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Canadian Research Report for 2011
Part A. Newfoundland and Labrador Region

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Part A. Newfoundland and Labrador Region

SUBAREAS 0 AND 1

A. Status of Fisheries

Nominal landings from 2002 to 2011 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 Div. 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 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 2010, Scientific Council advised for 2011 a TAC of 13,000 t for Greenland Halibut in Div. 0A+1AB and 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 Canada (NL) fishery only occurs in Div. 0B and catches from 2003 to 2006 were approximately 4,000 t, fully utilizing its allocation of the quota, then declined gradually to 3,400t in 2009. The catch increased to 3,900 t in 2010 remained near this level in 2011 with approximately one half taken by otter trawlers (1,240 t with single trawls and 960 t with twin trawls) and the remainder by gillnets (1,670 t). The 2011 catch was taken from January to September with a substantial portion of the 2011 catch (63%) was taken in May and June.

[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.

SUBAREA 2
A. <u>Status of Fisheries</u>

Nominal landings from 2002 to 2011 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Atlantic Salmon* – Subarea 2

The commercial fishery remains closed since 1998. The 2011 recreational catch, including both retained and hooked-and-released, was 7,569 fish, up 30% from last year and 18% over the previous 6 year mean. Preliminary information on subsistence fishery catches indicated that about 41 t of Atlantic Salmon were harvested in 2011, 14% higher than the 2010 harvest of 36 t.

All of the four assessed stocks achieved conservation spawning requirement in 2011. Returns of small and large salmon increased over the previous six year mean and are in contrast to a five year declining trend. Abundance of large salmon has remained particularly low since the late 1980s.

b) *Arctic Charr* – Subarea 2

Commercial landings of Arctic Charr from north Labrador in 2011 were 24 t, more than double that of 2010 when only 11 t of charr were harvested, and about 8% more than the average landings for the 10-year period 2001-2010. Over the past 38 years (1974–2011), more than 2,925 t of Charr have been harvested from a limited section of the north Labrador coast, and attests to the capacity of this area to produce fish. Recent surveys of Inuit domestic harvests from subsistence fisheries along the north coast of Labrador can approximate about 10,000 Charr annually.

c) *Cod* – Div. 2GH, Div. 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 2004-07 has ranged between 250 kg to 500 kg annually.

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 2006-11, a pilot-scale inshore stewardship fishery using vessels <35 ft was open and fishers were each permitted to harvest 3,000 lb (2006), 2,500 lb (2007), 3,300 lb (2008), and 3,750 lb (2009-2011) of Cod. 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. The total reported landings were 2,679 t in 2006. Landings for 2007 do not include those from recreational fisheries. The stewardship fishery landings were 2,364 t in 2007. In 2008, reported landings were 4,162 t including 3,089 t in the stewardship fishery which includes 121 t of by-catch and 818 t in the recreational fishery; in addition 254 t were landed in the sentinel surveys. In 2009, reported landings were 2,832 t in the stewardship fishery, 216 t in the sentinel survey, and

50 t of bycatch. There was no direct estimate of recreational fishery landings for 2009-2011; however, analysis of tag returns suggests that removals from recreational landings were in the range of 50- 64% of reported stewardship fishery removals during those years. In 2010, reported landings were 2,902 t which includes 44 t of by-catch, 209 t in sentinel surveys. In 2011, reported landings were 2,872 in the stewardship fishery, 214 t in the sentinel surveys, and 43 t taken as by-catch. The offshore portion of the stock area has remained under moratorium since 1992.

d) *American Plaice* – Subarea 2 + Div. 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 RV survey. Generally recruitment has been impaired when the survey 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. Ageing data is not yet completed for 2010 and 2011 so therefore SSB estimates are not available for the most recent years. It was not possible to determine an upper reference point or a removals (F-based) reference point for this stock. The main source of by-catch of American plaice since 2000 has been in the Greenland halibut gillnet and otter trawl fisheries. In 2010 and 2011, the total reported landings of American plaice were 22t and 17 t, respectively.

e) *Redfish* – Subarea 2 + Div. 3K

This stock has been under moratorium to directed fishing in the Canadian EEZ since 1997 although there had not been a persistent directed effort on this stock since 1990, when 2400 t was landed. Canada (NL) landings were between 22-221 t for the period 2002-11 with the 2011 catch at 74 t. Canadian (NL) landings since the moratorium in the Canadian EEZ are bycatch primarily from Greenland halibut fisheries. Reported landings from other countries fishing in the NRA with large midwater trawls increased rapidly from 1800 t in 2001 to a range of 5,000–5,400 t from 2003 to 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 2011 (<10 tons). 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 460 t in 2006 with a decline to 330 t in 2007. More recent data have not been analysed.

f) *Witch Flounder* - Div 2J3KL

There has been no directed fishing on this stock since 1994. In 2011, bycatch in other fisheries from the Newfoundland Region was 143 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. The fall 1998-2010 surveys indicate no change in this distribution pattern. 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 Division 3L. Estimates of biomass and abundance have increased slightly since 2003, but the stock size remains extremely low.

g) *Greenland Halibut* - Subarea 2 + Div. 3KLMNO

The Canadian (NL) catch of Greenland Halibut in 2011 in Subarea 2 and Div. 3KLMNO was approximately 6,200 t, a 5% decrease compared to the 2010 catch (6,500 t). Scientific Council estimated the total catch of this stock in 2010 to be 26,174 t.

In September 2003 at its annual meeting, the Fisheries Commission implemented a fifteen year rebuilding plan for this stock. It established TACs of 20,000, 19,000, 18,500 and 16,000 t respectively, for the years 2004 to 2007. TACs in 2008 - 2010 have been set at 16,000 t. The total catches estimated by Scientific Council over 2004 to 2009 exceeded the rebuilding plan TACs considerably, with the over-runs ranging from 22-47%. In September 2010, following the recommendations of WGMSE, the Fisheries Commission adopted a harvest control rule which uses trend information from various surveys to determine the TACs for each of 2011-2014 . Under this strategy, TACs for 2011 and 2012, have been set at 17,185t and 16,326t, respectively.

Biomass increased over 2004-2008 with decreases in fishing mortality. However, it has shown decreases over 2008-2011, in part due to weaker year-classes recruiting to the biomass. The 10+ biomass peaked in 1991 and although it remains well below that peak, it has tripled over 2006-2011. Average fishing mortality (over ages 5-10) has decreased considerably since 2003. The 2010 estimate of fishing mortality has increased due to higher catches coupled with the poor recruitment to the exploitable biomass. Year-classes about to recruit to the exploitable biomass are well below average strength.

h) *Shrimp* – Subarea 2 + Div. 3K

The Northern Shrimp (*Pandalus borealis*) fishery in Subarea 2 and the northern portion of Subarea 3 is divided into three management areas – 2G (Shrimp fishing area 4), Hopedale and Cartwright Channels (2HJ) (Shrimp fishing area 5), and Hawke Channel (2J) + 3K (Shrimp fishing area 6). The resource within these Shrimp Fishing Areas (SFA's) is normally assessed on a biennial basis. The last formal assessment was completed during March 2011. Due to continued concerns pertaining to the resource within Shrimp Fishing Area 6, an interim monitoring report was produced in March 2012. The next formal assessment is scheduled to be completed during February 2013.

Between 1998 and 2002, annual catches of approximately 8,000 t were taken in 2G from 8,320 t TACs. The 2003 TAC was increased to 10,320 t and during that year the Canadian Shrimp fishing industry requested and was granted a change in season, from a calendar year (January 1 – December 31) to a fiscal year (April 1 – March 31). An additional interim quota of 2,802 t was set for the January 1 – March 31, 2004 period. Thus the 2003-04 fishing season was 15 months long and had a 13,122 t TAC. The 2003-04 (April 1 – March 31) TAC (10,320 t) was maintained for the 2004-2008 seasons. Approximately 13,000 t of northern shrimp were taken during the 2003-04 management year while approximately 10,000 t were taken in each year over the 2004-2007 period. The TAC was increased to 11,320 t in 2008/09 and was maintained at that level through to 2011/12. Approximately 10,000 t and 10,700 t were taken during the 2008/09 and 2009/10 seasons respectively. Preliminary data indicate that 11,100 t and 10,900 t of Shrimp were taken during the 2010/09 and 2010/11 seasons respectively.

Historically, the fishery has been concentrated north of 60^{o}N in an area noted for producing high catch rates of large, high-quality Shrimp. During 1998, a separate quota was created for the area south of 60^{o}N to reflect the existence of high concentrations of Shrimp along the shelf slope. The new quota resulted in a southward shift in fishing effort. CPUE has increased since 2004/05 and

is now well above the long term mean. Since 2006/07, the standardized large vessel (>500 t) catch rates have been above 2000 kg/hr with the 2010/11 catch rates above 3000 kg/hr. In 2008 the condition forcing vessels to fish a portion of their quota south of 60°N was removed. This may have influenced the recent increases in CPUE.

Canadian Government conducted a bottom trawl research survey in 2G each autumn from 1996 to 1999. During the summer of 2005, the Northern Shrimp Research Foundation and the Government of Canada (DFO) began a series of collaborative annual research bottom trawl surveys in 2G. These surveys make use of a research Campelen 1800 Shrimp trawl with a 12.7 mm codend liner and fish at depths between 100 and 750 m. These surveys focus upon gathering data necessary for Shrimp stock assessments.

The Northern Shrimp Research Foundation – DFO research survey fishable biomass index has ranged between 62,000 t and 180,000 t since 2005. The recruitment index increased from 2005 to 2008 and has changed little in 2009 and 2010. Exploitation rates indices ranged between 6% and 16% during 2005-11. Current status remains positive. Biomass indices have changed little since 2006. The female spawning stock (SSB) index was assessed to be in the Healthy Zone of the precautionary approach (PA) framework, well above the upper stock reference (USR).

TACs in Hopedale and Cartwright Channels (2HJ) doubled from 7,650 t during 1994-96 to 15,300 t over the 1997-2002 period. TACs have been taken in most years. In 2003, the TAC increased to 23,300 t. During that year, the fishing season changed to April 1 – March 31, and an additional interim quota of 9,787 t was set for the period January 1 – March 31, 2004. Thus the 2003-04 fishing season was 15 months long and had a 33,084 t TAC. The 2003-04 fiscal year TAC (23,300 t) was maintained for the 2004-09 seasons. Approximately 23,000 t of Shrimp were caught annually since the 2003-04 season. In 2009-10, Shrimp landings increased to approximately 25,000 t, however, preliminary data indicate that 21,400 t were taken in 2010-11 while 22,400 t of Shrimp were landed in 2011-12. It is important to note that since 2007, a season bridging program has been in place allowing offshore license holders to fish up to 250 t of their total combined subsequent year quotas in the period March 1-30, or fish up to 250 t of their previous year quotas in the period April 1-30. Standardized catch rates within Hopedale and Cartwright Channels increased from 1992 (800 kg/hr) through to 2001 (2,300 kg/hr) and have since remained high with an average catch rate of 12,000 kg/hr. High CPUEs are being maintained over a relatively broad area indicating that the stock is healthy.

Only the 2J portion of SFA 5 (Cartwright Channel) has been surveyed over the history of the autumn multi-species surveys. Trends in indices and biological characteristics from SFA 5 and Cartwright Channel were broadly consistent. Surveys of the whole of SFA 5 were completed in only five (2001, 2004, 2006, 2008 and 2010) of the last twelve years. SSB and fishable biomass indices increased after 1999. SSB and fishable biomass indices within the entire of SFA 5 have remained relatively stable at between 65,000 t and 86,000 t and 128,000 t and 155,000 t respectively since 2001.

There has been relative stability in the fishable biomass for the past decade and the average exploitation rate index over this period has been 15%.

The fishery in Hawke Channel (southern Div. 2J) + 3K began in 1987 with landings of approximately 1,800 t. Catches increased to more than 7,800 t in 1988 and ranged between 5,500 and 8,000 t throughout 1989-1993. The first multi-year management plan covered the period 1994-96 and established an annual TAC of 11,050 t for the Hawke Channel, St. Anthony Basin, east St. Anthony, Funk Island Deep and three exploratory areas on the seaward slope of the shelf. Catches increased to 11,000 t in each of these years. TACs were increased to 23,100 t in 1997 as

a first step toward increasing the exploitation of an abundant resource within the 1997-99 Management Plan. Most of the increase was reserved for development of the small vessel fleet (<=500 t; LOA<=100'). TACs more than doubled between 1997 and 1999, increased slightly to 2002 and further increased to 77,932 t in 2003. An additional interim quota of 7,653 t was set for the period January 1 – March 31, 2004 to facilitate an industry requested change in fishing season from January 1 – December 31 to April 1 – March 31. Thus the 2003-04 fishing season was 15 months long and had an 85,585 t TAC. TACs remained at the 77,932 t level for the 2004-08 fishing seasons, but were increased to 85,725 t for the 2008-09 and 2009-10 seasons. Due to concerns pertaining to resource health, TACs were reduced to 61,632 t and 52,387 t for the 2010-11 and 2011-12 fishing seasons respectively. TACs have been reached in most years. Preliminary data indicate that 61,500 t and 53,300 t of Shrimp were landed during the 2010-11 and 2011-12 seasons respectively.

The SFA 6 large (>500 t) vessel CPUE remained at a high level between 1995 and 2006 after which it decreased to 2009. The small vessel (<100 ft) CPUE increased to 2003, remained high until 2007 and then decreased to 2009. The 2009 model CPUE indices for the large and small vessel fleets were 1,000 and 375 kg/ hr respectively.

Fishable biomass in the fall RV survey increased significantly from 433,000 t in 2003 to nearly 670,000 t in 2006, decreased by 56% to about 300,000 t by 2010 and then increased significantly by 36% to 409,000 t in 2011. The female spawning stock biomass index showed a similar pattern, declining from by 59% from 460,000 t in 2006 to 190,000 t in 2010 and then increasing by 27% to 241,000 t in 2011.

There is uncertainty related to the increase in biomass indices in 2011 because of steady declines in recruitment indices since 2006.

Based upon preliminary data to February 6, 2012, the 2011/12 exploitation rate index will be at least 18%. If the 2011/12 TAC of 52,387 t was maintained through 2012/13 and this quota was taken, the exploitation rate index would decrease to 13%. There have been major increases and decreases in biomass indices even though the average exploitation rate over the 1996-2011/12 time series has been a modest 14%. There are probably several factors such as predators, competitors, food and the physical environment that play important roles in Northern Shrimp population dynamics within SFA 6.

The mandatory use of sorting grates, low groundfish abundance, and avoidance of problem locations have minimized bycatch. Recent studies estimated that low numbers of Redfish and Greenland Halibut have been caught by Shrimp fishing fleets.

i) *Snow Crab* – Div. 2HJ

A commercial TAC was first established in Div. 2H in 2008. Prior to this, the fishery was of an exploratory nature. Stock assessments for Div. 2H Snow Crab began in 2008. Landings declined by 95% from 190 t in 2007 to 10 t in 2011. The TAC has not been taken for three consecutive years. Fishery data are very limited. However, **CPUE** has declined steadily since 2006. The exploitable biomass is very low. The post-season trawl survey exploitable biomass index decreased by 94% since the 2006 peak. Recruitment has decreased since 2004 and is expected to be low over the next several years. There were no pre-recruit males captured in the 2010 or 2011 post-season trawl surveys. Long-term recruitment prospects are poor. There have been no small (<60mm carapace width) males captured in the post-season trawl surveys since 2001.

In Div. 2J, landings decreased by 21% since 2008 to 1,900 t while effort increased by 52%. CPUE most recently peaked in 2008 and has since decreased by half. The exploitable biomass has decreased in recent years. The post-season trawl survey exploitable biomass index peaked in 2006 and has since decreased by half. Recruitment has recently been in decline and is expected to remain low in the short term. The post-season trawl survey pre-recruit index decreased sharply in 2005 and has since fluctuated without trend. Long-term recruitment prospects are unfavourable due to a warming oceanographic regime. The exploitation rate index changed little in the past three years. The pre-recruit fishing mortality rate index has remained low in recent years, but increased to its highest level since 2004 during 2011. Maintaining the current level of fishery removals would likely increase the exploitation rate in 2012.

j) Iceland Scallop – Div. 2HJ

Inshore aggregations were again fished in 2009, 2010 and 2011, with nominal catches estimated at 17 t ,16 t and 19 t, round, respectively, up from 13 t in 2008. The fishery is prosecuted 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) Benthic studies

DFO Science, Newfoundland and Labrador Region, are involved in a five-year project "Reducing Seabed Impacts of Bottom Trawls" with Fisheries and Marine Institute (Memorial University) and Industry (Vónin Ltd.). The primary goal is to develop, test and commercialize innovative bottom trawl fishing technology that will reduce the environmental impact on the seabed. Specific stages in the project involve, 1) design and computer simulation of new fishing systems (carried out in 2011), 2) flume tank testing of physical models, and 3) construction and field testing of full-scale prototypes.

b) Arctic Charr

Samples were obtained for food and feeding analyses, while biological characteristics information was updated from commercial landings from two north Labrador stock complex areas in 2011 and represented the 35th continuous year of sampling these populations. Following long term declines in mean weight of Charr harvested in north Labrador, current data continue to show that mean weight and mean-weight-at-age has stabilized in recent years. Collaborative studies with other researchers in Canada have resulted in recent publications on latitudinal variation in growth of Charr and an analysis of changes in growth patterns in response to fluctuating environmental conditions. Ongoing investigations include studies on trophic ecology, environmental influences on growth, and thermal habitat use.

c) Groundfish and Shellfish

Biological and oceanographic data from fall multi-species research vessel surveys were collected from Div. 2HJ to conduct distribution and abundance studies and detailed biological sampling is used to conduct analyses of growth, maturity and condition.

Analysis of sexual maturity data is conducted regularly on American Plaice, Cod, and Greenland Halibut and reported in the stock assessments of these species.

A joint project under the Canada Spain Marine Science Collaboration Initiative entitled 'Analysis of Stock Reproductive Potential to promote sustainability of Greenland Halibut fishery' has been running for the past 3 years with funding ending March 31 2012. This project aims at increasing our understanding of Greenland Halibut reproduction and integrating this increased understanding into stock assessments. Within this project work is being conducted on fecundity (application of the autodiametric method), maturity, sex ratio and growth. In addition, work has begun to test the robustness of the Greenland halibut harvest control rule to different assumptions about reproductive potential. Although funding has concluded work continues and NAFO will be made aware of the results.

d) Shrimp

In 2005, the first of a series of trawl surveys was conducted by the Northern Shrimp Research Foundation in partnership with DFO in Div. 2G. Biological and oceanographic data were collected to assess the distribution and abundance of the Shrimp population in this division. By 2007, sufficient data had been collected to begin using the NSRF-DFO joint survey data in Shrimp assessments. The Zonal Advisory Process (ZAP) meeting held in St. John's since March 2008 has been making use of this dataset.

e) Snow Crab

A trap survey for Snow Crab was conducted in Div. 2H in the summers of 2009 and 2010. The survey, conducted by the Torngat Joint Fisheries Secretariat with in-kind support from DFO, was 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.

f) *Atlantic Salmon*

Approximately 1600 Atlantic salmon from the subsistence harvest in coastal Labrador are currently being analyzed for river of origin using 15 microsatellite loci. These samples include tissue collected in 2011 and existing scale samples from previous years (2006-2010). Genetic samples from 15 rivers in coastal Labrador have been collected (2010 and 2011) and will be used to examine spatial population structure in Labrador. Salmon baseline data collected by Fisheries and Oceans will be integrated into the Canadian Atlantic salmon genetic database being coordinated by Laval University during the summer of 2012.

SUBAREA 3

A. Status of Fisheries

Nominal landings from 2002 to 2011 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Atlantic Salmon - Subarea 3

A moratorium on the commercial fishery has been in place since 1992. The 2011 recreational harvest, including both retained and hooked-and-released, was 34,662 fish, down 15% from last year but up 16% over the previous 5 year mean.

Four of the ten stocks assessed in this area achieved conservation spawning requirement in 2011.

b) *Capelin* – Subarea 2 + Div. 3KL

Inshore Capelin catches in Subarea 2 + Div. 3KL are taken during the inshore spawning migration. Catches increased from 15,471 t in 2010 to 20,104 t in 2011 representing 89% of the 2011 TAC. The most recent assessment (October 2010) examined several indicators that showed that biological and behavioural changes first observed in the early 1990s continue to persist. The mean size of mature Capelin in 2010 was similar to the mean size in 2009, the smallest in thirty years. The spawning biomass is comprised of two and three year-old fish instead of three and four-year olds. Condition has been declining since the early 1990s. Capelin are spawning four weeks later than observed in the 1980s. Capelin in most areas are not undertaking diurnal vertical migrations, instead remaining near the bottom. The offshore distribution of capelin in the fall remains contracted to the south similar to what has been observed since the 1990s. In the spring of 2010 Capelin were observed offshore in deeper water along the shelf edge and not in strata which have had typically high densities in recent years. There are no recent estimates of abundance available for the entire stock, however an acoustic survey covering Div. 3L in May, 2010 estimated abundances to be the lowest in the series at less than 1% of historic levels. The abundance estimate from the May, 2011 acoustic survey was higher than in 2010 and close to the average for the last 10 years, but still considerably lower than the 1980s. Four coherent recruitment indices indicated prospects for recruitment in 2011 were poor. Predation pressure on Capelin has likely increased in recent years due to population increases in Capelin predators and declines in other forage species such as shrimp.

c) *Cod* – 3NO and 3Ps

The 3NO stock has been under moratorium to all directed fishing, both inside and outside the NAFO Regulatory Area, since February 1994 and this continued into 2011. Total catch since 1994 has increased from 170 t in 1995 to 4,900 t in 2003, and declining to 600 t by 2006. Catches increased thereafter to 1,100 t in 2009 and 950 t in 2010. The provisional 2011 reported to NAFO based on monthly catch reports is 950 t. Canada (NL) landings ranged from 441 t to 714 t between 2002-2005, declined to 73 t in 2006 then increased to 231 t in 2008 and have since declined to 39 t in 2011. These catches were primarily taken in the 3NO yellowtail fishery.

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. This was subsequently increased to 20,000 t for 1998 and to 30,000 t for 1999. In 2000 the management year was changed to begin on 1 April. An interim quota of 6,000 t was set for the first three months of 2000. TACs under this revised management year schedule have ranged from a high of 15,000t to 11,500 t in for the 2011/12 management year. In the 2009/10 management year, total reported landings were 8,900 t, or 77% of the TAC. During the 2010/11 season, total reported landings were 7,800 t, just 68% of the available TAC. These differences between the TAC and landings are unusual; normally the entire TAC is utilized. Participants from

industry indicated multiple reasons which contributed to this change: reduced profitability, additional market considerations, a labour disruption in one fleet sector, and a reduction in the availability of large fish offshore during winter 2011. Canada (NL) calendar year landings have shown a steady reduction from 10, 600 t in 2007 to 5400 t in 2011. Most of the catch is typically taken by fixed gear.

The level of total removals is uncertain. It is likely that historical landings have been biased both upwards (e.g., due to misreporting of catch by area and/or species) and downwards (e.g., due to discarding). In addition, commercial catch accounting procedures pre- and post-moratorium are radically different, with current measures likely to provide improved estimates of removals. In assessing stock status, it would be useful to better understand the accuracy of total removals, especially in the post-moratorium. Estimates of recreational fishery landings have not been available since 2006.

The 2011 assessment of 3Ps cod indicated that the stock is above the limit reference point. The report of the assessment meeting concluded: "SSB decreased over the 2004-09 period. Median SSB was estimated to be below the LRP in 2008 and 2009. The SSB in 2011 is estimated to be above the LRP, with a low probability of being below the LRP (0.08). A one year projection to 2012 using the cohort model indicated that survey SSB will continue to increase if total mortality is similar to current values (i.e., within ±20%). This increase is due to the recruitment of the relatively strong 2006 year class (YC) to the spawner biomass. The projection also indicated that the probability of being below the LRP in 2012 is low (0.02 to 0.09). A three year projection to 2014 indicates subsequent declines in both total biomass and spawning biomass if total mortality is similar to current values (i.e., within ±20%). In 2014 the probability of being below the LRP ranges from 0.03 to 0.56..".

d) *American Plaice* - 3Ps

The status of this stock was updated in 2012 and limit reference points determined from a Bayesian Surplus Production model. From 1994 to 1998 the catch was 400 t or less. Catch then increased substantially. During 2001 to 2003 the catch was greater than 1,000 t in each year. Catch declined steadily since 2003 and was about 500 t per from 2006 to 2009 Catch in 2010 was 402 t by NL. This stock has been under moratorium since September 1993 and catch has been mainly as bycatch in the Cod and Witch Flounder directed fisheries. Since 2006 catch has been about 500 t in most years.

A Bayesian Surplus Production Model was applied to catch data from 1960-2010 and survey data from 1980-2010 for American plaice in Subdiv. 3Ps. Consistent with the DFO PA policy Blim is 40% Bmsy, the upper stock reference is 80% Bmsy and Flim is Fmsy. Stock status relative to these reference points was estimated from the model. Stock size estimated from this model has been increasing slowly since 1993, however, current biomass is 50% of Blim and therefore the stock is in the critical zone. The probability of being below Blim is high (0.94). Current fishing mortality is estimated to be 64% of Flim. The probability of being above Flim is 0.2.

e) *Witch Flounder* - 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 300 t and 1,000 t annually. In 2009 and 2010, the catch from the Newfoundland region was about 450 t each year, and in 2011 decreased to 175 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* – 3LNO

Since the fishery for this stock reopened in 1998, stock size has steadily increased and in 2011 was estimated to be 1.7 times Bmsy, 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 4000t to 11400t, well below the TAC in each year and in 2011 was 3947 t. Scientific Council noted that this stock is well above Bmsy, and recommended any TAC option up to 85% Fmsy for 2011 and 2012 (25.0 t and 22.9 t respectively). The TAC for 2011 was set to 17,000 t and Canadian catch was 3946 t. Scientific Council also noted that bycatch of Cod and American Plaice in the Yellowtail fishery needs to be considered in considering the TAC for yellowtail flounder.

g) *American Plaice* – 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. By-catch from all countries in 2010 was 2, 898 t, which is on par with by-catch in recent years. The majority of this by-catch was taken in the NAFO regulatory area (NRA). Canadian (NL) by-catch of American Plaice in 2010 and 2011 was 1154 t and 450 t, respectively. Increased by-catch allowances in the Yellowtail Flounder fishery have the potential to result in increased catches of American Plaice; however in recent years the quota of yellowtail flounder was not caught. The SSB estimated from VPA model output has been gradually increasing since the mid-1990s and was 34, 000 t in the 2010 assessment, still below the B*lim* of 50, 000 t set for this stock.

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

Redfish in the Canadian Atlantic within Div. 3P4RSTVWX were redefined into three management units in 1993. Based on subsequent studies a number of workshops on the biological basis for Redfish management units were held in 2006 and 2007, more specifically the interaction between management Unit 1 (4RST, 3Pn4Vn January to May) and Unit 2 (3Ps4Vs4Wfgj, 3Pn4Vn [June to December] for two species (*Sebastes fasciatus* and *S. mentella*). The final workshop concluded that a review of the biological data (genetics, morphometrics and otolith chemical signature) suggests that Units 1 and 2 corresponds to a single biological population of each species and recommended these Units should be combined for assessment purposes. The data were re-analyzed and evaluated separately for the *Sebastes mentella* stock and the stock of *S. fasciatus* in the area covered by the combined management units of Unit 1 and Unit 2 at an assessment meeting in February 2010 (see http://www.dfo-mpo.gc.ca/CSAS/Csas/publications/sar-as/2010/2010_037_e.pdf).

For the UNIT2 portion of the combined management 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 2011, whereas catches have fluctuated between 2,500 t to 6,700 t from 2006-2010 and were about 3,100 t in 2011. About 900 t of the 2011 catch was taken by the Canada (NL) fleet. The shortfall in the TAC from 2005-07 was due to corporate restructuring and a labour dispute in the Canadian fishing industry. Subsequent shortfalls have been attributed to poorer market conditions. Current management regulations include a closure related to peak spawning in May and June, and a minimum landing size restriction at 22 cm.

Canada has had limited interest in a fishery in Div. 3O because of small sizes of redfish encountered in areas more suitable for otter trawling. Canadian landings were less than 200 t annually from 1983-1991 but increased in the early 1990s. Between 1996 and 2000 Canadian catches have 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 100 t in 2011. Canada (NL) has generally accounted for more than 95% of the Canadian catch since 2001. 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.

i) Witch Flounder – Div. 3NO

There has been no directed fishing on this stock since 1994. Canada (NL) bycatch has ranged between 13 t to 94 t since 2001 and in 2011 was 11 t. There are signs of improvement in stock status, notably the increases in Canadian autumn survey indices in 2008-2010, but there is considerable uncertainty.

j) White Hake – Div. 3NOPs (Div. 3NO in NRA)

Prior to 1995, White Hake was taken as bycatch in other demersal fisheries on the Grand Banks. Average estimated catch during 1985-1990 was approximately 5,000 t. Annual catches in a new directed (Canadian) fishery on the Grand Banks, starting in 1995 and encompassing Divs. 3NO and Subdiv. 3Ps, averaged 460 t. However, in 2001 and 2002, a >10-fold increase in the catch of white hake Div. 3NO was attributable to EU-Spain, EU–Portugal and Russia in the NAFO Regulatory Area. STATLANT average reported catch was 1,542 t over 2006-2010. Preliminary 2011 STATLANT catch for 3NOPs is 226t. The current TAC for White Hake in 3NO for 2012 is 5,000 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 a low level relative to the 1999-2002 peak period.

k) Thorny Skate – Div. 3LNOPs

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 tons 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 tons for 2005-2009 in Div. 3LNO. This quota was lowered by NAFO to 12 000 t for 2010-2011; then to 8 500 t for 2012. The TAC for Subdiv. 3Ps in the EEZ was maintained at 1 050 t by Canada.

Average STATLANT catch for 2005-2010 was 3 116t in 3LNO, and 1,027t 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.

l) *Shrimp* – Div. 3LMNO

Catches increased dramatically since 1999, with the beginning of a regulated fishery. Over the period 2001-2009, catches increased from 7,000t to 28,500 t. Preliminary catch records indicate that 20,600 t of shrimp were taken from a 30,000 t TAC in 2010. By October of 2011, 11,400 t of shrimp had been taken, down from 12,600 t at the same time in the previous year. There was concern that the 2011 quota of 19,200 t may not be taken. As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 5,000 t in 2001 to 21,200 t in 2008 but have since decreased to 13,500 t in 2010. By October 2011, Canadian vessels took 9,000 t of shrimp. While the Canadian large and small vessel shrimp fishing fleets have the capacity to catch the 15,997 t quota for 2011 there was concern that the quota would not be taken for the following reasons:

1. Large vessel catch rates over the 2010 and 2011 fishing seasons were generally lower than in previous years;
2. This fleet concentrated in more northern areas where catch rates were better and operators wished to avoid ice that may be present later in the year; and
3. Generally the 3L quota is fished later in the year when catch rates in that area are generally much higher. Additionally there are no ice related concerns in this area.
4. The inshore fleet catch rates were good until the end of June. Since July, catch rates have been lower. To date, a much larger proportion of the quota has been harvested than in 2010. Harvesters believed that most of the small vessel quota would be harvested.

Catches by other contracting parties increased from 700 t in 2000 to 7,700 t in 2006 and between 2006 and 2010 have ranged between 5,500 and 8,000 t. Preliminary data indicate that non-Canadian vessels took 2,500 t of Northern Shrimp by October 2011 while they took 3,200 t by the same period in the previous year. It was anticipated that the 3 579 t quota for non-Canadian vessels would be taken by December 2011.

Canadian fleet

Since 2000, small (<=500 t; LOA<65') and large (>500 t) Shrimp fishing vessels catches have been taken from a broad area from the northern border with 3K south east along the 200 – 500 m contours to the NRA border.

The small vessel fleet fishes Shrimp mainly during the spring and summer months, while seasonality of the large vessel fleet varied over time.
Small vessel CPUE (2000 – 2011) was modeled using month, year and size class (class 1 = <50' LOA; 50' LOA <=class 2< 60' LOA; class 3 => 60' LOA) as explanatory variables. The model standardized data to 2000, class 3 and July values. The logbook dataset that was used in this analysis accounted for between 7.7% and 96.7% of the catch within any one year. The final model explained 82.4% of the variance in the data and indicated that the annual, standardized catch rates increasing from near 300 kg/hr over 2000 – 2002 to 650 kg/hr by 2005 before gradually decreasing to 300 kg/hr by 2011.

Seasonality among the large vessel fleet has varied greatly over the years; therefore large vessel catch rates were analyzed by multiple regression using data were standardized against December data. The model was weighted by effort, for year, month, number of trawls and vessel effects. The observer dataset used in this analysis accounted for between 55% and 99% of the catch within any one year. The final model explained 61% of the variance in the catch rate data. Standardized catch rates for large Canadian vessels have been fluctuating around the long term mean between 2004 and 2008 but have since been decreasing. The 2000 standardized catch rate index (904 kg/hr) was similar to the 2001 and 2011 values but significantly lower than the mean (1 494 kg/hr).

The small vessel fishery covers a larger portion of the resource whereas the large vessel fleet has always fished near the 200 Nmi limit and along the northern edge of 3L this reason, the small vessel fleet information may provide a better indicator of resource status than the large vessel fleet.

International fleet

A standardized international fleet CPUE model was created as the percent catch data accounted for in the international dataset ranged from 1 – 45% but in most years was less than 30% of that year's catch. Unstandardized international indices increased from 381 kg/hr in 2001 to 2 035 kg/hr in 2004, decreased to 570 kg/hr in 2005, remained near that level in 2006 before increasing to 1 395 by 2009 and subsequently dropping to 873 kg/hr by 2011. In 2011, the CPUE was near the long term mean CPUE of 915 kg/hr. It is not clear how representative these commercial catch rates are of the international fishery in the 3L NRA.

m) *Snow Crab* – Div. 3KLNOPs

In Div. 3K offshore, Landings peaked at 12,600 t in 2009 but decreased by 35% to 8,200 t in 2011. The TAC was not achieved in the past 2 years. Effort changed little until it increased by 71% in 2009 before decreasing by 15% in 2010 and increasing marginally in 2011. CPUE has declined sharply since 2008. The exploitable biomass, as indicated by the post-season trap and trawl survey indices, declined by more than half since 2008. Recruitment decreased in 2011 and is expected to decrease further in 2012. Prospects remain poor in the short term. Post-season pre-recruit biomass indices from both trap and trawl surveys have decreased by about 40% since 2008. Long-term recruitment prospects are unfavorable due to a warming oceanographic regime. The trawl survey-based exploitation rate index declined sharply between 2006 and 2008 and has

since increased back to the 2006 level. The pre-recruit fishing mortality rate index increased from 2007-2011. Maintaining the current level of fishery removals would likely result in an increase in the exploitation rate and high mortality on soft-shelled immediate pre-recruits in 2012.

In Div. 3K inshore, Landings increased from 2,700 t in 2005 to 3,600 t in 2009, but decreased by 31% to 2,500 t in 2011. The TAC was not taken in 3 of the 5 management areas in 2011. Effort has increased by 64% since 2008. CPUE increased sharply from 2005 to a record high level in 2008, but has since declined by more than half. The exploitable biomass, as indicated by the post-season trap survey index, decreased gradually between 2007 and 2010 and since changed little but there is considerable variability among management areas. While uncertain, recruitment prospects appear to have changed little and there is considerable variability among management areas. The trap survey-based exploitation rate index increased sharply in 2010 and then returned to the 2007–2009 level in 2011. Data are insufficient to estimate the pre-recruit fishing mortality rate index. Maintaining the current level of removals would likely have little effect on the exploitation rate in 2012. However, it would likely result in increased wastage of soft-shelled immediate pre-recruits in some management areas in 2012.

In Div. 3LNO offshore, Landings decreased from 24,500t in 2007 to 22,000t in 2009 but since increased to 26,000t. Effort increased slightly in 2011 following a 2008-2010 decrease. VMS-based CPUE declined to its lowest level in 2008, but has since increased to the long-term average. Opposing survey trends create uncertainty about the exploitable biomass. The trawl survey index decreased by 34% since 2009 while the trap survey index increased by 21%. Recruitment has recently peaked and will likely decrease over the short term. Long-term recruitment prospects are unfavourable due to a warming oceanographic regime. The exploitation rate index increased in 2011 following a sharp decrease from 2008-2010 while the pre-recruit fishing mortality rate index has remained near its lowest level during the past three years. Maintaining the current level of removals would have an uncertain effect on the exploitation rate in 2012.

In Div. 3L inshore, Landings increased by 19% from 6,100 t in 2005 to 7,300 t in 2010 and decreased slightly to 7,100 t in 2011. Effort increased by 24% from 2008-2010 but decreased slightly in 2011. CPUE has remained at the long-term average for the past three years. The post-season trap survey index suggests that the exploitable biomass has changed little over the past 6 years. Overall, recruitment prospects have recently improved. The trap survey-based exploitation rate index decreased slightly in 2011. Data are insufficient to estimate a pre-recruit fishing mortality rate index. Maintaining the current level of fishery removals would likely result in little change in the exploitation rate, but may increase mortality on soft-shelled immediate pre-recruits in some management areas in 2012.

In Subdiv. 3Ps offshore, Landings almost doubled from 2,300 t in 2006 to 4,300 t in 2011. Meanwhile, effort increased by 56 % since 2008. CPUE increased from 2005-2009 and has since declined slightly. The exploitable biomass, as indicated by both the spring trawl survey and the post-season trap survey indices, increased steadily from 2006-2009 and has since declined sharply to 2011. Recruitment has recently declined and is expected to decline further in the short term. Post-season pre-recruit biomass indices from both trap and trawl surveys declined sharply from 2009-2011. Long-term recruitment prospects are unfavorable due to a warming oceanographic regime. Exploitation and pre-recruit fishing mortality rates, as indicated by spring trawl survey indices, decreased from 2007-2009 but increased sharply to 2011. Maintaining the current level of fishery removals would likely result in an increase in the exploitation rate in 2012.

In Subdiv. 3Ps inshore, Landings more than tripled from 700 t in 2005 to 2,500 t in 2011. Meanwhile, effort declined from 2005-2010 and increased by 22% in 2011. CPUE increased steadily from 2005 to its highest level since 1996 in 2010 and decreased marginally in 2011. The

exploitable biomass, as indicated by the post-season trap survey index, increased substantially between 2006 and 2010 and decreased in 2011. Recruitment decreased in 2011 and is expected to decrease further in the short term. The post-season trap survey-based exploitation rate index changed little during 2008-2011. Data are insufficient to estimate a pre-recruit fishing mortality rate index. Maintaining the current level of fishery removals would likely result in an increase in the exploitation rate in 2012.

n) *Iceland Scallop* – Div. 3LNOPs

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 2009-2011. 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 2010 & 2011 there were no Iceland Scallop 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.

o) *Sea Scallop* – Subdiv. 3LPs

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 to 920 t (round).

There were 9 t (round) of Sea Scallops removed by inshore vessels in Div. 3L in 2010.
There were no Sea Scallop landings from Div. 3L in 2011.

p) *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 6,900 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, decreasing from about 520-640 t in 2008-2009 to about 100 t in 2010 and 2011.

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 2011 with three physical and biological oceanographic offshore surveys carried out along several cross-shelf NAFO and AZMP sections from the Southeast Grand Bank to Nail Bank on the mid- Labrador Shelf. The first was conducted on the CCGS Teleost from April 26 to May 2, supplemented with observations taken the Teleost Capelin survey from May 6-27. The second survey on CCGS Teleost took place from July 8-25 and the last on CCGS Hudson from November 20 to December 10. 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 2011 in NAFO Divs. 2J and 3KLNOP. The results were based on physical observations collected on the NL Shelf from Nain Bank to the Southern Grand Bank and on St. Pierre Bank from the AZMP and fisheries assessment surveys. Water temperatures on the NL Shelf remained above normal throughout 2011, setting new record highs in some areas. Water salinities were generally fresher-than-normal in many areas on the shelf from 2009-2011. At Station 27 (a standard monitoring site off eastern Newfoundland), the depth-averaged annual water temperature increased to a record high in 2011 at 2.9 SD (1.0°C) above the long-term mean. Annual surface temperatures at Station 27 were above normal by 0.6 SD (0.4°C) while bottom temperatures (176 m depth) were at a record high at 3.4 SD (1.3°C) above normal. The annual depth-averaged salinities at Station 27 were below normal for the 3rd consecutive year. The annual stratification index at Station 27 decreased to 2 SD below normal, the lowest since 1980. The area of the cold

intermediate layer (CIL) water mass with temperatures <0°C on the eastern Newfoundland Shelf (Bonavista Section) during 2011 was at a record low value at 2 SD below normal, implying warm conditions, while off southern Labrador it was the 4th lowest at 1.5 SD below normal. On the Grand Bank the CIL was the second lowest on record. Average temperatures along sections off eastern Newfoundland and southern Labrador were above normal while salinities were generally below normal. All spring bottom temperature measurements in NAFO Divs. 3Ps and 3LNO during 2011 were above 0°C and up to 1°-2°C higher than normal. During the fall, bottom temperatures in 2J and 3K were also at a record high value, at 2 and 2.7 SD above normal, respectively, and in 3LNO they were 1.8 SD above normal. Generally, bottom temperatures were about 1°-2°C above normal in most regions, with very limited areas of the bottom covered by <0°C water. The volume of CIL (<0°C) water on the NL shelf during the fall was below normal (4th lowest since 1980) for the 17th consecutive year.

b) Plankton studies

In general, nitrate inventories in NAFO Subareas 2 and 3 were above normal within the upper 50m in 2011. In contrast, the deeper inventories of nitrate that represent the main limiting nutrient for the following year showed a large reduction in 2011 compared to previous years. Lower than normal surface phytoplankton blooms and background chlorophyll *a* levels were detected with satellite imagery across the northwest Atlantic in 2011. Ship-based observations of phytoplankton standing stock along ocean transects which provides sub-surface information revealed lower chlorophyll *a* inventories on the Newfoundland and Labrador Shelves in 2011 consistent with satellite imagery. The duration of the spring bloom was mostly reduced along the northwest Atlantic in 2011 with few exceptions. The timing of the spring bloom varied across the NAFO Subareas in 2011 with near-normal conditions in the northern areas (2J, 3K), delayed blooms across the northern Grand Banks (3L-3M), to earlier blooms observed across the southern Grand Banks. Enhanced abundance of large and small copepods as well as total copepod zooplankton was observed for the Newfoundland and Labrador Subareas in 2011 with 1 to 2 standard deviation units above normal in the 13-year time series. The zooplankton dry weight anomalies ranged from near normal to below normal across NAFO Subareas 2 and 3 in 2011.

2. Biological Studies

a) Groundfish

Biological and oceanographic data from fall multi-species research vessel surveys were collected from Div. 3K, 3L, 3N, 3O and 3P to conduct distribution and abundance studies and detailed biological sampling is used to conduct analyses of growth, maturity and condition.

Analysis of sexual maturity data is conducted regularly on American Plaice, Yellowtail Flounder and other species. The Yellowtail and American Plaice analyses are presented to NAFO during the assessment of Div. 3LNO American Plaice and Yellowtail Flounder, and for Greenland halibut in SA2+Div. 3KLMNO as needed. Research on Greenland Halibut age and growth is ongoing, using bomb radiocarbon dating to validate an ageing method.

Work continues on the autodiametric method of determining fecundity for Yellowtail Flounder, American Plaice and Witch Flounder and Greenland halibut. Fecundity samples are being collected from the spring survey in 3Ps and 3LNO and will be analyzed using this new, more efficient method. There is sufficient data for calibration for Yellowtail Flounder and Greenland halibut but work continues to collect more samples for extending the calibration curves for American Plaice and Witch Flounder. This work is necessary before the new method can be used to estimate fecundity in these species.

b) Capelin

Monitoring larval emergence from beach sediments and from bottom spawning sites in Trinity Bay continued in 2011. Monitoring egg deposition and egg development in Trinity Bay which had been ongoing since 1990 was suspended in 2011 An ongoing offshore acoustic survey initiated in the spring of 1999 to examine Capelin distribution, behaviour, and feeding habits in Div. 3KL continued in 2011. Inshore surveys were conducted in August and in September of 2011 to map the abundance and dispersal of larval Capelin in Trinity Bay, Div. 3L. A research project initiated in 2008 as part of DFO's Ecosystem Research Initiative (ERI), incorporated acoustic data collection into the fall bottom trawl surveys of Div.2J3KLNO, along with enhanced sampling of the biology and feeding of forage fishes. This work continued in 2011.

c) Salmon

Differences in marine feeding ecology of three geographically distinct populations of Atlantic Salmon in the North Atlantic were examined using analyses of stable isotopes of carbon and nitrogen. Significant differences were found among populations and between different sea-age life history groups. Reported differences in marine feeding between populations from the Northeast and Northwest Atlantic were corroborated by stable isotope results. Expanded studies are now examining variation and changes in stable isotope signatures among life stages (smolt, 1SW, and 2SW from six of the populations) for 15 Canadian populations that extend from New Brunswick and Nova Scotia to Labrador, with comparisons with salmon obtained from the West Greenland area.

Several new Atlantic salmon genetic projects began in 2011 in Subarea 3, funded in part by the Genomics Research and Development Initiative. Population genetic data (microsatellite loci) is presently being collected (~50 rivers). This data will be used to examine spatial population structure and management units and preliminary analysis suggests significant spatial structuring on regional and local scales. This data will be used as part of a North American genetic baseline to analyze samples (collected in 2004) from several mixed stock harvests including the fisheries off Saint Pierre and Miquelon fishery and west Greenland. Genomic diversity associated with local adaptation is currently being explored for populations along Newfoundland's south coast using large panels (10,000's) of single nucleotide polymorphisms. All samples have been collected and analysis is underway.

d) Shrimp

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

Northern Shrimp samples from 2J3KL have been sent to Norway as a part of an international effort to determine whether genetics can be used to separate shrimp from various parts of the northern hemisphere into stocks.

In 2011, Northern Shrimp research with NL Region became involved in two International Governance Strategic Fund projects:

1) To Develop the precautionary approach to harvesting Northern Shrimp (*Pandalus borealis*) in NAFO Subdivisions 3LNO (Shrimp Fishing Area 7). The purpose of this project is to provide clear precautionary reference points for the Northern Shrimp resource within NAFO subdivisions 3LNO and conduct a Management Strategy Evaluation (MSE) on candidate Harvest Control Rules (HCR) for sustainable management of the fishery. While the work is to address a specific component of Shrimp

(SFA7/3LNO), the results of this work could be applied to the entire Shrimp resource off the eastern Canada and into the Arctic. This is an international project with collaboration from Dr. Carsten Hvingel of the Marine Institute in Tromso, Norway.

2) 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 that the 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 the latitude 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 2011. 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 2011. A mark-recapture tagging experiment was conducted during the Notre Dame Bay (3K) survey in 2011.

A post-season trap survey which began throughout portions of 2J3KLNOPs was continued in 2011.

f) Cod

A calibration curve for the autodiametric method of determining fecundity has been completed. Fecundity samples are being collected from the spring survey in Subdiv. 3Ps and Div. 3LNO and will be analyzed using this new, more efficient method. It is hoped that these analyses will become a regular part of the spring research vessel survey sampling and that a time series of fecundity estimates can be established.

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.

SUBAREA 4

A. Status of Fisheries

Nominal landings from 2002 to 2011 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Atlantic salmon* – Subarea 4

A moratorium on the commercial fishery has been in place since 1992. The 2011 recreational harvest, including both retained and hooked-and-released, was 24,313 fish, down 18% from last year but up marginally over the previous 5 year mean.

All three of the stocks assessed in this area achieved conservation spawning requirement in 2011.

b) *Snow Crab* – Div. 4R

In Div. 4R offshore, Landings declined by 83% from 190 t in 2007 to a historical low of 30 t in 2010, but increased to 150 t in 2011. Effort increased by a factor of four in 2011 following the historical low in 2010. The TAC has not been taken since 2002. CPUE declined from 2004 to a historical low in 2009, increased sharply in 2010, and fell to the 2009 level again in 2011. The exploitable biomass remains low. Recruitment has been low in recent years and prospects are uncertain. Data are insufficient to calculate exploitation rate and pre-recruit fishing mortality rate indices. The effect of maintaining the current level of removals on the exploitation rate in 2012 is unknown.

In Div. 4R inshore, Landings declined sharply by 80% from 950 t in 2003 to a historical low of 190 t in 2010 and increased to 450 t in 2011. Effort declined by 95% from 2004 to 2010 and doubled in 2011. The TAC has not been taken since 2003. CPUE declined from 2002-2007 and has since varied without trend below the long-term average. The post-season trap survey exploitable biomass index changed little from 2005-2009 but has increased greatly in the past two years. Recruitment has recently increased and short-term prospects remain promising in most management areas. The post-season trap survey-based exploitation rate index decreased from 2007-2010 but increased sharply in 2011. Data are insufficient to estimate a pre-recruit fishing mortality rate index. Increasing fishery removals in 2012 would likely have little effect on the exploitation rate but may increase mortality on soft-shelled immediate pre-recruits in some management areas.

c) *Iceland Scallops* – Div. 4R

The nominal catch from the Strait of Belle Isle (Div. 4R) in 2011 is estimated at 431 t (round) against a TAC of 1,000 t, almost double 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 2009 , 2010 & 2011 were 15 t ,27 t and 48 t (round) respectively.

SUBAREA 0 + 2 + 3

In 2009 a three year project proposal was accepted under the International Governance Strategy (IGS). The objectives were to develop sampling protocols for Sponge collections on all research surveys for the Newfoundland and Labrador, and eastern Arctic Regions, as well as increase taxonomic expertise on Sponges.

Since the inception of the project, all research surveys conducted by the Newfoundland and Labrador Region have a standardized collection protocol in place for Sponges. Sea-going staff, including fisheries observers from the Newfoundland and Labrador Region, have been briefed on sponge collections at sea.

To date over 1,500 sponges have been sampled and processed with at least 80 species delineated. Species identification sheets are being developed for each species as well as a general identification guide to be used on local research surveys and by fisheries observers. In addition, information on Sponges processed from this region contributed significantly towards the Sponge Identification guide for NAFO Areas (Best *et al.*, 2010).

SUBAREA 2 + 3 + 4

A. Status of Fisheries

Nominal landings from 2002 to 2011 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) Lobster

Landings declined through the 1990s to 1,800 t in 2000, from a long-term high of 3,200 t in 1992. Reported landings increased to 2,100 t in 2002 and 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 have since declined by 24% in 2011 to 1900 t. Landings have been increasing in in Subdiv. 3Ps (LFA 11 and 12) up to 2010 but had a sharp decline in 2011. Landings in Div. 4R had a recent peak in 2008 but now have declined to the values in the late 1990's. Landings in Div. 3K and 3L have declined to record lows. The lobster fishery is monitored at several localized sites through at-sea sampling programs and co-operative arrangements with harvesters who complete voluntary logbooks on commercial catch and effort. A mandatory logbook has been in place since 2010. At-sea sampling data from LFAs 5 (in Div. 3L), 10, 11 and 14 suggest that the catch consists largely of incoming recruits, and that annual survival of males is generally less than 0.2. Survival of females is higher. Sufficient data are not available to assess the overall status of the resource at this time.

B. Special Research Studies

1. Miscellaneous Studies

a) Atlantic Salmon License Stub Return System

The 'License Stub Return' system, implemented in 1994, provides recreational catch and effort data for ~190 Newfoundland and Labrador rivers. This data collection system is a collaborative project between the Federal Government, Fisheries & Oceans Canada, and the Government of Newfoundland and Labrador, Department of Environment and Conservation.

Currently, the Provincial Government sells approximately 21,000 recreational salmon licenses a year. The license stub return is not mandatory in this province and our return rate hovers around 40%. The project consists of a voluntary response, and then three mail out reminders to anglers. In March each year, a non-respondent telephone survey is conducted, to adjust our data for the remaining 60% or the non-respondent portion of the angling population. Information from the license stub return system is used in the annual assessment of Newfoundland and Labrador salmon and is also used by the ICES to derive pre-fishery abundance of salmon in the Northwest Atlantic for the annual West Greenland advisory process. On average during the past five years (2007-2011) more than 50 thousand salmon are angled annually in Newfoundland and Labrador (retained plus released).

Owing to the importance of the license stub return data, recent studies have now examined patterns of change in angler participation and demographics over a 17-year period (1994-2010). Significant changes in resident angler participation have been identified, with differences among regions apparent. Mean age of anglers has also increased significantly. Return rates of angler logs (catch history) have declined over time and were found to vary by age, sex and area of angler residence.

a) Sentinel Studies

The Sentinel Surveys, initiated in October 1994, were continued in 2011. Data collected were tabled at Regional stock assessments in the spring of 2012 for Divs. 2J3KL cod. Sites in Divs. 2J3KL, Subdiv. 3Ps and Divs. 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.

b) Cod Tagging and Telemetry

Tagging and telemetry studies on Cod in Div. 2J3KL were continued in 2011. Approximately 2,000 Cod were tagged and released with Floy tags; in addition detections of 150 acoustically tagged Cod were released inshore in 3KL during 2010 were obtained from acoustic receivers. The receivers have been deployed along a 350 km area of the inshore since 2006. The objectives were to obtain estimates of exploitation and population size to improve the assessment of this stock and to study migration patterns and survival rates. During 2009-11, estimates of exploitation (harvest) rate ranged from 2-10% for the cod released and recaptured inshore).

c) Hydrographic Surveys

The Canadian Hydrographic Service (CHS) priorities for Subareas 2, 3 and 4 for 2011 were several sites throughout Newfoundland and Labrador.

<u>CCGS Matthew</u>
As in previous years, the Canadian Coast Guard Hydrographic survey vessel CCGS Matthew conducted hydrographic surveys at various locations throughout Newfoundland and Labrador. During the 2011 survey season, surveys were completed at the Approaches to Cartwright in Labrador. On the Island of Newfoundland hydrographic surveys were completed in Bay of Islands, Bonne Bay and Notre Dame Bay.

Approaches to Cartwright, Labrador

A multibeam acoustic survey was conducted for the approaches to Cartwright, Labrador. This work was a continuation of surveys started previously. The data collected will be used for navigation safety.

Bay of Islands, Island of Newfoundland

The Bay of Island project was a continuation of surveys from the past several years aimed at collecting sufficient Hydrographic data to commence production of two new editions of charts covering the Bay of Islands area. Data collection for the Bay of Island area is now completed. The two charts 4653, and 4654 that cover the Bay of Islands are in feet and fathoms and need to be recompiled in the Metric standard from the collected data. Chart 4654 is a large scale chart that is mostly used for an anchorage area for vessels waiting to berth in Corner Brook. Chart 4653 is a class A chart of the CHS level of service. It is due for New Edition as a CHS commitment to provide high quality charting for the area identified as priority navigation routes.

Bonne Bay , Island of Newfoundland:

The CCGS Matthew and two survey launches, all equipped with multibeam acoustic echo sounders, began data collection which will be used to produce a new chart for Bonne Bay (chart 4881). This new chart will replace chart 4658 that was compiled from data from the 1890's. Chart 4881 will be compiled from multibeam data and will be to modern day standards.

Notre Dame Bay, Island of Newfoundland:

The Matthew and two survey launches completed the data collection required to produce two new charts in Notre Dame Bay. The two new charts; (**4867)** Leading Tickles to Little Bay Island and chart **(4868)** Halls Bay Head to Nippers Harbour will replace several older charts originally from the British Admiralty. The charts will be compiled from new multibeam data and will be to modern standards. Once published the two new charts will complete coastal Notre Dame Bay charting to modern standards.

Annual Sailing Directions Revisory Survey

The 2011 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 101, Cape Bauld to Cape Bonavista and ATL 120, Labrador, Camp Islands to Hamilton Inlet (including Lake Melville)

An integral part of the Sailing Directions Revisory Survey is chart dealership inspections. These inspections assured 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 various locations throughout 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. Presently three of the Sailing Directions publications for Newfoundland and Labrador are available in POD format.

Table 1: Summary of preliminary catches for stocks within the DFO, Newfoundland and Labrador Region, 2001-2010.
Note that unless otherwise specified, this table presents Newfoundland and Labrador landings only.

Subarea	Species	Division	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
0+1	Greenland halibut	SA 0 + 1A(offshore)+ 1B-F	3871	3862	3,363	3,348	3,742	4,045	4,005	4,993	4,017	2,560
	Shrimp*	0A							7,508	6,236	6,654	6,247
		0B							6,333	4,488	4,584	5,597
2	Cod	2GH	0	0	0	0	0	0	0	0	0	0
	Shrimp*	2G (SFA 4)		11,446	10,656	9,682	10,009	10,084	10,247	9,644	13,020	8,387
		2HJ (SFA 5)		14,960	25,094	20,503	23,768	22,612	22,904	22,785	30,437	15,339
		2J3K (SFA 6)		55,255	45,099	75,080	80,736	75,673	75,231	77,820	71,227	60,384
	Snow Crab	2HJ	1,933	2131	2,387	2,549	2,523	2139	1576	1,925	2511	3,521
	Iceland scallop	2HJ	19	16	17	13	40	686	672	495	528	272
	Arctic Charr	2J3KLPs+4R	24	11	16	18	28	40	22	19	19	21
	Atlantic salmon****		41	36	30	36	27	32	31.9	32	22.1	17.6
2+3	Redfish	2+3K	74	61	28	20	29	221	135	167	22	34
	Greenland halibut	2+3KLMNO	6166	6529	5,744	4,701	5,073	6,307	6,644	4,877	6,620	6,291
	American plaice	2+3K	18	22	10	10	23	60	29	16	33	100
	Witch	2J+3KL	143	160	45	5	22	53	40	26	110	167
	Cod*****	2J3KL	3139	2902	3,098	3,343	2,546	2,679	1,330	643	971	4,196
	Grenadier	2+3	113	41	13	10	38	99	151	135	183	274
	Capelin	2J3KL (offshore)		0	0	0	0	0	0	0	0	0
	Squid	2+3		100	643	515	228	6,879	548	2,525	1089	229
3	Redfish	3LN	1960	113	6	1	3	1	2	0	9	47
		3M	2	0		0	0	0	0	0	0	0
		3O	97	42	255	202	1,054	3,580	5,364	2,340	3,093	2,988
	Yellowtail	3LNO	3947	8056	5,414	10,216	3,674	177	13,268	12,577	12,705	9,959

Subarea	Species	Division	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
	American plaice	3LNO	450	1154	1,077	878	434	93	1,466	1,290	1,607	1,374
		3Ps	279	402	509	456	460	485	745	731	883	1,014
	Witch flounder	3NO	11	39	41	46	21	94	49	49	62	27
		3Ps	175	446	454	298	110	182	483	540	529	517
	Atlantic halibut	3	270	321	289	287	170	251	255	303	399	369
	Cod	3NO	39	103	158	231	123	73	459	441	714	422
		3Ps	5424	6,737	7,491	9,636	10,599	10,506	11,400	11,046	12,469	12,618
	Haddock	3LNO	42	27	104	60	30	23	44	18	67	183
		3Ps	88	129	173	288	302	128	219	123	137	111
	Pollock	3Ps	186	319	287	616	1,042	733	500	296	333	492
	White hake***	3NOPs	239	559	748	1383	1,680	2,112	2,145	1581	1538	1920
	Thorny skate***	3LNOPs	467	604	1334	1452	1639	1,392	2124	2026	3823	3413
	Capelin	3L	12,023	11,927	13,326	15,176	16,321	15,430	15,230	15,694	13,270	8,639
		3K	8,081	3,544	9,853	13,043	13,036	14,368	12,166	11,157	4,067	1,553
	Shrimp*	3M		0	0	0	0	0	0	0	0	8
		3L		13,535	20,494	21,187	18,316	18,128	11,109	10,560	10,701	5,417
	Sea scallop	3KLNO	0	27	0	0	9	10	35	0	0	0
		3Ps	920	842	432	293	359	518	2,132	3,473	647	51
	Iceland scallop	3LNO	0	0	0	1	0	347	128	0	0	0
		3Ps	0	0	2	5	6	132	1,748	40	87	478
	Snow Crab	3K	10,749	12,420	16,184	15,068	12,270	10,717	8,685	16,460	16,502	16,352
		3LNO	32,915	31,419	29,033	30,248	30,895	30,717	29,649	30,717	31,638	30,032
		3Psn	6,717	6,026	5,559	4,523	3,947	3,099	3,169	4,720	6,113	7,637
	Lobster	3K		96	107	135	120	156	209	157	207	206
		3L		114	99	109	82	111	112	73	116	128

Subarea	Species	Division	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
		3Ps		1,232	1,071	1,170	1,010	1,049	987	779	786	763
		3Pn		138	127	153	94	52	29	14	22	11
	Atlantic salmon**	2J3KLPs+4R	48	51	41	50	29	36	41	37	40	39
3+4	Redfish	3P+4V	907	2,275	2,265	1,217	1,402	2,439	1,918	3,428	3,956	3,451
4	Iceland scallop	4R	431	244	246	121	284	656	454	360	275	252
	Sea scallop	4R	48	27	15	0	0	0	0	0	0	0
	Lobster	4R		1,023	1,097	1,405	1,260	1,276	1,280	888	1,125	950
	Snow Crab	4R	595	221	287	380	554	543	862	1,462	1,562	1,851

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).
Please note that during 2003 industry requested and was granted a season change from a calendar year (Jan. 1 - Dec. 31) to Apr. 1 - Mar. 31.
Therefore all years subsequent to 2002 are Apr. 1 - Mar 31 for shrimp fishing areas 4, 5 and 6 only.
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.
Since 2007, all values will be according to the Apr. 1 - Mar. 31 management year for Shrimp fishing areas 4-6.
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-
2011

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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 2011/12, as well as those currently underway for 2012/13.

List of IGS Activities 2011-12	
Project Leader(s)	**Title**
P. Shelton/D. Miller	Developing precautionary harvesting strategies for high seas straddling stocks: Management Strategy Evaluation for the NAFO Divisions 2J3KLMNO Greenland halibut stock.
J. Morgan/Y. Lambert/E.Trippel	Canada-Spain Marine Collaboration -Analysis of Stock Reproductive Potential to promote sustainability of Greenland Halibut fishery
V. Wareham/ K. Gilkinson	Deep-sea sponge taxonomy and distribution
V. Wareham/ K. Gilkinson	Identification of Historical Concentrations of Corals and Sponges on the Newfoundland & Labrador Shelf and Slope from DFO Research Vessel Survey Records
W. Brodie	Understanding impacts of various fishing gears on VME and biodiversity.
E. Kenchington/M. Koen-Alonso/P. Pepin/K. Zwanemburg	Delineating ecoregions in the NW Atlantic to support the development of MPA networks
J. Lawson	Characterizing noise environment and marine mammal assemblages for candidate VME on the Grand Banks and the NRA.
B. Greenan	Connectivity and Uniqueness of Closed Areas in International Waters Adjacent to Canada

J. Loder	Ocean Climate Assessments and Indices for Ecosystem Issues in the Offshore NW Atlantic
K. Azetzu-Scott	Impact of Ocean Acidification on NW Atlantic Fisheries and Marine Ecosystems
E. Head	Ecosystem monitoring in the Northwest Atlantic using the continuous plankton recorder
E. Kenchington	Benthic surveys of VME in the NRA
E. Kenchington	Defining encounter protocols in the NRA
V. Kostylev	Detecting VMEs in the NRA using the habitat template approach
K. Dwyer/S. Campana	Bomb radiocarbon dating of Greenland halibut otoliths to validate age

Part B. Central and Arctic Region

SUBAREA 0

A. Status of the Fisheries

1. Shrimp

a) *Division 0A*

The shrimp fishery in 0A is based on *Pandalus borealis* fished east of 60°30'W which corresponds to the Canadian Shrimp Fishing Area (SFA) 1. The quota in 0A rose from 8,500t in the early 1990s to 18,417t in 2004 and remained at this level through 2011. Reported catches rose from a low of 517t in 1997 to 7,508t in 2005 (Table 1). Catches steadily declined over the next three years with no catch recorded in 2008. This decline in catch has more to do the increased operating costs mainly fuel price than stock status. Continued high operating cost continues to impact the fishery but improved catch rates in 2010 resulted in a total catch of 5883t. However in 2011 catch rates were again poor except in the first month of the season resulting in a total of 1296t with most of that coming in the first month.

b) *Division 0B*

The 0B shrimp fishery is a mix of *Pandalus borealis* and *Pandalus montagui*. SFAs with corresponding quotas for each species are used to manage the shrimp fishing within 0B. Catches are reported by SFA. Since the SFAs do no correspond exactly to NAFO boundaries the catches are estimated from a combination of SFAs. For this report shrimp reported in SFA2 and 3 are reported as 0B catch in this report. This is appropriate when the distribution of the fishing effort is considered. The exception would be the portion of NAFO 2G from 60°30'N-61°N and 63°W-64°30'W which is also reported as SFA2 catch. Therefore the accuracy of the level as it relates to the NAFO Division can be questionable.

The quota for the area rose from 3,500t in 1996 to 9,150t in 2006 for *Pandalus borealis* and 1,200t in 1996 to 4,300t in 2002 for *Pandalus montagui* where they have remained since. Catches of *Pandalus borealis* in 0B have fluctuated between 3,220t to 6,333t from 1996 to 2005 but the 2011 catch of 7869t in the highest in the time series (Table 1). Increased fishing effort in the area east of 63°W accounted for the higher catch in 2011. 1,545t of *P. montagui* were caught in 2011. DFO survey in Hudson Strait west of 66°W in 2007 and 2009 renewed interest in fishing the area and accounted for over half of the p. montagui taken. Catch rates in 0B remain at a high level.

2. Greenland Halibut

a) *Division 0B*

Offshore: Catches in 0B for vessels licensed by Central and Arctic Region (C&A) have varied between 20 t and 1720 t from 1992-2007 and increased since then to 2977 t in 2011 (Table 2). Approximately 68% of the 2011 catch from all regions in 2011 was caught using trawls (single and twin) with gillnets and long-lines catching the remainder (Table 4).

A standardized catch rate (CPUE index) using a General Linear Model for the Canadian offshore trawl fleet was updated. There have been frequent vessel changes in this fishery over the years and the catch from single and double trawl gear was often aggregated as "otter trawl" catch when this gear was first introduced to the fishery in the early 2000s. Very few of the vessels operating in the fishery in 2011 have been in the fishery for more than 3 years. Vessel/gear and month classes with fewer than 5 occurrences were removed from the database and catches (t) and hours fished with values less than 10 were removed.

The CPUE index increased to the highest observed level in 2009 but declined in 2010 and increased slightly in 2011. The CPUE is slightly above the level seen in the 1990s (Fig. 1a).

The un-standardized catch rate indices have been variable for both trawl gear types since 2002. Catch rates increased in 2011 and are slightly above the levels observed in the 1990s (Fig. 1b).

Un-standardized CPUE for gillnets remained relatively stable from 2003 to 2008, then increased in 2010. In 2011 the CPUE declined slightly (Fig. 3).

Length frequency distributions for the Div. 0B catch was prepared using Newfoundland region observer data. There was approximately 5% observer coverage for the gillnet fleet and 100% for trawl fleet (Fig. 4 and 5). The catches in the gill net fishery in Div. 0B were dominated by a mode at 64 cm. The length distributions in the single and twin trawl fishery in Div. 0B had modes at 49 cm and 53 cm, respectively. The modes have been around 51 cm, for both types of trawl gear in recent years (Fig. 4).

Inshore: The Cumberland Sound fishery began in 1987 and is the only inshore fishery in Subarea 0 that has operated on an annual basis. Since 2005 the inshore fishing grounds have been managed separately from the offshore with a TAC set at 500 t. The fishery is primarily a winter fishery (January to May) and the fishermen use long-lines set through holes cut in the land-fast sea ice, although interest in a summer small boat fishery is developing. Sea-ice conditions can affect the success of the winter fishery by restricting access to deeper more productive areas and thereby curtailing effort in some years. Catches were highest from 1989 to 1995, ranging from 139 t to 430 t (Table 3). Since 1995 catches have been < 100 t with the exception of 2002, 2003 and 2009. Fishing was conducted in Cumberland Sound in the summer open-water season in 1995, 2002 and 2009 to 2011. Early efforts to develop a summer fishery were not successful in locating exploitable aggregations of Greenland halibut but in 2009 and 2010 a small long-liner was brought up from southern Canada and catches were better. The vessel did not return in 2011 and only one or two local small boats fished that summer with a catch of <1 t.

b) *Division 0A*

The fishery began in 1996 and is fished exclusively by C&A licensed vessels. Between 1996 and 2000 catches were less than 330 t Table 2. In 2001 the TAC was set at 3500 t, in 2003 it increased to 4400 t and in 2006 it was increased to 6500 t. The TAC has been achieved in most years (Table 2). The total catch for 2011 was 6260 t (Table 2 and 4). Prior to 2006 a majority of the catch was caught using bottom otter trawl (both single and twin trawl gears have been used). Gillnets which were first introduced into the fishery in 2004. Long-line gear was used in this fishery in 2002 and 2003. Approximately 49% of the 2011 catch was caught using trawls (Table 4).

As in Div. 0B very few of the vessels operating in the fishery in 2011 have been in the fishery for more than 3 years. A General Linear Model was used to standardize trawl catch rates. Vessel/gear and month classes with fewer than 5 occurrences in the database were removed as were records where catch and hours fished were less than 10. The CPUE index was variable between 1996 and 2001, since then it has been relatively stable (Fig. 2a). The un-standardized catch rates for both single and twin trawl gears has been more variable with a slightly increasing trend for single trawl and a relatively stable trend for twin trawl (Fig. 2b).

The un-standardized CPUE for the 0A gillnet fleet has gradually increased since 2004 (Fig. 3).

Length frequency distributions for Div. 0A catches were prepared using Newfoundland region observer data (100% observer coverage on all gear types in Div. 0A). Catch in the Div. 0A gill net fishery was

dominated by a mode at 64 cm, similar to that seen in previous years (Fig. 4 and 5). The length distributions in the trawl fishery had a mode at 49 cm (Fig. 5) similar to a mode of approximately 48 cm seen in both types of trawl gear in previous years.

c) *Subarea 0*

Details on the main by-catch species in the Greenland halibut fisheries for Subarea 0 based on observer data for both C&A and Newfoundland and Labrador vessels are summarized in Tables 6 and 7 and include catch data on wolfish species and bottlenose whale that have been listed under the Canadian Species at Risk Act.

B. Special Research Studies

1. Environmental Studies

Oceanographic data (temperature, salinity and depth) within NAFO SA0 are collected with a headline mounted Seabird CTD on each survey tow.

2. Biological Studies

a) Greenland halibut

Division 0B was surveyed in 2012, the third time this area has been surveyed using M/Tr Pâmiut. Previous surveys were conducted in 2000 and 2001. Prior to this there had been a survey conducted in 1986 using the DFO RV Gadus Atlantica (SCR 12/023).

A Greenland halibut population study based on microsatellite DNA for samples from several locations throughout the North Atlantic was conducted over 2009-2012. Preliminary results are now available and a manuscript will be prepared for publication.

Results from the DFO and Greenland Institute of Natural Resources (GINR) offshore tagging program from 2007-2009 are being tabulated. During this period 12,225 fish were tagged. GINR returns to 2008 are 132 and DFO returns from 2009 to present are 42 (Figure 6). Some fish underwent long distance migrations with 6 re-captures in NAFO Divisions 2J3KL and 2 from East Greenland/Denmark Strait.

b) Shrimp

2011 was year 7 of the survey conducted by the Northern Shrimp Research Foundation in partnership with DFO. The standard trawl survey produces abundance and biomass indices of shrimp in Division 0B. Oceanographic parameters were recorded on each set taken during the survey.

A biennial DFO multi-species research survey has been conducted in SFA3 west of 66°W from 2007. While not strictly in NAFO 0B the survey supports the assessment of the fishing conducted in the division. The standard trawl survey produced abundance and biomass estimates for *Pandalus borealis* and *P. montagui*. Fecundity, length-weight and feeding habits of the shrimp were examined. Oceanographic parameters were recorded on each set taken during the survey.

Table 1. *Pandalus borealis* catch (t) reported by all Canadian vessels fishing from 1990-2011.

Division	2011	2010	2009	2008
0A	1296	5883	220	0
0B	7869	6523	5429	5110

Division	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
0A	1945	4127	7508	6236	6654	6247	3625	1588	2046	933	517	2623	2361	4727	5501	7493	6788	6177
0B	5717	6143	6333	4488	4584	5597	5829	4805	5132	5204	5670	3220	3564	476	106	1291	1107	1609

Table 2. Greenland halibut catch (t) in SA0 by Central and Arctic licensed vessels, 1992-2011.

Division	2011	2010	2009	2008
0A	6260	6390	6593	5093
0B[1]	2977	2954	2254	2014

Division	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992
0A	6150	6635	4268	3740	4142	3800	2625	320	0	42	203	329	0	0	0	0
0B[1]	1227	1219	1240	1061	1016	918	1017	1043	1568	1720	1446	1417	407	0	20	1020

[1]Does not include catches from the inshore Cumberland Sound long-line fishery which has been managed separately from Div. 0B offshore since 2005.

Table 3. Greenland halibut catch (t) in Cumberland Sound (Div. 0B-inshore), 1992-2011.

Fishery	2011	2010	2009	2008	2007	2006	2005	2004
Winter	54	33	156	30	3	70	9	61
Summer	<1	34	29					

Fishery	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
Winter	242	106	78	45	34	63	66	61	285	402	425	430	139	255	180	11	4

Table 4. Greenland halibut catch (t) in 2011 for Subarea 0 by division, region, month and gear. Data are from Fisheries and Oceans Statistics Branches. GN=gillnet, LL=longline.

	DIVISION 0B								**DIVISION 0A**				**SA 0**
	Can (N)			**Can (C&A)**					**Can (C&A)**				
	Single Trawl	Double Trawl	GN	Single Trawl	Double Trawl	LL	GN	**Total**	Single Trawl	Double Trawl	GN	**Total**	**Total**
Jan	142							**142**					**142**
Feb	371							**371**					**371**
Mar								**0**					**0**
Apr								**0**					**0**
May	691	171	198	537	105		129	**1831**					**1831**
June	12	525	856		621		108	**2122**					**2122**
July	30	267	456	36	120		188	**1097**	78	965	84		**1097**
Aug			94	211	221		15	**541**	81	1064	915		**541**
Sep			75		141	37		**253**	21	786	1002		**253**
Oct				5	131	44		**180**		94	888		**180**
Nov				9	32			**41**			282		**41**
Dec				54	233			**287**					**287**
Total	**1246**	**963**	**1679**	**852**	**1604**	**81**	**440**	**6865**	**180**	**2909**	**3171**	**6260**	**13125**

Footnotes:
1) In Division 0B, the Central and Arctic long-line catch from the Cumberland Sound inshore management area is not included above, it was 54 t in 2011.

Table 6. Catch (t) of Greenland halibut and select bycatch species (those with catches 1 t or greater) from the 2009 and 2010 Div. 0A Greenland halibut fishery for all regions not just C&A. Data are from observers with 100% coverage on all fleets.

	2009			2010		
Species	Trawl	Gillnet	Total	Trawl	Gillnet	Total
Greenland halibut (*R. hippoglossoides*)	4549	3075	7624	3906	2765	6671
Greenland shark (*S. microcephalus*)	50	11	61	22	5	27
Arctic skate (*A. hyperborea*)		19	19		9	9
Thorny skate (*A. radiata*)	6		6			
Roughhead grenadier (*M. berglax*)	3	10	13	1	10	11
Sponge	3		3			
Northern wolffish (*A. denticulatus*)	1	3	4	2	2	4
Bottlenose whale (*H. ampullatus*)		6	6			

Table 7. Catch and bycatch in the 2009 and 2010 Division 0B Greenland halibut fishery, all regions not just C&A. Data are from observers with approx. 5% coverage on the gillnet fleet and 100% coverage on the trawl fleet.

	2009			2010		
Species	Trawl Catch (t)	Gillnet (Catch t)	Total Catch (t)	Trawl Catch (t)	Gillnet (Catch t)	Total Catch (t)
Greenland halibut (*R. hippoglossoides*)	4184	56	4240	5042	116	5158
Greenland shark (*S. microcephalus*)	5		5	12	1	13
Thorny skate (*A. radiata*)	4		4			
Grenadier sp.	8		8	9		9
Roughhead grenadier (*M. berglax*)	6	1	7	6	3	9
Roundnose grenadier (*C. rupestris*)	6		6	4		4
Redfish (Sebastes. Sp.)	3	1	4	7	1	8
Sponge	8		8	11		11
Spiny crab (N. grimaldii)		1	1		2	
Northern wolffish (*A. denticulatus*)	5		5	15	1	16
Striped wolfish (*A. lupus*)	5	1	6	2		2
Spotted wolffish (*A. Minor*)	3		3	1		1

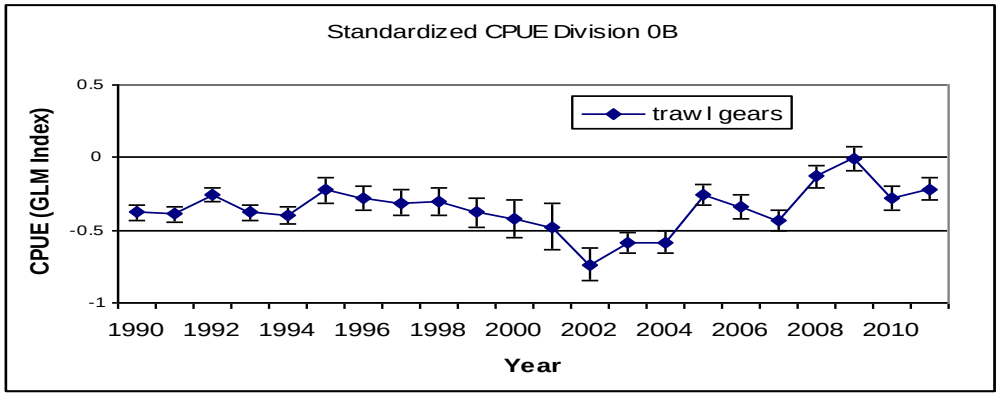


Figure 1a. Standardized CPUE series for trawlers operating in Div. 0B (+/- S.E).

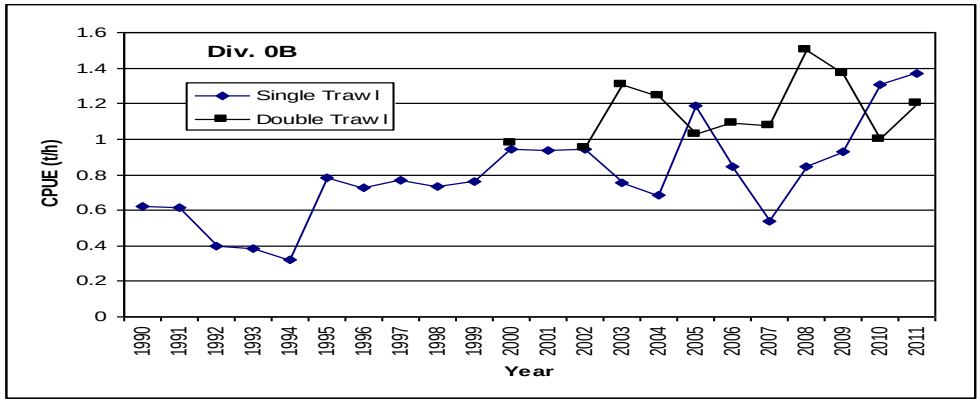


Figure 1b. Div. 0B trawl fleets, un-standardized CPUE series.

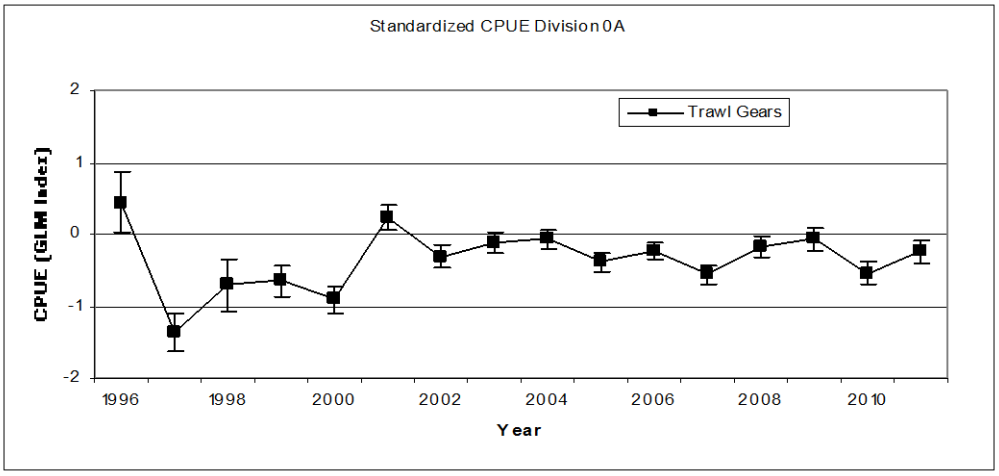


Figure 2a. Standardized CPUE series for trawlers operating in Div. 0A (+/- S.E).

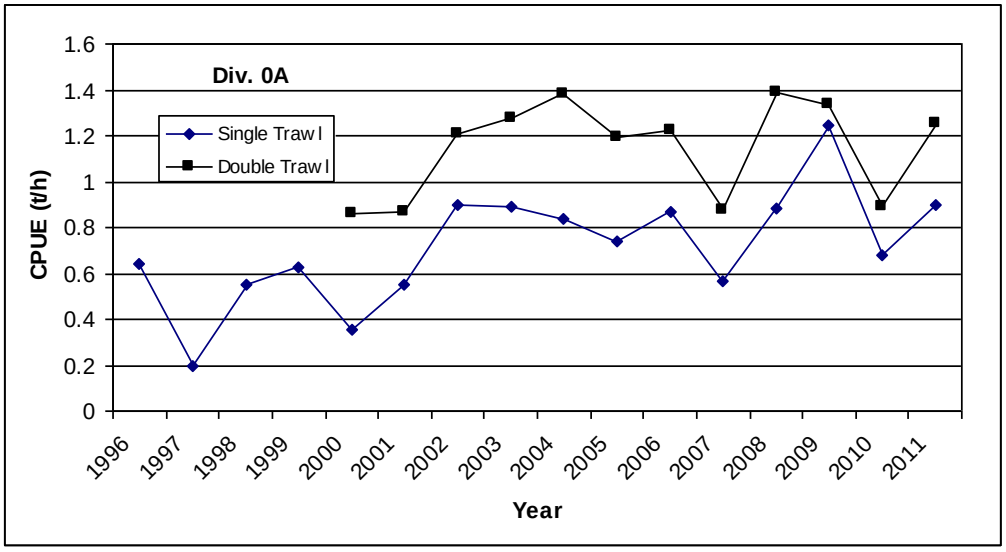
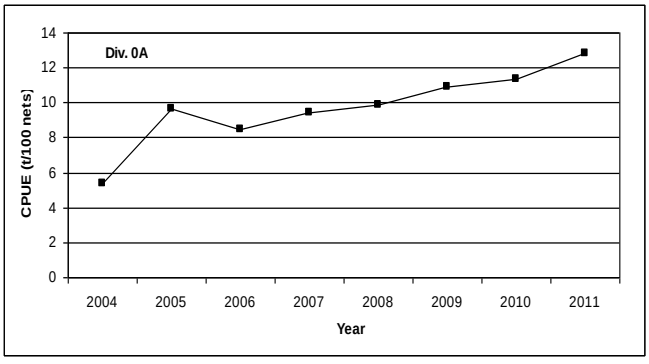


Figure 2b. Division 0A trawl fleet, un-standardized CPUE series.



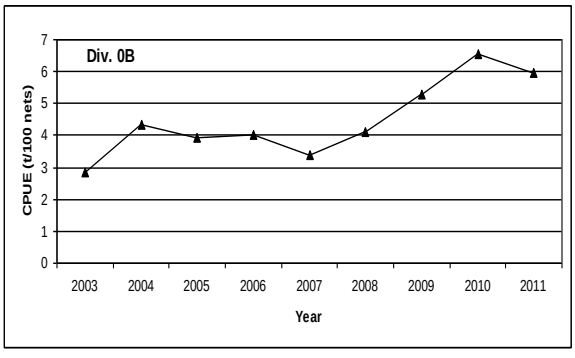


Figure 3. Division 0B and 0A gillnet fleets, un-standardized CPUE series.

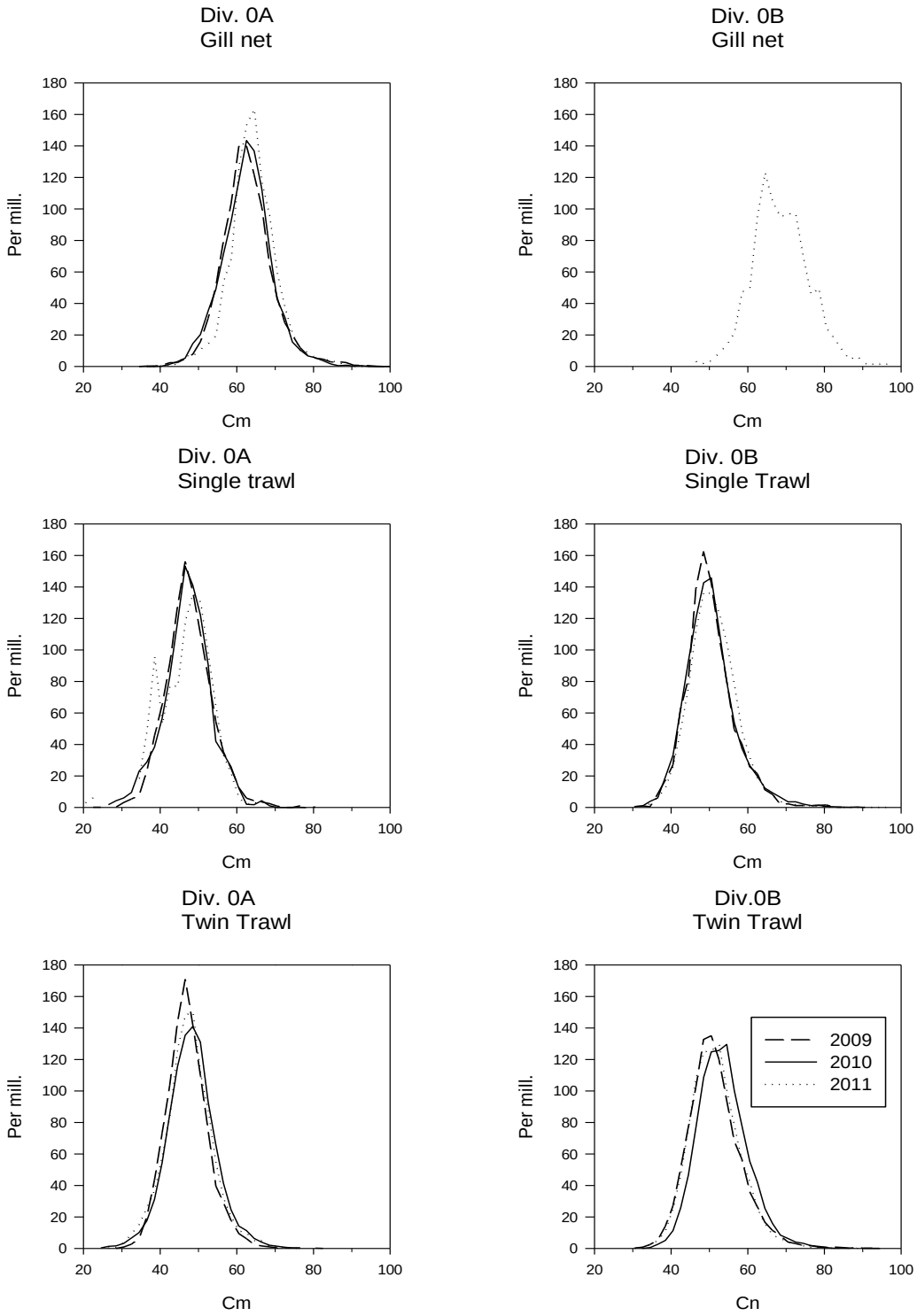


Fig.4. Length distribution from the fishery in Subarea 0 in 2009-2011 in per mill., 2 cm groups.

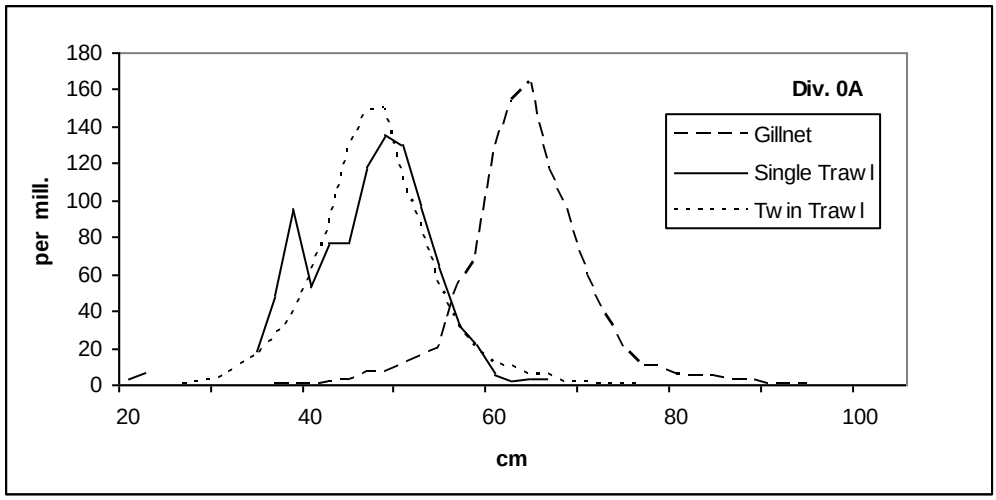


Fig.5a. Length distribution (2 cm groups) by gear for the 2011 fishery in Div 0A.

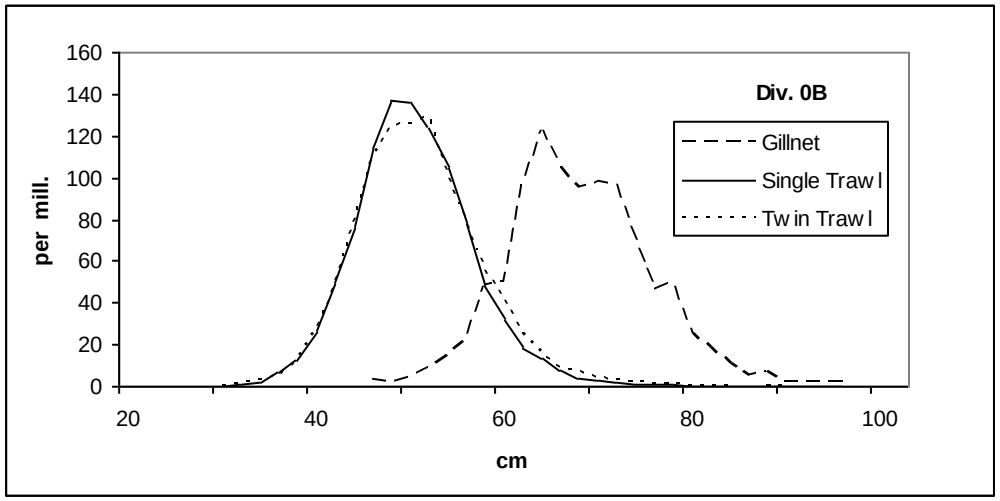


Fig.5b. Length distribution (2 cm groups) by gear for the 2011 fishery in Div 0B.

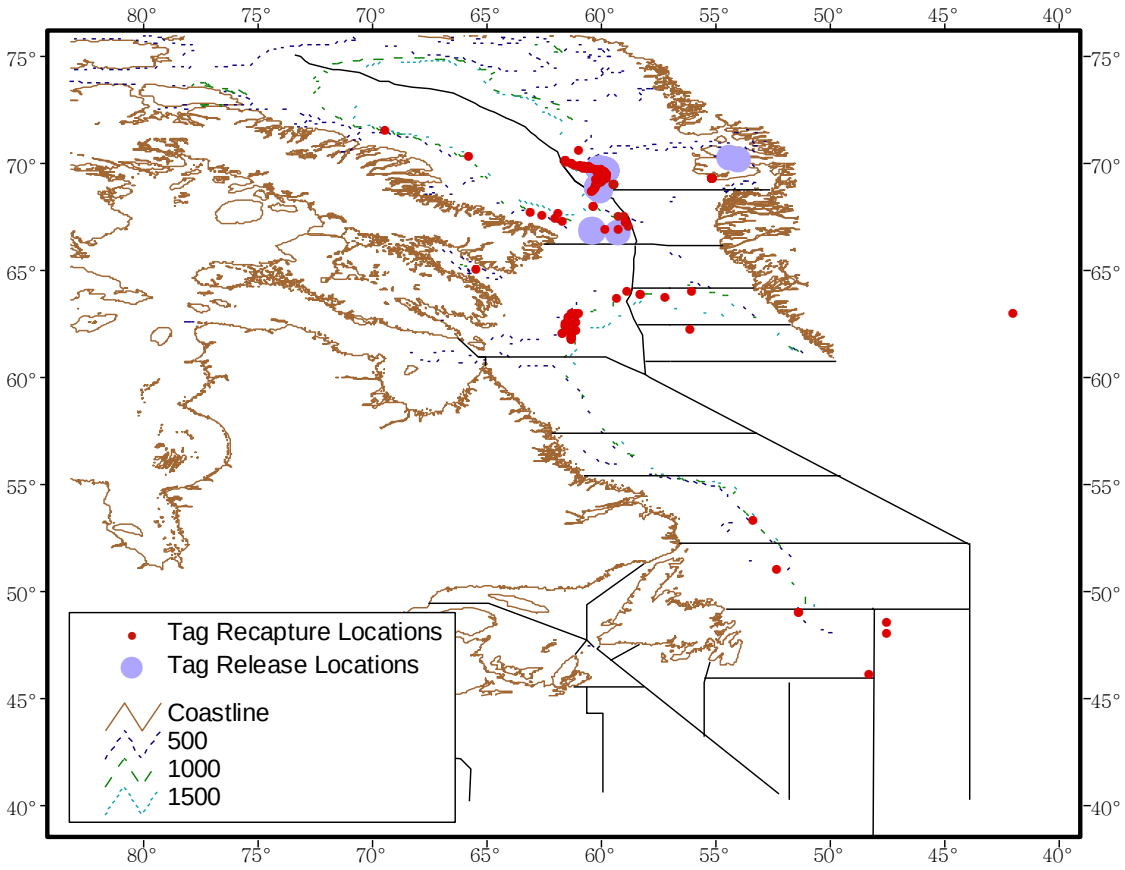


Figure 6. Update of tag recapture locations from tagging conducted in SA0 and SA1 by Canada and Greenland in 2007 and 2009.