



● Animal Collaborator
● Plant Collaborator

INTERNATIONAL
 5 Canada
 5 2 UK
 4 Brazil
 2 UAE
 1 Indonesia
 1 South Africa



Dr. Terri L. Roth
 VP of Conservation & Science and Director of CREW

ROTH'S REMARKS

Collaboration—the Key to CREW's Success

CREW's *Signature Project* strategy has been pivotal in its laudable efforts to help save targeted species from extinction, but that strategy relies on numerous colleagues, zoos, aquariums, botanical gardens, universities, NGOs, private individuals and governments all working with us to achieve our mission. Just in the past 10 years, CREW staff have partnered with hundreds of individuals and over 150 organizations spanning the globe from Indonesia to the United Kingdom to Brazil, but the majority of our partnerships are in North America where our work heavily depends on the participation of zoos and botanical gardens across the nation. A common thread of collaboration runs through the articles in this fall's CREW ReView. The new rhino initiative (AIRS) introduced in the center spread is built on a coalition of the nation's

expert rhino scientists, efforts to save the Texas ocelot working with private ranchers, universities, zoos and government agencies, in depth polar bear serum hormone analyses made possible by hundreds of samples sent to CREW from partner zoos, and the genetic documentation of the endangered Todsén's pennyroyal concluding a 15-year partnership with the Department of the Army in New Mexico, all demonstrate how CREW's work depends on team efforts. In a world where similar organizations often compete with each other and each boasts that they are better than the rest, we at CREW have a different philosophy; It is BECAUSE of others that CREW is better able to achieve its mission. So, to all our partners, supporters and collaborators, whether you are providing a single biological sample or serving as co-PIs on joint projects, we are so very grateful to each and every one of you for joining with us in our critical efforts to save species with science - together.

PLANT SIGNATURE PROJECT

Putting Pawpaw Protocols into Practice



The native pawpaw, or custard apple, naturally captures attention because it produces our largest native edible fruit. CREW's Plant Lab has worked with three, more rare, endangered pawpaws from Florida for a number of years—the four-petal pawpaw, the beautiful pawpaw, and the Rugel's pawpaw—and has developed both propagation and cryopreservation protocols that have been successful with all three species. Over the past three years, the Plant Lab has been a partner in a multi-institutional project, funded by the Florida Department of Agriculture and Consumer Services, to facilitate the conservation of the Rugel's pawpaw, which is found only in Volusia County in Florida. The project is comprehensive, including field surveys and land management of the

remaining populations, genetic and microbiome research, and cryopreservation and reintroductions, the last two being the areas involving CREW. Shoot tips from 54 plants of the few remaining wild populations were collected by partners from Bok Tower Gardens, the Missouri Botanical Garden, and YBE Consulting, Inc., representing a wider genetic sampling than we have had previously. Over 40 of these were uncontaminated in initial culture and 25 established propagating shoot cultures. Of these, we have rooted and acclimatized almost 100 plants to send to Florida and have cryopreserved 11 genotypes thus far. This project has given us the opportunity to build on the protocol development funded by the Institute of Museum and Library Services (IMLS) many years ago and contribute directly to the conservation of this rare, Florida species.

Reducing Iron May Be a Key to Oak Propagation

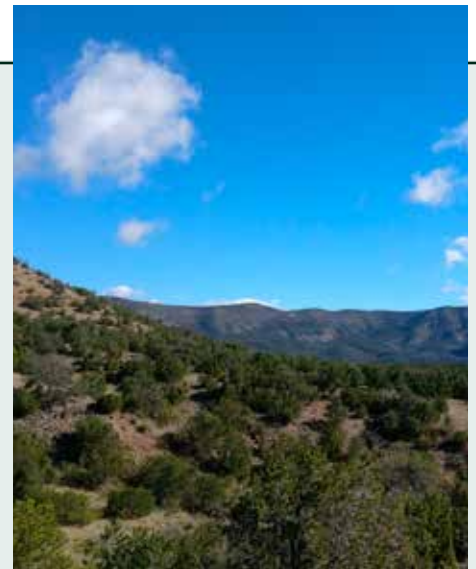
Like rhinos, oak tissues in culture may be harmed by too much iron. When it comes to propagating plants *in vitro*, there are a lot of components that go into making the growing medium. In addition to substances like hormones and gelling agents, ensuring that the plants have the right nutrients is vital to promoting their growth. Getting these conditions right is especially important in speeding up the growth of plants that have a tendency to drag their feet, like oaks. Hinckley's Oak (*Quercus hinckleyi*) is a critically endangered oak species that CREW has been working with for many years. However, getting enough material to propagate or cryopreserve can take quite a while, which is why we decided to look into optimizing which nutrients we include in our culturing medium. After breaking up the various elements into several groups and co-varying them together, we identified at least one factor that seems to be related to the production of new buds. Across all of the different treatment groups, iron and its chelating agent EDTA seemed to be strongly correlated with how the shoots developed. Lowering the amount of iron appeared to greatly increase the number of new buds produced, up to double that of the control, while increasing the amount of iron resulted in very few buds. Although CREW scientists have published several papers on iron overload in rhinos, this is our first report of iron's detrimental impact on a plant species. Fortunately for the oak cultures, there is an easy fix; sadly for the rhinos, that is not the case.



Hinckley's Oak (*Quercus hinckleyi*) *in vitro*

Fifteen Years of Pennyroyal Makes for a Well-protected Species

CREW's Plant Research Division has just completed a 15-year study in collaboration with the Department of the Army (DoA) to document the population genetics of Todsens's pennyroyal (*Hedeoma todsenii*). In total, we've sampled 585 individuals across 15 populations! *Hedeoma* grows on two opposing mountain ranges in New Mexico with about 50 miles separating them. It's thought that the species is a relict that thrived across the range 10,000 years ago when New Mexico was much cooler and wetter. As the climate warmed, populations kept moving further up the two mountain ranges in search of a suitable climate. It's no surprise that the populations on the two ranges appear very different from one another now, as there's likely very little gene flow between them. *Hedeoma* is also notorious for reproducing clonally in the wild, so we weren't surprised to find that genetic diversity is low within populations. However, most populations within an individual mountain range appear fairly similar to each other genetically, with the exception of one population with higher than expected diversity. Using these results, we're confident that the populations on the mountain ranges managed primarily by the DoA are comprehensively protected *ex situ* in our CryoBioBank, and that the diversity of our cryopreserved collection closely matches the diversity of the wild DoA populations. Using genetic and cryopreservation techniques, we've ensured that these plants will be around for years to come, despite the challenges they face with a further changing climate.



Todsens's pennyroyal's natural habitat, and in bloom in CREW's Endangered Species Garden

Solving the Melicope Cryopreservation Mystery

Last fall, CREW's Plant Research Division was excited by the prospect that *Melicope mucronulata*, our most recently banked species in our IMLS-funded project to cryopreserve endangered Hawaiian plants, may be more genetically diverse than we had originally thought. Seedlings from the same mother plant, which we expected to be genetically similar, had entirely different reactions to cryopreservation protocols. Once pulled from liquid nitrogen, we saw that *Melicope* survival rates varied from 0% to 60%. Varying survival makes developing a universal cryopreservation protocol challenging. Last year we compared a banking protocol developed by the USDA for citrus plants to CREW's standard cryopreservation protocol. Both the CREW and USDA protocols had different preculture and recovery media. We broke down the experiment and performed cryopreservation on a combination of the four media focusing specifically on genotypes with less than 40% survival following the original CREW protocol. Interestingly, the USDA preculture medium combined with CREW recovery medium had the highest survival rates, and this combination protocol boosted survival of low surviving genotypes from 1.5% to 6.8%. This number is not the desired 40%, but we combatted the problem by banking replicates for over 360 tips from low surviving genotypes over a 6-month period. Presently, there are 870 *Melicope* propagules banked proportionally according to their survival. Should CREW's banked *Melicope* ever be needed, we have adequately conserved the genetic diversity of the original population that we received from Hawaii.



Four-month-old *Melicope mucronulata* plant growing after successful cryopreservation.

IMPERILED CAT SIGNATURE PROJECT

A Deceased Texas Ocelot Gets a New Lease on Life



Camera trap photo of wild Texas ocelot, later killed by a car.

Just months after his untimely, accidental death, a wild Texas ocelot has been given another lease on life by scientists from the Laguna Atascosa National Wildlife Refuge (LANWR) and the Cincinnati Zoo's Center for Conservation and Research of Endangered Wildlife (CREW). Late in the evening of May 17th, a 9-year-old wild male ocelot was hit by a car just outside of the Refuge near the tip of South Texas. Dr. Hilary Swarts, a biologist with the United States Fish and Wildlife Service (USFWS), and Dr. Tom deMaar, a veterinarian at the Gladys Porter Zoo, recovered his body a few hours later and shipped the chilled testes overnight to the Cincinnati Zoo. The following morning, CREW's Dr. Bill Swanson processed the reproductive tissues, recovering ~250 million motile

sperm and freezing 20 semen straws for future artificial insemination (AI) procedures. This male's first opportunity to become a father by frozen semen AI occurred on July 28th at the ABQ BioPark in Albuquerque, New Mexico. Their female ocelot, Lucy, responded to her ovarian synchronization treatment with eight fresh ovulations and was inseminated with ten million motile sperm from the deceased male. If Lucy conceived, she is expected to give birth in mid-October to one or more kittens. A successful AI will demonstrate, for the first time, the feasibility of producing kittens using frozen semen obtained from the imperiled Texas ocelot population, comprised of just 60-80 cats living in the wild. The application of reproductive technologies for ocelot propagation is one component of an ongoing collaborative program involving CREW, USFWS, Texas A&M University, University of Tennessee, and the East Foundation to ensure the continued survival of wild ocelots in their native Texas habitat.

Cat Wheel Puts a New Spin on Enrichment

During these COVID-times, I'm sure many of you have turned to exercise to help manage stress, burn energy, control your weight, and stay both mentally and physically healthy. Well, would you be surprised to know that our CREW cats have also embarked on a wellness journey of their own? Earlier this year we had two generous donations of *One Fast Cat* exercise wheels. Through positive reinforcement we were able to train our kitten groups to use the exercise wheels, and let me tell you, they get used A LOT!! Wild felids are exceptional hunters that spend considerable time and energy tracking prey, but indoor cats don't have to look far for their next meal so they typically expend much less energy than their wild counterparts. As a result, weight gain and boredom can ensue. Fortunately for the domestic cats at CREW, the indoor version of hunting is play time, so having the exercise wheels available as an outlet for all their pent-up energy has been a real game-changer. Providing novel enrichment experiences that enable the animals to express species-typical behaviors and promote physical and mental well-being is a big part of our animal care program. Natural feline behaviors include climbing, scratching, hiding, perching, and hunting, and having items like the exercise wheels, play structures, hiding boxes, puzzle feeders, tunnels, and scratchers available allow for behavioral choice and keep our cats happy, healthy, and engaged. As animal care staff, we are always looking for new ways to incorporate enrichment into the animal environment, thus we are very thankful for the continued support of our donors who allow us to be creative in what we can offer our feline friends.



Special thanks to our *One Fast Cat* exercise wheel donors: Roger and Kathy Gross, Debbie Maruffi, Diane Vogelsang, Jessica Ruebusch, Donna Mancini, and Deanna Behrens.

If interested, please use your smart phone or tablet to scan the QR code provided and enjoy a video of our CREW cats enjoying their new exercise wheels!



Big Cats – Big Challenges – CREW’s Solutions!

In 2020, CREW was awarded a prestigious grant from the Institute of Museum and Library Services to help advance assisted reproductive technologies, such as semen banking and artificial insemination (AI), for the conservation of big wild cats. In just the past year, CREW’s Team Cat was able to perform 27 reproductive procedures in tigers, jaguars, snow leopards, and lions. Our main finding thus far - big cats come with even bigger challenges! For example, our standard technique for AI, using laparoscopy to deposit semen directly into the oviducts, was developed initially in small cats. While we have used this technique to produce one pregnancy in a tiger and jaguar in past years, it is not easily applicable to large animals that can weigh as much as 350 pounds. Large cats are just more difficult to safely anesthetize, transport and handle for laparoscopic procedures than smaller-sized felids. In response to this big (cat) challenge, Team Cat is modifying an older AI approach, more commonly used for dogs, called transcervical artificial insemination (TCAI). For TCAI in cats, a rigid endoscope is used to navigate through the female’s distal reproductive tract, visualize the cervix and pass a catheter into the uterus. This approach is non-surgical and can be conducted in the female’s holding area. However, one disadvantage is the inability to visualize the ovaries and uterus to ensure proper ovarian synchronization and reproductive health for conception. To overcome this challenge, we are incorporating another technological solution – transabdominal ultrasonography. Thanks to generous gifts from CREW donors, a high-resolution ultrasound machine was acquired that can provide detailed images of reproductive tissues in large cats. TCAI and ultrasonography present viable solutions to some of our most-pressing reproductive challenges and hopefully will result in big returns for our big cat conservation efforts in years to come.



The Science of Herding Cats (it involves Fitbits!)

Have you ever wondered what your cat is doing at home while you are away at work? These are actually the types of questions that CREW scientists ponder every day – but all in the name of science (and cat welfare)! As one component of CREW’s ongoing research to improve health and wellbeing of cats in shelters, we are developing novel methods to assess and quantify activity levels in domestic cats. For activity monitoring, one standard method requires continual video recording followed by manual reviewing of hours and hours of digital footage. As an alternative, CREW’s Team Cat has been exploring the use of high throughput methods to monitor feline activity levels 24-hours a day by adapting human activity trackers (Fitbits) for cat use. Our first feline “activity collar” was created by sewing a small pouch, housing a Fitbit Zip activity tracker, onto a breakaway cat collar. For validation, we recorded video of one cat for 8-days and manually scored her activities for each individual minute for comparison to data from the Fitbit. Statistical analysis revealed that the Fitbit accurately matched 82% of the hand scored activity throughout the day, confirming that Fitbits are a reliable method for monitoring relative activity levels of cats. This high throughput activity tracking technology is now being incorporated into our larger feline welfare study to evaluate and compare housing conditions at shelters. Three local shelters (SPCA Cincinnati, Ohio Alleycat Resource, Cincinnati Animal CARE) are currently collaborating with CREW and the University of Cincinnati for this study utilizing these collars. Our findings will help to determine the best housing arrangements to keep cats active and healthy in shelters until they can be adopted into their forever homes (where their pet parents likely will wonder what they do all day!). *(This study was funded by the Joanie Bernard Foundation.)*



American Institute of Rhinoceros

CREW is partnering with The Wilds, Disney's Animals, Science and Environment, George Mason University, the South-East Zoo Alliance for Reproduction & Conservation, and Stellenbosch University, South Africa, on a new, big initiative, taking rhino science and collaboration to a new level while helping to save rhinos from extinction.

AIRS in a Nutshell

AIRS is led by a coalition of expert rhino scientists and is founded on the partnership between CREW (with its renowned *Rhino Signature* Project), and The Wilds (one of the most successful rhino breeding and management facilities). This large coalition will employ a multidisciplinary, integrative strategy to overcome the four greatest scientific challenges to sustaining rhino populations within our nation's zoos. The team recognizes that the scientific challenges are inter-related, and studying one of them in isolation will fall short of what could be achieved by tackling all of them together. In short, **the whole is greater than the sum of its parts**. AIRS will consist of a diverse, inclusive team of scientists in all stages of their training/careers. The project will produce science-based, affordable and feasible management recommendations for monitoring and controlling physical condition, iron overload, and reproduction, while ensuring optimal rhino well-being. This program will set a precedent for saving species with science in zoos, a model with value for all species at risk in the wild. (AIRS is supported by a grant from the Institute of Museum and Library Services #MG-249011-OMS-21.)

The AIRS Team

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Cincinnati Zoo/CREW

Co-PIs/Team Leaders:

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George Mason University

Lara Metrione, PhD
South-East Zoo Alliance for
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Consultants:

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Michigan State University

Kari Morfeld, PhD
For Elephants, Inc.

AIRS Partners

AZA Rhinoceros Taxon Advisory Group
AZA Eastern Black Rhino Species Survival Plan
AZA Greater One-Horned Rhino Species Survival Plan
AZA White Rhino Species Survival Plan
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Buffalo Zoo
Cleveland Metroparks Zoo
Columbus Zoo & Aquarium
Detroit Zoological Society
Fossil Rim Wildlife Center
Indianapolis Zoo
International Rhino Foundation
Jacksonville Zoo and Gardens
Lincoln Park Zoo
Lion Country Safari
Lowry Park Zoo
Maryland Zoo
Milwaukee County Zoo
Museum of Osteology
North Carolina Zoo
Sedgewick County Zoo
Skulls Unlimited International, Inc.
White Oak Conservation



Science (AIRS) A model for saving species with science *ex situ*



Dr. Mandi Schook
"I am so excited that AIRS gives us the foundation to look at how physical fitness relates to health, wellbeing, and reproductive success in a holistic way across rhino populations."



Dr. Terri Roth
"Rhino iron overload disorder has stumped scientists for decades, but with so much expertise and diverse experience within AIRS, already novel approaches have evolved for studying this phenomenon."



Dr. Michele Miller
"AIRS offers the rare opportunity to apply new techniques for tackling key rhino health issues while comparing wild and human-managed rhinos."

PHYSICAL FITNESS

IRON STORAGE

The whole is greater than the sum of its parts



Dr. Elizabeth Freeman
"By demonstrating the importance of integrative research and the strength of women in STEM, AIRS is a model for training the next generation of conservation scientists."



Dr. Parker Pennington
"The AIRS partnerships provide a unique opportunity to learn from The Wild's historical success and develop new and innovative ways to support rhino reproduction into the future."

REPRODUCTION

WELLBEING

Dr. Lara Metrione

"Promoting the wellbeing of rhinos in our care is at the heart of what we do. The interdisciplinary approach of AIRS is the best way for us to comprehensively understand how to help our rhinos thrive."



Dr. Jan Ramer

"The Wilds is honored and excited to be a part of this program. Our successful rhino breeding herds and talented, experienced animal management staff make The Wilds an invaluable resource for this important work."



POLAR BEAR SIGNATURE PROJECT

In a Thawing World, Freezing May be the Answer

Polar bear survival is intricately woven with abundance of sea ice, which due to climate change, is disappearing at alarming rates. The development of assisted reproductive technologies (ARTs) such as artificial insemination in tangent with techniques like semen collection and cryopreservation can aid conservation efforts by supporting population management and preservation of genetic diversity. Over the last decade, CREW scientists have conducted 30 procedures to collect semen from 13 male polar bears in North American zoos. Samples were collected from live bears via electroejaculation (EEJ) or urethral catheterization (UC) and sperm were rescued from the testes of deceased males. Though commonly used to collect semen from a variety of other species, EEJ was only successful ~17% of the time and sample volume was low. UC was a much better option working 75% of the time. Interestingly, most of the UC procedures that failed occurred outside of or very early in the breeding season, suggesting sperm production does not occur during the non-breeding season. Sperm rescue was only successful 50% of the time, and once again, appeared season-dependent. Over the years, many semen extenders, used to support sperm survival during cryopreservation, were tested in an effort to find the best choice

for polar bears. As perhaps to be expected from an arctic species, polar bear sperm was not a fan of coconut-based extenders, immediately dying in the presence of this tropical killer. However, egg-yolk-based and lab-designed extenders performed with much more success, suggesting a more traditional, yet innovative preference by these picky cells. Though there is still more work to be done in evaluating techniques for collection and cryopreservation, thus far, multiple samples have successfully been banked for use in future reproductive efforts, hopefully providing some chill to the sweltering situation. *(This work was made possible in part by the Institute of Museum and Library Services grant # MA-30-18-0461-18.)*



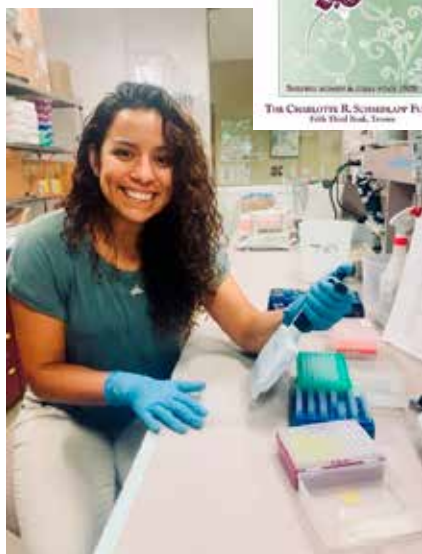
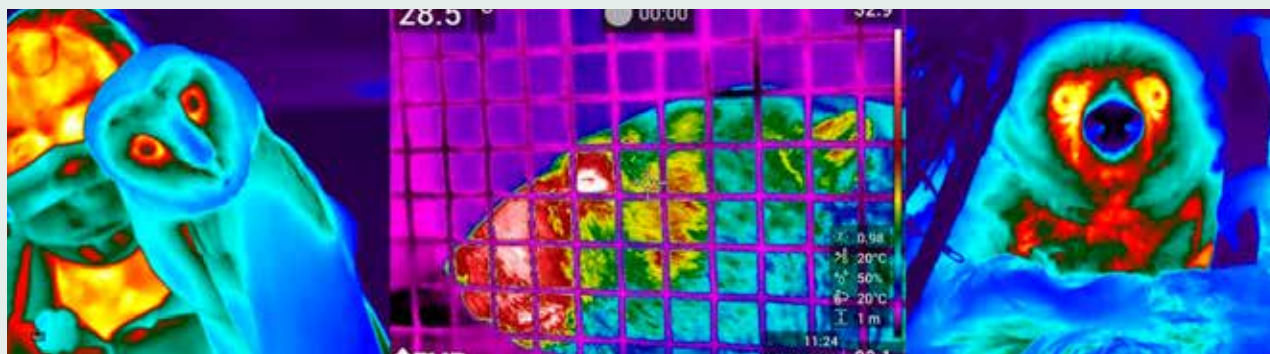
Why Measure One Hormone When You Can Measure Them ALL?

CREW Wildlife Physiologist Dr. Jessye Wojtusik was recently awarded a First Award Grant from the Morris Animal Foundation in the amount of \$92,388 over two years for her project entitled “Investigation of serum hormones as biomarkers of reproductive health in polar bears”. This grant is the very first ‘First Award’ granted to a CREW scientist and will provide support for developing a multiplex assay to measure multiple hormones simultaneously in polar bear serum samples. Maintaining healthy, diverse, and sustainable polar bear populations is critical to species survival. Unfortunately, reproductive success in U.S. zoos is dwindling, and cubs are not produced quickly enough. Reproduction in polar bears is complex; they experience embryonic diapause, delayed implantation, and sometimes, pseudopregnancy. These complexities make it difficult to determine when or why reproduction is failing. Monitoring hormones can help to determine what is going wrong, but which hormone, out of the dozens, holds the key? Thanks to this grant, an answer may be on the horizon. Advances in polar bear operant conditioning have resulted in the collection of hundreds of serum samples from happy-to-participate-for-a-treat bears. This multiplex technique will not only reduce the amount of valuable biological sample required, but will also help in assessing hormones quickly and efficiently. This study will advance the goals of CREW’s Signature Polar Bear Project, greatly enhance our understanding of hormones impacting reproductive processes in this species, and hopefully provide insight into why reproduction is failing and what can be done about it.



Psychedelic Snapshots for Science

Imagine if we could fly a drone over wild polar bears on the Arctic sea ice and assess their health, completely non-invasively? In collaboration with scientists from Woods Hole Oceanographic Institution (WHOI), CREW researchers are evaluating infrared thermography (IRT) to measure animal heart rates, respiration rates, and body temperature, which are indicators of animal health. Prior to implementation in a field setting, it is necessary to validate this technique by comparing direct measures of vital signs to those obtained via IRT to confirm that they are the same. Fortunately, zoological institutions like the Cincinnati Zoo & Botanical Garden provide unique opportunities to image a wide variety of species. CREW and WHOI scientists recently began collecting IRT images and video, while concurrently using a stethoscope to measure heart rates of ~50 different species. Preliminary results indicate that respiration is clear in nearly all species, as denoted by warm air coming out of the nostrils or mouth. Heart rate is more challenging because the motion of chewing/licking renders it difficult to distinguish changes that are due to facial muscle movements versus true pulse rate. However, by analyzing a small focal point between the eyes of a gorilla, scientists were able to calculate an oscillation in thermal temperature that matched precisely with the animal's heart rate, which was taken at the exact same time. Ultimately, this technology will be paired with unmanned aerial systems (drones), which may allow data to be obtained rapidly from a greater number of individuals using entirely non-invasive remote sensing.



Meet CREW's Animal Division 2021 Charlotte R. Schmidlapp Scholar

Ms. Maria Luna Rodrigo joined CREW in May as the Animal Division 2021 Charlotte Schmidlapp Scholar, an exceptional opportunity granted by the Charlotte Schmidlapp Fund which sponsors the advancement of promising young women in STEM fields. A Miami, Florida native, Maria earned her Bachelor's degree in Wildlife Biology and Conservation from the University of Alaska Fairbanks (UAF). While working at the Alaska SeaLife Center and UAF's Animal Resources Center, Maria cared for species ranging from arctic ground squirrels to harbor seals and muskox. After graduating, she spent several years as a marine mammal trainer at Discovery Cove in Orlando before returning to academia. Recently, as part of her Master's degree through Miami University's Project Dragonfly program, Maria traveled to Guyana to spend several weeks in the jungle learning field techniques from the indigenous Makushi tribe, as they build a sustainable future and guide conservation initiatives through traditional wisdom. During her internship at CREW, Maria hopes

to gain more laboratory experience which she will obtain by evaluating the use of a hormone, PGFM (13,14-dihydro-15-keto-prostaglandin F₂), as a biomarker of pregnancy in polar bear fecal samples. An accurate, non-invasive pregnancy test would be beneficial for improved husbandry and management of zoo bears, would provide a new tool for monitoring wild populations and the impacts of environmental stressors on pregnancy rates, and may be useful in pinpointing the timing of reproductive failure in females that breed but fail to produce cubs.

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Mrs. Kelly Young

SCIENTIFIC HIGHLIGHTS

PEER-REVIEWED PUBLICATIONS

Culley TM, **M Philpott**, R Tunison, BJ Merritt, JM Barreiro Sanchez, A Wafer and R Holdren. 2021. Research inequity in the plant sciences. *Applications in Plant Sciences* 9(4). <https://doi.org/10.1002/aps.3.11417>.

Curry E, M Skogen and **TL Roth**. 2021. Evaluation of an odour detection dog for non-invasive pregnancy diagnosis in polar bears (*Ursus maritimus*): Considerations for training sniffer dogs for biomedical investigations in wildlife species. *Journal of Zoo & Aquarium Research* 9:1-7. <https://doi.org/10.19227/jzar.v9i1.568>.

Pence VC, **D Ballesteros**, C Walters, BM Reed, **M Philpott**, KW Dixon, HW Pritchard, TM Culley and **A-C Vanhove**. 2020. Cryobiotechnologies: Tools for expanding ex situ plant conservation to all plant species. *Biological Conservation* 250:1-8.

Pence VC and **MF Chaiken**. 2021. Shoot tip cryopreservation as a conservation tool for species of *Quercus*: Effects of species and environment on recovery. *CryoLetters* 42:159-167.

GRANTS AWARDED

Funding Source: The Institute of Museum and Library Services. Project: American Institute of Rhinoceros Science (AIRS) – a model for saving species with science *ex situ*. Role: Principal Investigator. Duration: 9/1/21-8/31/24. Amount: **\$877,678**.

Funding Source: Joanie Bernard Foundation. Project: Improving the health and welfare of shelter and community cats. Role: Principal Investigator. Duration: 01/21-01/23. Amount: **\$217,000**.

Funding Source: The Institute of Museum and Library Services. Project: Enhanced stewardship of polar bear collections. Role: Principal Investigator. Duration: 9/1/21-8/31/23. Amount: **\$196,462**.

Funding Source: Morris Animal Foundation. Project: Investigation of serum hormones as biomarkers of reproductive health in polar bears (*Ursus maritimus*). Role: Principal Investigator. Duration: 11/1/21-10/31/23. Amount: **\$92,388**.

Funding Source: Michelson Found Animals Foundation. Project: Non-surgical sterilization of prepubertal domestic cats. Role: Co-Investigators. Duration: 03/21-03/22. Amount: **\$61,000**.

Funding source: Association of Zoological Horticulture. Project: Advancing cryobiotechnology research, networking, and information sharing for oak conservation. Duration: 11/1/20-10/31/21. Amount: **\$6,700**.

Funding source: International Oak Society. Project: Advancing the ex situ conservation of oaks using cryopreservation. Duration: 4/1/21-12/31/22. Amount: **\$5000**.

CREW WISH LIST



Help us in our mission of
Saving Species with Science!

FLIR C5 COMPACT THERMAL CAMERA

These will be used to obtain temperatures from polar bears and other species to determine if temperature shifts near the time of ovulation and embryo implantation. **Cost: \$560 each.** (need two)

ANTIBODIES

Needed to pre-treat plates for a variety of endocrine assays. One antibody aliquot is enough for 170 plates (or ~6,000 samples)! **Cost: \$325.** (need several each year)

SCIENTIFIC PRESENTATIONS

Bridgens R. 2021. Importance of genetic analysis in the conservation of threatened Hawaiian plant species. Botanical Society of America Annual Meeting online. Oral presentation.

Pence VC. 2021. The tip of the iceberg: What we know and don't know about exceptional plants. Virtual Center for Plant Conservation Annual Meeting. Oral presentation.

Pence VC and E Beckman. 2021. Scratching the surface: The critical need for *in vitro* research on exceptional plants. *In Vitro Cellular and Developmental Biology–Plant* 57:550-551. Virtual *In Vitro* Biology Meeting. Interactive poster presentation.

Pence VC and E Beckman. 2021. Cryopreservation of exceptional plants: What we do and don't know. Virtual Cryobiology 2021 meeting. Oral presentation.

Pence VC, E Beckman, A Meyer, H Pritchard, M Westwood, J Linsky, and J Gratzfeld. 2021. The tip of the iceberg: What we do and don't know about exceptional plants. Virtual Botany 2021 meeting. Oral presentation.

Pence VC, A Meyer, J Linsky, J Gratzfeld, H Pritchard, M Westwood, and E Beckman. 2021. Exceptional plants: Defining the diversity of barriers to conventional seed storage to improve conservation strategies. Virtual International Society for Seed Science, (ISSS) 2021 meeting. Invited oral presentation.

Philpott M, TM Culley and **VC Pence**. 2021. Population genetic analysis and *ex situ* conservation of the endangered exceptional species *Hedeoma todsenii*. Virtual Botanical Society of America Annual Meeting. Oral presentation.

Philpott M and **VC Pence**. 2021. Growth and proliferation of green globular bodies in the endangered Hawaiian fern species *Asplenium fragile* var. *insulare*. Virtual *In Vitro* Biology Meeting. Oral presentation.

Stafford M, **M Philpott** and **VC Pence**. 2021. Improving survival rates after cryopreservation due to genetic variation in the exceptional Hawaiian species *Melicope mucronulata*. Virtual Botanical Society of America Annual Meeting. Interactive poster presentation.

Thelen C, **VC Pence**, **M Philpott** and L Sallans. 2021. The effect of hyperhydricity on endogenous phytohormone levels in *Cycladenia humilis* var. *jonesii*. Virtual *In Vitro* Biology Meeting. Oral presentation.

Winkeljohn M, **VC Pence** and TM Culley. 2021. Improving *in-vitro* growth of critically endangered Hinckley's oak (*Quercus hinckleyi*) through manipulation of nutrient availability. Virtual Botanical Society of America Annual Meeting. Oral presentation.

CAT EXERCISE WHEEL

The wheel is designed for feline stress reduction and weight control. We currently have two of these and would like two more since they are used often by the cats in our colony. **Cost: \$249 each.**

PIPETTE AID

Electric pipette aid helps us draw up larger volumes of liquid with precision. Current aid is no longer recharging adequately. **Cost: \$430.**

MAGNETIC STIR PLATE

This item is essential for making buffers in the lab, especially when reagents don't readily dissolve. Our current stir plate is starting to falter and needs to retire. **Cost: \$399.**



Cincinnati Zoo & Botanical Garden
 Center for Conservation and Research of Endangered Wildlife
 3400 Vine Street
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