NORWAY - PROGRESS REPORT ON MARINE MAMMALS 2013

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I INTRODUCTION

This report summarises Norwegian research on pinnipeds and cetaceans conducted in 2013. The research presented here was conducted at, or by representatives and associated groups of,

The Institute of Marine Research (IMR);
The University of Tromsø – The Arctic University of Norway/ Department of Arctic and Marine Biology (UIT-AMB);
Norges Arktiske Universitet, Forskningsgruppe for arktisk infeksjonsbiologi (AIB);
The Norwegian Polar Institute (NP);
National Institute of Nutrition and Seafood Research (NIFES);
University of Oslo/Natural History Museum (NHM).

II RESEARCH BY SPECIES 2013

PINNIPEDS

Harp seals *Phoca groenlandica*
In the period 18 March to 1 April 2012 IMR conducted aerial surveys in the Greenland Sea pack-ice (the West Ice), to assess the pup production of the Greenland Sea populations of **harp** and **hooded seals**. Two fixed-wing aircrafts, stationed at Constable Pynt (East-Greenland) and Akureyri (Iceland), were used for reconnaissance flights and photographic surveys along transects over the whelping areas. A helicopter, operated from the applied expedition vessel (M/V"Nordsyssel") also flew reconnaissance flights, and was subsequently used for monitoring the distribution of seal patches and age-staging of the pups. On 28 March, a total of 27 photo transects, spacing 3 nautical miles, were flown using both aircrafts in the area between 70º43'N / 18º 31' - 18º 15' W and 72º 01'N / 17º 29' - 17º 29 W. All transects were flown with cameras operating to ensure about 80-90 % coverage of the area along each transect line, resulting in a total of 2792 photos shot. The survey resulted in a total pup production estimate for harp seals of 89 590 (SE = 12 310, CV = 13.7%), which is lower than estimates obtained in similar surveys in 2002 and 2007. (IMR)

Studies of **hooded seals** and **harp seals** from the Greenland Sea stock were conducted during a research cruise with R/V "Helmer Hanssen" to the Greenland Sea between 15 March and 2 April 2013. Seven adult female and 11 newborn hooded seals were culled for various scientific purposes: collection of brain tissue samples for continued studies of mechanisms underlying neuronal tolerance to lack of oxygen (hypoxia) (collaboration with Dr. T. Burmester, Zoologisches Institut und Museum, Universität Hamburg, Germany); anatomical studies of sensory organs and functions (collaboration with Dr. Martin Witt, University of Rostock, Germany); anatomical studies of tracheae for understanding of respiratory physiology in relation to diving in pinnipeds (collaboration with Dr. Andreas Fahlman, Texas A & M University, USA). In addition, samples and data were collected for other scientific projects at other Norwegian institutes that report separately. (UIT-AMB)

Hooded seals *Cystophora cristata*
During the aerial surveys conducted in the Greenland Sea pack-ice in 2012 data were also collected from hooded seal patches. The total estimate of hooded seal pup production was 13 655 (SE = 1 900, CV = 13.9%), which is lower than estimates obtained from comparable surveys in 2005 and 2007. (IMR)

To assess possible reasons for the apparent difficulties faced by the population of Greenland Sea **hooded seals** is a challenge. Based on new Norwegian reproductive samples collected in moulting patches off Northeast Greenland in July 2008 and July 2010, mean age at maturity was estimated at 3.7 (CI=0.4) years, which is considerably lower than the previous estimate of 4.6 years based on Russian moulting patch

samples for the period 1990-94 used in previous models. In contrast, proportion based estimates of mean age at primiparity (MAP(P)) were similar for the 2008-10 and the 1991-94 data sets (5.5 years and 5.8 years, respectively) and a common MAP(P) of 5.7 years could be fitted. There were also no indications of consistent trends in frequency based estimates of mean age at primiparity based on both moulting and breeding patch data collected over the period 1958-2010. Ovary based pregnancy rates were calculated for a total of 699 hooded seal females collected in Greenland Sea breeding patches over the periods 1958-62, 1978-80, 1982-85, 1987 and 1999. Estimates ranged from 0.62 to 0.74 over the study period and comparisons of 95% confidence intervals did not suggest any significant differences between sampling periods. The pregnancy rate for the total sample was estimated at 0.68 (95% CI=0.06). This is 20% lower than the pregnancy rate earlier estimated for Russian samples from 1986-1990 – these were, however, based on a more unreliable method. (IMR)

Four weanling **hooded seals** were live-captured and brought to the animal research facilities at Department of Arctic and Marine Biology (AMB) for studies of mechanisms underlying enhanced brain hypoxia tolerance and of metabolic responses during the post-weaning fast in this species. The described field research was combined with teaching of 20 students that participated on the cruise, which represents a mandatory part of the course "Arctic Biology" (BIO-2310) at the University of Tromsø-The Arctic University of Norway. (UIT-AMB)

Electrophysiological and biochemical studies of *in vitro* neuronal responses to hypoxic insult have been continued using fresh brain tissue from **hooded seals**, as part of ongoing collaborative studies (with Dr. T. Burmester, University of Hamburg, Germany) on the tolerance to hypoxia and to reactive oxygen species in the brain of diving mammals. (UIT-AMB)

Studies of chemical and histological changes in the liver of **hooded seal** pups during their initial nursing growth and the following post-weaning fast have been conducted to assess the metabolic functions of this organ in early life. (UIT-AMB)

Studies of body water homeostasis have been conducted in captive **hooded seals**. Pelagic hooded seals do not have access to freshwater. Experimental studies on harp seals suggest that seawater consumption may aid in maintaining water homeostasis and assist in the excretion of urea when more protein is used for metabolic energy in phase 1 of fasting. In order to determine the rate of seawater consumption in subadult hooded seals, five animals were injected with tritiated water early in a 5 day fasting period. Total body water, as well as total turnover rate of body water, was calculated in order to estimate the amount of metabolic water and exogenic water entering the total body water pool. Preliminary results suggest that also hooded seals supply their water budget by drinking seawater. (UIT-AMB)

Post mortem bronchoalveolar lavage and sampling of oesophagus and spleen of 4 hooded seals sacrificed due to other research purposes at the animal research facilities at Department of Arctic and Marine Biology. (AIB)

Brucella pinnipedialis: Cultured adherent cells from the epithelial lining of the esophagus in hooded seals are by immunocytochemistry found to be positive for the epithelial marker pan-cytokeratin after one week of culture and based on these characteristics they were verified to be epithelial cells. (AIB)

In vitro infection of primary hooded seal epithelial cells with *B. pinnipedialis* reference strain and two hooded seal isolates has been performed. The ability of the marine *Brucella* spp to enter and multiply intracellulary in hooded seal epithelial cells is evaluated by the use of a gentamicin protection assay. By killing the extracellular bacteria with gentamicin prior to harvesting the cells we are able to determine the number of surviving intracellular *brucellae* at fixed time points by plating serial dilutions of the cell lysate.(AIB)

The zoonotic aspect of *B. pinnipedialis* hooded seal strain was evaluated by *in vitro* infection of a human macrophage-like cell line and a human epithelial cell line as described above. By using a cholesterol-scavenging lipid inhibitor, entrance of *B. pinnipedialis* hooded seal strain in human macrophages by involvement of lipid-rafts was evaluated. Intracellular trafficking to lysosomal compartments was evaluated by confocal and electron microscopy. (AIB)

In vitro infection of primary cod macrophages with *B. pinnipedialis* from hooded seal are introduced to the *Brucella*-infection assays. This due to the fact that the hooded seal may not be a reservoir species but rather a spillover host, suggesting that these *Brucella* strains exists in a niche in the environment.(AIB)

We established an ELISA (assay test) for the detection of anti-*Brucella* antibodies in hooded seal, minke whale, fin whale, sei whale and polar bear compared its agreement to other serological tests. We also evaluated the different species ability to bind to Protein A/G, Protein A and Protein G. (AIB)

We utilized the ELISA method to investigate hooded seals for anti-*Brucella* antibodies. Some of the animals were also investigated with bacteriology.(AIB)

We infected BALB/c mice with a *B. pinnipedialis* hooded seal strain and assessed its pathogenic potential in the mouse model and compared the immunological response and the infection kinetics of *B. pinnipedialis* with that of *Brucella suis* 1330. Additionally we evaluated whether infection with *Brucella* spp. and concurrent exposure to PCB 153 in the diet lead to an altered immunological response and outcome of infection in the mouse model.(AIB)

The *in vitro* assays showed that tree different *B. pinnipedialis* strains were able to enter primary **hooded seal** epithelial cells *in vitro*. The *Brucella* spp. entered in low numbers, none of the strains multiplied intracellulary and all were nearly eliminated by 48 h p.i. These results suggest that the *B. pinnipedialis* is not able to multiply and induce a chronic infection in hooded seal epithelial cells. (AIB)

B. pinnipedialis hooded seal strain can enter human macrophages, as well as human epithelial cells. Intracellular entry of *B. pinnipedialis* hooded seal strain involves, but seems not to be limited to, lipid-rafts in human macrophages. Confocal microscopy revealed that intracellular *B. pinnipedialis* hooded seal strain colocalized with lysosomal compartments at 1.5 and 24 hours after infection. *Brucella pinnipedialis* hooded seal strain does not multiply or survive for prolonged periods intracellularly, suggesting a low zoonotic potential. (AIB)

Preliminary results from the infection assays in cod macrophages suggest that *B. pinnipedialis* hooded seal strain survives for prolonged periods intracellularly compared to mammalian cell lines. (AIB)

The ELISA results were consistent with other serological tests. The antibodies from hooded seals and polar bears reacted stronger to Protein A than to Protein G, whereas the sei whale, fin whale antibodies reacted stronger to Protein G than to Protein A. The minke whale antibodies reacted to Protein A and Protein G in a similar way. There was a strong correlation between the optical density results obtained with the ELISA with Protein A/G and Protein A or Protein G, showing that Protein A/G is as well suited as Protein A or G for the detection of anti-*Brucella* antibodies in these species by ELISA. The seroprevalences found with the ELISA for the different species were; **hooded seals** 23.8 % (n = 41/172), **minke whales** 12.2 % (n = 23/189), **fin whales** 5.3 % (n = 4/76), **sei whales** 12.5 % (n = 4/32), polar bear 13.5 % (n = 31/230).(AIB)

A closer investigation of serum samples from hooded seals in the Northeast Atlantic Stock revealed that pups had a lower probability of being seropositive than adults (3 % versus 25 %). The main reason for the increase in seroprevalence from pups to adults was a marked increase in probability of being seropositive for yearlings (35 %). The mean probability of being seropositive decreased with age for hooded seals > one year, and all seropositives were 1 – 5 years old. No relation was observed between *Brucella*-serostatus and body condition or reproductive traits. *Brucella pinnipedialis* was isolated from organs of one of 21 hooded seals; a seropositive yearling. (AIB)

In the mouse model we identified for *B. pinnipedialis* hooded seal strain a reduced pathogenicity as compared to positive control strain *B. suis* 1330. We were unable to detect any effect of exposure to PCB 153 on the immunological response to, or the outcome of infection with, *B. suis* 1330 or *B. pinnipedialis* hooded seal strain. (AIB)

Harbour seals *Phoca vitulina*

Harbour seals were counted along Norwegian coast during moult (August) in 1996-1999 and 2003-2006. Almost all known moulting areas along the coast were covered by aerial photo surveys during low tide (± 2

hours). In some sub-areas, two or three independent surveys were conducted. Additionally, visual counts from small boats and islands were carried out in some selected areas. The surveys revealed a total minimum population of about 7500 and 6700 harbour seals in 1996-1999 and 2004-2006, respectively. The results suggested an annual reduction by 1-2% between the two periods. In some areas the numbers have been reduced by about 50%. Increased anthropogenic removals, and the phocine distemper virus (PDV) epidemic in the Skagerrak region in 2002, might both have contributed to the observed population decline. In 2010-2013, new aerial photographic and boat based surveys aimed to count harbour seals were carried out along the entire Norwegian coast where harbour seals are distributed. The surveys resulted in a total minimum number of 7080 harbour seals along the mainland Norwegian coast, which was a small increase since 2004-2006. In the Østfold county, annual counting during the last years revealed a population of 250-300 seals. In the area including the counties Vestfold, Telemark and Aust-Agder only c. 50 harbour seals were observed in 2010. At the west coast, including the counties Rogaland, Sogn and Fjordane, Møre and Romsdal, approximately 500, 550 and 700 harbour seals were counted, respectively. In Sør-Trøndelag county 632 harbour seals were observed, which was a significant reduction since 2003-2006 when 1527 seals were counted. Also in Nord-Trøndelag a significant reduction was observed, from 138 in 2003-2006 to 61seals in 2012. In the Nordland county, the results in both periods were identical, 2465 seals were observed. In the Troms county, an increase from 727 harbour seals in 2003-2006 to 986 in 2012-2013 were observed. In the Finnmark county, a total of 981 harbour seals were counted, which includes areas in western part of Finnmark that was not counted until 2010. (IMR)

The EPIGRAPH project (2008-2011) has collected data for the comparative study of the ecosystem of two major fjords in Norway: the Porsangerfjord and Hardangerfjord. The project has had a wide focus on all levels of the ecosystem, including, in Porsangerfjord, a study on the ecological role of the top predator thought to be most influential in the area: the **harbour seal**. Between 2009 and 2013, 15 harbour seals were equipped with GPS phone tags and data on their movement and diving behaviour collected and analysed. Otolith analysis of a limited number of scat samples indicated that the species' diet in the area was composed mainly of Gadidae and Cottidae, with a smaller fraction of pelagic fish such as herring. Results from the analysis of individual movements have shown that the habitat used by this resident population is limited to a relatively restricted area, the inner part of the fjord, with occasional trips to the outer areas occurring mainly during the autumn. In order to understand the foraging behaviour of this population, comparison of the temporal and spatial patterns of foraging with the distribution of different types of potential prey in the fjord will be done. However, methodological issues needed to be addressed first. Indexes based on both horizontal and vertical movements are available in the literature for inferring foraging behaviour in free ranging diving animals. For the horizontal movements, increases in path tortuosity and residence in given areas have been related to increases in profitability and therefore to the onset of foraging. However, the analysis of the temporal patterns of dives and dive characteristics has shown that in this species a relevant proportion of time is spent resting, not only at haul out sites, but also at sea, by floating at the surface or during low-activity diving. These behaviours have been found to generate a confounding effect in the analysis of horizontal movement, by positively biasing the times of residence in certain areas. For the vertical dimension, longer times spent at the bottom of the dives are thought to be related to the presence of prey. This study, however, has shown that for this coastal species several factors can affect this measure and therefore its interpretation. In particular, the type of resource targeted and therefore the predatory tactic used (pelagic vs benthic foraging) have been found to generate variation in the times spent at the bottom of dives, suggesting that ecological factors need to be taken into account when inferring foraging from movement and diving patterns. (IMR, UIT)

The haul-out behaviour of **harbour seals** was investigated during the moulting period in three different localities in Finnmark, North Norway, by performing repeated land based visual counts at haul-out sites. The results from the counts were modelled using generalized additive mixed modeling to gain a better understanding of the relationship between the fine scale haul-out behaviour of harbour seals and the tidal cycle, as well as other sources of variability affecting the number of seals hauled out. In addition, results from aerial survey photographs of harbour seals from the same areas were compared to the results from the land based counts. The development of hauled out seals in time at haul-out sites was explained by the tidal cycle and other sources of variation on haul-out behaviour such as disturbance, time of day and movement of seals between haul-out sites were factors influencing seal numbers. The within-day variation in seal numbers along the tidal cycle was also investigated through the use of correction factors which revealed that counting-surveys should be performed around low tide when corrected estimates have a small

uncertainty. The unexpected between-days variation in seal numbers, together with the investigated quality of aerial surveys, revealed the need for replicate counts at haul-out sites to provide a measure of uncertainty in the population estimates of Norwegian harbour seals.

Other species
Previously collected satellite tracking data from **harp seals, hooded seals, crabeater seals, Ross seals** and **leopard seals** have been reviewed, to put the introduction of this technology and its importance for the management of seal populations into perspective. (Blix et al. 2013a) (UIT-AMB)

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species and numbers. During 2013, 102 pinniped observations were recorded. Of these, 11 observations were of **harp seal** groups, 4 **bearded seals**, and 43 **walrus** groups. (IMR)

CETACEANS

Minke whales *Balaenoptera acutorostrata*
The Norwegian **minke whale** DNA register is a data base monitoring commercial harvest and trade of whale products. The register has also been used in a number of ad hoc scientific studies resulting through the accumulation of genetic, demographic and biological data. A pregnant female, captured in the North Atlantic in 2010, differed genetically from other whales in the register. Minke whales are separated into two genetically distinct species: the Antarctic minke whale found in the southern hemisphere, and the common minke whale which is cosmopolitan. All statistical parameters demonstrated that the pregnant female from 2010 was a hybrid displaying maternal and paternal contribution from North Atlantic common and Antarctic minke whales respectively. Her female fetus displayed greater genetic similarity to North Atlantic common minke whales than herself, strongly suggesting that the hybrid mother had paired with a North Atlantic common minke whale.This demonstrates, for the first time, that hybrids between minke whale species may be fertile, and that they can back-cross. (IMR)

The fatty acid (FA) composition were assessed in the blubber of 56 **minke whales** caught during the Norwegian commercial whaling in 2009-2011. Minke whales from four regions were sampled: The North Sea, Vesterålen, Spitsbergen/Bear Island and Finnmark. The FA profile of the whale blubber were compared with FA profiles of potential prey species to investigate if FA analysis can be used to predict the diet of minke whales and how the FAs profile of the blubber reflect the regional ecosystem in which the whale was caught. Clear differences were found in blubber FA profiles between minke whales from different areas, and the results confirm earlier studies that suggested a "three-geographic region model". Even though the FA profiles of minke whale inner layer blubber obviously are affected by the whale diet in the different areas, there were also found a strong impact from endogenous metabolism which may mask and dominate many of the dietary differences. The whale blubber FAs separates from the prey by having relative high levels of FAs likely to originate from endogenous metabolism, like chain shorting products of 22:1 (n-11) (20:1 (n-11) and 18:1 (n-11)), and 22:5 (n-3) which is a elongation product of 20:5 (n-3). It is also remarkable that the whale blubber have much lower levels of the long chain PUFAs 20:5 (n-3) and 22:6 (n-3) than found in the prey organism. It is likely that this is a result from selective partitioning of diet FAs between the storage lipids and membrane lipids. The results of this study indicate that the adipose tissue of the whale blubber is highly metabolism active and strongly determined the FA profile by endogenous metabolism. (IMR, UIT)

Chemical testing of oil from Minke whale and comparison with previously analyzed oils from whale blubber: White Paper 27 from 2005 points out the importance of utilizing the whole whale, including in addition to the meat, both blubber, heart and tripe. The blubber has previously been considered as the residual material with the greatest potential. Health effects of whale oil are not well described in the literature, but previous research conducted in part by NIFES and Haukeland University Hospital have shown that whale oil may be beneficial in the treatment of inflammatory bowel diseases. This is partly due to the high level of marine omega-3 fatty acids (eicosapentaenoic acid, EPA and docosahexaenoic acid, DHA) found in whale oils and various fish oils. In addition, sea mammals have a high content of imidazole

related compounds such as balenine in muscle tissue. These compounds are postulated to have several positive biological functions but the scientific documentation is scarce.
The main objective of this project was to contribute to an overall assessment of applications for oil made from blubber and bones as well documenting the contents of positive components and level of contaminants in the various parts including meat from minke whale so that a better overall utilization of the whale can be achieved. This was done by determining the content of contaminants in various whale oils and documenting whether whale meat is a good source of balenine. During the project we have established a method for the qualitative determination of balenine and we have documented the contents of balenine in products from different parts of the whale which have previously been less utilized. The results of the project have shown that the analyzed whale oils have a beneficial fatty acid profile which does not differ from previous analyzes of whale oil that gave positive health effects. New maximum limits for the concentration of polychlorinated biphenyls (PCB_6) and lower limits for dioxins and dioxin-like PCBs have turned out to be a challenge for unrefined whale oils. During the project it has become evident that whale oils must be refined before they can be used for human consumption. The results for balenine show very low concentrations in the fat-rich samples, but that elevated levels are present in the extracts from bone and in samples of muscle. It should be emphasized that the method developed is only qualitative and not quantitative, and it remains to validate the method. Our results have contributed to the building of a better knowledge base for achieving a higher utilization of the entire minke whale. An important prerequisite for this to succeed will be to document that balenine provide health benefits beyond what is currently known about the marine omega-3 fatty acids. If it turns out that balenine possesses unique health-promoting effects, these results will contribute to better utilization of whale resources, and thus increased value for the whaling industry. The results will also provide increased environmental benefits because the disposal of whale blubber and bone on the fishing grounds ceases. We plan to apply for a continuation of this project initiated by the Myklebust Hvalprodukter AS in Norway and partly financed by the Norwegian Seafood Research Fund (FHF) http://www.fhf.no/prosjektdetaljer/?projectNumber=900921. (NIFES)

During the periods 25 June to 15 July and 15 July to 18 August, sighting surveys were conducted with the institute vessel R/V *Håkon Mosby* and the chartered vessel M/S *Båragutt*, respectively, in the eastern Barents Sea Norwegian coast. The area which was covered is the IWC *Small Area EB* (eastern Barents Sea) which is part of the Medium Management Area E which comprises waters in the northeast Atlantic. This was the sixth and last year of the six-year program 2008-2013 to cover the northeast Atlantic to provide a new abundance estimate of **minke whales** every sixth year as part of the management scheme established for this species. A total of 3,613 nautical miles was surveyed with independent double platforms on primary effort. During primary search effort, the number of observations from the primary platform was 144 sightings of **minke whales**. Sightings of other cetacean species include **fin whales** (22 primary sightings), **humpback whales** (35 primary sightings), **harbour porpoises** (18 primary sightings), **Lagenorhynchus dolphins** (71 primary sightings), **beluga** (27 primary sightings), and **sperm whale** (9 sightings) (IMR).

Minke whale catch data for the 2013 season have been computerised and evaluated. (IMR)

Bowhead whale *Balaena mysticetus*
Biopsy samples of bowhead whales from western Greenland are continued to be analyzed using DNA techniques for analyses of population structure and size. A manuscript on the subject is under publication in MMS. (GINR, UWash., NHM).

Beluga whale *Delphinapterus leucas*
A list of the mammalian type specimens in the collection of the Natural History Museum, University of Oslo, has been compiled by Wiig and Bachmann. The collection contains the holotype and a paratype of the Galapagos fur seal (*Zalophus wollebaeki*) described by Sivertsen in 1953 and a syntype of *Delphinus leucopleurus* described by Rasch in 1843 but later withdrawn. (NHM)

Harbour porpoise *Phocoena phocoena*
An anatomical and histological description of the thoracic and intravertebral arterial retia of **harbour porpoises** has been made. Their location and organization suggests that they may be involved in freeing blood from nitrogen under supersaturated conditions, and thereby contribute to reduce the risk of intravascular nitrogen bubble formation and decompression sickness (Blix et al. 2013b). (UIT-AMB)

Other species

Killer whales *Orcinus orca,* **Sperm whales** *Physeter macrocephalus:* A study of possible interactions between **sperm whales** and **killer whales** took place in the Bleik canyon in the Vesterålen archipelago, North Norway. This area is a habitat for large solitary male sperm whales and killer whale pods. Using local whale-watching boats as opportunistic platforms and photo-identification as indirect method, the study examined the quantity and the nature of interactions between sperm whales and killer whales from 2008 to 2012. The results suggest that killer whale aggressions toward sperm whales are common in the area. The study shows that there are significant annual, but not seasonal, variation in killer whale attacks on sperm whales. Killer whales do not display a selective biting of the sperm whale fluke, suggesting that all the parts of the fluke are equally likely to be attacked. (IMR, UIT)

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species and numbers. During 2013 a total of 891 cetacean observation incidents have been reported. The most frequently observed species were **minke whales** (181 groups), **Lagenorhynchus dolphins** (234), **fin whales** (72), **humpback whales** (107), **killer whales** (120), **harbour porpoises** (64 groups), **blue whales** (4), **sperm whales** (29), **northern bottlenose whales** (7), **long-finned pilot whales** (18), **bottlenose dolphins** (1), **sei whales** (6), **common dolphins** (9 groups) and **narwhal** (1). (IMR)

During 2013 photo IDs have been collected from about 203 **humpback whales** during field work and from incidental sources. In addition, biopsy samples have been collected from 4 minke whales, and 30 humpback whales. (IMR)

During the period 19 August to 27 September 2013 mapping of whale distributions was conducted in connection with the annual ecosystem surveys in the Barents Sea. Data were collected by dedicated marine mammal observers following a line transect protocol on board the research vessels R/V *G O Sars*, R/V *Helmer Hansen* and R/V *Johan Hjort*. (IMR)

III ONGOING (CURRENT) RESEARCH

Analyses of **hooded seal** reproduction data (historical as well as new, sampled in 2008 and 2010) from the Greenland Sea are in progress. (IMR)

Analyses of historical and new data on demography and reproduction of **harp seals** in the Greenland Sea and Barents Sea / White Sea are in progress. (IMR)

Grey seal pup production was last surveyed along the Norwegian coast in 2006-2008. A new survey, aimed to give a new abundance estimate for the entire coast, was started in 2013 and will continue in 2014-2015.

Final analyses of **grey seal** diet data from the Norwegian coast are inm progress, an article will be submitted. (IMR)

Genetic and population studies of **harbour** and **grey seals** continue. (IMR)

Ecological studies designed to provide data on habitat use, diet and food consumption of **harbour seals** will be continued in North Norway. (IMR, UIT)

To try and develop a simpler way of describing **minke whale** diets (as compared with stomach sampling), the predator-prey relationship with respect to fatty acids is being studied in minke whales taken in the hunt in 2009-2011 in the North Sea, off Vesterålen, off Finnmark and in and in the Svalbard area. The analyses also compare fatty acid composition between the hunting areas. (IMR – UIT - NPI)

Comparison of the ecological role of **minke whales** and **harp seals** in the Barents Sea, using fatty acid composition and stable isotopes, are in progress. Material for the study was collected in 2011. (IMR – UIT - NPI)

Various aspects of **minke whale** genetics, using data from the Norwegian DNA register, are being studied in work in progress. (IMR)

Ship based registrations of **grey seal** pups, including tagging, counting and staging of pups, will be conducted in Nordland during the period September-November 2013. This is the second of a three year program aimed to provide a new abundance estimate for the species along the entire Norwegian coast from Rogaland county in the south to Finnmark county in the north. All known and many other potential whelping areas along the Norwegian coast will be surveyed. (IMR)

Previous studies in **hooded seals** have shown that their brain is unusually tolerant to lack of oxygen (hypoxia). Several potential mechanisms may underlie this phenomenon. One that is currently under investigation is that the release of excitatory neurotransmitters is blunted, while the release of inhibitory neurotransmitters may be enhanced, during exposure to hypoxia. This would put the brain in a less excitable state and hence reduce its energy costs and demand for oxygen. We are currently investigating this by use of both electrophysiological and biochemical approaches. (UIT-AMB)

Results from studies of chemical and histological changes in the liver of **hooded seal** pups during their initial nursing growth and the following post-weaning fast, to assess the metabolic functions of this organ in early life, are under way. (UIT-AMB)

B. pinnipedialis: Present studies aim to provide knowledge of a possible environmental niche of *B. pinnipedialis*. Experimental infection in cod will be performed along with further work with the infection assays in primary cod macrophages. Environmental samples (algae/phytoplankton, crustaceans) from the West-Ice area will be evaluated for the presence of marine *Brucella* spp. Survival of marine *Brucella* spp. in a sea-water model and protein expression profiling (proteomics) during starvation are currently investigated by our collaboration partner in Germany (Federal Institute of Risk Assessment (BfR), Berlin). (AIB)

Phocine distemper virus (PDV): Blood samples from harbour seals (Forlandet, Svalbard) will be investigated for presence of antibodies against phocine distemper virus (PDV). PDV usually gives respiratory disease in seals, but also symptoms from CNS, as seen during two major epizootics in Europe (1988 and 2002; "Seldøden"). A serological test (virus neutralization; VNT) is under establishment, which can be used also for other marine mammal species. (AIB)

Walruses *Odobenus rosmarus:* Camera surveillance of **walrus** haul-out sites continued. Digital cameras taking pictures hourly were deployed on 5 different walrus haul-out sites during the period late June - early October to study haul-out behaviour and potential impact of visiting tourists to these sites. (NP)

Two acoustic recorders (AURALs) listening for **bowhead whales** *Balaena mysticetus***, white whales** *Delphinapterus leucas* **and narwhals** *Monodon monoceros* (but also other species- and sounds) was deployed autumn 2012 and was retrieved during autumn 2013. One AURAL was deployed in the Framstrait, the other on the continental slope north of Svalbard. These two AURALs were redeployed at the same sites. In addition two new AURALs were deployed; one in the mouth of Kongsfjorden and one north of Rijpfjorden.(NP)

A new program on **white whales** was initiated with the goals of 1. Determine space use (satellite telemetry) over the entire annual cycle - to discern how these whales move in relation to sea ice, bathymetry, glacier fronts and oceanographic conditions, 2. Assess diet via stable isotope and fatty acid analyses bases on blood and blubber samples from live-captured whales, 3. Update the general health status of Svalbard's white whales based on screening of serum samples, 4. Conduct a screening of levels of various pollutants based on blood and blubber samples from live-captured whales. (NP)

Abundance data collected during recent sightings surveys on large whales and odontocetes are being analysed with respect to distribution and trend information. Whale sightings collected during ecosystem surveys are analysed with respect to relative abundance and distribution patterns. (IMR)

Local abundance, migration and habitat use of **humpback whales** in the Barents Sea are studied based on photo ID (IMR) and population structure by genetic analyses of biopsy samples (IMR and University of Gröningen, Palsbøll).

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Sealing

Advice on the management of harp and hooded seals is based on deliberations in the ICES Working Group on Harp and Hooded Seals (WGHARP). WGHARP met during 26-30 August 2013 at PINRO, Murmansk, Russia, to assess the status and harvest potential of stocks of Greenland Sea harp and hooded seals and harp seals in the White Sea. The advice given by ICES in September 2013, based on the 2013 WGHARP meeting, were used by the Joint Norwegian-Russian Fisheries Commission to establish management advice for 2014.

The basis for the advice was a request from Norway in September 2012 where ICES was requested to assess the status and harvest potential of harp seal stocks in the Greenland Sea and White Sea/Barents Sea and of the hooded seal stocks in the Greenland Sea, and to assess the impact on the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of: 1) Current harvest levels; 2) Sustainable catches (defined as the fixed annual catches that stabilizes the future 1+ population); 3) Catches that would reduce the population over a 10-year period in such a manner that it would remain above a level of 70% of current level with 80% probability.

ICES have developed a Precautionary harvest strategy for the management of harp and hooded seals. The strategy includes two precautionary and one conservation (limit) reference levels. The reference levels relate to the pristine population size, which is the population that would be present on average in the absence of exploitation, or a proxy of the pristine population (which in practical terms is referred to as the maximum population size historically observed, N_{max}). A conservation, or lower limit reference point, N_{lim}, identifies the lowest population size which should be avoided with high probability. The first precautionary reference level is established at 70% (N_{70}) of N_{max}.When the population is between N_{70} and N_{max}, harvest levels may be decided that stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. ICES has suggested that this could be done by designing the TAC to satisfy a specific risk criterion which implicate 80% probability of remaining above N_{70} over a 10-year period. When a population falls below the N_{70} level, conservation objectives are required to allow the population to recover to above the precautionary (N_{70}) reference level. N_{50} is a second precautionary reference point where more strict control rules must be implemented, whereas the N_{lim} reference point (set by ICES at 30% (N_{30}) of N_{max}) is the ultimate limit point at which all harvest must be stopped.

The ICES management of harp and hooded seals require that the populations in question are defined as "data rich". Data rich stocks should have data available for estimating abundance where a time series of at least three abundance estimates should be available spanning a period of 10-15 years with surveys separated by 2-5 years, the most recent abundance estimates should be prepared from surveys and supporting data (e.g., birth and mortality estimates) that are no more than 5 years old. Stocks whose abundance estimates do not meet all these criteria are considered "data poor", and should be managed more conservatively.

Population assessments were based on a population model that estimates the current total population size, incorporating historical catch data, estimates of pup production and historical values of reproductive rates. The modelled abundance is projected into the future to provide a future population size for which statistical uncertainty is provided for various sets of catch options. In case of "data poor" populations, catch limits are estimated using the more conservative Potential Biological Removal (PBR) approach.

Using the population assessment model, the size of the **Greenland Sea harp seal** population was estimated as 627 410 (95% C.I. 470 540 – 784 280) animals in 2013. ICES consider this population to be data rich, and above the N_{70} level (i.e., more than 70% of known maximum abundance measured). Thus, it is appropriate to provide catch advice using the assessment model and to apply the Precautionary harvest strategy. Current catch level will likely result in an increase in population size of 21% over the 10 years period 2013-2023, whereas a catch of 14 600 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), per year would sustain the population at present level over the same period. Catches that would reduce the population over a 10-year period in such a manner that it would remain above a level of 70% of current level with 80% probability are 21 270 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2014 and subsequent years. Any allowable catch should be contingent on an adequate monitoring scheme to detect adverse impacts before it is too late for them to be reversed, particularly if the TAC is set at a level where a decline is expected.

Recent Russian aerial surveys of the **White Sea/Barents Sea harp** seal stock suggest that there may have been a drop in pup production of since 2003. As a result of the 2009 and 2010 surveys, ICES have suggested that the reduced pup production observed since 2004 does not appear to be a result of poor survey timing, poor counting of imagery, disappearance or mortality of pups prior to the survey or increased adult mortality. The most likely explanation for the change in pup production seems to be a decline in the reproductive state of females.

The population assessment model used for the White Sea/Barents Sea harp seal population provided a poor fit to the pup production survey data. Nevertheless, ICES decided to use the model which estimated a total 2013 abundance of 1 419 800 (95% C.I. 1 266 910 – 1 572 690) seals. Based on current data availability, the Barents Sea / White Sea harp seal population is considered to be "data poor". The modelled total population in 2013 is estimated to be about 83% of N_{max}. Current catch level will likely result in an increase in the population size of 13% over the 10 year period 2013-2023. The equilibrium catch level is 17 400 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2014 and subsequent years. A catch level of 26 650 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups) will bring the population size down to N_{70} with a probability 0.8 within 10 years. The PBR removals are estimated to be 40 430 (14% pups) seals. This catch option indicates a 16% reduction of the 1+ population over the next 10 year period. Despite the fact that this population is now classified as data poor, ICES expressed concerns over the high removals and declining population resulting from the PBR estimations, and concluded that the estimated equilibrium catches were the most preferred option.

Results from the most recent (2012) pup survey suggest that current **Greenland Sea hooded seal** pup production remains very low, and lower than observed in comparable surveys in 1997, 2005 and 2007. Due to some uncertainty regarding the historical data on pregnancy rates, the population model was run for a range of pregnancy rates (assuming that 50%, 70% or 90% of the mature females produced offspring, respectively). All model runs indicated a population currently well below N_{30} (30% of largest observed population size). Recent analyses have indicated that pregnancy rates have remained rather constant around 70% in the period 1958 – 1999. Using this scenario, the model estimates a 2013 total population of 82 830 (95% C.I. 67 104 – 98 573). Following the Precautionary harvest strategy and the fact that the population is below N_{lim} , ICES recommend that no harvest be allowed for Greenland Sea hooded seals at this time.

Traditionally, both Russia and Norway have participated in the sealing operations in the West Ice and the East Ice and have, therefore, allocated quotas on a bilateral basis in negotiations in the Joint Norwegian-Russian Fisheries Commission. However, the Russians cancelled their sealing operations in the West Ice in 2001. The Norwegian shares of the 2014 quotas would be the total TAC of harp seals in the West Ice. In the East Ice, the Norwegian quota was set at 7,000 harp seals.

In 1996 new regulations for the **coastal seal hunt**, including catch reports, were introduced. Quotas were set based on the available information on seal abundance along the coast. In 2003, quotas were increased substantially compared to the recommendations based on scientific advice, when they were set at 1186 grey seals (25% of abundance estimate) and 949 harbour seals (13% of abundance estimate). In 2003-2010,

annual catches varied between 302-516 grey seals and 457-905 harbour seals. In 2010, new management plans for harbour and grey seals were implemented. The goal is to ensure sustainable populations of grey and harbour seals within their natural distribution areas. Regulating measures should be designed to ensure that they have the greatest impact in areas where there is documented significant damage to the fishing industry caused by seals. Target population sizes were decided to be 7000 harbour seals counted during moult and a grey seal population producing 1200 pups annually along the Norwegian coast. Hunting quotas should be set in order to regulate the seal populations in relation to the target levels. For 2011, quota for harbour seals was set to 460 and 230 seals were taken. For grey seals recommended quota was 460, set quota was 1040 but only 111 grey seals were taken. Compensations paid for shot seals were stopped for 2011. For 2012 and 2013, recommended and set quotas were 460 and 482 harbour seals, respectively, and 460 grey seals both years. Compensations paid for shot seals were again introduced in 2012 (250 NOK/seal): 355 harbour seals and 64 grey seals were taken in 2012: 483 harbour seals and 177 grey seals in 2013.

Whaling

At the IWC Annual Meeting in 1992 Norway stated that it intended to reopen the traditional **minke** whaling in 1993. So far, IWC has accepted the RMP developed by its Scientific Committee as a basis for future management decisions but has not implemented the procedure. The Norwegian Government therefore decided to set quotas for the 1993 and following seasons based on RMP, with parameters tuned to the cautious approach level as expressed by the Commission and using the best current abundance estimates as judged by the IWC Scientific Committee. In recent years research has been conducted on modification and retuning of the procedure to other target levels than the original 0.72, chosen by the Commission.

Starting in 2009, a new five-year block quota was set with an annual total catch quota of 885 animals of which 750 could be taken within the Northeastern stock area (the E Small Areas, i.e. the EW, EN, ES and EB Small Areas) and 135 within the CM area of the Central **minke whale** stock. The catch quotas are set for each of the five management areas, and the whaling within an area is stopped when this quota limit is reached. On the other hand, untaken quotas may be transferred to following years within the time period which the block quota is set for.

For 2013 the total catch quota was set to 1286 **minke whales**, the same as for 2012. The catching season opened April 1 and was closed medio September 2013.

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VI APPENDIX 1 – CATCH DATA

Sealing

Norwegian catches in the Greenland Sea in 2013 was taken by 4 vessels, whereas no Russian seal vessels participated in the area. Due to the uncertain status for Greenland Sea hooded seals, no animals of the species were permitted taken in the ordinary hunt operations in 2013. Only some animals were taken for scientific purposes. The 2013 TAC for harp seals in the Greenland Sea was set at 25 000 1+ animals (where 2 pups balance one 1+ animal), i.e. the removal level that would reduce the population with 30% over the next 10 year period.

A possible reduction in harp seal pup production in the White Sea may have prevailed after 2003. Due to concern over this, ICES recommended that removals be restricted to the estimated sustainable equilibrium level of 15,827 1+ animals (where 2 pups balance one 1+ animal) in the White and Barents Sea in 2013. The Joint Norwegian-Russian Fisheries Commission has followed this request and allocated 7,000 seals of this TAC to Norway.

Table IV.I shows the Norwegian catches of harp and hooded seals in 2013. The total quotas given were not fulfilled in any area: In the West Ice, 54% of the harp seal quota was taken. Russian sealing in 2013 was planned to be continued using the new boat-based approach introduced in the White Sea catch in 2008. This catch, using ice class vessels fitted with small catcher boats, would focus primarily on weaned pups (beaters), to a much less extent on adult seals. No white-coats would be taken. However, as was also the case in 2009-2012, Russian authorities implemented a ban of all White Sea pup catches. Despite considerable effort from PINRO specialists to explain that a sustainable harvest from the population would be perfectly possible, the Russian authorities concluded that all pup catches in the White Sea should be banned in 2013. Due to this, there were no commercial Russian harp seal catches in the White Sea in 2013. No Norwegian vessel aimed for this hunting area in 2013.

Table IV.1. Norwegian catches of harp and hooded seals in 2013. 1+ means one year old or older seals.

Catching area:	*The West Ice*			***The East Ice***		
Species	Pups	1+	Total	Pups	1+	Total
Harp seals	13,911	2,122	16,033	0	0	0
Hooded seals	15	7	22			

Whaling

After a temporary suspension, the traditional small type Norwegian **minke whaling** was again permitted in 1993 and quotas were implemented based on the Revised Management Procedure (RMP) developed by the International Whaling Commission's (IWC) Scientific Committee. The RMP allocates catch quotas to specific management areas. There are five such management areas within the region of interest to Norwegian whalers. The present areas are a revision of the original implementation and introduced by the IWC/SC at their Implementation Review of North Atlantic minke whales conducted at the 2003 Annual Meeting and later kept at the Implementation Review made in 2008. The areas are (1) the Svalbard-Bear Island area (coded ES), (2) the eastern Barents Sea (EB), (3) the Norwegian Sea and coastal zones off North Norway, including the Lofoten area (EW), (4) the North Sea (EN) and (5) the western Norwegian Sea-Jan Mayen area (CM).

In total, 17 vessels participated in the 2013 season of whaling and the catching period was 1 April to mid September. Table IV.2 shows the number of minke whales taken by area in the 2013 season. The quotas are given as five-year block quotas but is not fully utilised in all areas. There are several reasons for that, including problems with processing the catches and accessing remote areas like the Jan Mayen area and the eastern Barents Sea. The present five-year quota period started in 2009 and is given as annual basic quotas of 885 animals within Medium Area E and 135 whales within the Small Area CM, plus numbers not taken in previous years.

Table VI.2. Quotas and catches of minke whales in 2013 by management area as defined in RMP.

2013	Management area					
Small-type whaling	EB	EN	ES	EW	CM	Total
Catch	68	3	282	241	0	**594**
Quota						1286
Stock area	Northeastern				Central	

VII APPENDIX 2 – BY-CATCH DATA

Harbour porpoises are caught in gillnets in the coastal fisheries. To estimate the total bycatch of harbour porpoises in fisheries for cod and angler fish along the coast, we have used data collected by contracted small vessels in the Coastal Reference Fleet (CRF) which use the same nets as the commercial coastal fleet. Estimated porpoise catch rates relative to catches of cod and angler fish in the CRF are being used to extrapolate to the entire commercial coastal fleet based on their total catches of cod and angler fish. Furthermore, detailed information from the CRF about the fishing operation allowed us to identify influential factors potentially relevant as mitigation factors. Such factors include bottom depth were nets were set, net soaking times and geographic and seasonal variation in bycatch rates. The analyses indicate very high by-catch rates of harbour porpoises. The work has been finalized and published in 2013 (Bjørge et al. 2013).