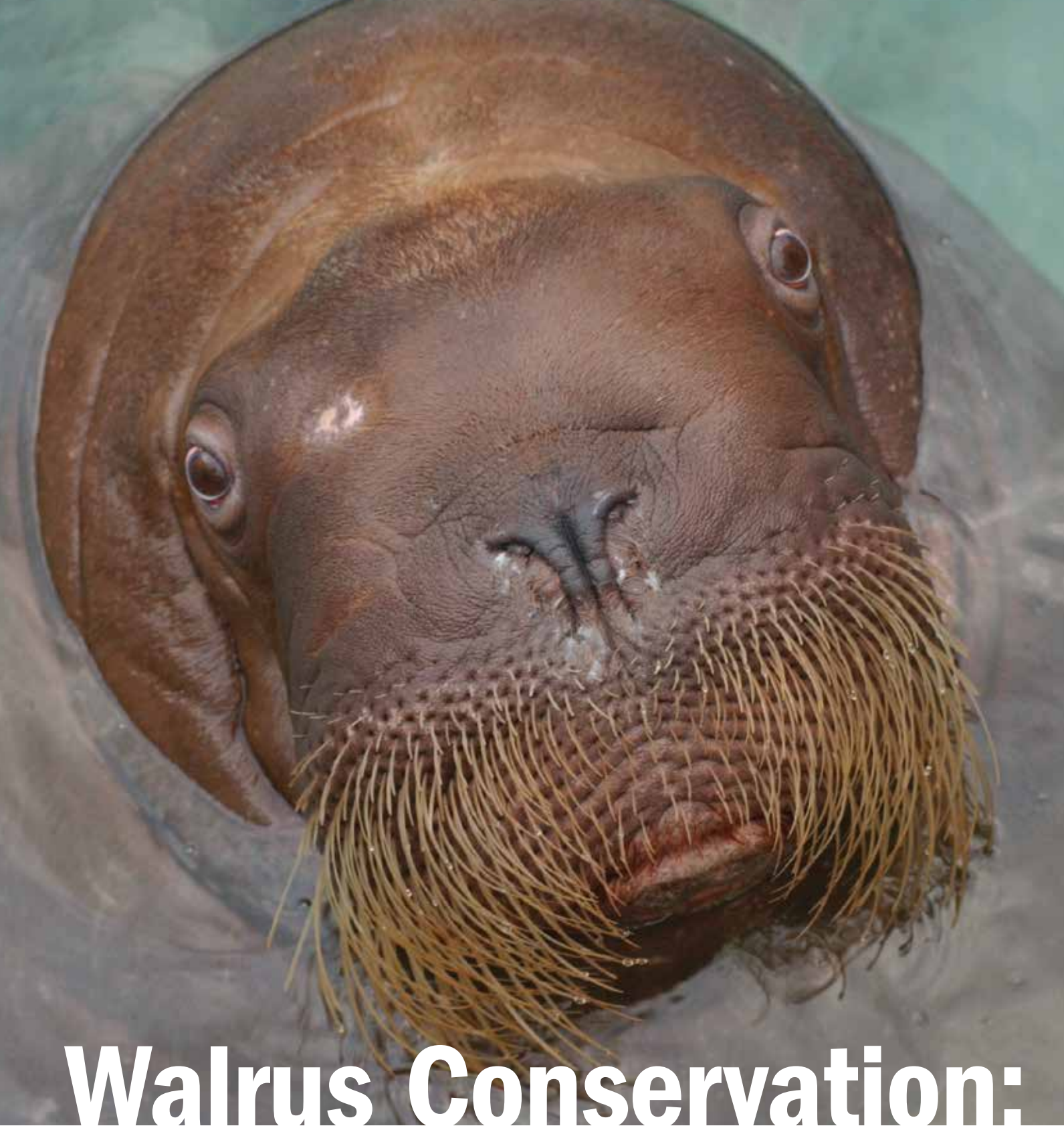

Walrus Conservation:
Connecting Research and Zoo Keepers

Elizabeth Miller • Senior Keeper, Seven Seas • Brookfield Zoo • Brookfield, Illinois

Author and Joan the walrus, building keeper/animal relationship. *Photo by Mark Gonka.*

Introduction

The walrus (*Odobenus rosmarus*), a somewhat elusive member of the pinniped community, continues to baffle researchers and keepers alike. Walrus populations in the wild struggle to maintain viable populations, especially with the decline of sea ice from which to hunt, calve their young, and seek safety from predators. Zoos and aquariums continue to learn more everyday about populations of walruses in human care. Even though replicating artificial, but natural environments for the reproduction and growth of marine species is near impossible, many cooperating zoos have made it a priority to develop strong, comparable breeding environments for walruses. Experienced keepers explain that mastering a successful walrus breeding program *ex situ* has been a challenge, but facilities continue to strive to learn as much as possible about their reproductive system (Personal Communication, Lisa Triggs, April 15, 2013) The importance of these breeding programs is to increase genetic diversity and strengthen the viability of the walrus genome. By looking into the extensive history of the walrus species connected with the human impacts endured, conservationists can continue to extend their knowledge and help walruses thrive in the future. My intention is to inspire and empower zoo keepers to build on their basic roles of animal care by taking ownership of their vital role to educate the public and instill a sense of wonder and responsibility for all endangered species.

Natural history of the walrus

Pinnipeds have evolved to spend part of their lives on land, but many of their adaptations to do so present challenges that make them vulnerable (Riedman, 1990). The walrus species is divided into three subspecies: Atlantic, Pacific, and Laptevi walruses; all named based on their regional preference for habitats (Reeves et al., 1992). During breeding season, large groups normally gather to haul out on ice packs (Reidman, 1990). The lengthy 16-month gestation period and minimum one-year nursing time makes their reproduction rate of once-every-two-years much slower (Reidman, 1990). With the constant movement of pack ice, the mating animals are steadily shifting with the ice flow (Reidman, 1990). Walruses tend to choose pack ice, detached from landmasses versus fast ice, which is associated with land (Jay et al., 2011). The benefits of inhabiting pack ice are accessible food resources, good haul-out space for breeding, molting, and resting, and predator avoidance (Riedman, 1990). Walruses feed on mollusks primarily, and typically require ingesting on average 60 kilograms of soft tissue per day to maintain their necessary body condition (Riedman, 1990).

History of population status

The history of walrus populations over the last 150 years is extensive, traumatic, and mostly due to human exploitation (Fay et al., 1989). The mass hunting for walrus tusks, hides, and body oils was turned into a commercial business that has vacillated between American, Canadian, and Russian cultures (Fay et al., 1989). As described from Eskimo tribes, the population numbers were massively depleted by commercialization (Fay et al., 1989). Various half-hearted efforts to show concern for the species have been made in the last century (Fay et al., 1989). The most impacting effort was the development of the Marine Mammal Protection Act of 1972, helping the United States and then U.S.S.R. government to collaborate on shared marine mammal population conservation efforts (Marine Mammal Protection Act of 1972 Annual Report, 1991, p. 64).

It is believed that around this time there was a significant change in the wild population. As of 1989, the estimated wild walrus population was at 250,000 and considered to fluctuate in stability (Reidman, 1990). Natural predation by killer whales and polar bears certainly effect numbers; however, evidence suggests that walrus populations may be strongly impacted by a lack of food availability in their documented habitat (Riedman, 1990). Additionally, loss of sea ice has greatly reduced haul-out space for walrus habitation (Jay et al., 2011). While human predation has affected numbers in the past, the largest threat to the population is the loss of sea ice caused by global warming, reducing haul-out space for walrus habitation (Jay et al., 2011).

Biodiversity of a keystone species

The low taxonomic diversity of existing walruses deviates greatly from the long history of diversity found in the ancestors of the Odobenidae family (Boessenecker & Churchill, 2013). Walrus biodiversity can be analyzed at several levels. It is most impacting to look at their ecosystem diversity. Ecosystem diversity can be interpreted as the species make-up of one locale, but as increasing negative environmental effects continue to play a role on ecosystems around the world, this diversity

Walruses at the Brookfield Zoo, *Photo by Jim Schulz.*

is in constant flux (Primack, 2010). Keystone species, such as the walrus to the arctic region, are denoted because of the precedent that is set by their existence. The health of a keystone species is indicative of the survival of most other species found in the ecosystem (Primack, 2010). Walrus statuses are good "indicators of the health of the arctic marine ecosystem" explains Gilbert, of the vital necessity for his aerial census project and continued population monitoring (1989). Due to their widespread foraging patterns, walruses seem to be affecting the genetic diversity and overall health of their benthic prey, such as mollusks (Jay et al., 2011). Specifically, walrus censuses are performed often to track the progression of the population (Gilbert, 1989). The most recent and accurate survey from 2006 showed a conservative estimated population of 129,000 walruses (Jay et al., 2011).

Within the walrus population, collecting data to measure genetic diversity has proven extremely difficult, with limited access to the water-bound mammals found in low numbers throughout varying regions (Scribner et al., 1997). The research that has been done indicates that walruses show potential for high genetic variability and significant gene flow (Scribner et al., 1997). It is critical to recognize that regardless of the population, walrus breeding is strongly affected by the sea ice flow, as the walruses base their annual haul-out choices on the sea ice availability. Without varying options they also have limited choices when choosing a mate to breed, thereby affecting the genetic variation (Scribner et al., 1997). Unfortunately, due to lack of data available the walrus status on the IUCN red list is marked as "data deficient" (www.IUCNredlist.org). With increased research of wild and professional care populations it is possible to change this status to promote better awareness and protection of the walrus species.

Wild population research successes and hurdles

One of the biggest concerns for walruses in the wild is the lack of food resources that will be depleted as the sea ice continues to melt. Specifically, the animals will have started to haul out in more concentrated numbers and for longer periods of time, in which the food supply is likely not able to support these populations (Noren et al., 2012). More so, the caloric changes noted in certain studies may indicate that environmental changes to the walrus habitat, such as melting sea ice, could severely modify their energy requirements for survival (Noren et al., 2012).

Other studies on wild walrus populations include learning more about their morphometric details and how their natural history affects their population success. Many studies shed light on the impacts humans have on the natural environment, and others focus on how the species is adapting to the changing environments (Kastelein et al., 1993). A pilot study on a wild population of walruses in Norway was looking into the accuracy of data collection in regards to getting close enough to the subjects without upsetting the necessary controls for the study (Kastelein et al., 1993). The study focuses on the effects of man-made noises audible above and underwater. Specifically, they looked at how the walrus behavior was changed by these noises (Kastelein et al., 1993). This preliminary study showed great effort in trying to learn about human impact on this species, particularly to animals hauled out of the water onto human populated beaches and islands (Kastelein et al., 1993). Further research could benefit protection and conservation efforts by proving that walruses are negatively impacted by human influence.

Another study performed in 1989 focused on learning about the energy requirements necessary for individual animals based on their body growth measurements. It is understood that between the subspecies populations of Pacific and Atlantic walruses these morphometric details can differ (Knutsen & Born, 1994). It was discovered that the overall condition of the Hudson Bay population of walruses was significantly smaller than that of the Greenland population (Knutsen & Born, 1994). By learning about the inner make-up of different populations, observing a leaner crop of walruses; scientists can decipher how diets are affecting the health of the population (Knutsen & Born, 1994).

Basilla and Joan - Brookfield Zoo walruses in 2006. *Photo by Jim Schulz.*

More contemporary walrus research of wild populations has been developed with the use of software to create a Bayesian Network model consisting of variable nodes addressing multiple environmental stressors in order to predict the future state of the walrus populations in various regions, specifically the range of the Pacific walrus (Jay et al., 2011). This predictor can give scientists information about dietary needs and habitat requirements for the species.

Due to the elusive nature of the walrus lifestyle and their avoidant tendencies, scientists have concluded that retrieving data from wild animals is extremely difficult. An enormous challenge that researchers face with *in situ* populations is the natural tendency of the walrus to be easily startled by outside noises or general presence of humans (Personal communication, Shawn Noren, April 19th, 2013). There is still very little understood about walrus physiology due to how difficult it is to obtain samples from the wild. Some scientists have even used wild animals in a controlled setting, strictly for data collection, in order to monitor sleep patterns as closely as possible (Pryaslova et al., 2009). With wild haul-out spaces being so difficult to access without icebreakers and weather restrictions, there is minimal understanding of vocal communication between adult and juvenile

walruses above land (Charrier et al., 2011). Even during census projects, scientists find that the low flying planes cause the walrus herds to sometimes trample each other, especially young calves, in an effort to flee the area. Noren claims that research in the field has been successful in using satellite tagging to track the animals without disturbing them, but this also involves a stressful tagging process (personal communication, April 19th, 2013). Other challenges arise from the fact that all of their feeding time takes place under murky, cold waters. Due to the extreme difficulty to observe natural foraging, let alone measure the intake of these techniques, scientists have turned to studying walruses under professional care to learn about their metabolic patterns (Noren et al., 2012).

Research efforts under professional care

Recently, scientists have started looking to populations under professional care to collect samples which has improved their data and knowledge of the species overall. An example of how these populations have helped scientists to understand the physiology and social networking of these animals was done at the Dolfinarium, Harderwijk Netherlands focusing on six Pacific walruses (Charrier et al., 2011). By video recording their behavior and analyzing vocalizations they were able to assess the importance of vocalizations to courtship behavior (Charrier et al., 2011). Other studies have used walruses in human care to learn more about their general behavior patterns, in relation to enrichment as well as seasonal environmental changes (Franks et al., 2010). This study indicated that walruses under human care are exhibiting similar behaviors as seen in wild walruses, specifically, the time they spend in the water as well as activity done after feeding periods (Franks et al., 2010). This study also helps caregivers assess the animals' behavior patterns and potentially avoid any stereotypic oral or locomotive behaviors from developing (Franks et al., 2010).

Research focus is shifting towards learning how to successfully breed in professional care, so that zoo settings do not rely on wild contributions to learn about the species for diversity preservation. As an expert in the field of *ex situ* walrus care, Lisa Triggs explains how the breeding of wild walruses doesn't seem to struggle nearly as much as the populations under human care (personal communication, April 15th, 2013). Currently, researcher Shawn Noren is in the process of collecting data from facilities to study hemoglobin levels of *ex situ* walruses in efforts to learn more about the walrus dive capacity and duration (personal communication, April 19th, 2013). Comparatively, similar research with wild grey seals has been done to look more closely at weaned pup feeding behavior. Discoveries show that pups' dive capacity when hunting is significantly smaller than the adults, and could be a clear indication for pup mortality (Noren et al., 2005). Noren explains that learning about their maximum performances needed to obtain diminishing food resources will result in providing indicative information needed to get walruses appropriately labeled on the IUCN RedList (personal communication, April 19th, 2013).

Author and Joan the walrus, building their relationship through husbandry training. *Photo by Mark Gonka.*

Connecting *In Situ* and *Ex Situ* Research Information

Shawn Noren and colleagues like her are enhancing walrus research exponentially by collaborating with zoo and aquarium populations. By taking a multitude of morphometric measurements on walruses from participating facilities of Point Defiance Zoo, Indianapolis Zoo, Brookfield Zoo, Six Flags, and later, New York Aquarium, she continues to create a more detailed baseline understanding of walrus growth. She goes on to proclaim that working with animals under professional care promotes great accessibility to the animals and samples obtained from the cooperative efforts of the animal care specialists. When discussing the importance of learning more about walruses to help their wild representation, researcher Noren claimed that, "being able to use animals for a question that needs to be answered about policy or decision is critical" (Personal communication, April 19th, 2013).

Role of a zoo keeper

The root of this paper reaches for a way to connect the importance of walrus conservation research and the role that zoo keepers should be playing to inspire awareness. As a senior keeper of Seven Seas, Brookfield Zoo's marine mammal department, I know the level of commitment and devotion that goes into caring for every single one of our animals. The rewarding value of contributing to research efforts through training is immense. Our department as a team is training daily to teach our collection various behaviors that will enable data to be collected, through measurements, samples, and behavioral observations. Even more gratifying is the ability to share these accomplishments with the zoo guests and our supportive communities. Whether through a dolphin show presentation or a Backstage Adventure program, we are able to personally educate the public about the importance of our work.

My passion for caring for walruses was cemented years ago, as I had the pleasure of working with Joan and Basilla, two female Pacific walruses. Our exhibit conditions required them to be moved to a new facility at Point Defiance Zoo; however, Brookfield Zoo's responsibility to continue walrus conservation efforts still remains strong. My goal is to strengthen these efforts, with or without walruses on zoo grounds!

My vision for the future of Brookfield Zoo is to bring walruses back on exhibit with an exceptional foundation of conservation and education about the species, stemming from our staff and branching out into our members and guests. This manuscript is just one step towards my plan to include colleagues of all departments, to understand and share the passion that will drive walrus conservation into a progressive future. If we exude our passion for the animals we care for, the guests will no doubt join us in fighting to halt global warming and; more so, these actions will help to improve population statuses for both wild species' and those under professional care.

ACKNOWLEDGMENTS

I acknowledge the Chicago Zoological Society and specifically the Animal Programs staff for playing a pivotal role in providing an outlet for sharing my passion to connect people with wildlife and nature.

Literature Cited

Boessenecker, R., and M. Churchill. 2013. A Reevaluation of the Morphology, Paleoecology, and Phylogenetic Relationships of the Enigmatic Walrus Pelagiarctos. *Plos One* 8(1):1-17.

Charrier, I., Burlet, A., and T. Aubin. 2011. Social vocal communication in captive Pacific walruses *Odobenus rosmarus divergens*. *Mammalian Biology* 76:622-627.

Fay, F., Kelly, B., and J. Sease. 1989. Managing the exploitation of pacific walruses: A tragedy of delayed response and poor communication. *Marine Mammal Science* 5(1):1-16.

Franks, B., Lyn, H., Klein, L., and D. Reiss. 2010. The influence of feeding, enrichment, and seasonal context on the behavior of Pacific walruses (*Odobenus rosmarus divergens*). *Zoo Biology* 29: 397-404.

Gilbert, J. 1989. Aerial census of pacific walruses in the Chukchi Sea, 1985. *Marine Mammal Science* 5(1):17-28.

Jay, C., Marcot, B., and D. Douglas. 2011. Projected status of the Pacific walrus (*Odobenus rosmarus divergens*) in the twenty-first century. *Polar Biology* 34:1065-1084.

Kastelein, R., Ligtenberg, C., Gjertz, I., and W. Verboom. 1993. Free field hearing tests on wild Atlantic walruses (*Odobenus rosmarus rosmarus*) in air. *Aquatic Mammals* 19(3):143-148.

Knutsen, L., and E. Born. 1994. Body growth in Atlantic walruses (*Odobenus rosmarus rosmarus*) from Greenland. *Journal of Zoology* 234:371-385.

Noren, S.R., Iverson, S.J., and D.J. Boness, 2005. Development of the blood and muscle oxygen stores in Gray Seals (*Halichoerus grypus*):Implications for juvenile diving capacity and the necessity of a terrestrial postweaning fast. *Physioogical and Biochemical Zoology* 78(4):482-490.

Noren, S.R., Udevitz, M.S., and C.V. Jay. 2012. Bioenergetics model for estimating food requirements of female Pacific walruses *Odobenus rosmarus divergens*. *Marine Ecology Progres Series* 460:261-275.

Primack, R. 2010. What is biological diversity? In *Essentials of Conservation Biology 5th Ed.* (pp. 23-50). Massachusetts: Sinauer Associates, Inc.

Pryaslova, J.P., Lyamin, O.I., Siegel, J.M., and L. M. Mukhametov. 2009. Behavioral sleep in the walrus. *Behavioural Brain Research* 201:80-87.

Reeves, R., Stewart, B., and S. Leatherwood. 1992. *The Sierra Club handbook of Seals and Sirenians.* Sierra Book Clubs.

Riedman, M. 1990. The Pinnipeds: Seals, Sea Lions, and Walruses. Berkeley, Los Angeles, and Oxford: University of California Press.

Scribner, K., Hills, S., Fain, S., and M. Cronin. 1997. Population genetic studies of the walrus (Odobenus rosmarus): A summary and interpretation of results and research needs. Molecular Genetics of Marine Mammals 3:173-184.