Date: July 23, 2014

TO: Board Members – Vancouver Park Board

FROM: General Manager – Parks and Recreation

SUBJECT: Review of Captive Cetaceans in Stanley Park

RECOMMENDATION

THAT the Board receive the attached report entitled: A review of the Vancouver Aquarium's current operations pertaining to cetaceans with comparison to other aquariums.

POLICY

The Park By-Laws, under section 9(e), set out the conditions under which cetaceans (whales, dolphins, and porpoises) can be acquired and kept. The by-laws state that no person shall bring into any park or maintain in any park cetaceans including baleen whales, narwhals, dolphins, porpoises, killer whales and beluga whales, which have been captured or taken from their wild habitat except:

i) Captive cetaceans caught from the wild prior to September 16, 1996, and cetaceans born into captivity at any time;

ii) Cetaceans which are already being kept or maintained in a park as of September 16, 1996;

iii) A member of an endangered cetacean species, provided that approval for bringing it into a park has first been obtained from the Park Board; and

iv) An animal that has been injured or is otherwise in distress and in need of assistance to survive or rehabilitation, whether or not the intention is to release it back into its natural wild habitat.

BACKGROUND

At their regular meeting of April 28, 2014 the Board unanimously approved the following motion:

A. Staff prepare a report to the Vancouver Park Board by July 2014 on the Vancouver Aquarium's current operations that pertain to cetaceans and review the operations of other comparable Aquariums that may or may not have captive cetaceans;

B. Staff provide a public memo with an overview of the current agreements and relationship between the Vancouver Park Board and the Vancouver Aquarium, and post it on the Vancouver Park Board website;

C. Staff invite the Vancouver Aquarium to present to the Park Board on their programming, education and rehabilitation related to cetaceans, as well as their work with other aquariums.

D. Staff ensure that the public is given a full and timely opportunity to review the report, provide comments, and speak to the report.

Staff has undertaken the necessary steps to address the directions in this motion.

Staff retained Dr. Joseph K. Gaydos to provide a non-biased, third party review of the Vancouver Aquarium's captive cetacean program and a comparison of these operations to other comparable aquariums. Dr. Gaydos is a practicing wildlife veterinarian (veterinary degree University of Pennsylvania 1994; PhD Medical Microbiology with an emphasis on wildlife health University of Georgia 2001). Dr. Gaydos currently serves as the Chief Scientist for the UC Davis Wildlife Health Center's SeaDoc Society Program and resides in Washington State.

The scope of Dr. Gaydos' review included:

- A review the Vancouver Aquarium's current operations pertaining to cetaceans;
- A comparison of these operations in context of other aquariums around the world and compare them in more detail to the operations of other similarly sized institutions in North America;
- An overview of aquariums around the world, review legislation, policy and trends regarding the captive display of cetaceans around the world, and detail information on legislation related to the display of cetaceans as well as on the capture of wild cetaceans for the purpose of display;
- An overview of accrediting agencies and policies; and
- A comparison of a subset of North American aquariums to the Vancouver Aquarium including:
    - standards of husbandry and veterinary care as well as aquarium
    - actions regarding capture of cetaceans,
    - cetacean breeding,
    - contribution to cetacean research, and
    - activities related to wild cetacean response and rehabilitation

Not included in the scope of this review is an evaluation of standards for space, nutrition, care of cetaceans, the ethical or moral aspects of keeping cetaceans in captivity and the economic and tourism impact of the Vancouver Aquarium.

Dr. Gaydos' work is summarized in a report titled 'A review of the Vancouver Aquarium's current operations pertaining to cetaceans with comparison to other aquariums' (attached).

On July 11, 2014, a public memo with an overview of the current agreements and relationship between the Vancouver Park Board and the Vancouver Aquarium was posted on the Vancouver Park Board website: http://vancouver.ca/files/cov/Vancouver-Aquarium-Memo-2014.pdf.

SUMMARY

The review of the Vancouver Aquarium, requested by the Board and conducted by Dr. Gaydos, provides a comprehensive overview of operations as they pertain to cetaceans, and benchmarks these operations to comparable aquariums across North America.

As requested by the Board, a special public meeting has been called for July 26, 2014, at which time Dr. Gaydos will present the findings of his review. In addition, as requested by the Board, the Vancouver Aquarium will present their work pertaining to cetaceans (e.g. programming, education, breeding and rehabilitation), including their work with other aquariums. Meeting details are available online: http://vancouver.ca/news-calendar/park-board-special-meeting-on-captive-whales-in-stanley-park.aspx

General Manager's Office
Vancouver Board of Parks and Recreation
Vancouver, BC

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DH/clc

A review of the Vancouver Aquarium's current operations pertaining to cetaceans with comparison to other aquariums

Report to the Vancouver Board of Parks and Recreation
July 23, 2014

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Introduction

The Vancouver Aquarium

The Vancouver Public Aquarium opened its doors on June 15, 1956. Since then more than 35 million guests have visited the Aquarium (http://www.vanaqua.org/about), with over 1 million visitors reported in 2013 (Vancouver Aquarium, 2013). As reported on its website, the Aquarium was the first aquarium in North America to benefit from educational interpreters (1956), established the first on-site killer whale habitat (1967), was the first aquarium to be accredited by the American Association of Zoological Parks and Aquariums (1975), and became the first facility in the world to undertake to never again capture, or cause to be captured, a wild whale or dolphin (1996).

The Vancouver Board of Parks & Recreation

The Vancouver Board of Parks and Recreation has exclusive jurisdiction and control over Stanley Park, which is owned by the Government of Canada and leased in perpetuity to the City of Vancouver. The Vancouver Board of Parks and Recreation permits and regulates the Vancouver Aquarium's activities in Stanley Park through a license agreement. The Aquarium is governed by all Park Board bylaws. Section 9(e) of the bylaws sets out the conditions under which any cetacean can be acquired and kept.

While the Vancouver Aquarium provides exceptional care for cetaceans and does not acquire them from the wild except through those that have been injured and cannot be released, the Vancouver Board of Parks and Recreation recognizes that, increasingly, keeping cetaceans in captivity is becoming an issue of heightened public interest. On April 28, 2014, the Board moved (Appendix 1) that the Staff prepare a report to the Board on the Vancouver Aquarium's current operations pertaining to cetaceans, specifically comparing them to operations of similar Aquariums that may or may not have cetaceans in captivity. Veterinary and scientific staff from the Karen C. Drayer Wildlife Health Center, a Center of Excellence at the UC Davis School of Veterinary Medicine, were asked to prepare this report and present findings to the Vancouver Board of Parks and Recreation and the general public at a special meeting of the Board to be held on July 26, 2014.

The Scope of this Review

We review the Vancouver Aquarium's current operations pertaining to cetaceans, set them in context of other aquariums around the world, and compare them in more detail to the operations of other similarly sized institutions in North America. Specifically we provide an overview of aquariums around the world, review legislation and trends regarding the captive display of cetaceans around the world, and detail information on legislation related to the display of cetaceans as well as on the capture of wild cetaceans for the purpose of display. We then compare a subset of North American aquariums to the Vancouver Aquarium including standards of husbandry and veterinary care as well as aquarium actions regarding capture of cetaceans, cetacean breeding, contribution to cetacean research, and activities related to wild cetacean response and rehabilitation.

Every effort was made to attain all possible relevant data. In some cases, desired data were not publically available and although efforts were made to retrieve these data, some facilities were not comfortable sharing proprietary data. We qualitatively analyzed all of the data available and point out where a more comprehensive dataset would permit more rigorous analysis.

Whale and Dolphin Nomenclature

In popular terminology, people speak of whales and dolphins. In taxonomic terms, however, these animals are collectively known as cetaceans. Under the sub-order Cetacea, the Society for Marine Mammalogy (see Appendix 2; Committee on Taxonomy. 2014) separates whales and dolphins into two super-families, Mysticeti, comprised of whales with baleen, and Odontoceti, made up of toothed whales. The American Society of Mammalogists' checklist committee on mammal taxonomy, which annually updates the book Mammal Species of the World (Wilson and Reeder, 2005), however, lists all whales and dolphins under the order Cetacea (as opposed to the sub-order Cetacea) and classifies Mysticeti and Odontoceti as suborders (as opposed to super-families). As to not get bogged down in taxonomy discussions, the important thing to remember for the purposes of this work is that all species currently kept in captivity around the world, including those specifically being discussed in this report, fall into the toothed whale group, Odontoceti. These include belugas (Family *Monodontidae*), dolphins (Family *Delphinidae)* like killer whales and Pacific white-sided dolphins, as well as porpoises (Family *Phocoenidae*) such as harbor porpoises. For simplicity, this report will refer to these animals collectively as cetaceans.

Ethics and Morals

This report compares the care of cetaceans in captivity at the Vancouver Aquarium to guidelines and standards set by Canadian and US governing bodies, accrediting association, and to other institutions that keep cetaceans. It is beyond the scope of this work to scientifically evaluate if guidelines (such as standards for space, nutrition and care) are adequate for the well-being of cetaceans in captivity and it is beyond the scope of this report to evaluate the ethical (societal) or moral (personal) aspects of keeping cetaceans in captivity.

Materials and Methods

General profile of aquariums around the world

Research Analysts at the City of Vancouver provided us with data on 617 aquariums around the world, some of which were temporarily or permanently closed. Data provided also included information on what cetacean species were held, some information on when facilities were opened, information on membership or accrediting organizations for some aquariums, and a suite of other facts. These data were augmented and used for analysis.

Review of Legislation and Trends Worldwide

Web search engines were used to identify and review countries with legislation that banned the capture of cetaceans or their public display. Phrases such as "countries

that ban cetacean captivity" or "countries that ban cetacean capture" with numerous variations in words (e.g. prohibit, dolphinaria, dolphin, whale, cetacean) were used. These revealed numerous websites and blogs, considered secondary and tertiary sources. Attempts were made to find primary sources for all accounts. These included trying to find the actual legislative mandates where possible, or in some instances, accepting credible national or international news stories as primary sources. A country was considered to ban or prohibit cetacean capture or display if a primary source could be found that showed the prohibition of live capture or public display of cetaceans and that document was still in effect (e.g. a more recent document voiding the prior document could not be found). The Google Translate tool was used to translate and assess government documents in languages other than English.

Accrediting Agency Policies on Live Capture and Display

In North America, several international and regional organizations accredit aquariums or oversee guidelines for the care of captive cetaceans. Some of these organizations have general policies regarding the live capture and display of cetaceans. The following organizations were reviewed for information pertaining to such regulations or recommendations: Canada's Accredited Zoos and Aquariums - Aquariums et Zoos Accrédités du Canada (CAZA-AZAC), Association of Zoos and Aquariums (AZA), the Alliance of Marine Mammal Parks and Aquariums (AMMPA), and the World Association of Zoos and Aquariums (WAZA). Additionally, the Canadian Council on Animal Care (CCAC) and the US Department of Agriculture's Animal Plant and Health Inspection Service (USDA / APHIS) were reviewed.

Comparison of aquariums comparable to the Vancouver Aquariums

A subset of the 150 aquariums identified in North America was used for a more detailed comparison between the Vancouver Aquarium and aquariums of similar size that do, and do not, have cetaceans. Aquariums having more than 750,000 visitors recorded in 2013 were used as a general guideline for inclusion in this comparison. One aquarium with less than 750,000 annual visitors that housed captive cetaceans was used as a lower-limit outlier and one with considerably greater number of annual visitors was included as an upper-limit outlier. Ideal data identified for comparison between facilities included accreditation status (CAZA, AZA, AAMMP, WAZA, USDA), number of annual visitors, annual admission and merchandise sales, total land area, total floor space, total water volume, number of fish, avian, reptile and invertebrate displays, number of marine mammal displays, and the total number of animals, including the number of specific cetaceans, housed. For veterinary care, we chose to compare the number of full time, part-time, and contract veterinarians, number of veterinary staff, and how many of the veterinarians were certified as specialists in zoo and wild animal medicine as demonstrated by Board Certification by the American College of Zoological Medicine. Regarding their involvement in wild cetacean response and rehabilitation over the last 10 years, we asked if they were involved, if so, for how many years, which species they responded to, the total number of responses conducted, the total number of animals taken into rehabilitation, the total that died, the number that remained in captivity and the number released. To evaluate research efforts regarding wild cetaceans, we asked if they pioneered any response or rehabilitation techniques, how many peer-reviewed publications they produced, the number of book chapters or technical memos published, the number of professional presentations given on

cetacean research, and the number of external wild cetacean research projects they supported. In most cases, professionals at the aquariums were contacted and asked to oversee the completion of the form. In some cases electronic mail with a request for information was sent to veterinarians or top management personnel. Where a person could not be contacted, email went unanswered or people declined to participate, publically available electronic data (facility websites, annual reports, etc.) were used to gather as much information as possible.

Comparisons on a species by species basis for cetaceans housed at Vancouver

The Vancouver Aquarium currently keeps 3 cetacean species in captivity: Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), harbor porpoise (*Phocoena phocoena*) and belugas (*Delphinapterus leucas*). Sources that track the captive maintenance of cetaceans in North America (such as the AZA and ceta-base) were used to identify other facilities that kept one or more of the same species as well as the number each facility has. No facilities in North American besides the Vancouver Aquarium currently keep harbor porpoise in captivity. However, historically, other aquariums such as the Mystic Aquarium and New England Aquarium have kept harbor porpoises. Because of the lack of North American facilities keeping harbor porpoise, Internet resources and communication with experts were used to find all other facilities in the world that currently keep harbor porpoise.

Findings

General profile of aquariums around the world

From data provided by the City of Vancouver with additional effort, we were able to identify 608 public aquariums around the world that are currently operating. Their distribution by continent is: Africa (n=11), Asia (n=158), Australia Oceania (n=29), Caribbean (n=26), Europe (n=218), North America (n=150) and South America, including Central America (n=16); see Table 1 and Appendix 3. The Caribbean had the highest percentage of aquariums housing cetaceans (88.5%), with Australia / Oceania having the fewest (17.2%). Of the 11 aquariums identified in Canada, only 2, the Vancouver Aquarium and Marineland of Canada, Inc. (Ontario, Canada) keep cetaceans in captivity.

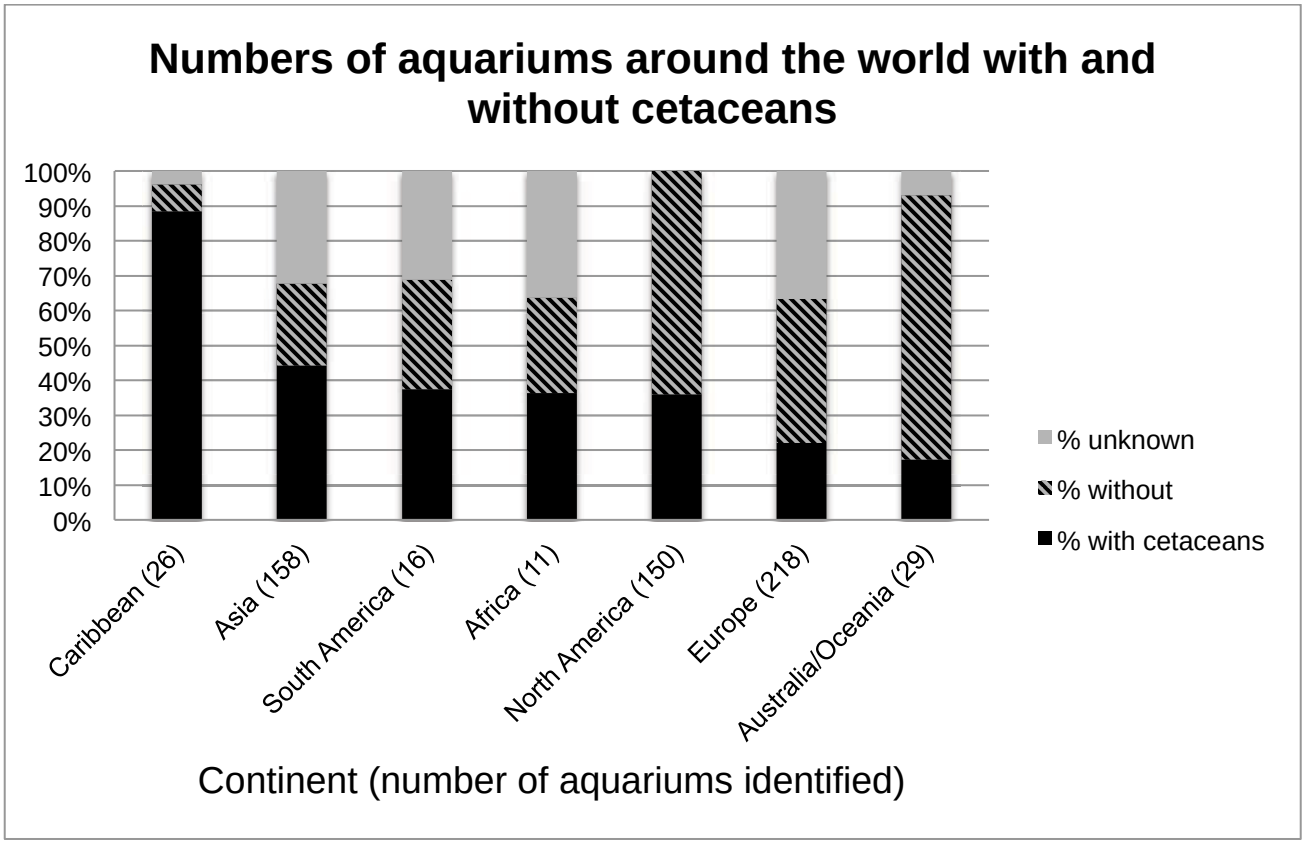

Table 1: Number of aquariums by continent with details on the % known to have captive cetaceans, those that don't and those where it is unknown.

Review of Legislation and Trends Worldwide

We identified 7 countries and 1 County and one 1 State within the United States that have legislation banning the importation of cetaceans, the live capture of cetaceans, cetaceans in captivity, or the use of cetaceans for commercial purposes or exhibition. Numerous wildlife conservation websites and newspaper articles were found that list from 10 to 15 such countries without citing legislation or other reliable sources. Legal documentation was only accessible confirming this legislation in 7 countries: Chile, Costa Rica, Croatia, Cyprus, India, Slovenia, and Switzerland (Table 2).

Country	Imports banned	Live Capture banned	Captivity banned	Display banned	Date	Literature Cited
South Carolina, USA	no	no	no	yes	1976 (amended 2011)	South Carolina, 2002
Cyprus	yes	no	no	yes	1997	Cyprus, 1997
Hawaii (Maui County) USA	no	no	no	yes	2002	Maui, 2002
Costa Rica	no	yes	no	no	2005	Costa Rica, 2005
Chile	no	yes	yes	yes	2008	Chile, 2008
Croatia	no	no	yes	no	2009	Croatia, 2009
Slovenia	no	no	no	yes	2011	Slovenia, 2011
Switzerland	yes	no	no	no	2012	Switzerland, 2012
India	yes	yes	yes	yes	2013	India, 2013

Table 2. Laws pertaining the capture or display of cetaceans by year of legislation

Hungary is commonly described as having banned cetacean captivity, but we were unable to find primary sources supporting this. Other sources suggest Greece has banned cetacean captivity, however, their Animal Welfare Law (4039/2012), which has been touted as prohibiting dolphin captivity, actually has no mention of cetaceans and instead prohibits the use of any animals in circuses. Similarly, Bolivia's ban on circus animals has been falsely interpreted as an end to cetacean captivity in that country.

The Solomon Islands also are occasionally reported to ban the export of live cetaceans from its waters. In fact, in 2003, the Solomon Islands licensed the capture of cetaceans and sent dolphins to Mexico and Quatar. After copious international attention and pressure, they banned capture and exportation of cetaceans in 2005. As of 2007, they have lifted the ban and now have an export quota (Solomon Islands, 2011). The international Union for the Conservation of Nature (IUCN) Global Plan of Action for the Conservation of Cetaceans states as a general principle, that small cetaceans should not be captured or removed from a wild population unless that specific population has been assessed and shown capable of sustaining the removals. A recent study (Oremus et al., 2013) on the sustainability of the Solomon Islands export quota suggested it was not sustainable. Specifically, authors state that "Calculations of Potential Biological Removal (PBR) levels suggest that removals should be limited to one dolphin every five years for north-western Guadalcanal and the Florida Islands and one dolphin every two and a half years for southern Santa Isabel and western Malaita. On the basis of the PBR, the authorized export quota of 50 dolphins/year appears to be unsustainable for local populations (Oremus et al., 2013)."

Additionally, we found claims that other countries, including Brazil, Luxembourg, Nicaragua, Norway, and the United Kingdom, have regulations so strict that the opening of a new captive cetacean display facility is impossible, however these regulations were

reviewed and they did not fit our criteria for a ban. The specific findings by location follow.

Asia

In 2013, India's central zoo authority passed a policy banning the establishment of dolphinaria, including the importation, capture and exhibition of cetaceans for private or public exhibition or interaction purposes. They also called cetaceans "non-human persons" in the legislation.

Europe

In Croatia in 2009 (Croatia, 2009), a government policy was passed prohibiting the keeping of all cetaceans in captivity. In 1997 the government of Cyprus (Cyprus, 1997) banned the use of cetaceans for performance for entertainment purposes. The creation of dolphinaria and the importation of any cetaceans also were banned. The government of Slovenia in 2011 (Slovenia, 2011) passed a law prohibiting the use of cetaceans for purposes including commercial dolphinaria and therapeutic programs. And, in 2012, the Swiss government (Switzerland, 2012) approved a ban on the importation of dolphins and whales.

North America

In 2011 the state government of South Carolina (USA) amended a 1976 statute related to the unlawful exhibit of marine mammals to prevent display of a wild caught or captive bred cetacean (South Carolina, 2011). In Hawaii (USA), Maui County passed an ordinance (Maui, 2002) prohibiting the exhibition of captive cetaceans within the county.

South America / Central America

In 2008, the government of Chile (Chile, 2008) passed a supreme decree banning the capture of cetaceans within its waters including the holding and marketing of cetaceans. In a similar move 3 years earlier, the government of Costa Rica banned the capture of cetaceans in its waters (Costa Rica, 2005).

Accrediting Agencies and Policies on Live Capture and Distribution

Canada's Accredited Zoos and Aquariums - Aquariums et Zoos Accrédités du Canada (CAZA-AZAC)

The CAZA-AZAC has a standardized accreditation procedure that includes benchmarks, inspection teams and review of institutional practices. Facilities must apply for accreditation, and then once accredited, become re-accredited by the CAZA-AZAC every 5 years. Additionally, each facility must have an acquisition / disposition policy that incorporates CAZA's policies (CAZA, 2012). Briefly (section 1.25.), legal restrictions on the acquisition or disposition of animals must be observed and section (1.26.) The institution must be concerned that the manner of disposition or acquisition be in the best interests of the animals, the species, the institution and the public it serves. Also, (1.27.) Live animals may be disposed to or acquired from animal suppliers having the qualifications and facilities to care for the animals in accordance with the CAZA Code of Professional Ethics. The source from which the suppliers have obtained the animals

must be acceptable within CAZA guidelines. Similarly, the ultimate destination of animals sent to suppliers must be disclosed and approved before animals are sent to them. Interestingly, exceptions to these standards can occur as the policy also states "While the words "should" and "must" are both used in these standards, under certain circumstances, the Commission may waive a "must" or strongly encourage the implementation of a "should"."

Canadian Council on Animal Care (CCAC)

The Canadian Council on Animal Care (CCAC) is responsible for overseeing the use of animals in research, teaching and testing. Participation in the CCAC program is mandatory for academic institutions, but not for aquariums. In Canada, the care and use of wildlife is regulated through provincial, territorial and federal legislation, however some agencies responsible for wildlife follow CCAC guidelines for wildlife (Canadian Council on Animal Care, 2003). The Vancouver Aquarium follows CCAC guidelines for an animal care committee and all research conducted at the Aquarium goes through this animal care committee. A CCAC Committee inspects the Vancouver Aquarium's marine mammal facility (specifically pinniped operations) for research conducted through University of British Columbia. According to the CCAC website (http://www.ccac.ca/en_/standards/guidelines/additional/recommendations-species), the CCAC does not currently have species-specific guidelines for marine mammals, but they are being developed. These draft marine mammal recommendations are intended to complement the CCAC guidelines on the care and use of wildlife by providing information on 'best practices' for various species groups. These recommendations are to be viewed alongside the more general guidelines on wildlife.

Association of Zoos and Aquariums (AZA)

Zoos and aquariums accredited by the AZA undergo a thorough review that includes a detailed accreditation application as well as a multiple day on-site inspection by a team of experts from around the country. This is similar to the CAZA accreditation process. The AZA Accreditation Commission evaluates every zoo or aquarium to make sure it meets AZA's standards for animal management and care, including living environments, social groupings, health, and nutrition. The AZA uses the standards set by the US Department of Agriculture's Animal and Plant Health Inspection Service. In addition to standards for care and management, the Accreditation Commission also evaluates the veterinary program, involvement in conservation and research, education programs, safety policies and procedures, security, physical facilities, guest services, and the quality of the institution's staff. Once accredited, zoos and aquariums must undergo re-accreditation every 5 years. Acquisition of animals for AZA-accredited facilities can include propagation, trade, donation, loan, purchase, capture, or rescue (AZA, 2014). There is no firm requirement that AZA-accredited institutions acquire or dispose of animals from AZA institutions, but it is stated, "As a matter of priority, AZA institutions should acquire animals from other AZA institutions and dispose of animals to other AZA institutions." The AZA does permit wild capture of animals, including cetaceans. Specifically, the AZA states, "The maintenance of wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. To accomplish these goals, it may be necessary to acquire wild-caught specimens. Before acquiring animals from the wild, institutions are encouraged to examine sources including other AZA institutions or regional zoological

associations. When acquiring animals from the wild, careful consideration must be taken to evaluate the long-term impacts on the wild population. Any capture of free-ranging animals should be done in accordance with all local, state, federal, and international wildlife laws and regulations and not be detrimental to the long-term viability of the species or the wild or captive population(s). In crisis situations, when the survival of a population is at risk, rescue decisions are to be made on a case-by-case basis."

Alliance of Marine Mammal Parks and Aquariums (AMMPA)

According to their website, the Alliance of Marine Mammal Parks and Aquariums is an international association representing marine life parks, aquariums, zoos, research facilities, and professional organizations dedicated to marine mammals and to their conservation in the wild through public education, scientific study, and wildlife presentations. Membership is based on successful completion of the Alliance's accreditation process, which assures that an applicant meets the association's Standards and Guidelines. The Alliance standards are not publically available but states that their standards are more stringent than USDA/APHIS standards. To become an accredited member, a facility must submit an application and two letters of recommendation from current Alliance members who have visited the facility and can attest that the applicant meets Alliance standards. Following submission and review of the accreditation application, the applicant must make a presentation before the full membership at the association's annual meeting where they describe in detail the facility and its amenities; all marine mammal programs; education, training, husbandry, and veterinary care programs; food preparation; research activities; and a history on each marine mammal animal at the facility. Finally, a team of experts conducts an on-site inspection and evaluation to ensure full compliance with Alliance standards.

The AAMPA acquisition standards require that all applicable local, state/provincial, regional, national, and international laws and regulations be followed when acquiring and exhibiting marine mammals and that CITES requirements, for example, must always be met when moving animals internationally (AAMP, 2008). They do support responsible collection from the wild to support management of robust, healthy and genetically diverse populations in human care and require that any wild collection be conducted using safe and humane methods consistent with professionally accepted practices. Importantly, members must have scientific information to demonstrate that any removal of an animal from the wild will not compromise the sustainability of the stock or population from which the animal is taken.

World Association of Zoos and Aquariums (WAZA)

According to its website, the WAZA’s goal is to guide, encourage and support the zoos, aquariums and like-minded organisations of the world in animal care and welfare, environmental education and global conservation. Other than being nominated and being able to fulfill the initial membership requirements, there is no accreditation standard for the WAZA. The WAZA does promote conservation but also recognizes that aquariums are “Often still dependent on wild-caught stock for exhibits (in a way that modern terrestrial zoos generally are not).” They do state “public aquariums are responding by becoming increasingly engaged in collaborative, international conservation breeding programmes (e.g. Species Survival Plans and Taxon Advisory

Groups)" but do not go so far as to recommend the cessation of wild capture of species (Penning et al., 2009).

US Department of Agriculture's Animal Plant and Health Inspection Service (USDA / APHIS)

Currently in Canada, the Canadian Council on Animal Care (CCAC) has guidelines for the minimum standard of care for animals held in Canada. While they have draft guidelines for marine mammals that have not been published, USDA/APHIS standards (also adopted by the AZA) are currently the highest available standards for keeping cetaceans in captivity. In the United States, the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) was mandated by Congress to develop regulations and standards needed to enforce the Laboratory Animal Welfare Act of 1966. This was the predecessor of the current Animal Welfare Act (AWA, 7 U.S.C. §§ 2131 et. seq.) and the beginning of APHIS' role in enforcing its legislated provisions. As written, the AWA applies to all warm-blooded animals in commerce used for research, exhibition, or the pet trade. The Secretary of Agriculture has been empowered to designate which animals and activities will be regulated. For example, retail pet stores are exempt from licensure, while wholesale trade in pet animals is regulated. Amendments to the AWA and revisions of the regulations and standards have been periodically undertaken to accommodate the expansion of covered animals and activities.

APHIS first proposed to regulate marine mammals in captivity, under the AWA, in 1978. This action was undertaken at the request of the Marine Mammal Commission (MMC), the National Marine Fisheries Service (NMFS), and organized sectors of the marine mammal industry. Regulations and standards were developed by APHIS in close association with the National Marine Fisheries Service, Marine Mammal Commission, marine mammal exhibitors, and the American Zoo and Aquarium Association (AZA, formerly AAZPA). A Memorandum of Agreement (MOA) was signed in 1979 by APHIS, NMFS, and the U.S. Fish and Wildlife Service (F&WS). Under this agreement, AWA standards and regulations were acknowledged to be the evaluation criteria for captive care and maintenance requirements for marine mammals, and APHIS was designated to provide the inspection and enforcement workforce to implement the regulations.

Salient examples of standards included in the Animal Welfare Act that pertain to marine mammal care (USDA, 2013), include:

§ 3.101 - Facilities, general.
(a) **Construction requirements.**
(1) Indoor and outdoor housing facilities for marine mammals must be structurally sound and must be maintained in good repair to protect the animals from injury, to contain the animals within the facility, and to restrict the entrance of unwanted animals
(2) All marine mammals must be provided with protection from abuse and harassment by the viewing public

(b) **Water and power supply.** Reliable and adequate sources of water and electric power must be provided by the facility housing marine mammals

(e) **Waste disposal.** Provision must be made for the removal and disposal of animal and food wastes, dead animals, trash, and debris.

(g) **Enclosure or pool environmental enhancements.** Any nonfood objects provided for the entertainment or stimulation of marine mammals must be of sufficient size and strength to not be ingestible, readily breakable, or likely to cause injury to marine mammals, and be able to be cleaned, sanitized, and/or replaced effectively.

§ 3.102 - Facilities, indoor. [Covers ambient temperature, lighting, & ventilation]

§ 3.103 - Facilities, outdoor. [Covers environmental temperature, shelter, & perimeter fence requirements.]

§ 3.104 - Space requirements.
(b) Cetaceans. Primary enclosures housing cetaceans shall contain a pool of water and may consist entirely of a pool of water. In determining the minimum space required in a pool holding cetaceans, four factors must be satisfied. These are MHD [minimal horizontal dimension], depth, volume, and surface area. For the purposes of this subpart, cetaceans are divided into Group I cetaceans and Group II cetaceans (Author's Note: Belugas are Group I cetaceans with average length of 4.27m; Harbor porpoise are Group I cetaceans with an average length of 1.68 cm; and Pacific white-sided dolphins are Group II cetaceans with an average length of 2.29m).

(1)(i) The required minimum horizontal dimension (MHD) of a pool for Group I cetaceans shall be 7.32 meters (24.0 feet) or two times the average adult length of the longest species of Group I cetacean housed therein (as measured in a parallel or horizontal line, from the tip of its upper jaw, or from the most anterior portion of the head in bulbous headed animals, to the notch in the tail fluke), whichever is greater; except that such MHD measurement may be reduced from the greater number by up to 20 percent if the amount of the reduction is added to the MHD at the 90-degree angle and if the minimum volume and surface area requirements are met based on an MHD of 7.32 meters (24.0 feet) or two times the average adult length of the longest species of Group I cetacean housed therein, whichever is greater.
(ii) The MHD of a pool for Group II cetaceans shall be 7.32 meters (24.0 feet)
or four times the average adult length of the longest species of cetacean to be housed therein (as measured in a parallel or horizontal line from the tip of its upper jaw, or from the most anterior portion of the head in bulbous headed animals, to the notch in the tail fluke), whichever is greater; except that such MHD measurement may be reduced from the greater number by up to 20 percent if the amount of the reduction is added to the MHD at the 90-degree angle and if the minimum volume and surface area requirements are met based on an MHD of 7.32 meters (24.0 feet) or four times the average adult length of the longest species of Group II cetacean housed therein, whichever is greater.
(iii) In a pool housing a mixture of Group I and Group II cetaceans, the MHD shall be the largest required for any cetacean housed therein.
(iv) Once the required MHD has been satisfied, the pool size may be required to be adjusted to increase the surface area and volume when cetaceans are added.

Animal Health & Husbandry Standards

§ 3.105 - Feeding.
(a) The food for marine mammals must be wholesome, palatable, and free from contamination and must be of sufficient quantity and nutritive value to maintain marine mammals in a state of good health. The diet must be prepared with consideration for factors such as age, species,

condition, and size of the marine mammal being fed. Marine mammals must be offered food at least once a day, except as directed by the attending veterinarian.

§ 3.106 - Water quality.
(a) General. The primary enclosure shall not contain water which would be detrimental to the health of the marine mammal contained therein.
(b) Bacterial standards.
(1) The coliform bacteria count of the primary enclosure pool shall not exceed 1,000 MPN (most probable number) per 100 ml. of water.

§ 3.107 - Sanitation. [States that enclosures need to be cleaned at least once a day, more if necessary.]

§ 3.109 - Separation.
Marine mammals, whenever known to be primarily social in the wild, must be housed in their primary enclosure with at least one compatible animal of the same or biologically related species, except when the attending veterinarian, in consultation with the husbandry/training staff, determines that such housing is not in the best interest of the marine mammal's health or well-being. However, marine mammals that are not compatible must not be housed in the same enclosure. Marine mammals must not be housed near other animals that cause them unreasonable stress or discomfort or interfere with their good health.

§ 3.110 - Veterinary care. [Requires that new animals are kept isolated from residents, that proper holding facilities exist, and that they be adequately disinfected, as necessary.]

(d) Individual animal medical records must be kept and made available for APHIS inspection. These medical records must include at least the following information:
(1) Animal identification/name, a physical description, including any identifying markings, scars, etc., age, and sex; and
(2) Physical examination information, including but not limited to length, weight, physical examination results by body system, identification of all medical and physical problems with proposed plan of action, all diagnostic test results, and documentation of treatment.
(e) A copy of the individual animal medical record must accompany any marine mammal upon its transfer to another facility, including contract or satellite facilities.
(f) All cetaceans and sirenians must be physically examined by the attending veterinarian at least annually, unless APHIS grants an exception from this requirement based on considerations related to the health and safety of the cetacean or sirenian. These examinations must include, but are not limited to, a hands-on physical examination, hematology and blood chemistry, and other diagnostic tests as determined by the attending veterinarian.
(g)
(1) A complete necropsy, including histopathology samples, microbiological cultures, and other testing as appropriate, must be conducted by or under the supervision of the attending veterinarian on all marine mammals that die in captivity.

Additionally, the US Animal Welfare Act provides standards for the transportation of marine mammals. These are not very prescriptive and essentially require that animals are transported in sufficiently durable, non-toxic, environmentally appropriate containers and that all necessary documents be kept nearby. Animals need to be properly fed and hydrated in transit. Handling should be as expedient as possible.

All aquariums in the United States display animals and are therefore required to be routinely inspected by USDA/APHIS (Kohn, 1994). Canadian facilities can choose to abide by USDA / APHIS standards as the highest available bar for care of marine mammals, but are not investigated by the USDA/APHIS as they are not US facilities. The AZA, however, does use USDA/APHIS standards so aquariums like the Vancouver Aquarium that are AZA accredited are using USDA/APHIS standards.

Comparison of the Vancouver Aquarium to Other Aquariums

Thirty-four zoos and aquariums were compared to the Vancouver Aquarium; 3 are from Canada (Vancouver being the 4th) and 31 are from the United States (Appendix 4). Three of the facilities included did not have readily accessible data on the number of visitors per year, but were included because they were believed to be of similar size. Gulf World (Panama City Beach, FL) was the lower attendance outlier with 175,000 visitors in 2013 and SeaWorld Parks (all parks combined) was the upper outlier with over 20 million visitors in 2013. Excluding the lower and upper outliers for attendance, the average number of visitors in 2013 for all institutions used in the comparison was 1,360,393. For this report the Vancouver Aquarium self-reported 928,000 visitors in 2013.

The following 9 institutions provided complete data: Columbus Zoo and Aquarium (OH), Denver Zoological Gardens (CO), Gulf World Marine Park (Panama City Beach, FL), John G. Shedd Aquarium (Chicago, IL), Monterey Bay Aquarium (Monterey, CA), Seattle Aquarium (Seattle, WA), SeaWorld Parks (all locations combined in one data set), Six Flags Discovery Kingdom (Vallejo, CA), and the Vancouver Aquarium. Some institutions did not respond, others were unable to provide data for various reasons, and some declined to participate. Of the 35 institutions compared (including Vancouver), 12 of 35 (34%) maintain cetaceans in captivity.

Accreditation

Of the 35 institutions evaluated, 31 of 35 (91%) are AZA accredited and 9 of 35 are AMMPA accredited (26%). All 4 institutions from Canada also are CAZA accredited. The Vancouver Aquarium is CAZA, AZA and AMMPA accredited. The Vancouver Aquarium also follows the USDA / APHIS standards for care as required for AZA accreditation. They are not inspected by USDA/APHIS because they are not a US Facility but they are AZA-inspected every 5 years. The Biodome de Montreal follows USDA/APHIS standards, as it is an AZA-accredited facility. It is not clear if the other 2 institutions from Canada (Marineland and Edmonton Valley Zoo) follow the rigorous USDA/APHIS standards.

Of the aquariums compared that have cetaceans 75% (9/12) are AZA accredited and 91% of aquariums without cetaceans are AZA accredited (21/23). Of the aquariums with cetaceans only 58% (7/12) are AMMPA accredited and 9% (2/23) of those without cetaceans are AMMPA accredited.

Annual Visitors

The average number of visitors per year was higher for institutions that housed cetaceans. For the 33 aquariums compared (Gulf World and SeaWorld, the lower and upper outliers for visitor numbers, were excluded), in 2013, aquariums with cetaceans had an average of 1.5 visitors while those without cetaceans had less with an average of 1.3 million people visit their institution. Insufficient data were available to evaluate admission sales between aquariums with and without cetaceans.

Cetacean stranding response and rehabilitation

Of the aquariums with cetaceans, 100% have cetacean stranding and response programs, while 40% of those without captive cetaceans have these programs. The program qualities were not compared. Facilities without captive cetaceans would be unable to provide long-term care for cetaceans unless they have access to net pens or similar temporary housing facilities (the presence of such capacity could not be determined). Additionally, facilities that do not house captive cetaceans would most likely be unable (or unwilling, depending on their reason for not having cetaceans) to provide life-long housing for animals that could not be released back into the wild after stranding and rehabilitation (the source of the Vancouver Aquarium's 2 harbor porpoises).

Through its cetacean stranding and response program, the Vancouver Aquarium has pioneered cetacean emergency care and transport protocols, developed critical care and neonatal diets and feeding protocols, and developed techniques for the antemortem (before death) diagnosis of diseases such as cryptococcosis using advanced techniques like magnetic resonance imaging (MRI). They also report to have adapted other medical techniques for stranded cetaceans such as ultrasound, radiography, and endoscopy and feel their ability to detect pathogens (viruses, bacteria, etc.), especially those with the ability to cause disease in cetaceans and humans (zoonotic potential) has increased due to their cetacean response and rehabilitation program. Also, they have helped pioneer satellite-linked telemetry and post-release monitoring of stranded cetaceans.

Examples of their cetacean stranding response outside of British Columbia include providing response to bottlenose dolphins stranding during the BP oil spill in the Gulf of Mexico, consultation on stranded beluga calves in the Gulf of St. Lawrence, and consultation on a large number of non-specified cetacean stranding events in Washington State and around the world in terms of data analysis, technique, and pathological findings.

Veterinary Care

For facilities where complete data were available and excluding the size outliers (based on admissions) SeaWorld and Gulf World, aquariums with cetaceans employ an average of 1.75 full-time veterinarians (n=4), whereas aquariums without cetaceans employ an average of 2.6 full-time veterinarians (n=5). The Vancouver Aquarium employs 2 full-time veterinarians, one of whom is ACZM Board Certified; the other is a veterinary intern in post-graduate training.

Cetacean Research

For facilities providing these data, the number of peer-reviewed, cetacean-related publications varied greatly. Facilities housing cetaceans published on cetaceans more frequently than facilities without cetaceans. Among facilities housing cetaceans, individual aquariums ranged from 6 peer-reviewed publications (Gulf World) to greater than 84 (John G. Shedd Aquarium). This could be due to the length of duration of the research program, the number of veterinarians or researchers, or other factors we could not determine. Combined, SeaWorld Parks have published more than 150 cetacean-related papers. The Vancouver Aquarium has published 20 peer-reviewed manuscripts on cetaceans in care at the facility (Appendix 5). Additionally they have published 12 peer-reviewed manuscripts from research conducted on wild cetaceans.

Aquariums without captive cetaceans were more likely to report that this question was not applicable, most likely because they did not have animals in care to study or report on. In contrast, some institutions, which lack captive cetaceans, like the New England Aquarium, have published papers based on their wild cetacean research projects and programs.

The Vancouver Aquarium has an active cetacean-related research program as evidenced by peer-reviewed publications, technical memorandums and presentations at professional meetings. (Appendix 5). The gold standard for science is the publication of peer-reviewed manuscripts and secondarily, Masters theses and PhD dissertations. These alone were used to evaluate the outcome of the Vancouver Aquarium's cetacean research program.

A subset of the publications reported (n=20) were conducted using cetaceans housed at the Vancouver Aquarium. Of these, 75% (15/20) provide benefit to free-ranging cetacean management and conservation and 5 (25%) provide data specific to the captive care or husbandry of cetaceans and are not directly applicable to wild cetacean conservation.

The Vancouver Aquarium reports 12 cetacean-related publications from research on free-ranging cetaceans. Of these 12 publications, 3 (25%) use data gathered by the Vancouver Aquarium or other facilities the complete a part of this research.

Cetaceans housed at the Vancouver Aquarium

Other Institutions Housing Similar Species

Including the Vancouver Aquarium, there are 6 facilities in North America that keep a total of 79 belugas in captivity (Appendix 6). No other facilities in North America keep harbor porpoise, however one facility in the Netherlands maintains 6 and one in Denmark 3 (Appendix 6). A total of 4 aquariums, including Vancouver, keep 18 Pacific white-sided dolphins in captivity.

Animals are moved between the Vancouver Aquarium and other facilities for reasons such as breeding, to temporarily free space for construction, or to separate incompatible animals. In such instances, the Aquarium maintains ownership of the animals while housed at other facilities and loan agreements are used between the Vancouver Aquarium and the institution housing the Vancouver Aquarium's cetacean to guide the sharing or loan of animals between the two facilities.

Cetacean Breeding at the Vancouver Aquarium

The Association of Zoos and Aquarium's (AZA) Marine Mammal Taxon Advisory Group guides breeding of belugas at the Vancouver Aquarium and has the goal of maintaining genetic diversity in captive belugas. While there is an active AZA program for belugas, there is not one for harbor porpoises or Pacific white-sided dolphins as there are too few kept at AZA facilities. According to the Vancouver Aquarium, they have done some preliminary work to develop artificial insemination techniques with belugas and Pacific white-sided dolphins, however currently all breeding attempts used by the aquarium are done by pairing likely animals and not by artificial insemination. When animals are sent from the Vancouver Aquarium to another institution, the breeding loan agreement specifies who will have ownership of the offspring. Generally, every other offspring will go to each of the facilities involved.

Discussion

The scope of this evaluation enabled the gathering of a considerable amount of data that the Vancouver Board of Parks and Recreation will be able to use for their deliberations regarding the Vancouver Aquarium's care of captive cetaceans. In the future, a much larger research effort will be needed produce more substantial data that would permit detailed examination of animal care standards and the behavioral implications for housed cetaceans. Such an effort is currently underway to evaluate the animal welfare implications of housing elephants in captivity (http://www.elephantwelfarestudy.com/).

Of the 79 countries in the world with one or more aquariums only 5 (6%) have passed national legislation prohibiting the capture or captive display of cetaceans. These include 1 of 17 countries (6%) in Asia (India) and 4 of 31 (13%) of European countries (Croatia, Cyprus, Slovenia and Switzerland). One state in the US (South Carolina), one county (Maiu, Hawaii) have passed similar legislation. Two countries in Central / South America that do not have public aquariums (Chile and Costa Rica) also have passed similar legislation.

The data acquired show the Vancouver Aquarium is currently meeting all North American industry standards for the care and husbandry of marine mammals. They are staffed with an ACZM-board certified veterinarian and are accredited by the CAZA, AZA, and AMMPA. An in-depth evaluation of accreditation standards by these groups shows that while accreditation is the gold standard for the industry, it does not guarantee that a facility does not engage in the live capture of marine mammals or the trade of animals that could have been live-captured. The Vancouver Aquarium does

report, however, that it does not capture or cause to be captured a wild cetacean and actually became the first facility to set adopt this standard in 1996.

The data needed to completely compare the Vancouver Aquarium to similarly-sized institutions are not easily available to the general public. While some institutions freely gave such information, others declined for a variety of reasons. In a time where such facilities are under greater scrutiny by the public for their care and well being of cetaceans in captivity, some people will misinterpret an organization's unwillingness to share as possibly having something to hide. The Vancouver Aquarium responded to all requests for information completely.

The Vancouver Aquarium has an active research department that seems to make good use of studying captive cetaceans, not only for being able to provide better care and understanding of captive animals, but to a greater extent as suggested by peer-reviewed publications, to benefit our understanding and conservation of cetaceans in the wild. They also have an active cetacean stranding and response program. If the Vancouver Aquarium were to no longer house cetaceans they would have the option to continue both their research program and their stranding and response program, but the quality of those programs could be compromised. They would no longer be able to use captive cetaceans to learn information that could benefit the management and conservation of free-ranging cetaceans. Similarly, they could respond to cetacean strandings, but would no longer have an option for the long-term care of animals that could not be released back into the wild.

Considerations for the Vancouver Board of Parks and Recreation

Concept of a large-scale cetacean welfare study

The Vancouver Board of Parks and Recreation should recognize that a large-scale scientific study on the welfare of captive housed cetaceans would be an ideal next step for evaluating the ethics of housing captive cetaceans. Approximately 70 AZA-accredited zoos in North America have been collecting data on the behavior and husbandry of 255 captive Asian and African elephants in zoos. These data are currently being analyzed in a scientific effort to understand captive elephant welfare. This project, costing approximately $800,000, has taken about 3 years. A similar project with cetaceans might be the next scientific step in assessing the complex societal issue of captive cetaceans.

Concept of complete public disclosure

People want to know how cetaceans in captivity are doing and the difficulty of acquiring these data has the potential to, correctly or incorrectly, lead people to believe that some institutions housing cetaceans have something to hide. In the spirit of full disclosure, the Vancouver Board of Parks and Recreation should acknowledge that the Vancouver Aquarium willingly provided all data requested for this report. That is not, however, a guarantee that such data will be made available in the future. Requesting that the Vancouver Aquarium provide an annual state of cetaceans at the aquarium report would go a long way to ensure that the public feels that data is being shared.

Such a report could include information on the number and species of cetaceans currently owned by the Vancouver Aquarium, the location where these species are being housed, the number of births and deaths that have occurred in the past year, the number of research projects and presentations that have come from captive cetaceans or have been supported by captive cetacean research, the number of wild cetacean strandings that have responded to, and the number of people that have visited the aquarium to learn about cetaceans.

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Appendices

Appendix 1. Motion by Vancouver Board of Parks and Recreation to review the practice of keeping captive cetaceans in Stanley Park

Appendix 2. Taxonomy of whales and dolphins

Appendix 3. Aquariums by continent with and without cetaceans

Appendix 4. Zoos and Aquariums used for comparison

Appendix 5. Cetacean Research Conducted by the Vancouver Aquarium

Appendix 6. Facilities keeping the same cetacean species as the Vancouver Aquarium

Appendix 1. Motion by Vancouver Board of Parks and Recreation to review the practice of keeping captive cetaceans in Stanley Park

A Review of the Practice of Keeping Captive Cetaceans in Stanley Park

Excerpted from Minutes 2014-04-28

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MOVED by Commissioner Jasper
SECONDED by Commissioner Blyth

WHEREAS:

1. The Vancouver Park Board has a long-term lease with the Vancouver Aquarium to operate within Stanley Park (expiry date December 31, 2029);

2. The Vancouver Aquarium provides exceptional research and education related to oceans and marine wildlife;

3. The Vancouver Aquarium provides rehabilitation for injured marine mammals and, in instances where they cannot be released into the wild, provides care for them;

4. The Vancouver Aquarium does not acquire cetaceans from the wild, only through those who have been injured and cannot be released, or who were born in captivity;

5. The issue of keeping cetaceans in captivity is increasingly becoming an issue of heightened public interest;

6. The Vancouver Park Board, through its bylaws, has it within its authority to enable or prevent the use of cetaceans in captivity at the Vancouver Aquarium;

THEREFORE BE IT RESOLVED THAT:

A. Staff prepare a report to the Vancouver Park Board by July 2014 on the Vancouver Aquarium's current operations that pertain to cetaceans and review the operations of other comparable Aquariums that may or may not have captive cetaceans;

B. Staff provide a public memo with an overview of the current agreements and relationship between the Vancouver Park Board and the Vancouver Aquarium, and post it on the Vancouver Park Board website;

C. Staff invite the Vancouver Aquarium to present to the Park Board on their programming, education and rehabilitation related to cetaceans, as well as their work with other aquariums.

D. Staff ensure that the public is given a full and timely opportunity to review the report, provide comments, and speak to the report.

CARRIED UNANIMOUSLY
(Commissioner Coupar absent for the vote)

Appendix 2. Taxonomy of whales and dolphins

(Committee on Taxonomy. 2014)

Order *Cetartiodactyla* (artiodactyls and cetaceans)

CETACEA (cetaceans; 90 species, of which 1 possibly extinct)

MYSTICETI (baleen whales, 14 species)

Family *Balaenidae* (right whales, 4 species)

Eubalaena glacialis (Müller, 1776). North Atlantic right whale
Eubalaena japonica (Lacépède, 1818). North Pacific right whale
Eubalaena australis (Desmoulins, 1822). Southern right whale
Balaena mysticetus Linnaeus, 1758. Bowhead whale, Greenland whale

Family *Neobalaenidae*

Caperea marginata (Gray, 1846). Pygmy right whale

Family *Eschrichtiidae*

Eschrichtius robustus (Lilljeborg, 1861). Gray whale

Family *Balaenopteridae* (rorquals, 8 species)

Megaptera novaeangliae (Borowski, 1781). Humpback whale
Balaenoptera acutorostrata Lacépède, 1804. Common minke whale
B. a. acutorostrata Lacépède, 1804. North Atlantic minke whale
B. a. scammoni Deméré, 1986. North Pacific minke whale
B. a. un-named subsp. Dwarf minke whale
Balaenoptera bonaerensis Burmeister, 1867. Antarctic minke whale
Balaenoptera edeni Anderson, 1879. Bryde's whale
B. e. edeni Anderson, 1879. Eden's whale
B. e. brydei Olsen, 1913. Offshore Bryde's whale
Balaenoptera omurai Wada, Oishi and Yamada, 2003. Omura's whale
Balaenoptera borealis Lesson, 1828. Sei whale
B. b. borealis Lesson, 1828. Northern sei whale
*B. b. schlegellii (*Flower, 1865). Southern sei whale
Balaenoptera physalus (Linnaeus, 1758). Fin whale
B. p. physalus (Linnaeus, 1758). Northern fin whale
B. p. quoyi Fischer, 1829). Southern fin whale
B. p. patachonica Burmeister, 1865. Pygmy fin whale
Balaenoptera musculus (Linnaeus, 1758). Blue whale
B. m. musculus (Linnaeus, 1758). Northern blue whale
B. m. intermedia Burmeister, 1871. Antarctic blue whale
B. m. indica Blyth, 1859. Northern Indian Ocean blue whale
B. m. brevicauda Ichihara, 1966. Pygmy blue whale
B. m. un-named subsp. Chilean blue whale.

ODONTOCETI (toothed whales, dolphins and porpoises: 76 named and 1 un-named species; one named species possibly extinct)

Family *Physeteridae*

Physeter macrocephalus Linnaeus, 1758. Sperm whale, cachalot

Family *Kogiidae*

Kogia breviceps (Blainville, 1838). Pygmy sperm whale
Kogia sima (Owen, 1866). Dwarf sperm whale

Family *Ziphiidae* (beaked whales, 22 species)

Ziphius cavirostris G. Cuvier, 1823. Cuvier's beaked whale, goose-beaked whale
Berardius arnuxii Duvernoy, 1851. Arnoux' beaked whale
Berardius bairdii Stejneger, 1883. Baird's beaked whale
Tasmacetus shepherdi Oliver, 1937. Shepherd's beaked whale, Tasman beaked whale
Indopacetus pacificus (Longman, 1926). Longman's beaked whale, tropical bottlenose whale,
Hyperoodon ampullatus (Forster, 1770). Northern bottlenose whale
Hyperoodon planifrons Flower, 1882. Southern bottlenose whale
Mesoplodon hectori (Gray, 1871). Hector's beaked whale
Mesoplodon mirus True, 1913. True's beaked whale
Mesoplodon europaeus (Gervais, 1855). Gervais' beaked whale
Mesoplodon bidens (Sowerby, 1804). Sowerby's beaked whale
Mesoplodon grayi von Haast, 1876. Gray's beaked whale
Mesoplodon perrini Dalebout, Mead, Baker, Baker and van Helden, 2002. Perrin's beaked whale
Mesoplodon peruvianus Reyes, Mead and Van Waerebeek, 1991. Pygmy beaked whale
Mesoplodon bowdoini Andrews, 1908. Andrews' beaked whale
Mesoplodon traversii (Gray, 1874). Spade-toothed whale
Mesoplodon carlhubbsi Moore, 1963. Hubbs' beaked whale
Mesoplodon ginkgodens Nishiwaki and Kamiya, 1958. Ginkgo-toothed beaked whale
Mesoplodon stejnegeri True, 1885. Stejneger's beaked whale
Mesoplodon layardii (Gray, 1865). Strap-toothed beaked whale, Layard's beaked whale
Mesoplodon densirostris (Blainville, 1817. Blainville's beaked whale
Mesoplodon hotaula Deraniyagala, 1963. Deraniyagala's beaked whale.

Family *Platanistidae*

Platanista gangetica (Lebeck, 1801). South Asian river dolphin, Indian river dolphin
P. g. gangetica (Lebeck, 1801). Susu, Ganges river dolphin
P. g. minor Owen, 1853. Bhulan, Indus river dolphin

Family *Iniidae*

Inia geoffrensis (Blainville, 1817). Amazon river dolphin
I. g. geoffrensis (Blainville, 1817). Boto
I. g. humboldtiana Pilleri and Gihr, 1977. Orinoco bufeo
Inia boliviensis d'Orbigny, 1834. Bolivian bufeo

Family *Lipotidae*

Lipotes vexillifer (Miller, 1918). Baiji, Yangtze river dolphin – possibly extinct

Family *Pontoporiidae*

Pontoporia blainvillei (Gervais and d'Orbigny, 1844). Franciscana, toninha.

Family *Monodontidae*

Monodon monoceros Linnaeus, 1758. Narwhal
Delphinapterus leucas (Pallas, 1776). Beluga, white whale

Family *Delphinidae* (38 species)

Cephalorhynchus commersonii (Lacépède, 1804). Commerson's dolphin
C. c. commersonii (Lacépède, 1804). Commerson's dolphin
C. c. kerguelenensis Robineau, Goodall, Pichler and C. S. Baker, 2007. Kerguelen Islands Commerson's dolphin
Cephalorhynchus eutropia (Gray, 1846). Chilean dolphin
Cephalorhynchus heavisidii (Gray, 1828). Heaviside's dolphin, Haviside's dolphin
Cephalorhynchus hectori (Van Beneden, 1881). Hector's dolphin, New Zealand dolphin
C. h. hectori (Van Beneden, 1881). South Island Hector's dolphin
C. h. maui A. Baker, Smith and Pichler, 2002. Maui's dolphin, North Island Hector's dolphin
Steno bredanensis (G. Cuvier *in* Lesson, 1828). Rough-toothed dolphin
Sousa teuszii (Kükenthal, 1892). Atlantic humpback dolphin
Sousa chinensis (Osbeck, 1765). Pacific humpback dolphin
Sousa plumbea (G. Cuvier, 1829). Indian Ocean humpback dolphin
Sousa un-named species. Australian humpback dolphin
Sotalia fluviatilis (Gervais and Deville in: Gervais, 1853). Tucuxi

Sotalia guianensis (Van Bénedén, 1864). Guiana dolphin, costero
Tursiops truncatus (Montagu, 1821). Common bottlenose dolphin
T. t. truncatus (Montagu, 1821). Common bottlenose dolphin
T. t. ponticus Barabash-Nikiforov, 1940. Black Sea bottlenose dolphin
Tursiops aduncus (Ehrenberg, 1833). Indo-Pacific bottlenose dolphin
Stenella attenuata (Gray, 1846). Pantropical spotted dolphin
S. a. attenuata (Gray, 1846). Offshore pantropical spotted dolphin
S. a. graffmani (Lönnberg, 1934). Coastal pantropical spotted dolphin
Stenella frontalis (G. Cuvier, 1829). Atlantic spotted dolphin
Stenella longirostris (Gray, 1828). Spinner dolphin
S. l. longirostris (Gray, 1828). Gray's spinner dolphin
S. l. orientalis Perrin, 1990. Eastern spinner dolphin
S. l. centroamericana Perrin, 1990. Central American spinner dolphin
S. l. roseiventris (Wagner, 1846). Dwarf spinner dolphin
Stenella clymene (Gray, 1850). Clymene dolphin
Stenella coeruleoalba (Meyen, 1833). Striped dolphin
Delphinus delphis Linnaeus, 1758. Short-beaked common dolphin, saddleback dolphin
D. d. delphis Linnaeus, 1758. Short-beaked common dolphin
D. d. ponticus Barabash, 1935. Black Sea common dolphin
Delphinus capensis Gray, 1828. Long-beaked common dolphin
D. c. capensis Gray, 1828. Long-beaked common dolphin
D. c. tropicalis van Bree, 1971. Indo-Pacific common dolphin
Lagenodelphis hosei Fraser, 1956. Fraser's dolphin
Lagenorhynchus albirostris (Gray, 1846). White-beaked dolphin
Lagenorhynchus acutus (Gray, 1828). Atlantic white-sided dolphin
Lagenorhynchus obliquidens Gill, 1865. Pacific white-sided dolphin
Lagenorhynchus obscurus (Gray, 1828). Dusky dolphin
L. o. obscurus (Gray, 1828). African dusky dolphin
L. o. fitzroyi (Waterhouse, 1838). Fitzroy's dolphin
L. o. posidonia (Philippi, 1893). Peruvian/Chilean dusky dolphin
L. o. un-named subsp. New Zealand dusky dolphin
Lagenorhynchus australis (Peale, 1848). Peale's dolphin
Lagenorhynchus cruciger (Quoy and Gaimard, 1824). Hourglass dolphin
*Lissodelphis borealis (*Peale, 1848). Northern right-whale dolphin
Lissodelphis peronii (Lacépède, 1804). Southern right-whale dolphin
Grampus griseus (G. Cuvier, 1812). Risso's dolphin, gray grampus
Peponocephala electra (Gray, 1846). Melon-headed whale, Electra dolphin
Feresa attenuata Gray, 1874. Pygmy killer whale
Pseudorca crassidens (Owen, 1846). False killer whale
Orcinus orca (Linnaeus, 1758). Killer whale, orca
O. o. un-named subsp. Resident killer whale
O. o. un-named subsp. Transient killer whale, Bigg's killer whale
Globicephala melas (Traill, 1809). Long-finned pilot whale
G. m. melas (Traill, 1809). North Atlantic long-finned pilot whale
G. m. edwardii (A. Smith, 1834). Southern long-finned pilot whale
G. m. un-named subsp. North Pacific long-finned pilot whale
Globicephala macrorhynchus Gray, 1846. Short-finned pilot whale
Orcaella brevirostris (Owen *in* Gray, 1866). Irrawaddy dolphin, pesut
Orcaella heinsohni Beasley, Robertson and Arnold, 2005. Australian snubfin dolphin

Family *Phocoenidae* (porpoises, 7 species)

Neophocaena phocaenoides (G. Cuvier, 1829). Indo-Pacific fin-less porpoise
*Neophocaena asiaeorientalis (*Pilleri and Gihr, 1972). Narrow-ridged finless porpoise
*N. a. asiaeorientalis (*Pilleri and Gihr, 1972). Yangtze finless porpoise
N. a. sunameri Pilleri and Gihr, 1975. East Asian finless porpoise, sunameri
Phocoena phocoena (Linnaeus, 1758). Harbor porpoise, common porpoise

P. p. phocoena (Linnaeus, 1758). Atlantic harbor porpoise
P. p. vomerina (Gill, 1865). Eastern Pacific harbor porpoise
P. p. relicta Abel, 1905. Black Sea harbor porpoise
P. p. un-named subsp. Western Pacific harbor porpoise
Phocoena sinus Norris and McFarland, 1958. Vaquita, Gulf of California harbor porpoise
Phocoena spinipinnis Burmeister, 1865. Burmeister's porpoise
Phocoena dioptrica Lahille, 1912. Spectacled porpoise
Phocoenoides dalli (True, 1885). Dall's porpoise, Dall porpoise
P. d. dalli (True, 1885). *Dalli*-type Dall's porpoise
P. d. truei Andrews, 1911. *Truei*-type Dall's porpoise

Appendix 3. Aquariums by continent with and without cetaceans

Continent	Country	Total	Cetaceans	No Cetaceans	Unknown
Africa (n=11)	Egypt	5	2	3	0
	Morocco	1	0	0	1
	Namibia	1	0	0	1
	South Africa	4	2	0	2
		11	**4**	**3**	**4**
Asia (n=158)	Barhain	1	1	0	0
	China	17	14	3	0
	India	18	0	0	18
	Indonesia	4	1	0	3
	Iran	1	1	0	0
	Isreal	3	1	0	2
	Japan	73	40	33	0
	Kuwait	1	0	1	0
	Malaysia	3	0	0	3
	Pakistan	1	0	0	1
	Philipines	5	2	0	3
	Singapore	4	1	0	3
	South Korea	9	4	0	5
	Taiwan	2	1	0	1
	Thailand	9	2	0	7
	United Arab Emirates	4	2	0	2
	Vietnam	3	0	0	3
		158	**70**	**37**	**51**
Australia/Oceana (n=29)	Australia	20	2	18	0
	French Polynesia	1	1	0	0
	Guam	1	0	0	1
	New Caledonia	1	0	0	1
	New Zealand	3	0	3	0
	Palau	2	1	1	0
	Solomon Islands	1	1	0	0
		29	**5**	**22**	**2**
Caribbean (n=26)	Anguilla	1	1	0	0
	Bahamas	3	3	0	0
	Burmuda	2	1	1	0
	British Virgin Islands	1	1	0	0
	Cayman Islands	3	3	0	0

Continent	Country	Total	Cetaceans	No Cetaceans	Unknown
	Cuba	7	6	0	1
	Dominican Republic	4	4	0	0
	French Antilles	1	0	1	0
	Jamaica	3	3	0	0
	Netherland Antilles	1	1	0	0
		26	**23**	**2**	**1**
Europe (n=218)	Austria	1	0	1	0
	Belgium	5	1	4	0
	Bulgaria	1	1	0	0
	Croatia	2	0	2	0
	Cyprus	1	0	1	0
	Denmark	9	1	1	7
	Finland	5	1	1	3
	France	20	3	17	0
	Germany	14	2	12	0
	Greece	4	1	0	3
	Hungary	1	0	0	1
	Iceland	1	0	0	1
	Ireland	3	0	2	1
	Italy	11	3	8	0
	Lithuania	1	1	0	0
	Luxumburg	1	0	1	0
	Malta	1	1	0	0
	Monaco	1	0	0	1
	Netherlands	6	1	1	4
	Norway	5	0	0	5
	Poland	8	0	1	7
	Portugal	6	2	1	3
	Romania	4	1	0	3
	Russia	15	2	1	12
	Slovenia	1	0	0	1
	Spain	16	10	6	0
	Sweden	9	1	0	8
	Switzerland	1	1	0	0
	Turkey	11	5	0	6
	United Kingdom	43	0	29	14
	Ukraine	11	10	1	0
		218	**48**	**90**	**80**
North America (n=150)	Canada	13	2	11	0
	Mexico	23	21	2	0

Continent	Country	Total	Cetaceans	No Cetaceans	Unknown
	USA	114	31	83	0
		150	**54**	**96**	**0**
South America (n=16)	Argentina	4	2	1	1
	Brazil	4	0	4	0
	Columbia	2	1	0	1
	Honduras	1	1	0	0
	Peru	1	1	0	0
	Puerto Rico	1	0	0	1
	Venezuela	3	1	0	2
Have a ban on import or display		**16**	**6**	**5**	**5**

Appendix 4. Zoos and Aquariums used for comparison

Name of Aquarium	Country	CAZA-AZAC Accreditation	AZA Accreditation	AMMPA Accreditation	Follows USDA / APHIS Standards	# of Annual Visitors (2013)
Gulf World (FL)	USA	No	No	Yes	Yes	175,000
New York Aquarium (NY)	USA	No	Yes	Yes	Yes	747000
Mystic Aquarium & Institute for Exploration, (CT)	USA	No	Yes	No	Yes	750,000
Seattle Aquarium, (WA)	USA	No	Yes	No	Yes	815,000
Biodôme de Montreal (Quebec)	CAN	Yes	Yes	No	Unknown	845,000
Toledo Zoological Gardens (OH)	USA	No	Yes	No	Yes	862,000
Riverbanks Zoological Park (SC)	USA	No	Yes	No	Yes	919,000
Vancouver Aquarium Marine Science Centre (BC)	CAN	Yes	Yes	Yes	Yes	928,000 (self reported for project)
Shark Reef Aquarium at Mandalay Bay (NV)	USA	No	Yes	No	Yes	990,000
Ripley's Aquarium at Myrtle Beach, (SC)	USA	No	Yes	No	Yes	1,000,000
Ripley's Aquarium of the Smokies, (TN)	USA	No	Yes	No	Yes	1,000,000
Steinhart Aquarium (CA)	USA	No	Yes	No	Yes	1,000,000
Pittsburgh Zoo and PPG Aquarium (PA)	USA	No	Yes	Yes	Yes	1,026,000
Indianapolis Zoo (IN)	USA	No	Yes	No	Yes	1,118,000
Albuquerque Biological Park (NM)	USA	No	Yes	No	Yes	1,123,000
Minnesota Zoo/Discovery Bay (MN)	USA	No	Yes	No	Yes	1,162,000

Name of Aquarium	Country	CAZA-AZAC Accreditation	AZA Accreditation	AMMPA Accreditation	Follows USDA / APHIS Standards	# of Annual Visitors (2013)
San Antonio Zoo and Aquarium (TX)	USA	No	Yes	No	Yes	1,162,000
Cleveland Metroparks Zoo (OH)	USA	No	Yes	No	Yes	1,208,000
New England Aquarium (MA)	USA	No	Yes	No	Yes	1,300,000
Omaha's Henry Doorly Zoo (NE)	USA	No	Yes	No	Yes	1,388,000
National Aquarium (MD)	USA	No	Yes	No	Yes	1,431,000
Aquarium of the Pacific (CA)	USA	No	Yes	No	Yes	1,512,000
Houston Zoo - Kipp Aquarium (TX)	USA	No	Yes	No	Yes	1,613,000
Six Flags Discovery Kingdom (CA)	USA	No	No	Yes	Yes	1,700,000
Denver Zoological Gardens (CO)	USA	No	Yes	No	Yes	1,965,371
Monterey Bay Aquarium (CA)	USA	No	Yes	No	Yes	1,976,944
Columbus Zoo & Aquarium (OH)	USA	N/A	Yes	No	Yes	1,993,464
John G. Shedd Aquarium (IL)	USA	No	Yes	No	Yes	2,020,000
Brookfield Zoo (IL)	USA	No	Yes	Yes	Yes	2,076,000
Georgia Aquarium (GA)	USA	No	Yes	Yes	Yes	2,193,000
Saint Louis Zoo (MO)	USA	No	Yes	No	Yes	2,988,000
Sea World Parks, All Locations	USA	No	Yes	Yes	Yes	>20,000,000
Disney's Animal Programs at the Seas (FL)	USA	No	Yes	Yes	Yes	Unknown
Edmonton Valley Zoo (Alberta)	CAN	Yes	No	No	Unknown	Unknown
Marineland (ON)	CAN	Yes	No	No	Unknown	Unknown

Appendix 5. Cetacean Research Conducted by the Vancouver Aquarium

April 21, 2014

The Vancouver Aquarium's mission is to effect the conservation of aquatic life through, among other activities, research. For three decades the Aquarium has conducted two complimentary programs of conservation-oriented cetacean (whale, dolphin and porpoise) research, the first focused on animals in its own care and the second on the same and similar species in the wild. Most of this research has been led by Aquarium staff scientists and/or Aquarium research associates, often working in collaboration with university or government-based scientists or with graduate students. This document highlights studies focused on cetaceans in the Aquarium's care and on directly-related field studies in the wild. For information on additional field research, see : http://killerwhale.vanaqua.org/page.aspx?pid=1360.

Concurrent with its own research on cetaceans, for over 20 years the Aquarium has hosted an ambitious program of research on pinnipeds (seals and sealions) for the University of British Columbia. For more information about program see: http://www.marinemammal.org/.

Historical Overview of Research at the Vancouver Aquarium

The Vancouver Aquarium was founded in the 1950's by a group of fisheries professors from the University of British Columbia with the mandate that it be used for research, in addition to educating the public about marine life. It has remained true to its original vision, initially by providing facilities and marine animals for university-based researchers, and in the last three decades by appointing staff scientists to conduct research both on-site and in the wild. It hired its first marine mammal researcher on a contract basis in 1967 to study learning and vision in killer whales and created a full time permanent marine mammal scientist position in 1989 to lead a research program focused on killer whale communication. Since then, the Cetacean Research Program has broadened to include studies of cognition, echolocation, endocrinology, echolocation, metabolic physiology, population genetics and, most recently, ecotoxicology. In addition to its own research it continues to provide external scientists with the opportunity to conduct conservation-oriented research on the cetaceans in its care, and also participates actively in training and supporting graduate students and post-doctoral fellows.

Highlights of Current and Recent Research on Cetaceans at the Vancouver Aquarium

Hearing and Acoustic Behaviour of Belugas

UBC doctoral student Christine Erbe conducted research on the hearing abilities of belugas at the Vancouver Aquarium in the mid 1990's with the goal of understanding how noise from icebreakers and other ships affect their ability to detect the vocalizations of their companions. This was followed by a systematic study of beluga vocal behaviour by another UBC doctoral student, Valeria Vergara, on the types and contexts of call use and how calls are learned. Vergara discovered that belugas use a repertoire of discrete, stereotyped calls that are learned from their companions, and that mothers and calves use a specific call type to maintain contact (Vergara et al. 2008, 2010, 2011). These contact calls can easily be masked by boat noise (McKillop et al. 2010) and will be the

focus of a new field study by Vergara and Barrett-Lennard in the eastern Arctic starting in 2014.

Echolocation Use by Pacific white-sided dolphins

Accidental entanglement in fishing nets kills tens of thousands of dolphins and porpoises every year. Vancouver Aquarium Research Associate Kathy Heise is studying the ability of the Aquarium's Pacific white-sided dolphins to detect and avoid nets using echolocation alone. Heise records the dolphins as they navigate around and between obstacles while wearing vision-blocking gelatine eyecups. The goal of the study, midway to completion at present, is to make it possible to improve fishing gear and modify fishing methods to reduce dolphin mortality from entanglements in the future (Heise 2010, 2012).

Reproductive rate, diet, energy requirements and growth of Pacific white-sided dolphins

Scientific knowledge of the basic biology of a species is necessary to develop effective and efficient means of studying it. Very little was known about the biology of Pacific white-sided dolphins until the Vancouver Aquarium supported studies of diet of the species in the wild in the 1990s (Heise 1996, 1997a, 1997b). Among other findings, this research showed that the species is long-lived, has a very slow reproductive rate and feeds on a wide variety of fish and invertebrates. These studies led to research by graduate student Erin Rechsteiner on total food and energy requirements of the species at the Vancouver Aquarium (Rechsteiner et al. 2013a, 2013b). The combined findings of these studies has led to a greater understanding of habitat use by dolphins (Recksteiner et al. 2012), and will make it easier to determine whether future shifts in distribution or changes in abundance are the result of human activities.

Dolphin acoustic behaviour and responses to noise.

In 2012 the Aquarium installed a state of the art, round the clock sound monitoring and analysis system in its dolphin habit to monitor and study the dolphins' acoustic behaviour and to study their responses to changes in their ambient sound field. The system records sound over the dolphins' entire auditory spectrum, separates it into frequency bins, measures sound pressure levels in each bin, and records the time and duration of unusual noise events (Heise et al. 2013a, 2013b). The system will make it possible to more fully understand the range of acoustic behaviours of the dolphins at the Aquarium and to compare them with behaviours recorded in the wild.

Ecotoxicological studies of cetaceans

Exposure to environmental contaminants represents a pressing conservation threat to many marine mammals around the world. As a result of their long lives and often high position on ocean food webs, many cetaceans are exposed to high levels of persistent organic pollutants (POPs), including PCBs and DDT. For example, British Columbia's killer whales are considered as the most PCB-contaminated marine mammals in the world. In addition, arctic beluga whales are contaminated by POPs, despite being far removed from sources of these chemicals. The Vancouver Aquarium has participated in studies of the fate and effects of POPs and other pollutants through a combination of logistically-challenging field studies and samples obtained from cetaceans at the Aquarium (Desforges, et al. 2012, 2013; Bennett et al., 2009). The latter work on animals at the Aquarium has led to important contributions to the scientific literature, providing a basis to model the uptake, accumulation and loss of many hundreds of different contaminants in cetaceans (e.g. Alava et al., 2012; Hickie et al., 2007). These studies would simply not be possible in the wild where controlled understanding of diet (exposure) and pharmacokinetics (in cetaceans) is lacking. Research comprising the duality of wild cetaceans in the 'real world' and a small number of Aquarium cetaceans provides for powerful insight into the health risks associated with pollutants in cetaceans and their habitat. Such an understanding provides a defensible means of designing regulations that safeguard wild populations from new pollutants of concern.

Veterinary medical research

The Aquarium's Animal Health Department conducts research on the causes of disease and responses to treatment in cetaceans with the ultimate goal of better understanding threats to wild populations. This research is not confined to cetaceans in permanent care of the Aquarium—indeed, much of it focuses on marine mammals in rehabilitation at the Aquarium's Marine Mammal Rescue Centre. Members of the Department also assist with studies of cetaceans and other marine mammals in the wild in association with collaborators from academic institutions or government agencies. As with other research at the Aquarium, all findings are made available to the scientific community via journal articles and papers presented at professional conferences (see below). The specific aims of the Aquarium's veterinary research program include:

1) production of case reports of novel health conditions or threats to cetacean health

2) development of controls for studies on cetacean populations including biomedical parameters, exposure to pathogens and physiologic monitoring

3) development of novel medical diagnostic techniques

4) evaluation of novel physiologic or telemetry monitoring for use in field studies

5) development of veterinary medical therapeutic techniques for use in cetacean rehabilitation Current projects include the evaluation of blowhole exhalations for monitoring of endocrine function in beluga whales, the development of novel functional respirometry technology to evaluate the cetacean pulmonary system, and the development of a heart rate monitor for use in estimating metabolic rate in free-ranging marine mammals.

Studies of Cetaceans in the care of the Vancouver Aquarium

Peer-reviewed papers

Bennett, E.R., Ross, P.S., Huff, D., Alaee, M., Letcher, R.J. 2009. Chlorinated and brominated organic contaminants and metabolites in the plasma and diet of a captive killer whale (Orcinus orca). Marine Pollution Bulletin 58: 1078-1095.

Brodie, P., K. Ramirez and Haulena, M. 2013. Growth and maturity of belugas (Delphinapterus leucas) in Cumberland Sound, Canada and in captivity: evidence for two growth layer groups (GLGs) per year in teeth. Journal of Cetacean Research and Management 13: 1-18.

Erbe, C., Farmer, D.M. 1998. Masked hearing thresholds of a beluga whale (Delphinapterus leucas) in icebreaker noise. Deep Sea Research 45: 1373-1388.

Frouin, H., Loseto, L.L., Stern, G.A., Haulena, M., Ross, P.S. 2012. Mercury toxicity in beluga whale lymphocytes: limited effects of selenium protection. Aquatic Toxicology 109: 185-193.

Heise, K., Yurk, H., Nordstrom, C., Barrett-Lennard, L. In press. Eds. A. Popper and T. Hawkins. A permanent soundscape monitoring system for the care of animals in aquaria. Effects of Noise on Aquatic Life II. Springer International Publishing.

Kot, B.C.W., Dalton, L., Fernando, N., Haulena, M., Jen I.F., Kinoshita R., Martelli, .P, Ramer, J., Van Bonn, W. 2011. Applications and limitations of marine mammal sonography: a radiographer's

perspective. Ultrasound in Medicine and Biology 37:S15

Maggi R.G., Raverty, S.A., Lester, S.J., Huff, D.G. Haulena, M., Ford, S.L., Nielsen, O. Robinson, J.H., Breitschwerdt, E.B. 2008. Bartonella henselae in captive and hunter-harvested beluga (Delphinapterus leucas). Journal of Wildlife Disease 44: 871-877.

Piercey, R.S., Rechsteiner, R.U., Battaile, B.C., Trites, A.W. 2013. Seasonal changes in the food intake of captive Pacific white-sided dolphins (Lagenorhynchus obliquidens). Aquatic Mammals 39: 211-220.

Rechsteiner, E.U., Rosen, D.A.S., Trites, A.W. 2013. Seasonal resting metabolic rate and food intake of captive Pacific white-sided dolphins (Lagenorhynchus obliquidens). Aquatic Mammals 39: 241-252.

Rosen, D.A.S., Trites, A.W. 2013. Resting metabolic rate of a mature male beluga whale (Delphinapterus leucas). Aquatic Mammals 39:85-88.

Leung, E.S., Vergara, V., Barrett-Lennard, L.G. 2010. Allonursing in captive belugas. Zoo Biology 29: 1–5.

Rechsteiner, E.U., Rosen, D.A.S., Trites, A.W. 2013. Energy requirements of Pacific white-sided dolphins (Lagenorhynchus obliquidens) as predicted by a bioenergetic model. Journal of Mammalogy 94: 820-832.

Vergara, V., Barrett-Lennard, L.G., Michaud, R. 2010. What can captive whales tell us about their wild counterparts? Identification, usage, and ontogeny of contact calls in belugas (Delphinapterus leucas). International Journal of Comparative Psychology 23: 278-309.

Vergara, V., Barrett-Lennard, L.G. 2008. Vocal development in a beluga calf. Aquatic Mammals 34:123-143.

Theses Erbe, C. 1997. The masking of beluga whale (Delphinapterus leucas) vocalizations by icebreaker noise. PhD. dissertation. University of British Columbia.

Javdan, S. 2010. A preliminary study on the effect of visitor density and intensity on the space use, behaviour and vocalization patterns of captive Pacific white-sided dolphins, Lagenorhynchus obliquidens. MSc. thesis. University of St. Andrews.

Leung, E. 2004. Social organization of captive beluga whales, Delphinapterus leucas. Honours thesis. University of British Columbia.

MacLeod, C. 2009. Vocal learning in a captive beluga calf (Delphinapterus leucas). Honours thesis. University of British Columbia.

Recchia, C. A. 1994. Social Behaviour of Captive Belugas, Delphinapterus leucas. PhD. dissertation. Massachusetts Institute of Technology & Woods Hole Oceanographic Institution. University of British Columbia.

Vergara, V. 2011. Acoustic communication and vocal learning in belugas (Delphinapterus leucas). PhD. dissertation. University of British Columbia.

Conference Presentations

Colitz, C., Mejia-Fava, J. Yamagata, M., Smolensky, P., Renner, M.S., Haulena, M., Dalton, L., Schmitt, T., Sanchez, R., Orona, J.F. 2012. Preliminary intraocular pressure measurements from 4 cetacean species. Internal Association of Aquatic Animal Medicine. May 12-16. Atlanta, GA.

Haulena, M., Dold, C., Van Bonn, W., Walker, K.A. 2012. Marine mammal analgesia: where have we been and where do we still need to go? American Association of Zoo Veterinarians. October 21-26. Oakland, CA.

Haulena, M, D. Huff, M. Ivančić, M. Muhammad, L. Hoang,E. Zabek and S. Raverty. 2010. Intestinal torsion secondary to chronic candidiasis caused by Candida krusei in a pacific white- sided dolphin (Lagenorhynchus obliquidens). Proceedings of the 40th Annual Conference of The International Association for Aquatic Animal Medicine. May 8-13. Vancouver, BC.

Haulena M., D. Huff, S. Raverty, S. Myers, M. Murphy and M. Papich. 2007. Severe vesiculobullous

dermatopathy in a Pacific white-sided dolphin (Lagenorhynchus obliquidens) associated with a sudden increase in caloric intake. Proceedings of the 38th Annual Conference of The International Association for Aquatic Animal Medicine. May 5-9. Orlando, FL.

Haulena, M., S. Raverty, C. Wright, B. Sheehan, J. Fitz-Gibbon, G. Hewlett, L. Barret-Lennard and D. Huff. 2007. Morbidity and mortality of beluga whales maintained at the Vancouver Aquarium. Proceedings of the 1st International Workshop on Beluga Whale research, Husbandry and Management in Wild and Captive Environments. March 9-11. Valencia, Spain.

Rechsteiner, E. 2012. Resting metabolism, energetics, and seasonal distribution of Pacific white-sided dolphins. MSc. thesis.

Heise, K., Yurk, H., Barrett-Lennard, L. 2013a. A permanent soundscape monitoring system for aquatic animals at the Vancouver Aquarium. Presentation at the 20th Biennial Conference on the Biology of Marine Mammals. December 9-13. Dunedin, New Zealand.

Heise K., Yurk, H., Nordstrom, C., Barrett-Lennard, L. 2013b. An acoustic monitoring system for the care of animals in aquaria. Presentation at the 3rd International Conference on the Effects of Noise on Aquatic Life. August 11-16. Budapest, Hungary.

Heise, K., Cavanaugh, R., Heffron, K., Johnstone, A., Juarez, A., Marquez, L., Nagata, C., Sheehan, B., Barrett-Lennard, L. 2012. The echolocation abilities of the Pacific white-sided dolphins at the Vancouver Aquarium. Presentation at the UBC Marine Mammal Symposium November 24. Vancouver, BC.

Heise, K.A., Refcio, S., Barrett-Lennard, L.G. 2010. Changes in echolocation use by captive Pacific white-sided dolphins under different environmental conditions. Presentation at the 2nd International Conference on the Effects of Noise on Aquatic Life. August 15-20. Cork, Ireland.

Ivančić, M., Haulena, M. 2010. A veterinary radiologist's perspective on advanced cross-sectional diagnostic imaging techniques in aquatic animal medicine. Proceedings of the 40th Annual Conference of The International Association for Aquatic Animal Medicine. May 8-13. Vancouver, BC.

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Appendix 6. Facilities keeping the same cetacean species as the Vancouver Aquarium

Captive Cetaceans	Country	Individuals Housed on Site
Belugas		
Vancouver Aquarium Marine Science Centre	Canada	2*
Georgia Aquarium	USA	4*
Marineland	Canada	43
Mystic Aquarium	USA	4
SeaWorld, All Locations	USA	19*
Shedd Aquarium	USA	7
Total		***79***

Harbor Porpoises		
Vancouver Aquarium Marine Science Centre	Canada	2
Dolfinarium & SOS Dolifign Harderwijk	Netherlands	6
Fjord & Belt	Denmark	3
Total		***11***

Pacific White-Sided Dolphins		
Vancouver Aquarium Marine Science Centre	Canada	2
Miami Seqauarium	USA	6
SeaWorld, All Locations	USA	6
Shedd Aquarium	USA	4
Total		***18***

*Note: although only 2 of the Vancouver Aquarium's belugas are on-site, the Vancouver Aquarium owns 9 belugas. Five of these are currently housed at SeaWorld and 2 at the Georgia Aquarium.