Northwest Atlantic Fisheries Organization

Serial No. N5899 **NAFO SCS Doc. 11/09**

SCIENTIFIC COUNCIL MEETING – JUNE 2011

Canadian Research Report for 2010 Newfoundland and Labrador Region

Submitted by

D. Richards[1]

SUBAREAS 0 AND 1

A. Status of Fisheries

Nominal landings from 2001 to 2010 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 2009, Scientific Council advised for 2010 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 with approximately one half taken by otter trawlers (1,100 t with single trawls and 970 t with twin trawls) and the remainder by gillnets (1,850 t).

[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. Status of Fisheries

Nominal landings from 2001 to 2010 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. Approximately 5,391 Salmon were retained or hooked and released in the recreational fishery. Preliminary information on subsistence fishery catches indicated that about 36 t of Salmon were harvested in 2010. None of the three assessed stocks achieved conservation spawning requirements in 2010.

b) *Arctic Charr* – Subarea 2

Commercial landings of Arctic Charr from north Labrador in 2010 were 11 t, a decrease of about 28% from 2009 and almost 60% less than the average landing for the 10-year period 2000-2009. Over the past 37 years (1974–2010), more than 2,900 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. Bycatch 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. Over this time catches ranged 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 2006-10, 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 and 2010) of Cod. This fishery was a recreational fishery. It 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 reported landings were 2,679 t in 2006, and 2,364 t in 2007 although the 2007 estimate does not include recreational landings and, total catch in 2007 is uncertain. 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; however, analysis of tag returns suggests that removals from recreational landings could be as much as 64% of reported stewardship fishery removals. In 2010, reported landings were 2,902 t which includes 44 t of by-catch, 209 t in sentinel surveys but excludes recreational fishery removals; analysis of 2010 tag returns suggests that removals from recreational landings could be 58% of reported stewardship fishery removals. 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 stock has not been fully assessed since 2003 but research vessel surveys continue to indicate that the stock of American Plaice in Subarea 2 + Div. 3K remains at a very low level. Bycatch, mainly from the Greenland Halibut fishery has been low in recent years, being 10 t to 22 t since 2006. There is also some bycatch of Plaice in the shrimp fishery in this area (average 2004-07 is 20 t). Until 2003, the composition of the American Plaice bycatch in the Greenland Halibut fishery was composed mainly of sexually mature females and the size composition of the bycatch has not been updated since then.

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 2000-10 with the 2010 catch at 61 t. Canadian (NL) landings since the moratorium in the Canadian EEZ are primarily bycatch 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 2010 (<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 were not analysed prior to the compilation of this report.

f) *Witch Flounder* - Div 2J3KL

There has been no directed fishing on this stock since 1994. In 2010, bycatch in other fisheries from the Newfoundland Region was 160 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 1998-2009 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 2010 in Subarea 2 and Div. 3KLMNO was approximately 6,500 t, a 15% increase compared to the 2009 catch (5,700 t). Total catch of this stock in 2009 was estimated to be 23,160 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 to determine the TAC for at least the next four years. The TAC for 2011 was subsequently set at 17,185t.

Exploitable biomass of this stock increased over 2004-2008 with decreases in fishing mortality. However, it has decreased over 2008-2010, as weaker year-classes have recruited to the biomass. The level of recent biomass estimates was higher than reported in previous assessments, as a result of including the new deep-water information from the EU survey, as well as a reduction in the amount of F-shrinkage required. The 10+ biomass peaked in 1991 and although it remains well below that peak, it has tripled over 2006-2010. Average fishing mortality (over ages 5-10) has been decreasing since 2003. Recent recruitment has been far below average.

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 concerns pertaining to the resource within Shrimp Fishing Area 6. An interim monitoring report will be produced in March 2012.

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 2010/11. Preliminary data indicate that 10,700 t and 11,446 t of Shrimp were taken during the 2009/10 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^{o}N was removed. This may have influenced the recent increases in CPUE.

Autumn 1999 was the last time that the Canadian Government conducted a bottom trawl research survey in 2G. However, during the summer of 2005, the Northern Shrimp Research Foundation and the Government of Canada (DFO) began a series of at least five 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 66,000 t and 181,000 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 2005-10. Current status appears positive from fishery catch rate indices and survey exploitation rate indices.

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. Preliminary data indicate that 25,000 t of Shrimp were taken during the 2009-10 while 15,000 t were taken thus far in the 2010/11 season. It is important to note that since 2007, a season bridging program has been in place allowing offshore licence 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. Most model catch rates since 1999 were statistically similar ($P>0.05$) to 2010/11 (12,300 kg/hr) while indices previous to 1999 were lower than the 2010/11 index ($P < 0.05$). 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) was 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 eleven years. SFA 5 fishable biomass indices declined by 16% from 2006 to 2008 remaining near the 2008 level in 2010. Fishable biomass in Cartwright Channel, surveyed every year, decreased by 40% to 34,400 t in 2009; but then rebounded to 50,400 t in 2010. Recruitment in the short-term, while uncertain, appears average. Exploitation rate index was 20% in 2010, slightly above the long term mean.

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. TACs have been reached in most years. Between 75,600 t and 80,700 t were taken each fishing season between 2004-05 and 2007-08. Quota monitoring statistics indicate that 75,000 t and 45,100 t were taken in 2008-09 and 2009-10 respectively. These shortfalls were due to operational (i.e., weather, mechanical problems etc…) and commercial (price of Shrimp) constraints.

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.

Biomass indices (total, fishable and female spawning stock) from fall multi-species surveys generally increased from 1997 to peak levels in 2006 but have since decreased by 50%. The present catch levels may not be sustainable given the declining biomass. If the current TAC is taken in 2010/11, the exploitation rate index would increase to between 20 and 37% (based on an 85,725 t TAC and 2009/10 fishable biomass 95% confidence intervals). Due to concerns about the declines in survey and fishery indices, the TAC was reduced by 28% in 2010/11 to 61,632 t. The preliminary quota monitoring reports indicate that 45,100 t of Shrimp were taken in SFA 6 during the 2010/11 fishing season.

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 63% from 190 t in 2007 to 70 t in 2009. Meanwhile effort decreased by 40% from 2007-2009 before increasing slightly in 2010. The exploitable biomass changed little from 2008-2010. The post-season trawl survey exploitable biomass index peaked in 2006, decreased by 68% to 2008, and remained unchanged in 2010. A trap survey conducted by the Torngat Joint Fisheries Secretariat during the summers of 2009 and captured few commercial-sized Crabs. 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 post-season trawl survey. Maintaining the current level of fishery removals would likely result in little change to the exploitation rate in 2011, but would increase the exploitation rate in future years.

In Div. 2J, landings increased by 60% from 1,500 t in 2005 to 2,400 t in 2008. They decreased by 14% to 2,100 t in 2010. Effort increased by 27% in 2009 and changed little CPUE increased from 2004-2007 and changed little until it decreased sharply in 2010. The exploitable biomass has decreased in recent years. The post-season trawl survey exploitable biomass index peaked in 2006, declined to 2009, and changed little in 2010.

Recruitment has recently declined and is expected to remain low in the short term. The post-season trawl survey pre-recruit index was exceptionally high in 2004 and has otherwise fluctuated without trend since 1999. The exploitation rate index declined between 2003 and 2007 but has since gradually increased. The pre-recruit fishing mortality index declined sharply between 2003 and 2005, and has since remained low.

Maintaining the current level of fishery removals would likely have little effect on the exploitation rate in 2011.

j) Iceland Scallop – Div. 2HJ

Inshore aggregations were again fished in 2009 and 2010, with nominal catches estimated at 17 t and 16 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. <u>Special Research Studies</u>

1. Biological Studies

a) 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 2010 and represented the 34th continuous year of sampling these populations. Following long term declines in mean weight of Charr harvested in north Labrador, recent 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 and thermal habitat use.

b) 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.

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

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.

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 initiated and will run until 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.

c) 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. This survey series is scheduled to continue until 2012 but is anticipated to continue beyond 2012.

d) 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.

SUBAREA 3

A. Status of Fisheries

Nominal landings from 2001 to 2010 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 Canadian commercial fishery has been in place since 1992. The 2010 recreational harvest, including both retained and hooked-and-released was 29,182 fish.

b) *Capelin* – Subarea 2 + Div. 3KL

Inshore Capelin catches in Subarea 2 + Div. 3KL are taken during the inshore spawning migration. Catches decreased from 23,190 t in 2009 to 15,471 t in 2010 representing 55% of the 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. Four coherent recruitment indices indicated prospects for recruitment in 2011 are 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

This stock has been under moratorium to all directed fishing, both inside and outside the NAFO Regulatory Area, since February 1994 and this continued into 2010. Total catch since 1994 has increased from 170 t in 1995 to 4,900 t in 2003, and declining to 600 t by 2006 then increased steadily to 1,100 t in 2009. The provisional 2010 reported catch is 750 t. Canada (NL) landings ranged from 422 t to 714 t between 2001-2005, declined to 73 t in 2006 then increased to 231 t in 2008 and have since declined to 103 t in 2010. Fishing mortality has been declining since 2006. Estimates for ages 4-6 in 2008 and 2009 were less than 0.06 and are amongst the lowest estimated during a moratorium. Recruitment remains low but has been improving in recent years with current estimates of the 2005-2007 year classes comparable to those from the mid- late 1980s. The 2010 estimate of spawner stock biomass is 12 700 t which is still well below the current best estimate of Blim (60,000 t).

The 2010/11 TAC for the Cod stock in Subdiv. 3Ps was 11,500 t - the fishing season runs from 1 April to 31 March of the following year. This stock is jointly managed by Canada and France (in respect of St. Pierre et Miquelon). The autumn 2010 assessment of stock status indicated that the stock is marginally above the limit reference point. The report of the assessment meeting concluded: "Estimated survey SSB from a cohort model (SURBA) decreased in recent years and in 2008 and 2009 were below the limit reference point (LRP) with probability of 0.59 and 0.75, respectively. The survey SSB in 2010 is estimated to be above the LRP, although the probability of being below the LRP is 0.37. A one year projection to 2011 using the cohort model indicated that survey SSB will increase if total mortality rates are similar to current values (i.e. within ±20%), and that the probability of being below the LRP in 2011 is low (0.04 to 0.17)." Projected increases in SSB result mainly from the recruitment of the 2006 year-class, estimated to be much stronger relative to other recent cohorts. This year-class should fully recruit to the fishery in 2011.

d) American Plaice - 3Ps

The last assessment of this stock was carried out in October 2005. This stock has been under moratorium since September 1993. 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. Catch has been mainly as bycatch in the Cod and Witch Flounder directed fisheries.

The Canadian survey in spring 2006 was incomplete and data on abundance and biomass could not be updated. There has been an increase since 1993 in both biomass and abundance indices, but over the last 3 surveys (2008-2010) average biomass is less than 30% and abundance 60% of the 1983-87 averages from the survey.

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. 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 2010 was estimated to be 1.6 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. Canadian catch was still low in 2007 at 3,673 t, and in 2008 catches increased to 10,216 t (with TACs of 15,500 t each year). In 2009 only 5,414 t of the 17,000 t TAC was caught. Scientific Council noted that this stock is well above Bmsy, and recommended any TAC option up to 85% Fmsy for 2010 and 2011 (25.5 t and 23.5 t respectively). The TAC for 2010 was set to 17,000 t and Canadian catch was 8037 t. Scientific Council also noted that bycatch of Cod and American Plaice in the Yellowtail fishery needs to be considered.

g) *American Plaice* – 3LNO

Catches from this stock were generally in the range of 40,000 to 50,000 t per year throughout the 1970's and 1980's, before declining to low levels in the early 1990's. There has been no directed fishing on this stock since 1993. Bycatch from all countries in 2009 was 3,015 t, which is on par with bycatch in recent years. The majority of this bycatch was taken in the NAFO regulatory area (NRA). Canada (NL) bycatch of American Plaice in 2009 and 2010 was 1077 t and 1154 t, respectively. Increased bycatch allowances in the Yellowtail Flounder fishery have the potential to result in increased catches of American Plaice.

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 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 in 2010, whereas catches have fluctuated between 2,500 t to 4,800 t from 2006-2009 and were about 6,700 t in 2010. About 2,300 t of the 2010 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 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 260 t in 2010. Canada (NL) has accounted for more than 95% of the Canadian catch since 2001 but only took 42 t in 2010. 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 2010 was 39 t.

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. Following a very large 1999 year class, the stock has declined to a lower level comparable to levels observed prior to the recruitment pulse. The stock is currently at a low level.

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. The Canadian fishery includes otter trawl, gillnet and longline gear while the non-Canadian catches are taken by otter trawl. In 2000, Russia commenced a directed fishery for Thorny Skate. Annual landings have averaged about 6,000 t since 2004.

Thorny Skate underwent a decline in the late 1980s to early 1990s followed by a slight increase in the late 1990s. Since then, abundance remained relatively constant at low levels. The current TAC for Skates in 3LNOPs presently amounts to 13,050 t (12,000 t in 3LNO and 1,050 t in 3Ps).

l) *Shrimp* – Div. 3LMNO

Subarea 3 has been divided into two Shrimp management areas – Div. 3LNO and 3M. The Div. 3LNO Shrimp stock is distributed along the edge of the Grand Banks mainly in Div. 3L. The fishery began in 1993 and catches were approximately 1,800 t. Exploratory fishing from 1996-99 resulted in catches ranging from 179 to 795 t. In 2000, the NAFO Fisheries Commission implemented a TAC of 6,000 t, and fishing was restricted to Div. 3L, in water depths greater than 200 m. The catch in 2000 increased to 4,900 t, 4,300 t of which was caught by Canada. The remainder of the catch was taken by vessels from 7 other countries.

STACFIS estimated that the 2001 fishery took approximately 10,600 t, with Canada taking just over 5,100 t. However, reliable catch reports were not available for all countries in 2001. Similarly, estimates of catch in 2002 were not available for all countries. However, STACFIS noted that the total catch in 2002 was likely lower than that estimated for 2001, however, there was considerable uncertainty with estimates of catch in both years. Canadian vessels caught 5,400 t of Shrimp in Div. 3L during 2002.

During November 2002, Scientific Council (SC) noted that there had been a significant increase in biomass and recruitment in Div. 3LNO Shrimp since 1999. Applying a 15% exploitation rate to the lower 95% confidence interval of biomass estimates, averaged over the autumn 2000-01 and spring 2001-02 surveys, resulted in a catch of approximately 13,000 t. Accordingly, SC recommended that the TAC for Shrimp in Div. 3LNO in 2003 and 2004 should not exceed 13,000 t. Over the period 2000–2004, catches were 4,900, 10,600, 7,000, 12,000 and 12,600 t respectively.

In 2004, SC recommended a 2006 TAC of 22,000 t based upon 12% of the inverse variance weighted average fishable biomass from the most recent surveys. SC did not update this calculation in 2005, due to the incomplete survey in autumn 2004. Catch data indicate that 14,000 t of shrimp were taken against a 13,000 t quota in 2005 while 24,000 t were taken against a 22,000 t TAC in 2006. Preliminary data indicate that 21,600 t had been taken against a 22,000 t TAC in 2007 while 24,700 t were taken against a 25,000 t TAC in 2008. Subsequently, during 2009 the TAC was increased to 30,000 t and maintained at that level in 2010.

As per NAFO agreements, Canadian vessels took most of the catch during each year. Canadian catches increased from 4,200 t in 2000 to 21,200 t in 2008. Preliminary data indicate that 20,500 t were taken by Canadian vessels in 2009 against a Canadian TAC of 25,324 t. Preliminary quota monitoring reports indicate that 13,500 t of shrimp were taken during 2010. Catches by non Canadian nations increased from 600 t to 5,700 t over this period. Preliminary data indicate that by October 2010, 3,600 t had been taken against a non Canadian TAC of 4,676 t.

Canadian fleet catch rates

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 percent area occupied by the large vessel fishery has been increasing since 2002, but is still less than 4% of the total area available. The small vessel fleet has occupied no more than 8% of the total available area and has also shown an increasing trend, however, the percent area occupied has varied greatly. It is important to note that an increasing trend does not necessarily mean that the total area occupied by the fishery has increased, rather it means that the catches are more evenly distributed.

The small vessel fleet fishes Shrimp mainly during the spring and summer months, while seasonality of the large vessel fleet varied over time.

Due to a lack of data it was not possible to model small vessel CPUE up to and including 2010. Small vessel CPUE (2000 – 2009) 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 logbook dataset that was used in this analysis accounted for between 57.2% and 93.7% of the catch within any one year. The final model explained 85.0% of the variance in the data and indicated that the annual, standardized catch rates increasing from near 350 kg/hr over 2000 – 2002 to 690 kg/hr by 2005 before gradually decreasing to 434 kg/hr by 2009. The 2009 catch rate index was similar to the 2003 and 2004 indices while being significantly lower than all intervening indices. No clear trends were found in the plots of residuals.

Seasonality among the large vessel fleet has varied greatly over the years; therefore large vessel catch rates were analyzed by multiple regression using data collected throughout the entire year. 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 26% and 88% of the catch within any one year. The final model explained 66% of the variance in the catch rate data. Standardized catch rates for large Canadian vessels have been fluctuating around the long term mean since 2004 with the 2010 standardized catch rate index (1 479 kg/hr) near the long term average (1 620 kg/hr) and similar to the catch rates for 2001 and 2004 - 2009 indices.

The number of strata fished by the small vessel fleet increased from 7 in 2001 to 16 in 2007 and remained near that level through to 2009. Most of the small vessel commercial fishing is completed within 183 – 549 m depths. The stratified analysis of fishery data did not indicate a contraction of the fishery. The stratified analysis of index strata biomass increased from 29 000 t in 2003 to 47 000 t in 2006 but has subsequently decreased to 31 000 t by 2009. Similarly mean catch (t/hr) increased from .47 t/set in 2003 to .76 t/set in 2006 but decreased to .50 t/set by 2009.

A comparison between stratified analyses of large and small vessel catches clearly shows that the large vessel fishery is restricted to few strata compared to the small vessel fishery and that most of the catch is taken in 274 m – 549 m depth ranges.

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. For 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 not completed as the percent catch data accounted for in the international dataset ranged from 1 – 45% and in most years was less than 20% of that year's catch. Unstandardized international indices increased from 381 kg/hr in 2001 to 2035 kg/hr in 2004, decreased to 570 kg/hr in 2005, remained near that level in 2006 before increasing to 1021 kg/hr in 2007 and finally reaching 1395 kg/hr by 2009. It is not clear how representative these commercial catch rates are of the international fishery in the 3L

The use of a sorting grid to reduce bycatches of fish is mandatory for all fleets in the 3LNO and 3M fisheries. Bycatch of groundfish has been quantified, and consists primarily of Redfish and Greenland Halibut.

m) *Snow Crab* – Div. 3KLNOPs

In Div. 3K offshore, landings more than doubled from 6,000 t in 2005 to 12,600 t in 2009 but decreased by 24% to 9,600 t in 2010 (13% below the TAC). Meanwhile effort changed little until it increased by 73% in 2009 before decreasing by 15% in 2010. CPUE declined sharply since 2008. The exploitable biomass, as indicated by the post-season trap and trawl survey indices, declined by about half since 2008. Recruitment decreased in 2010 and is expected to change little in 2011. Prospects remain poor in the short term. Post-season pre-recruit biomass indices from both trap and trawl surveys have declined by 34-52% respectively since 2008. The trawl survey exploitation rate index declined sharply between 2006 and 2009 and has since increased back to the 2006 level. The pre-recruit fishing mortality index increased from 2006-2009 and changed little in 2010. 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 2011.

In Div. 3K inshore, landings increased by 33% from 2700 t in 2005 to 3,600 t, in 2009, but dropped by 22% to 2,800 t in 2010 (16% below the TAC). Effort has increased by 67% since 2008. CPUE increased sharply from 2005 to a record high level in 2008, but has since declined by half. The exploitable biomass, as indicated by the post-season trap survey index, decreased gradually between 2007 and 2010 but there is considerable variability among management areas. Recruitment prospects, as indicated by the post-season trap survey index, have improved slightly, but there is considerable variability among management areas. It was not possible to estimate the exploitation rate index in 2010 because of uncertainty concerning the 2009 exploitable biomass index. Data are insufficient to estimate the pre-recruit fishing mortality index. It is not possible to infer how maintaining the current level of removals would affect the exploitation rate in 2011. However, it would likely result in increased wastage of soft-shelled immediate pre-recruits in 2011.

In Div. 3LNO offshore, landings remained at 22,000-25,000 t since 2000. Effort increased steadily from 2000-2008 and has since declined by 16%. CPUE declined steadily from 2000-2008, to the lowest level since 1991, but has increased during the past two years. The exploitable biomass has recently increased. Both the trap and trawl survey exploitable biomass indices

increased sharply in 2009. The trap survey index increased further in 2010, while the trawl survey index decreased. However, both indices remain above 2005-2008 levels. Both post-season surveys indicate that recruitment has been recently increasing. Prospects remain promising for the next two to three years, as both the trap and trawl survey pre-recruit biomass indices have remained at high levels since 2007. Both the exploitation rate index and the pre-recruit fishing mortality index peaked in 2008 and have since declined. The latter index was near its lowest level in 2010. Maintaining the current level of removals would likely have little effect on the exploitation rate in 2011.

In Div. 3L inshore, landings increased by 19% from 6,100 t in 2005 to 7,300 t in 2010. Meanwhile, effort decreased by 23% from 2005-2008, and has subsequently increased by 21%. CPUE has changed little during the past four years and remains near the long-term average. The post-season trap survey index indicates the exploitable biomass has changed little over the past 7 years. Overall, recruitment prospects have recently improved, but there is considerable variability among management areas. The exploitation rate index from the post-season trap survey has varied without trend since 2005. Data are insufficient to estimate pre-recruit fishing mortality 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 areas in 2011.

In Subdiv. 3Ps offshore, landings increased by 70% from 2,300 t in 2006 to 3,900 t in 2010. Meanwhile effort decreased from 2006 to 2008 and increased slightly to 2010. CPUE increased from 2005-2009 and changed little in 2010. The exploitable biomass, as indicated by both the spring trawl survey and the post-season trap survey indices, increased steadily from 2006-2009 and decreased slightly in 2010. Recruitment appears promising for 2011 but is expected to decline thereafter. Exploitation and pre-recruit fishing mortality rates, as indicated by spring trawl survey indices, decreased from 2007-2009 but increased in 2010. Maintaining the current level of fishery removals would likely have little effect on the exploitation rate in 2011.

In Subdiv. 3Ps inshore, increased from 700 t in 2005 to 2,200 t in 2010 while effort declined slightly. CPUE has increased steadily from 2005 to its highest level since 1996. The exploitable biomass, as indicated by the post-season trap survey index, increased substantially between 2006 and 2008 and has since changed little. Recruitment has recently increased and prospects for 2011 and 2012 are promising. The post-season trap survey-based exploitation rate index changed little during 2008-2010. Data are insufficient to estimate a pre-recruit fishing mortality index. Maintaining the current level of fishery removals would likely have little effect on the exploitation rate in 2011.

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 in 2009 and 2010. 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, 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 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.

There were 9 t (round) of Sea Scallops removed by inshore vessels in Div. 3L in 2010.

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 remained low, at 520 t in 2008 and 640 t in 2009.

B. Special Research Studies

1. Environmental Studies

Physical oceanographic observations are routinely collected during fish assessment and research surveys in the Newfoundland and Labrador Region. The Atlantic Zonal monitoring program (AZMP) initiated in 1998 continued during 2010 with three physical and biological oceanographic offshore surveys carried out along several cross-shelf NAFO and AZMP sections from the Southeast Grand Bank to Hamilton Bank on the southern Labrador Shelf. The first was conducted on the CCGS Teleost from April 15 to May 4, the second on CCGS Teleost from July 8-24 and the last on CCGS Hudson from November 23 to December 11. 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) Plankton studies

The onset of deepening of the mixed-layer that normally begins in the early autumn was delayed at Station 27 in 2010, in contrast to average conditions. The seasonal development of stratification was also delayed compared to earlier years. The inventory of nitrate within the upper 50 m and deep layers at the fixed station was the lowest observed since the start of the time-series in 1999. MODIS satellite imagery covering the northwest Atlantic indicated that the surface blooms occurred earlier, were more intense and in some cases longer in duration in 2010 in contrast to previous years. The abundance of most large copepods at the fixed station in 2009 and 2010 has increased significantly since the low levels observed in 2008. Only *Calanus glacialis* and large copepod nauplii remain at near average levels. The abundance of the small copepods *Microcalanus* sp., *Oithona* sp., *Pseudocalanus* sp. and *Oncaea* sp. reached peak or near-peak levels while that of the warm water species *Acartia* sp., *Centropages* sp., and *Temora longicornis* were at low levels of abundance. On the Bonavista and Seal Island sections, all four functional groups of zooplankton (small and large copepods, meroplankton and carnivores) demonstrated similar long term patterns of variation, with the lowest abundances being recorded at the start of the time-series (1999), with a gradual increase to a peak or plateau between 2004 and 2006, after which small and large copepods as well as carnivores have returned to values that are near the long term average. The abundance of zooplankton on the Flemish Cap and southeast Grand Banks sections in 2009 and 2010 are characterized by generally higher levels of abundance than in previous years, with more than 60% of taxa from each functional group having abundance levels above their long term mean.

Across the region, annual nitrate inventories (shallow and deep) have declined since 2008 and appear to be continuing to decrease in 2010. Chlorophyll concentrations in 2009 were at their highest levels since the start of AZMP activities in the region but returned to near normal values in 2010. In 2009 and 2010, the principal zooplankton indices indicated that abundance was generally higher than average, with densities reaching their highest levels in 2010 along many of the oceanographic sections. The indices of inventories and abundances across trophic levels (nutrients, phytoplankton and zooplankton) generally exhibit weak associations (i.e. correlations) between adjacent trophic levels. There was no single environmental variable that demonstrated a widely consistent pattern of correlation with either nutrient inventories, phytoplankton abundance or with the wide diversity of zooplankton taxa. This may be the result that over the last decade the physical environment of the Newfoundland shelf showed the lowest overall variability relative to previous decades going back to 1950.

2. Biological Studies

a) Flatfish

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. Research on Yellowtail and Greenland Halibut age and growth is ongoing, using a variety of methods.

Work continues on a calibration curve for the autodiametric method of determining fecundity has been initiated for Yellowtail Flounder, American Plaice and Witch Flounder. 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 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

A comparative study to determine factors governing Capelin survival during egg development and larval emergence from beach sediments and from bottom spawning sites in Trinity Bay continued in 2010. Samples of adult Capelin were collected in 2010 at Bellevue Beach in Div. 3L in the final sampling year of a genetic study on Capelin biodiversity. Otoliths were collected in 2010 as part of an otolith exchange and age reading comparison with Capelin age readers from Norway, Russia, and Iceland. An ongoing offshore acoustic survey initiated in the spring of 1999 to examine Capelin distribution, behaviour, and feeding habits in Div. 3KL continued in 2010. Inshore surveys were conducted in the fall of 2010 to map the abundance and dispersal of larval Capelin in Trinity Bay, Div. 3L. The survey time was reduced from three trips (August, September, October) to two (August, September) in 2010. 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 2010.

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.

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.

The following two international governance fund projects are being initiated;

1) One is a collaborative project with researchers in the Maurice Lamontagne-Institute in Quebec and England to assess the response of Northern Shrimp (*Pandalus borealis*) populations to climate change and variability.

2) While the other is a collaborative effort within NL Region to hire a post doc who will develop the precautionary approach to harvesting Northern Shrimp (*Pandalus borealis*) in NAFO subdivisions 3LNO (Shrimp Fishing Area 7).

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 2010. 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 2010.

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.

SUBAREA 4

A. Status of Fisheries

Nominal landings from 2001 to 2010 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 Canadian commercial fishery has been in place since 1992. The 2010 recreational harvest, including both retained and hooked-and-released, was 24,337 fish.

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, while effort declined by 91%. The TAC has not been taken since 2002. CPUE declined slightly from 2006-2009 but increased sharply in 2010. However, the 2010 increase was associated with a record low level of both landings and effort. The exploitable biomass is low as reflected by virtual abandonment of the fishery in recent years. The post-season trap survey index decreased in 2009 and was unchanged in 2010. Recruitment has been low in recent years and prospects for the short term are poor. The time series of information from the post-season trap survey is insufficient to interpret any trend in the exploitation rate index. Data are insufficient to calculate a pre-recruit fishing mortality index. Maintaining the current level of fishery removals would likely result in little change to the exploitation rate in 2011

In Div. 4R inshore, landings and effort were at historical lows in 2010. Landings declined by 90% from 950 t in 2003 to 190 t in 2010, while effort declined by 60%. The TAC has not been taken since 2002. CPUE declined steadily from 2002 to its lowest level in 2008 and has changed little since. The post-season trap survey exploitable biomass index changed little between 2005 and 2009 but increased in some management areas in 2010. Recruitment has recently increased. Prospects remain promising for the next two to three years, but there is considerable variability among management areas. The post-season trap survey exploitation rate index has changed little since 2005. Increased fishery removals would not likely increase the exploitation rate in 2011, 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 2010 is estimated at 244 t (round) against a TAC of 1,000 t. This is similar to the 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 and 2010 were 15 t and 27 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. <u>Status of Fisheries</u>

Nominal landings from 2001 to 2010 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 increased to about 2,600 t in 2005, remained the same for 2006 and 2007, increased to 3,000 t in 2008, then decreased to 2,500 t in 2009. A preliminary value for 2010 landings is 2,600 t. Landings have been increasing in Lobster Fishing Areas (LFAs) 10 and 11 in Subdiv. 3Ps, in LFA 12 in Subdiv. 3Pn, and LFA 6 in Division 3L. LFAs 13A, 13B, 14A and 14B in Division 4R have been declining in recent years. LFA 4 in division 3K has declined to a record low. In 2007, reported landings in LFAs 8 and 9 (in Div. 3L), declined to record lows and have changed little since. 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. 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) Sentinel Studies

The Sentinel Surveys, initiated in October 1994, were continued in 2010. Data collected were tabled at Regional stock assessments in the spring of 2011 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 2010. Approximately 2,000 Cod were tagged and released with Floy tags; in addition approximately 150 acoustically tagged Cod were released inshore in 3KL during 2010. A series of arrays of acoustic 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 2010, estimates of exploitation (harvest) rate ranged from 3-10% for the cod released inshore and 2% for cod tagged offshore (but recaptured inshore).

c) Hydrographic Surveys

The Canadian Hydrographic Service (CHS) priorities for Subareas 2, 3 and 4 for 2010-2011 were several sites throughout Newfoundland and Labrador.

CCGS Matthew

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 2010 survey season, surveys were completed at the Approaches to Cartwright and Makkovik Bank in Labrador. On the Island of Newfoundland hydrographic surveys were completed in the Bay of Islands, Fogo Island and Carmanville.

Makkovik Bank, Labrador

A multibeam acoustic survey was continued on the Makkovik Bank of Labrador. This work was a continuation of surveys started previously. The data collected will be used for navigation safety and to study geo-hazards along possible pipeline routes.

Approaches to Cartwright, Labrador

A multibeam acoustic survey was continued for the approaches of 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 aimed at collecting sufficient Hydrographic data to commence production of two new editions of charts covering the Bay of Islands areas. The two charts 4653, 4654 that covers the Bay of Islands are in feet and fathoms and therefore 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 vessel waiting to berth in Cornerbrook. 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.

Fogo Island, Island of Newfoundland

The existing navigation chart for the north side of Fogo Island, Notre Dame Bay, contained several areas delineated as uncharted or not charted to modern survey standards. A number of requests were made from clients to provide modern charting for these areas. A hydrographic survey was conducted at this site to complete outstanding hydrographic work which was not achievable last season due to inclement weather and extend the survey coverage on the eastern side of the island.

Carmanville, Island of Newfoundland

Carmanville is an important harbour for the region as the coast is mostly exposed to the sea and the water are shallow. The harbour was identified as secondary survey area to Fogo Island, for time when weather conditions would not permit work around the Fogo Island. It was also the Port of Call to resupply the ship for food and fuel as well as for any change in crew. As a result of the survey Notice to Mariners were produced in the field to publish depths that were significantly shallower than those shown on the chart.

Annual Sailing Directions Revisory Survey

The annual Sailing Direction Revisory survey gathered hydrographic data from many sites throughout Newfoundland and Labrador. This data is used in revising and updating the Sailing Directions publications, ATL 101, Cape Bauld to Cape Bonavista, ATL 102, Cape Bauld to Ferryland Head , ATL 103, Ferryland Head to Port Aux Basques, ATL 109 Gulf of St. Lawrence (Northeast Portion), ATL 120, Labrador, Camp Island to Hamilton Inlet (including Lake Melville) and ATL 121, Labrador, Hamilton Inlet to Cape Chidley (including Button Islands and Gray Strait).

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.

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

During 2010 a new edition of the Sailing Directions Publication ATL 103, Newfoundland, Southwest Coast was produced.

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	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
0+1	Greenland halibut	SA 0 + 1A(offshore)+ 1B-F	3862	3,363	3,348	3,742	4,045	4,005	4,993	4,017	2,560	3,184
	Shrimp*	0A						7,508	6,236	6,654	6,247	3,625
		0B						6,333	4,488	4,584	5,597	5,829
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	8,117
		2HJ (SFA 5)	14,960	25,094	20,503	23,768	22,612	22,904	22,785	30,437	15,339	15,116
		2J3K (SFA 6)	55,255	45,099	75,080	80,736	75,673	75,231	77,820	71,227	60,384	52,590
	Snow Crab	2HJ	2131	2,387	2,549	2,523	2139	1576	1,925	2511	3,521	3,738
	Iceland scallop	2HJ	16	17	13	40	686	672	495	528	272	218
	Arctic Charr	2J3KLPs+4R	11	16	18	28	40	22	19	19	21	33
	Atlantic salmon****		36	30	36	27	32	31.9	32	22.1	17.6	16.3
2+3	Redfish	2+3K	61	28	20	29	221	135	167	22	34	40
	Greenland halibut	2+3KLMNO	6529	5,744	4,701	5,073	6,307	6,644	4,877	6,620	6,291	8,238
	American plaice	2+3K	22	10	10	23	60	29	16	33	100	133
	Witch	2J+3KL	160	45	5	22	53	40	26	110	167	148
	Cod*****	2J3KL	2902	3,098	3,343	2,546	2,679	1,330	643	971	4,196	6,887
	Grenadier	2+3	41	13	10	38	99	151	135	183	274	212
	Capelin	2J3KL (offshore)		0		0	0	0	0	0	0	0
	Squid	2+3	100	643	515	228	6,879	548	2,525	1089	229	23
3	Redfish	3LN	113	6	1	3	1	2	0	9	47	40
		3M	0		0	0	0	0	0	0	0	0
		3O	42	255	202	1,054	3,580	5,364	2,340	3,093	2,988	4,557
	Yellowtail	3LNO	8056	5,414	10,216	3,674	177	13,268	12,577	12,705	9,959	12,238

Subarea	Species	Division	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
	American plaice	3LNO	1154	1,077	878	434	93	1,466	1,290	1,607	1,374	1592
		3Ps	402	509	456	460	485	745	731	883	1,014	877
	Witch flounder	3NO	39	41	46	21	94	49	49	62	27	13
		3Ps	446	454	298	110	182	483	540	529	517	450
	Atlantic halibut	3	321	289	287	170	251	255	303	399	369	315
	Cod	3NO	103	158	231	123	73	459	441	714	422	487
		3Ps	6,737	7,491	9,636	10,599	10,506	11,400	11,046	12,469	12,618	13,339
	Haddock	3LNO	27	104	60	30	23	44	18	67	183	86
		3Ps	129	173	288	302	128	219	123	137	111	102
	Pollock	3Ps	319	287	616	1,042	733	500	296	333	492	815
	White hake***	3NOPs	559	748	1383	1,680	2,112	2,145	1581	1538	1920	1458
	Thorny skate***	3LNOPs	604	1334	1452	1639	1,392	2124	2026	3823	3413	3202
	Capelin	3L	11,927	13,337	15,176	16,321	15,430	15,230	15,694	13,270	8,639	13,898
		3K	3,544	9,853	13,043	13,036	14,368	12,194	11,157	4,067	1,553	5,022
	Shrimp*	3M	0	0	0	0	0	0	0	0	8	293
		3L	13,535	20,494	21,187	18,316	18,128	11,109	10,560	10,701	5,417	4,984
	Sea scallop	3KLNO	27	0	0	9	10	35	0	0	0	0
		3Ps	842	432	293	359	518	2,132	3,473	647	51	338
	Iceland scallop	3LNO	0	0	1	0	347	128	0	0	0	39
		3Ps	0	2	5	6	132	1,748	40	87	478	498
	Snow Crab	3K	12,420	16,184	15,068	12,270	10,717	8,685	16,460	16,502	16,352	15,288
		3LNO	31,419	29,033	30,248	30,895	30,717	29,649	30,717	31,638	30,032	28,172
		3Psn	6,026	5,559	4,523	3,947	3,099	3,169	4,720	6,113	7,637	7,843
	Lobster	3K	96	107	135	120	156	209	157	207	206	275
		3L	114	99	109	82	111	112	73	116	128	124

Subarea	Species	Division	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
		3Ps	1,232	1,071	1,170	1,010	1,049	987	779	786	763	709
		3Pn	138	127	153	94	52	29	14	22	11	25
	Atlantic salmon**	2J3KLPs+4R	44	41	50	29	36	41	37	40	39	39
3+4	Redfish	3P+4V	2,275	2,265	1,217	1,402	2,439	1,918	3,428	3,956	3,451	3,213
4	Iceland scallop	4R	244	246	121	284	656	454	360	275	252	638
	Sea scallop	4R	27	15	0	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	985
	Snow Crab	4R	221	287	380	554	543	862	1,462	1,562	1,851	1,683

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

***Canadian catches only

**** Subsistence Fisheries

***** Excludes recreational catch for 2007

Acknowledgements

The following staff of Fisheries and Oceans Canada (Newfoundland and Labrador Region) have contributed to the completion of this report: J. Brattey, B. Brodie, N. Cochrane, W. Coffey, E. Dawe, B. Healey, G. Maillet, J. Manning, J. Morgan, C. Morris, M. Simpson, B. Nakashima, D. Orr, D. Maddock Parsons, P. Pepin, D. Power, R. Rideout, M. Robertson, V. Wareham.

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 2010/11, as well as those currently underway for 2011/12.

List of IGS Activities 2010-11	
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
K. Gilkinson	Deep-sea sponge taxonomy and distribution
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
E. Kenchington/K. Gilkinson	Participation in Nereida surveys onboard Miguel Oliver