ICELAND

PROGRESS REPORT ON MARINE MAMMALS IN 2018

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I INTRODUCTION

The following text reports on studies on marine mammals in Icelandic and adjacent waters in 2018. The studies were conducted by the following research institutes: Marine and Freshwater Research Institute, Reykjavík, Húsavík Research Centre (HRC), Húsavík Whale Museum (HWM); Faxaflói Cetacean Research project (FCR), Innovation Centre, Iceland (ICI); Keldur, Institute for Experimental Pathology (KIEP); The National University Hospital of Iceland; The Institute of Natural History (INH); University of Iceland (UI), University of British Columbia in Canada, University of Barcelona in Spain, University of St Andrews in Scotland, Icelandic Seal Center (ISC), BioPol, Hólar University Collage, the University of Stockholm, Natural History Museum of Sweden, Natural History Museum of Denmark, Maine University and University of Aarhus, Denmark, University of Potsdam. Queries for information on research were sent to all offices, individuals and private commercial platforms such as whaling and whale watching companies known to have been involved in marine mammal research or data collection during the period.

II RESEARCH BY SPECIES 2018

Fin whale

The long-term biological sampling program of fin whales was continued in 2018 by the MFRI after a two-year halt in the whaling operations. The total catch of 144 fin whales was sampled at the whaling station in addition to two blue/fin hybrids whales. This data collection includes measurements of morphometrics, body condition and sampling for age determination, reproduction, feeding ecology, genetics and various chemical analyses. For the first time two fin/blue whale hybrids were caught in a single season. Previously four such hybrids had been caught in the fin whaling operations since 1983, and two more identified from biopsy samples in Icelandic waters. A whale research team from the University of British Columbia has conducted various research projects on fin whales at the whaling station in Hvalfjörður in recent years. The research program is wide ranging and has i.a. focused on analysis of anatomical features related to engulfment feeding and diving in fin whales. This includes a study of many structures in the head and thorax including diaphragm, arteries, nerves and muscles in the ventral groove blubber and tongue, esophagus, pharynx, lung and baleen.

Starting in 2014, a research collaboration has been established between the marine mammal research group of the University of Barcelona, led by Alex Aguilar and Asunción Borrell, and the MFRI. The objective is to validate and expand the use of a number of chemical tracers to investigate the ecology and demographic structure of baleen whales, particularly fin and common minke whales and lately also sperm, killer and humpback whales. Research has focused on the use of stable isotopes of various elements (C, N, O, S), trace elements, as well as several biochemical and molecular markers.

Research on the structure and function of the inner ear of fin whales continued under leadership of National University Hospital of Iceland. Some of the samples have been submitted to large international study on the effects of acoustic pollution on the hearing of cetaceans (https://horizon-magazine.eu/article/noisier-waters-linked-behaviour-change-hearing-loss-whales.html). A summary of this project is given in Appendix 4.

Common minke whale

Biological sampling from the common minke whale hunt in Iceland continued under the auspices of the MFRI. For all minke whales, the mitochondrial Control Region and a standard set of 16 nuclear microsatellites is genotyped for population/stock assessment in collaboration with the University of Potsdam.
Studies continued at the MFRI on the development of a new ageing method for common minke whales. Analysis of stomach contents were continued using traditional methods and preparations are undeway to use DNA analysis of food remains for comparison.
The HRC in Húsavík contined their long-term photo-identification and sightings studies of common minke whales.

Humpback whale

As in 2015-2017 humpback whales were the primary species of a whale observation effort during an ecosystem survey focused on capelin in September 2018.
The abundance of capelin was low but as in previous years the humpback whales were concentrated in the area where capelin was detected.
Two humpback whales were tagged in NW Icelandic waters towards the end of this cruise.

The HRC in Húsavík contined their long-term photo-identification and sightings studies of humpback whales in Skjálfandi bay. The MFRI continued their photo-identification studies including the development of the central national humpback whale photo-id database: https://www.hafogvatn.is/en/research/whale-research/whale-photo-id

Pinger trials were conducted in connection with the PhD project of Charla Basran, this included playbacks using whale pinger and seal scarer as well as test with whale pingers on a purse seine vessel.

Blue whale

The HRC in Húsavík continued their long-term photo-identification and sightings studies of blue whales in Skjálfandi bay. Acoustic tags were deployed on two blue whales in Skjálfandi Bay and playbacks with low frequency sounds to blue whales.
Two more fin/blue whale hybrids were genetically confirmed by the MFRI (see fin whales above).

Killer whale

In 2018 the MFRI and the Icelandic Orca Project conducted a field season in Vestmannaeyjar during June, July and August, continuing a long-term project on killer whales, which started in 2008. The current focus of the project is to investigate dietary specialisation in killer whales and thus the field work focused on collecting information on prey targeted and dietary preferences of individual whales by collection of photo-identifications and observation of feeding events. There was also a land-based station that allowed for a broader monitoring of variations in the occurrence of killer whales as well as other cetaceans in the local marine ecosystem. In collaboration with Dr. Paul Wensveen of the University of Iceland, two moored hydrophones were deployed during the summer to monitor cetacean occurrence in the area and effects of vessel noise. The Icelandic killer whale catalogue containing over 400 killer whale individuals identified between 2006 and 2015 was published on the MFRI web in 2017: https://www.hafogvatn.is/static/research/files/hv2017-005pdf

White-beaked dolphins

The HRC in Húsavík contined their long-term photo-identification and sightings studies of white-beaked dolphins in Skjálfandi bay. C-PODS were deployed in Skjálfandi Bay for detection of white-beaked dolphins.

Efforts to estimate bycatch of white-beaked dolphins in fisheries continued at the MFRI.

Harbour porpoise

Efforts to estimate bycatch of harbour porpoises in fisheries continued at the MFRI. Status of this work was reported to the NAMMCO WG on Bycatch estimation in 2018.
Accoustic porpoise deterrents (pingers) were tested for the first time in the Icelandic cod gillnet fishery in April of 2017, but their use showed no reduction in porpoise bycatch, as 7 porpoises got caught in nets with pingers, while 5 porpoises got caught in control nets nearby. Another type of porpoise deterrents (PALs) were tested in the cod gillnet fishery in April of 2018 and like the pingers, showed no reduction in porpoise bycatch as 12 porpoises were caught in nets with the devices, while 11 porpoises got caught in the control nets. Further trials with pingers are planned in April this year.

Collaboration of the MFRI with the University of Potsdam on harbour porpoise genetic research is ongoing (Lah et al. 2016). Among the objectives of this study is estimation of population size based on close kin analysis. For all harbour porpoises, the mitochondrial Control Region and a standard set of 15 nuclear microsatellites is genotyped for population/stock assessment and close-kin-based estimation of population size. Furthermore, multiple nuclear Single Nucleotide Polymorphisms (SNPs) are typed in a representative subset of samples. Since 2017 fishermen have received a payment for each harbour porpoise DNA tissue sample that they send in to the MFRI, and this has resulted in increased number of samples obtained. Around 200 samples have been received per year this way in addition to the samples from bycaught porpoises in the gillnet survey around Iceland in the spring and occasional samples from stranded animals. Preliminary results were presented to a workshop on harbour porpoises in November 2018.

C-PODS were deployed in Skjálfandi Bay for detections of harbour porpoises.

Other (multi) cetacean species

Unusually many cetacean stranding events were recorded in Iceland in 2018, the highest number since the establishment of MFRI's stranding network in the 1980's.

Harbour seals

A new harbour seal census was conducted by MFRI and ISC during 2018 and analysis is ongoing (Granquist and Hauksson, in prep.). Due to the recent decrease in the population, efforts are taken by MFRI and ISC to improve knowledge on population demographics and factors contributing to mortality and/or affecting the status of the population. Research on timing of pupping period and pup production was initiated in 2009 and analysis and manuscript preparation carried out during 2018. A new project was initiated, where haul-out behavior was monitored by using camera traps. The results from the project will increase knowledge in factors affecting haul-out behaviour,and will assist in improving census design. Efforts to estimate bycatch of harbour seals in fisheries continued at the MFRI.

Results of harbour seal diet in river mouths in the north west of Iceland (project initiated in 2008 by ISC and MFRI) based on hard-part analysis and prey-DNA metabarcoding analysis was published in a paper (Granquist et al. 2018).

A study on the effect of land- and boat-based tourism on the spatial and behavioural haul-out patterns of harbour seals was initiated by ISC and MFRI in 2008, as well as interdisciplinary research on best practice and management of seal watching. The study continued during the year and results regarding the perception of marine mammal watching tourists towards marine mammal conservation (Burns et al., 2018) and ethics (Aquino et al. 2018) was published.

Results from a study conducted in co-operation between MFRI, ISC, UI and University of Aarhus, Denmark on vocalisations and behaviour of male Icelandic harbour seals during the mating season was published in a master thesis (Rössler 2018).

A study of harbour seal genetics was initiated in 2016, in cooperation between MFRI, ISC and the Natural history museum of Denmark and analysis continued during 2018.

Grey seals

To estimate the current status of the Icelandic grey seal population, an aerial census was conducted by MFRI in cooperation with ISC during the pupping period in 2017 and analysis was made during 2018 (Granquist and Hauksson 2019).

A project was initiated in October 2016 where five grey seal pups were tagged with satellite tags to map habitat use and the analysis and manuscript preparation continued during 2018 (Baylis et al. in prep.).

A study of grey seal genetics was initiated in 2016, in cooperation between MFRI, ISC, the Natural history museum of Denmark and Main University, and analysis continued during 2018.

Efforts to estimate bycatch of grey seals in fisheries continued at the MFRI.

Other (multi) pinniped species

A project investigating environmental toxicants in seals in Icelandic waters was initiated by MFRI during 2017 and analysis continued in 2018. Very little is known about contaminants in Icelandic seal populations. The focus of the project is to investigate the contents of new contaminants of concern in marine mammals, including new brominated flame retardants and PFAS (per- and polyfluoroalkyl substances). The project is an international cooperation between Sweden (Naturhistoriska Riksmuséet and Stockholm University), Greenland (Grönlands Naturinstitut) and MFRI (Iceland).

Marine mammal redlist

In 2018, the first National Redlist on Icelandic mammals based on the IUCN criteria was published by the Icelandic Institute of Natural History in co-operation with MFRI (https://www.ni.is/midlun/utgafa/valistar/spendyr/valisti-spendyra). In total 18 species were assessed, thereof 15 marine mammals. North Atlantic right whales and harbour seals were classified as critically endangered (CR) while blue whales and grey seals were assessed as vulnerable (VU). Both cetacean species harvested by Iceland, fin whales and common minke whales, were assessed as least concern (LC) as were seven other cetacean species including humpback whales and sei whales. Two species (sperm and N-bottlenose whales) could not be assigned conservation status due to data deficiency (DD).

III ONGOING (CURRENT) RESEARCH

Pinnipeds

A harbour seal aerial census is planned in 2020.

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Cetaceans

Based on assessments conducted by the Scientific Committees of NAMMCO and the IWC, the MFRI recommended in 2017 that annual catches in 2018-2025 do not exceed 161 fin whales on the East Greenland

– West Iceland management area and 48 fin whales in the East Iceland-Faroes management area. On the same basis the MFRI recommended in 2018 maximum annual takes of 217 common minke whales in the Icelandic continental shelf (CIC) area during 2018-2025.

Pinnipeds

Harbour seals: MFRI advices that direct hunt should be prevented and that actions must be taken to reduce by-catch of seals in commercial fisheries. MFRI also advices that a hunting management system should be initiated, and that reporting of all seal hunt should be mandatory.

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VI APPENDIX 1 - CATCH DATA

VII APPENDIX 2 - BY-CATCH DATA

a. Short narrative

Bycatch of marine mammals was monitored in all major fisheries in Icelandic waters in 2018, through logbook submissions, reports from onboard inspectors from the Directorate of Fisheries and in the MFRI annual gillnet survey. Draft report on bycatch in Icelandic fisheries was presented to the NAMMCO Bycatch working group in May 2017, and has since been edited to account for the recommendations of the group.

By-catch in research surveys and when observed by inspectors on fisheries vessels is reported in Appendix 2. By-catch by fishermen now comes from electronic log-books only. Fishermen category "Lumpsucker nets" may include monk fish nets. It should be noted that reported numbers of by-catch is underrepresented to an uncertain extent and hence numbers should not be regarded as reliable. However, some increase has occurred in the by-catch reporting from fishermen the past year (see last year's *Iceland progress report* and the report from the NAMMCO Scientific Committee Working Group on By-catch, in Cph). There may be some overlap in the by-catch reported by fishermen and reports from the inspection. Numbers are given as requested in a separate sheet.

VIII APPENDIX 3 - STRANDINGS

a. Short narrative

All cetacean standings should be reported to the MFRI and when possible autopsies are conducted. Genetic samples are stored in the genetic database at the institute.

Numbers are given as requested in a separate sheet.

No records are kept of pinniped strandings at the MFRI.

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IX APPENDIX 4 – Special study (summary)

Whale inner ears and sea sickness evolutionary and anatomical considerations

Prof. Hannes Petersen
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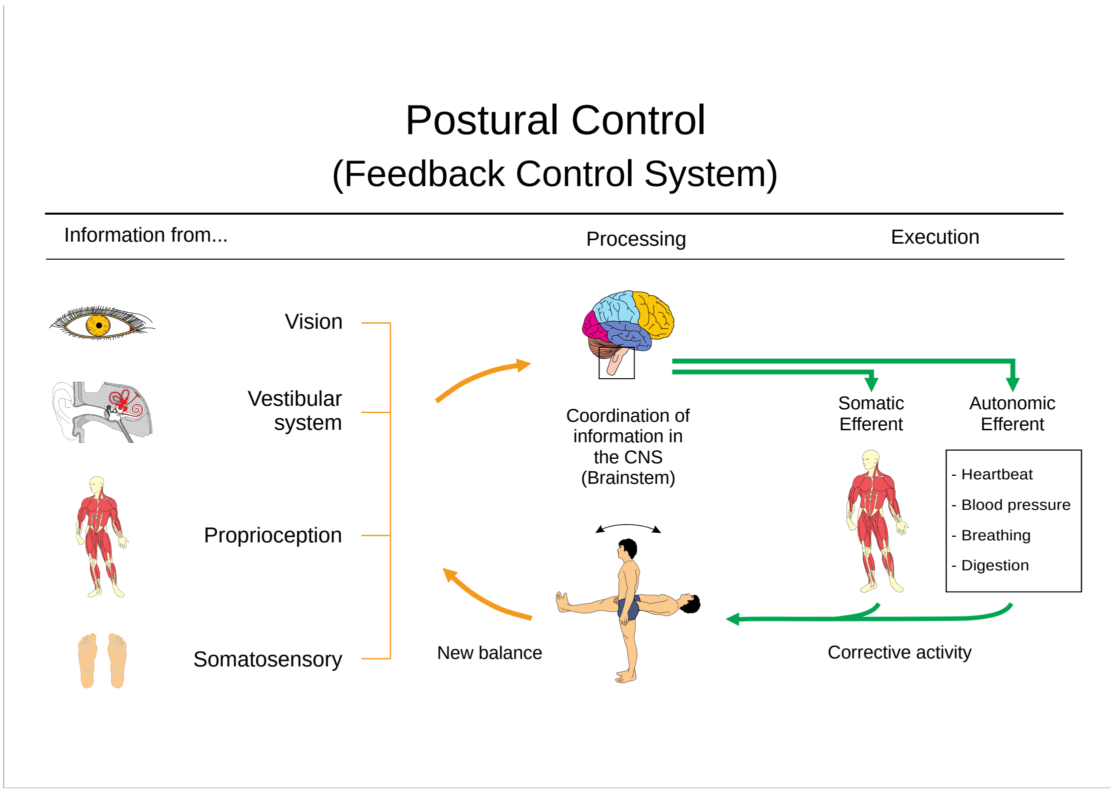
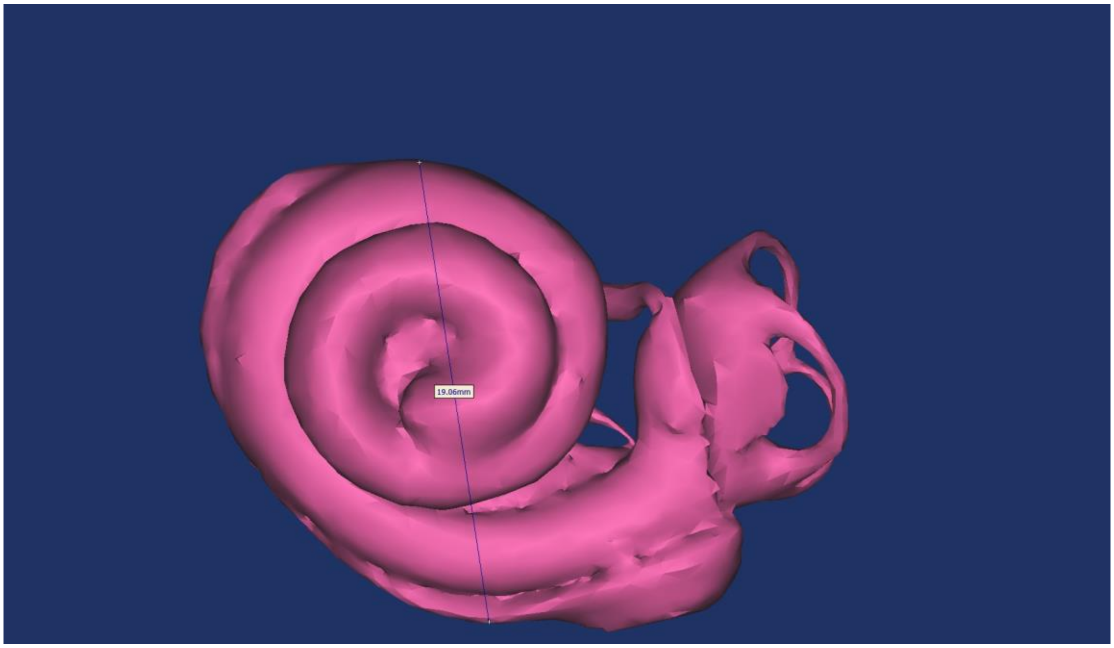
Background

The vestibular part of the inner ear is of special interest regarding sea sickness, as observation has shown that if you do not have functional inner ear, you won't become sea sick. In a motion rich environment as at sea, both inner ears are equally stimulated, giving the brain the sensation of this extensive movement. At the same time the eyes and proprioception are signalling almost motionless environment. This conflict of sensory information conveyed to the central nervous system for computation, generates efferent autonomic link that is responsible for most of the disturbing symptoms a person feels during motion sickness.



As a healthy inner ear is required, one can say that motion sickness and seasickness are symptoms of a healthy individual finding himself in an unhealthy environment, as experienced at sea or more important when swimming in sea. The most frequent report of those swimming across The Canal is that the most difficult thing about it is not the actual enduring of the swim itself, but more the burden of seasickness. In the same sense one can argue that aquatic mammals must also suffer from seasickness, unless they have developed means to adapt against the moving environment of the troubled sea. Therefore it has been interesting to look into the inner ear of whales and try to find out how they have compensated through evolution against sea sickness. It has been shown that medical imaging is a usefull tool, evaluating the evolutonary changes between species [J Anat. 2000 Jul;197 (Pt 1):61-76. Using diagnostic radiology in human evolutionary studies. Spoor F, Jeffery N, Zonneveld F.]. Using these techniques an interesting

Inner ears of some 26 fin whales have been scanned and modelled. The preliminary results are, that the vestibular part of the inner ear, i.e. the semicircular canals as well as utriculus and sacculus which are the main gravity detecting receptors of the inner ear have diminished.



This corresponds with the fact that people that find themselves in water, do not detect gravity, even though gravity exists in water, i.e. it is more the pressure against the skin that gives information about the depth. Regarding the semicircular canals and their importance in moving the eyes (vestibulo ocular reflex) in accordance with head movemenst, the fact that they have also diminished is reflected by the head movements of whales that are very restricted owned to the fact that their cervical vertebrate are fused. The inner ear is the part of the ear where forces of the environment are transformed into electrical signals, used by the central nervous system for computation that base body orientation, posture and movement. These receptors have certainly caused the ancient aquatic mammals to be seasick and therefore the central nervous system has reduced the liability of this information and kept it aside and that is probably the cause of the fact that they have atrophied.

Methods:

A non-invasive method was developed to reconstruct the 3D appearance of whale inner ear and to compare its morphology to human inner ear. This work uses method based on computed tomography (CT), segmentation techniques and rapid prototyping technologies to isolate and visualize the inner ear structure. Moreover this work establishes methods and protocols to determine volume and voxel based density. Spiral computed tomography images and special computational tools are used to image and isolate whale inner ear. Both the cochlea and the vestibular part of the inner ear with it's semicircular canals are made visual through imaging and 3D reconstruction and modelling. The CT scan data are imported into a special image processing and editing computer program called MIMICS. In this software environment, bone, muscles and other tissues can be isolated using the Hounsfield (HU) scale which allows discrimination amongst different tissues based on their linear attenuation coefficient. To select and visualise only the region of interest a threshold based on HU values is defined. A maximum and minimum value is established and individual pixels are selected if their value falls in between the threshold values.

The segmentation process is based on the visual reorganisation of a region of interest which is very small; indeed the total volume including the whale inner hears is approximately 2000 mm3. A special spiral CT protocol is developed for this propose having tube voltage 140 KV, slice increment 0,29 mm and slice thickness 0,58 mm. The elements present within the inner hear volume and target of the segmentation process are bone tissues with different densities, cartilages and fluid filled cavity these elements appear as areas with low density on HU scale. The image processing starts by selecting an initial cross-section within the region of interest and defining a threshold which display it. Using special editing tools available on MIMICS the contours are adjusted manually around cochlear and vestibular organs. The shape created is projected to the next cross-section and adjusted to fit the new cross-sectional area. The process continues until all cross-sections which build up the cochlear and vestibules, with semicircular canals are added afterwards using editing tools are covered. Finaly a 3D printout is performed.

Discussion

Results have shown that the vestibular part of whale inner ears is smaller compared with vestibular part of terrestial mammals, taking into account the animal body size. Further reserch of the microscopic morphology of the receptor areas in the inner ear are planned in collaboration with Dr. Maria Morell Maria Morell, PhD, Institute for Neurosciences of Montpellier France and Dr. Stefan Hegemann, University of Zurich, UZH, Switzerland. Where existence or shape of otoconia is in focus.