# FISHERIES & OCEANS CANADA PROGRESS REPORT ON MARINE MAMMAL RESEARCH AND MANAGEMENT IN 2013

## October 16, 2014

## 1.0 INTRODUCTION

This report provides an overview of the research activities, management programs, and catch statistics of marine mammals for Canada's East Coast and Arctic Archipelago in 2013. Most of the research projects in this report were conducted by the Canadian Department of Fisheries and Oceans. Many research projects involved cooperation with various universities, aboriginal organizations, and/or other research groups. Canadian universities and research groups conducted a wide variety of research on marine mammals in Canada that are not included in this report.

## 2.0 RESEARCH

### *2.1 ARCTIC*

#### 2.1.1 Community-Based Monitoring Network (S. Ferguson, B. Dunn, B. Young)

Continuation of the partnership started in 2003 to develop community-based monitoring with several Nunavut communities. The focus is on tissue collections from marine mammals (ringed, bearded, harbour, and harp seals; and beluga, narwhal, and bowhead whales). Biological samples and information continue to be gathered and has resulted in a long-term data set of marine mammal biological information. Monitoring provides trend analysis to determine how stressors such as climate warming may affect marine mammals and Canadian Arctic communities that depend on them. The community-based monitoring network is built on existing northern expertise, provides additional training and work opportunities for Nunavummiut, and ensures a blending of scientific and traditional methods and knowledge. These partnerships are an important element in detecting changes in the ecosystem and guiding research projects specific to the needs of the local resource users. The collection network in 2014 includes the following communities: Arviat, Sanikiluaq, Pangnirtung, Grise Fiord, Pond Inlet, Resolute Bay, Kugluktuk, Gjoa Haven, Kugaaruk, and Resolute, Nunavut.

#### 2.1.2 Narwhal Feeding Ecology (S. Ferguson, C. Watt, K. Heide-Jorgensen)

Narwhals (*Monodon monoceros*) are top predators in Arctic ecosystems, yet relatively little is known about their diet. This study investigated diet in three spatially and genetically distinct narwhal populations, the northern Hudson Bay (NHB), Baffin Bay (BB), and east Greenland (EG) populations using stable isotope analysis on skin tissues and fatty acids of blubber collected by Inuit hunters as well as dive data from telemetry studies. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) were significantly different among the three populations suggesting they have different preferred prey. Stable isotope mixing models with prey from each of the respective regions revealed narwhals in EG forage more on

pelagic prey, particularly capelin, while those in NHB typically forage in the benthos. Males in all populations had significantly higher $\delta^{13}C$, indicating a greater benthic prey input in their diet. This is likely due to males having an enhanced diving ability due to their larger size enabling them to forage more intensively on benthic organisms. Seasonal and long-term dietary trends were investigated for the NHB and BB populations using stable isotope and fatty acid analyses. In NHB from 1993-2011, $\delta^{15}N$ significantly increased while $\delta^{13}C$ displayed a parabolic trend. $\delta^{15}N$ was stable and $\delta^{13}C$ decreased over time in BB. Stable isotope mixing models indicated a dietary reduction in capelin and increase in Greenland halibut from 1994-2000 to 2006-2011 in BB, which may be attributed to changes in sea ice resulting in later timing of spring migration. In contrast, capelin was an important dietary component for narwhals in NHB in recent years (2006-2011), which may also be linked to changes in sea ice and migration. Seasonal dietary changes, as evidenced by changes in skin and muscle stable isotopes, were not apparent in the NHB population, which may be indicative of a reduced migratory distance. Satellite tracking of animals provided information on narwhal foraging behaviour, behavioural flexibility, and potential prey. Differences in diet among narwhals in diet should correspond to differences in dive behaviour among populations, which we evaluated using satellite-linked tags. Narwhals from EG made significantly more dives and spent more time in the mid-water column compared to other populations. NHB narwhals made more dives and spent more time in the benthos than in the mid-water region. BB narwhals spent time and made most dives within the upper water column and the benthos, which suggests benthic prey may contribute substantially to their diet. Within each population there were sex-specific differences in time spent at depth and we identified seasonal changes in diving for all populations. Results suggest that narwhals employ diverse and specialized foraging strategies, which may have repercussions on their potential ability to adapt to changing ice conditions. Narwhals are top predators in Arctic ecosystems and by monitoring changes in their ecology; we can monitor changes in the entire Arctic food web. By predicting changes in distribution and abundance of narwhals, one of the main food sources for the Inuit, we can hopefully help Inuit adapt to a changing Arctic.

### 2.1.3 Beluga Whale and Ringed Seal Chronic Stress (S. Ferguson, J. Roth, G.W. Anderson, G. Tomy)

Global warming may negatively impact belugas (*Delphinapterus leucas*) and ringed seals (*Phoca hispida*) by altering the sea-ice landscape that they are adapted to use seasonally. Indirect effects of climate warming include increased predation risk related to declines in their sea ice refuge and changes in food availability. Increased stress can cause a hormonal response by the stressed animal resulting in increase in the release of chronic and acute stress hormones. We continued a study of Canadian beluga and ringed seal populations to test the effects of climate change, predation, and food by comparing changes in potential stressors and levels of chronic stress hormones (glucocorticoid). The same beluga whale tissue from harvested whales was used for stress testing and for stable isotope analysis to compare possible explanations for differences among populations. Beluga populations differed in their background levels

of chronic stress with the Cumberland Sound beluga population being most negatively affected. Patterns over time were not observed with preliminary analyses. However, for ringed seals stress in the Hudson Bay population appears to have increased in the recent decade. Research into beluga health and feeding will expand in the future by combining fatty acid analysis and contaminant research.

### 2.1.4 Arctic Killer Whales (S. Ferguson)

Killer whale observations from 2005 on have been collected in a GIS database. Sightings of killer whales increased from 1800s to present and were most frequent in the eastern Canadian Arctic from Hudson Bay to Baffin Bay. A model of predation in the Hudson Bay area estimated killer whale predation of different marine mammal prey. Results indicated that killer whales do not show strong prey specialization and instead alternatively feed on narwhal (*Monodon monoceros*) and beluga (*Delphinapterus leucas*) whales early and late in the ice-free season and bowhead whale (*Balaena mysticetus*) prey in August. In addition, to summarizing killer whale ecological scientific knowledge, we summarized Nunavummiut Inuit traditional knowledge on killer whale predation with the publications describing the extent of knowledge by Inuit about killer whale ecology and include: predation and prey, Inuit values, and distribution and movements of killer whales. Current research focuses on developing a Nunavut network of communities to train local guides on the necessary skills to deploy satellite tags, take biopsy samples, photograph, and acoustically record killer whales observed near their communities. Plans for 2014 include returning to Eclipse Sound area to tag, biopsy, photograph, record, and follow killer whales and assess predation. In addition teams will be visiting other killer whale hot spots, Repulse Bay, Pangnirtung, and Arctic Bay to set up local teams to conduct the research in their community area.

### 2.1.5 Marine Mammals and Emerging Fisheries (S. Ferguson, B. LeBlanc, M. Marcoux, K. Hedges, A. Fisk)

We used a combination of three different passive acoustic devises to sample marine mammal calls: C-PODs that detect and log echolocation clicks used for whale navigation and feeding, AURALs that record vocalization sounds used for whale communication, and SM2M devices that record both echolocation clicks and vocalizations. We have deployed moorings in Scott Inlet (near Clyde River) and Cumberland Sound that are designed to detect buzzes and acoustics produced by toothed whales during feeding events. Boat surveys for sea birds and marine mammals were conducted in August in Clearwater Fjord, Shark Fjord, Pangnirtung Fjord, and Kingnait Fjord. Bowhead whale photographic identification and biopsy samples were collected from Cumberland Sound area. The survey results of sea birds and marine mammals are being used in an assessment of trends in abundance. Overwinter acoustic recorders deployed in Scott Inlet were used to verify seasonal selection by communicating whales in conjunction with fish acoustic tagging and receivers to correlate movements of a variety of marine predators. Plans for 2014 include returning

to Cumberland Sound to deploy Passive Acoustic Monitoring devices as well as continue the work in Scott Inlet.

### 2.1.6 Ringed Seal Foraging Behaviour (S. Ferguson, B. Young, O. Nielsen)

Almost 100 ringed seals have been tagged with satellite telemetry transmitters across the Canadian Arctic. Food habits results from recently completed western Hudson Bay ringed seal diet studies indicate that all ages fed predominantly on sand lance (*Ammodytes sp*.), particularly during the open-water season. Prior to break-up of the sea ice in spring, the diet was more diverse and dominated by other fish: Arctic cod (*Boreogadus saida*) in the 1990s and capelin (*Mallotus villosus*) in the 2000s, and invertebrates increased relative to the open-water season. Adult ringed seals exploited a more benthic and/or inshore habitat and fed on a slightly higher trophic level than younger age classes, likely due to their better diving capacities and abilities. A change in secondary fish consumed by ringed seals took place at the end of the 1990s, with Arctic cod becoming less important and capelin and rainbow smelt (*Osmerus mordax*) appearing in the diet, perhaps in response to a rise in water temperature as part of the current trend of climate warming. Assessing seasonal feeding by Belcher Island ringed seals described a pattern of open-water pelagic feeding, followed by more benthic under-ice feeding overwinter, and a diverse spring feeding prior to fasting during the molt. A spatial comparison of foraging ecology suggests dietary differences in ringed seals between eastern and western Hudson Bay, including a possible ecological divergence between east and west related to warming spring temperatures. It appears that the diet of ringed seals in western Hudson Bay consists largely of pelagic fish such as capelin and sand lance, whereas eastern Hudson Bay ringed seals rely more heavily on invertebrates. Spring temperature and timing of ice break-up were found to have a significant influence on ringed seal foraging ecology, likely due to environmentally driven changes to prey availability. A summary of aerial seal surveys from 1995-2013 indicates a trend of declining seal abundance in western Hudson Bay. Continued environmental and ecological change in Hudson Bay could have important consequences to the ringed seal energy budget and hence to their reproductive success and abundance. Research analysis for 2014-15 includes assessing summer distribution associated with warming ocean temperatures, analysis of the 20 year trend in seal abundance from aerial surveys of western Hudson Bay ringed seals, analysis of sea ice condition data to understand seal population abundance patterns across Hudson Bay, and research into reproduction to assess recent downward trends in ovulation and pregnancy rates and pups in harvest.

### 2.1.7 Bowhead Whale Foraging Behaviour (S. Ferguson, B. LeBlanc, A. Trites, M.F. Baumgartner)

This project will delimit summer and winter range, timing of migration, habitat use and diving behaviour of Eastern Canada-West Greenland bowhead whale population. Diving results will be used to estimate a survey correction factor, in support of science advice

for hunt management and habitat conservation. Bowhead tracks will add to a growing movement database and will provide further insights of seasonal habitat use and timing of migration. Satellite tagging of bowhead whale took place in Foxe Basin and Cumberland Sound in July and August since 2008-2013. Thirty eight bowhead whales were fitted with satellite-linked position and dive recording tag. As of June 2014, twelve tags remain attached and continue to transmit, documenting movements in Foxe Basin, Prince Regent Inlet and Gulf of Boothia, Hudson Strait and Cumberland Sound. Over two hundred skin/blubber biopsy samples were also obtained.

This research project will also study bowhead whale diet composition across their eastern Canadian Arctic range and to understand bowhead whale habitat use in the context of foraging ecology. Bowhead whale diet was examined using several analytical tools including satellite telemetry, stomach content analysis and biochemical tracers (stable isotopes and fatty acids) in the skin and blubber of bowhead whales and of their potential prey. As a result we were able to identify plausible summer feeding areas in the eastern Canadian Arctic, notably the Gulf of Boothia. Using telemetry, diet, and oceanographic results defined habitat features that characterize bowhead whale feeding (upwelling areas, sea ice cover, water masses).The variability observed in isotopic signatures of zooplankton prey assemblages across the eastern Arctic was used to examine variability in diet among bowhead whales and identify their potential foraging areas. The proportional contributions of various sources (zooplankton) to the diet of bowhead whales were calculated using a Bayesian stable isotope mixing model (SIAR). Results from this study indicated variability in isotopic composition among groups of individuals, but not specifically between males and females or age classes. The isotopic model discounted Davis Strait and Disko Bay as potential foraging areas for bowhead whales, at least in spring and summer. Lancaster Sound, Baffin Bay and the Gulf of Boothia were the three main areas likely used for summer feeding, where they fed primarily on large arctic calanoid copepods, mysids and euphausids. Finally, the blubber of bowhead whales from the Eastern Canadian Arctic was composed of high proportions of Calanoid copepod markers (20:1n–9 and 22:1n–11), especially compared to the adipose tissue of western Arctic bowhead whales. This suggests that *Calanus* spp. were likely a major prey item, a result which is consistent with findings from other studies. Research planned for 2014 includes using short-term tags to assess fine-scale foraging as well as net sampling of the water column to associate specific foraging behaviour to prey movements.

### 2.1.8 Assessment of Range and Seasonal Habitat Use of Jones Sound Narwhals (J. Orr, S. Ferguson)

The project objectives were to instrument narwhals in Jones Sound (Grise Fiord) and study their seasonal distribution and diving in relation to management issues concerning stock identity and the wintering area of the stock. The science questions included: What is the use of Jones Sound, North Water, and Baffin Bay by individual narwhals and how is it related to harvesting by Grise Fiord and Greenland communities? Are narwhals remaining in Jones Sound during summer? Is there variation in the wintering

area of that stock? The telemetry narwhal tracking project will help to delimit summer and winter ranges, estimated a survey correction factor, and define seasonal movement needed to support science advice for narwhal hunt management and habitat conservation.

### 2.1.9 Movement Behavior and Estuary Use of Hudson Bay Belugas (S. Ferguson, M.O. Hammill)

Concerns have arisen over the status of the Western Hudson Bay beluga stock which has seen greater numbers being hunted in both Nunavut and Nunavik waters as well as increased predation pressure from killer whales. To better understand summer estuary site fidelity and critical habitat needs of belugas, six whales were captured and outfitted with satellite transmitters in 2012 near Seal River. Killer whales attacked the belugas in the Seal River area and tracking information is being analyzed to assess predator avoidance behavior. The tagged beluga spent the winter in the western part of Hudson Strait. These results add another key overwinter area for Hudson Bay beluga population that has recorded overwintering sites extending from the recent western site out to the Labrador Sea in the east. Plans are to continue the satellite tracking study in 2015 in conjunction with an aerial survey of Western Hudson Bay to assess beluga abundance. In collaboration with Quebec DFO region, past telemetry data back to the early 1990s is being analyzed to interpret inter-estuary use and movements to assess summer site fidelity and sub-population structure of the entire Hudson Bay beluga population.

### 2.1.10 Marine Mammal Genetics (L. Postma, S. Ferguson, S. Petersen)

Several life history traits suggest that narwhal may exhibit population genetic structure, include fidelity to summer and winter areas and fidelity to migration routes identified using satellite telemetry. However, detecting this hypothesized structure has been a challenge and previous research using molecular data has revealed significant overlap among regions using microsatellite and mitochondrial haplotype frequencies. This may be because of either biological factors (i.e., high dispersal and large population size) or sampling factors (i.e., mixed stock sampling during migration and low sample size). Removing samples harvested at flow edge hunts has allowed for greater resolution in defining summer stocks; however, reductions in sample size as a result of this subdivision has limited the ability to understand structure over the entire range. Over 800 narwhals have been profiled to date, including the major Pond Inlet entrapment from December 2008. Continuing research will focus on: increase effort to sample summer harvests; incorporate recent samples (2009-2011); examine maternal patterns of genetic structure; and profile narwhals from two Greenland narwhal entrapments that were sampled in 1994.

Information from traditional knowledge and research programs in Hudson Bay suggests that belugas found in James Bay are a non-migratory population of whales. Population genetic analyses of beluga samples from James Bay in comparison to samples

collected from adjacent locations in western Hudson Bay, eastern Hudson Bay and the Belcher Islands were performed using mitochondrial DNA sequences and microsatellite genotypes. Results confirmed that belugas in James Bay form a distinct stock from other management stocks in Hudson Bay. The results also suggest the presence of a local breeding population that has recently diverged, mixes to some extent with groups of whales in other areas, and/or are being hunted at the edge of their range by hunters from Sanikiluaq and east Hudson Bay.

Several other projects are continuing. 1) Examination of the options with regard to using genetic capture-mark-recapture (CMR) methods to estimate population size in cetaceans. Bowhead whales are proposed as the test case as there have been significant biopsy efforts in the past and there is the potential for future collaborations with Greenland if genetic CMR seems feasible over the long term. 2) Development of new markers for monitoring Arctic marine mammal populations; specifically, the sequencing of entire mitogenomes for targeted sequence and/or SNP (single nucleotide polymorphism) panels and the development of species-specific tetramer microsatellite markers. 3) Collaborations to determine how Eastern Arctic killer whales are related to other globally distributed killer whales. 4) Continuing efforts to separate narwhal stocks based on genetic markers to better model harvest patterns by communities hunting during migration.

### 2.1.11 Aerial Survey to Estimate Abundance of Cumberland Sound Beluga Population (S. Ferguson)

As a result of commercial exploitation from the late 1800s to the early 1900s, the Cumberland Sound beluga population is depleted in comparison to historical population levels (Kilabuk, 1998). Thus, the Committee on the Status of Endangered Wildlife in Canada has designated this population as ‘Threatened’ (COSEWIC, 2004). The Cumberland Sound beluga population was surveyed in 1990 and 1999 and estimated to number around 2000 individuals in 1999 (Richard, 2013). The latest survey, in 2009, did not provide the information needed to assess the trend in population size (Richard, 2013) and a new survey is needed. An updated abundance estimate is also needed to continue the long-term monitoring of the recovery of this beluga population. In addition, as this beluga population is the target of a subsistence hunt by local Inuit, an accurate abundance estimate is needed to inform management and recommend a harvest level. The project has two main objectives: (1) to estimate the abundance of the Cumberland Sound beluga population and (2) to use this updated abundance estimate to look at trends in population size since 1990.

### 2.1.12 Aerial Survey of Hudson Bay and Hudson Strait Walrus (M.O. Hammill, S. Ferguson, B. Dunn)

To address concerns about the lack of information on walrus stock sizes, this project aims at estimating abundance of walrus in south and eastern Hudson Bay, in James

Bay and in Hudson Strait (including Coats Island and Mansel Island) using coastal aerial surveys. With funding to be confirmed, the survey area could also be extended to northwest Hudson Bay (i.e. Southampton Island, adjacent islands and the coast roughly from Repulse Bay to Arviat). This project proposes an extensive coverage of the coastlines of the different regions while maintaining coverage of haul-out sites recognised from ITK and from previous observations. The survey will be conducted using two Twin Otter aircraft with three observers including an observer designated from Nunavut and Nunavik hunter associations (HTO, RNUK). Detected walruses will be counted visually by each observer and oblique aerial photographs will also be taken for latter counts. Correction for walruses not hauled out at the time of the survey will be estimated using results from published work. The information on abundance will be used to provide advice on allowable harvest limits and evaluate sustainability of these stocks.

### 2.1.13. Arctic Council/CAFF/Circumpolar Marine Biodiversity Program S. (S. Ferguson, J. Watkins)

The Arctic Marine Biodiversity Program (previously the CBMP-Marine Plan) is a circum-Arctic, long-term, integrated biodiversity monitoring plan developed by Conservation of Arctic Flora and Fauna's (CAFF) under the Arctic Council. The objectives of the CBMP-Marine Plan are to integrate existing circumpolar monitoring datasets and models to improve the detection and understanding of changes in Arctic marine biodiversity, as well as to inform policy and management responses to these changes. Of the five Expert Networks, the Marine Mammals Experts Network (MMEN) deals with the seven species of Arctic marine mammals with circumpolar or nearly circumpolar distribution: bowhead whale, narwhal, beluga, polar bear, walrus, ringed seal and bearded seal. A number of key stressors are affecting Arctic marine mammals, including climate change, harvesting, increased shipping, and emerging industrial activities, such as hydrocarbon and mineral exploration and production. To meet these challenges, Canada as a participating country, is represented by Fisheries and Oceans Canada (DFO) with Dr. Steven Ferguson, Central & Arctic Region, as the Canadian Lead of the MMEN. Current research is to coordinate monitoring and conducting analyses of marine mammals in the Canadian Arctic as part of Canada's international responsibility. To assist the MMEN five-year work plan we will continue community-based monitoring efforts and develop databases of relevant demographic, distribution, and condition information for all populations of marine mammals in the Canadian Arctic. This includes a summary of past abundance and harvest estimates to establish historic baselines and trends and as a reference for future monitoring. Existing data sets have been identified, aggregated and analyzed to establish indicator baselines on abundance of marine mammals (Canadian Data Report of Fisheries and Aquatic Sciences) and in 2014-15 research will focus on the collection and aggregation of harvest statistics for narwhal, bowhead, and walrus. Future efforts will focus on summarizing Canadian Arctic marine mammal body condition and health databases and movement/distribution, diet, genetics, contaminants.

### 2.1.14. Aerial Survey of High Arctic Cetaceans (S. Ferguson, K. Hedges, M.O. Hammill)

The purpose of the large-scale aerial survey conducted in the Canadian High Arctic in August 2013 was to obtain new abundance estimates of the Baffin Bay narwhal population and the Eastern Canada-West Greenland bowhead whale population. The last estimates were approximately 10 years old and known to be incomplete, given the broad range of both populations. The primary target species of the 2013 survey was the narwhal since it is more heavily hunted, and since there are pressing management and export issues related to that hunt. The bowhead whale was the secondary target species because it is of international concern and no precise abundance estimate of the Eastern Canada-West Greenland population is currently available. There is considerable overlap between the ranges of the two species in August and thus important areas for bowhead could be covered by the narwhal survey design. Other species surveyed included beluga, walrus, killer whales, and seals. Strata of high narwhal density areas were covered using systematic parallel transects with greater coverage (7-15%) than had been done in the past. In addition to visual observations, the three aircrafts collected continuous photographic records below the aircraft using dual oblique cameras pointing downwards towards either side of the track line. A complete assessment and primary publications will be completed in 2014-2015.

### 2.1.15 Monitoring body condition, ovulation and pup production in the ringed seal of Canada's Western Arctic, 1992-2014 (Harwood, L.A., Smith, T. G., Melling, H., and Alikamik, J.)

2013 projects involved continued writing up of ringed seal tagging and tracking projects, beluga growth, ringed seal monitoring, and planning for bowhead whale tagging in 2014. Ringed seal monitoring continued in 2013, with 2013 being the 23$^{rd}$ consecutive sampling year. Samples/measurements are collected for body condition, reproduction, disease, contaminants and diet. Results published to date (1992-2011) show ringed seal adults and subadults exhibited a significant, sustained temporal decline in body condition, measured in late spring and beginning in 1994. These results suggest there has been a shift in the quality, quantity and/or distribution of the seal's prey. Further, it was found that ovulation failed and reproduction was reduced in years with particularly late retreat of the sea ice in spring (1974, 2005). Extreme ice year of 2005 coincided with the year of poorest seal condition, thinnest blubber measured in belugas, lowest measured body condition in Arctic char in Amundsen Gulf, and a time when nutritional stress was detected in polar bears (Stirling et al., 2008). The consequences of the downturn in seal body condition, and fluctuations in productivity associated with ice conditions, could be far-reaching for the eastern Beaufort /Amundsen ecosystem. In 2012, 2013 and 2014, the proportion of ringed seal pups in the summer harvest sample were among the lowest measured, and consecutively low for three years, since the inception of the study in 1992. This may be linking with prey shifts and declining body condition that have been observed since 1994. Monitoring is continuing.

## *2.2 ATLANTIC*

### 2.2.1 North Atlantic Right Whale Monitoring (Lei Harris, Danielle MacDonald)

In collaboration with the New England Aquarium (NEAq), DFO conducted an aerial survey of Canadian waters for North Atlantic Right Whales, with a focus on the Gulf of Maine and Scotian Shelf areas. The NEAq survey crew found 5-8 whales in Roseway Basin and 2 on the Grand Manan Banks during their late September survey. DFO conducted a vessel-based survey of the North Atlantic Right Whale Critical Habitat in the Bay of Fundy in October 2013. Weather conditions were marginal but nevertheless we had two sightings of right whales.

2013 marked year two of a campaign called “Wanted! North Atlantic Right Whales” in search of areas outside of the Critical Habitat where North Atlantic Right Whale aggregate. Over 300 posters were placed on wharves, community bulletin boards, Coast Guard vessels, ferries, whale watch companies and DFO area offices in Prince Edward Island, Nova Scotia, New Brunswick, Quebec, and Newfoundland and Labrador to solicit information from the public on sightings of these whales. Pamphlets with additional information on the project were also made available. This project has resulted in an increase in reported sightings, including sightings in areas and seasons in which few sightings data existed previously.

In addition to using the data for monitoring of North Atlantic Right whale habitat use, sightings were shared with members of the fishing industry via VHF broadcast and the US National Oceanic and Atmospheric Administration for addition to web-based Interactive North Atlantic Right Whale Sightings Map in near real-time for public education and to mitigate the threats of ship-strike and entanglement in fishing gear.

### 2.2.2 Scotian Shelf Northern bottlenose whales (Hilary Moors-Murphy)

DFO continues to conduct research activities in support of Endangered Scotian Shelf northern bottlenose whale recovery efforts. A substantial effort was made to collect, digitize and archive photo, video, acoustic media and associated metadata relevant to Scotian Shelf northern bottlenose whales dating back to the 1980’s from various sources in a centralized database to be maintained by DFO. This database will provide researchers with a more complete record of the data available on this species and allow for more efficient analysis in future studies such as ongoing photo identification efforts. A long-term passive acoustic monitoring study to investigate how the population uses the shelf-break areas between the critical habitat identified in the Gully, Shortland and Haldimand canyons and to potentially identify additional critical habitat of the population is being led by DFO in collaboration with JASCO Applied Sciences. Data collection for this study was initiated in October 2012 and continued throughout 2013, resulting in a near-continuous year-round acoustic dataset that is currently being analyzed for the presence of northern bottlenose whale vocalizations. An analysis of the characteristics

of northern bottlenose whale echolocation pulse trains and associated reflections/echoes recorded on bottom-mounted recorders in the Gully was also completed (Martin and Moors-Murphy 2013) to aid in the development of automated detectors for the species.

### 2.2.3 Passive acoustic monitoring of cetaceans and ocean noise on the Scotian Shelf (Hilary Moors-Murphy and Norman Cochrane)

DFO is conducting a long-term passive acoustic monitoring study on the eastern Scotian Slope in collaboration with JASCO Applied Sciences using bottom-mounted autonomous acoustic recorders that will be used to collect two years of near-continuous acoustic data from the Gully Marine Protected Area and slope areas between the Gully, Shortland and Haldimand canyons. This dataset will be used to characterize cetacean occurrence and the acoustic environment of the Scotian Slope region. Data collection was initiated in October 2012 and continued throughout 2013 and analysis is ongoing. In addition to investigating use of these areas by northern bottlenose whales, these recordings will be used to establish baseline information on the presence and behavior of various cetacean species (including blue, fin, sei, humpback, sperm whales and delphinids) and natural and anthropogenic noise levels within the Gully MPA and adjacent slope areas. This information is essential for assessing the year-round importance of these areas to cetaceans and for gaining a better understanding of the current acoustic environment of the Scotian Slope. Such knowledge is vital for evaluating and mitigating the potential impacts and cumulative effects of anthropogenic activities on species at risk and in areas of enhanced biological importance.

### 2.2.4 Development of improved acoustic monitoring using sensor diversity (Hilary Moors-Murphy)

Passive acoustic monitoring is often suggested as an effective method of detecting cetaceans for mitigation purposes during anthropogenic activities; however, the ability to reliably detect, locate and count cetaceans using passive acoustic technology is still very much in development. Through a project funded by the Offshore Energy Research Association (OERA) being led by Akoostix Inc., DFO is collaborating on study aimed at investigating methods of detecting and estimating the number of vocalizing cetaceans using multiple passive acoustic sensors. In 2013, two weeks of acoustic data from four bottom-mounted acoustic recorders were collected from the Emerald Basin in August and analysis has been ongoing. Results of this study will further refine and increase the accuracy of methods used to acoustically detect and count odontocetes.

### 2.2.5 Harvest advice for Nunavik beluga (Thomas Doniol-Valcroze, Mike Hammill, Jean-François Gosselin, Véronique Lesage)

Inuit hunters in Nunavik (northern Quebec) harvest beluga from a mix of discrete stocks designated after their specific summering areas, including the depleted Eastern Hudson Bay stock (EHB). Genetic analyses of samples provided by a community sampling program have shown that the proportion of EHB beluga in the harvest varies spatially and seasonally. Samples from Hudson Strait indicate a lower proportion of EHB beluga in the spring harvest than during the fall harvest. Redirecting harvesting effort from the fall to the spring thus appears to be one approach to reduce harvest pressure on the EHB stock, while continuing to ensure access by hunters to the resource.

Harvests in Nunavik have been stable in the past five years. Catch statistics were used to update a population model that integrates abundance estimates from aerial surveys and proportions from genetic analyses. Results suggest that there were ~3,240 EHB beluga in 2013, with indications of modest population growth. Simulations using a modified version of the model show that flexible allocation of takes over 3-year management periods has little impact on the probability of decline of the EHB stock compared to an annual TAT. Only catching the entire TAT in the first year of each 3-year period had a measurable effect on the number of beluga associated with a given risk of stock decline after 12 years.

Removing 180 EHB beluga in each 3-year period has a 50% probability of causing stock decline, while lower harvests would likely allow some recovery. Precise information on age structure of the stock and composition of the harvest is lacking. Harvesting a disproportionate amount of reproductive females in a single year, or removing entire family units during years of large harvests, would have negative effects on the stock that cannot be anticipated by the current model. At current harvest rates, rebuilding the stock to levels observed in the early 1980s is unlikely.

Collaborative work with Trent University has continued, using Traditional Knowledge to learn more about beluga foraging ecology in waters around Nunavik. A new project looking at Traditional Knowledge associated with walrus ecology was also initiated.

### 2.2.6 Population Management of Grey Seals (Mike Hammill, Aline Carrier)

An MSc thesis was recently completed which examines the impacts of reducing the Gulf of St. Lawrence grey seal population, and how this reduction might affect cod recovery using the ECOPATH with ECOSIM ecosystem model.

### 2.2.7 Winter Diet of Grey Seals (Mike Hammill, Garry Stenson)

Grey seal predation has been identified as a potential contributing factor to the high adult mortality observed in the southern Gulf of St. Lawrence (NAFO area 4T) Atlantic cod. Estimates of consumption indicate that significant amounts of 4T cod are being consumed by grey seals, but the stomach content data indicate that the diet is dominated by fish smaller than 35 cm long which is inconsistent with the observed

pattern of high mortality among larger adult cod. To determine if diet sampling biases might account for this inconsistency, an ongoing study examines the diet of grey seals that overlap with over-wintering 4T cod in areas that have been poorly sampled in the past, including the Cabot Strait and around the Magdalen Islands. Five seasons of sample collection have been completed.

### 2.2.8 Grey Seal Life History (Don Bowen)

The Bowen laboratory continued long-term research on life history traits of grey seals on Sable Island and conducted the 6th year of deployments of grey seals equipped with Argos GPS tags and mobile transceivers to detect acoustically tagged Atlantic cod, salmon and tuna as part of the Ocean Tracking Network.

### 2.2.9 Harbour Seal Growth and Development (Mike Hammill, Gwenael Beauplet, Caroline Sauvé, Joanie Van de Walle, Pierre-Étienne Lessard, John Arnaould, Isabelle Charrier)

Research into the development of harbour seal pups, growth, development of diving skills and activity budgets in collaboration with Laval University is continuing.

### 2.2.10 Habitat Use by Northwest Atlantic Seals (Garry Stenson, Mike Hammill)

In order to determine movements and habitat use by northwest Atlantic hooded seals, a cooperative project between DFO and the Greenland Institute of Natural Resources was initiated in 2004. Papers describing habitat selection and an analysis of diving behaviour by hooded seals have been published. The occurrence of drift dives has determined and the results accepted for publication.

Oceanographic data were also collected by the transmitters. Data collected by hooded seals was combined with temperature data from other marine mammals and traditional oceanographic monitors to determine the movement of Atlantic water on the southeast Greenland shelf. The results of this study were published in 2013.

### 2.2.11 Role of Harp and Hooded seals in the Northwest Atlantic Ecosystem (Garry Stenson, Mariano Koen-Alonso)

Multi-disciplinary studies on harp and hooded seal population dynamics and seal-fish interactions continued in 2013. Consumption of Atlantic cod and capelin by harp seals off the east coast of Newfoundland in NAFO Divisions 2J3KL was estimated by integrating information on the numbers at age, age specific energy requirements,

seasonal distribution and diet of harp seals in the Newfoundland area. The impact of different diet determination methods was explored by estimating consumption based upon the proportion of cod in the diet obtained using traditional hard part analysis, a multinomial regression approach and fatty acid signatures. Bioenergetic-allometric biomass dynamic models were constructed to determine if predation by seals is an important factor controlling the population dynamics of Atlantic cod or capelin in the area. Overall, the best model to fit the data to explain abundance of cod was one including capelin and fisheries catches, but without seal consumption. Based upon the results of this simple model, consumption of cod by harp seals does not appear to be an important driver of Northern cod during the study period. Instead, fisheries and availability of food appear to be the important drivers of the dynamics of this stock. Environmental factors such as ice cover appear to be more important in influencing the dynamics of capelin stocks than seal predation. A paper describing the factors influencing capelin abundance off Newfoundland has been accepted for publication. A second manuscript describing the results of the modelling to determine factors impacting cod abundance has been submitted for publication.

Additional samples of diets in Newfoundland have been collected and are being analyzed.

### 2.2.12 Biological Sampling of Northwest Atlantic Harp, hood, ringed and grey seals (Garry Stenson, Becky Sjare, Jack Lawson, Mike Hammill)

An ongoing programme of collections involving sealers and DFO personnel from Newfoundland, Labrador and the Gulf of St. Lawrence continues to provide annual biological samples of seals captured during the commercial hunt in the region. These data facilitate the long term monitoring of reproductive status, diets, and the growth and condition of seals during a period of significant ecological change.

### 2.2.13 Stock structure of harp seals (Garry Stenson, Dawn Marshall and Elizabeth Perry)

Stock structure of harp seals from different whelping areas was explored using mtDNA and microsatellites. Preliminary results indicate that harp seals are divided between three populations that pup in the White Sea, Greenland Sea and Northwest Atlantic. There were high levels of genetic variation within each of the Front and Gulf subpopulations, but no differentiation between the two subpopulations. This supports previous genetic studies which indicated that Front and Gulf subpopulations lack genetic differentiation and thus these are not separated breeding units.

### 2.2.14 Changes in reproductive rates in northwest Atlantic harp seals (Garry Stenson, Nadine Wells)

Annual sampling of late term pregnancy rates, fecundity and mean age of sexual maturity of Northwest Atlantic harp seals were continued. Fecundity rates were extremely low (<30%) in 2010 and 2011. The proportion of mature females that were pregnant appeared to be higher in 2012 and 2013 but samples sizes were small. The sampling program for the winter of 2013/2014 was expanded to increase the sample size.

Annual fecundity rates have declined, and increased in variability, since the 1970s. These changes can be described by a model that incorporates changes in population and the occurrence of late term abortions. The abortion rate appears to be influenced by January ice conditions and capelin biomass.

### 2.2.15 Assessing the status of Northwest Atlantic harp seals (Garry Stenson, Mike Hammill, Jack Lawson, Jean-François Gosselin)

An aerial survey to estimate harp seal pup production was flown in 2012. Analyses were completed and presented for peer-review in 2013.

The abundance of Northwest Atlantic Harp Seals was estimated using a population model that incorporated information on reproductive rates, reported removals, estimates of non-reported removals and losses through bycatch in other fisheries to determine the population trajectory. The model was fit to eleven periodic estimates of pup production from 1952 to 2008, and to annual pregnancy rate data collected between 1954 and 2012. Pup production declined throughout the 1960s reaching a minimum in 1971, and then increased to a maximum in 2008. Estimated pup production in 2012 was 1.5 million animals (95 % CI=1.0-2.1million); the total estimated population size in 2012 was 7.1 million (95 % CI=5.9 to 8.3 million). Fitting the model to both the aerial survey data and the reproductive rate data (age classes 8+ only), resulted in estimates of carry capacity (K) =10.0 million. Ice conditions, reproductive rates and removals from the Greenland harvest continue to be important factors affecting the dynamics of this population. Modifications to the assessment model have provided a means of estimating environmental carrying capacity assuming a certain functional relationship between total population size and juvenile survival, and between population size and reproductive rates.

### 2.2.16 Developing Improved Methods of Determining Diets (Garry Stenson, Don Bowen)

Current methods of diet analysis in marine mammals, particularly hard part analysis (HPA), have biases that will affect the accuracy of species and frequency of prey in estimated diet. All methods of diet analysis in marine mammals, including hard part analysis (HPA), have biases affecting the accuracy of prey-species identification and frequency in the estimated diet due to differential consumption, digestion and retention. The usefulness of using genomic methods has been examined in the past. While simple

PCR amplification provides data on the presence or absence of a prey species, qPCR may provide a method that provides a quantitative estimate of diet. Experiments involving simulated stomach contents are being carried out to determine the feasibility of using quantifiable PCR techniques.

A comparison of the diets of harp and grey seals estimated using stomach contents, hard part remains from the intestines and DNA is underway.

### 2.2.17 Diet of Grey seals in Newfoundland waters (Garry Stenson, Mike Hammill)

A study to examine the diet of grey seals inhabiting the west and south coasts of Newfoundland was continued. Sand lance were the primary prey of grey seals collected in this area. This study is a joint project between Fisheries and Oceans, Canada, Memorial University and the Fish, Food and Allied Workers Union. The study has also examined the impact of assumptions associated with hard part analysis in estimating diet composition.

A study comparing the diets of harp, hooded and grey seals was completed and the results published (Tucker et al 2013).

### 2.2.18 Assessing the status of grey seals in the Northwest Atlantic (Mike Hammill, Don Bowen, Garry Stenson)

Grey seals form a single genetic population that can be divided into three groups for management purposes based on the location of breeding sites. Most pups (78%) are born on Sable Island, 18% are born in the Gulf and 4% are born along the coast of Nova Scotia. This distribution has changed over time, with a decline in the fraction of the population born on the ice compared to on small islands, and an increase in the proportion of animals born on the coast of Nova Scotia, compared to the Gulf.

Reproductive data from the Gulf of St Lawrence were re-analysed and indicate that there has not been any decline in reproductive rates among females aged 8 years and older. This segment of the population accounts for 70% or more of annual pup production. The last survey was completed in 2010. There is little information on environmental carrying capacity and on the shape of the density-dependent relationship. Current model runs suggest that the population is currently over 500,000 animals in Atlantic Canada.

### 2.2.19 Seasonal Movement Patterns of Ringed Seals in the Lake Melville Region of Labrador (Becky Sjare, Sebastian Luque and J. Whalen)

In 2013, there are two ongoing satellite tagging program for ringed Seals along the Labrador coast; one in collaboration with the Torngat Joint Fisheries Board and the

other with the ArcticNet Nunatsiavut Nuluak Project. There have been ten Seals tagged in the Torngat Program with the possibility of an additional three to be deployed in the spring of 2014. Thirteen Seals have been tagged in the Nunluak Project with data analyses and manuscript preparations ongoing. Ringed Seals along the Labrador coast exhibit movement patterns that are consistent with other areas where tagging has been done on this species. Some Seals travelled several hundred kilometers as far north and west as Baffin Island and Ungava Bay and as far south as Notre Dame Bay in Newfoundland while others show very localized movements. Research examining the changing availability of Ringed Seal pupping habitat along the coast of Labrador is continuing. In 2013, research to identify and map Ringed Seal pupping habitat from RADARSAT-II imagery using a GIS-based model is ongoing. Effort was focused on the preparation of habitat maps for seven study areas along the coast of Labrador.

### 2.2.20 Killer Whales of Atlantic Canada (Jack Lawson)

To assess the status of killer whales in this region, and therefore their susceptibility to anthropogenic threats, DFO continues to collect information on their abundance, distribution, and lifestyles through a combination of photographic identification, directed and opportunistic sightings collection, and genetic and acoustic sampling.

Based on sightings and a multi-year photographic catalogue; there were almost 900 sighting events between 1758 and 2012, with almost half recorded in the last 10 years, and during the June-September period in the Newfoundland and Labrador Region. This temporal and spatial pattern is likely a reflection of observer effort and an increased public awareness for this species.

In Atlantic Canada, killer whales have been sighted both alone and in groups, with most groups have been comprised of 3-7 individuals. Based on the photographic records analyzed to date, there are at least 69 individual killer whales in this region, although this is an underestimate given that DFO is still reviewing its photographic collection, and given the positively-sloped discovery curve. Results of this population study were published in a Special Issue of JMBA (Lawson and Stevens 2013).

DFO is continuing to collect further imagery and biopsy sampling to examine stock structure and relationships with other north Atlantic populations such as Greenlandic killer whales. DFO will also undertake a satellite tagging programme in 2013 in an effort to track killer whale groups.

### 2.2.21 Standardized, Risk-based Framework for Assessing Cumulative Impacts of Marine Development Projects, Including Arctic Shipping and Seismic, on Marine Mammals and Sea Turtles in Canada (Jack Lawson and Veronique Lesage)

This SPERA-funded project is addressing priorities on Ecosystem Impacts of Human Activities and will also provide ways for Assessing and Reporting on Ecosystems.

Building on a draft framework to quantify risks of impacts on Arctic marine mammal populations from shipping noise or ship strikes (Lawson and Lesage 2013), we are expanding this approach into a national risk-based framework, which will also include seismic exploration activities, other impulsive sound sources, noise from subsea cable laying activities, and other marine predators such as marine turtles. This enhanced framework will incorporate effective thresholds for assessing impacts against population productivity in the context of population sustainability, and will be extended to take into account uncertainty in input parameters, and to assess cumulative impacts from multiple activities and/or projects and on multiple ecosystem components. The end products will include: (1) a user-friendly electronic tool for evaluating MDP impacts in an objective, stepwise manner, (2) clear guidance for DFO staff and Industry as to the information required from proponents to assess MDP impacts adequately, (3) the criteria to determine probability and magnitude of such impacts, and (4) means to cumulate MDP impacts at the population and regional levels.

In association with other DFO colleagues in other regions, together with marine mammal researchers from multiple NGOs and other countries, a two-day international workshop was held in Quebec City in March 2014 to begin the expert consultation process to refine the framework. A second workshop will be held in March 2015 to finalize the approach, and prepare the roll-out and publication of the final framework.

### 2.2.22 Mid-Labrador Marine Megafauna and Acoustic Survey (Jack Lawson, Alejandro Buren, Lee Sheppard)

The Labrador coast may be a significant source of petrochemical products in the future. Residents' concerns about the potential impacts of industrial efforts to extract oil and gas off Hopedale and other sites on the Labrador Shelf is paired with a paucity of baseline knowledge concerning the abundance and distribution of marine mammals, seabirds, and other marine fauna which might be affected by anthropogenic activities. In addition to marine mammal and seabird issues, baseline measures of natural and anthropogenic sounds on the Labrador coast are needed to assess the potential impacts of the noise from petrochemical development on marine mammals such as endangered cetaceans, and coastal ringed and harp seal populations which are important to hunters.
The best way to gather these data is with multiple approaches: aerial, shipboard, and acoustic surveys. Each offers complementary strengths to minimize risks of failure, and facilitates involvement of local residents in conducting the tasks as a capacity-building exercise. Environmental Studies Research Fund (ESRF) provided funding to DFO and Environment Canada (EC) to conduct aerial and boat-based surveys of a study area, in waters adjacent to the mid-Labrador coast, to estimate the distribution and abundance of marine fauna - including marine mammals and seabirds. Additional equipment and expertise was provided by DFO and EC.

Total survey effort was 1,264 nautical miles, with 645 nautical miles flown in October and 619 nautical miles flown in November, 2013. In addition to sightings of cetaceans

and pinnipeds, we are currently analysing the records from the autonomous acoustic recorders (in which we have detected calling pinnipeds and cetaceans throughout the year, with some unexpected occurrences such as calling humpbacks in November). We have recently conducted larger-scale, replicate aerial surveys in 2014.

### 2.2.23 Acoustic Programme in Collaboration With St. Pierre et Miquelon Off the South Coast of Newfoundland, 2011 (Jack Lawson, Association SPM Fragîles, and Olivier Adam)

In association with Association SPM Fragîles, DFO again assisted with construction and deployment of a new mooring and deployment of AURAL acoustic recorders to the north and south of the French islands of St. Pierre et Miquelon off the south coast of Newfoundland to study the distribution and identity of marine fauna based on vocalization patterns.

The sounds made by humpback, fin, and minke whales, plus odontocetes such as pilot, sperm, and northern bottlenose whales, and dolphins have been detected. DFO researchers in Newfoundland and Quebec have developed more formal agreements with Dr. Adam (France) to facilitate a student project to analyse these data. All acoustic data collected by DFO NL on the south coast of Newfoundland for the past four years was sent to Dr. Adam to begin the process of filtering the data through automatic acoustics detectors – primarily for blue and killer whales initially.

One of the benefits of the DFO and French deployments on the Newfoundland south coast has been an opportunity to compare vocal patterns of cetaceans over a broad area of the northwest Atlantic. Recently, we have developed a new stock structure model for western and central North Atlantic fin whales (*Balaenoptera physalus*) based on geographic song variations as recorded using DFO, French and JASCO acoustic recorders (Delarue et al. 2013).

## 3.0 CATCH DATA

a. Pinnipeds

| | Atlantic Canada (including Quebec) | Eastern Canadian Arctic |
|---|---|---|
| Harp Seal | 97,918 | no data |
| Hooded Seal | 0 | no data |
| Bearded Seal | 0 | no data |
| Grey Seal | 111 | no data |
| Harbour Seal | 0 | no data |
| Walrus | 36** | * |
| Ringed Seal | 16 | no data |

b. Cetaceans

| | Western Canadian Arctic | Eastern Canadian Arctic | Quebec Region |
|---|---|---|---|
| Beluga | 83 | 231** | 268 |
| Bowhead | 0 | 3 | 0 |
| Narwhal | 0 | 644 | 0 |

* no reporting for communities in Nunavut.

** This number does not include all of the walrus harvested in the Nunavik Marine Region

*** 8 communities still need to report their beluga harvest in Nunavut.

## 4.0 BYCATCH DATA

There is no systematic reporting of bycatch of marine mammals for most species in Canada. Currently, there is a dedicated analysis of certain marine mammals in Newfoundland and Labrador Region.

## 5.0 SCIENCE ADVICE PROVIDED

- Canadian Science Advisory Secretariat Reports (advice provided in 2013):
    - Science Advisory Report 2014/004: Impacts of Rerouting Marine Traffic in the St. Lawrence Estuary on Beluga (*Delphinapterus Leucas*): Science in Support of Risk Management
    - Science Advisory Report 2013/076: Status Of Beluga (*Delphinapterus Leucas*) in the St. Lawrence River Estuary

- Science Advisory Report 2014/011: Status of Northwest Atlantic harp seals, *Pagophilus groenlandicus*
- Science Advisory Report 2014/010: Stock Assessment of Canadian Grey Seals (*Halichoerus Grypus*)
- Science Advisory Report 2014/005: Harvest advice and effects of a flexible Total Allowable Take system for Nunavik beluga (*Delphinapterus leucas*)
- Science Special Response 2014/006: Advice Regarding Harvesting Seal Products of High Quality for Human Consumption

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