studies

The inventories of nutrients are strongly influenced by seasonal biological processes operating throughout the upper water-column. In general, shallow (0-50m) macronutrient inventories of nitrate (principal limiting nutrient) were above the 1999-2010 average across Newfoundland and Labrador AZMP Sections in 2015. The deep inventories of nitrate, an index of nutrient availability to fuel the base of the marine food chain in the subsequent spring bloom, were consistently below normal across all standard sections but particularly on the Grand Bank, maintaining a pattern that started in 2008/09. The chlorophyll *a* inventories inferred from the seasonal oceanographic surveys, which provide an index of phytoplankton biomass throughout the water-column, were also consistently below normal throughout the survey area in 2015, continuing a pattern that started in 2011.

Satellite ocean colour observations from 11 sub-regions off Newfoundland and Labrador indicated that the magnitude and peak intensity (amplitude) of surface phytoplankton blooms detected was generally below normal throughout the area in 2016. The timing of the spring bloom was near normal to early onset along the Labrador Shelf but delayed along the northeast Shelf and Grand Bank in 2016. The bloom was generally shorter than normal throughout the northeast Shelf and Grand Bank but above normal blooms were associated with the most northern and Flemish Cap sub-regions most of in 2016.

The abundance of key functional zooplankton groups were generally higher across the AZMP standard transects and fixed stations in 2016. The abundance of an important small grazer copepod (*Pseudocalanus spp*.) remained elevated as in previous years across the northern transects (2J) through the southern Gulf of St. Lawrence ((4T). The abundance of dominant copepods and non-copepods (mostly gelatinous and carnivorous zooplankton) were consistently higher across the entire zone. One exception to this general trend in abundance of key functional zooplankton groups is for the larger grazing copepod, *Calanus finmarchicus,* an important prey to a variety of different life stages of fish, with reduced standing stocks throughout the entire zone.

2. Biological Studies

a) Multispecies Trawl Surveys

Biological and oceanographic data from fall (Div. 3KLNO) and spring (3LNOP) multi-species research vessel surveys were collected in 2016 to support stock assessment, distribution and abundance studies, and detailed biological sampling were conducted on important commercial species (eg. 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 2016, the annual spring survey completed a total of 140 successful sets in 3L (61m-694m), 78 in 3N (44m-624m), 75 in 3O (64m-592m) and 157 in 3Ps (37m-671m). During the fall survey, a total of 143 successful sets were conducted in Div. 3K (150m-1385m), 138 sets in 3L (60m-673m), 70 in 3N (36m-668m) and 74 in 3O (60m-678m). 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 data is conducted regularly on cod, American Plaice, Yellowtail Flounder, Greenland Halibut and other species and are presented to the annual meeting of NAFO Scientific Council during assessments of cod in Div. 3NO, American Plaice in Div. 3LNO, Yellowtail Flounder in Div. 3LNO, Greenland halibut in SA2+Div. 3KLMNO as needed.

b) Capelin

Monitoring larval emergence from beach sediments and from bottom spawning sites was discontinued in 2013, however monitoring of recently emerged larvae in the Bellevue Beach area of Trinity Bay is on-going and occurred in 2016. An ongoing offshore acoustic survey initiated in the spring of 1999 to monitor Capelin distribution, behaviour, and feeding habits in Div. 3L did not occur in 2016. Inshore surveys were conducted in August and in September of 2016 to map the abundance and dispersal of larval Capelin in Trinity Bay, Div. 3L. Since 2008, acoustic data have been collected during the fall multispecies bottom trawl survey in Div. 2J3KL, along with enhanced sampling of the biology and feeding of forage fishes. Analyses of these fall acoustic data are ongoing.

c) Atlantic Salmon

Research examining aspects of the trophic ecology of Atlantic Salmon using stable isotopes continues. Variation in adult Atlantic Salmon run timing was found to vary over time with evidence showing that the median date of return has advanced by almost 12 days over a 35-year interval going back to the late 1970s. Temporal changes in run timing were associated with overall warming conditions on the Newfoundland and Labrador Shelf.

d) Shrimp

A baseline of pathology is being constructed from past research survey datasets.

In 2011, Northern Shrimp research with NL Region became involved in an International Governance Strategic Fund project to assess the response of Northern Shrimp (*Pandalus borealis*) populations to climate change and variability. This project has inter-regional collaboration with the Drs. Patrick Ouellet and Denis Chabot of the Maurice Lamontagne-Institute as well as international collaboration with Dr. Piero Calosi of University of Plymouth in England. The objective of this project is to assess how the ongoing changes in ocean water temperatures (Climate Change) will affect the distribution, productivity and resilience of Northern Shrimp populations in the Northwest Atlantic, both inside and outside Canadian waters. Polar taxa or populations also have been shown to be highly stenothermal and limited in their abilities to adapt; therefore, we predict northern-most shrimp populations to be highly vulnerable to warming. This hypothesis is in opposition to the current popular suggestion that shrimp abundance may increase at higher latitudes and/or expand further northward as warming continues.

e) Snow Crab

Long-term trap and trawl surveys in White Bay (3K), Notre Dame Bay (3K), Bonavista Bay (3L), and Conception Bay (3L) were continued in 2016. 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 2016.

Similar surveys were initiated in Fortune Bay in 2007, and Trinity Bay and St. Mary's Bay in 2013. These continued in 2016.

A post-season trap survey, conducted by Snow Crab harvesters, which began throughout most of 2J3KLNOPs in 2004 was continued in 2016 but was incomplete in 3Ps.

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 (2008-2016). The degree to which these observations reflect broader coast-wide phenomena and offshore stock biomass are being investigated.

SUBAREA 4

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2016 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 2016 recreational harvest, including retained and hooked-and-released fish, was 215,024 salmon, 39% greater than the previous 5 year mean (2011-2015).

All three of the assessed rivers in Subarea 4 achieved conservation spawning requirement in 2016.

b) Snow Crab–Div. 4R

In Div. 4R3Pn, landings increased from a historic low of 190 t in 2010 to between 750-900 t since 2012. Effort has been relatively unchanged since 2012. Overall CPUE has been low throughout the time series relative to most other divisions. However, most management areas within 4R3Pn experienced catch rates near time series' highs during 2012-2014. CPUE has returned to low levels in most management areas in the past two years but remains relatively strong in Crab Management Areas (CMAs) 12C and 12G. The post-season trap survey exploitable biomass index most recently peaked in 2011 and has since gradually declined, reflecting patterns in most surveyed areas. Overall recruitment most recently peaked in 2012 and has since declined to low levels in all surveyed areas. Recruitment prospects appear relatively weak for the next 2-3 years because pre-recruit indices have been low in most surveyed areas following relatively high levels within the period of 2008-2013. The overall exploitation rate index has increased since 2013 in all surveyed areas. Status quo removals would elevate the exploitation rate index to a new high, predominately reflecting a large increase in the Bay of Islands (CMAs 12EF).

c) Iceland Scallops–Div. 4R

The nominal catch from the Strait of Belle Isle (Div. 4R).

In 2013 removals 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, landings again decreased, to 192 t, the lowest since 2008. The TAC remains at 1000 t (round). Landings in 2011 almost doubled to 431 t (round), from the 2010 removals estimated at 244 t (round). There was 246 t removed in 2009, up from 111 t removed in 2008. 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 updated for the Strait based on a survey in August 2007.

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 4 t (round) in 2016.

SUBAREA 2 + 3 + 4

A. STATUS OF FISHERIES

Nominal landings from 2007 to 2016 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 have remained relatively stable since the 1960s. 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 2,150 t in 2014. 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 980 t in the last few years. Landings in Div. 4R peaked in 2008 at 1,400 t but have since declined to approximately 900 t in the last couple of years. Landings in Div. 3K and 3L have declined to record low levels of 50 t and 80 t respectively. Landings in all Divisions combined, Div. 3KLP4R, have decreased slightly from 2,600 t in 2010 to approximately 2,100 t in 2014. Nominal effort (based on active fishers, trap limits & fishing days) decreased by 45 % from 2006 to 2015 due to license retirements, fewer active fishers, shorter seasons, and trap limit reductions.

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 (2004-2015) and mandatory DFO logbooks (2010-2015) CPUE (number of lobster caught/number of traps hauled) has increased gradually over the last decade.

b) Marine Mammals

Multi-disciplinary studies on Harp and Hooded Seal population dynamics, seal-fisheries interactions, and the impact of climate change continued in 2016. The ongoing programme of collections involving sealers 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) in the region. These data facilitate the long term monitoring of reproductive status, diets, and the growth and condition of seals during a period of significant ecological change.

A study on the impact of changing abundance and prey availability associated with climate change was published. While climate change has been shown to affect harp seals directly through increased mortality of young, it may also impact indirectly through changes in prey and subsequent reproductive rates. Over the past four decades, harp seals have also undergone a large change in abundance, increasing from approximately1.5 million seals in the early 1970s to 7.4 million seals today and, since 1987, late-term abortions have been observed. To determine the importance of biological and environmental factors influencing reproduction, pregnancy and abortion rates of harp seals were estimated from samples collected between 1954 and 2014 off Newfoundland, Canada. Since the early 1980s, late-term pregnancy rates among mature females have declined while interannual variability increased, ranging from 0.2 to 0.86. Analyses indicated that while the general decline in pregnancy was associated with increased population size, including the rate of late-term abortions captured much of the interannual variability. Changes in abortion rates were described by a model that incorporated capelin biomass and mid-winter ice cover (likely a proxy for ecosystem changes in overall prey abundance). Harp seals appear to respond to relatively small variations in environmental conditions when they are at high population levels. If the observed changes in climate continue, negative impacts on the Northwest Atlantic harp seal population will likely increase due to the predicted warming trend and associated reduction in ice cover.

Attendance and nursing patterns of harp seals were examined under varying environmental conditions to determine whether these patterns respond to changing weather conditions. The behaviour of females and pups off north- eastern Newfoundland was recorded during daylight hours. Air and water temperature, and wind speed were recorded at the beginning of each observation session. GAMM models were constructed to examine the importance of these variables in predicting attendance and nursing patterns. The best model for predicting attendance included time of day, air temperature, wind speed, and the interaction between wind and air temperature. The best model for predicting nursing included wind speed, air temperature and time of day. Females were more likely to attend their pups during the afternoon when solar radiation appeared to be high, but reduced attendance during high winds and/or low temperatures. The likelihood of attending females nursing during these poor weather conditions was greater than when conditions were better. Thus, females were less likely to be present when weather conditions were poor but when present, they were more likely to be provisioning their pups. This strategy may help these females defray the thermoregulatory demands on their limited resources while ensuring that their young attain weights that are likely to increase post-weaning survival and hence maternal fitness. It is likely that nursing and attendance patterns will change as global changes in the weather increase the frequency and severity of storms.

Reported Canadian commercial catches of harp and hooded seals		
Year	Harp	Hood
2003	289,512	151
2004	365,971	389
2005	329,829	28
2006	354,867	40
2007	224,745	17
2008	217,850	5
2009	76,668	10
2010	69,101	0
2011	40,393	2
2012	69,189	1
2013	90,703	0
2014	54,830	7
2015	35,304	1
2016	66,805	13

In the late summer and fall of 2016, DFO undertook a large-scale aerial survey of Canadian waters from the northern tip of Labrador in the north to the U.S. border in the south. This North Atlantic International Sightings Survey (NAISS), like DFO's 2007 TNASS survey, employed three fixed-wing aircraft flying at slow speed and 183 m altitude on transect lines from the coast to beyond the shelf break. Despite being hampered by poor weather during much of the survey period, most planned transects were flown. While analysis is underway, the number of sightings were greater than during the 2007 survey. White-beaked dolphins were the most commonly-sighted cetacean species in 2016, accounting for half of the sightings and almost 80% of the total number of animals around Newfoundland and Labrador. Many cetaceans were sighted on the Grand Banks and NAFO Regulatory areas, including at the edge of the shelf breaks.

The study examining the noise environment and marine mammal assemblages for candidate Valued Marine Ecosystems (VMEs) on the Grand Banks and NAFO Regulatory areas has continued, and now includes deployments on the southern Labrador Shelf. In cooperation with research partners in St. Pierre and Miquelon (France), DFO deployed AURAL autonomous acoustic recorders in multiple locations to 1) characterize the acoustic environment of several VME and/or LOMA sites, and 2) use these data to characterize ambient noise levels and identify which marine mammal species are associated with identified VMEs/LOMAs, some of which are listed under SARA. Analysis of the recordings is underway, and DFO researchers in Newfoundland and Labrador have been working with colleagues in other Atlantic Canadian DFO labs, and with a private firm (JASCO Ltd.) to coordinate acoustic collections and automate analyses. Further, an international effort with Canadian and American government, academic, and NGO researchers is underway to coordinate large-scale acoustic deployments in the western offshore and nearshore Atlantic in the next several years. There are seasonal and inter-annual variations in the species that have been detected; unusual results include detection of calling humpback whales off the coast of Labrador in the winter period, and species at risk such as blue and right whales off the southern Grand Banks of Newfoundland.

Predicted distribution of cetaceans in the northwest Atlantic Ocean - Using long-term sightings and environmental data from government, NGO, and industry sources, Species Distribution Models (SDM) were developed to predict suitable habitat for many of the cetacean species found in Atlantic Canadian waters and the NAFO Regulatory Area. For example, the most suitable habitat for blue whales was located primarily on the Scotian Shelf and along the southern Grand Banks. Highly suitable habitat for northern bottlenose whales was identified in areas along the edge of the Scotian, and Newfoundland and Labrador Shelves, submarine canyons, and deep basins. We interpreted suitable habitat as regions where cetacean monitoring efforts should be prioritized to determine if they are important areas for these species. The SDM results and tools as presented in this study are a timely component in the process of identifying human activities that may be contributing to the lack of recovery of these whales at risk in Canadian and international waters.

The abundance and distribution of marine mammal and sea turtle populations is influenced by a variety of factors, including resource availability, reproductive status, predator distribution, ice presence and structure, or more generally, mortality risks. Recently, anthropogenically-related, non-harvest removals are being considered for managed marine mammal populations worldwide; a high-profile recent example is the role of climate change as a population-level factor that might reduce carrying capacity and/or increase mortality. More "proximal" negative consequences could arise from industrial activities and associated noise, vessel strikes, or introduction of new predators or other invasive species. There is currently no internationally-accepted approach as to how impacts of marine development projects should be evaluated. DFO is developing a general assessment framework that could be used to quantify and cumulate risks of impacts on marine mammal and sea turtle populations associated with anthropogenic activities, while taking into account population conservation status and vulnerability, cumulative impacts from other stressors (such as climate change), and those associated with similar projects, expected susceptibility to stressors, and the expected efficacy of mitigation measures. This framework could be extended to encompass other types of marine species, anthropogenic activities, or stressors. DFO convened two international workshops to solicit expert assessment and garner the scientific support for the rationale behind the framework and integral thresholds, and the applicability of the framework in the legal and applied context that are typical of environmental impact assessments by developers and governmental agencies worldwide.

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. In 2010, COSEWIC designated Atlantic Salmon populations along southern Newfoundland (DU4) as threatened. As previous work had shown unusually high genetic differentiation throughout southern Newfoundland, the population structuring in the region was re-examined with extensive parr sampling (2008-2012) and both genetic and genomic analysis. Multivariate and Bayesian clustering support a hypothesis of two discrete groups with the dividing boundary located near the Burin Peninsula. Genomic analysis confirms that the groups represent populations that are both discrete and differ adaptively (relevant genes) and represent deep divergent lineages (mtDNA). Similarly, through collaboration with Dalhousie and Memorial Universities, genetic analysis is being used to explore population structure among salmon rivers within Labrador, specifically Lake Melville to assign individuals harvested within the lake back to their river of origin.

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

b) Sentinel Studies

The Sentinel Surveys, initiated in October 1994, were continued in 2016. Data collected were tabled at the Regional stock update in the spring of 2016 for Div. 2J3KL cod, and the 3Ps cod Regional Stock Assessment in October 2015. Sites in Div. 2J3KL, Subdiv. 3Ps and Div. 3Pn4Rs were sampled by inshore fish harvesters using traditional fishing gears based on historic fishing patterns. The objectives of the program are: to develop a reliable inshore catch rate, length frequencies, sex, maturity, and age series for use in resource assessment; to incorporate the knowledge of inshore fish harvesters in the process of resource assessment; to describe temporal and spatial inshore distributions; to establish a long-term physical oceanographic and environmental monitoring program of the inshore area; and to provide a source of biological material for other researchers for genetic, physiological, food and feeding, and toxicological analyses.

c) *Cod Tagging and Telemetry*

Ongoing tagging and telemetry studies on cod in Div. 2J3KL and conventional (Floy) tagging on cod in NAFO Subdiv. 3Ps were continued in 2016. There were 7, 057 (6,554 in Div. 2J3KL and the remainder in Subdiv. 3Ps) cod tagged and released with Floy tags; in addition, detections of acoustically tagged cod released inshore in 3KL during 2010-2016 were obtained from acoustic receivers. The receivers have been deployed along a 350 km area of the inshore since 2006 and additional receivers were deployed in the offshore during 2013 and retrieved in December 2014. The objectives were to obtain estimates of exploitation and to study migration patterns and survival rates. Among cod in Div. 2J3KL estimates of exploitation (harvest) rate were <6 % during 2011-2014 and continued to be low and averaged 4.4% in 2016. Among cod in Subdiv. 3Ps the exploitation rates in 2013 and 2014 were generally similar (10-16%) among cod tagged in Placentia Bay or Fortune Bay; the only exception was among the larger cod (> 65 cm) tagged in Fortune Bay where harvest rates were higher (21%-25%). Harvest rates in 3Psa (northwestern 3Ps) in 2014 were low (6%-8%) irrespective of cod size. The distribution of tag returns did not give any indication of significant exploitation of 3Ps cod in adjacent stock areas (3KL/3Pn-4R), although local movement of cod between 3Pn and adjacent areas in northwestern 3Ps, and between 3Ps and southern 3L, was evident.

Information from tagging was also used directly in a new integrated state-space assessment model for cod.

d) *Hydrographic Surveys*

The Canadian Hydrographic Service (CHS) conducted Revisory surveys in several areas of the island to update charts in production. Chart production is in progress 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.

New charts were released in the Trinity Bay area, (Subarea 4) and in the Voisey Bay area (Subarea 2).

Annual Sailing Directions Revisory Survey

The 2016 Sailing Direction Revisory survey gathered hydrographic data to revise and produce a New Edition of ATL 109, Gulf of St. Lawrence (Northeast Portion) and ATL 120, Labrador, Camp Islands to Hamilton Inlet (including Lake Melville). A New Edition of Sailing Directions ATL 121, Labrador, Hamilton Inlet to Cape Chidley (including Button Islands and Gray Strait) was published. A New Edition of Sailing Directions ATL 120, Labrador, Camp Islands to Hamilton Inlet (including Lake Melville) has publishing projected for 2017/18. A New Edition of Sailing Directions ATL 109, Gulf of St. Lawrence (Northeast Portion) has publishing projected for 2018/19.

An integral part of the Sailing Directions Revisory Survey is chart dealership inspections. These inspections assure that CHS chart dealers are selling the most recent edition of charts to clients, an important marine safety consideration. The inspections also provide an avenue to gather client feedback.

Three chart dealership inspections were conducted at locations within the Island portion of Newfoundland and Labrador.

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

REFERENCES

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.

Table 1. Summary of preliminary catches for stocks within the DFO, Newfoundland and Labrador Region, 2007-2016. Note that unless otherwise specified, this table presents Newfoundland and Labrador landings only.

Subarea	Species	Division	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
0+1	Greenland halibut	SA 0 + 1A(offshore)+ 1B-F	3589	4,012	3,568	3,747	3,571	3,871	3,862	3,363	3,348	3,742
	Shrimp*	0A										
		0B										
2	Cod	2GH	0	0	0	0	0	0	0	0	0	0
	Shrimp*	2G (SFA 4)	13,796	15,050	14,958	14,969	13,847	10,441	11,134	10,656	9,682	10,009
		2HJ (SFA 5)	18,203	20,282	21,748	22,317	24,529	25,264	21,425	25,094	20,503	23,768
		2J3K (SFA 6)	21,982	47,409	46,340	59,032	58,334	59,685	61,501	45,099	75,080	80,736
	Snow Crab	2HJ	1,700	1,769	1736	1392	1606	1933	2131	2387	2549	2523
	Iceland Scallop	2HJ	5	8	6	20	16	19	16	17	13	40
	Arctic Charr	2J3KLPs+4R	29	25	22	25	11	24	11	16	18	28
	Atlantic Salmon****		39	42	38	37	54	41	36	30	36	27
2+3	Redfish	2+3K	16	5	48	66	103	74	61	28	20	29
	Greenland halibut	2+3KLMNO	6089	6524	7223	6410	6176	6166	6529	5744	4701	5073
	American plaice	2+3K	1	4	9	100	11	18	22	10	10	23
	Witch	2J+3KL	53	187	178	182	94	143	160	45	5	22
	Cod*****	2J3KL	9911	4314	4583	4299	3305	3139	2902	3098	3343	2546
	Grenadier	2+3	0	1	5	11	28	113	41	13	10	38
	Capelin	2J3KL (offshore)	0	0	0	0	0	0	0	0	0	0
	Squid	2+3	104	0	0	0	17	90	100	643	516	228
3	Redfish	3LN	3005	4139	1446	2730	920	1960	113	6	1	3
		3M	0	0	0	0	0	2	0		0	0
		3O	21	31	34	0	0	97	42	255	202	1054
	Yellowtail	3LNO	6248	5442	6800	7920	1795	3947	8056	5414	10216	3674
	American plaice	3LNO	750	436	748	1041	267	450	1154	1077	878	434
		3Ps	168	100	46	96	140	279	402	509	456	460

	Witch flounder	3NO	798	222	9	62	3	11	39	41	46	21
		3Ps	479	343	144	226	235	175	446	454	298	110
	Atlantic halibut	3	519	361	570	400	364	270	321	289	287	170
	Cod	3NO	136	130	187	223	25	39	103	158	231	123
		3Ps	4964	4961	4378	3058	4254	5424	6737	7491	9636	10,599
	Haddock	3LNO	186	62	10	13	4	42	27	104	60	30
		3Ps	224	167	189	69	101	88	129	173	288	302
	Pollock	3Ps	357	190	305	148	335	186	319	287	616	1,042
	White hake***	3NOPs	363	205	397	301	264	239	559	748	1383	1,680
	Thorny skate***	3LNOPs	192	169	388	294	531	467	604	1334	1452	1639
	Capelin	3L	8890	11,380	9,808	12,423	11,645	12,023	11,927	13,326	15,176	16,321
		3K	16,619	13,640	13,365	11,332	10,672	8,081	3,544	9,853	13,043	13,036
	Shrimp*	3M	0	0	0	0	0	0	0	0	0	0
		3L	0	0	1,769	6,119	8,019	9,276	13,535	20,494	21,187	18,316
	Sea scallop	3KLNO	3	0	0	0	0	0	27	0	0	9
		3Ps	883	1,126	1158	1071	1,190	920	842	432	293	359
	Iceland scallop	3LNO			0	0	11	0	0	0	1	0
		3Ps	368	45	1	4	2	0	0	2	5	6
	Snow Crab	3K	5550	7182	7828	8519	8390	10,744	12,420	16,184	15,068	12,270
		3LNO	32,316	37,159	34,499	33,892	33,511	32,914	31,419	29,033	30,248	30,895
		3Psn	1188	2540	4904	6047	6225	6716	6026	5559	4523	3947
	Lobster	3K	76	121	50	63	66	61	96	107	134	120
		3L	92	113	81	81	84	75	111	98	109	83
		3Ps	1199	1100	940	1048	952	917	1228	1071	1171	1010
		3Pn	157	150	161	138	164	112	139	127	153	94
	Atlantic salmon**	2J3KLPs+4R	49	46	37	48	39	48	51	41	50	29

3+4	Redfish	3P+4V	372	71	533	192	295	907	2275	2265	1217	1402
4	Iceland scallop	4R	192	200	310	378	295	431	244	246	121	284
	Sea scallop	4R	7	4	6	42	66	48	27	15	0	0
	Lobster	4R	1354	1260	906	873	857	769	1022	1096	1404	1260
	Snow Crab	4R	694	776	850	891	742	596	188	268	365	558

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 3, 2017, 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 2009-2014

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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 and 15 million for enforcement 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 four main components of the science program include:

Science in support of straddling stocks and highly migratory species,

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…), Ocean variability and marine ecosystems, and program coordination and enabling functions.

The following tables outline those IGS activities of interest to NAFO that were completed 2016/17, as well as those currently underway for 2017/18.

List of IGS Activities 2016-17 and 2017-18	
Project Leader(s)	Title
I. Bradbury	Genetic determination of catch composition and stock exploitation of Atlantic salmon harvested in mixed stock fisheries in the northwest Atlantic
I. Bradbury	Temporal evaluation of regional contributions to Northwest Atlantic mixed stock Atlantic salmon fisheries
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
P. Ouellet	Assessing the response of Northern shrimp (Pandalus borealis) populations to Climate Change and Variability
R. Rideout	A detailed examination of cod spawning in NAFO Subdivision 3Ps and a review of the use of spawning closures as a tool for the management of fish stocks.
P. Pepin /M. Koen-Alonso	Linking Bottom-up Projections of Ecosystem Production Potential for the Newfoundland and Labrador Shelves and Grand Banks with Environmental Drivers
M. Koen-Alonso	Multispecies dynamics in Northwest Atlantic marine ecosystems: Towards practical tools for multispecies management decisions.
K. Azetzu-Scott	Ocean Acidification in the Arctic: drivers and impacts.
E. Head	Ecosystem monitoring in the Northwest Atlantic using the continuous plankton recorder
E. Kenchington/ K. Gilkinson/ V. Wareham	Identification and Mapping through Predictive Modelling of Coldwater Coral and Sponge Species in the Sub-Arctic/Eastern Arctic
Koen-Alonso/Pepin	Making the NAFO Roadmap for an Ecosystem Approach to Fisheries (EAF) operational: Incorporating ecosystem and multispecies information into fisheries management advice
E. Edinger/ K. Gilkinson/ V. Wareham	Biodiversity and Distributions of Corals and Sponges in the Eastern Canadian Arctic: Targeted Field Surveys and Sampling of Inaccessible and Previously Unfished Habitats using a Remotely Operated Vehicle.
K. Gilkinson/ E. Kenchington/ V. Wareham	Collection of In Situ Baseline Data on Sea Pen and Non-coral and Sponge VME in the NAFO Regulatory Area for Future Evaluation of Protection Measures
N. Ollerhead	Spatial analysis of commercial fishing effort and its relationship to Vulnerable Marine Ecosystems (VMEs) in Newfoundland-Labrador waters.