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Application of the One Health Approach Using Respiratory “Spout” Samples of Cetaceans

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The One Health concept recognizes the interdependence of environmental, animal and human health. The approach of One Health is holistic to the well-being of all ecosystem components, including humans, and its goal is to improve health outcomes and enhance resilience to natural and induced challenges. Environmental health serves to ensure optimal conditions, which are considered safe and sanitary for air, water, food, and habitat. Animal health can be characterized relative to the stability of the wildlife population they are from, as well as by metrics of individual animal health. It should also be noted that some of these animal populations provide subsistence food safely and sustainably to human communities. Human health is, therefore, intimately involved in the One Health concept and includes resilience and adaptation, along with individual and community health and well-being. The characteristic depiction of One Health is in Figure 1.

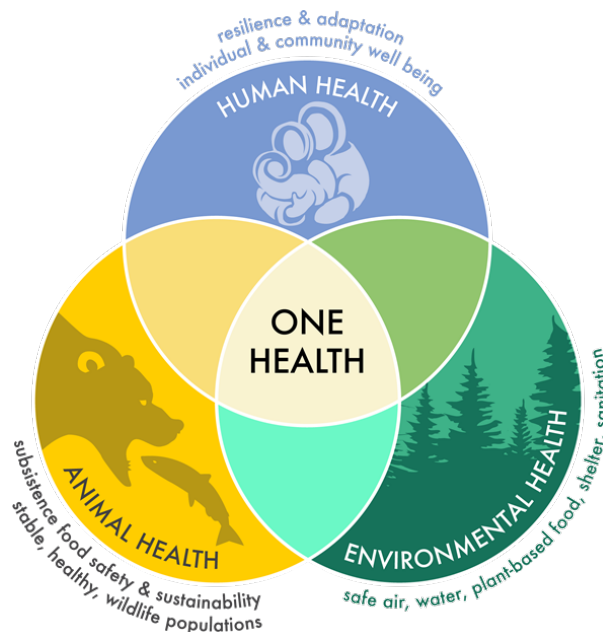


Figure 1. University of Alaska One Health Program depiction of the interdependence of environmental animal and human health (UAF, 2023).

The One Health concept employs an interdisciplinary approach to a broad range of problem-solving. By seeking to be proactive and treat root causes, it can be more successful than methods that only focus on individual symptoms. The One Health approach has been endorsed by the American Veterinary Medical Association, the American Medical Association, the World Health Organization, the United Nations and the Arctic Council. Local and traditional knowledge of One Health concepts and ideas also lie at the core of many Indigenous worldviews.

In a veterinary context, the term “One Health” captures how relationships between humans, animals and the environment may affect the spread of diseases. The United States Centers for Disease Control’s One Health Program has reported that more than 70% of emerging human diseases are zoonotic, meaning they originate in animals and can cross to human and other animals. With recent pandemic diseases acting at global scales, zoonotic diseases are a critical area of research, education and outreach (CDC, 2023).

The IWC Scientific Committee’s Subcommittee on Environmental concerns had an Inter-Sessional Correspondence group (ICG) on One Health approach (SC/68D/E/14), which states: *“The ICG objectives were to propose specific recommendations on how the One Health approach can be operationalised within the Scientific Committee, and its sub-committees, particularly to inform preventative, mitigation, and management actions. It was noted that One Health could be addressed at least for three major stressors (zoonoses, pollution and climate change) which may overlap in space and time. The ICG proposed to advance on recommendations at two levels: to integrate One Health considerations into existing sub-committee groups of the IWC and to increase collaboration with other international organizations on One Health matters. The ICG noted that several IWC programmes and groups are already applying a One Health approach to their protocols and research, including the IWC Global Entanglement Response Network, the IWC Strandings Initiative, and the sub-committee on Environmental Concerns. The ICG also considered that international collaboration with other organisations, such as the World Animal Health Organisation, IUCN, FAO, WHO, UNEP, Wildlife Disease Association, CITES, CMS, and others, is an important step to develop a broad and synergistic One Health approach to facilitate a good conservation status of cetaceans and marine ecosystems. The ICG undertook a literature search on One Health and marine wildlife, that could be applied to the work and aims of the IWC. The review identified over 200 published research articles with about 40 studies directly addressing One Health. It remains a work in progress as new papers are identified. ”*

The Environmental Concerns Subcommittee also encouraged the development of a case study to apply the One Health approach to a Conservation Management Plan or marine protected area, to develop a proof of concept and show how the approach can be operationalised.

Here we present progress to date as an initial step towards satisfying the recommendation to apply the One Health approach in preventive and informative actions related to cetacean health. Specifically, through the non-invasive technique of collecting

respiratory exhalate (also known as respiratory blow or spout samples) using unoccupied aerial drones, numerous health related factors were analyzed to assess large whale health. Three major kinds of analyses, genetics, endocrine profiling, and metagenomics were undertaken with the goal of performing all techniques on a single respiratory blow sample. Preliminary analyses have been published (Atkinson et al., 2021), although technique development continues. To date the collection of respiratory blow samples has included 10 species, 7 mysticetes, including blue, sei, southern right, fin, gray, humpback, Bryde's, sperm, orca, bottlenose dolphin. Humpback and blue whales provided the greatest number of samples and all lab analyses met with varying degrees of complexity and initial success. Genetic analyses were able to sequence *mtDNA*, genotype microsatellites and positively identify sex, for some samples. In a comparison of these DNA profiles from humpback whales to a DNA register for North Pacific humpback whales, the identity and long-term resighting histories of two individuals was matched, providing the basis of a 3 to 10-year health record at the individual level.

Endocrine profiles for 5 steroid hormones were validated for humpback whales and for blue whales. Humpback whale respiratory blow is contaminated with larger amounts of seawater incursion or intranasal lavage than blue whales, and procedures for normalizing hormone concentrations are needed to allow data to be compared between individuals, populations, or species. Nonetheless, combining genetic and endocrine analyses allowed genetically confirmed individuals to have concentrations evaluated that confirmed age class/life history states. Metagenomic analysis from respiratory blow was successfully conducted from humpback whales. Seawater samples were collected and run alongside the blow analyses, providing both overlap and a comparison to environmental samples. Taxa found in whale blow only contained bacteria, fungi, protozoa, and viruses, with the majority of sequencing reads from the respiratory blow coming from microbial genomes. Current studies are underway to better link the microbiome of pregnant whales and repeat samples from individuals over time.

In summary, the approach of analyzing multiple bioindicators from non-invasive samples allows for the expansion of increasingly comprehensive health assessments to be conducted. Wildlife health is not static, but influenced by the vulnerability and resilience of individuals in increasingly complex ecosystems, such that the dynamic state of health in both individuals and groups or population of whales needs to be monitored to the extent possible.

The One Health concept recognizes that animal, human, and environmental health are intrinsically intertwined. Using large whales as sentinels of the marine environment is a progressive addition to the One Health approach, as these cetaceans often have substantial migrations that make them bioindicators that can potentially integrate information from large ocean basins. While the scientific field of performing health assessments on large cetaceans is complex and can be logistically difficult, the outcome has the potential to be extremely informative. Scientists, researchers, veterinarians, and natural resource managers need to invest in establishing acceptable success rates or determining critical thresholds, which will undoubtedly require time and dedicated sampling of known whales at various life history stages.

Reference:

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