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**Posters**


# Table of Contents

**Comparing blue monkey (Cercopithecus mitis) enrichment variety at Zoo Knoxville with enrichment at a leading primate sanctuary in Kenya.**

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As animal caregivers, it is important that we collaborate with other institutions to ensure the highest quality of care for our animals. This study aimed to compare enrichment categories provided for blue monkeys (Cercopithecus mitis) being cared for by humans at Zoo Knoxville in Knoxville, Tennessee, USA, and Colobus Conservation in Diani Beach, Kenya. For this study I collected information to compare types of enrichment provided for blue monkeys at Zoo Knoxville and to determine if they are different from the enrichment provided to a similar species at Colobus Conservation. I viewed daily enrichment logs recorded at Zoo Knoxville and sorted them into categories based on enrichment type. I then compared this information to categories shared by Colobus Conservation used with their Sykes' monkeys (Cercopithecus mitis, sometimes classified as Cercopithecus albogularis). The purpose of this study was to determine if Zoo Knoxville provides similar enrichment to a well-respected in-situ conservation organization that promotes species-typical behaviors. Results indicated that Zoo Knoxville provides significantly more food enrichment than environmental enrichment, while Colobus Conservation provides primarily environmental enrichment options and virtually no extra food enrichment. By transitioning to using less food-based enrichment items for the blue monkeys at Zoo Knoxville, we may be able to reduce obesity and encourage species-typical behaviors, ultimately improving overall welfare.

# Comparing blue monkey (*Cercopithecus mitis*) enrichment variety at Zoo Knoxville with enrichment at a leading primate sanctuary in Kenya

·· Tiffany James · Zoo Knoxville · Knoxville, TN, USA ··

## Introduction

Blue monkeys (*Cercopithecus mitis*) are a species of guenon, native to sub-Sarahran Africa. They live in troops of 10-40 individuals with one dominant male, often with other guenon species[6]. In zoos and sanctuaries, the groups are often much smaller. Blue monkeys are classified as a "phase-out species" by the Association of Zoos and Aquariums (AZA) and are housed at only four facilities in the USA, at which most maintain a 1 male to 1 female (1.1) group[1]. However, sanctuaries across Africa are seeing an increase in the number of orphaned monkeys in their care as a result of habitat loss, increased hunting, the illegal pet trade, and the spread of pathogens[5]. These individuals are often not prepared for the social dynamics of their own kind and must be slowly integrated to learn (or re-learn) species-typical behaviors, and enrichment is often used to help teach these skills[7]. Enrichment is essential to the physical and mental wellbeing of all primates under human care, and facilities accredited by the Pan African Sanctuary Alliance (PASA) are required to have programs similar to what we maintain at AZA accredited facilities.

The purpose of this study was to determine if Zoo Knoxville provides similar enrichment to a well-respected in-situ conservation organization that promotes species-typical behaviors. Working in conjunction with Colobus Conservation, a PASA-member primate sanctuary known for their outstanding care and conservation work in Diani Beach Kenya[4], I compared the types of enrichment provided to their Sykes' monkeys (*Cercopithecis mitis albogularis*) with the types being provided to 1.1 Stuhlmann' blue monkeys (*Cercopithecus mitis stuhlmanni*) at my facility in Tennessee, USA. I predicted that Zoo Knoxville's blue monkeys were given significantly more (non-diet) food enrichment than their counterparts at Colobus Conservation and less environmental enrichment. By comparing my team's current practices to those of Colobus Conservation, we were hoping to promote more species-typical behaviors, a higher standard of nutrition, and overall a better quality of life for the monkeys under our care at Zoo Knoxville.

*Zoo Knoxville "hanging chair" and "forage bucket" enrichment*

*Colobus Conservation "leaf litter" enrichment*

## Methods

To compare types of enrichment provided at Zoo Knoxville with enrichment at Colobus Conservation, I viewed daily enrichment logs recorded at Zoo Knoxville and sorted them into categories based on enrichment types established by my facility. I then categorized the enrichment provided by Colobus Conservation[3] based on Zoo Knoxville's standards (Figure 1). To compare Zoo Knoxville's enrichment with Colobus Conservation's, I calculated the mean for each category based on the number of times each item was given out of the total amount. I compared the means using pie charts to determine similarities and differences in the enrichment types and amounts between the two organizations (Figures 2 and 3.

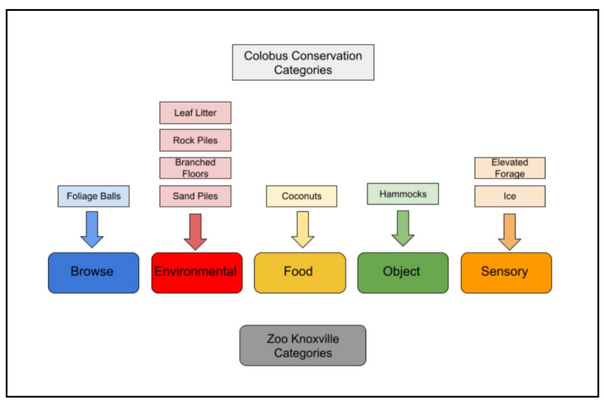
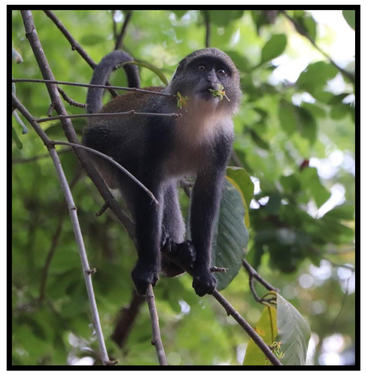



*Figure 1: Categorizing enrichment items given by Colobus Conservation to match Zoo Knoxville's established categories*



## Results

Zoo Knoxville provides substantially more food-related enrichment than any other categories. 24.6% of the overall enrichment provided during the study period was additional (non-diet) food items. When removing the required dietary items provided that are included in the overall enrichment, keepers choose to provide "Non-Diet Food" items 29.5% of the time, often paired with "Objects" which are provided 29.7% of the time. Zoo Knoxville offers "Environmental" enrichment 9.4% of the time based on our overall enrichment data. "Browse" enrichment is provided 23.0% of the time, while "Sensory" enrichment makes up just 3.7% of our total and "Training" is only 4.7%. (Figure 2).

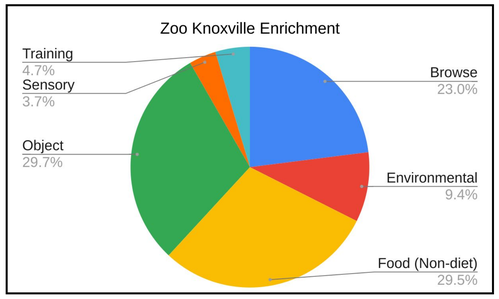



*Figure 2: Enrichment by category offered at Zoo Knoxville*

Colobus Conservation provides primarily naturalistic enrichment that would fall under the "Environmental" category (62%). They provided "Browse" 9% of the time, "Sensory" items 19%, "Object" was 3%, and "Food" enrichment was 7% (Figure 3). They do not provide additional food enrichment other than coconuts, but vary diet presentation daily (typically by scattering, burying, or providing bowls of food)[2].

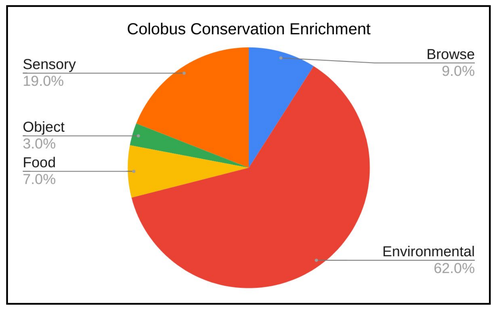



*Figure 3: Enrichment by category offered at Colobus Conservation*

## Discussion

Zoo Knoxville's enrichment program varies greatly from the Colobus Conservation enrichment program. A likely reason for this discrepancy is the availability of various items; Colobus Conservation keepers can easily access natural items that the monkeys may use in the wild but do not have the same access to store-bought products like we do at Zoo Knoxville. Likewise, we do not have access to the same items that can be readily found near Colobus Conservation. We do, however, have many comparable items to those used by Colobus Conservation, and could work to offer more naturalistic items like sand and rock piles or leaf litter.

For the 1.1 blue monkeys at Zoo Knoxville, we used the information learned from this study to modify our enrichment goals practices and enhance the quality of care for our monkeys. In the past, our main enrichment goal was to promote foraging (Table 1), and keepers often struggled to find enrichment ideas other than additional food options as treats to motivate our monkeys. This continued practice led to increased concerns regarding obesity of our monkeys, and after learning from Colobus Conservation's practices, we decided to re-structure our goals entirely (Table 2). By transitioning to using less food-based enrichment items for the blue monkeys at Zoo Knoxville, we are working to reduce obesity and encourage species-typical behaviors, ultimately improving overall welfare. We intend to continue recording and analyzing our enrichment practices as done through this study and are working to build relationships with our monkeys to further monitor their weight. Additionally, repeating the study with guenon species across multiple zoos and conservation organizations could help us to learn ways to provide the highest quality of care and enrichment for our animals.

**East Mammals Department 2018-2020 Primate Enrichment Goals**

| | |
|---|---|
| Goal | Promote foraging behaviors |
| Action | Offer enrichment items daily that require monkeys to search for food and others |
| Evaluation | A log will be added to record items given |

*Table 1: 2018-2020 Departmental blue monkey enrichment goals*

**East Mammals Department 2022 Primate Enrichment Goals**

| | |
|---|---|
| *East Mammals General Primate Goals* | Our department currently cares for 1.1 blue monkeys. They are housed in an atypical group setting for this species, because of which our goals are modified to encourage species-typical behaviors and opportunities. As a department we will prioritize an increase in training opportunities for the monkeys. As our new hires join the department, we will be able to establish a routine that will improve the monkeys' overall welfare. We will continue to provide novel enrichment and browse daily, and will work to provide more cognitive stimulation through complex enrichment and training. |
| *Blue Monkey Enrichment Goals* | Our main goal is to reduce aggressive behaviors between the monkeys as well as to encourage species-typical behaviors. This will be accomplished through increased training, diversifying our current enrichment items to elicit more behaviors without using as much food, and more behavioral observations. We will continue to provide novel browse and enrichment daily. |
| *Blue Monkey Training Goals* | Shifting is a top priority for training, and we would also like to have hand-injection training completed by the end of the year. Reducing the amount of food enrichment that is provided with high value items may help increase the success and interest with training new behaviors. |

*Table 2: 2022 departmental primate enrichment goals, updated to better establish ideal care and practices*

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I extend my thanks to the entire team at Colobus Conservation in Kenya for allowing me to volunteer and examine enrichment practices, as well as to my management team at Zoo Knoxville for supporting this project. Lastly, I could not have completed this project without my instructors and peers at Project Dragonfly. Thank you to all for your support throughout this process.

## For further information

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**United Keepers Uniting Otters : A case study**

Sabrina Ridel & Cylia Civelek, Montreal Biodome, sabrina.ridel@montreal.ca

The Montreal Biodôme, an indoor zoological museum, closed to the public for a large-scale renovation "Migration project", from 2018-2022 (delays due to COVID). During this time, the Biodôme's North American river otters (NAROs) were permanently moved to another institution. To renew our collection, we prepared for a young, reproductive, wild-caught female NARO to arrive from the USA in August 2020. A young, nonreproductive, captive-born male NARO from Calgary Zoo was scheduled to arrive in May 2021 in hopes of forming a reproductive couple. In the midst of these challenges, mouvements of staff and retirements made it so that new animal care technicians with different levels of experience were integrated into the team. Knowledge gained through this process motivates us to share in a poster with fellow AAZK members, our successes and areas of improvement, through collaboration, innovation, experience and a lot of passion. We have united a Canadian and an American otter into our francophone province. Wouldn't you say that's a great pair, eh? Online forums, collaborative documents, and interpersonal communications were consulted to ìmplement our NARO introduction protocol. Collaboration between several departments allowed for the necessary structural modifications and the installation of monitoring equipment. The female's quarantine and introduction into her new habitat was our first challenge. She was then gradually introduced to our new male using olfactory, auditory, visual and tactile communication, before their first physical contact. Ultimately, the otters' introduction was a success, through a combination of careful planning and decision making, with many more to come.

# United Keepers Uniting Otters: A Case Study

Cylia V. Civelek, Sabrina Ridel **Biodôme, Montréal, Québec, Canada**

## BACKGROUND

**ABOUT THE BIODÔME**
- Open since 1992
- 2018-2022 : closed for a large-scale renovation project “Migration”, then again due to COVID-19
- Some animals relocated temporarily & others permanently (ex NAROs)
- 1.1 NAROs acquired to renew the collection

**OBJECTIVES FOR NARO INTRODUCTION**
- Form a reproductive NARO couple
  - Support conservation and education, two of the Biodôme’s missions
  - Follow SSP recommendations
- Ensure otters’ and keepers’ safety, Gold-standard for wellbeing and welfare
- Successfully integrate the otters with each other and into their environment
  - Desensitization; create an human-animal bond; use enrichment and training

## METHODS


**Female**
North American River Otter
(*Lontra canadensis*)
Age: ~3Y (adult)
9 kg
Wild-caught
Originally from
Texas/Mississippi
Little known history

**Preparation: began in Nov 2019**
- Team: Chief of division, curator, foreman, veterinarian, animal welfare coordinators, and animal care technicians
- New, learning experience for many team members
- Protective contact
- COVID-19 protective measures

**Arrival and quarantine: mid-Aug 2020**
- Priorities during 1st week of quarantine:
  - Set a positive routine and first encounters with keepers
  - Respect boundaries & build trust
  - Desensitization: name, meatstick, novel food
  - Enrichment
- Monitor appetite, diet preferences & behaviour
- Cameras and record keeping: Data sheets, ethograms, ZIMS
- COMMUNICATION

**Access to habitat 1 week into quarantine**
- Training: bridge, target, scale, shift, recall, crate for veterinary exam (2 months)

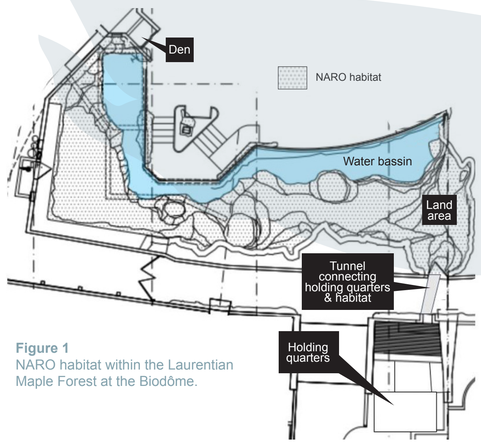


**Figure 1**
NARO habitat within the Laurentian Maple Forest at the Biodôme.


**Male**
North American
River Otter
(*Lontra canadensis*)
Age: 1Y 2M (juvenile)
9 kg
Captive-born
Calgary Zoo, Alberta, Canada
Known history

**Preparation:**
- Quarantine (incl. COVID), husbandry, introduction protocols and intervention chart
- Previous medical and behavioural history
- Adjustments to quarantine area, holding quarters & habitat (Fig. 2)
- Name unchanged

**Arrival: mid-April 2021 AM**
- Priorities during quarantine:
  - Refer to female’s
  - Training (same cues as with female): bridge, target, shift, crate (for transfer)

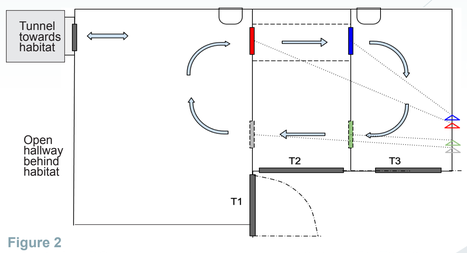


**Figure 2**
Layout of NARO holding quarters which include 3 stalls (T1, T2, T3). Dotted lines represent door handle to guillotine door cables; dash-dotted lines represent door direction; and dashed lines represent modifications made for male otter’s arrival. Guillotine doors are labelled by color. Blue arrows demonstrate an example of how the otters rotate through stalls.

**Figure 3**
(Left) Clear, acrylic, partial-cylindrical tunnel, used to train voluntary IM and SC injections of NAROs.
(Top right) Lollipop sticks used to train target.


- Step 1a - **Olfactory** (post-quarantine)
  - Exchange of odors (stool, bedding, enrichment items)
- Step 1b - **Auditory**
  - Female in habitat
  - Male transferred to holding quarters (Fig. 2)
  - Fed before intro, then simultaneously, with empty stall between them
- Step 2 - **Limited visual**
  - Step 1 repeated but in adjoining stalls
- Step 3 - **Full visual and limited contact**
  - Certain visual + tactile barriers removed
  - Select enrichments offered simultaneously
- Step 4 - **Shared space with rotation between habitat & holding quarters**

  **Steps 1-4 completed with positive interactions before proceeding. Note, female not in estrus**
- Step 5 - **Physical**
  - In holding quarters:
    - > Experienced personnel and veterinarian on-site
    - > Tools available if altercation (food, nets, brooms, crate, water hose, sound alarm, intervention chart)
    - > Contact-time based on behavioural observations. Goal to separate individuals on a positive note.
  - Gradually extended daily; non-food enrichment items offered
  - In habitat + holding quarters:
    - > Absence of visitors
    - > Access to habitat one after the other (distance)
    - >Team members positioned on both sides with tools


- Presence of visitors
- Access to all habitat spaces (incl. den, hideaways, den boxes)
- Feedings on-exhibit:
  - One keeper per individual to start
  - Fed at opposite ends; gradually reduced distance
  - Food-based enrichment items
- Training sessions together


- Bridge established
- COME & recall (bell)
- TOUCH with colored lollipop target (DeLong et al., 2019)
- Voluntary IM & SC injection (Fig. 3)
- STEADY
- STAND
- SCALE

**In progress:**
- MOUTH
- Nail trim
- Tail present (desensitisation)
- STATION (habitat & using shape/color marker)

**The work of our peers, such as Reed-Smith, J. et al., is extensive and we are grateful for the NARO keeper community. The introduction of our 1.1 otters is well documented, and through our experience, hope that our work will be used as a resource and tool that other institutions can use and implement with their otters. Although some of the challenges we faced were unique to the social-economic-health status of our time, our methods can be employed broadly.**
**Ultimately, we are *United keepers uniting otters throughout institutions-united,* in other words *…collaborotters***

## RESULTS

- **Successful introduction and maintenance of 1.1 NAROs; reproduction remains an objective**
- **Behavioural:**
  - Female initially timid (9 months alone); became dominant over male
  - Male aversive to habitat and visitors’ presence (reared during COVID)
  - Several husbandry behaviours rapidly trained; in turn, improved animal welfare (Fig.3)

**TOTAL INTRODUCTION = 54 days**
- **Olfactory (14 days): male displayed curiosity and tactile interest; female’s interest was neutral**
- **Visual (7 days):**
  - Ate calmly in the presence of the other
  - Vocalisations by male (mostly chirps & squeaks) and female (creeks and some blows)
  - Male scratched and pushed the guillotine doors between him and female; Female would lunge towards male
- **Physical (19 days):**
  - At first, female seemed less receptive: lunged & blocked male’s entry into habitat. Male given more time to acclimate alone.
  - Male’s vocalisations evolved to mosty buzzy grunts & some chirps
  - Later, allo-grooming, nuzzling, wrestling in/out of the water, some anal-anogenital sniffing, some mounting
  - (+5 days) Together during the day with access to HG (1 day) but separated at night
  - (+4 days) Access to den
  - (+10 days) Isolated together in habitat during the day, given access to holding quarters at night
- **Acclimatization towards 24/7 isolation in habitat (14 days)**

## CONCLUSION

**CHALLENGES**
- **Movement of animals (*Migration*)**
- **Movement of staff (retirements, new keepers)**
- **Staff with different levels of experience**
- **Grand reopening of the Biodôme (collaboration with management and education)**
- **New individuals with no animal-keeper relationship**
  - Wild-caught female with limited human contact
- **COVID-19 pandemic**
  - Health and safety of animals and staff
  - Quarantine husbandry, order of contact with other mammals (biomedical risk)
  - Captive-born male with limited visitor contact
  - Training: modified bridge (N95 mask)
  - Transportation (e.g. permits)
  - Skeleton staff; limited technical services/trades

**KEY POINTS OF SUCCESS**
- **Animal welfare and safety are at the foreground of our decision-making**
  - Research and understanding of NARO’s and the individuals’ needs
  - Human-animal bond; build trust
  - Incorporated training and enrichment rapidly
  - Applied positive reinforcement
- **Team collaboration and frequent communication (animal care team, education)**
- **Administration’s support and patience**
- **Informative, time-sensitive decision-making**
- **Use of monitoring equipment**
- **Approved protocols used as a solid foundation**
- **Flexibility and team consensus for adjustments as needed**
- **Used resources available to us**


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## CONTACT INFORMATION

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Communauté métropolitaine de Montréal · Montréal · espace pour la vie montréal biodôme

**Artificial intelligence in monitoring animal identification, health, & behaviour**

Dr. Jenna V. Congdon, Toronto Zoo, jcongdon@torontozoo.ca

Modern zoos, like the Toronto Zoo, are at the forefront of efforts to save species from extinction, and to ensure that animals in their care enjoy enriched, healthy lives in species-typical environments. Research on animal behaviour is a vital part of these efforts, however, this is typically achieved by scientists collecting real-time data in a fairly lengthy and tedious process. Together with our partner organization, the technology company EAIGLE Inc., we have created artificial intelligence (AI) capable of mass data collection, which will provide 24/7 animal monitoring to greatly improve animal welfare outcomes, monitoring where the animals are, what they are doing, and with whom in their social group they are interacting. This will allow for change of management and environment to improve welfare outcomes. We will report on the function and application of this technology with regards to animal health and welfare, successes in training with Toronto Zoo orangutan footage, as well as the challenges faced in developing innovative technology. In addition, we will share what we have learned about connecting with industry partners, and how to navigate assembling a team to tackle a project effectively.

# Artificial intelligence in monitoring animal identification, health, & behaviour

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## Introduction

- Technology for monitoring non-human lives has advanced to be smaller, more affordable, and highly accurate.
- Types of technology include:
  - *Accelerometers*
  - *Drones*
  - *Radiotracking & GPS collars*
  - *Camera traps*
  - *Artificial Intelligence (AI)*
- Primary purposes for technological advances:
  - *Monitoring health*
  - *Differentiating between individuals*
  - *Tracking behaviours*

## Current Limitations & Proposed Novel Technology


**Figure 1. An image of EAIGLE's original artificial intelligence, identifying the number of people in a room (top left), monitor individual body temperature (top center), and flag suspected cases (top right) of COVID-19.**

*Current Limitations*:

- Current technology is not compatible with many species.[1]
- Evidence suggests wearable devices affect individuals' behaviour.[2,3]
- *No* current camera technology is capable of collecting all types of data remotely.

***Objective***: Training AI to collect information on zoo animals' location, identity, and behaviour in order to monitor and improve individual welfare, provide advanced enrichment, and for 24/7 mass data collection to aid in scientific research.

## Results

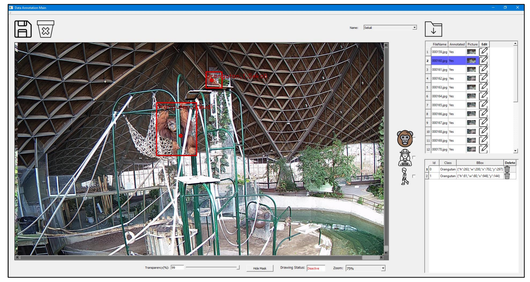


**Figure 2. An example of an annotated image of training the artificial intelligence (AI) model to identify Sumatran orangutans. The displayed tool allows for a choice between annotating orangutan vs. zookeeper vs. guest, and identification between the six orangutans.**

**Monitored Behaviours:**
Foraging
Brachiation
Locomotion
Fiddling
Scanning
Patrolling
Hiding
Inactivity
Urination
Defecation
Object Play
Object Manipulation
Agitated Movement
Affiliative Behaviour
Agonistic Behaviour
Keeper-directed
Self-directed
Baby-directed
Tech-directed

**Study species**:
Sumatran orangutans
(*Pongo abelii*)

**Figure 3. Screen capture of the AI detecting an orangutan. Characteristics include facial details, hair colour and consistency, etc.**

**Figure 4. A blueprint of the indoor orangutan exhibit study area. The location of each of the five (5) cameras are indicated above in red. Note: The moat is indicated in blue (bottom).**

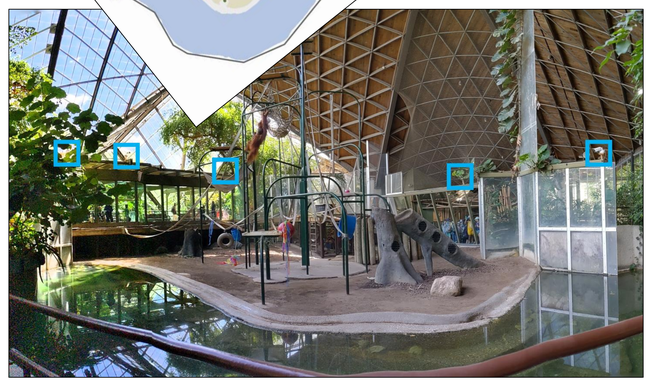
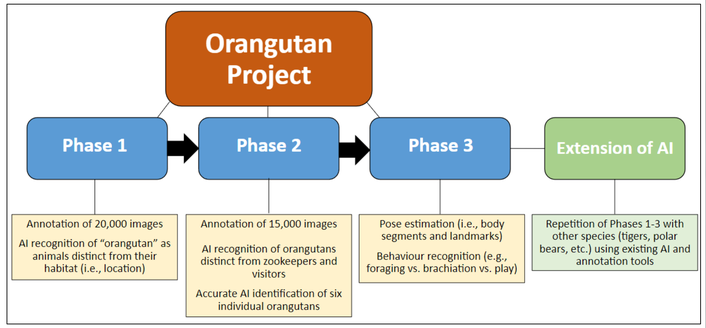


**Figure 5. A panoramic photo taken from the edge of the moat at Toronto Zoo's indoor orangutan exhibit. Blue boxes indicate the location of each of the five (5) cameras around the perimeter of the enclosure.**

## Conclusions & Future Directions




Our proposed novel AI addresses a current gap in technology for unobtrusive monitoring, collecting a wide-range of information that can ultimately inform:

- Where animals spend their time
- How to rearrange enclosures to be more suitable, comfortable, and cognitively stimulating
- How to further improve enrichment
- How to decrease any detrimental impacts incurred

Once the AI is fully validated, we propose extending this project to record and analyze the behaviours of other critically endangered non-human animals, such as polar bears and Sumatran tigers.

## References

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## Acknowledgements

Special thanks to Ezekiel Gading, Mahdi Masousi, & Toronto Zoo keepers for their contributions.

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**Infrared Thermography for the Modern Zoological Facility**

Janel Lefebvre, African Lion Safari, jkuska@lionsafari.com

The potential value of infrared thermography (IRT) has begun to be recognized in the zoological world with the advance of the technology and a decrease in cost associated with equipment. African Lion Safari has been integrating IRT into our research, conservation, husbandry and veterinary care programs since 2018. While the technology is similar to a point and shoot camera, thermography does require the user to recognize some key considerations when using the technology. Understanding the factors that can impact the accuracy of a thermal image is imperative to obtaining inferable results. Considerations include distance to object, ambient conditions and animal behavior, which can be accounted for when analyzing thermal images. We will present results from a variety of our projects, ranging from tracking estrus cycles, monitoring pregnancy and adaptation to a temperate climate, with the intent of highlighting the pros and cons associated with use of the imagery in a modern zoo.

# Infrared Thermography in the Modern Zoological Facility

Janel Lefebvre – Research and Conservation Assistant, African Lion Safari, Cambridge, ON, Canada
Contact: jkuska@lionsafari.com

## Introduction

**What is Infrared Thermography (IRT)?**
- Digital imagery of emitted thermal radiation converted to a surface temperature.

**Background**
- IRT is widely used in husbandry in the agricultural industry.
- It is gaining interest in zoological facilities due to its non-invasive nature.
- Validation is needed for individual species, and uses.
- African Lion Safari is integrating IRT into every-day animal care.

**IRT can help:**
- Detect inflammation and injury
- Monitor treatment efficacy
- Monitor cryptic species
- Track estrus and ovulation
- Confirm and monitor pregnancy

## Methods

**Hypothesis: Based on the success in the agricultural industry, IRT is predicted to be a beneficial tool in husbandry and veterinary care in zoological facilities.**

- We use two Teledyne FLIR models in thermography research:

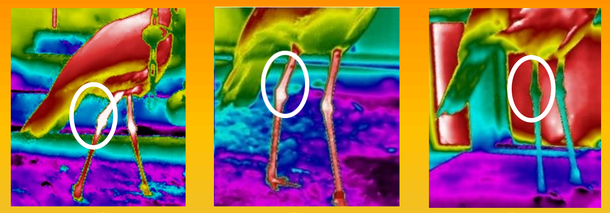
**FLIR T540**
- Research grade
- High resolution
- Still image and video modes

**FLIR ONE PRO**
- Phone attachment
- Lower resolution
- Cost effective
- Still image only


**Research Program**
- Focal species include elephants, rhino, lions and birds.
- Study design and analysis conducted by trained expert
- Collaborative implementation by staff, veterinarians and researcher
- Staff training and support provided as required.
- Images analyzed by trained expert using specialized software
- Results disseminated in layperson reports and used for manuscripts in peer-reviewed journals
- We are working to create a network of IRT researchers within the zoological community

## Results

**Detecting and monitoring inflammation**



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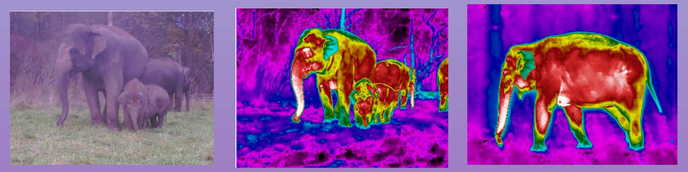
1. Keepers noted the Seriema displayed weakness in the right leg. IRT identified increased surface temperature in the leg, indicative of inflammation.
2. IRT was used to monitor the bird while receiving treatment. Images suggested improvement.
3. Images indicated a decrease in the surface temperature following treatment. Keepers noted improvement consistent with results suggested by IRT.

**Monitoring cryptic species**

- Bongo prefer dense shrub and shade where they are hard to locate and monitor (left).
- IRT images easily detect animals (right), which allows keepers to conduct daily census and remote health checks for animals maintained in the reserves.

**Reproductive status**



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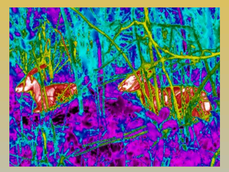
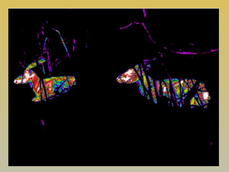
1. Tests underway to monitor ovulation and pregnancy in multiple species.
2. Results suggest reproductive females present unique thermal profiles.
3. Surface temperatures of mammary glands is increased while nursing

## Discussion

**Benefits**
- IRT is a tool that has the potential to increase animal care in zoological facilities
- The non –invasive nature makes it ideal for gaining valuable information while allowing the animal to continue its normal routine
- Can provide key insights that aren't visible to the naked eye

**Drawbacks**
- Research grade technology is costly
- Validation is required for the zoological setting
- Many factors can effect the image (e.g. distance, solar radiance, animal behaviour), *which must be documented and accounted for to minimize error*
- Software is required to analyze thermal images for conclusive results





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1. Image as shown on camera playback and raw file.
2. Same image manipulated in software for a clearer view.

## Conclusions

- Integration of IRT into animal care has improved our ability to monitor and care for the animals in our care, including veterinary care.
- Studies must be carefully designed and integrate validation.
- The value of IRT is enhanced through communication and cooperation with animal care staff and veterinarians
- While the technology is accessible to the layperson, research staff need to conduct analysis and ensure results are correctly interpreted.

**Acknowledgements**
I would like to thank the continual efforts of the animal care staff, Managers, veterinarian staff and research team at African Lion Safari for their assistance in research and validation efforts, and for always welcoming new ideas.

**Using Physiotherapy to Manage Pain and Mobility in a Babirusa with a Pre-Existing Injury**

Laura Huculak, Toronto Zoo, lhuculak@torontozoo.ca

Olive is a 12-year-old female North Sulawesi babirusa who came to the Toronto Zoo in 2011 on a breeding recommendation. Unfortunately, during transport Olive suffered an injury to her hip and right hind leg that has affected her use of this leg ever since. Although initial surgery allowed Olive to be well enough to breed, her condition began to further deteriorate in 2017. After a second surgery in 2018 to help increase the range of motion of her leg, zoo vets suggested physiotherapy as way to build up and maintain Olive's use of her leg. Keepers began physiotherapy in early 2019. It was important to make this process rewarding enough for Olive to voluntarily participate despite some of the exercises being potentially uncomfortable for her. Keepers chose to use tactile reinforcement in a protected contact scenario where Olive had the space and freedom to leave the session at any time. Since beginning this training, keepers have been able to introduce more exercises while also progressing on the initial exercises. Olive's mobility has improved in this time. It is difficult to know if this is from physiotherapy or due to other factors, such as her surgery or adjustments in medications that also occurred over this time. Despite this lack of certainty, keepers feel the physiotherapy training has improved Olive's welfare in additional ways. For example, increasing Olive's confidence, strengthening her trust in her care team, and allowing keepers to better observe and treat other conditions as they arise.

# Using Physiotherapy to Manage Pain and Mobility in a Babirusa with a Pre-Existing Injury

By Laura Huculak & Elise Schembri Swann, Indo-Malaya Keepers, Toronto Zoo

## Background

- Olive is a 13-year-old female North Sulawesi babirusa (*Babyrousa celebensis*) who was injured on route to Toronto in 2011. She presented as lame on her right hind leg.
- Surgical removement of her dislocated right femoral head allowed Olive to live a relatively normal life for a time. She had a barely perceptible limp and successfully raised a piglet.
- In 2017, her lameness appeared to be getting worse and she was no longer able to fully extend her hip. She had almost no use of her leg, either from pain or a physical inability.
- To improve her range of motion, Olive underwent a surgical debridement of the remnants of her right hip joint in September 2018.

## The Problem

- Three months after Olive's debridement surgery, she was only using her right hind leg about 1 step out of every 3.
- When walking her toes did not fully extend -likely due to non-use.

## Training Objectives

- To increase the use of her leg, veterinarians and keepers discussed introducing Olive to a light physiotherapy program with the goals of:
  1. Improving mobility of the hip with a hip extension stretch.
  2. Decrease contraction of the toes with a toe extension stretch.
  3. Increase blood flow to the hip and right hind leg and help manage and reduce pain with massage.

## Training Methods

- Training began in January of 2019. At this point, Olive was already lining up at a fence and allowing keepers to rub her hip/leg.
- Keepers progressed from massaging the leg/hip to gradually applying pressure to her leg/foot for stretches.


**Trainer 1 focusses on exercises**

**Trainer 2 reinforces Olive**

- We chose to use protected contact where keeper safety could be maintained, and Olive had the freedom to leave a session. This was important given the potential for discomfort.
- Positive reinforcement was used with keeper contact (scratches) as the reinforcer.

## A Typical Physiotherapy Session

- Ideally starts after Olive has been up and moving around and muscles are already warm. A hot compress is sometimes applied to help.

**Massaging inner & outer thigh of affected limb**

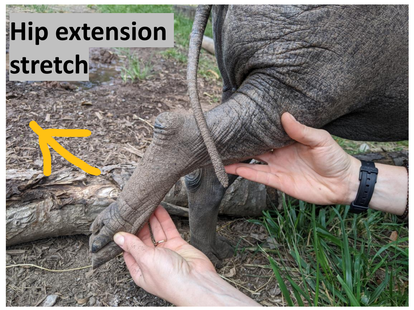
### Massage

- Next, we apply gentle stroking massage which can decrease pain and muscle tension, reduce inflammation, and increase lymphatic drainage in her hip.
- Massage of her unaffected limbs is also performed to help compensation limb tension and correct muscle balance

**Feeling for knots along her spine with a massage ball to help.**

### Stretches

- We start with easy stretches, extending 75-80% of her total range and hold for 10-20 seconds. We then progress to deeper stretches pushing until we feel mild tension and holding position.



**Hip extension stretch**

**Toe extension stretch**

**Hind leg forward stretch**

### Cold Therapy

- Cold therapy can be good when dealing with swelling and inflammation, particularly after exercise/ therapeutic exercises or after a flare up when she is particularly sore.
- Cold therapy can absorb heat from the irritated area which reduces the metabolic rate, keeping inflammation down.
- We use a flexible covered cold pack and hold it to her hip for 5-10 minutes.

## Results

- **Increased use of leg**: She uses her leg almost all of the time when she is walking and sometimes uses it when running.
- **Hip extension:** At first, we were only able to hold this stretch for a few seconds before Olive walked away. Olive will now allow us to hold it for up to a minute. Initially, we were also only able to extend her leg back by a couple of degrees. Now we are able to extend it back almost fully.
- **Toe extension:** She is walking better on her toes and we are able to feel them extend further during the stretch.
- **Muscle gain:** While there is still marked muscle atrophy on her right hind leg, her annual veterinary exams report that this is less severe than it was prior to the start of her physiotherapy program.

## Conclusions

- It is difficult to know if her improvements are from physiotherapy or due to other factors, such as her surgery or adjustments in medications that also occurred over this time. Despite this lack of certainty, keepers feel the physiotherapy training has improved Olive's welfare in additional ways, such as:
  1. Increased confidence and stronger bond with her keepers.
  2. Keepers are better able to observe and treat other conditions as they arise. For example, being able to treat and prevent cracks on her feet in winter with topical treatment.
  3. OLIVE APPEARS TO ENJOY PHYSIOTHERAPY!! We conclude this based on her willingness to participate and her relaxed state during sessions (ex. yawning, closing eyes, and stretching on her own).

## Future Goals

- Use of video to watch progression and monitor progress and use of leg
- Take measurements around each of her hind legs to track muscle growth and loss
- Veterinarians and keepers have discussed the possible use of laser therapy as an additional treatment.

## Acknowledgements

- We owe many special thanks to Dr. Pauline Delnatte, DVM, Staff Veterinarian at the Toronto Zoo, for the care and support she has provided to both Olive and her care team on this journey.
- We would also like to thank Dr. Brendan Ringwood, DVM, who performed both of Olive's surgeries, and Dr. Conny Mosley, DVM, who has consulted on Olive's case providing advice and feedback on her pain management and physiotherapy program.

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**Preparing 0.1 Southern White Rhino for a Dental Procedure**

Scout Sinnett, North Carolina Zoo, schuylerscout@gmail.com

By the end of winter 2020, keepers noticed that Abby, a Southern White Rhino, had a sharp tooth on the top left side of her mouth. She was eating normally but her left eye was watery. A decision was made by keepers and vet staff to anesthetize to take care of it. There is a rhino barn all rhinos are used to going to, but this area was deemed not easily accessible for all involved; keepers, vet staff, and ASAR (animal search and rescue).

The annex is a separate barn, with three paddocks, currently housing retired 0.1 rhino, Olivia. The space has what is called the "Sandrock paddock" that has horizontal cables and plenty of space to maneuver large equipment. There are two main issues:

1. Abby has never been to the annex before
2. Bonnie, another 0.1 Southern White Rhino, has an attachment to Abby and separating the two may be difficult, as white rhinos operate in herd bonds.

Keepers had to not only train Abby rhino to leave the comfort of her 40 acre habitat and her small herd, but they had to train Bonnie to remain calm with Abby's absence. With operant conditioning, keepers not only trained Abby to enter the annex by herself, but to enter a chute to put on a sling and received the injection, then walk out into the Sandrock paddock for the procedure.

# Training 0.1 Southern White Rhino for a Dental Procedure

Scout Sinnett, Jade Tuttle, Anna Hinson, Tamara Trull, Stacey Weatherly and Lane Batot

*Abby*

**Abby** is a 16-year-old southern white rhino at the North Carolina Zoo. In December 2020, keepers noticed that her left eye was watering and her breath smelled unusual. After investigating, a sharp tooth was found on the top left side of her mouth. To properly take care of it, it was decided that she should be anesthetized.

*Abby's Tooth*

Abby weighs 5,660 pounds, so staff required help from Animal Search and Rescue. ASAR has a mobile tripod hoist capable of lifting Abby from a sling in the case she went down in an undesirable location. (Abby is already trained to wear this sling.) The challenge became where this procedure would take place. The rhino barn is too cramped and there is not space for all of the people and equipment needed for the procedure. The annex retirement barn, however, has a sandrock paddock that is spacious and mostly flat.

**The next problem is twofold:**

**1.** Abby has never been to the annex
**2.** She is part of a group including 0.3 other southern white rhinos, (Natalie, Nandi, and Bonnie,) that have a close bond. Bonnie has an attachment to Abby, so keepers had to ensure she was calm once Abby is out of sight during the procedure and recovery.

*Dr. Mike Lowder*

*Abby in her sling*

**Training Methods: (need 4+ keepers)**

- Bring 0.4 moms and calves into our holding boma so keeper(s) can focus on Natalie, Nandi, and Bonnie.
- Keep 0.3 rhinos focused on keepers at the fence with food, (alfalfa, orchard grass, timothy cubes,) and attention.
- One keeper navigates the truck, one sits at the back the truck, and a third is at the annex chute ready to receive Abby.
- Keeper in the back of the truck is equipped with a target stick and treats to lure Abby.
- Once Abby is secure in the chute, 0.7 rhinos are led away with orchard grass hay towards opposite end of the habitat, keeping Bonnie busy with food and her other companions.
- Abby is led from chute to the barn into another chute where a sling is put on.
- Abby walks out into the sandrock paddock with the sling on and line up against the fence for injection.

*View from the annex chute*

**Results:**

**Abby** was brought to the annex the day before her procedure for fasting overnight. Morning of, we lined her up in the chute and she allowed keepers to put on her sling without a problem.

ASAR had requested we add extra straps they had brought to help with the weight load, Abby was mostly ok with the additional straps but due to her size, the carabiners clinked against the bars of the chute and made her nervous. In the end, she did not stand for the injection. She was darted in a stall and let out into the sandrock paddock, where she went down and keepers and staff helping with the ASAR equipment were able to get in and get her lifted and adjusted into position with relative ease. Bonnie was calm and hanging out with her other companions on habitat.

*__Abby__ was too tense to open her jaw and due to complications, vets made the call to wake her, she was released from the equipment and all materials were taken out of the paddock within minutes. Abby is healthy and happy. Despite the result not being preferred, her training made the entire process much easier for everyone involved.

****Acknowledgments:**

**Grasslands Team –** Jade Tuttle, Anna Hinson, Tamara Trull, Stacey Weatherly and Lane Batot

**North Carolina Zoo Veterinary Team and Veterinary Techs –** Dr. JB Minter, Dr. Tim Georoff, Dr. Megan Cabot, Dr. Alissa Mones, Heather Scott, Kelly Tardif, Sam Knowles and Dave Hill

**Rhino Dental Specialist –** Dr. Mike Lowder

**Anesthesiologist –** Dr. Julie Balko

**ASAR –** Eric Thompson, Carla Lewis

**North Carolina Zoo Staff –** That came to help with the equipment, Nancy Kauffman, Deb Miller, Jason Balder, Nicole Barr, Bob McCrory, Kelly Murphy, Jason Joines, Cathy Mingee, Hannah Tulloch and Jay Stutz

**Special Thanks** - *Brian Petty, Frank Perkins, Hannah Tullock, Julianna Villarosa*

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North Carolina Zoo

**The Positive Impact of Mysids on Lake Ontario's Repopulation of Deepwater Cisco**

Samantha Brijbassi, Toronto Zoo, samanthabrijbassi@gmail.com

Deepwater cisco are a food source for predatory species of fish in the great lakes. The population of deepwater cisco in the 1900s was abundant, as these fish did not have any natural predators. They experienced commercial fishing exploitation and went extinct in the 1940s. This extinction negatively impacted the food chain and ecosystem, so actions are now being taken to cultivate and reintroduce them to the great lakes, as they are an important food source for other freshwater fish. Bloaters are important trophic integrators because they feed on different plankton as they vertically traverse the water column throughout their life cycle. The OMNRF has been breeding deep water cisco for several years at the White Lake Fish Culture Station, their focus is on trying to improve reproductive performance of broodstock held in captivity by altering feed formulations. The captive Bloater egg production and quality have been abnormally low, limiting successful restocking, despite the extensive research and practices that exist. Researchers believe that the use of fish feeds that are formulated for piscivorous species being fed to broodstock is directly correlated with nutritional deficiencies that cause poor sperm and egg quality. Controlled experiments have compared and contrasted wild versus captive Bloater diets and evaluated the impacts of diet and nutrition on the growth and survival of the fry. The supplementation of Mysids is helpful for introducing them to wild feedstuffs, the fatty acids, protein, and carotenoids are linked to higher survival rates and superior gamete viability and quality.

# THE POSITIVE IMPACT OF MYSIDS ON LAKE ONTARIO'S REPOPULATION OF DEEPWATER CISCO

Samantha Brijbassi, Tim Drew, Justin R. Chan, Zoe Zrini, Flavia M. Damasceno, David Huyben and Dominique P. Bureau
Dept. of Animal Bioscience, University of Guelph & Ontario Ministry of Natural Resources and Forestry

## INTRODUCTION

Deep water ciscoes (Coregonus spp.) are species that inhabit the Great Lakes and are an important food source for predatory fish species, such as Lake Trout. Bloaters (*Coregonus hoyi)*) were driven to extinction by over-exploitation and environmental degradation of the Great Lakes. Efforts in Canada and the USA are underway to re-introduce deep water cisco (Coregonus hoyi) in Lake Ontario by breeding brood fish in captivity. The reproductive performance of captive fish is poor and may be related to nutritional deficiencies because they are fed salmonid diets. Since these fish feed mainly on zooplankton in the natural environment, it has been hypothesized that supplementation of the diet with krill or mysis could improve the fecundity of these animals.

## EXPERIMENTAL APPROACH

- At the White Lake Fish Culture Station, bloater broodstock were fed various diets with different ingredients and nutritional values
- Commercial diets were fed with automatic feeders and items such as frozen krill were hand-fed
- Egg and brood tissue samples were taken during the spawning period for further analysis and eggs were incubated in egg jars
- The measurements such as egg size and quality, viability and size of larvae, and survival were analyzed

Eye-Up Rates in Bloater Eggs from Broodstock of Different Origins or Year Class Fed Different Diets

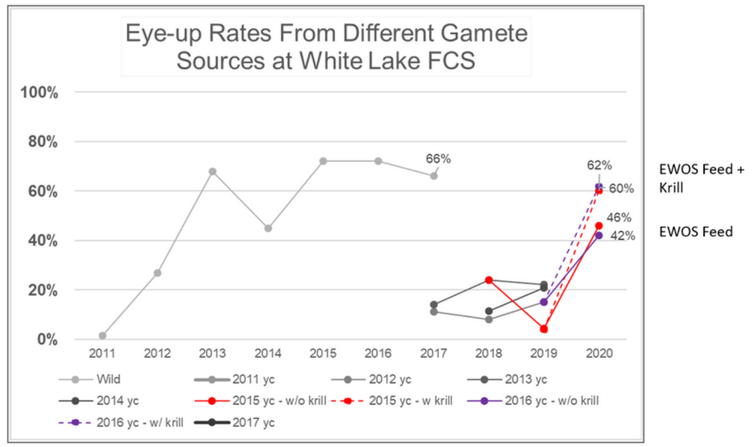



Figure 1. Eye-up rate of eggs from wild and captive deep water cisco female over time and in response to different treatments

**Table 1**. Summary data from the bloater diet pilot study. Overall mean values ± SEM.

| | Ewos | 34% Krill | 67% Krill | 34% Mysis | 67% Mysis |
|---|---|---|---|---|---|
| **Bulk Sampling** [1] | | | | | |
| *Weight* | | | | | |
| Initial (g) | 63.9 ±1.4 | 63.1 ±1.3 | 65.2 ±0.7 | 62.5 ±0.5 | 63.1 ±0.5 |
| Final (g) | 71.9 ±0.9 | 72.9 ±1.5 | 74.4 ±0.9 | 72.7 ±0.8 | 74.2 ±1.0 |
| Gain (g) | 8.0 ±0.6 | 9.8 ±1.4 | 9.3 ±0.7 | 10.3 ±0.3 | 11.2 ±0.5 |
| Gain (%) | 12.6 ±1.2 | 15.5 ±2.3 | 14.3 ±1.1 | 16.4 ±0.3 | 17.7 ±0.7 |
| **Individual Sampling** [2] | | | | | |
| *Weight* | | | | | |
| Initial (g) | 63.0 ±2.9 | 63.3 ±3.0 | 60.0 ±2.7 | 63.8 ±3.0 | 65.4 ±2.8 |
| Final Before Spawn (g) | 77.2 ±4.0 | 80.6 ±4.3 | 84.1 ±4.1 | 86.3 ±4.3 | 80.2 ±3.7 |
| Gain Before Spawn (g) | 14.2 ±0.5 | 17.3 ±7.5 | 24.0 ±4.6 | 22.5 ±4.9 | 14.9 ±1.6 |
| Gain Before Spawn (%) | 22.6 ±0.9 | 29.0 ±13.0 | 40.8 ±9.2 | 35.5 ±7.8 | 23.0 ±3.3 |
| *Condition Factor* | | | | | |
| Initial | 0.84 ±0.01 | 0.85 ±0.01 | 0.83 ±0.01 | 0.85 ±0.01 | 0.84 ±0.1 |
| Final Before Spawn | 0.88 ±0.02 | 0.90 ±0.02 | 0.90 ±0.04 | 0.90 ±0.02 | 0.89 ±0.02 |
| Change (%) | 4.6 ±2.7 | 6.2 ±2.8 | 9.0 ±1.7 | 5.8 ±1.7 | 6.2 ±4.0 |
| *Spawners per Tank* | | | | | |
| Females (%) | 6.0 ±0.8 | 6.2 ±0.6 | 9.3 ±1.4 | 6.0 ±0.8 | 4.4 ±1.2 |
| Males (%) [3] | 7.8 ±2.1 | 7.3 ±1.0 | 8.4 ±1.0 | 6.2 ±0.6 | 6.0 ±1.7 |

## SUMMARY OF EXPERIMENTAL WORK CONDUCTED

- 2017- 2018: Comparison of wild broodstock vs. captive broodstock at the White Lake FCS in two year-classes (2012 & 2013 stocks)
- 2019-2020: Comparison of commercial feed and commercial feed plus frozen krill in broodfish from two year-classes (2015 & 2016 stocks)
- 2020-2021: Comparison of a commercial feed, frozen krill, or frozen freshwater m*ysis*
- 2021-2022:Comparison of commercial and custom complete feeds with and without krill
- 2022-2023: Comparison of commercial feeds - upcoming

**Reference: Mandrak, N.E. 2018. Recovery Strategy for the Shortnose Cisco (Coregonus reighardi) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ministry of the Environment, Conservation and Parks, Peterborough, Ontario.**

**CONTACT INFORMATION: SAMANTHA BRIJBASSI SBRIJBASSI@TORONTOZOO.CA**

## RESULTS

- The supplementation of krill in a first study had a positive effect on reproductive success (eye-up egg, Figure 1) but in a subsequent trial, krill and mysid shrimp supplementation did not appear to have beneficial effects (Ex: Table 1).
- Compositional analysis of diet, gonads, eggs and fish samples for fatty acids and carotenoids are being conducted to determine if some measures of reproductive success can be linked to certain nutrients

## CONCLUSIONS

Further research is needed to understand the nutritional requirements of Bloater in order to improve the success of restoration program for these species

**ACKNOWLEDGEMENTS: THIS RESEARCH EFFORT WAS SUPPORTED BY FUNDING FROM THE ONTARIO MINISTRY OF NATURAL RESOURCES AND THE GREAT LAKES FISHERIES COMMISSION. THE EXPERT ASSISTANCE AND DEDICATION OF THE PERSONNEL OF THE WHITE LAKE FISH CULTURE STATION IS ACKNOWLEDGED.**

**"Bear with us": Developing a strategy to safely perform laser therapy treatments on a large carnivore**

Kimmy McIntyre, Utah's Hogle Zoo, kmcintyre@hoglezoo.org

Photobiomodulation therapy (formerly known as low-level laser therapy) has seen increased use and success in treating arthritis-related mobility issues in exotic animals in recent years. Utah's Hogle Zoo currently employs photobiomodulation therapy techniques to treat a 0.1 Southern white rhinoceros and a 0.1 Hartsmann's mountain zebra with varying levels of success.

The Rocky Shores team at Utah's Hogle Zoo cares for a variety of North American species, including 1.2 wild-born rescued grizzly bears. One 0.1 grizzly bear has a rear left leg chronic limp. Medical records from a previous institution that housed the bear as a juvenile noted that the rear left leg bone is shorter than the rear right leg bone but were unspecified as to whether this was a result of a growth deformity or an injury. A medical work-up in May 2021 showed significant arthritis in the knee and surrounding area of that rear left leg. Current oral treatment includes a Cosequin supplement, resulting in no visual improvement.

Rocky Shores keepers are interested in attempting photobiomodulation therapy with the previously mentioned 0.1 grizzly bear. As this treatment has not been performed on a large carnivore at Utah's Hogle Zoo before, this will be a learning experience for both animal care and veterinary staff. This presentation will cover the process for planning how to do this therapy safely with a large carnivore and show all of the factors that the Rocky Shores staff will be taking into consideration (i.e. animal holding modifications, equipment modifications and desensitization training).

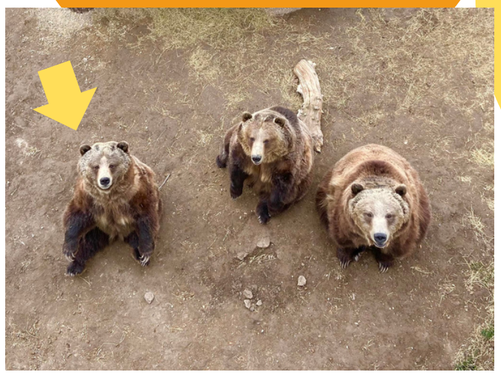
# Bear with us:

## Developing a plan to safely perform photobiomodulation therapy on a large carnivore

**Kimmy McIntyre, Rocky Shores Team, UHZ Hospital Staff**
**Utah's Hogle Zoo**
**Salt Lake City, Utah**

### The Patient:

0.1 grizzly bear "Dolly" has a rear left leg chronic limp as a result of either an injury sustained as a juvenile or a growth deformity.



### The Goal:

To relieve some of the symptoms of severe arthritis that are being observed in Dolly's rear left leg using **photobiomodulation therapy.**

### The Challenge:

UHZ has not done this type of therapy with a large carnivore before. **What do we have to do to perform this therapy safely and successfully?**

**Training "Dolly":**

1. Line up against the mesh of an indoor holding stall for proper positioning using pre-established "target" behavior
2. De-sense to photobiomodulation equipment (beeping noises, red light), bridging for calm behavior/indifference toward equipment
3. Touch de-sense to allow keepers to remove debris from fur (due to heat from laser, fur should be free of any debris that may catch fire)
4. Hold positioning for duration of therapy process (4-5 minutes)

**Animal Holding Modifications:**

Build a plexi-glass access panel (with an open space/window in the middle) to slide into a mesh panel slot to allow for safe, close contact of therapy equipment.

**Therapy Equipment Modifications:**

Modify a PVC pipe to use as an extender/sleeve for the photobiomodulation probe to help increase the distance between the staff member's hand holding the probe and the plexi-glass access panel opening.

**How does photobiomodulation therapy work?**

An infrared light is applied over the area to reduce inflammation, stimulate healing in soft tissue or to provide relief for acute or chronic pain issues.

**What is the latest update on how Dolly's therapy is going? Scan to find out!**