Penguin Conservation

The Penguin TAG Newsletter

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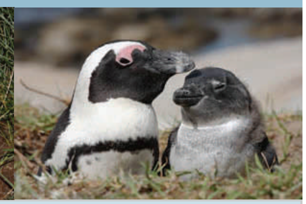

A Note from Cynthia Cheney

Editor, Penguin Conservation (1988-2000)

Twenty-two years ago, the publication that would become the first *Penguin Conservation* started; it was four pages, photocopied, titled *Spheniscus Penguin Newsletter*. My goal then was to promote communication among all levels of staff, at all the zoological institutions housing penguins of that genus (since I was working with Humboldt Penguins). Soon, after illuminating conversations with Dee Boersma, I added field researchers to the intended audience; clearly we zoo folks could learn useful things from them, and we could share information from zoo colonies that couldn't be gathered in the wild. At that time the communication between these two groups was slight, with many not even seeing a need for such interchange. The small publication expanded also to include all species of penguin, took on the title *Penguin Conservation,* and grew in size and circulation. By 2000, when health problems forced me to stop, 600+ institutions and individuals, worldwide, received the publication free of charge. [Back issues are now online at www.faunapub.org.]

Now, the inaugural issue of a new *Penguin Conservation* is making its debut in a one-time print format especially for the 7th International Penguin Conference, where field researchers and zoo professionals meet. Never has the conservation of these birds been at such a critical point. If knowledge is power, then timely and accurate communication is a "force multiplier" of that power. Conservation benefits greatly from specialized publications like this.

After this issue, *Penguin Conservation* will be an electronic publication, easily accessible to most of those working with penguins and much cheaper (my thanks to the Oregon Zoo, which paid the postage for all those print issues of the first *PC*!). But it's still a good bit of work to edit and correspond with authors, and lay out each issue, and I am delighted that Linda Henry and Jessica Jozwiak are bringing their energy and expertise to this new beginning. They have the support of the Penguin TAG, and of all of us who work with and for penguins.

A Letter from the Editors

Linda Henry and Jessica Jozwiak

We are grateful to Cynthia for her support and her ongoing commitment to penguin conservation issues. Furthermore, we are pleased to carry on the work she started with *Penguin Conservation*. Her work has provided a firm foundation for us to advance the mission of the Penguin TAG by promoting conservation concern and conservation action for penguins. In recent years, both field biologists and zoo professionals have identified the need for this type of communication tool. Penguin populations continue to decline making the need for a global response to ocean conservation more urgent. We all realize that it will require the cooperative efforts of all of us, zoo professionals, field researchers, governments and the public, working at all levels in society to effect change. It is our hope that *Penguin Conservation* will help to serve as a conduit for communicating timely information between penguin professionals and help to translate that information for dissemination to the public. Look for *Penguin Conservation* online at www.zoopenguins.org. You can also email the editors to receive a copy of the biannual newsletter via email. We look forward to your support.

Penguin Conservation is supported by the Penguin TAG. For subscription, article submission or other inquiries contact the editors:

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The North American Penguin TAG: Mission and Goals

Tom Schneider, North American Penguin TAG Chair

For those not familiar with zoo and aquarium programs, your first question may be what is a TAG and what does it do. Regional zoo organizations, such as the Association of Zoos & Aquariums (AZA) have formed committees that are responsible for developing initiatives that address the population management, conservation, and research needs of the species under their purview. These are the Taxon Advisory Groups, or TAGs. Currently there are 46 TAGs that oversee everything from insects to marine mammals.

The North American Penguin TAG's mission is to provide leadership for the *ex situ* management of penguins in North America in order to maintain healthy, sustainable populations for the purposes of:

- Engendering appreciation for these charismatic species that are indicators of the health of marine and coastal environments.
- Promoting conservation concern and conservation action through education programs and internet resources.
- Furthering *in situ* conservation and research in support of *ex situ* management.

The TAG has a Steering Committee composed of fifteen AZA members that provide the leadership needed to implement the TAG's goals. In addition, each species recommended for management has a species manager that participates in TAG programs and decisions. And finally, there are advisors from a range of disciplines including veterinarian, nutrition, population management, field conservation, education, marketing, and fund raising that assist with the TAG's programs.

The main responsibility of a TAG is to develop and publish a Regional Collection Plan (RCP) that guides the management of all species under the purview of that TAG. The goal of an RCP is to develop a list of species that are recommended for management at AZA institutions, determine what level of management is recommended for each species, and set target population sizes for each recommended species. This information is then used by institutions when they are planning their individual collection plans insuring that their animal management and conservation goals can be accomplished.

The Penguin TAG completed their fourth RCP in 2010 and is recommending that eleven species of penguins be managed in AZA institutions. Ten of these species are recommended to be managed by a Species Survival Plan (SSP) or Population Management Plan (PMP). Both levels of management undergo a demographic and genetic analysis that results in animal by animal and institution by institution recommendations. The emperor penguin is a demographically aging population and is being managed at a display/education level (DERP). The chart below summarizes the current population size and management level for penguins in North American institutions.

Species	2009 Population	2013 Desired Population	Program Recommendation
Adelie	149	168	PMP
Chinstrap	127	122	PMP
Emperor	33	48	DERP
Gentoo	411	389	PMP
King	241	293	PMP
Macaroni	150	212	PMP
Rockhopper	341	394	PMP
African	648	909	SSP
Little	56	68	PMP
Humboldt	300	376	SSP
Magellanic	192	281	PMP

In addition to developing a RCP, TAGs also have the following responsibilities:

- Publishing Animal Care Manuals.
- Development and implementation of an Action Plan.
- Establishing management, education, research, and conservation priorities.
- Advancement of animal management techniques based on scientific studies.
- Oversight of animal management programs.

The TAG and its individual AZA institutions have been involved in many programs including publishing and worldwide distribution of a husbandry manual, support and coordination of conservation projects in South America and South Africa, performing husbandry research, developing educational programs, and overseeing management programs for each of the species that are recommended to be maintained in North America. Future issues of *Penguin Conservation* will highlight the different TAG programs in greater detail.

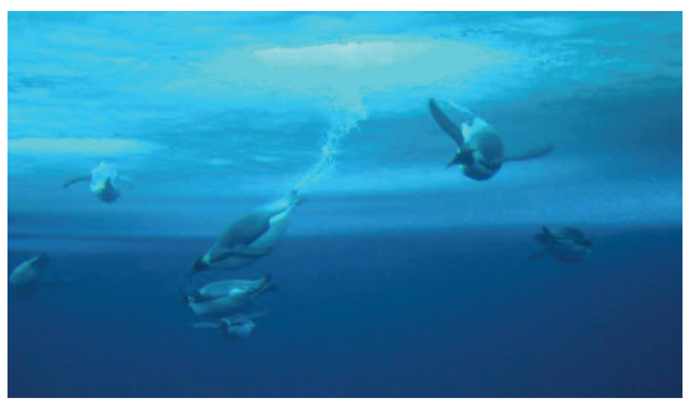
Diving Physiology of Emperor Penguins at Penguin Ranch

Cassondra Williams, Ph.D. Candidate, Scripps Institution of Oceanography, UCSD

The emperor penguin (*Aptenodytes forsteri)* is a premier avian diver which breeds on the sea ice in Antarctica. It has routine dive durations of 5-12 min, with a record dive duration of 23.1 min (Ponganis, Stockard et al. 2007). Emperor penguins regularly dive to 100 m and can dive as deep as 500 m (Kooyman and Kooyman 1995). The remarkable diving ability of the emperor penguin and its sea ice habitat make it an ideal model to investigate diving physiology.

In early diving physiology studies, researchers forcibly submerged seals in a laboratory to simulate diving. They discovered a series of physiological responses to these simulated dives, often referred to as the dive reflex. These responses include a severe bradycardia (decline in heart rate) and peripheral vasoconstriction (constriction of blood vessels to stop or reduce the blood flow to the extremities, including muscle) (Scholander 1940; Scholander, Irving et al. 1942). It was unclear whether freely diving animals would have the same response as the forcibly submerged seals.

In 1987, to study diving physiology in freely diving emperor penguins, Jerry Kooyman and Paul Ponganis set up the first Penguin Ranch on the sea ice in McMurdo Sound (Kooyman, Ponganis et al. 1992). Penguin Ranch was a temporary sea ice camp consisting of two isolated dive holes (isolated from any other holes or cracks in the ice for at least 1 km) with a series of huts around the holes. Non-breeding adult emperor penguins wandering the sea ice were captured and taken to Penguin Ranch for four to six weeks. After physiological recorders were attached to the penguins, they were allowed to dive freely through the isolated holes and researchers were assured the penguins, as well as the instruments they carried, would return. Since 1987, and as recently as 2008, the isolated dive hole protocol at Penguin Ranch has made many important physiological studies possible, helping us understand the physiology behind the remarkable diving capabilities of these birds.



In one of the first studies at Penguin Ranch, researchers studied heart rate in resting and freely diving emperor penguins and found heart rate declined during diving to an average of 63 beats per minute (bpm) compared to 72 bpm at rest (Kooyman, Ponganis et al. 1992). This contrasts with the classic response of increased heart rate during exercise. Diving heart rate was revisited in a recent study using digital electrocardiogram (ECG) recorders (Meir, Stockard et al. 2008). Results of this study demonstrated that dive duration and heart rate were correlated - as dive duration increased, so did the magnitude of the decline in heart rate. In an 18 min dive, heart rate declined to 6 bpm or less for the last 5 min of the dive. The decrease in heart rate is a way to conserve oxygen (O_2) since heart rate is believed to be a primary determinant of the O_2 consumption rate. Heart rate increased right before dives (pre-dive tachycardia) to an average of 174 bpm and increased again after dives (post-dive tachycardia) to a similar rate (177 bpm) (Meir, Stockard et al. 2008). Pre- and post-dive tachycardia likely provide for efficient reloading of O_2 stores and a quick recovery from dives.

Another important study conducted at Penguin Ranch was the determination of the aerobic dive limit (ADL). The ADL is widely used in the interpretation of diving behavior and foraging ecology studies. It is defined as the dive duration associated with the onset of post-dive blood lactate accumulation (Kooyman, Wahrenbrock et al. 1980). To determine the emperor penguin ADL, blood samples were obtained immediately after dives of known duration and then analyzed for lactate concentration. Results indicated the emperor penguin has an ADL of 5.6 min (Ponganis, Kooyman et al. 1997). In general, dive durations are limited by (1) O_2 stores in the respiratory system, blood and muscle tissue; and, (2) the O_2 consumption rate of those stores. At the ADL, it is believed that at least one O_2 store has been significantly depleted, anaerobic metabolism has begun and lactate starts to accumulate (Ponganis, Kooyman et al. 1997). Understanding the management of the three O_2 stores and discovering

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(Continued from page 3)

what triggers the onset of post-dive lactate accumulation will aid in understanding the limits of the emperor penguin's diving abilities.

To investigate the underlying mechanism of the ADL, utilization of two of the three O_2 stores was studied at Penguin Ranch. First, research on the respiratory O_2 store (air sacs and lungs) revealed that penguins have significant tolerance to hypoxia (low O_2 level) (Stockard, Heil et al. 2005). End-of-dive P_{O2} values in the air sac were below 20 mmHg in 42% of dives (Stockard, Heil et al. 2005), which is lower than air sac P_{O2} values in pekin ducks forcibly submerged to the point of 'imminent cardiovascular collapse' (Hudson and Jones 1986). Next, research on the blood O_2 store revealed similarly impressive tolerance to low O_2 levels in the blood (hypoxemia). During the record 23.1 min dive, venous P_{O2} declined to 6 mmHg by the end of the dive (Ponganis, Stockard et al. 2007). This is equivalent to 1% venous Hb saturation (Meir and Ponganis 2009). In contrast, the human threshold for shallow-water blackout is near 25 mmHg and mixed venous values for terrestrial mammals exercising at maximum O_2 consumption are 27-34 mmHg (Ponganis, Stockard et al. 2007). These two studies revealed the emperor penguin's remarkable tolerance to hypoxia and hypoxemia. Tolerance to hypoxia and hypoxemia allows penguins to dive longer as they can utilize a larger portion of their O_2 stores than animals with lower tolerance to hypoxia and hypoxemia.

Although respiratory and blood O_2 stores are often nearly depleted at the end of long dives, neither store is completely consumed at the ADL. This suggests that the muscle O_2 store may be depleted at the ADL and subsequent anaerobic metabolism may be the trigger for the ADL (or the primary source of increased post-dive blood lactate concentration). The most recent study at Penguin Ranch examined muscle O_2 depletion during dives. Results from that study are forthcoming.

These studies, as well as others at Penguin Ranch, have revealed the emperor penguin's extraordinary diving abilities and notable adaptations to diving. Their ability to dive for extended periods is facilitated by their tolerance to low O_2 levels in both the respiratory and blood systems. Other research studies and stories about Penguin Ranch can be found online at http://penguinranch.blogspot.com/.

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Semen Collection and Artificial Insemination of Rockhopper Penguins at the Indianapolis Zoo

Tammy Root and Jenny Waldoch, DVM
Contributors: Karen Imboden, Orville Van Dame, Jeanette Floss, DVM

Introduction

The Indianapolis Zoo's rockhopper penguin (*Eudyptes chrysocome*) population is aged and is not self-sustaining. For this reason, the Indianapolis Zoo implemented a research project to determine how our rockhopper penguin breeding success could be improved. A survey was sent out to all institutions that hold rockhopper penguins. The survey results indicated that several populations are aging and are not self sustaining. It was decided that the first step to determine why reproduction is low would be to look at the quality of semen.

Training for Semen Collection

Since semen collection had never been done before on rockhopper penguins, information about semen collection techniques was gathered from poultry examples. I was able to find valuable information on the internet as well as visiting the poultry unit at Purdue University, in West Lafayette, Indiana, to practice semen collections on their poultry flock.

In order to start the training, I considered a couple of factors about the penguins: access and tractability. I chose to work solely with birds that were owned by the Indianapolis Zoo. This allowed me to train six males, one of which was hatched in 1999 and the others which hatched in 1987. I also took into account that none of the target birds were accustomed to routine handling. At the Indianapolis Zoo, penguins are handled infrequently for weights (once every three weeks) or as medical issues arise. All birds are hand fed twice a day.

Training began in November of 2002 with the acclimation of the birds to human touch. This was accomplished by frequently approaching the target birds, touching the abdomen and rewarding acceptance. (Figure 1) As birds demonstrated through behavioral cues, that they accepted human approach, movement and touching, trainers began extending touching from the abdomen to the vent area. (Figure 2) Training logs were kept of each session noting the length of session and behavioral progress. Other data collected included daily food intake, weekly weights, behavioral changes and progress toward training goals. In all instances, sessions were discontinued if the bird showed behavioral changes consistent with stress or discomfort.

Figure 1: *Belly Pats*

As sessions progressed and incremental training objectives were achieved, birds were also conditioned to being picked up and relocated to a behind-the-scenes area. They were then habituated to lying down on their belly. (Figure 3) This was the final training and habituation stage before semen collection could begin.

To collect semen, acclimated birds were placed on their belly and the vent cleaned with sterile gauze prior to vent massage. Semen was collected in a 1 cc syringe for analysis.

Semen Collection Outcomes

At the Indianapolis Zoo, the rockhopper breeding season normally starts around the end of September. Since we were unsure of when semen production began, we started collecting a couple of weeks prior to breeding season on September 17, 2004. We were able to collect samples from five of the six birds. However, we ran into problems with the temperatures of the microscope and the hot plate. Because the collections took place in a room with an ambient temperature of 65-70 degrees F (18-21 degrees C) we needed to keep samples warm during examination. Our initial samples were destroyed when the set temperature of the hotplate was too high. Through trial and error we learned that the temperature of the hot plate needed to be set at 85 degrees F (29.5 degrees C.) We also found that the microscope had to be turned on at least 20 minutes prior to viewing sperm. The hotplate, microscope and the entire table of equipment needed to be warmed with a heat lamp for approximately 30 minutes prior to collection to give us the best sample readings.

On October 1, 2004, we successfully collected semen containing sperm. On October 7, we placed river rocks on exhibit for nesting material to officially start breeding season. Over the years, we found that the birds didn't start building nests until the beginning of October. This has been an annual ritual.

By October 28, we were able to see sperm in samples collected from all six birds involved in the study. From this point for-

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ward, we collected weekly until we stopped seeing sperm from each bird for two consecutive weeks. If sperm was not obtained from an individual bird for two consecutive weeks, collection was discontinued for that individual for the breeding season. We were able to collect semen with sperm from 2-9 consecutive weeks, depending on the bird.

To ensure that collections were consistent, the staff schedule and bird husbandry schedule were considered. This also provided consistency with training. During one of the bird's last three collections, he milked himself. He seemed to get the signals as soon as he was picked up and set on the sink counter.

Figure 2: *Upright Vent Massage*

Throughout the study, each bird was monitored by their behavior, food consumption and weight. Each bird exhibited normal penguin behavior.

Artificial Insemination and the Future

Since 2004, we have introduced 10 more males into the study. We have also introduced six females into the study for artificial insemination. The training protocol for artificial insemination was similar to that of semen collection training. Artificial insemination was attempted during the 2005 breeding season. Unfortunately, we were unable to obtain enough good quality samples from any one individual. It was decided that all of the good quality semen samples from each male in the study would be pooled and diluted to produce the amount of semen needed.
Each female in the study was artificially inseminated using the pooled semen. Three fertile eggs were produced, but none of the embryos survived. DNA analysis to determine paternity was planned, but was not completed.

Figure 3: *Stimulating for Collection*

In 2006, the Oceans building (where the rockhopper penguins are housed) was under construction and all of our birds were sent to another institution for holding. They returned to Indianapolis just before the 2007 breeding season. Since 2007, we have collected semen from a group of males every year. The samples we have collected have been minimal and we are seeing less and less sperm. Our population is aging, but we are unsure if the decrease in sperm is age related or due to other factors.

Note: This paper is a summary taken from "Semen Collection on Rockhopper Penguins at the Indianapolis Zoo" previously published in the Animal Keeper's Forum. You can find a detailed description of the training protocol and procedures within this publication.

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Events and Announcements

Sept 7-11	First World Seabird Conference www.worldseabirdconference.com	Oct 16	4th Annual Penguin Run, Walk (or Waddle) * www.mysticaquarium.org
Oct 2	African Penguin Awareness Day www.sanccob.co.za		* *Money raised will help support African penguin research and conservation efforts.*