

ZB8.06 - Attachment 1
Part 1 of 2



**CONSERVATION PROGRAMS
AND ACTIVITIES REPORT**

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A VISION FOR THE FUTURE

Dolf DeJong, CEO



Did you know? Really... did you? As I finish my first full year as the CEO of your incredible Toronto Zoo, I continue to be amazed by the huge amount of Conservation work done by the team and our partners. Year-end reports like this are an amazing tool to review and reflect on the activities of the past 365 days and for us, that means looking back on how we have served the animals in our care, served their wild counterparts and how we connected our 1.2 million guests to how they can help with challenges nature is facing.

While budget and attendance are our most frequently discussed metrics of success, the projects and accomplishments included in this book make us equally proud. These wins for wildlife and nature would not be possible without the tremendous support from local partners, elected officials, our Board of Management, as well as our community. With the establishment of the Toronto Zoo Wildlife Conservancy in 2019, we now have new ways to connect people to our mission with the goal of increasing our financial resources to support conservation programs and projects to help transform our Zoo and grow the impact it can have. I am excited about these possibilities and our future fundraising efforts!

I am grateful to be part of your Toronto Zoo team and couldn't be more proud of the great work being done as conservation champions! Our Toronto Zoo has earned its reputation as a premier conservation organization and living centre for education and science—we have great people who are experts in their fields and bring passion, pride, talent, and experience together to inspire future generations to protect species and their habitats!

We are looking forward to the year ahead and the launch of our new Strategic Plan. This new 5-year plan will be building on these successes and charting a path to increase the profile of these projects, the health and future of our natural world and the animals living there depend on it



OUR VISION

Canada's national leader in saving wildlife to ensure the rich diversity of nature for future generations.

OUR MISSION

A living centre for education and science, committed to providing compelling guest experiences and inspiring passion to protect wildlife and habitats.

OUR VALUES

Excellence
Conservation
Innovation
Collaboration
Integrity
Passion

STRATEGIC GOALS

Goal 1: Conservation Impact
Goal 2: Guest Engagement
Goal 3: Governance
Goal 4: Financial Stability
Goal 5: Strategic Alliances
Goal 6: People
Goal 7: Understanding & Caring

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Visit torontozoo.com for more information.

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TORONTO ZOO IS AN ACCREDITED MEMBER OF CANADA’S ACCREDITED ZOOS AND AQUARIUMS (CAZA) AND THE ASSOCIATION OF ZOOS & AQUARIUMS (AZA)



Founded in 1975, Canada’s Accredited Zoos and Aquariums (CAZA) is a private charitable organization representing the country’s leading zoological parks and aquariums. CAZA is committed to the advancement of accredited zoos and aquariums as humane agencies of animal welfare, conservation, science and education. CAZA has 30 member institutions across the country who are Canada’s leading zoos and aquariums, all of whom participate in CAZA’s comprehensive accreditation program, abide by the Code of Professional Ethics , and meet the highest professional standards in animal care. CAZA member institutions also provide expert assistance and advice in animal investigations, partner with government and animal welfare agencies, and provide training to others.

Each year at CAZA’s annual conference, the accomplishments of its member institutions are celebrated with the CAZA Achievement Awards. CAZA recognizes its members in the fields of conservation, exhibit design, educational programming, professional development, and volunteer engagement. In 2019 the Toronto Zoo received the following CAZA Achievement Award:

Colonel G. D. Dailey Award for *ex-situ* species propagation for the Wood Bison recovery program

This award recognizes ex-situ propagation and management programs that contribute to the long-term survival of animal species or populations.

The Toronto Zoo has been involved in wood bison conservation since 1977 with captive breeding and reintroduction of animals back in the wild. Since that time, efforts from various organizations have resulted in the species being down listed from “endangered” to “threatened”. Ongoing disease concerns in remaining wood bison populations continue to threaten this species.

The Toronto Zoo’s accomplishment with the Wood Bison recovery program is not only a one-of-a-kind success in Canada, but one of the few programs in the wild to repeatedly produce calves from insemination. Furthermore, no other conservation species, or Zoo-based species, has been successfully inseminated with 35-year frozen sperm!



The Association of Zoos & Aquariums (AZA) is a non-profit organization dedicated to the advancement of zoos and aquariums in the areas of conservation, animal welfare, education, science, and recreation. AZA is the accrediting body for the top zoos and aquariums in the United States and seven other countries. AZA sets high standards and best practices necessary to be leaders and innovators in animal care, wildlife conservation and science, conservation education, the guest experience, and community engagement.

Every 5 years the Toronto Zoo must successfully complete a rigorous accreditation process in order to maintain its accreditation with AZA and CAZA. This includes undergoing a thorough review to ensure the Zoo has, and will continue to meet, ever-rising standards in animal care, veterinary programs, conservation, education, and safety.

The accreditation process includes a detailed application and a meticulous on-site inspection by a team of trained zoo and aquarium professionals. The inspecting team observes all aspects of the institution’s operation, including animal care, keeper training, safety for guests, staff and animals, educational programs, conservation efforts, veterinary programs, financial stability,

AZA’s Annual Report on Conservation and Science

Each year AZA publishes an Annual Report on Conservation and Science which summarizes the education programs, field conservation activities, green business practices, and scientific research of its AZA-accredited and certified related facilities. Submissions are reviewed by AZA’s Field Conservation Committee and Research Technology Committee, and must meet defined criteria.

Field conservation focuses on efforts having a direct impact on animals and habitats in the wild. Education programming includes those with specific goals and delivery methods, defined content and a clear primary discipline and target audience.

Mission-focused research projects involve application of the scientific method, are hypothesis- (or question-) driven, involve systematic data collection and analysis of those data, and draw conclusions from the research process.

Green business practices focus on the annual documentation and usage of key resources: energy, fuel for transportation, waste and water, as well as identification of specific green practices being implemented.

This annual report underscores what the AZA community accomplishes together.



In 2019, the Toronto Zoo submitted 71 field conservation and mission-focused projects for the 2018 publication.



CONSERVATION RESEARCH



HABITAT & SPECIES SPECIFIC RESEARCH

Saving the Massasauga Rattlesnake

The massasauga rattlesnake is Ontario's only venomous snake and is at risk of extinction. With expanding human populations, habitat alteration and fragmentation from development, and unfounded fear due to the many myths surrounding this animal, the population is declining.

To ensure the future existence of the massasauga in Ontario, the Toronto Zoo has been working with a wide range of partners and even initiated the massasauga rattlesnake conservation strategy in the late 1980s in response to increasing interest from the public about the species.

regarding population dynamics and animal behaviour, we are able to collaborate with many partners in Ontario as well as the United States to aid in the international recovery efforts for massasaugas. Our staff also provide recommendations for husbandry protocols of zoo populations throughout North America, to ensure optimal health of the snakes and encourage breeding efforts for the long term survival and fitness of individual animals and important genetic lineages. The Zoo's own massasauga rattlesnakes are also considered to be assurance

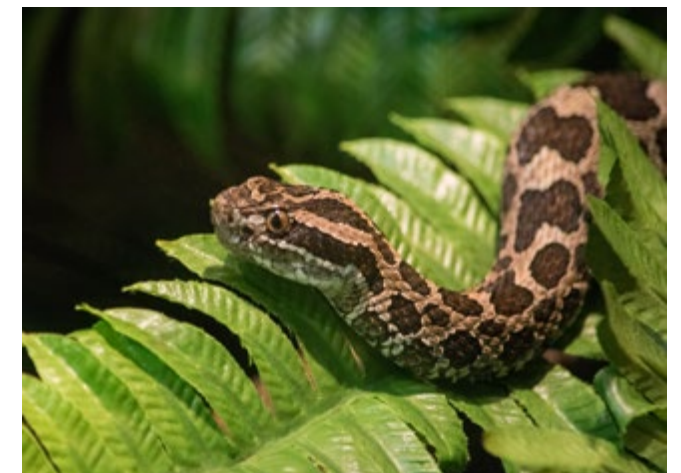
populations that may serve to augment or re-establish wild populations in the future. Ongoing studies are

helping to identify populations which may benefit from increased conservation efforts so that our contributions to the future of the massasauga rattlesnake can have the most meaningful impact.

As an AZA accredited zoo, we have been active members of the Massasauga Rattlesnake Species Survival Plan® (SSP) since its inception and have been assisting in long-term population monitoring in southwest Michigan. Each year the Zoo sends staff to participate in field surveys in hopes of better understanding the population dynamics (mortality, reproductive,

and population growth rates) of this snake population.

Over the years, we have produced a variety of outreach and education resources including informative posters, snake identifiers, guidebooks and stickers intended to demystify the massasauga rattlesnake and create a better understanding of these fascinating animals. The Toronto Zoo also hosts annual "Living with Rattlesnakes" workshops. This type of outreach is part of a study into the impact of the Zoo's educational presentations on long-term conservation actions for amphibians and reptiles. Attendees learn about the challenges facing the massasauga rattlesnake, the conservation efforts to save them, how the public can help, and even the snakes' biology and behavior. Guests also learn to identify the rattlesnake and other snake species that are similar in appearance. We also provide snakes on loan to Ontario conservation organizations that help spread the word about the importance of these animals.

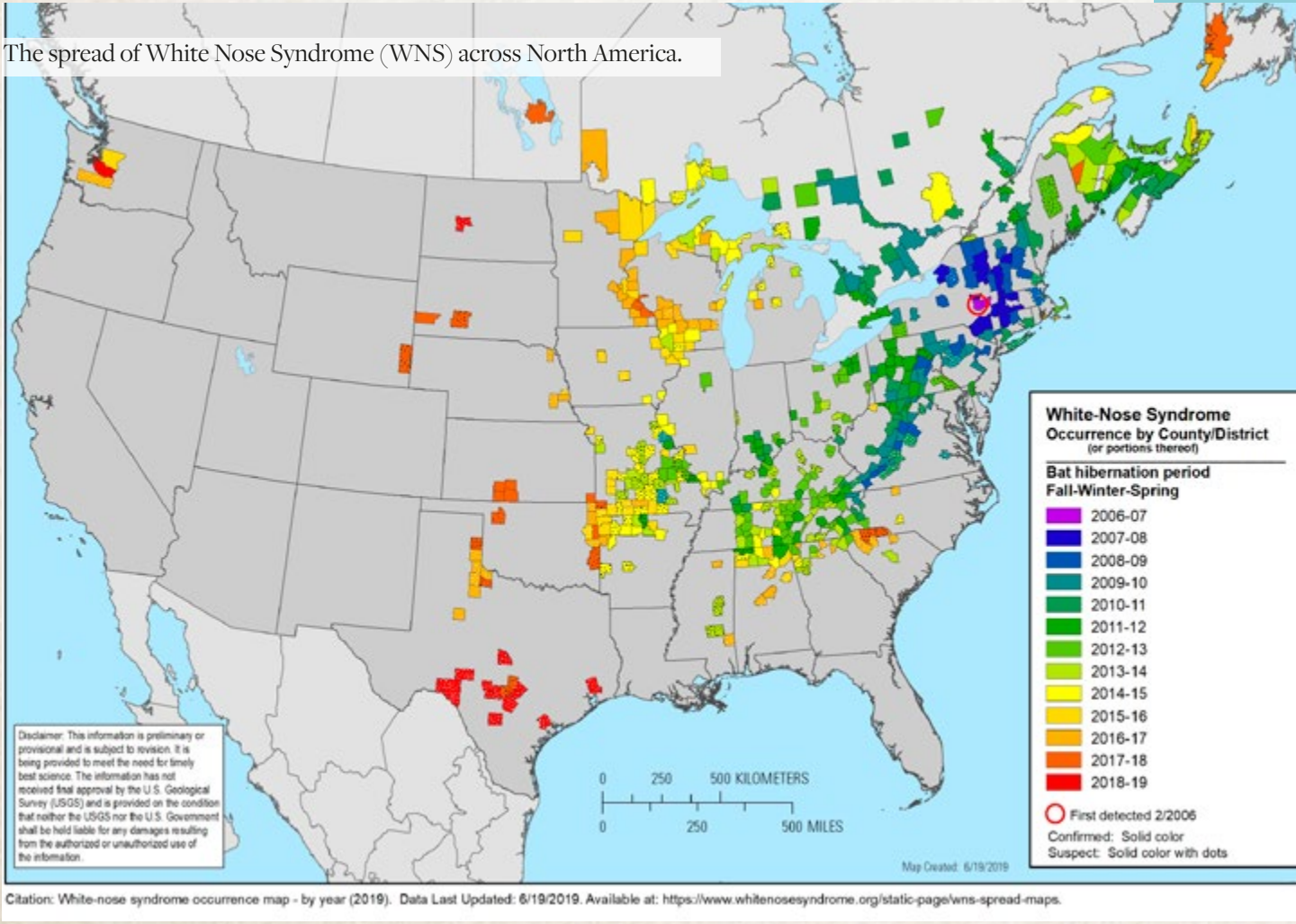


BATS

Native Bat Conservation Program

Program Overview

Bats in North America face considerable threat from habitat loss, wind turbines and White Nose Syndrome (WNS), a fungal disease introduced to North America by human actions, and first recorded in 2006. The fungus affects cave hibernating species and has caused the deaths of millions of bats. In Ontario, WNS affects four of the eight bat species, which have been categorized as endangered since 2012. The Toronto Zoo’s Native Bat Conservation Program is part of an international effort to conserve our bats! The program is growing, with a number of projects seeking to fill gaps in knowledge, conserve habitat, promote bats, and improve their public image.



HABITAT & SPECIES SPECIFIC RESEARCH

Monitoring Bat Populations in the Greater Toronto Area (GTA)

In 2017 the Native Bat Conservation Program was awarded \$211,171 by Environment Canada to fund a three-year project monitoring bats in southern Ontario, and in particular the Greater Toronto Area (GTA). With matching funds from the Zoo and our partners, the project budget amounts to more than half a million dollars! Our major partners for this project are Toronto and Region Conservation Authority, Georgina Island First Nation Community, Nature Conservancy of Canada, and Bird Studies Canada.

The project began in 2017 and continued in 2018 with acoustic monitoring at sites across the GTA. Using automated monitors to record the echolocation calls of passing bats, we are able to identify areas of high activity. We were even able to discern species and compare activity levels at different times. Through this monitoring, we were able to identify a number of sites of interest. In early 2019 our acoustic data led us to discover a brand new roost of endangered little brown myotis bats in suburban GTA. We used radio-telemetry to track these bats and follow them as they flew through subdivisions and foraged in tiny urban parks. This fascinating insight into bat behavior highlights the importance of monitoring them, especially in urban areas and as the GTA continues to expand.

Northern Myotis Sightings - Exciting Discovery in the Field

Toronto Zoo’s Native Bat Conservation Program continues to make exciting discoveries. The team was particularly enthusiastic to have identified several northern myotis (bats) flying around the GTA.

The northern myotis is one of three species in the myotis genus in Ontario and one of four endangered bats in Ontario, three of which are also federally endangered species in Canada. The classifications don’t end there, the northern myotis is also considered threatened by U.S. Fish and Wildlife Service, and these are very substantial protections for a bat that weighs less than a toonie.

“When we set out to do this project we had high hopes because we had recorded bat calls that made us think these species were here,” said Toby Thorne, Bat Researcher, at the Toronto Zoo. “However, there is no proof like a bat in the hand. In 2018 we captured four breeding female northern myotis, and four juveniles that were born that year. This demonstrates unequivocally that this rare and threatened species is right here in the GTA. It’s about the best result we could have hoped for.”

In 2019 the Zoo’s bat program was awarded approximately \$30,000 in funding through the United States Fish and Wildlife Service Small White Nose Syndrome Grants Funding Program to further investigate the population we discovered. With no published literature on this species’ habits in urban areas, our investigation of this suburban population is groundbreaking research and may be relevant for conserving this species across the continent.



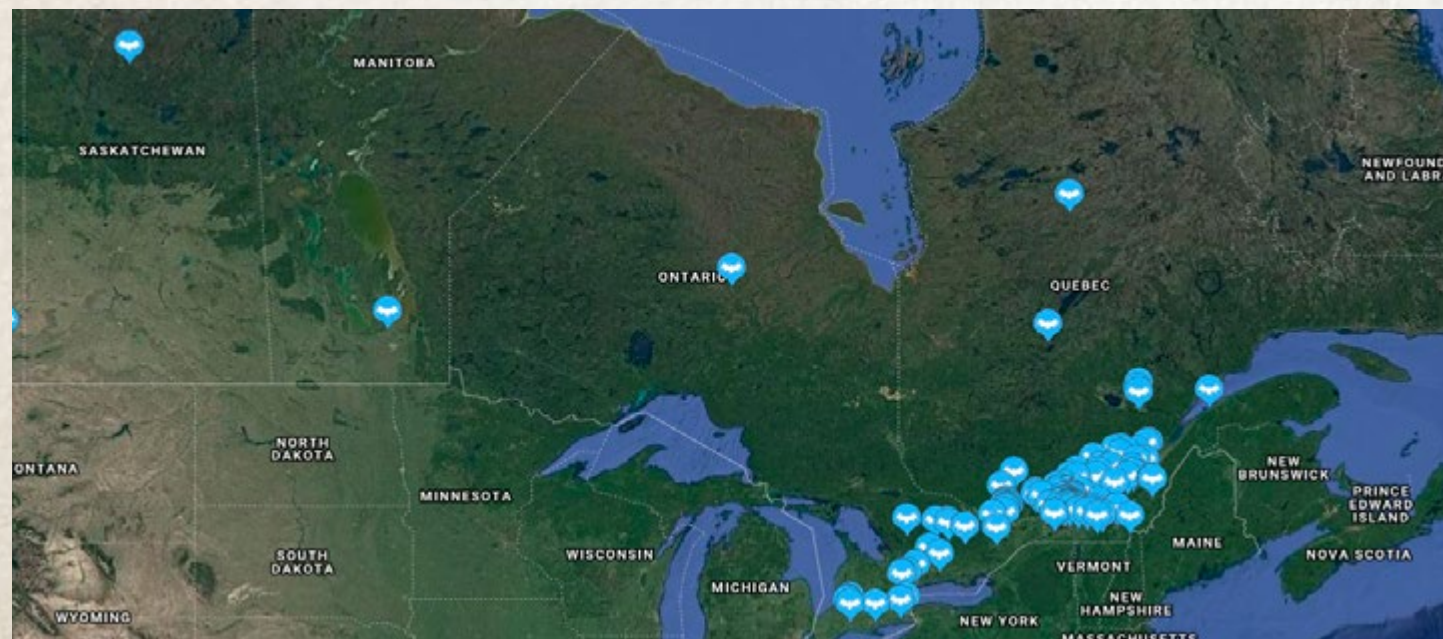
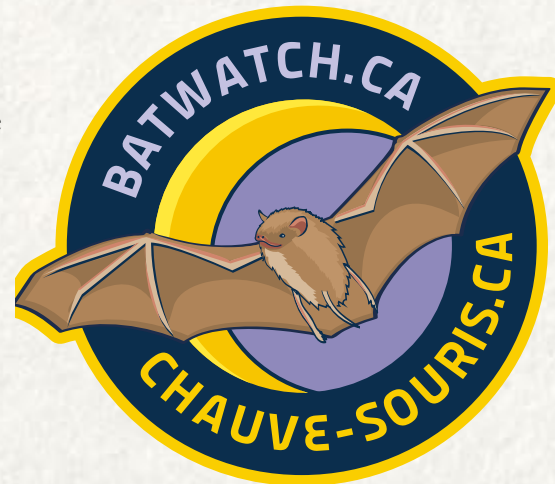
Bat Diversity in Rouge National Urban Park

Since 2015 the Toronto Zoo has partnered with Parks Canada to monitor bats in the fledgling Rouge National Urban Park. To date we have recorded several hundred thousand observations of bats in the Park. By monitoring at multiple sites over a number of years, we have confidently identified seven of the eight Ontario bat species and are beginning to learn about their seasonal activity patterns and spatial variation.



Bat Watch - We Want Your Roosts!

In early 2018 the Toronto Zoo became an official partner for the multi-province 'Neighbourhood Bat Watch' project. Currently covering five provinces, the project aims to link citizen scientists and people with bats in their homes with bat researchers seeking roosts. Anyone who knows the location of a bat roost can register on the website – www.batwatch.ca – and report the location. Precise location data is protected and only shared with project partners, who can contact homeowners and request to arrange a visit to roosts of interest. Locating roosts allows us to better understand bat populations and habitat requirements. Anyone knowing the location of a roost should consider reporting it on the Bat Watch website and can contact the Zoo's bat staff with any questions or concerns – bats@torontozoo.ca.



Bat Outreach

Meeting and learning about bats has proved very popular with Toronto Zoo members and non-members alike. Each year we aim to raise bats' profile with our summer 'Bat Awareness Weekend'. The activities include a ticketed evening talk and 'bat walk' around the Zoo looking for wild bats and listening to their echolocation with 'bat detectors'. In 2019, there were approximately 3,000 participants.

The opportunity to visit the Zoo at night always proves popular, and this event has been a sell out for the past few years. Due to the popularity, we also offer additional walks in August. To learn more about the event from this past year, turn to the achievements section of this publication. To learn about upcoming walks visit our website!

Bats in Happy Valley

In 2018, the Toronto Zoo entered a new partnership with the Nature Conservancy of Canada (NCC) to monitor bats in Happy Valley Forest, near King City. NCC owns a large portion of Happy Valley, which they manage for conservation.

Following a few recent acoustic observations of endangered bats in the forest, NCC purchased four acoustic monitors. In 2019 Native Bat Program staff from the Toronto Zoo assisted with installation and training for these monitors, and will be analysing the data. We will also spend some time trying to catch bats in Happy Valley as part of our Environment Canada-funded monitoring.



Studying Bats with First Nations Communities

In 2018, the Native Bat Conservation Program (NBCP) received funding from the Species at Risk Stewardship Fund, provided by the Ontario Ministry of Natural Resources & Forestry.

Partnering with five First Nations communities across the province, this project used acoustic monitoring and roost examinations to learn about bat activity and to understand the populations in these understudied areas. NBCP also provided training on the maintenance of scientific equipment in order to conduct population surveys and to provide practical wildlife field skills to members of these First Nations. We also conducted Traditional Ecological Knowledge interviews to collect culturally significant stories and information regarding bats, which was then shared with the community. All of the data collected throughout this project belongs to each First Nation, and we encouraged data sharing with non-profit organizations such as Neighbourhood Bat Watch.

The overarching goal of this project is to teach members about the importance of these beneficial creatures and to gain a greater understanding of bats in these communities. We are continuing our work with these First Nation communities and have inspired a few of the communities to apply for funding to continue the work protecting bats on their lands.



Blanding's Turtle Head-Start Program



Photo Credit: Kelsey Bowles



Photo Credit: Kelsey Bowles

Since 1974 the Toronto Zoo has participated in some of the most significant conservation efforts in the zoological industry. One such program is the Blanding's Turtle Head-Start Program, where the Zoo participates in the annual release of threatened Blanding's turtles back into the Rouge Valley. The project was started in 1999 when the Urban Turtle Initiative observed seven Blanding's turtles while conducting research in the Rouge Park. Blanding's turtles were once abundant in the area but urban threats have caused their numbers to dwindle. Since they are listed as a threatened/endangered species in Ontario and Canada, and have been observed in declining numbers in Ontario over the past 50 years, this program is a prime example of how the unique strengths of accredited zoos can benefit species conservation.

The main issues Blanding's turtles face are low nest success and hatchling survivorship. This is because of high predation rates in urban areas, which have a higher proportion of predators as a result of human influences such as increases in food attractions (e.g. garbage, agricultural crops) and restrictions on hunting and trapping of top predators. In addition, road mortality has become an increasing problem.

What is Head-Starting?

Head-starting is the term used for raising individuals in a controlled protected environment during their early and most vulnerable stage of life. The mortality rate of turtles decreases as turtles grow larger, and as they develop larger and harder shells which are more difficult for predators to overcome. The goal of the Head-starting Program is to create a self-sustaining, natural population in the wild by rescuing eggs that have been laid in unsuitable conditions where they will not survive and then raising them until they can be released to have an approximate survival rate of 75 percent. According to our

Population Viability Analysis, by releasing 50 hatchlings every year for 20 years (60 percent female-to-male ratio), we could reach a target population size of 150 which is required for a functional population that can sustain itself.

Reintroduction

Eggs are collected from at-risk areas, and brought to the Zoo and incubated for approximately two months under the watchful eye of our Wildlife Care staff. Turtles are fed and cleaned three times a week, shells are notched, and they are weighed and measured monthly. Once the eggs hatch, the turtles spend the first two years in the nursery under optimum conditions to help them grow big and strong for release. This two-year period is called "Turtle Bootcamp." The turtles undergo daily temperature and weather variations, are introduced to live food, and are acclimated to natural conditions and seasonal light cycles to refine their natural behaviours. They have a radio transmitter affixed to their carapace and Passive Integrated Transponder (PIT) tags



Finding suitable release sites.

After the turtles spend two years in bootcamp, they are placed a soft-release enclosure for one week at a known habitat for Blanding's turtles (picture on the right). After final release, Zoo staff continue to monitor them to see how they interact with their new environment while they undergo important milestones such as migration and hibernation. With 213 turtles released so far, the information gained from monitoring these turtles helps inform us about their habitat requirements and what we can do to ensure they are continually provided with suitable areas to live.

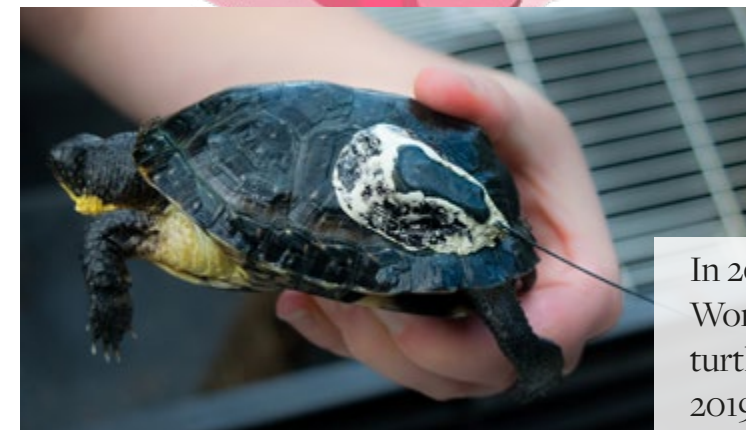
Restoration

In southern Ontario more than 75 percent of wetlands have disappeared, resulting in poor water quality, increased flooding and habitat loss for many species such as the Blanding's turtle. Alongside the Toronto Zoo, the Toronto Region Conservation Authority and Parks Canada are working to restore wetlands in the Rouge River Valley as well as locations on the Zoo site.



Reformation

Toronto Zoo actively participates in many outreach programs in order to increase awareness of urban turtles and highlight the importance of wetlands. Our citizen science programs help save species by allowing the public to submit their own turtle and frog observations. In 2018, Toronto Zoo officially opened a turtle nursery exhibit. This new exhibit gives the public the opportunity to see the animals up close and watch them develop throughout their first year of life, from hatchling to release!



In 2019, to commemorate the Toronto Raptors World Championship win, 37 out of 48 Blanding's turtles released into the wild were named after the 2019 Raptors team members, coaches, owners, and super fans. Pictured above is Blanding's turtle, Kawhi Leonard!



Giving the Wood Turtle a Head-Start

The Toronto Zoo has been assisting the Ministry of Natural Resources & Forestry and the Huron Stewardship Council with the recovery of the wood turtle in Ontario since 2010. Ministry staff monitor the wood turtles in their natural habitats and collect their eggs, which are raised in a protected zoo environment as part of a head-starting program. As with all turtles, the young have an extremely high mortality rate due to environmental pressures. The young turtles are brought to the Zoo where they are raised for two years before releasing them back into the wild. Once released, the turtles are monitored through the use of radio telemetry equipment to learn more about their behaviour and overall success. Toronto Zoo has head started over 400 turtles for release since joining this effort in 2010.

Breeding the Oregon Spotted Frog

The Oregon spotted frog is Canada's most endangered amphibian, with an estimated population of fewer than 340 adults in the wild. The Toronto Zoo is working with the Federal Recovery Team for the Oregon spotted frog to help recover this imperiled species. At the Toronto Zoo we have a breeding group of frogs in the Amphibian Rescue Centre (ARC) to support the recovery team's long-term goal to improve the Oregon spotted frog's chances for survival, prevent its extirpation, and to maintain or restore self-sustaining viable populations throughout its current, historic, and naturally occurring range.

Oregon spotted frogs have been successfully bred at Toronto Zoo, with over 250 offspring being sent to British Columbia for release to the wild. In 2018, the Zoo began applying the same technique of Artificial Reproductive Technologies (ART) that produced Dusky gopher frogs a year earlier and witnessed success with this new species. This was the first report of successful ART in Oregon spotted frogs and we are happy to say that the process was repeated again in 2019 with even more success!

Eastern Loggerhead Shrike Program

The Eastern Loggerhead shrike is a remarkable songbird that breeds in Ontario and is one of several grassland birds that is declining in the province. In 1997, only 100 shrikes were estimated to remain in all of Canada, with a mere 18 pairs found in Ontario. The Toronto Zoo serves as one of the breeding facilities for the reintroduction program currently taking place in the province.

The program has released over 800 shrikes to date and has confirmed that some of these birds have returned to the province in subsequent years as breeding adults. Nearly 200 shrikes have been bred for the program at the Toronto Zoo, the majority of which have been released into the wild. In 2019, there were 14 fledglings released.



The Vancouver Island Marmot Program

The Vancouver Island marmot (*Marmota vancouverensis*) is found only on Vancouver Island. It is one of the most rarest mammals in the world and is Canada's most endangered mammal - in 2003 there were only 30 individuals left in the wild.

The year 2019 marked Toronto Zoo's twenty-second year of involvement in the conservation breeding program. At the Zoo, breeding pairs are kept out of the public eye in a specialized breeding centre. Pups that are born are sent to the Tony Barrett Mount Washington Marmot Recovery Centre in British Columbia where final preparations are made for their first over-winter hibernation and eventual release into the wild.



The Black-Footed Ferret Program

The black-footed ferret breeding and reintroduction program involves more than 50 organizations across Canada, United States, and Mexico, where they were listed as extirpated in 1978. The combined threats of habitat loss and fragmentation, prey loss, and disease have been a big challenge for these small mammals as they try to re-establish themselves in their old range.

The Toronto Zoo started working on the captive breeding of this species, the total number of ferrets born and raised on site is over 400.

Four kits born at the Zoo were sent to the National Black-footed Ferret Conservation Center in Colorado, while two animals remained in Toronto to participate in breeding efforts. This program will continue through 2020.

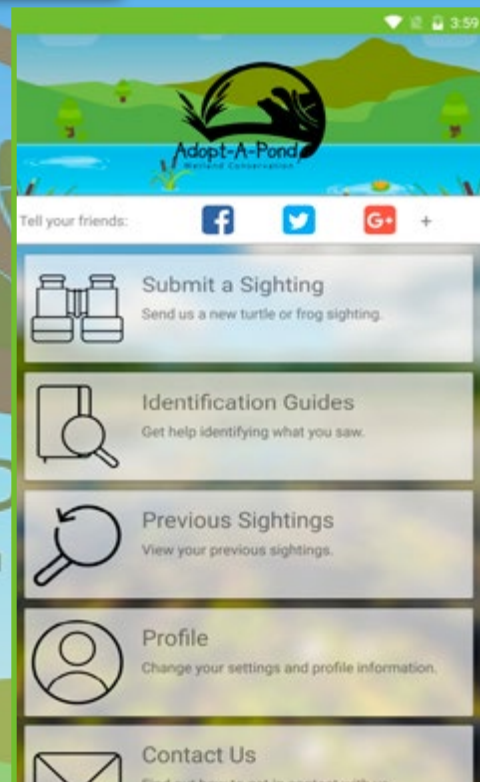


Adopt-A-Pond Programs

Toronto Zoo's Adopt-A-Pond Wetland Conservation Program works to design and deliver impactful conservation-focused research, restoration, and outreach that highlights the importance of saving Canada's sensitive wetland species and their habitats.

Over the last several decades, frogs, toads and salamanders — animals that rely on wetland habitat for most or part of their life — have become increasingly rare. In response, the Adopt-A-Pond Wetland Conservation Program was created to change this trend of decline by actively working with schools, community groups, and citizens to implement local initiatives that protect Ontario's wetland ecosystems and aquatic wildlife. Since its inception in 1991, Adopt-A-Pond has expanded and evolved into one of the Zoo's most active conservation programs. Today, Adopt-A-Pond includes a variety of citizen science programs, restoration initiatives, wildlife research, and targeted public engagement opportunities.

Download our Adopt-A-Pond App to submit any frog or turtle sightings, use our identification guide, and much more!



Urban Turtle Initiative

For over a decade, the Toronto Zoo's Adopt-A-Pond Wetland Conservation Program has undertaken a series of research projects, as a collective entitled the Urban Turtle Initiative, to learn more about what species of turtles are in the Rouge Valley, where they are living, and how they use the landscape to survive. After learning of the decline in local Blanding's turtle populations we began a head-starting and reintroduction program to boost their numbers. Over the past 10 years we have studied painted turtles, snapping turtles, Northern map turtles and Blanding's turtles. Many of the turtles in our project are monitored through radio tracking, to find out what habitats they are living in and to track their movements between those areas. We have radio tracked several hundred turtles through their travels in the Rouge Valley as part of this initiative.

Turtle Island Conservation

Toronto Zoo's Turtle Island Conservation (TIC) Program respectfully shares the hopes and goals of First Nations partners in our commitment for the preservation of biodiversity. The program celebrates culturally diverse and community-based approaches to conservation, recognizing that socially relevant programming is an imperative component to educating and motivating people to take action for the protection of wildlife and wildlife habitat.

The TIC Program has partnered with First Nation communities to develop culturally appropriate programming to protect and preserve community knowledge and significant natural and cultural landscapes since 2005. Our TIC staff visit numerous First Nations communities each year and have developed strong ties that enable a sharing of experiences and knowledge that fosters stewardship and sustainable practices.



Frogwatch Ontario

Toronto Zoo's Adopt-A-Pond Program is the Provincial Coordinator for the Canada-wide Frogwatch program, now nationally led by the University of Ottawa. This program monitors amphibian population health throughout the country, uses the information to collect data on the distribution of amphibian species, and shares this data with similar programs across Canada and around the world to contribute to scientific knowledge of the effects of global climate change.

Ontario Turtle Tally

Ontario Turtle Tally is a wildly popular program that encourages nature lovers from all walks of life to report observations of turtles they see in the wild to an online registry at the Zoo. This data, in turn, helps to implement habitat conservation projects and inspire participants to become advocates for turtles all across the province. The information gathered through Turtle Tally is made available to a number of local conservation groups so that they too can use it to help turtles across the province.

Wetland Conservation on the Toronto Zoo Site

Since 1999, the Toronto Zoo's Adopt-A-Pond Program and the Toronto and Region Conservation Authority have maintained a long-term partnership in order to restore wetlands for wildlife in the Rouge River Valley.

Our most recent project increased landscape connectivity for migrating wetland species in the Rouge River Valley and restored habitat for breeding amphibians that rely on vernal pools to complete their life cycle. Four ephemeral wetlands (Western Education Pond, Forest Ephemeral Pool, Salamander Ephemeral Pool and Historic Chorus Frog Pond) were restored, as the habitats were altered by infrastructure development or construction projects and no longer supported amphibian metamorphosis from egg to larvae to adult. The construction of the Chorus Frog Swale took place in fall 2018.

Road mortality is a major threat for many species, but there are many solutions to this issue where community support can be obtained. The XING exhibit installation in the Zoo's Americas Pavilion (in partnership with Ryerson University) highlights the emerging dialogue on landscape connectivity, engaging the public on the ways in which we collide and converge with wildlife and ultimately how we reconnect fragmented landscapes as part of a continental project to ensure safe passage for both humans and animals on and across our roads. There is powerful scientific evidence that wildlife road crossings are working. Together with these innovative and economical new technologies, public support and political leadership is needed to advance landscape connectivity.



The removal of phragmites, an invasive perennial grass.

Adopt-A-Pond and the Donkey Sanctuary of Canada



In the fall of 2018, Adopt-A-Pond (AAP) staff and the Donkey Sanctuary of Canada (DSC) staff and volunteers constructed a nesting beach for turtles living in the wetlands around the sanctuary, with funding provided by the Environment of Climate Change Canada's Habitat Stewardship Program. AAP and DSC selected an appropriate site on the property and began construction with an excavator, digging out the area which was then lined with perforated material (that allows for drainage, but also prevents vegetation from growing through). The area was filled with a layer of pea gravel, and then sand. Different species of turtles prefer different types of substrate in which to lay their eggs, so the mixture was tailored to accommodate multiple species. Since construction of the beach, painted turtles and snapping turtles have been observed around the nesting site, with a painted turtle seen digging around the beach! In 2019, Toronto Zoo provided informational resources.

Great Lakes Program



In-Class and Community Outreach

The Great Lakes Program offers free, bilingual, curriculum-based and interactive outreach programs to schools and community events from Chatham-Kent to Ottawa. As part of the in-class program, students receive take home materials and teachers receive a flash drive containing educational resources, including lesson plans and fish-focused games. Program materials are available in English, French, Mandarin, Punjabi and Urdu to meet the needs of the Great Lakes Program's diverse audience.

Participants learn how local aquatic Species at Risk such as the reidside dace (endangered), pugnose shiner (endangered in Ontario) and freshwater mussels contribute to a healthy aquatic ecosystem and the actions they can take to ensure a future for these and other local aquatic species. Through in-class and community outreach at libraries, scout groups, and special events, the Great Lakes Program reaches over 20,000 participants annually.

This year the Great Lakes Program has been as busy as ever attending water festivals in the GTA and southwestern Ontario, delivering high-quality in-class outreach presentations in English and French, attending and hosting teacher's conferences, developing program resources and analyzing participant feedback.



Redside Dace

Recently up-listed to Schedule 1 of the Species at Risk Act, the reidside dace is a federally recognized endangered species (COSEWIC). Formerly found in the Rouge River in Toronto Zoo's backyard, the reidside dace represents the foundation of the Great Lakes Outreach Program. As a member of the National Redside Dace Implementation Team, Toronto Zoo and local partner, Ontario Streams, undertake habitat rehabilitation projects in the Morningside Tributary to support this locally endangered species. In 2020, we plan to mark the 10 year anniversary of the reidside dace as a listed species at risk with a major outreach event and various stewardship initiatives.



Regional Assistants

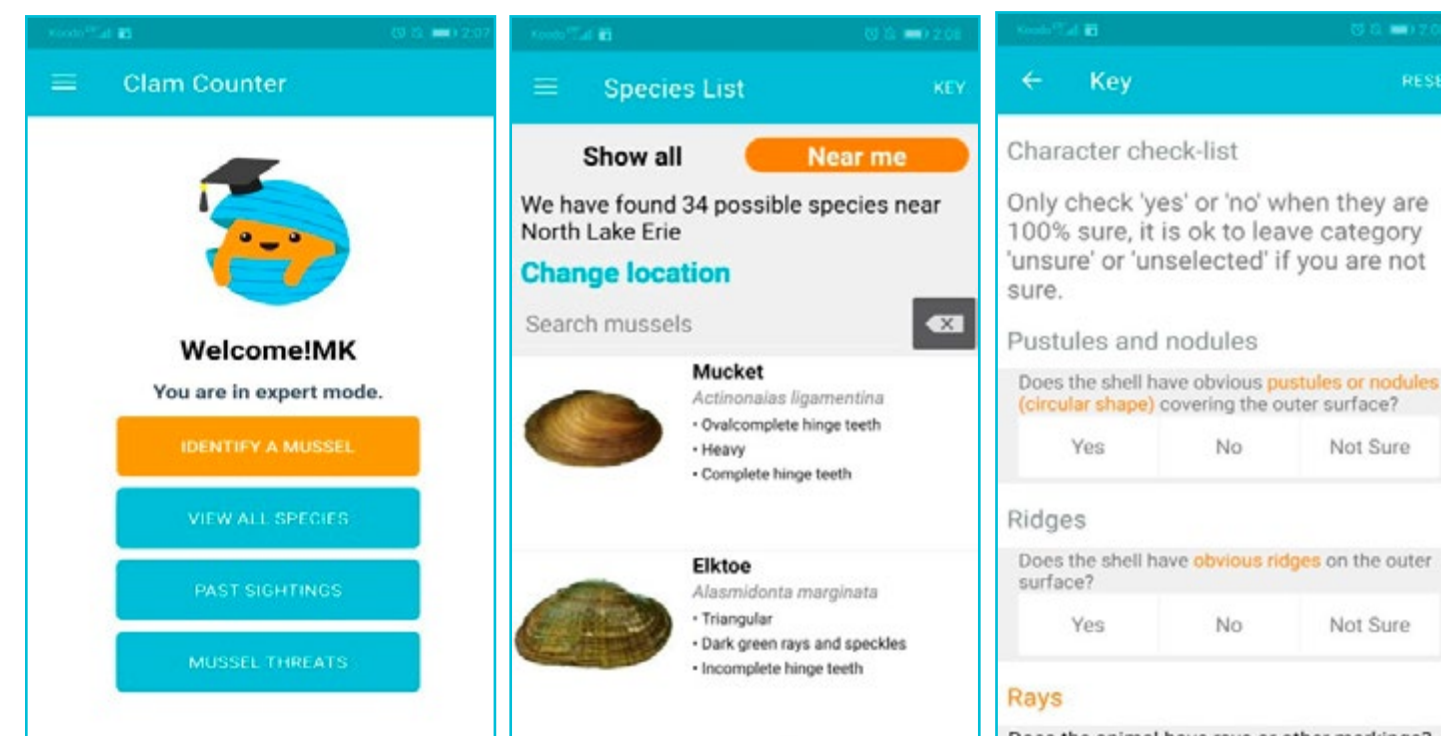
In 2019 the Great Lakes Program intensified efforts to deliver outreach in southwestern Ontario and along the eastern shores of Lake Ontario. Regional outreach staff completed in-class presentations and distributed support materials from Sarina to Chatham-Kent to Kitchener-Waterloo reaching over 10,000 students in the 2018-19 academic year. Additionally, program staff placed in the east region of Lake Ontario facilitated focused outreach delivery to approximately 3,000 students from Cobourg to Kingston. The program was fully booked for English and French program delivery in the three primary regions of the Lake Ontario watershed (southwest Ontario, GTA and east Lake Ontario) and an ongoing waiting list for new and returning schools is prepared for the upcoming academic year.

Freshwater Mussels Public Campaign: 'I am Important! I am Protected!'

Complementing Toronto Zoo's freshwater mussel field research, the "I am Important! I am Protected!" public campaign raises public (and scientific) awareness for these highly endangered invertebrates. Commonly referred to as clams, native freshwater mussels play a little known but vital role in the aquatic ecosystem. As part of Toronto Zoo's Great Lakes Program, this campaign offers educational in-class outreach focused on freshwater mussel biology and ecology, outdoor posters for waterfront property owners, public presentations, and static-cling decals for the fridge and windows. Since the launch of the Clam Counter app for freshwater mussel identification and reporting in spring 2017 (developed in partnership with Fisheries and Oceans Canada), the app has been installed over 200 times and approximately 40 reports were submitted during the first field season the app was in use. Through winter 2018 several updates were made based on user feedback including: the ability to manually enter coordinates and upload photos from the device gallery; the option to subscribe to the app mailing list; and redesigned identification key.



Toronto Zoo staff attended the Canadian Freshwater Mollusk Research Meeting in 2019 to continue to introduce the app and solicit feedback.



Freshwater Mussels Field Program

The 2017 field season marked the 5th year of Toronto Zoo's field surveys to document freshwater mussel abundance and distribution in the inland watersheds of Lake Ontario. Four native mussel species were documented across the 5 watersheds surveyed in 2017. Surveys on Credit River were intensified to increase the likelihood of documenting live mussels following the initial discovery of live mussels in the Credit River in 2016. Humber, Don and Rouge Rivers were also surveyed as select sites in the Kawartha Lakes. In addition to documenting mussel species, water chemistry parameters are also measured and analyzed to determine trends in the aquatic ecosystem at survey locations. A summary of the results from Toronto Zoo's 5-year field survey of freshwater mussel distribution and abundance was presented at the Canadian Freshwater Mussel Research Meeting at the Canada Centre for Inland Waters in Burlington in the fall of 2017. This research contributes to the growing knowledge of mussel species at risk at a time when the pressures of urban development and climate change continue to grow and evolve.

Aqua-Links Program

Classroom Hatchery: Lake Ontario Atlantic Salmon Recovery Program

The Toronto Zoo's Aqua-Links Program has participated in the Lake Ontario Atlantic Salmon Recovery Program (LOASRP) for 10 years. In partnership with the Ontario Federation of Anglers and Hunters (OFAH) and the Ministry of Natural Resources and Forestry, the Zoo distributes 100 "eyed" Atlantic salmon eggs to participating schools each year. Approximately 500 eggs are also kept at the Zoo for rearing. In the spring, participating students personally release their salmon fry with Aqua-Links Program staff at specific locations on designated tributaries of Lake Ontario to help restore this extirpated species.

In 2019, 26 schools participated in the classroom hatchery program thanks in part to a partnership with the Toronto District School Board. Toronto Zoo program staff facilitated a pre-program workshop to introduce new teachers to the salmon rearing program, demonstrate hatchery set-up and maintenance, and facilitate idea sharing among participants. In total, 3,000 Atlantic salmon fry were released in spring 2019 into Duffin's Creek, Credit River, and Cobourg Creek through the Aqua-Links Program.



"Eyed" salmon eggs for participating schools.



"Alevin", 8 week old Atlantic salmon.



Releasing Atlantic salmon fry.



Atlantic salmon "Fry".



Full grown Atlantic salmon.



Kat Lucas, collecting the Atlantic salmon fry for release.

Linking Students in Ontario and East Africa: Lake Victoria Education Initiatives

Building on the success of the Great Lakes Outreach Program, Aqua-Links educates students about water quality issues facing two Great Lakes regions of the world: North America and East Africa. Focusing on the importance of conserving these precious freshwater resources, Toronto Zoo links students in Ontario and East Africa via the Internet to share water stories and conservation ideas. For example, Kelsey from Gayaza High School in Uganda shared, "*I love Uganda because it has one of the biggest lakes in Africa, which is Lake Victoria, and I would love to have a pen pal from Canada so they can know more about the country*" in a video sent to Ontario students. Linking is made possible through contacts gained from the Lake Victoria Species Survival Plan in East Africa. Program coordinators in both countries visit classrooms to provide lessons and facilitate program delivery.



Additionally, Ontario students gain hands-on experience caring for Atlantic salmon right in their classroom. At the same time, students in East Africa visit the National Fisheries Resource Research Institute in Jinja, Uganda to learn about locally endangered Lake Victoria cichlids.

Resources are available to teachers and Toronto Zoo continues to facilitate and build linkages with the lesson plans.



Blue Schools



The Toronto Zoo created the Blue Schools Program to address the strain that high water consumption places on both infrastructure and ecosystems. On average, Canadians use more than 300 litres of water everyday, not including 'hidden water' used to manufacture everyday items like clothes and prepared food. This ranks Canada near the top in water-consumption per capita, second only to the United States. The Blue Schools Program, running for its second year under the Great Lakes Program "umbrella", is a STEM-based program (science, technology, engineering and mathematics) linked to multiple areas of the Ontario Curriculum and allows for four certification levels to foster deeper learning. It allows for classes across the GTA to participate in hands-on experiences for both staff and students and runs for the full school year. This year, with 8 classes participating, students were able to conduct water audits and develop an action plan to conserve water at their own school!

These Blue School Programs run throughout the year and involve a step-by-step process. From September to October, students establish support and make a plan for their academic year. Then from November to December, students conduct a school-wide water audit, collecting and analyzing school baseline data. In January, the class then prepares an action plan to reduce water consumption in their school. From February to May these students finally implement the action plan, and in June they receive their certification for successful achievement of Action Plan goals.

Featured in 2019 was the Allan A. Martin Public Schools Rain Garden, where rain water is diverted into a school garden. This garden will re-use rain water and trap pollutants such as oil, salt and fertilizer to prevent untreated water runoff into local water bodies!



Grand opening of the Allan A. Martin Public School Rain Garden.



Getting Involved

Our programs are delivered in both English and French for visiting students and community members, and offer brochures as well in many additional languages such as Mandarin, Punjabi, and Urdu to ensure that our program can be as accessible as possible to the Toronto region! Brochures in these languages are handed out to different organizations across the GTA to try and get as many people involved as possible.

Partnerships

One of our key partners for the Aqua-Links program is the Toronto District School Board. They help us coordinate the hatchery set up workshop for teachers, the distribution and maintenance of the hatcheries, and any administrative troubleshooting we encounter. This 5-year partnership with the Toronto District School Board has helped the Zoo expand the program across Toronto.

Through the Aqua-Links Program we are also partners in the Lake Ontario Atlantic Salmon Restoration Program which collaborates with organizations on the municipal, provincial, and federal level. In addition, we work closely with the Ontario Federation of Anglers and Hunters who run a program similar to Aqua-Links but with a larger reach across Ontario. With the Ontario Ministry of Natural Resources providing the Zoo with Atlantic salmon eggs, as well as running large scale hatcheries across the province, as a team, we have a goal of establishing a self-sustaining population of Atlantic salmon in Lake Ontario by 2025.

Staff Feature: Aqua-Links

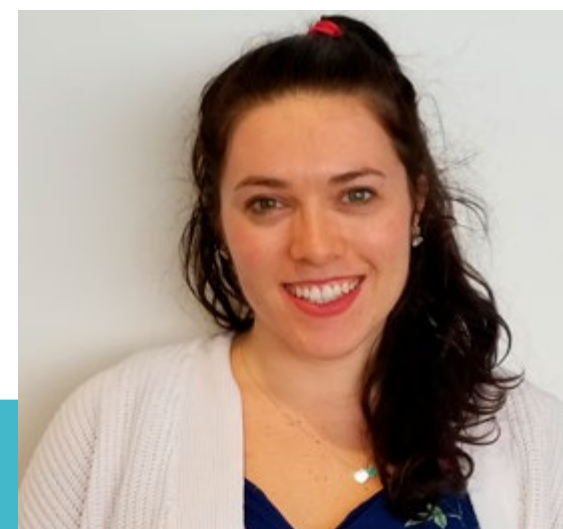
Mary-Kate Whibbs, Aqua-Links Program Coordinator

Mary-Kate Whibbs is the Great Lakes Program Coordinator at the Toronto Zoo and manages our aquatic conservation programs which include the Great Lakes Program, Aqua-Links Program, Freshwater Mussels Field Program, and Blue Schools Programs. In addition, she also writes grants to fund these programs, develops educational/community resources, liaises with local and international partners, and conducts field research on freshwater mussels. She holds Bachelor of Science and Bachelor of Education degrees from Trent University, as well as a Masters degree in Museum Studies from the University of Toronto. She started working at the Zoo in 2008 as a field technician on the Blanding's and snapping turtle research programs for Adopt-A-Pond. In 2010 she joined the fish team and the Great Lakes Program.



Kat Lucas, Aqua-Links Program Assistant

Kat Lucas is our Aqua-Links Program Assistant at the Toronto Zoo. In this role, she helps coordinate the Aqua-Links and Blue Schools programs and often leads classroom presentations and community outreach through our Great Lakes Program as well. In addition, she previously worked at the Zoo as an interpreter in the Wildlife Health Gallery and as a bilingual outreach lead with the Great Lakes Program. She has a Masters of Environmental Science degree, which studied the effects of pharmaceuticals on fish reproduction. She is extremely passionate about aquatic ecosystems and loves teaching others about how to help wildlife and the environment.



BEYOND BORDERS

The Zoo's impact on wildlife and their habitats extends beyond our 700 acre site. We release endangered species bred at the Toronto Zoo into the wild, which has helped to make great strides in preserving many threatened and endangered animals. Our work extends beyond Canadian borders, with the breeding and re-introduction of the Puerto Rican crested toad and the dusky gopher frog, field work with fish in Madagascar, and contributing to many Species Survival Plans throughout North America.

Dusky Gopher Frog

The wild population of the dusky gopher frog hovers around 100 individuals, and they have only a single ephemeral pond where they can breed, making the dusky gopher frog the most critically endangered frog in the United States.

The wild population is threatened by habitat degradation (fire suppression), ongoing and vigorous commercial development in the immediate vicinity of the breeding pond, disease, a genetic bottleneck, and critically low population size. Thus, this is truly a case where the Zoo population is an assurance colony to prevent complete extinction of the species in the event the last remaining wild population disappears, something that could happen with little warning. Toronto Zoo responded to this crisis situation by providing housing and breeding space to the Dusky Gopher Frog Species Survival Plan®.

Since their arrival at the Zoo in 2014, we have succeeded in naturally cycling the frogs, with females producing eggs. In 2017, Amphibian & Reptile Curatorial staff and the Reproductive Physiology team overcame challenges of natural breeding using techniques developed by Dr. Andy Kouba in Mississippi. Following hormone injections, egg and sperm collection, and in vitro fertilization, the first dusky gopher frog embryos developed in Canada, metamorphosing into tadpoles and juvenile frogs, and set for release into the wilds of southern Mississippi in the summer of 2019.

Puerto Rican Crested Toad

Our most successful breeding project involves the critically endangered Puerto Rican crested toad. The Puerto Rican crested toad is listed as critically endangered by the International Union for Conservation of Nature (IUCN), and is found only in Puerto Rico. In collaboration with the U.S. Fish and Wildlife Service and the AZA Puerto Rican Crested Toad Species Survival Plan®, tadpoles hatched at Toronto Zoo are released in Puerto Rico each year for the purpose of sustaining and rebuilding the wild population. Toronto Zoo has been an active participant in the breeding program for over 30 years and we are proud of the fact that we have released a total of 156,556 Puerto Rican crested toads into the wild, including sending 8,700 tadpoles to Puerto Rico in 2019.

Madagascar Fishes

The fish lab at Toronto Zoo has been breeding different species of Madagascar fish since 2014, when one of our Keepers, Tim McCaskie, travelled to East Africa and brought the fish back with him. Over the past 4 years we have successfully bred multiple groups of *Rheocles vatasoa*, a Madagascar rainbowfish. We have been sending some of our offspring groups to other accredited zoos and aquariums around the world to help increase the captive numbers and ensure the species survival. In the past year, we have also been breeding *Ptychochromis insolitus*, a cichlid thought to be extinct and have increased the numbers to over 300 individuals.

We are still continuing to work with the four other species collected in Madagascar: *Ptychochromis loisellei*, *Paretroplus loisellei*, *Paratilapia* sp. *Andapa*, and *Bedotia* sp. *Sambava*. We have had some success in breeding these last four species but we are working to improve our breeding techniques and document all of our findings to help ensure the species future.

Toronto Zoo has also received the last remaining *Bedotia marojejy* in captivity. As we have been the only successful zoo to breed this valuable endangered species, the Species Survival Plan has put their faith in us to breed this very difficult species and bring their numbers back from the brink of extinction. Since their arrival, we have been successful in breeding them and look forward to increasing their numbers again acting as mentors to others willing to try again.

In 2019, 70 Madagascar fishes were sent to Germany and 40 were sent to London, England.

Pictured: Puerto Rican Crested Toad

SPECIES SURVIVAL PLAN®

The Species Survival Plan® (SSP) is a cooperatively managed program overseen by the Association of Zoos and Aquariums (AZA). The main objective of the program is to oversee the population management of select species within AZA member institutions and to enhance conservation of this species in the wild. Each SSP program coordinates the individual activities of participating member institutions through a variety of species conservation, research, husbandry, management, and educational activities.

17 Red SSP Programs

- Captive populations of very few individuals and are not sustainable in the long term at present time



19 Green SSP Programs

- Captive populations that are thriving



90 Yellow SSP Programs

- Captive populations present but are not yet strong enough to persist long term



14 Candidates for SSP Programs

- Populations that need to grow to meet minimum criteria to be an SSP®

SSP Species at Toronto Zoo

Of the 5,000 animals here at Toronto Zoo, 141 are part of the Species Survival Plan. Our staff work hard to participate in this important program, assisting in SSP planned births of 32 different species! For example, the list below highlights which SSP program they fall under. The column on the right classifies them under IUCN Red listings (least concern, near threatened, vulnerable, endangered, critically endangered, extinct in the wild, and extinct).

SPECIES	GREEN SSP	YELLOW SSP	RED	Candidate
MAMMALS				
African cheetah (<i>Acinonyx jubatus jubatus</i>)		X		
African lion (<i>Panthera leo</i>)	X			
American beaver (<i>Castor canadensis</i>)				X
American moose (<i>Alces alces canadensis</i>)			X	
Amur tiger (<i>Panthera tigris altaica</i>)	X			
Babirusa (<i>Babyrousa celebensis</i>)		X		
Bactrian camel (<i>Camelus bactrianus</i>)				X
Bennett's wallaby (<i>Macropus rufogriseus</i>)	X			
Bettong (<i>Bettongia penicillata (no subsp.)</i>)		X		
Bison (<i>Bison bison</i>)				X
Black-footed ferret (<i>Mustela nigripes</i>)		X		
Black-handed spider monkey (<i>Ateles geoffroyi geoffroyi</i>)		X		
Canadian Lynx (<i>Lynx canadensis</i>)		X		
Capybara (<i>Hydrochoerus hydrochaeris</i>)		X		
Clouded leopard (<i>Panthera nebulosa</i>)		X		
Cougar (<i>Felis concolor</i>)		X		
Crested porcupine (<i>Hystrix africaeaustralis</i>)		X		
Eland (<i>Taurotragus oryx</i>)		X		
Feather-tailed glider (<i>Acrobates pgmaeus</i>)				X
Gaur (<i>Bos gaurus</i>) offsite				X
Golden-lion tamarin (<i>Leontopithecus rosalia</i>)	X			
Great Indian rhinoceros (<i>Rhinoceros unicornis</i>)		X		
Greater Kudu (<i>Tragelaphus strepsiceros</i>)		X		
Grevy's zebra (<i>Equus grevyi</i>)	X			
Jaguar (<i>Panthera onca</i>)	X			
Lion-tailed macaque (<i>Macaca silenus</i>)			X	
Long-tailed chinchilla (<i>Chincilla lanigera</i>)				X
Malayan tapir (<i>Tapirus indicus</i>) offsite			X	
Masai giraffe (<i>Giraffa camelopardalis tippelskirci</i>)		X		
Matschie's tree kangaroo (<i>Dendrolagus matschiei</i>)			X	
Mouflon (<i>Ovis</i>)				X
North American river otter (<i>Lontra canadensis</i>)	X			
Polar bear (<i>Ursus maritimus</i>)		X		
Prehensile-tailed porcupine (<i>Coendou prehensilis</i>)		X		
Przewalski's horse (<i>Equus przewalskii</i>)		X		
Pygmy hippopotamus (<i>Choeropsis liberiensis</i>)			X	
Pygmy marmoset (<i>Cebuella pygmaea</i>)		X		
Red panda (<i>Ailurus fulgens fulgens/styani</i>)	X			
Red River Hog (<i>Potamochoerus porcus</i>)		X		
Ring-tailed lemur (<i>Lemur catta</i>)	X			
River Hippo (<i>Hippopotamus amphibious</i>)		X		
Sable antelope (<i>Hippotragus niger</i>) offsite		X		
Serval (<i>Leptailurus serval</i>) offsite		X		
Short-beaked echidna (<i>Tachyglossus aculeatus</i>)			X	
Slender-tailed meerkat (<i>Suricata suricatta</i>)		X		
Snow leopard (<i>Uncia uncia</i>)		X		
Southern hairy-nosed wombat (<i>Lasiorhinus latifrons</i>)				X
Spotted hyena (<i>Crocota crocuta</i>)		X		
Spotted-necked otter (<i>Lutra maculicollis</i>)			X	
Straw coloured fruit bat (<i>Eidolon helvum</i>)		X		
Sumatran orangutan (<i>Pongo pygmaeus abelii</i>)	X			
Sumatran tiger (<i>Panthera tigris sumatrae</i>)		X		
Two-toed sloth (<i>Choloepus didactylus</i>)		X		
Warthog (<i>Phacochoerus africanus</i>)		X		
Western grey kangaroo (<i>Macropus fuliginosus melanops</i>)		X		
Western lowland gorilla (<i>Gorilla gorilla gorilla</i>)	X			
White rhinoceros (<i>Ceratotherium simum simum</i>)		X		
White-faced saki monkey (<i>Pithecia pithecia</i>)		X		
White-handed gibbon (<i>Hylobates lar</i>)		X		
Wildebeest (<i>Connochaetes taurinus</i>)		X		
TOTAL	11	34	7	8

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Leaf frog secured for shipment.



Butterfly pupae ready for shipment.



Puerto Rican crested tadpoles, a species that is a part of our Conservation Breeding Program.

ANIMAL TRANSFERS & SHIPMENTS

Animal Transfers & Shipments

Shipping live animals is challenging. Every shipment is different than the last and many factors must be considered in order to get the animal to their final destination. What species are involved and how many are there? Where are they going or coming from? What are the permitting and health testing requirements? What is the best mode of transportation? What sort of shipping crate/container should be used? How does weather restrict the shipment? How will the animal be loaded/unloaded? The list can be endless!

Animal welfare is always a priority so shipments must occur quickly and efficiently which requires a great deal of planning. Toronto Zoo employs an Animal Logistics Coordinator to tackle more than 100 transfers each year. Many shipments facilitate SSP breeding recommendations as well as breed and release programs.

For example, this year, we swapped female Matschie's tree kangaroos with the Kansas City Zoo, and also received a male greater kudu from the North Carolina Zoo, both SSP breeding recommendations. We also bred Oregon spotted frogs and Vancouver Island marmots which were sent back to their native range for release into the wild. So, whether it's a tarantula or a rhinoceros, travelling down the road or across the ocean, all live cargo is precious. Preparedness is key in ensuring a transfer goes smoothly.



Nandu, our Indian Rhino, being lifted by crane onto a truck set for Safari Niagara.

Our Role in the International Zoo Community

Species 360

Toronto Zoo is a contributing member to Species360, a non-profit organization (NGO) and global leader in wildlife care and conservation. With over 1,100 zoo, aquarium, university, research and governmental members worldwide, the organization and its members work to improve animal welfare and species conservation by addressing today’s most urgent wildlife issues. This includes establishing best practices in husbandry, enrichment, medical care, welfare, reproduction, population management, and biodiversity. The Species360 Conservation Science Alliance, is comprised of researchers that provide conservationists with evidence-based findings, which encompass a full range of global data including IUCN Red List, CITES, TRAFFIC, EDGE, AZE, ZIMS, and more. Research led in collaboration with IUCN Species Survival Commission, Convention on International Trade in Endangered Species of Flora and Fauna (CITES), and others, can provide data to create decisions such as enforcing illegal wildlife trade laws or even calculating the viability of insurance populations.

ZIMS (Zoological Information Management System)

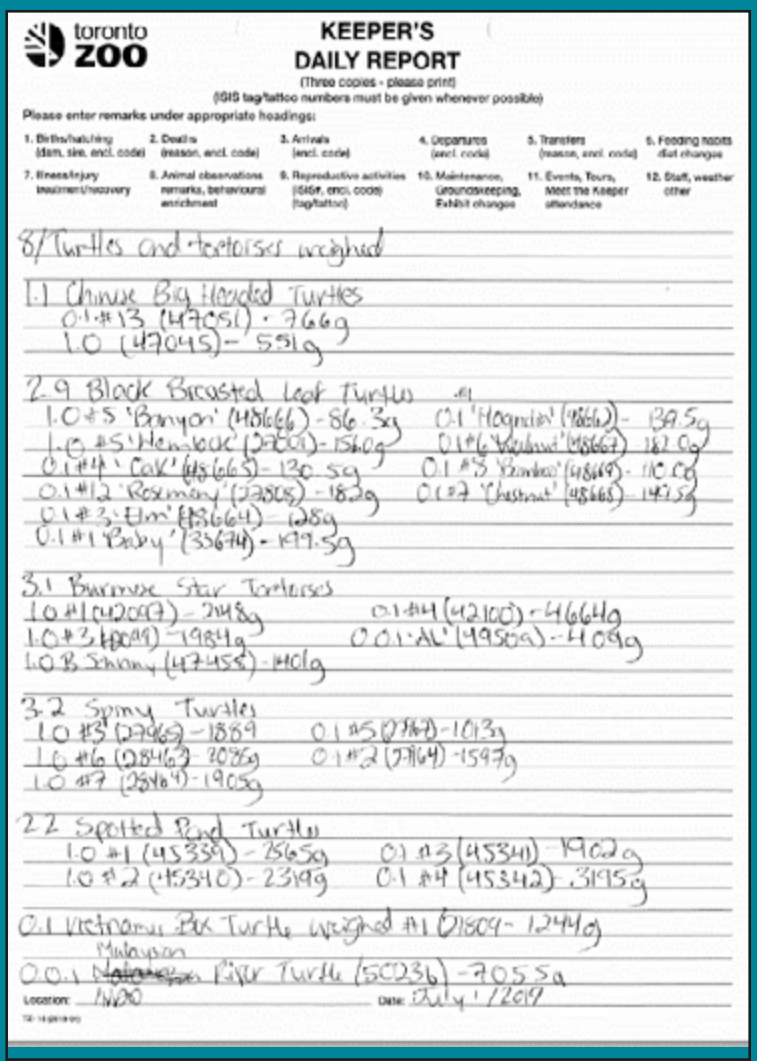
Species360 members curate the zoological information management system (ZIMS), the world’s most comprehensive open database of knowledge on more than 22,000 species. Wildlife professionals within zoos and aquariums as well as refuge, research and education centres across 97 countries, contributions to this system vastly increases what is known about thousands of species, and is instrumental in identifying sustainability strategies for many of the species assessed as vulnerable, endangered, and extinct in the wild. This data is also used to update Regional and International Studbooks and help to advise Species Survival Plan (SSP) decisions. Toronto Zoo has been contributing data on our animals since 1973, working hard every day to record information about our animals in our care. Since then, we have added critical information on 34,723 birds, reptiles, amphibians and mammals of 1,177 species!

Sharing Information

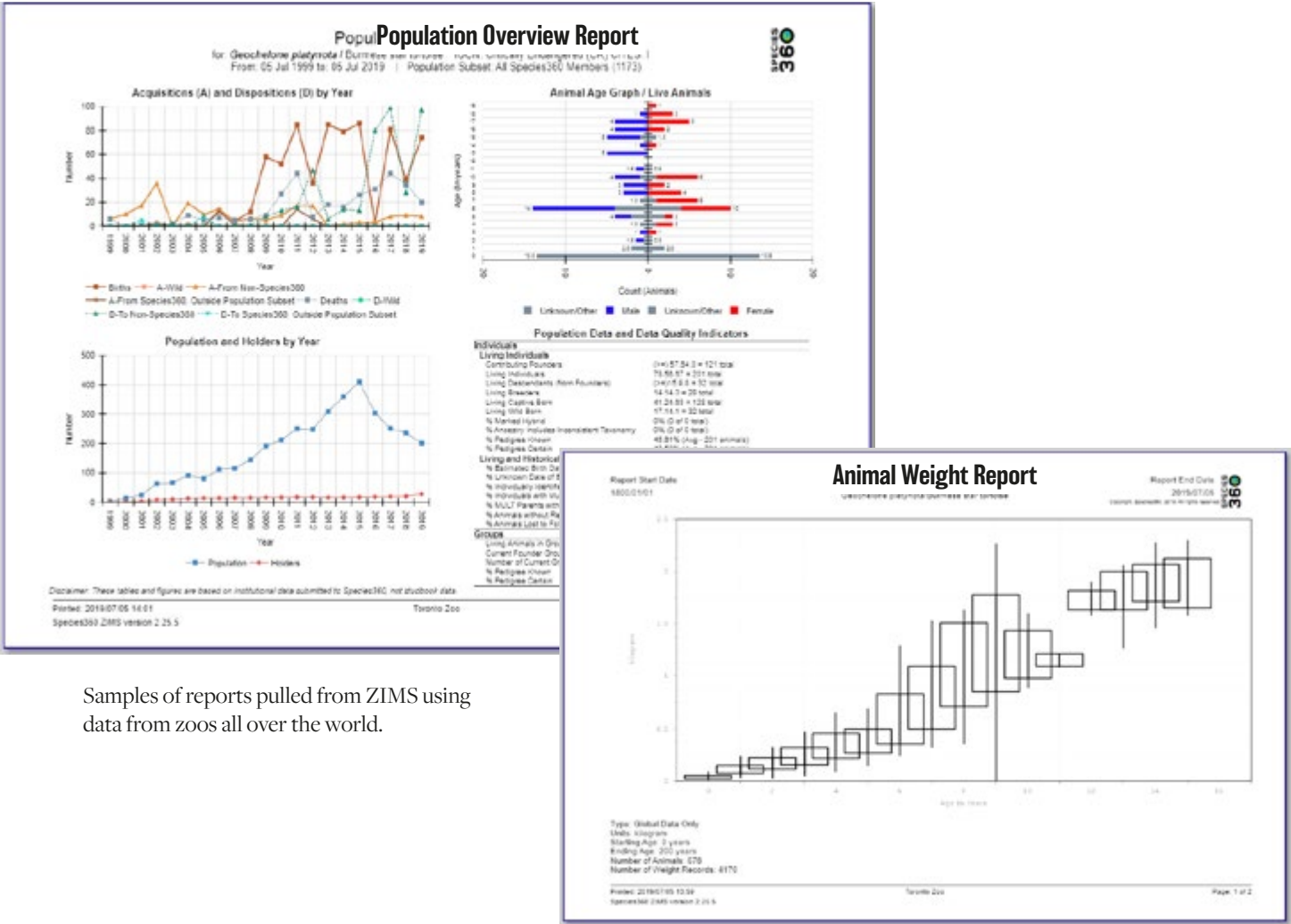
It is the job of the Registrar to input all data collected from various sources all around the Zoo site. Keeper daily notes, medical records, behavioural and welfare observations, maximum and minimum room temperature monthly reports, and weight spreadsheets are just some of the



documents. Once the data is entered into ZIMS it can be accessed by staff to keep them up to date on animal care and any new changes or trends. Since ZIMS is shared among members, individual animal information can also be shared. When an animal is transferred to another location, often as part of an SSP recommendation, that animal’s data can be shared with the new zoo, allowing the full history of the animal to be in one place to insure proper care as well as allowing the new zoo to contribute new information.



One of the daily reports our registrar receives.



Samples of reports pulled from ZIMS using data from zoos all over the world.

Toronto Zoo Delivers Missing Information Critical to Sustaining Biodiversity

Although currently there seems to be an overwhelming amount of information on mankind with volumes of data and research, we surprisingly know little about other species we share this planet with. According to a paper published in the journal *Proceedings of the National Academy of Sciences* (PNAS), critical information such as fertility and survival rates, is missing from global data for more than 98 percent of known species of mammals, birds, reptiles, and amphibians! This gap in knowledge has massive implications for conservationists attempting to reduce the impact of mass extinctions. To make more informed decisions, we require more complete data, especially for scientists working worldwide on behalf of organizations such as IUCN Red List or CITES.

Using data recorded in ZIMS by Toronto Zoo and other zoos and aquariums worldwide, key missing information was filled in, allowing a multi-disciplinary team led by the Species360 Conservation Science Alliance with participants from 19 different institutions, analyze this important data which was previously overlooked. When it comes to predicting when species are at risk or how to best bolster populations, it is necessary to understand when females reproduce (at what age), how many hatchlings or juveniles survive to adolescence and how long adults live. This is why researchers developed a Species Knowledge Index (SKI), which is able to classify available demographic information for 32,144 species of mammals, birds, reptiles and amphibians. However, when analyzing global sources of information, the index registers comprehensive birth and death rates for only 1.3 percent of these major classes of species. By adding the information collected in ZIMS by Species360 members, “it was like turning on the lights in an otherwise very dim room”, boosting the Species Knowledge Index by eightfold - with information on the age of first reproduction for females growing as much as 73 percent.

TORONTO ZOO IS A REGISTERED RESEARCH FACILITY

REGISTERED RESEARCH FACILITY

Animal Care & Research Process

Toronto Zoo takes great pride in the care it provides to its animals and its involvement in the various conservation programs and research projects.

The Toronto Zoo is not only a state-of-the-art animal care facility but is also a registered research facility. The Toronto Zoo is overseen by the Canadian Council on Animal Care (CCAC) and the Ontario Ministry of Food, Agriculture and Rural Affairs (OMAFRA).



Toronto Zoo participates in animal-based science programs and maintains a Canadian Council on Animal Care (CCAC) Certificate of GAP – Good Animal Practice which is an ongoing process that recognizes an institution’s commitment to achieving high standards of animal ethics and care in science.

Toronto Zoo is enrolled in the CCAC Assessment and Certification Program and is certified every three years based on its compliance with CCAC policies, guidelines and other CCAC-recognized standards as evaluated by an assessment panel composed of scientists, veterinarians, community members, and CCAC Assessment and Certification Committee.

Each participating institutions must set up a local institutional animal care committee. Toronto Zoo’s Animal Care & Research Committee (ACRC) is responsible for overseeing all aspects of animal ethics and care at the Zoo, undertakes animal care protocol review and approval, and must adhere to the CCAC’s guidelines and policies.



Toronto Zoo is registered as an animal research facility under the Animals for Research Act of Ontario which is overseen by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

To maintain an annual license renewal the Zoo must meet various requirements for registration including:

- Having an established institutional Animal Care Committee who are responsible for reviewing animal use protocols and providing animal oversight at the Zoo including ensuring that animals are housed in appropriate facilities under suitable conditions;
- The Committee ensures that researchers and animal care staff are appropriately trained and qualified to care for the animals;
- The Zoo has the necessities to properly care for and handle animals that are in the research facility, and abide by the Act and the regulations.
- Due to its research status, Toronto Zoo is exempt from the Ontario Society for the Prevention and Cruelty of Animals Act, so OMAFRA is responsible for conducting site visits of Toronto Zoo throughout the year.

VETERINARY SCIENCE



A BUSY MULTI-FACETED AREA THAT STRIVES EVERYDAY TO ACHIEVE EXCELLENCE IN WILDLIFE HEALTH, WILDLIFE CARE, & RESEARCH.

The Wildlife Health Centre

Once coined the “hidden zoo,” Toronto Zoo’s Wildlife Health Centre is now very much visible and available for the public to view. Completed in 2017, it is a \$19.1 million state-of-the-art facility and the first of its kind in Canada. In total, it is approximately 50,000 square feet in size, which includes over 32,000 square feet of new interior space, plus 17,000 square feet of the original animal hospital.

The new building offers medical facilities, such as treatment, surgery, diagnostic imaging rooms, a clinical laboratory, various multi-purpose animal wards, an expansive quarantine wing, as well as office and laboratory space for reproductive programs and research. Of particular note is the “Windows on Wildlife Science Gallery,” where visitors have a close-up, behind-the-scenes view of the exceptional medical care provided to our animals, and where ongoing research can be showcased.

Staffed by three veterinarians, two veterinary residents, three veterinary technicians, a supervisor, and seven zookeepers, the Wildlife, Health & Veterinary Science Branch provides exemplary care to the Zoo’s animals. Their health is maintained through preventive and interventional medicine, and surgical, diagnostic, and pathology programs. Providing a high standard of veterinary care to over 5,000 animals is no easy feat. Over 490 anesthetic events, 236 radiographic examinations and 19,455 internal laboratory tests took place in 2019 alone, as part of the comprehensive care provided to the Zoo’s animal population. Staff also develop or support important comparative research in many scientific disciplines, providing information which can be used to improve conservation, education, and management programs for select threatened or endangered species.



An African penguin getting an X-ray.



Outside of Wildlife Health Centre building.



A digital X-ray of a chameleon.



Public viewing windows at the Wildlife Health Centre.

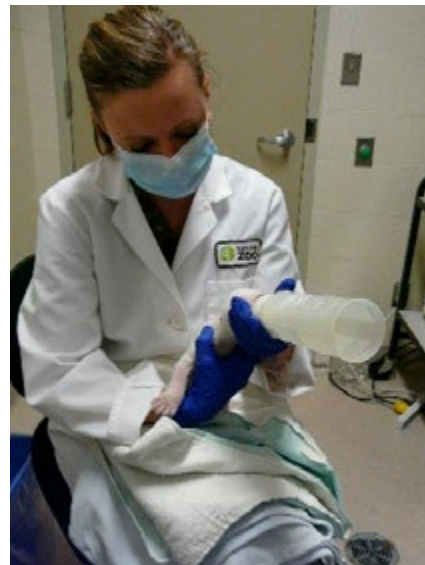
Feature: Wildlife Health Technicians



Dawn Mihailovic assisting in the examination of polar bear cub, Juno.



Cassia Devison feeding clouded leopard cubs.

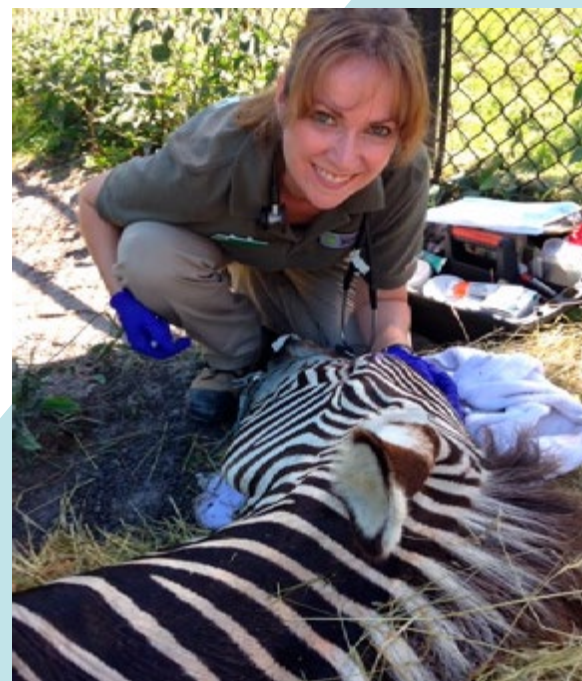


Michelle Lovering feeding polar bear, Juno.

Our Wildlife Health technicians, along with our Wildlife Health Supervisor, are a group of specially trained, highly skilled individuals, who assist our veterinarians in the care of the Zoo's diverse wildlife population. Routine tasks may include, but are not limited to, assisting with general exams, restraining animals for examination or procedures; preparing animals for surgery, anesthetic monitoring, maintaining patient records, the preparation and taking of radiographs; administering fluids, injections, and various medications; and collecting samples and performing diagnostic tests. From ensuring inventory is stocked, to keeping the rooms clean and organized, to preparing and collecting materials and equipment for procedures taking place, our Wildlife Health technicians provide invaluable support to ensure the Wildlife Health Centre is running in tip-top shape!

Our Wildlife Health technicians also work closely with the keepers, such as when neonate animals require hand rearing or during the training of animals for voluntary procedures. If it is deemed necessary to hand raise a newborn animal, it is typically transferred to the NICU in the Wildlife Health Centre and the Wildlife Health technicians take over. Hand rearing involves round-the-clock care including maintaining the animal's feeding schedule, providing general husbandry, and medical care until the animal is deemed ready to return to the keeper's care. Certain animals are trained to participate in voluntary procedures. This means the animal is participating as much or as little as they choose to. Voluntary procedures

may include tasks such as blood collection, receiving injections, having blood pressure taken, or participating in ultrasound and/or radiographs. Animals trained to participate in voluntary procedures often experience less stress when requiring medical intervention which often reduces the need for general anesthesia.



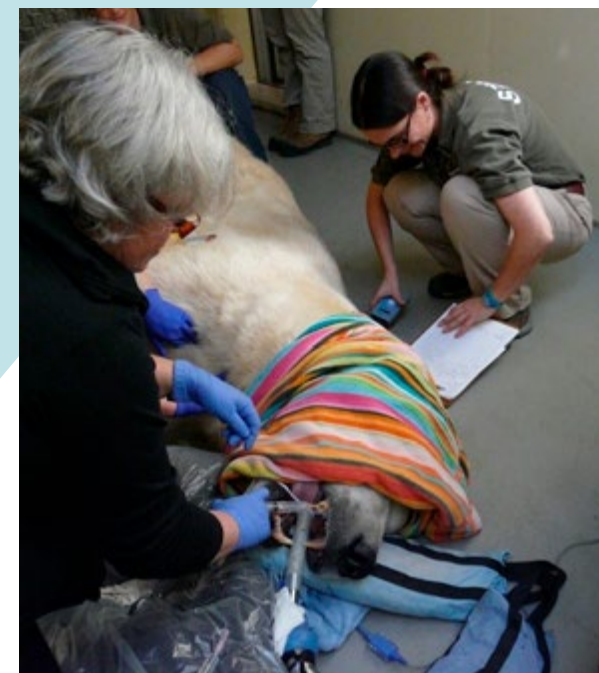
Tasha Long monitoring the wound repair of one of our Grevy's zebras.



Preparing a lion for surgery (ovariohysterectomy).



Blood collection from a cheetah.



Specialist veterinary dentist Dr. Sharon French performing a root canal treatment on a polar bear.



Former Veterinary Resident Dr. Ellie Milnes and Wildlife Health Technician Dawn Mihailovic prepare a cheetah cub for surgery to repair an umbilical hernia.

Veterinary Research

The use of midazolam, isoflurane, and nitrous oxide for sedation and anesthesia of ball pythons (*Python regius*)

C. B. Larouche, C. Dutton, D. Bienzle, N. Nemeth, H. Beaufrère, C. Mosley, R. Johnson

Snakes are commonly anesthetized for research purposes, diagnostic testing, as well as medical and surgical treatments. However, inhalation anesthesia is complicated by their unique anatomy and physiology. For example, their blood can shunt from one side of the heart to the other and bypass the lungs, and some species can survive prolonged periods with very low levels of oxygen. Despite an increasing number of studies in the last decade, clinical studies regarding snake anesthesia remain scarce. The objectives of this project were to characterize the pharmacodynamics (sedative and cardiovascular effects) and pharmacokinetics (absorption, distribution, and elimination) of midazolam in the ball python (*Python regius*), and to evaluate the effects of midazolam and nitrous oxide (N₂O) on the minimum anesthetic concentration of isoflurane in this species.



Relationship between diet, lipid metabolism, body composition, and hibernation in the critically endangered Vancouver Island marmot (*Marmota vancouverensis*)

J. Aymen, P. Delnatte, H. Beaufrère, J. Wensvoort, S. Gourlie, M. McAddie, S. Abood



Vancouver Island marmots are large rodents related to squirrels, and are a critically endangered species endemic to Vancouver Island, British Columbia. Captive breeding and release programs aim to recover their wild population. The Toronto Zoo is one of three institutions involved in this conservation program. However, the captive-bred animals appear to have lower overwinter survival rates compared to wild ones. As fat-storing hibernators, the diet and fatty acid profiles prior to release may play a role in their reduced hibernation survival. This study aims to evaluate the lipid metabolism and body composition in captive-bred Vancouver Island marmots and to compare them to their wild counterparts. The effect of a diet reflecting natural changes in polyunsaturated fatty acids, on hibernation, will be



assessed on a marmot model, woodchucks (*Marmota monax*). The findings of this study may ultimately lead to an understanding or improvement of the survival of captive-bred Vancouver Island marmots, thus contributing to the ongoing conservation efforts that hope to restore the wild population of this important Canadian species.

Assessment of physiologic parameters during anaesthesia in Przewalski's horses (*Equus przewalskii*)

E. Milnes, A. Skelding, C. B. Larouche, P. Delnatte, C. Dutton, A. Ferro

The Przewalski's horse (*Equus przewalskii*) is a flagship species for the role of ex situ programs in wildlife conservation. Immobilization of non-domestic equids, such as Przewalski's horses, is challenging, and every anesthetic event bears a small, but significant, risk of injury and potential death. In the domestic horse, the mortality risk is around 1% (1 case in 100) for healthy, elective cases, which is significantly higher than for other domestic species. In species where anesthetic information is lacking, veterinarians depend on extrapolation of data from similar animal groups, which may or may not be accurate. The aim of our study is to use the twice-yearly immobilizations (routine health checks) of Przewalski's horses at the Toronto Zoo as an opportunity to gather data about the physiologic status of these animals during anesthesia with two different drug regimens. Our anticipated research outcome is to inform zoo veterinarians about the anesthetic options for this species beyond the traditional narcotic combinations.



Investigating the molecular determinants of mammalian lifespan

R. Kafri, M. Ginzberg, N. Patel, C. Tan

A novel correlation was recently identified between the size of pancreatic cells and the maximum lifespan of the species – mammals that have smaller cells tend to live longer. This association was further shown to be independent of other well-known correlates of lifespan such as body weight and basal metabolic rate. Since then, a similar reciprocity has also been observed in liver cells, salivary gland cells, and to a lesser extent in skeletal muscle cells. Although correlations do not imply causations, links of cell size and lifespan are also suggested on a molecular level: both are products of the same regulatory pathway within cells. To understand the mechanisms underlying the correlation between mammalian lifespan and cell size, one aspect of this project is to explore the tissues in which a similar reciprocity exists. Understanding which organs demonstrate this correlation may hint towards the biology that drives the association. To this end, researchers at the Hospital for Sick Kids have partnered with the veterinary staff at the Toronto Zoo to acquire different tissue samples from mammals. Preliminary results indicate an absence of the correlation among kidney cells, which suggests to that the association would manifest more strongly in tissues directly involved in anabolic functions (building molecules instead of breaking them down). Because of the tight link between cell size and animal lifespan, how cell size is regulated in the lab is also being concurrently investigated.



REPRODUCTIVE SCIENCES

The program focuses on improving our understanding of the reproductive biology of diverse species and developing assisted reproductive technologies (ARTs) to enhance ex-situ conservation breeding and in-situ population management programs. Our primary objective is to provide scientific and technical knowledge to improve reproductive outcomes for both zoo-based and free-ranging populations through active partnerships with other zoological, academic, and governmental organizations.

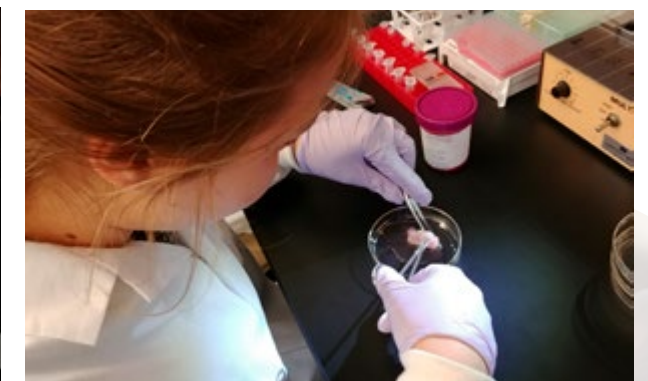
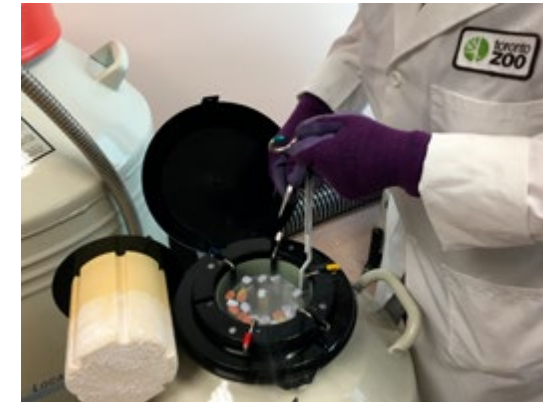
Hormone Monitoring & Therapy

We carry out hormone analyses on more than 25,000 samples per year. Longitudinal analysis of reproductive hormones (estrogen, testosterone, progesterone) allows us to establish seasonal breeding periods, predict ovulation for breeding introductions, and detect pregnancies, to name a few. More importantly, changes in normal hormone patterns are identified and treatment protocols, including ovulation induction and contraception, can then be developed to overcome any potential concerns.

Reproductive dysfunction is known to be correlated with stress. For zoo animals, stressful events could include a move to a new enclosure or competition within a social group. Free-ranging populations experience even greater challenges, such as evading predators, foraging for food, or responding to an ever-changing ecosystem resulting from human activities. Monitoring stress-related hormones (cortisol, corticosterone) can provide insight into the health and well-being of a population and identify potential factors leading to population decline or reproductive failure.

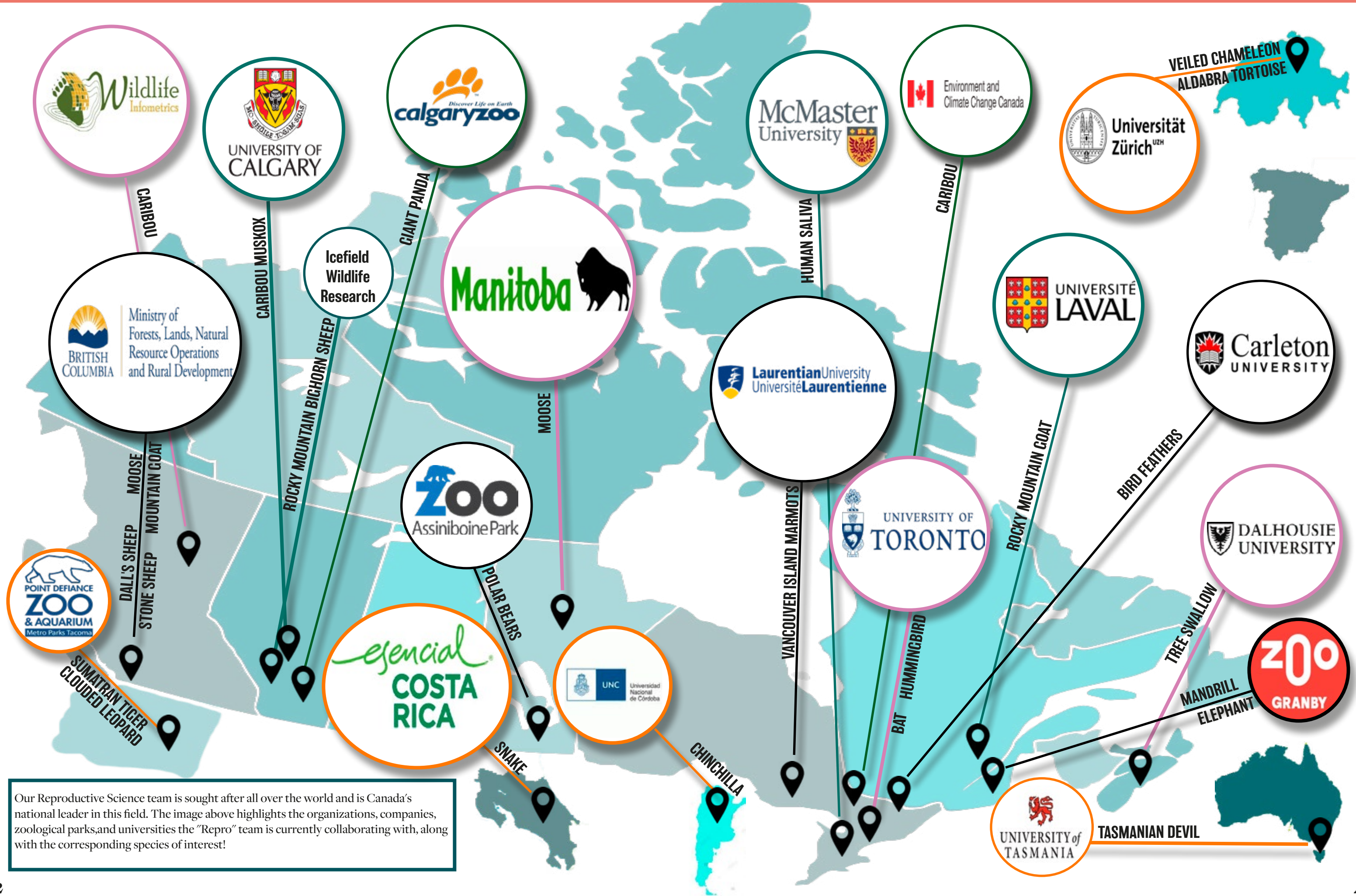
Gamete Collection & Preservation

Various factors, including environment and nutrition, can impact gamete quality and quantity. We assess gamete fitness of breeding individuals for more than 50 species. Any observed fertility-related changes lead to the development of assisted fertilization techniques, including artificial insemination and in-vitro production of embryos. These assisted reproductive technologies (ARTs) are not only necessary to overcome infertility, but facilitate the distribution of genetic material between institutions and continents. In 2017, a wood bison calf was born following the transfer of an embryo produced by in vitro fertilization from wild-caught wood bison at the University of Saskatchewan and shipped frozen to Toronto Zoo.



In the Zoo's cryogenic biobank, sperm, eggs, embryos, and skin cells are stored from more than 50 species, the largest repository of living frozen cells from endangered species in Canada. Long-term preservation of viable biological material, combined with ARTs, will one day play an important role in re-establishing genetically healthy and sustainable populations. These tools will ensure that individuals can contribute to the gene pool long after they are gone.

Toronto Zoo has been involved in wood bison conservation since 1977, and since that time, efforts from various organizations have resulted in the species being down listed from "endangered" to "threatened".



Our Reproductive Science team is sought after all over the world and is Canada's national leader in this field. The image above highlights the organizations, companies, zoological parks, and universities the "Repro" team is currently collaborating with, along with the corresponding species of interest!

Training Highly Qualified Personnel

Our branch is committed to the educational growth and technical training of graduate and post-graduate students interested in natural and assisted reproduction research.

Elucidating variation in somatic cell lines that influence reprogramming potential

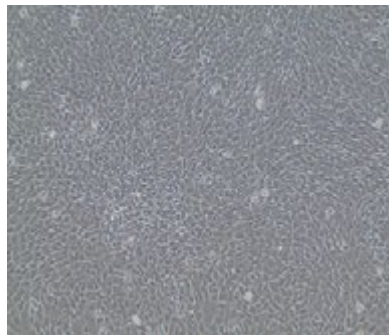
T. Toorani (MSc Candidate), L. Favetta (Co-Advisor), G. Mastromonaco (Co-Advisor)

Toronto Zoo and University of Guelph

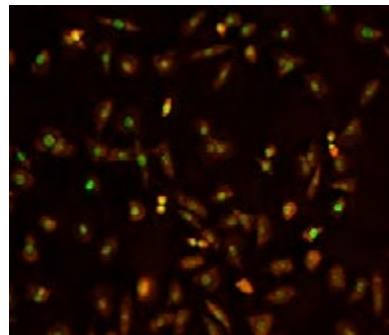
Somatic cell biobanking and related technologies, such as somatic cell nuclear transfer (SCNT), offer significant promise as methods for embryo production for the conservation of wildlife species. However, these technologies have yet to achieve optimal success and fail to produce consistent results. Cell lines from the same individual may also yield different outcomes, corroborating the existence of intra- and inter-individual differences. Researchers evaluate some basic cellular characteristics prior to use in SCNT, such as chromosomal abnormalities and DNA damage, but the necessity for a standardized characterization method for somatic cell lines has become increasingly evident. We aim to elucidate the differences among bovine fibroblast cells grown in culture and determine the possible effects on reprogramming potential, an essential process for successful SCNT.



Chromosomes from a domestic cow fibroblast cell.



Fibroblast cells grown in-vitro (left) and stained to show DNA damage (right).



Determining the effect of epigenetic modulators on the reprogramming potential of bovine fibroblast cells

B. Chan (MSc Candidate), L. Favetta (Co-Advisor), G. Mastromonaco (Co-Advisor)

Toronto Zoo and University of Guelph

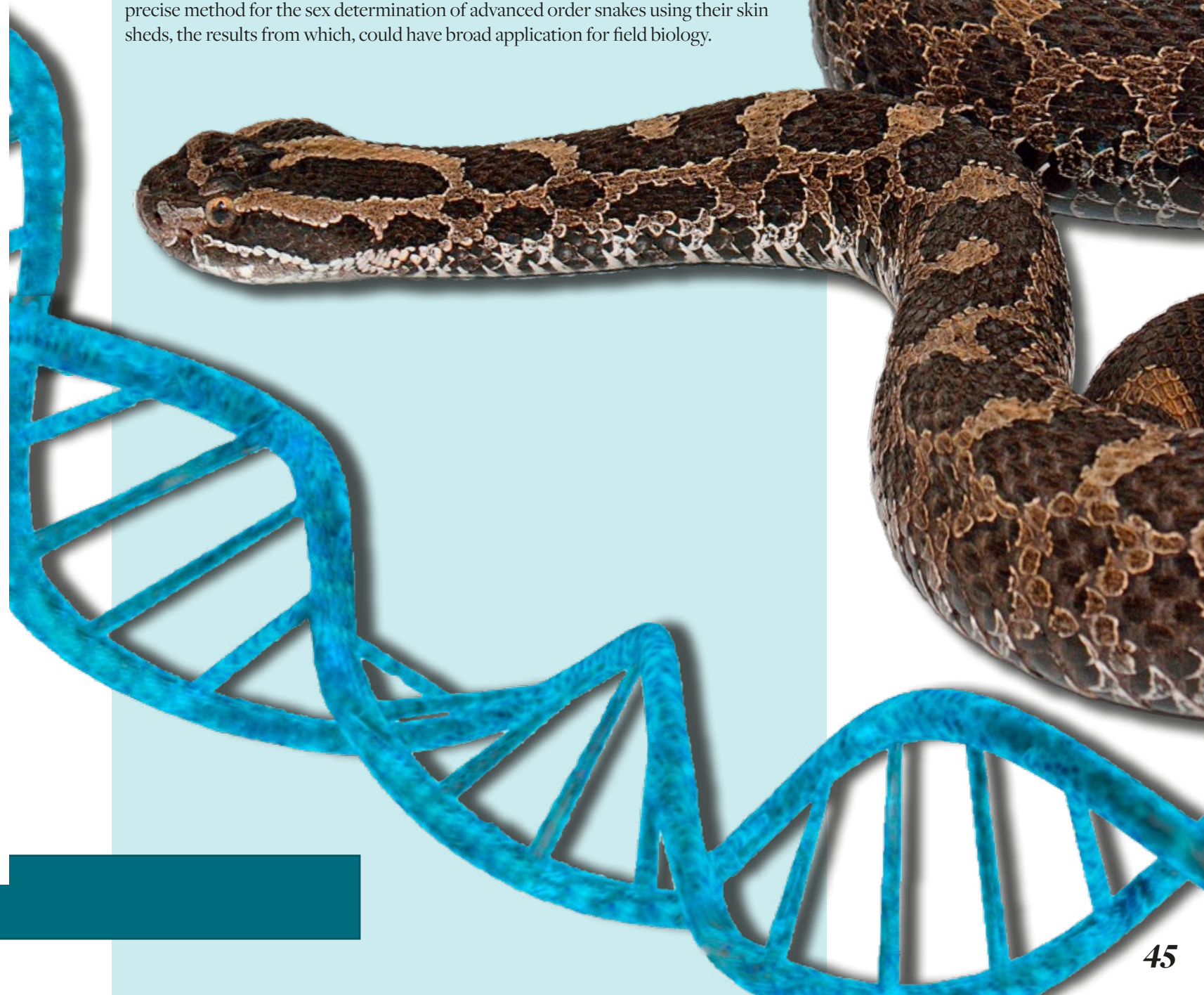
Despite the successful cloning of "Dolly" the sheep and several other mammalian species, somatic cell nuclear transfer (SCNT) is still an inefficient technique with low offspring production. Successful SCNT requires epigenetic reprogramming or resetting of the donor cell nucleus. However, donor cells used for SCNT may vary in reprogramming potential despite coming from the same individual, making it a tedious process. To investigate these issues, we will examine the effect of exogenous epigenetic modulators on bovine fibroblast cells and evaluate the reprogramming potential between different cell lines grown in-vitro. The results of this study will help us further understand the underlying mechanisms that lead to successful SCNT.



Non-invasive sex determination of advanced snakes by qPCR

S. Martone (MBS Candidate), L. Favetta (Co-Advisor), G. Mastromonaco (Co-Advisor)
Toronto Zoo and University of Guelph

Snakes represent one of the most diverse vertebrate groups on this planet and can be found in almost every ecosystem. Population data and accurate estimates are often lacking because of their secretive nature and capturing individuals is not always possible, as it can be dangerous with venomous species. Snakes do, however, shed their skins intermittently to maintain their health, and this cast off skin holds genomic DNA that can be analyzed to determine the sex of the animal; information that is valuable for assessing species population status and overall health. The current method for identifying gender relies on morphometric differences between males and females that is complicated by individual differences and age, leading to inaccurate determinations. Using quantitative PCR (qPCR), we are developing a non-invasive, universal and highly precise method for the sex determination of advanced order snakes using their skin sheds, the results from which, could have broad application for field biology.



Evaluating the thermodynamics of stress in bird species

J. Robertson (PhD Candidate), G. Burness (Co-Advisor), G. Mastromonaco (Co-Advisor)

Toronto Zoo and Trent University

Changes in body temperature following a stressful experience have been documented for nearly two thousand years. Although stress-induced changes in body temperature have now been reported across many species (from fish to lizards, rodents, and birds), the physiological drivers and ultimate value of this “stress-induced fever” remain a target of hot debate. Using wild-caught black-capped chickadees, we tested a new hypothesis that stress-induced changes in body temperature, at the level of the skin, reflect adaptive changes in blood-flow to conserve or dissipate heat that is generated during the stress response (Thermoprotective Hypothesis). Our results supported the Thermoprotective Hypothesis, and showed that chickadees at low temperatures (4 – 14°C) conserved more heat and had colder skin temperatures (as measured around the eye) when stressed than rested, while those at high temperatures (30 – 40°C) dissipated more heat and had higher skin temperatures when stressed than rested. While these findings help resolve arguments regarding the value of stress-induced changes in body temperature, they also raise questions about how organisms may cope with the combined effects of stressful environments and increasing global climate.

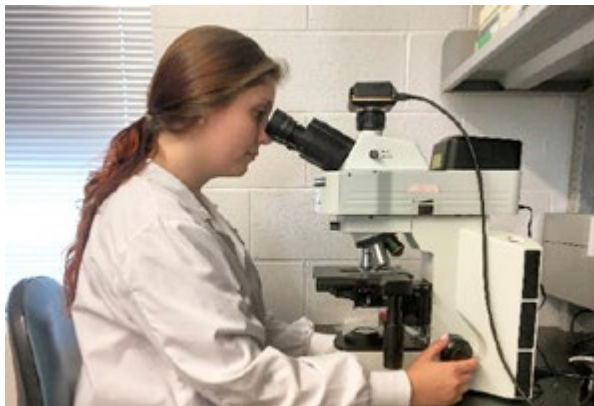


Effects of parasites on captive breeding success in the Eastern Loggerhead Shrike (*Lanius ludovicianus migrans*)

I. Zimmerman (MSc Candidate), A. Schulte-Hostedde (Co-Advisor), G. Mastromonaco (Co-Advisor)

Toronto Zoo and Laurentian University

Parasites are defined by an energetically demanding relationship with their host, which can have detrimental consequences, including lower breeding success rates. We are evaluating the relationship between parasitofauna and reproduction of captive and wild populations of the eastern loggerhead shrike (*Lanius ludovicianus spp.*), an endangered species of passerine bird with raptor-like habits. We will review historical records from the different breeding centres and carry out parasitological exams on fecal samples collected from captive shrikes to evaluate parasite load and diversity, and study their effect on reproductive success. This study may provide further information to support the long term success of this species.



Feature: Collaboration Outside of the Zoo

Flange development of male orangutans in relation to skeletal growth

C. Knott, F. Harwell

Boston University

Male orangutans exhibit a rare phenomenon called male bimaturism where there are two sexually mature forms: unflanged and flanged. All males are born without flanges (prominent cheek pads) as well as other secondary sexual characteristics. Some males flange early in development, while others do not flange until later in adulthood. Likewise, there are males that go their entire lives without flanging. The cause of flanging is still unknown, despite the importance of these secondary characteristics for reproductive behavior and mating success in the wild. Testosterone levels are monitored in two unflanged male Sumatran orangutans by collecting urine samples, since flanged males are known to have higher testosterone levels. Photographs are taken and arm length measured to monitor skeletal growth, as flanged males are notably larger in body size compared to unflanged males. These data are valuable for testing hypotheses related to the cause of flanging and development of these secondary sexual characteristics.

Unflanged Male

Male orangutans can actually exhibit facial differences. This difference is called a flange, so males can either be flanged or unflanged. These flanges are prominent cheek pads that are made of fatty tissue, and play a role in their reproductive behaviour.

Flanged Male



NUTRITION SCIENCE



Nutrition Science Centre

Toronto Zoo has been a leader in wildlife nutrition since the early days of zoo history, being the first North American zoo to hire a professional full-time staff nutritionist. Currently, Toronto Zoo has two qualified staff Zoo nutritionists that help to develop and implement nutritionally balanced and stimulating nutritional programs to all of the animals that call Toronto Zoo home. These specialized programs are designed to meet each animals’ specific needs with an emphasis placed on optimizing health and ensuring the highest level of welfare. Each animal’s diet is carefully evaluated and adjusted, when required, to suit an animal’s individual life stage, health status, and behavioural requirements.



Jaap Wensvoort, full-time Nutritionist.

A small team of nutrition assistants prepare, package and deliver an array of high quality diets to 500+ species and approximately 5,000 individual animals across Zoo site daily. As you can imagine this takes passionate, team-oriented staff to accomplish such a feat! The Nutrition Assistants are on site starting at 6:00am daily, delivering baskets full of prepared diets to the various pavilions and paddocks. Our staff are the first line of quality control for all diet items, carefully inspecting fruits and vegetables, frozen fish, and dry feeds for signs of damage, deterioration or pests, ensuring that only the best items are integrated into diets.

Ultimately, the Nutrition Science Centre hopes to inspire the public to think outside the box and consider the effect food has on the diversity of life on our planet. Animals have evolved spectacular morphological, physiological, and behavioural adaptations to extract nutrients from their habitats that allow them, however small or large, to survive and thrive.

Green Initiatives

Throughout all activities of the Nutrition Science Centre, there is a strong green initiative to re-use items, separate and reduce waste, and to use energy and water resources responsibly. As everyone knows, your kitchen at home produces a large amount of household waste, imagine that times 500! Our staff have worked hard to find ways to reduce the amount of waste and re-direct items from landfill.

In an effort to reduce our reliance on single-use plastics, we have moved to packing all dry feeds (cubes, pellets, seeds, nuts, etc.) in brown paper bags instead of plastics. This switch from plastic to paper has saved approximately 63,000 individual plastic bags from entering the waste or recycling system. To ensure that items are not ending up in the wrong disposal bins, our Green Team representative, Elvira Di Nuzzo, has created Nutrition Science Centre specific garbage, recycling and compost signs. In addition, in an effort to reuse everything we can, Ben Martin, saved our earth worm castings for the Horticulture department to use as compost! We also save large plastic baskets that some of our fresh produce arrive in weekly to pack and organize feeds throughout the year. Furthermore, whenever possible, the Nutrition Science Centre will purchase in bulk to reduce on packaging and plastics. Most notably, this past year, 400 kg of marine oil was purchased in one large container and decanted in-house, into recycled ten gallon buckets. This marine oil is a staple food for polar bear training! Finally, although our staff of six permanent and three non-permanent staff may be relatively small, we still produce a ton of waste. That is why Nutrition staff participate in the Terra-cycle Program, where close to 10,000 pairs of nitrile gloves are diverted from the land-fill to a recycling program every year.



Browse

Browse is a collective term used to describe the edible leaves, twigs, bark, buds, and flowers collected from trees and shrubs. It is considered an essential requirement for the nutrition and welfare of various animals. The variability found in the morphology, volume, and nutrients of browse materials is a vital component of a holistic nutrition program that optimizes health and provides environmental stimulation that encourages natural behaviours.

All Browse Collection Totals

	2015	2016	2017	2018	2019
Fresh (kg)	7400	7200	8700	7500	9800
Silage (kg)	4500	6556	4455	2004	7143
Total (kg)	11 900	13 756	13 155	9 504	16 943

Nutrition staff started off the 2019 browse season by engaging several community partners which has led to our most successful season yet! With a massive donation from a local company, Acorn Development Corporation, of almost 100 apple trees the Nutrition Science Centre has been working like beavers to harvest material for the Zoo’s herbivores. Toronto Zoo is fortunate to have engaged and supportive community partners such as PricewaterhouseCoopers (PWC) and Acorn Development Corporation. PWC and Acorn Development Corporation volunteered to work with Zoo staff and were able to harvest, pack and ensile almost 2,600 kg of apple and pear silage. This is a two year supply of the most favored food item for our Western Lowland gorilla family to munch on over the winter! Not only was silage and fresh apple browse obtained from the donation, there were also numerous truckloads of large branches, trunks, and root stumps used for perching and enrichment, basically natural “furniture” for animal’s habitats.



PricewaterhouseCoopers group helping with the apple tree donation.



PricewaterhouseCoopers group feeding their collected browse to one of our gorilla troops.



Over the years the Nutrition Science Centre has learned that bark is a favored diet item by many species. This prompted us to ensure that nothing goes to waste. Branches left over from silage production or un-stripped branches from the Masai giraffe have a second life as feed for species that are equipped to strip and nibble bark from branches. To supplement the leafy browse provision, browse sticks are stored outside, in coolers and freezers and used for a variety of species including Vancouver Island marmots, two-toed sloth, West Caucasian tur and many more. Once branches are stripped they can be used as perching material or “furniture” for our animal’s habitat or used as mulch used our gardens.



The Nutrition Science Centre continues to be leaders in the supply of fresh and ensiled browse material in North America. Toronto Zoo has shared the schematics of the hydraulic browse press and provided technical expertise to assist other zoos, including Denver Zoological Gardens, Cheyenne Mountain Zoo, Omaha Zoo, Woodland Park Zoo, and Oregon Zoo in building their own sustainable browse program and browse plantation designs.

In many other zoological institutions browse is still seen as an occasional enrichment item, and the amounts given are normally not weighed. Toronto Zoo puts a tremendous amount of effort into quantifying the amount of browse provided across site. Fresh material is weighed out into 5kg, 10kg, or 20kg bundles and delivered to the appropriate areas on site. Browse silage barrels are also weighed to provide an up-to-date inventory to allow for rationing to the highest priority browsing animals. The amounts collected and paired with seasonal nutritional analysis (i.e. protein, fat, fiber, and minerals) allows the Zoo’s nutritionists to more accurately assess the nutritional impact of this essential forage item on an animal’s diet, health, and well-being.



Nutritional Enrichment and Training

Training animals is essential to maintaining their health and well-being. From something as simple as a tiger opening it’s mouth to inspect it’s teeth, to asking a pygmy hippo to step onto a scale, or asking a polar bear for a blood sample, critical information regarding an animal’s health can be obtained through these behaviours and more often than not food is used as a positive motivating factor. Careful consideration needs to be made to ensure the appropriate items and amounts are provided to individuals so that diets remain healthy and balanced. That is why this year we have rolled-out our first point based system for our orangutans to ensure that calories, sugar, and fats are in check as great ape species, similar to humans, are prone to cardiovascular issues.

Special Treats

Enrichment feeding is something the Nutrition Science Centre always tries to help out with. Often on birthdays or holidays special treats are created in coordination with our Behavioural Husbandry Supervisor. This year we helped to celebrate our Western Lowland gorilla baby Charlie’s first birthday with a specially made frozen juice and gel layered cake and cupcakes iced with applesauce. Petal, our 33-year-old river hippo, received a special watermelon filled pool. In addition, we helped to create special Easter treats by dyeing quail and chicken eggs, as well as coconuts for a myriad of species. Just after Halloween we receive donations for pumpkins, and after the holidays we receive Christmas trees that are stored and distributed for festive treats.



Carcass Feeding

The Carcass Feeding Program involves providing large carcass pieces to stimulate animals basal instincts and behaviours such as stalking, tearing, jumping, pulling, purring, and even caching for later. Allowing animals to use their jaw muscles and bones improves their dental health and skull morphology. Carcass pieces also provide “animal fibre” in the form of hair, fur and cartilage. This animal fibre is essential for the proper gastrointestinal health of carnivore. Having extremely high product standards, the Zoo only uses Milliken meats, made with horse meat inspected by the Canadian Food Inspection Agency (CFIA).



Nutrition Advice

The nutritionists in the Nutrition Science Centre provide nutrition resources, guidance, and recommendations to various institutions internationally. They are involved with supporting several breeding and releases programs such as the Vancouver Island Marmot Recovery Team, Loggerhead Shrike Recovery Team, and Black-footed Ferret Species Survival Plan.

Training & Instructing:

The Smithsonian’s National Zoo holds a Wildlife and Zoo Nutrition Management course each spring at their Front Royale Campus in conjunction with the George Mason School of Environmental Sciences. This past session, the Nutrition Science Supervisor, Sarra Gourlie was invited to be a course instructor and helped to teach students about the practical aspects of nutritional management of wildlife. Topics included carcass feeding programs, browse and forage procurement, conscientious integration of training and enrichment feeds, as well as specialized feeding programs for canid and ursid species. Throughout the week students were coached through a feed intake study and diet evaluation.

Nutrition Resident:

The Sue Crissey Animal Residency Fund (SCARF) grant funded postgraduate position was granted to Toronto Zoo’s Nutrition Science Centre by the Zoo and Wildlife Nutrition Foundation (ZWNF). The Nutrition Resident will train at Toronto Zoo to become a zoo Nutritionist, qualified for employment in an AZA and CAZA accredited facility.



Nutrition & Physiology Research

The scientific research and development projects initiated and executed by the Nutrition Science Centre help to increase our collective knowledge of nutrition and physiology of non-domesticated species and support welfare of the animals under our care and conservation of species in the wild.



Assessing the nutritional status of free-ranging and human managed populations of black-footed ferrets (*Mustela nigripes*)

S. Gourlie, J. Wensvoort, M. Franke, B. McGregor, G. Mintha, P. Delnatte

The black-footed ferret is one of North America’s most endangered mammals. This species became part of the breeding and re-introduction program in 1987 when the last known remaining wild individuals were found at a farm in Wyoming. Currently there are only 200 individuals remaining in the wild. In 2000, Toronto Zoo spearheaded an initiative to create a balanced diet that could be fed to all individuals in the breeding program. This diet remains the only commercially available diet endorsed by the Black-footed Ferret Species Survival Plan. In recent years, the breeding population has been affected with reproductive issues with no clear reason as to why. The wild populations appear to have greater reproductive stability, potentially because they have access to a natural diet of various prey species. Although, the managed populations are offered a nutritionally balanced diet composed of whole animals, like rats and mice, as well as the Toronto Zoo Small Carnivore Diet, there still may be something missing. Very little data exists regarding the nutritional composition of wild

prey species, such as prairie dogs, grasshopper mice, and cottontail rabbits. There is even less information known regarding the feeding ecology of this seldom seen, fossorial predator. Toronto Zoo will assess the nutritional status of both wild and human-managed populations of black footed ferrets through blood, fur, and nail samples, in the hopes that improved dietary recommendations can be established. This project is currently seeking funding, through grant proposals.

Effect of provision of partial carcasses on behaviour of Sumatran tigers

L. Steffler (University of Guelph)

The purpose of the study was to determine if feeding partial carcass pieces affected the scope and frequency of behavioural patterns as well as habitat use in Sumatran tigers cared for by Toronto Zoo. A species specific ethogram was developed for the tigers that included behaviour patterns such as feeding, natural behaviours, stereotypic behaviours, and active or inactive. Findings indicated that the provision of carcass pieces significantly influenced the occurrence of feeding behaviours compared to regular diet items and a reduction in pacing behaviours observed several days after carcass presentation. There were no effects on natural behaviour, enclosure use, or active/inactive behaviours observed in other studies. This may have partially been due to the low sample size (only 2 tigers were observed) or that the carcasses were only partial (no skin, fur, or organs). Overall these findings suggest that partial carcass pieces provide an enriching feeding experience that likely improves individual animal’s welfare.



Captive studies to improve diet estimates and bioenergetics modeling of polar bears in the wild

J. Wensvoort, C. Dutton and J. Young (Toronto Zoo), G. Thiemann and M. Glennie (York University), P. Molnar and S. Penk (University of Toronto), I. Duncan (University of Guelph)
Other investigators: C. Robbins (Washington State University), K. Rode (US Fish and Wildlife Service), S. Cherry (Parks Canada)



Due to climate change, it is predicted that some subpopulations of polar bears will diminish in size and some will possibly relocate to other areas. Changes in the distribution and availability of preferred habitat and prey will likely have negative effects on the body condition of polar bears. A more robust understanding of body condition patterns and physiological responses of polar bears would improve the understanding of seasonal feed intake and body condition; essential information, required to better predict the ecological effects of food web changes of polar bears in the wild.

Validation of the Body Condition Assessment of Polar Bears
Mathematical models to determine body composition of polar bears are used at Toronto Zoo and only require measurement of bears straight body length and body weight. Because polar bears at the Zoo, in contrast to being in the wild, can be weighed and measured very accurately, a validation of body condition estimates has been attempted. This integrates the use of bioelectric impedance analysis (BIA) to confirm that the mathematical models are able to calculate the percentage of body fat, an

important aspect of body composition for survival of polar bears during the ice-free period.

Studies on the Behaviour and Physiology of Polar Bears under Human Care

Individual polar bears, within a simulated seasonal feeding program, will undergo periods of varying food supply, to establish relationships between growth/loss and calorie supply. Intensively behavioural observations paired with determining internal body temperature has elucidated that polar bears have some behavioural adaptations to handling the seasonal decrease in energy supply during the summer ice-out period. Throughout the year regular measurements in body mass fluctuations and voluntary blood samples allow us to observe how the biochemical and hormonal markers change during the anabolic and catabolic periods that polar bears experience in the wild.



Feature: Collaboration within the Zoo

Development of a marmot research pellet for improved hibernation robustness

S.Gourlie, J. Wensvoort, J. Aymen, P. Delnatte

The Vancouver Island marmots (VIMs) are a critically endangered hibernating species that inhabit remote alpine meadows at high elevations on Vancouver Island. Their diminishing natural habitat has been a threat to their survival and in 1997 the Vancouver Island Marmot Recovery Team determined that a captive breeding and reintroduction program was essential to save the species from extinction. The breeding and release program has been highly successful, reintroducing hundreds of VIMs back into the wild. Through intensive monitoring efforts it has been determined that first year pups released from the breeding centres do not fare as well as the first year wild born during their first hibernation period. This interesting observation has led to a collaborative project between the Veterinary and Nutrition branches of Toronto Zoo. Successful hibernation is reliant on several factors including adequate body fat stores and the composition of these fats. Little is known regarding the seasonal composition of the plants that VIMs consume in the wild and how they may select plants and plant parts in order to obtain the fatty acids required for a robust hibernation. The Nutrition Science Centre has developed a research pellet with a ratio of omega 3s and 6s more similar to what might be found in early season alpine meadow plants that will be tested by Veterinary Resident, Dr. Jessica Aymen on a model species, the woodchuck at Toronto Zoo, to determine its effect on various markers of hibernation success.

Behavioural Enrichment



What is Behavioural Husbandry?

Have you ever wandered by your favourite animal's exhibit and wondered what that giant ball, plastic jug or cardboard box is doing in there? Those items are in there to serve a very important purpose! Here at Toronto Zoo we use a variety of items, both recyclable and new, to enrich the lives of the animals we take care of. The Toronto Zoo Behavioural Husbandry Program strives to attain the highest level of animal care by developing species appropriate training and enrichment programs. Not only do we have to make sure they have adequate food, water and shelter, we also have to make sure that their psychological health is given top priority. This is referred to as their "behavioural husbandry". Essentially, this means providing animals with as much choice and control in their environment so that they can perform as many natural behaviours as their wild counterparts. We accomplish this by providing various forms of daily enrichment and developing training programs that allow the animals the choice to participate in their own care. Utilizing the natural history of our animals we can provide stimulating natural environments and then take their individual personalities into account to develop specialized enrichment and training programs. Giving animals the opportunity to display these natural behaviours helps to improve both their physical and mental well-being.



Voluntary Training

By using positive reinforcement techniques and scientifically tested methods to train various medical behaviours, our keepers and veterinary staff are able to obtain valuable information about the animals' health without the need for anaesthetic, which is huge! Giving our animals the choice, we have been able to get voluntary blood collection from the polar bears and voluntary foot x-rays from giraffe, Mstari. We are also now actively vaccinating the majority of our animals voluntarily.



Polar bear voluntarily withdrawing blood.

Enrichment Assessment

A key component in developing these behavioural programs, is to first observe our animals. As our keepers work with these animals continually, they are constantly observing them and taking notes on what behaviors they are displaying. We can then provide or develop enrichment items or events that would either increase or decrease desired or undesired behaviour. There are five main categories of enrichment: sensory (using their senses), environmental (ex. climbing, burrowing, etc.), forage/feeding, occupational (ex. grooming, chewing, etc.), and play (i.e. toys). As we learn more about the animals we care for daily we are able to develop more comprehensive programs for both their physical and mental well-being. This dynamic process of assessing the animals' behavioural husbandry ensures that they receive top quality care.

It is important to the Toronto Zoo that our valued guests experience our animals in their natural settings in order to inspire action to conserve their wild habitats. We also love to share how we care for our animals and have incorporated some of our training sessions into daily routines that can be seen on exhibit by our guests. For example, you may be able to watch a training session with one of our polar bears while exploring the Tundra Trek.



Foraging

Many species spend the majority of their day in the wild foraging and essentially working for their food. In order for keepers to keep the animals active and involved throughout the day, we offer them food at various times and in different “toys” or enrichment devices, increasing the time spent searching and working for their food. This allows the animals to display their natural foraging behaviour. In addition to scattering their food, burying it under logs, placing it in enrichment toys, and even freezing it in popsicles, we also add various scents into our carnivore exhibits which encourages them to “hunt” and explore!

Carcass Feeding

Whether through foraging or hunting, finding, and procuring food is of vital importance for survival in the wild. The natural behavioural repertoire for carnivores includes: smelling, licking, clawing, chewing and consumption of all edible parts, and chewing on bones and tearing through skin. Therefore, it is very important that we provide our carnivores with food items large and complex enough to allow them to perform these natural behaviours. This type of enrichment feeding may allow for some animals to have social feeding and digesting experiences.

Stay tuned for our Carnivore Enrichment Feeding Calendar to catch a glimpse of these animals exhibiting their natural behaviours!



Enrichment Feature: Shintay's Den

This past winter, Shintay, our female North American grizzly bear was able to demonstrate her natural instinct to dig a den in preparation for her winter sleep. Although Samson does not partake in the digging, Shintay loves to dig and has a natural instinct to do so! Although she is given the opportunity to dig each year (she tends to dig in the same area as the ground is often softer at the back of her enclosure), our keepers do not want her to actually den up here, so her den is filled in each spring as it is safer for staff and Shintay to “hibernate” in her bear house. Both Samson and Shintay are provided with two indoor rooms (one of which is filled with the bedding material, wood wool) and an outdoor yard. During the winter, our keepers will check on both Shintay and Samson bi-monthly when they are in their houses to make sure they are doing well.



Enrichment Goals and Projects

After observing our animals over time and recording what behaviours they are exhibiting, whether desired or undesired, keepers will develop some enrichment goals. These goals are then turned into projects, where our keepers implement strategies to either reduce an undesired behaviour or increase a desired behaviour. For example, one of last year’s projects for the Sumatran tigers included implementing an enrichment plan to reduce pacing. Strategies incorporated included providing a privacy area, the choice for preferred enclosure, switch-ups, and scattered feeds. These strategies were a success and resulted in the reduction of the female tigers pacing by 64.6% and the males by 53.3%. This is an example of how foraging and environmental enrichment can change an animal’s behaviour.

Enrichment Giving Tree

In December of 2018, Toronto Zoo held its first ever Enrichment Giving Tree! As it was such a success, the Giving Tree continued in 2019. The tree was located in the Zootique Gift Shop and was filled with requests for enrichment items from the Zoo keepers. Requests included hair brushes, coffee, and perfume, as well as hoof stock balls, bubble machines and drones, to help care for the animals. Guests donated money that went towards providing our animals with special enrichment items at Christmas. Thanks to our wonderful guests, we managed to raise \$5,519 for our animals.



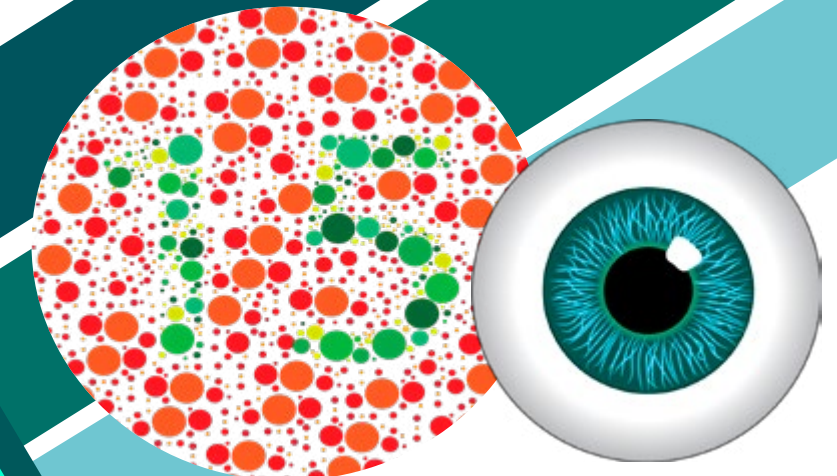
Behavioural Research

Do orangutans choose to choose?

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The purpose of this study is to gather baseline data on Sumatran orangutan choice behaviour, using a computer touch screen setup. The orangutans are familiar with the touchscreen, having used it for many years for enrichment. In this study, individual orangutans are presented with a computer 'game' that will let us determine whether—and to what extent—they prefer having control and choice over the outcomes of the game. The data will be used to help us design games and enrichment for the orangutans, which can be incorporated into their new outdoor exhibit.

The objectives of this project are (a) to provide orangutan cognitive stimulation and enrichment, (b) to determine if orangutans share human and monkey preference for free-over forced-choice, and (c) to determine if orangutans choose to choose even when the alternative (i.e., not having a choice) is appealing in other ways.



Assessing the potential for visual and behavioural cues of reproductive ability in Golden Lion Tamarins (*Leontopithecus rosalia*)

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This study will investigate whether colour changes occur with age and puberty and across ovarian phase/estrous in the bare skin of tamarin monkeys (*L. rosalia*). The evolution of concealed versus advertised ovulation in mammals is of enduring interest to biologists because it plays a key role in governing mechanisms of sexual selection. Facial colouration varies across the menstrual cycle in many Old World monkeys (OWM), but this phenomenon has not yet been studied in New World monkeys (NWM).

However, recent research has revealed subtle yet perceptible changes in female skin colouration during pregnancy, which may trigger males to prepare for care giving in species with high paternal care. The role of skin colour signals in socio-sexual communication in NWM is an under-explored area with great potential for discovery. In addition, colour vision is highly variable within NWM. Individuals can be either dichromats (red-green colour blind, all males and some females) or trichromats (colour normal relative to humans, some females). Many studies have highlighted the role that social and sexual selection plays in the evolution of colour vision in OWM, but in NWM this is a relatively new area of inquiry. The study will shed new light on these topics by 1) investigating the potential role of facial skin colour as an indicator of age and sexual maturity in a New World Monkey species, the golden lion tamarin (*Leontopithecus rosalia*), 2) investigating the potential role of facial colour as cues of estrous in female golden lion tamarins, and 3) modeling whether variation in facial color is perceptible to group members possessing different colour vision phenotypes.