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This revision document contains an updated version of the document 2-6 ´Health Team Report".

Note that this document was submitted after the established deadline.
It will be decided by the Meeting whether the document can be discussed or is postponed to the next meeting.

Background

This document contains an overview of the recent activities of the Health Team.

Action requested

The Meeting is invited to take note of the information.

Health Team Report

After a very successful meeting of the HELCOM Health Team in Büsum, Germany in August 2019 the next workshop planed in March 2020 in Lithuania had to be cancelled last minute because of developments in relation with Covid-19. This was very unfortunate as it was planned to harmonize monitoring protocols and baselines for indicator based on further practical exercises during necropsies of different marine mammal species. It has been agreed to catch up on this as soon as the situation allows it. Furthermore, future work on harmonizing not only the protocol, but the interpretation of pathological lesions, ergo health status and internationally unified database are planned.

Summary of the BONUS BALTHEATH Project (duration 2017 to 2020)

From 2017 to 2020 the BONUS BALTHEALTH project investigated "Baltic Sea Multi Level Health Impacts on Key Species of Anthropogenic Hazardous Substances" with a consortium of Danish, Swedish, Finnish and German research institutions and scientists. Key findings and scientific outcome of this cooperative project are taken from the final project report and disseminated here for the HELCOM community. Some parts were shortened, edited or added. In several workpackages different aspects of the research were targeted.

Firstly, two comprehensive databases have been compiled, one on the available samples and data among the project members (at the start of the project) and one on de novo food web tracer, contaminant, health and disease biomarker data generated along the course of the BONUS BALTHEALTH project (at the end of the project). Data has been extracted from the databases of the International Council for the Exploration of the Sea (ICES) and the Swedish Environmental Research Institute (IVL), pertaining to mercury (Hg), persistent organic pollutants (POPs) and per-and polyfluoroalkyl substances (PFAS). These have been combined in modeling assessment of population effects and multiple stressor approaches (WP6). Samples from Environmental Specimen Banks (e.g. German environmental specimen bank, the Swedish Natural History Museum, Stockholm, Aarhus University and University of Turku) or other research projects have been exchanged between project partners for chemical analyses (WP3).

Secondly, five decades of food web tracer data for the feeding origin and trophic position of a key Baltic contaminant biomonitoring species, the white-tailed eagle (*Haliaeetus albicilla*), have been generated, in order to support several time series of a wide range of contaminants (WP3). A review of Baltic Sea seal diet have been performed based on more than 40 years of fish otolith data collected in previous studies and through the BaltHealth programme. The data have been compiled into an open access database provided as supplementary table with the publication of the main results by Scharff-Olsen et al (2018). A detailed investigation of food web dynamics in the Baltic Proper was carried out using newly collected samples from the Archipelago Sea in order to support

investigations of Hg, POP and PFAS dynamics from zooplankton up to avian and marine mammal predators. A detailed investigation of the historical record of fish stock dynamics and consumption by humans, seals and birds was performed, uncovering changing food web dynamics from the 1920s up to the present day (Härkönen et al. in prep).

In a third workpackage targeting environmentally persistent substances, five decades of exposure data of a key Baltic contaminant biomonitoring species, the white-tailed eagle (*Haliaeetus albicilla*), have been generated for a wide range of contaminants, including Hg, POPs and PFAS. These investigations show that top predators of the Baltic Sea still carry a high burden of legacy contaminants, which are still believed to impose health impacts, while at the same time some emerging contaminants are on the rise (Sun et al. 2019a,b, 2020). White-tailed eagle and great cormorant (*Phalacrocorax carbo*) chicks were sampled to test their capacity as spatial sentinels of environmental contamination, among these hotspots for metal leaching from sulphate-soils, as well as Baltic-wide hotspots for Hg and PFAS. The results show that use of these nestlings is promising to investigate large-scale patterns of these contaminants (Vainio et al. 2020, Vainio et al. in preparation; Sun et al. in preparation). Eider duck females and their blue mussel food were sampled for POPs from their breeding grounds along coastal Gulf of Finland, Archipelago Sea and Sea of Bothnia as well as from wintering grounds in Danish waters. As high burden of certain POPs have been reported from breeding ducks in Gulf of Finland, this study will expand on the spatial extent of contamination as well as differentiate between POPs captured while staying in wintering vs. breeding regions. A detailed investigation of food web dynamics of Hg in the Baltic Proper was carried out, determining Hg concentrations from zooplankton up to avian and marine mammal predators. While very low concentrations were observed at lower trophic levels, i.e. fish and their prey, the long lifespan of avian and especially marine mammal top predators seem to result in high levels up, i.e. elevated by several magnitudes. This initial investigation is currently extended to POPs and PFAS (Vainio et al. in preparation). A wide range of emerging contaminants, i.e. chlorinated paraffins (CPs), chlorinated, brominated and organophosphate ester-based flame retardants (CFRs, BFRs, OPEs), and novel PFAS (nPFAS), were screened for in key species (invertebrates, fish, seabirds, predatory birds, marine mammals) along the Baltic food web. This screening shows they are widely present as well as indications of biomagnification (increasing levels along the food chain) for many. Concentrations of some emerging contaminants are similar as those for legacy POPs in some species (de Wit et al. in review; Yuan et al. 2019). This initial screening is currently further investigated for its temporal perspective (Yuan et al. in preparation). An easy-to-use experimental workflow for non-selective extraction, purification (lipid removal), and non-target GC-MS analysis of biological samples to identify a wide range of biomagnifying lipophilic organic contaminants in the top consumers of the Baltic ecosystem was established. The experimental workflow was complemented with an appropriate data processing workflow. With the help of these two workflows, the relative biomagnification factors (BMFs) of the contaminants in the species of the food webs in the Baltic Sea were estimated (Rebryk & Haglund 2020; in preparation).

In a fourth workpackage focusing on health and biomarkers, multiple field campaigns on birds and mammals have been conducted to assess contaminant exposure and health endpoints throughout the Baltic i.e. from Western Danish Belts to Northern Gulf of Bothnia including Finland and Sweden. Garbus et al. (2018a,b,c, 2019a,b,c), Lam et al. (2020, in review) and Ma et al. (in review) have analysed parasite burdens, health, egg viability and contaminant exposure of common eiders (*Somateria mollissima*) in three colonies in the Western Baltic. A review by Sonne et al. (in review) shows how exposure and health biomarkers have evolved in a historic perspective in multiple species including marine mammals, seabirds and white-tailed eagles. Pertoldi et al. (2018) and Schmidt et al. (in review) show how bone mineral density and bone pathology have changed over the last century. There are still pathoanatomical changes related to stress and exposure to POPs both natural fluctuations, gender related and polychlorinated biphenyl (PCB) levels affect bone mineral density. Schmidt et al. (In review) have investigated the prevalence of liver lesions in Baltic grey seals (*Halichoerus grypus*) between 1981-2015. The study showed that age was an important factor for the development of liver lesions, but PCBs burden may be an influencing factor. This agrees with previous studies of marine mammals in the Baltic as well as in the Arctic. In conclusion, the age of the animals as well as exposure to PCBs needs to be taken into account when understanding and evaluating the current health status of Baltic grey seals. Ometere et al. (in prep) established molecular biomarkers in Baltic ringed seals in a multi-tissue approach to investigate early on-set effects of environmental stressors on the health of vulnerable top predators by using minimally invasive sampling for free-ranging wildlife. A comprehensive genomic dataset has been generated for harbour seals (*Phoca vitulina,* N=500), ringed seals (*Pusa hispida,* N=240) and grey seals (*Halichoerus grypus,* N=190) covering the species' range in the Baltic and North Atlantic. The resulting data is currently being analysed and interpreted for publications by Bang et al (in prep), Norling et al (in prep), Nielsen et al (in prep) and Schjøtt et al (in prep).

In a fifth workpackage infectious diseases, such as the prevalence of Brucella spp. was compared among Baltic seals and Arctic seals (Sonne et al. 2018). The results showed that ringed seals (*Pusa hispida*) in the Baltic ecosystem may be exposed to and possibly infected by *Brucella* spp. No seropositive individuals were detected among the Greenland harp (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*). Although our initial screening shows a zoonotic hazard to Baltic locals, a more in-depth epidemiological investigation is needed in order to determine the human risk associated with this. Sonne et al. (2020) conducted a review on infectious diseases in the Baltic ecosystem focusing on important key species. This showed that the occurring pathogens are zoonotic and thus also pose a potential risk for human health. Marine mammal handlers, as well as civilians that by chance encounter marine mammals, need to be aware of this risk. It is therefore important to continue the monitoring of diseases affecting key Baltic species in order to assess their relationship to population dynamics and their potential threat to humans. These infectious agents are valuable indicators of host ecology and can act as bioindicators of distribution, migration, diet

and behaviour of marine mammals and birds, as well as of climate change and changes in food web dynamics. In addition, infectious diseases are linked to pollutant exposure, overexploitation, immune suppression and subsequent inflammatory disease. Ultimately, these diseases affect the health of the entire ecosystem and, consequently, ecosystem function and services. As global warming is continuously increasing, the impact of global change on infectious disease patterns is important to monitor in Baltic key species in the future. The studies by Garbus et al. (2018a, b, c, 2019a,b,c) and Ma et al. (in review) reported on infectious diseases in eiders from three colonies in the Baltic ecosystem. It showed that parasites were a significant contribution to energetic stress in eiders and that 50% of the eiders are exposed to avian influenza. Stokholm et al (2019) provided the first comprehensive phylogenetic assessment of the spread of phocine distemper virus (PDV) among harbour seals in 1988 and 2002, finding that an early potentially less infectious PDV strain occurred already in the winter of 1987 before the 1988 outbreak, and that during the 2002 outbreak the virus spread in multiple pulses from the Kattegat epicenter, rather than in a stepping-stone manner. Worsøe-Havmøller (in prep) provided a comprehensive phylogenetic assessment of the spread of influenza A amoung harbour seals in Europe and North America.

Finally, population level effects were modelled and an extremely detailed dynamic energy budget model (DEB) to the Baltic grey seals (Silva et al. accepted) was developed. The model takes metabolic costs of every developmental stage into account and provides a unique tool to investigate population consequences of new stressors such as pollutants, varying food quality and disease. Several mathematical models for analyzing the population level response from anthropogenic stressors were developed. Cervin et al. (accepted) tailor the first ever age structured population model to the Baltic harbor porpoise (*Phocoena phocoena*) and was able to show haw also low levels of pollutants in combination with by-catch can lead the population to rapid extinction. A realistic metapopulation model with local population sizes and migration rates was developed for the harbor seal population. Here we show that also seemingly stable and large populations are very easy to overexploit by hunting and that the age structure and local population sizes must be taken into account. Outbreaks of infectious disease makes this population vulnerable in the long term also if they are abundant in the short term (Silva et al. in review). Desforges et al. (2018) were the first to develop a population effect model on marine mammal top predators. Applying an individual and agent-based model predicted collapses of certain killer whale (*Orcinus orca*) populations from effects of PCB exposure due to effects on reproduction. The model predicted ca. 53% (10 out of 19 populations worldwide) of the global populations to be extinct within 30-100 years including the North Sea population bordering the BONUS water bodies. The Baltic harbor porpoise, ringed seal and grey seal will be used to further evaluate the model. Dietz et al. (in review) assessed a wide range of species, including marine mammals, seabirds, birds of prey, fish and bivalves, to evaluate potential population health risks resulting from contemporary (post-2000) Hg exposure, using novel risk thresholds calculated from both literature and *de novo* exposure data. The main geographic focus is on the Baltic Sea, though data from the same species in adjacent waters, such as the Greater

North Sea and North Atlantic, were included for comparative purposes. High risk category (HRC) and Severe Risk Category (SRC) prevalence for marine mammals, birds, fish and bivalves were 23.0%, 2.7%, 25.0% and 8.0%, respectively. Juveniles from all species showed no or low risk. In comparison to the same species in adjacent waters, i.e. the Greater North Sea and the North Atlantic, the estimated risk for Baltic populations is not considerably higher considering post-2000 exposure levels. These findings suggest that over the past few decades the Baltic Sea has improved considerably with respect to Hg exposure to its local species, while it does still carry a legacy of elevated Hg levels resulting from high industrial and agricultural activity and slow water turnover in the Baltic Basin.

Coordination, communication, education and dissemination were also organised in a workpackage. Future research goals were defined and are in part already being tackled, e.g.

- In-depth food web dynamics of both legacy contaminants still found at high levels (POPs and PFAS) as well as emerging contaminants (CPs, CFRs and nPFAS).
- Time trends of emerging contaminants (CPs, CFRs and nPFAS) in several Baltic Sea species that are key in the food web as well as for human consumption.
- Further efforts to promote the white-tailed eagle as an indicator species for spatiotemporal patterns of legacy and emerging contaminants, using a specialized approach to analyse feathers collected over several decades as well as from nestlings across the basin.
- An expansion of the spatial and population-level impact assessment for marine mammals, birds, fish and bivalves, now performed for Hg, to legacy contaminants still found at high levels (POPs and PFAS).

Furthermore, general research questions have emerged:

- How will global warming affect contaminant and disease dynamics in Baltic key species, and will it introduce certain tipping points compromising ecosystem health and the attached goods and services for humans?
- Are Baltic wildlife and key species harboring a potential broad number of zoonotic diseases that may increase in the future, similar to COVID-19?
- What are the population level effects from multiple-stressor exposure, i.e. to parasites, diseases, contaminants, and changed energetic demands? Is there risk that some of the harbor porpoise or seal populations may go extinct as has been predicted for some killer whale populations?
- What are the combined effects of exposure to the still relatively high legacy POP concentrations in top predators together with those of increasing numbers and concentrations of emerging contaminants?
- How are the current levels of a suite of legacy POPs and emerging contaminants in Baltic Sea fish and other species related to human exposure to chemicals and potential adverse effects in humans?

Addressing these basic scientific questions will improve our predictive capacity through models, provide relevant information to policy makers and allow us to assess consequences of contaminant, disease, and density-dependent effects and climate management scenarios at a local scale as well as for the entire Baltic Sea.

Report from Schleswig-Holstein, Germany

By Kristina Lehnert and Ursula Siebert, Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover

In 19 harbour seals and 7 grey seals were found dead on the Baltic coast of Schleswig-Holstein. 146 harbour porpoises stranded on the beaches of Schleswig-Holstein of which 13 were suspected to be by-caught or by-catch could not be excluded. Additionally, four other porpoises were by-caught and handed over directly from fishermen. The effects of the large number of PALs deployed in the waters of Schleswig-Holstein on the health and survival of the porpoises have still not been studied. The number of dead grey and harbour seals on the coast of Schleswig-Holstein continues to raise and may cause an increase of interactions with fisheries and touristic activities.

In addition to the yearly marine mammal monitoring funded by the Ministry of Energy, Agriculture, Environment, Nature and Digitalisation of Schleswig-Holstein, investigations on effects of explosions on harbour porpoises were supported by the German Federal Agency of Nature Conservation after fourty-two British base mines of the type MK 1-7 from World War II were cleared by means of blasting in the period from 28 August to 31 August 2019 by a NATO unit with the participation of the German Navy in the Exclusive Economic Zone within the NSG Fehmarnbelt.

Since serval weeks there is common dolphin in the Bight of Eckernfoerde, stationary in a relatively small area showing skin lesions and causing a lot of public attention.

Investigations on the antimicrobial resistant *Escherichia coli* isolated from marine animal species and microplastic analyses continue as part of PhD- thesis and results will be presented at the EG MAMA 2021. After the publication on the health status of harbour porpoises from different HELCOM regions, genetic results will be directly connected to biological and health findings in order to increase the understanding of the situation of the two different harbour porpoise populations in the Baltic. As reported above within the BONUS BaltHealth project several biomarkers for health assessment of seals in the Baltic Sea were established and further research is ongoing to extend this approach.

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(For further references please visit: https://www.tiho-hannover.de/kliniken-institute/institute/institut-fuer-terrestrische-und-aquatische-wildtierforschung/publikationen/)

Report from Sweden

By Sara Persson and Britt-Marie Bäcklin, Department of Environmental Research and Monitoring, Swedish Museum of Natural History

Seals found dead on shores are reported by the public to the Swedish Museum of Natural History through a web site. The number of carcasses on the Swedish west coast this summer (Fig. 1) is somewhat high but seems to follow the seasonal pattern. We only had one report of a sighting of a sick seal on the west coast, in June.

The number of reported carcasses on the south and east coast did not follow the usual pattern this year (Fig 2.). There were two reports of observations of grey seals with symptoms from the respiratory tract in the south-west of Sweden and Gotland in June but none after that.

Factors that could affect the number of reports might be weather (affects the number of people along the coast) and the public awareness of the reporting system. The warm weather during June and August fits well with the increased reports in these months, indicating that this system is sensitive such bias. Also, the number of hunted seals may affect the figures as not all seals are possible to collect after death (they sometimes sink into deep water). Disease as a causative factor to the seemingly high mortality has not been ruled out. The Swedish Veterinary Institute have received funding this year for investigating causes of death and pathogens in seals. None of the seal carcasses reported during the summer was autopsied due to severe autolysis, but efforts to investigate and collect carcasses are ongoing.

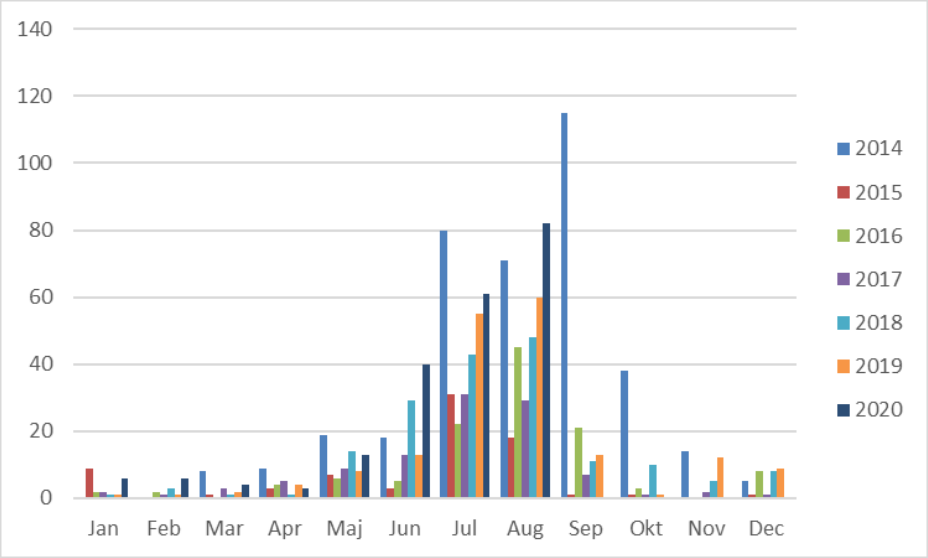

Figure 1. Monthly frequency of reports of seals found dead along the Swedish west coast

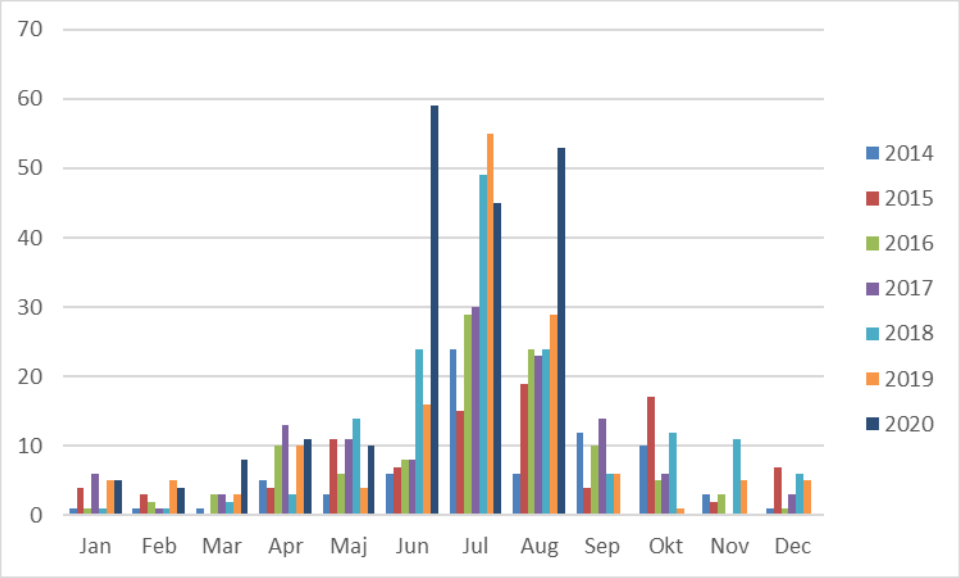

Figure 2. Monthly frequency of reports of seals found dead along the Swedish south and east coast (the Baltic proper and Bothnian bay)

Health

Most recent data regarding intestinal ulcers in grey seals indicate that it is still a significant problem that needs monitoring.

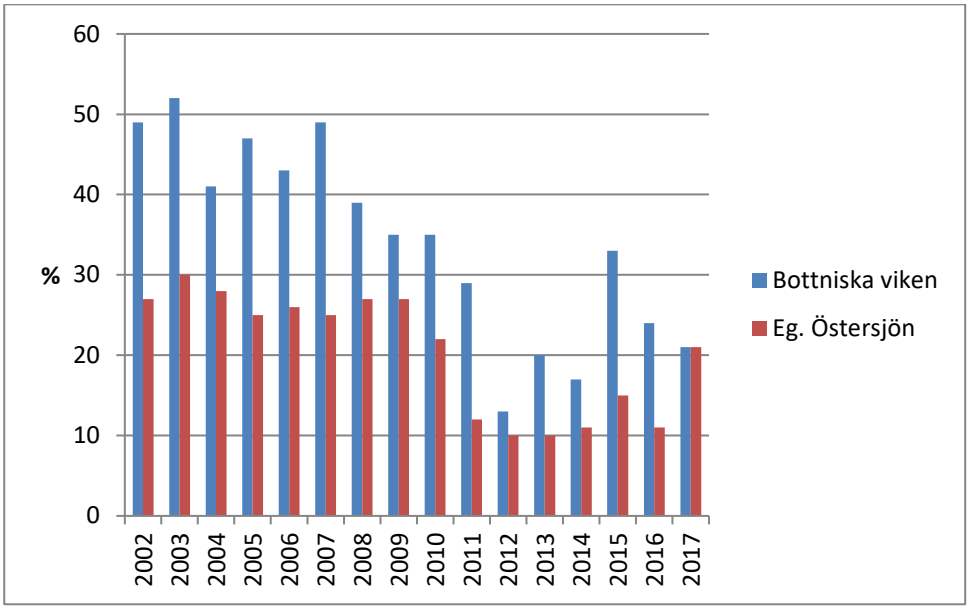

Figure 3. Percentage of greys seals with intestinal ulcers during 2002-2017 in the Bothian Bay (red, Bottniska viken) and the Baltic proper (blue, Eg. Östersjön)

Report from Lithuania

By Vaida Surviliene, Institute of Biosciences, Life Sciences Center, Vilnius University

So far 54 seals found dead on Lithuania coast in 2020 and 78 in 2019. Majority again May-June. The cause of death, age and sex were not identified. It seems that there were more sightings of live grey seals and even harbor seals reported to Lithuanian sea museum by random observers this year.
22 grey seal pups were brought to rehabilitation at Lithuanian Sea Museum. 21 survived and will be released in September.
Baltic rehabilitation center in Smiltyne, Klaipeda is under construction and should be finished in two years.
Previous high mortality of grey seals on Lithuanian coast (2017-2019) coincided with increased use of traditional traps by local small scale fisheries.
Pontoon traps were successfully tested by two fisheries companies on several locations of Lithuanian coast this year. Male grey seal recorded next to the trap by underwater camera. Grey seals are protected under Lithuanian law (no categories) and listed as DD (data deficiency) under IUCN red list categorization in Lithuania. An initiative to implement monitoring of grey seal blubber thickness and reproductive status from dead individuals has been shown from Lithuanian Ministry of Environment, discussions of particular actions will take place in September. Also, project of collecting info from fishermen about marine mammal by-catch (mainly from questionnaires) will start next year.

Report from Denmark

By Morten Tange Olsen, Natural History Museum of Denmark, Heidi Huus Petersen, Veterinary Faculty, DTU, Charlotte Bie Tøstesen, Fisheries and Maritime Museum Esbjerg, Anders Galatius, Rune Dietz, Christian Sonne, Aarhus University

General information

In Denmark, marine mammal stranding network, health monitoring and assessments are conducted by the Fisheries and Maritime Museum in Esbjerg (FIMUS), Aarhus University (AU), the Veterinary Faculty (DTU VET), the National History Museum of Denmark (NHMD) and the Danish Nature Agency.

Seal strandings

Of those animals 20 harbour seals and 6 grey seals were necropsied in 2019 and 2020 at the Institute for Terrestrial and and Aquatic Wildlife Research of the University of Veterinary Medicine Hannover in Büsum Germany. All seals with the exception of one grey seal originated from the Baltic. They

were found between February and October 2019. Five seals were born in the same year, 11 in 2018 and 10 were several years old. The exact age still needs to be determined. 11 seals were males and 15 females. 16 seals were shot, one by-caught and the others found dead on the beach. Based on the state of muscles and blubber thickness 13 seals were in good nutritional status, nine were in a moderate nutritional status and four were emaciated. Pathological findings included parasites in the heart, intestine, oesophagus, fur, nose, bronchopneumonia, urolithiasis, enteritis, hemosiderosis, hyperplasia of lymph nodes. Parasitological, virological and microbiological analyses still need to be conducted, but funding is lacking.

Whale strandings

14 harbour porpoises from the North and Baltic Seas were necropsied in 2019 and 2020 at the Institute for Terrestrial and and Aquatic Wildlife Research of the University of Veterinary Medicine Hannover in Büsum Germany. Of those animals six were females and eight males. They were found between March and September 2019. Two originated from the North Sea and 12 from the Baltic Sea. Two were by-caught and 12 were strandings. Among the 12 strandings two were suspected to be by-caught based on the pathological findings. Based on the length, pathological findings and the date of findings, six animals were classified as neonates, four as juveniles and four as adults. The nutritional status of the neonates was not judged as the date of birth has been unknown. Furthermore, the state of preservation of one of the adults did not allow the evaluation of the nutritional status. Based on the state of muscles and the blubber thickness three juveniles and one adult individual were judged to be in a good nutritional status. Emaciation was diagnosed in one juvenile and two adult harbour porpoises. Among the pathological findings were e.g. ulcerations of the esophagus, fatty liver and kidneys, bleedings in the blubber, alveolar histiocytosis, interstitial pneumonia, granulomatous bronchopneumonia, parasites in the lung, heart, liver, ears, follicular hyperplasia in the lymph nodes, proliferation of bile ducts, cholangitis and pericholangitis. Parasitological, virological and microbiological analyses still need to be conducted, but funding is lacking.

Publications on marine mammal health in the HELCOM region

Mikkelsen L., Johnson M., Wisniewska D.M., van Neer A., Siebert U., Madsen P.T., Teilmann J. 2019. Long-term sound and movement recording tags to study natural behavior and reaction to ship noise of seals. *Ecology and Evolution*, 9(5), 2588–2601. doi:10.1002/ece3.4923

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