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ICELAND

PROGRESS REPORT ON MARINE MAMMALS IN 2021

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I INTRODUCTION

The following is a brief summary of research on marine mammals in Icelandic and adjacent waters in 2021. The studies were conducted by the following research institutes: Marine and Freshwater Research Institute (MFRI), Húsavík Research Centre (HRC), Húsavík Whale Museum (HWM), Faxaflói Cetacean Research project (FCR), Keldur, Institute for Experimental Pathology (KIEP), The National University Hospital of Iceland, The Icelandic 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, Stockholm University, Natural History Museum of Sweden, Natural History Museum of Denmark, Maine University, University of Aarhus, RIF research center and 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 2021

Fin whale

Studies continued at the MFRI on the biology and ecology of fin whales based on data from commercial catches in recent years. Fin whale research conducted at the whaling station in Hvalfjörður is wide ranging and includes i.a studies on age, reproduction, feeding ecology, energetics, pollutants, genetics, hybridization, anatomy and physiology and involves several research institutions including the National University Hospital of Iceland, University of British Columbia in Canada, University of Barcelona and Keldur, Institute for Experimental Pathology.

Researchers at the Shadwick lab at University of British Columbia continued their wide-ranging research on anatomy and physiology of fin whales based on experiments and sampling at the Hvalfjörður whaling station. In 2021, the research focused i.a. on the arterial system. In particular, the anatomy of blood supply to the brain and hemodynamic modelling of attenuation by a vascular rete of cerebral pulsation originating from swimming movements (Lillie et al submitted). Research on the functional anatomy of the fin whale respiratory and digestive tracts comprised a PhD thesis (K. Gil, PhD, Gil et al 2020, 2022).

In addition, this team also used MRI facilities at the University Hospital in Reykjavik to examine anatomy in two fin whale fetuses in 2021 with assistance from Marine and Freshwater Research Institute of Iceland. Ongoing research modelling energetics of lunge feeding in rorquals with collaborators in several US institutions. Aspects of this are based on anatomical details obtained at Hvalfjörður over many years (Potvin et al. 2021).

The first analysis of synthetic particles (including microplastics) ingested by fin whales off Western Iceland was published in 2021 (Garcia-Garin et al. 2021).

Investigation on the applicability of CpG methylation frequency for age determination of fin whales from skin samples was conducted on known-age individuals caught off Iceland (Garcia-Vernet et al. 2021).

Common minke whale

Genetic analyses have been completed for all common minke whale samples received until the end of 2020. The dataset now encompasses 737 specimens from Iceland typed at 16 microsatellites and the mitochondrial control region. These data have been analysed regarding affinity of Icelandic minke whales to other regions of the North Atlantic in an IWC context, i.e., 2014 for the Icelandic RMP implementation review and 2018 for the Greenlandic AWMP implementation review. Microsatellite data are currently used to infer Parent-Offspring (PO) pairs which will inform about regional and ocean-wide movements. Collaboration between the MFRI and the University of Potsdam on common minke whale genetic research is ongoing. Genetic analyses have been completed for all minke whale samples received until end of 2019. Population genetics analyses across the entire North Atlantic were performed, including samples from Iceland, Greenland, Canada, Norway, and the North Sea, to be finalized in 2022. Microsatellite data were used to infer Parent-Offspring (PO) pairs which informed about regional and ocean-wide movements. Final analyses are to be performed in 2022.

New nuclear Single Nucleotide Polymorphisms (SNPs) have been developed using the ddRAD protocol. Further SNPs are currently developed by Whole Genome Resequencing of a representative set of minke whales. These SNPs will form the basis for the development of an informative minke whale SNP panel for population structure assessment across the entire North Atlantic.

Blue whale

The HRC in Húsavík continued their long-term photo-identification and sightings studies of blue whales in Skjálfandi bay. Continued analysis of hybrids between blue and fin whales has revealed the first known record of 2nd generation hybrid (Pampoulie et al. 2021).

Humpback whale

Humpback whales were the primary species of a whale observation effort during ecosystem surveys focused on capelin in 2021. The MFRI's long-term tagging program continued in 2021. The MFRI continued their photo-identification studies and the development of the national humpback whale photo-id database (ISMN Catalog): <https://www.hafogvatn.is/en/research/whale-research/whale-photo-id>.

The ISMN catalogue records over 1538 unique individuals seen in Icelandic waters with more than 8000 sightings recorded, as well as an additional 1050 individuals from partner's catalogues (Guadeloupe (443), Norway (320), Azores (67), Irish (70), Scotland (5) Capo verde (51), Bermuda/Samana Bay (59) and Greenland (30)). The ISMN catalogue includes 69 individuals seen around the world and at least once in Iceland.

A special effort has been made in comparing the ISMN Catalogue to the NAHW Catalogue (North Atlantic Humpback whale).

The HRC in Húsavík continued their long-term photo-identification and sightings studies of humpback whales in Skjálfandi bay.

A research project on the life-history strategy of humpback whales in the sub-arctic waters around Iceland during the winter in comparison to other seasons continued in 2021. This study is done in collaboration between UI, MFRI, the University of St Andrews, Scotland and University of Barcelona, Spain. The biopsy samples are used in a variety of studies including feeding ecology (stable isotopes/fatty acids), stock structure (DNA) and seasonality in reproduction (hormones). The project also involves i.a. tagging, photo-identification and behavioural observations. This study is ongoing until 2022.

The UI in Vestmannaeyjar started studies during the wintertime with humpback whales including photo-identification mainly from land, many of which are contributed by citizen scientists, and sound recordings. Research in the summer of 2021 also included tagging with Dtags in order to understand the behaviour of humpback whales in the area.

Killer whale

In 2021, the UI and the Icelandic Orca Project conducted a field season in Vestmannaeyjar during June, July and August, continuing the long-term project on killer whales started in 2008. The current focus of the project is to investigate dietary specialization on killer whales, to observe interspecific interactions with pilot whales and to investigate the acoustic behaviour of killer whales. Tagging with Dtags was also conducted during the summer field season as well as playback experiments of pilot whale sounds to killer whales to investigate their interspecific interactions. Land-based observations also allowed for broader monitoring of variations in the occurrence of killer whales and other cetaceans in the local marine ecosystem.

In January 2014, year-round systematic data collection on killer whales via photo identification in the waters off the Snæfellsnes peninsula started, with the primary aim of recognizing individual killer whales and documenting their associations and behaviour. This will potentially aid in identifying critical habitat or important feeding grounds, feeding behaviour, prey types, natural mortality and behavioural patterns of the Icelandic killer whale population. The project is the collaboration of West Iceland Nature Research Centre, Láki Tours and Orca Guardians.

Northern bottlenose whale

Continued research on northern bottlenose whales by UI in Vestmannaeyjar this year included deployments of mono and stereo acoustic recorders in deep waters off the east and northeast of Iceland to study acoustic occurrence and movement directions, and photographic analyses for understanding individual movement, group compositions, and age-sex distributions. A joint PhD project was instigated by UI and University of St Andrews on the acoustic behaviour of bottlenose whales from stationary recorders and acoustic tags as well as a Master's project on long-term dive behaviour inferred from SPLASH satellite tags

Long-finned pilot whale

A comprehensive research project on pilot whales that started in 2019 continued compiling photo-identifications, studying their behaviour in Vestmannaeyjar during interactions with killer whales and investigating the ecology of pilot whales through stable isotopes of carbon and nitrogen. The project aims to gather knowledge on this species in Iceland, such as understanding its occurrence in Icelandic coastal waters, the prey targeted by the species and whether that has changed in recent times. The project is conducted by UI in collaboration with MFRI.

White-beaked dolphins

The HRC in Húsavík continued 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. Samples of white-beaked dolphins from stranded or bycaught individuals from the MFRI tissue bank collected from the 1980s until the present were analysed for stable isotopes of nitrogen and carbon to investigate their trophic ecology, as part of a study to investigate the diet composition of killer whales undertaken by UI and MFRI.

Harbour porpoise

Collaboration between the MFRI and the University of Potsdam on harbour porpoise genetic research is ongoing (Lah et al. 2016). Genetic data for the entire set of Icelandic harbour porpoise samples (2109 specimens typed at 13 microsatellites, one sex-determining locus, and the mitochondrial control region) were analysed regarding affinity of Icelandic porpoises to other regions of the North Atlantic as well as with regard to population structure within Iceland. Towards the latter, microsatellite data were used to infer Parent-Offspring (PO) pairs which informed about local movements. PO pair inferences were further used to obtain estimates of population size/abundance. These estimates are currently updated.

New analyses on nuclear Single Nucleotide Polymorphisms (SNPs) have been performed on 150 harbour porpoise specimens from the North Atlantic, including 12 specimens from Iceland. These analyses yielded 26,320 informative SNPs which were used for population structure assessment across the entire North Atlantic. A manuscript draft has been completed in 2021, to be submitted in early 2022.

Whole Genome Resequencing was completed for 9 harbour porpoises and is currently performed on a further 65 specimens in early 2022, including specimens from Iceland, Canada, Norway and the North and Baltic Sea.

Efforts to estimate bycatch of harbour porpoises in fisheries continued at the MFRI.

Acoustic 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. A pinger with a different signal was tested in 2019, but no porpoises were caught. Further trials with that pinger in 2020 were successful. The device was tested over two weeks, where over 3000 50m nets were hauled. Half of the net sets were equipped with the devices, while the other half acted as control. A total of 15 marine mammals were caught in the trial, 14 harbour porpoises and one harbour seal. Significant difference in the number of harbour porpoises was observed between the two treatments ($t = 3.78$, $p = 0.00017$), as all 14 of the harbour porpoises were caught in the control sets, while none were caught in the PAL equipped sets. The single harbour seal bycaught was caught in a PAL equipped set. These results suggest that this configuration of the PAL might be effective in reducing harbour porpoise bycatch in Icelandic waters.

Samples of harbour porpoises from stranded or bycaught individuals from the MFRI tissue bank collected from the 1990s until the present were analysed for stable isotopes of nitrogen and carbon to investigate

the trophic ecology of harbour porpoises, as part of a study to investigate the diet composition of killer whales undertaken by UI and MFRI.

Other (multi) cetacean species

A total of 43 stranding events of cetacean was recorded by the MFRI in 2021 including a single mass stranding of long-finned pilot whales (60 animals) and nine single strandings of sperm whales.

The HÍ Research Centre in Húsavík continued long-term photo-id studies in Skjálfandi bay and initiated a new PhD project using drones to estimate body condition of cetaceans in the bay.

Research on ecological niche partitioning between baleen whales in Icelandic waters was published in 2021. This is a part of a collaborative research between the University of Barcelona and the MFRI, using stable isotope analyses of three elements, nitrogen, carbon and sulfur (Garcia-Vernet et al. 2021).

Harbour seals

A new harbour seal census was conducted by MFRI and ISC during the moulting period of 2020 and the results were published in 2021 (Granquist, 2021a). In total, 4,559 harbour seals were observed, which after correction factors had been applied resulted in an estimated population size of 10,319 (CI 95%= 6.733-13.906).

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 monitoring of local pup production at important sites was initiated in 2009 and analysis and manuscript preparation continued during 2021. A new project was initiated in 2018, where haul-out behaviour was monitored by using camera traps and analysis continued during 2021. The results from the project will increase knowledge on factors affecting haul-out behaviour and will assist in improving census design.

Harbour seal diet and interactions with the fishing industry has been studied at MFRI in cooperation with ISC since 2008. Currently, dietary studies using stable isotopes and fatty acids is ongoing and data analysis was carried out during 2021.

Efforts to estimate bycatch of harbour seals in fisheries and research on mitigation methods continued (see harbour porpoise above).

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 and continued during 2021. The study includes interdisciplinary and international cooperation with researchers from Hólar University Collage, University of Iceland and Griffith University in Australia. The interdisciplinary research focus on research on best practice, management of seal watching and development of an ethical framework. Results were published in two papers during 2021 (Aquino et al. 2021; Chauvat et al. 2021).

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 continued during the year and a manuscript was published (Rössel et al. 2021).

A study of harbour seal genetics was initiated in 2016, in cooperation between MFRI, ISC and the Natural history museum of Denmark and analysis and writing manuscript continued during 2021 and the results will be published shortly (Liu et al. 2022).

Grey seals

To estimate the current status of the Icelandic grey seal population, an aerial census is planned by MFRI in cooperation with ISC during the pupping period in 2022.

A study of the effect of grey seals and seabirds on plant succession on the volcanic island Surtsey in the southern archipelago of Iceland was carried out in cooperation with the Icelandic Institute of Natural History. Monitoring will continue the following years.

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 2021.

Efforts to estimate bycatch of grey seals in fisheries and research on mitigation methods continued.

Other (multi) pinniped species

A project investigating environmental toxicants in seals in Icelandic waters was initiated by MFRI during 2017 and analysis continued in 2021. 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). A recently published paper based on results from the study show low levels of PFAS in Icelandic harbour seals and grey seals compared to levels in mammals in other countries included in the study. Analysis and manuscript preparation on results regarding new brominated flame retardants continued during 2021. The project is an international cooperation between Sweden (Naturhistoriska Riksmuséet and Stockholm University), Greenland (Grönlands Naturinstitut) and MFRI (Iceland).

III ONGOING (CURRENT) RESEARCH

Pinnipeds

A grey seal aerial census is planned in 2022.

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. In 2019, Icelandic authorities issued a regulation on catch limits according to this advice for the period 2019-2023 (annual catch of 161 fin whales and 217 common minke whales). The whaling quotas have not been fully utilized in recent years due to economic reasons and the Covid-19 pandemic. In 2022, whaling was restricted to one common minke whale caught in Icelandic waters.

Pinnipeds

A new legislation was initiated in 2019, where seal hunting is banned. However, seal hunters can apply for exemption from this ban to the Directorate of Fisheries, to hunt seals for own utilization.

Harbour seals: The governmental management objective states that the Icelandic harbour seal population should be kept above 12.000 animals. Based on the population assessment carried out in 2020 which resulted in an estimated population size of 10.319 animals, MFRI advises that direct hunt should be limited and that actions must be taken to reduce by-catch of seals in commercial fisheries to enable the population size to reach management objective. MFRI further advises that attempts to minimize anthropogenic disturbance of harbour seal colonies are initiated, in particular during breeding and moulting seasons between May and August.

Grey seals: The governmental management objective from 2005 states that the Icelandic grey seal population size should be kept above 4100 animals, which corresponds to the observed population size from 2004.

A new advice will be released only after the new population estimate for 2022 has been finalized

V PUBLICATIONS AND DOCUMENTS

Peer-reviewed publications in 2021

Aquino, J.F., Burns, G.L and Granquist, S.M. (2021). A Responsible Framework for Managing Wildlife Watching Tourism. Ocean and coastal management. 210(11):105670. <https://doi.org/10.1016/j.ocecoaman.2021.105670>

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Bertulli C.B., Rasmussen M.H, Rosso M. (2021) Fission-fusion dynamics of a pelagic delphinid in the arctic: the white-beaked dolphin (*Lagenorhynchus albirostris*). *Integrative Zoology* 0:1-15, doi: 10.1111/1749-4877.12524

Chauvat, C. M., Aquino, J., & Granquist, S. M. (2021). Visitors' values and perceptions of seal watching management in Northwestern Iceland. *Journal of Sustainable Tourism*, 1-20. <https://doi.org/10.1080/09669582.2021.1995395>

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García-Vernet, R., Martín, B., Peinado, M.A., Víkingsson, G., Riutort, M., Aguilar, A., 2021. CpG methylation frequency of TET2, GRIA2, and CDKN2A genes in the North Atlantic fin whale varies with age and between populations. *Mar. Mammal Sci.* <https://doi.org/10.1111/mms.12808>

García-Vernet, R., Borrell, A., Víkingsson, G., Halldórsson, S. D., & Aguilar, A. (2021). Ecological niche partitioning between baleen whales inhabiting Icelandic waters. *Progress in Oceanography*, 199, 102690. <https://doi.org/10.1016/j.pocean.2021.102690>

Gil, K.N., Lillie, M.A., Vogl, A.W. and Shadwick, R.E. 2020. Rorqual whale nasal plugs: protecting the respiratory tract against water entry and barotrauma. *J. Exp. Biol.* 223, jeb219691. doi:10.1242/jeb.219691. 2020.

Gil, K.N., Vogl, A.W. and Shadwick, R.E. 2022. Anatomical mechanism for protecting the airway in the largest animals on earth. *Current Biology* 32, 1-6. <https://doi.org/10.1016/j.cub.2021.12.040>.

Granquist, S. M. 2021. The Icelandic harbour seal (*Phoca vitulina*): Population estimate in 2020, summary of trends and the current status. (HV 2019-36). Reykjavík: Marine and Freshwater Research Institute.

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Hammond, P. S., Francis, T. B., Heinemann, D., Long, K. J., Moore, J. E., Punt, A. E., Reeves, R. R., Sepúlveda, M., Sigurðsson, G. M., Siple, M. C., Víkingsson, G., Wade, P. R., Williams, R., & Zerbini, A. N. (2021). Estimating the Abundance of Marine Mammal Populations. *Frontiers in Marine Science*, 8, 1316. <https://doi.org/10.3389/fmars.2021.735770>

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Mruszczok M-T, Violi B, Fakhri M, Calogero G, Biasissi E, Jaouhar A, Scullion A, Würtz M (2021) Long-distance movements of North Atlantic killer whales (*Orcinus orca*) from Iceland via Spain and Italy to Lebanon. *Marine Mammal Science.* <https://onlinelibrary.wiley.com/doi/10.1111/mms.12866>

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Thesis (PhD, MS)

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Gil, K.N. 2021. Functional anatomy and mechanics of the aerodigestive tract in rorqual whales. PhD in Zoology, University of British Columbia. June 2021

O'Brien, Eilidh (2021) Passive acoustic monitoring and seasonal occurrence of Icelandic killer whales in herring spawning grounds. Master in Marine Biology thesis, University of St Andrews, 50 pp.

Rodríguez, AAM (2021). Variations of migratory patterns and behavior of Humpback whales in northern Iceland. MS thesis. University of Stockholm, Sweden.

Saldanha Blackwood, Gabriela (2021) Evaluating the Morphological and Ecological Information of the Cephalopod Specimens Collected During MFRI Trawls, Between 2018 and 2020. Report on the Placement Year for the MSciMarine and Freshwater Biology, University of Glasgow, 31 pp.

Poster/ Conference abstracts/unpublished reports

Chauvat, C., Aquino, J. and Granquist, S.M. (2021). Analyzing visitors' values and perceptions to inform management at seal watching sites in northwestern Iceland. The UK Polar Early Career Conference. Online conference 5-6 May 2021. Presenting author: C. Chauvat.

Chosson V., Sigurðarson B.D., Sigurðsson G. M., Halldórsson S. D, Pampoulie C., Víkingsson G. A. , 2021. Photo Identification: The National PhotoID database. The ISMN (Ísland Megaptera Novaeangliae) Catalog. The Icelandic Biological Society Bio ICE 2021 Conference.

Granquist, S.M. Seal research in Iceland: Population ecology, fluctuations in the seal populations and anthropogenic interactions. Nordic seal, Online workshop 29. April 2021. Sandra M. Granquist.

Jakobsdóttir, H (2021). Group size and composition of northern bottlenose whales (*Hyperoodon ampullatus*) between Iceland and Jan Mayen. Thesis for BSc Biology, University of Iceland. 41pp.

Maunder, William (2021). The Orcinus Orca of Southern Iceland Víkingsson, G. (2021). Hvalir (Cetaceans). In Staða umhverfis og vistkerfa í hafinu við Ísland og horfur næstu áratuga (Vol. 14, p. 127). Hafrannsóknastofnunin and their Relationship with North Atlantic Fish Stocks. BSc Marine Geography with Honours Dissertation, Cardiff University, 50 pp.

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VI APPENDIX 1 - CATCH DATA

Catch data for pinnipeds are under re-evaluation and should not be considered reliable at this stage.

VII APPENDIX 2 - BY-CATCH DATA

a. Short narrative

Bycatch of marine mammals was monitored in all major fisheries in Icelandic waters in 2021, through logbook submissions, reports from onboard inspectors from the Directorate of Fisheries and in the MFRI

annual gillnet survey. Onboard inspections by the Directorate of Fisheries were fewer than in a normal year due to Covid-19 restrictions.

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 logbooks only. 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. 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

According to the Icelandic stranding protocol, the MFRI is responsible for documentation and biological investigations related to cetacean strandings. Therefore, all strandings should be reported to the MFRI, that subsequently organizes autopsies and/or biological sampling depending on circumstances. Genetic samples are stored in the genetic database at the institute and other biological samples stored at the MFRI or sent to cooperating institutes/scientists.

Live-strandings and associated actions (rescue/euthanasia etc) are managed by the Veterinary Authorities (MAST).

Stranding numbers for 2021 are given as requested in a separate sheet.

No systematic records are kept of pinniped strandings at the MFRI.