Northwest Atlantic Fisheries Organization

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Canadian Research Report for 2015 Newfoundland and Labrador Region

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SUBAREAS 0 AND 1

A. STATUS OF FISHERIES

Nominal landings from 2006 to 2015 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 2014, Scientific Council advised to maintain the TAC from at 16,000 t for 2015 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 2006 catch has fluctuated between 3,400 t to 4,000 t. Overall, catch by gear and by month remained about the same in 2015. The catch was approximately 4,000 t in 2015 and about equally split between otter trawlers (239 t with single trawls and 1,776 t with twin trawls) and gillnets (1,996 t).The fisheries occurred from July to September with about a third of the catch being taken in July.

SUBAREA 2

A. STATUS OF FISHERIES

Nominal landings from 2006 to 2015 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 2015 preliminary recreational catch, including retained and hooked-and-released fish, was 6,137 salmon, 17% less than the previous 6 year mean (2009-2014). Preliminary subsistence fisheries catches of Atlantic Salmon for 2015 were 42 t, which is the largest harvest by weight since 2000. There has been a general increasing trend in subsistence fishery harvests since 2000 from 16 t to 42 t, averaging 38 t per year from 2000–2015.

Three of the four assessed rivers in Subarea 2 achieved conservation spawning requirement in 2015. The number of large salmon returning to Labrador rivers continues to vary annually, however, large returns in 2015 increased relative to 2014 and were above the previous 6 year mean (2009-2014).

b) Arctic Charr–Subarea 2

Commercial landings of Arctic Charr from north Labrador in 2015 were approximately 25 t and about 14% higher than 2014 and similar to landings in 2013. This is equivalent to almost 15 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). There is interest in expanding the commercial fishery by as much 50%. In addition to the commercial fishery, estimates of subsistence fishery catches show upwards of 10,000 Charr may be caught annually with an annual average during the past 10 years of approximately 6500 fish.

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. By-catch 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 (Div. 2J+3KL) cod stock was closed to directed commercial fishing in 1992. A small directed commercial fishery was reopened in the inshore only during 1998-2002 with annual catches ranging from 4,200 to 8,500 t. In April 2003 the whole stock area was closed indefinitely to directed commercial and recreational fishing. Monitoring by means of limited fishing by a small number of fish harvesters at specific sites (sentinel surveys) continues. Most of the catch from 2003-05, which ranged from about 600 t to 1,300 t, was bycatch from the gillnet fishery for Winter Flounder in shallow inshore waters (<25 fathoms).

During 2006-15, a pilot-scale inshore stewardship fishery was open. Fishers were each permitted to harvest an annual amount ranging from 3,000-3,750 lb of cod during 2006-2012 and this was increased to 5,000 lb during 2013 2015. There was also a recreational fishery that was open for a few weeks during summer and fall and fishers were allowed 5 fish per trip or 15 fish per boat per day. Total reported landings ranged from 2,500 t to 4,400 t during 2006-14. There was no direct estimate of recreational fishery landings for 2007, 2009-10, and 2013-2015; however, analysis of tag returns suggests that removals from recreational landings were on average 30 % of reported stewardship fishery removals during those years. In 2015, reported landings were 4,436 t which included 4,071 t in the stewardship fishery, 268 t in the sentinel surveys, and 97 t taken as bycatch. The offshore portion of the stock area has remained under moratorium since 1992.

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. This 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) survey. 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 2010-15. 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 2015, the total reported landings of American Plaice were between 4-23 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

This stock has been under moratorium to directed fishing in the Canadian Exclusive Economic Zone (EEZ) since 1997 although there had not been a persistent directed effort on this stock since 1990, when 2,400 t was landed. Canadian (NL) landings were between 22-221 t for the period 2005-2015 with the 2015 catch at 56 t exclusively from 3K. Canadian (NL) landings since the moratorium in the Canadian EEZ are bycatch primarily from Greenland halibut fisheries. 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 2014 (<10 t). It is assumed increased catches in the NRA were from the pelagic stock of redfish that resides primarily in the Irminger Sea between Greenland and Iceland.

Based on observer data, estimates of redfish bycatch discarded from Canadian Shrimp fisheries in the Div. 2G to Div. 3K area since 1980 have ranged from 14 t in 1983 to 665 t in 1990. There has been a steady increase in discards from 260 t in 2004 to a peak of 460 t in 2006 followed by a decline to 65 t in 2009 (Orr et al. 2010). More recent data have not been compiled.

f) Witch Flounder-Divisions 2J3KL

There has been no directed fishing on this stock since 1994. In 2015, bycatch in other fisheries from the Newfoundland and Labrador Region was 187 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 2015 in Subarea 2 and Div. 3KLMNO was approximately 6,524 t.

In September 2003 at its annual meeting, the Fisheries Commission implemented a fifteen year rebuilding plan for this stock. In September 2010, following the recommendations of the Working Group on Greenland Halibut Management Strategy Evaluation (WGMSE), the Fisheries Commission adopted a harvest control rule which used trend information from various surveys to determine the TACs for each of 2011-2014. This management approach has been extended to 2017. A Management Strategy re-evaluation is scheduled to occur prior to the setting of a TAC in 2018.

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. The last formal assessment was completed during April, 2016 after the interim monitoring report showed significant reductions in resource status in SFA. The next formal assessment is scheduled to be completed during February 2017.

The regional Composite Climate Index declined for the fifth year in a row to seventh lowest in 66 years, indicating a continued regional cooling trend since 2010 which is a departure from broader warmer-than-average conditions across the north Atlantic. As in 2014, the seasonal cycle of surface sea temperature was characterized by a colder than average spring which, combined with a delayed retreat of sea ice, resulted in later than average onset of the spring phytoplankton bloom. This may lead to stronger shrimp productivity in the medium term. Fall bottom temperatures in SFA 6 were above normal, resulting in near normal and above normal areas of the potential thermal habitat for shrimp in Northwest Atlantic Fisheries Organization (NAFO) Divisions 2J and 3K, respectively.

Environmental forcing, predation and fishing are correlated with subsequent shrimp production. The build-up of shrimp until the mid-2000s occurred during a period with a combination of favorable 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 recent decline. However, recent departures in environmental conditions from the decadal trend may lead to increased shrimp per-capita production over the medium term but are unlikely to trigger a rapid rebuilding of the resource.

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. In 1998, 2,184 t of the TAC was allocated to the area south of 60°N to promote spatial expansion of the fishery. The 2003 TAC was increased to 10,320 t. In 2003 the management year changed from January 1-December 31 to April 1-March 31, and an additional interim quota of

2,802 t was set for the period January 1-March 31, 2004. The 10,320 t TAC was maintained through to 2007/08. By 2009/10, the regulations were changed such that the vessels no longer had to fish a portion of their catch in southern SFA 4. The TAC was set at 11,320 t for the 2008/09 to 2010/11 management years and increased to 13,018 t in 2012/13. In 2013/14 until 2015/16, the TAC was set at 14,971 t. Commercial catch increased from approximately 10,000 t from 2005/06-2011/12 to about 15,000 t in the past three years. While the fishery is open year round, ice conditions in SFA 4 typically only allow access from early summer to late fall or early winter.

Large-vessel standardized CPUE fluctuated without trend near the long term mean. The fishable biomass index varied without trend from 2005 to 2015 with the 2015 point estimate at 91,000 t, which represents a decrease of 13% from 2014. The female SSB index for 2015 was 58,000 t, representing a decrease of 18% from 2014. The exploitation rate index reached 16.5% by 2015/16. Female SSB index in 2015 was in the Healthy Zone within the IFMP PA Framework with a 40% 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. Commercial catch has been about 23,000 t over the past five years. It is expected that the 2015/16 TAC of 23,300 t will be taken.

Standardized large-vessel CPUE over the last four years has been stable at high levels. Fishable biomass index has been relatively stable since 2010, and was 148,000 t in 2015. Female SSB index has changed little since 2010, and was 83,000 t in 2015. The exploitation rate index has varied without trend around 15% from 1997-2015/16. Female SSB index is in the Healthy Zone within the IFMP PA Framework. If the 23,300 t TAC is maintained and taken in 2016/17, then the exploitation rate index will be 16%.

SFA 6 (HAWKE CHANNEL + NAFO DIVISION 3K)

The TAC was set at 11,050 t in 1994 and increased to 23,125 t in 1997 as a first step towards increasing the exploitation of an abundant resource. Most of the increase was reserved for development of the small vessel fleet. The TAC more than doubled between 1997 and 1999, increased to 61,632 t in 2002 and then to 77,932 t in 2003. An additional interim quota of 7,653 t was set for the fishing season January 1, 2003-March 31, 2004. Thus the 2003/04 management period was fifteen months long and had an 85,585 t TAC. As a result of the seasonal bridging program, the 77,932 t TAC for 2007/08 was increased by 2,000 t. The TAC was increased to 85,725 t in 2008/09 and maintained through 2009/10. The 2010/11 TAC was reduced to 61,632 t and further to 52,387 t in 2011/12. Resource status improved during 2011 and subsequently the TAC for 2012/13 was increased to 60,245 t and maintained through 2013/14. The TAC was reduced in 2014/15 to 48,196 t and remained at that level in 2015/16. Commercial catch has been about 50,000 t over the past two years. It is expected that the 2015/16 TAC of 48,196 t will be taken.

Large and small-vessel standardized CPUE have varied without trend since 2010 around the long-term mean. Fishable biomass index declined from 785,000 t in 2006 to 138,000 t in 2015 which is the lowest in the time series. There was a 41% decline between 2014 and 2015. Female spawning

stock biomass (SSB) index declined from 466,000 t in 2006 to 89,000 t in 2015 which is the lowest in the time series. There was a 35% decline between 2014 and 2015. The exploitation rate index ranged between 5.5% and 21.4% from 1997 to 2015/16, and has averaged 18.3% in the last five years. The 2015/16 exploitation rate index will be 20.7% if the TAC is taken. The female SSB index is currently close to the limit reference point (LRP), in the Cautious Zone of the Integrated Fisheries Management Plan (IFMP) PA Framework, with a 20% probability that it is in the Critical Zone. If the 48,196 t TAC is maintained and taken in the 2016/17 season, the exploitation rate index will be 34.9%.

i) Snow Crab–Divisions 2HJ

Most of the landings are derived from Div. 2J in all years. Landings have remained relatively low at less than 2,000 t since 2011. Meanwhile, effort has been substantially reduced and been at its lowest level during the past three years. CPUE has increased throughout the division since 2012. The trawl and CPS trap survey-based exploitable biomass indices both increased sharply in 2014. The trawl index returned to a relatively low level in 2015 but the CPS trap survey index suggests the biomass remains unchanged on primary fishing grounds. Recruitment increased sharply to a recent high in 2014 but subsequently decreased to a relatively low level in both the trap and trawl surveys in 2015. Short-term **recruitment** prospects appear poor. With the exception of 2014 the pre-recruit biomass index has been relatively low in recent years and was at its lowest level in 2015. The thermal habitat index suggests further deterioration of recruitment potential over the next 2-3 years. The pre-recruit fishing mortality index was very low in 2015. The exploitation rate index peaked in 2012 but since decreased to about its lowest level in 2015. Status quo removals in 2016 would once again increase the index to a level similar to recent norms. Status quo removals in 2016 would once again increase the exploitation rate index to a level similar to recent norms.

j) Iceland Scallop–Divisions 2HJ

Inshore aggregations were fished in 2009, 2010, 2011, 2012, 2013, 2014 and 2015 with nominal catches estimated at 17 t ,16 t, 19 t,16 t, 20 t, 6 t and 8 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 2015 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 53 successful sets were conducted in Div. 2H between 90m-489m and 114 sets in 2J between 116m – 1418m. Only the deep water in Div. 2H (>750m) was not covered. 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, 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) 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 Div. 2H in the summers of 2009, 2010 and 2012-2014. 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 Div. 2H. The fixed-station survey covered the area between the Makkovik and Nain Banks using commercial crab gear. Small-meshed pots were also incorporated into the study to capture females and small males. Since 2007, a similar study but of broader scale was conducted in Div. 2HJ..

d) Atlantic Salmon

The stock composition of Atlantic Salmon harvested in three fisheries in the northwest Atlantic was quantified using genetic mixture analysis and individual assignment with a microsatellite baseline (15 loci, 12409 individuals, 12 regional groups) encompassing the species western Atlantic range. A total of 353 individuals collected from the Saint Pierre and Miquelon fishery (2004, 2011-2014) were analyzed and estimates of stock composition showed consistent dominance of three regions, Gulf of St. Lawrence, Gaspe Peninsula, and Newfoundland. Together these account for > 70 % of annual harvest and this was stable over the decade examined. In the West Greenland harvest, we analysed 2336 individuals from 2011-2014 of which 342 were identified as European in origin. North American contributions were largely from Labrador, the Gulf of St. Lawrence, and the Gaspe Peninsula. Preliminary comparison with historical samples (1968, 1978, 1988, and 1998) again suggests stability in the dominance of these groups. No evidence of spatial or temporal trends in mixture composition was apparent. Finally a total of 771 individuals were analyzed from the Labrador aboriginal food, social and ceremonial (FSC) fishery during the period 2012-2014. In contrast to the other fisheries, here the mixture estimates suggest the harvest is dominated by a single region with ~95% of the catch originating from central Labrador. Minor components were also allocated to Northern Labrador / Ungava and Newfoundland (<4 %). Again this is consistent with previous analysis conducted for the period 2006-2011 which estimated 96.0% of the harvest originating from central Labrador. Regional and size group comparisons of stock composition indicated elevated contributions of central Labrador in Salmon Fishing Area (SFA) 1B (4-7%) and in small salmon (~8%).

SUBAREA 3

A. STATUS OF FISHERIES

Nominal landings from 2006 to 2015 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 2015 preliminary recreational harvest, including retained and hooked-and-released fish, was 30,779 salmon, 6 % less than the previous 5 year mean (2009-2013).

Five of the ten assessed rivers in Subarea 3 achieved conservation spawning requirement in 2015. 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 2014 and 2015 were 23,173 t and 25,020 t, respectively, against a Total Allowable Catch (TAC) in Div. 2J3KL of 22,771 t in 2014 and 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 March 2016 a capelin update was provided as information to the Northern cod assessment process. This update included only data from the 3L acoustic survey and Trinity Bay larval indices. The acoustic abundance has fluctuated markedly over time from a peak of 6 million tons in the late 1990s to a low of 25000 tonnes in 2010. In the last three years the index has shown 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. Current age 2 abundance suggests that age 3 capelin in 2016 will be maintained at recent levels or lower. This 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 last two years, similar to patterns common in the 2000s. The fall distribution of capelin also changed in 2015 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 both 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 have increased in the last two years, which is consistent with observed improvements in Capelin abundance indices.

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 2015. 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 2004-2015. The provisional 2015 value reported to NAFO based on monthly catch reports is 567 t. Canada (NL) landings ranged from 444 t to 818 t between 2002-2005, and from 26 t to 247 t between 2006-2015. Canadian catches in 2015 totalled 151 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 2014/15 was set at 13,225 t. Total landings for 2014/15 totalled 7,166 t, marking the seventh consecutive year that the TAC has not been taken. Reasons given for not taking the complete TAC have included economic factors and reduced cod availability. The majority of recent catches are taken by fixed gear (gillnet and line-trawl).

The 2015 assessment of 3Ps Cod indicated that the stock has declined since 2012 and is currently estimated to be 41% above the limit reference point since 2009 and is currently estimated to be 60 % above the limit reference point (BRecovery). The probability of being below the LRP in 2015 is low (p=0.05).

d) American Plaice-Subdivision 3Ps

Can (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. The status of this stock was last updated in 2014 with data to 2013. Biomass in 2013 is estimated to be 60 % below Blim (40% BMSY) and therefore the stock is in the Critical Zone. The probability of being below Blim is high (0.97). Current median fishing mortality is estimated to be 20% of Flim and the probability of being above Flim (FMSY) is low (0.05). Although fishing mortality is low, the stock has declined since 2010. Projections of stock size were conducted under current productivity conditions at various catch levels from 2014 to 2016. Five scenarios were considered (zero catch, current catch, current catch + 15 % and current F). Although there was growth under all scenarios, the stock remained well below Blim in all cases. Additional projections determined that annual catches of 1,000 t or more will result in stock decline.

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 3 years with the 2015 catch at 343 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 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 2015 was 5,442 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 2015 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 plaice, primarily from thethe Can(NL) yellowtail fishery, decreased in the past three years from 1, 041 t in 2013 to 436 t in 2015. The majority of bycatch for other countries was taken in the NAFO regulatory area (NRA) in the skate, redfish and Greenland halibut fisheries.

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 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 2015, whereas Canadian catches have averaged 3, 775 t from 2010-2015. Industry reports that limitations in market conditions and management measures had a major effect on catches. The Can (NL) catch in UNIT 2 declined from about 2,300 t in 2010 to 71 t in 2015.. 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 2014 and only 31 t in 2015. 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 fishery yielded an average of 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 from 113 t in 2010 to 4,139t in 2015

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. The 2015 Canadian catch was 223 t from a Canadian TAC of 600 t. Canada (NL) bycatch has ranged between 2 t and 94 t with an average of 38 t from 2001 to 2014. There were signs of improvement in stock status, based on the increases in Canadian survey indices from 2010 to 2013, however survey indices have trended downwards in 2014 and 2015.

In 2015 a surplus production model in a Bayesian framework was accepted by the NAFO SC and utilized for the assessment of 3NO witch flounder. The surplus production model results indicated that stock size decreased from the late 1960s to the early 1990s and has increased since the late 1990s. The model suggests that a maximum sustainable yield (*MSY*) of 3 760 (2965-4820) tons can be produced by a total stock biomass of 59 680 (44 600-73 700) tons (B_{msy}) at a fishing mortality rate (F_{msy}) of 0.06 (0.05-0.09).

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 were 521 t during the period 2009-2013. Preliminary 2015 Canadian landings for NAFO Div. 3NO and Subdiv. 3Ps are 205 t. The current TAC for White Hake in 3NO for 2014 is 1,000 t, although inseason adjustments are possible for this stock.

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) 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 2013-16. The TAC for Subdiv. 3Ps in the EEZ was maintained at 1,050 t by Canada.

Average STATLANT landings for 2009-13 were 5,047 t in NAFO Divisions 3LNO, and 431 t in Subdivision 3Ps. Preliminary Canadian landings for 2015 are 3 t in NAFO Divisions 3LNO, and 166 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 2013-2015 annual Fishery Commission meetings, the 2014 TAC being was at 4,300 t, and no directed fishing was permitted for 2015-2016, during the 2013 and 2014 Fishery Commission meetings. Preliminary catch records, as of August 2015, confirm that no fishing had taken place in 2015. 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 90% from 2007 to 2014 while the autumn SSB index decreased by 94% from 2007 to 2014. The autumn 2014 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. 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 since 2007 to 2013, even though catches were decreasing during this period, but dropped drastically in 2014.

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

In Div. 3K, landings declined by 52% since 2008 to 7,200 t in 2015, their lowest level in two decades. Meanwhile, effort has declined by 35% and been near its lowest level for the past three years. CPUE declined by 55% from 2008 to 2011 and has since changed little, remaining near a historic low and reflecting trends throughout most of the division. The post-season trawl and trap survey exploitable biomass indices both declined since 2008 to their lowest observed levels. Both indices decreased by a third from 2014 to 2015, reflecting decreases throughout the division. Recruitment is at or near time series' lows throughout the division. Recruitment is expected to decline further in the short term with all trawl and trap pre-recruit indices near historical lows during the past three years. The thermal habitat index suggests further deterioration of recruitment potential over the next 2-3 years. The pre-recruit fishing mortality index was relatively low from 2005-2013 but has since increased to a recent high. The exploitation rate index was about average during 2014 and 2015. Maintaining the current level of removals would increase the exploitation rate in all management areas in 2016 with the overall trawl survey exploitation rate index increasing to its highest level in a decade and second highest level in the time series. Maintaining the current level of removals would increase the exploitation rate in all management areas in 2016 with the overall trawl survey exploitation rate index increasing to its highest level in a decade and second highest level in the time series.

In Div. 3LNO offshore, landings increased gradually since 2009 to a historic high of 28,750 t in 2015. Effort declined considerably from 2011-2013 but increased slightly in the past two years. Overall CPUE most recently peaked in 2013. It declined slightly in the past two years but remains high. The trawl survey of exploitable biomass shows the resource has become increasingly localized into portions of Division 3L, with the biomass index at its lowest observed level in 2015. The CPS trap survey index suggests the density of exploitable crabs remains unchanged on the primary fishing grounds. Overall recruitment has declined since 2012 to be near its lowest level, reflecting trends throughout most of the division. Recruitment is expected to decline further in the short term (2-3 years). The trawl survey pre-recruit biomass index has steadily declined since 2009 to a historic low while the CPS trap survey index is at or near its lowest observed level in most surveyed areas. The pre-recruit fishing mortality index has remained relatively low since 2008 while the exploitation rate index changed little from 2010-2014. Maintaining the current level of fishery removals would substantially increase the trawl survey exploitation rate index to a new high in 2016. Maintaining the current level of fishery removals would substantially increase the trawl survey exploitation rate index to a new high in 2016.

In Div. 3L inshore, landings increased gradually since 2012 to a historic high of 8,400 t in 2015 while effort changed little. Overall CPUE has been near its highest level for the past four years. This reflects trends in CMAs 6A, 6B, and 6C, while other CMAs have been declining during the past two years. The overall post-season trap survey exploitable biomass index increased steadily from 2011-2014 to its highest levels in the time series. However, it decreased in all areas in 2015 and returned to the 2011 level. Overall recruitment has declined gradually since 2010 to its lowest observed level. Recruitment is expected to decline further in the short-term (2-3 years). Pre-recruit biomass surveys from CPS and DFO trap surveys throughout the division have been at or near their lowest levels in a decade during the past two years. The overall post-season trap survey-based exploitation rate index changed little from 2005-2015. Maintaining the current level of fishery removals would increase the exploitation rate index in all areas in 2016.

In Subdiv. 3Ps landings declined from a recent peak of 6,700 t in 2011 to 2,500 t in 2015. Effort reached a historic high in 2014 and decreased slightly in 2015, when only 60% of the TAC was taken. CPUE has steadily declined since 2009 to a record low in 2015, reflecting declines throughout the division in recent years. The trawl survey exploitable biomass index declined by 78% since 2009 to a time series low in 2015. The CPS trap survey was not conducted in most areas

in 2015 due to poor resource status, thus no biomass index is available from that survey. 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 trawl survey pre-recruit biomass index has been at its lowest levels for three consecutive years. The pre-recruit fishing mortality index and the exploitation rate index have both been at or near their highest observed levels during the past three years. Maintaining the current level of fishery removals would result in a continued high exploitation rate in 2016.

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 2015. 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, removals were 45 t, the highest since 2004. In 2013 there was 4 t and in 2014 there was 1 t of Iceland Scallop removals, in 2012 there was 2 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. 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 has been no reported landings since 2012.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Physical oceanographic observations are routinely collected during marine resource assessment and research surveys in the Newfoundland and Labrador Region. The Atlantic Zonal monitoring program (AZMP) initiated in 1998 continued during 2015 with three physical and biological oceanographic offshore surveys carried out along several cross-shelf NAFO and AZMP sections from the Southeast Grand Bank to Makkovik Bank on the mid- Labrador Shelf. The first was conducted on the CCGS Teleost from April 10 to 27, 2015. The second survey on CCGS Teleost took place from July 9-27, 2015 and the last on CCGS Hudson from November 15 to December 6, 2015. 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 2015 in NAFO Div. 2J and 3KLNOP. The results were based on physical observations collected on the NL Shelf from Makkovik Bank to the Southern Grand Bank and on St. Pierre Bank from the AZMP and fisheries assessment surveys.

Annual sea-surface temperatures (SST) in 2015 based on infrared satellite imagery across the Newfoundland and Labrador Shelves ranged from about normal in some areas to as low as 1.5 SD below normal some offshore regions. The annual bottom (176 m) water temperature and salinity at the inshore monitoring station (Station 27) was below normal in 2015 by -0.7 and -1.4 standard deviations (SD), respectively. The cold-intermediate layer (CIL; volume of <0°C) in both 2014 and 2015 was at its highest level since 1985 on the Grand Bank during the spring. During the summer, the CIL remained slightly above normal but by late fall it had eroded to below normal values off eastern Newfoundland and completely eroded off southern Labrador. Spring bottom temperatures in 3Ps remained above normal by about 0.5oC (0.8 SD) and about normal on the Grand Banks. Fall bottom

temperatures in 2J, 3K and 3LNO decreased from 2, 2.7, and 1.8 SD above normal in 2011 to 0.2 and 0.8 SD above normal in 2J and 3K and to -0.4 SD below normal in 3LNO in 2015, a significant decrease in the past 4 years.

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 above normal in northern Labrador but substantially weaker on the Grand Bank in 2015. The timing of the spring bloom was earlier in northern Labrador but delayed along the northeast Shelf and Grand Bank in 2015. The bloom was generally shorter than normal throughout most of the Zone in 2015, continuing a general pattern observed in recent years.

The abundance levels of different functional mesozooplankton taxa varied across the AZMP Sections in 2015. The zooplankton abundance anomalies for a key small grazer and dominant copepod, *Pseudocalanus spp*., were substantially higher again in 2015 similar to the pattern observed in the previous year with the largest changes observed over the Flemish Cap (3LM). These small epipelagic, subarctic copepods represent an important preferred prey to many early life stages of gadoid fish and invertebrates. In contrast, the abundance of a dominant large grazing copepod (*Calanus finmarchicus*) were again lower throughout the Newfoundland and Labrador Shelves in 2015. In general, the total number of copepod taxa increased from 2013 levels with larger proportions of smaller subarctic and temperate taxa in 2015. The non-copepod taxa, characterized by carnivorous zooplankton, gelatinous invertebrates, and meroplankton, have increased substantially in recent years throughout the Grand Bank and northeast Newfoundland and Labrador Shelves.

2. Biological Studies

a) Multispecies Trawl Surveys

Biological and oceanographic data from fall (Div. 3KL) and spring (3LNOP) multi-species research vessel surveys were collected in 2015 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 2015, the annual spring survey completed a total of successful 56 sets in 3L (65m-685m), 72 in 3N (39m-674m), 74 in 3O (63m-678m) and 173 in 3Ps (38m-667m). During the fall survey, a total of 151 successful sets were conducted in Div. 3K between 134m-1408m and 142 sets in 3L between 116m – 1418m. Coverage of the spring survey was severely reduced in 3L due primarily to mechanical issues

with the CCGS Alfred Needler. 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. An ongoing offshore acoustic survey initiated in the spring of 1999 to monitor Capelin distribution, behaviour, and feeding habits in Div. 3L continued in 2015. Inshore surveys were conducted in August and in September of 2015 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 is 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. Preliminary analyses have also been carried out to examine the utility of angling data to infer trends in abundance of salmon across various spatial scales (e.g. regional versus individual). Frequent closures of angling fisheries owing to environmental reasons, changes in seasonal or daily bag limits, and the promotion of catch-and-release fisheries can all influence the interpretation of angling data to infer abundance trends.

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 Charbot 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 2015. 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 in NL Snow Crab. A similar survey was initiated in Fortune Bay (3Ps) in 2007 and was continued in 2015. Similar surveys were initiated in Trinity Bay and St. Mary's Bay in 2013 and continued in 2015.

A post-season trap survey, conducted by Snow Crab harvesters, which began throughout most of 2J3KLNOPs in 2004 was continued in 2015 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 8-year period (2008-2015). 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 2005 to 2015 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 2015 recreational harvest, including retained and hooked-and-released fish, was 20,315 salmon, 11% greater than the previous 5 year mean (2009-2013).

All three of the assessed rivers in Subarea 4 achieved conservation spawning requirement in 2015.

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 remained near its highest observed level in the past four years but there is considerable variability among management areas. The post-season trap survey exploitable biomass index has been unchanged for the past three years. Overall recruitment has been low for the past two years. Recruitment prospects appear relatively weak for the next 2-3 years. The CPS trap survey pre-recruit index has been relatively low since 2012. The post-season trap survey-based exploitation rate index has varied since 2005 and was about average in 2015. Maintaining the current level of fishery removals would result in little change to the exploitation rate index in 2016.

c) Iceland Scallops–Div. 4R

The nominal catch from the Strait of Belle Isle (Div. 4R) in . 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 2015, landings again decreased, to 200 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 in 2010, 2011, 2012, 2013, 2014 and 2014 2015 were 27 t, 48 t, 66 t, 2 t, 6 t and 6 4 t (round) respectively.

SUBAREA 2 + 3 + 4

A. STATUS OF FISHERIES

Nominal landings from 2005 to 2015 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 31 % from 2008 to 2012 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 (2004-2013) and mandatory DFO logbooks (2010-2012) CPUE (number of lobster caught/number of traps hauled) has increased gradually over the last decade.

b) Marine Mammals

An 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. Multi-disciplinary studies on Harp and Hooded Seal population dynamics, seal-fisheries interactions, and the impact of climate change continued in 2015.

The population model used to estimate total abundance of Northwest Atlantic harp seals was reviewed and published in the primary scientific literature Harp seals require pack ice as a platform for resting, to give birth and nurse their young. They are also subject to commercial and subsistence

harvesting. In the late 1990's there were concerns that the Northwest Atlantic population would decline to very low levels unless a management system using Potential Biological Removals (PBR) was adopted. Canada followed a different approach and high harvests based on an alternative management framework continued throughout the next decade. We examined the status of the Northwest Atlantic harp seal population using a three-parameter population model that incorporates information on reproductive rates, removals, and ice-related mortality acting on young of the year. By 1971, the population had declined to a minimum of 1.1 million animals and a quota was introduced, which allowed the population to increase. In 1996, the quota was raised and harvests increased substantially. Population growth continued, even as herd productivity declined. The population reached a maximum of 7.8 million animals in 2008 and has leveled off at around 7.4 mil- lion animals. Climate change is expected to result in a decline in the amount of seasonal pack ice in Atlantic Canada, which adds uncertainty to the future of this population. Although the results presented in this paper focused on how the status of this population has evolved over the last 60 years, our integrated modeling approach can also be used to examine scenarios that project into the future, to test the impacts of various management decisions in a changing environment.

A genomic study to determine stock structure of North Atlantic harp seals was carried out using the complete gene sequence of mitochondrial DNA. Harp seals have historically been separated into 3 putative populations based upon their whelping locations, the White Sea Barents Sea, the Greenland Sea and the Northwest Atlantic. The latter population is considered to have two whelping locations, one being off northeast Newfoundland and southern Labrador ('The Front') and the other in the Gulf of St Lawrence. DNA sequencing on microarrays was used to obtain complete genomes of more than 50 Harp Seals. Monte Carlo simulation indicates that there is a significantly non-random distribution of families among breeding patches. The genomic analyses supports the existence of three genetically distinguishable populations of Harp Seals in the White Sea, Greenland Sea, and Northwest Atlantic. and indicated a "stepping stone" model of East ◄► West dispersion across the Atlantic. The White Sea/Barents Sea population was considered to be the oldest branch while the Greenland Sea was estimated to be the youngest. The Front and Gulf whelping areas were considered to be of intermediate age.

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	35,263	1

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 partner 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 several private firms (Akoostix Inc., JASCO Ltd.) to coordinate acoustic collections and automate analyses. Further, an international effort with Canadian and American government, academic, and NGO researchers in 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 off 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.

The results from a large-scale analysis of north Atlantic song structure provided new information on the diversity of fin whale songs in the Northwest Atlantic. Song structure results from the northwest Atlantic locations support conclusion that there are three acoustically-distinct fin whale populations.

The southern population appears to range as far south as Delaware and as far north as the Gulf of Maine. A second population ranges primarily in the Gulf of St. Lawrence as well as the eastern Scotian Shelf. Finally, fin whales recorded on the Grand Banks range along the coast of Labrador at least as far north as 56°N.

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 and to assign individuals harvested within the lake back to their river of origin.

Given recent reports of escaped farmed salmon along the south coast of Newfoundland, the potential to use both genetic and genomic tools for the identification of farmed escaped Atlantic Salmon and subsequent hybridization is being explored. Highly accurate identification of aquaculture escapes is now possible using both microsatellites and single nucleotide polymorphisms (SNPs). However accurate identification of various hybrid classes (F1, F2 etc) is also possible with the targeted SNP panels. These genomic tools are currently being used to quantify levels of interbreeding among wild and farm escaped Atlantic Salmon in Atlantic Canada.

b) Sentinel Studies

The Sentinel Surveys, initiated in October 1994, were continued in 2015. Data collected were tabled at the Regional stock update in the spring of 2015 for Div. 2J3KL cod, and the 3Ps cod Regional Stock Assessment in October 2014. 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 2015. Approximately 6,200 (5,864 in Div. 2J3KL and the remainder in Subdiv. 3Ps) cod were tagged and released with Floy tags; in addition, detections of acoustically tagged cod released inshore in 3KL during 2010-2015 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 2011-2013 and ≤ 5 % during 2014. Among cod in NAFO Subdiv. 3Ps the exploitation rate in 2012 for cod tagged in Placentia Bay tended to increase with size of cod from 14 % among cod >50 cm at tagging to 22 % among those >60 cm. These exploitation rates are modest, but only 42 % of the TAC was taken. In 2013 harvest rates for cod tagged in Placentia Bay were broadly similar among cod size groups ranging from 13-16 %; for those tagged in Fortune Bay the range was 14-22 %. However, only 35 % of the TAC was taken. If the entire TAC had been harvested in 2013 it is likely that harvest rates would have exceeded 30 % in both areas.

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

d) Hydrographic Surveys

The Canadian Hydrographic Service (CHS) conducted a Hydrographic Survey in the Burgeo area South Coast of Newfoundland (Subarea 3).The Survey was conducted using an airborne bathymetric LiDAR system. High Resolution orthorectified photogrammetry was also produced. The survey data will be used to update the charts in the area covered.

A Hydrographic Surveys was conducted in St. John's harbour and the approach (Subarea 3) using a CHS survey launch equipped with a multibeam echo sounder and associated equipment. The survey data will be used to update the chart for St. John's harbour.

New charts were released in the Placentia Bay area, Notre Dame Bay area (Subarea 3) and Bay of Islands area (Subarea 4) and in the Voisey Bay area (Subarea 2).

Annual Sailing Directions Revisory Survey

The 2015 Sailing Direction Revisory survey gathered hydrographic data from selected sites throughout Newfoundland and Labrador. This data was used in revising and updating the Sailing Directions publications, ATL 102, Newfoundland East and South Coasts, ATL 103, Newfoundland Southwest Coast. A New Edition of ATL 121, Labrador, Hamilton Inlet to Cape Chidley (including Button Islands and Gray Strait) is being completed with publishing projected for 2016. A New Edition of Sailing Directions ATL 120, Labrador, Camp Islands to Hamilton Inlet (including Lake Melville) was commenced with publishing projected for 2017.

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.

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

Efforts are now underway in the Canadian Hydrographic Service to produce Print On Demand (POD) Sailing Directions publications. It is estimated that by mid-2016 all Canadian Sailing Directions will be 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, 2006-2015. Note that unless otherwise specified, this table presents Newfoundland and Labrador landings only.

Subarea	Species	Division	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
0+1	Greenland halibut	SA 0 + 1A(offshore)+ 1B-F	4,012	3,568	3,747	3,571	3,871	3,862	3,363	3,348	3,742	4,045
	Shrimp*	0A										
		0B										
2	Cod	2GH	0	0	0	0	0	0	0	0	0	0
	Shrimp*	2G (SFA 4)	15,050	14,958	14,969	13,847	10,441	11,134	10,656	9,682	10,009	10,084
		2HJ (SFA 5)	20,282	21,748	22,317	24,529	25,264	21,425	25,094	20,503	23,768	22,612
		2J3K (SFA 6)	47,410	46,340	59,032	58,334	59,685	61,501	45,099	75,080	80,736	75,673
	Snow Crab	2HJ	1,769	1736	1392	1606	1933	2131	2387	2549	2523	2139
	Iceland scallop	2HJ	8	6	20	16	19	16	17	13	40	686
	Arctic Charr	2J3KLPs+4R	25	22	25	11	24	11	16	18	28	40
	Atlantic Salmon****		42	38	37	54	41	36	30	36	27	32
2+3	Redfish	2+3K	5	48	66	103	74	61	28	20	29	221
	Greenland halibut	2+3KLMNO	6524	7,223	6410	6176	6166	6529	5,744	4,701	5,073	6,307
	American plaice	2+3K	4	9	100	11	18	22	10	10	23	60
	Witch	2J+3KL	187	178	182	94	143	160	45	5	22	53
	Cod*****	2J3KL	4,314	4,583	4,299	3,305	3139	2902	3,098	3,343	2,546	2,679
	Grenadier	2+3	1	5	11	28	113	41	13	10	38	99
	Capelin	2J3KL (offshore)	0	0	0	0	0	0	0	0	0	0
	Squid	2+3	0	0	0	17	90	100	643	516	228	6,979
3	Redfish	3LN	4,139	1,446	2730	920	1960	113	6	1	3	1
		3M		0	0	0	2	0		0	0	0
		3O	31	34	0	0	97	42	255	202	1,054	3,580
	Yellowtail	3LNO	5,442	6,800	7,920	1,795	3947	8056	5,414	10,216	3,674	177
	American plaice	3LNO	436	748	1,041	267	450	1154	1,077	878	434	93
		3Ps	100	46	96	140	279	402	509	456	460	485

	Witch flounder	3NO	222	9	62	3	11	39	41	46	21	94
		3Ps	343	144	226	235	175	446	454	298	110	182
	Atlantic halibut	3	361	570	400	364	270	321	289	287	170	251
	Cod	3NO	130	187	223	25	39	103	158	231	123	73
		3Ps	4,961	4,378	3,058	4,254	5,424	6,737	7,491	9,636	10,599	10,506
	Haddock	3LNO	62	10	13	4	42	27	104	60	30	23
		3Ps	167	189	69	101	88	129	173	288	302	128
	Pollock	3Ps	190	305	148	335	186	319	287	616	1,042	733
	White hake***	3NOPs	205	397	301	264	239	559	748	1383	1,680	2,112
	Thorny skate***	3LNOPs	169	388	294	531	467	604	1334	1452	1639	1,392
	Capelin	3L	11,380	9,808	12,423	11,645	12,023	11,927	13,326	15,176	16,321	15,430
		3K	13,640	13,365	11,332	10,672	8,081	3,544	9,853	13,043	13,036	14,368
	Shrimp*	3M	0	0	0	0	0	0	0	0	0	0
		3L	0	1,769	6,119	8,019	9,276	13,535	20,494	21,187	18,316	18,128
	Sea scallop	3KLNO	0	0	0	0	0	27	0	0	9	10
		3Ps	1,126	1158	1071	1,190	920	842	432	293	359	518
	Iceland scallop	3LNO	45	0	0	11	0	0	0	1	0	347
		3Ps		1	4	2	0	0	2	5	6	132
	Snow Crab	3K	7,182	7,828	8,519	8,390	10,744	12,420	16,184	15,068	12,270	10,717
		3LNO	37,290	34,499	33,892	33,511	32,914	31,419	29,033	30,248	30,895	30,717
		3Psn	2,540	4,904	6,047	6,225	6,716	6,026	5,559	4,523	3947	3099
	Lobster	3K	121	50	63	66	61	96	107	134	120	156
		3L	113	81	81	84	75	111	98	109	83	111
		3Ps	1,100	940	1,048	952	917	1,228	1,071	1,171	1,010	1,052
		3Pn	150	161	138	164	112	139	127	153	94	52
	Atlantic salmon**	2J3KLPs+4R	46	37	48	39	48	51	41	50	29	36

3+4	Redfish	3P+4V	71	533	192	295	907	2,275	2,265	1,217	1,402	2,439
4	Iceland scallop	4R	200	310	378	295	431	244	246	121	284	656
	Sea scallop	4R	4	6	42	66	48	27	15	0	0	0
	Lobster	4R	1,260	906	873	857	769	1,022	1,096	1,404	1,260	1,275
	Snow Crab	4R	776	850	891	742	596	188	268	365	558	514

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 March 23, 2016, 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 2015/16, as well as those currently underway for 2016/17.

List of IGS Activities 2015-16 and 2016-17	
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
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
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.