
Sonorensis
ARIZONA-SONORA DESERT MUSEUM
THIS IS HOW WE DO
Conservation

2019
Sonorensis
ARIZONA-SONORA DESERT MUSEUM

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The Arizona-Sonora Desert Museum
Co-founded in 1952 by
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Cover: Young ocelot. Photo by Jocobo Quero.

Back cover: Leopard frog. Photo by Rhonda Spencer.

We gratefully acknowledge all the authors, translators, photographers, and organizations who contributed articles, photos, or maps for this issue of *Sonorensis*.

Photos on this page, from top down: Arizona unicorn mantis from the Museum's invertebrate collection; High school Earth Camp in the Coronado National Forest; Mexican wolf; Museum Explorers Camp at the Desert Museum.

THIS IS HOW WE DO

Conservation

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Above, and clockwise: Desert Museum Art Institute Patio; Rufous hummingbird; Desert Museum Coati Club Tree House; Curator Howard Byrne with our youngest Museum Explorers Campers; Tony Palmer with *Lucanus* beetle larva; Halloween enrichment for our mountain lion.

"IS THIS A ZOO?"

Debra Colodner, Ph.D., Director of Conservation Education and Science

"Is this a zoo?" This was a question from a recent Desert Museum guest when asked to participate in a nationwide survey of zoo visitors. He explained that he didn't like zoos, but liked the Museum very much.

Well, we are a zoo, and also a botanical garden, natural history museum, art institute and aquarium. Each of these labels carries with it the awesome responsibility of helping to preserve nature's treasures for future generations, but none so urgently as the label "zoo." Zoos today are essential partners in wildlife conservation, providing refuge and expertise in captive breeding for critically endangered species, as well as funding and other resources for conservation in the field.

This issue of Sonorensis will introduce you to the world of "Zoos and Wildlife Conservation" with an overview of zoo history, challenges and successes. We'll see that current conservation practices connect our work in zoos to efforts in the wild. ASDM keepers and scientists describe their important work with field conservation partners in "The Faces of Conservation: Desert Museum People Saving Species in the Wild". Here you'll note one important difference between the Desert Museum and many zoos. The Museum places more emphasis on saving plants and habitats than many of its fellows.

We'll then take a deeper look into the rapidly evolving field of captive breeding in "Matchmaking at the Museum," and learn about the extensive efforts to keep Desert Museum animals mentally and physically healthy in "Challenge, Choice and Play: Animal Enrichment." The issue concludes with a look at "Conservation Learning at the Zoo." With over 700 million visitors annually to zoos and aquariums worldwide, these institutions have the potential to shape attitudes toward wildlife and conservation. How to optimize and measure conservation learning is an area of active research at the Desert Museum and zoos around the globe.

Rhonda Spencer

ZOOs & wildlife conservation

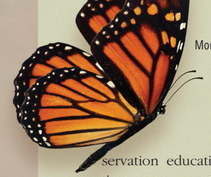
Craig Ivanyi
Executive Director ASDM

Mexican wolf
Above right in title: Corroboree frog; Przewalski's horse.

Animal menageries have been around for thousands of years. These precursors to the modern zoo focused on the rare, unknown, and exotic. Their purpose was to amuse, impress, entertain, and to a lesser degree, provide us with subject material for scientific study, often post-mortem. Such collections were only available to the privileged – primarily royalty. They weren't about education, let alone conservation. Even after the first public menagerie opened in France around 1793, conservation, if applicable at all, was utilitarian in nature. Conserving collected animals benefitted humans by maintaining healthy animals for our entertainment.

Concern for the wild didn't emerge until the middle of the 19th century, and the intrinsic value of animals and questions about the role zoos could or should have in conservation didn't see the light of day until much later. Despite U.S. zoos developing much later than their European counterparts, their focus was similar. On occasion, a rare voice of alarm would sound off about the loss of American wildlife, such as that of Joel Asaph Allen and William Temple Hornaday (both of whom were naturalists and museum curators). Their concern for American bison led to recognition that this species was near extinction and to early efforts to save it. Nonetheless, a true conservation ethos wasn't embraced by zoos at large until the late 20th century. Fortunately, today's accredited institutions have taken on conservation as their *raison d'être* and are heavily invested in saving species and protecting their habitats.

Before going deeper into zoo conservation, let's define what this term means. For our purposes we include direct, hands-on, in-situ (in the field, in a species' natural range) and ex-situ (outside of natural population) conservation, as well as indirect conservation education. The majority of a zoo's time, money and greatest potential impact is invested in conservation via education. With this in mind, data from the Association of Zoos and Aquariums (AZA) and World Association of Zoos and Aquariums (WAZA) on audience size and the impacts of visiting a zoo become relevant. These data reveal zoos to be the third largest contributors (in dollars spent) to direct conservation efforts and show that over 700 million people visit zoos annually, providing a huge audience for conservation education. Of course, exposure to information doesn't necessarily translate to action, nor do organizational outputs guarantee meaningful conservation outcomes. This is one of the central questions zoos face today – does education result in behavioral change? Although this field of inquiry is still young, research indicates that a zoo visit does inspire positive change. Zoos and Aquariums are working together with researchers to learn how to maximize that change.



Monarch butterfly

Going, Going, Gone, or (Back) Into the Wild?

Historically, direct conservation work in zoos often occurred as if in a vacuum; even today, this remains a risk. Conservation biologists outside the zoo didn't recognize the value of zoos as conservation partners and zoos collected and bred species without consideration of whether a given species merited selection, or would benefit from such efforts. As a result, captive breeding took place with species that were unsuitable for release into the wild. Conversely, wild species disappeared that might have benefited from being brought into and bred in captivity. Such an approach to wildlife conservation does little to stem losses in biodiversity, nor does it foster a positive attitude toward the conservation work of zoos.

DIRECT CONSERVATION

Research, management or policy work to conserve a species either

In-situ – in their natural habitat, part of their natural population

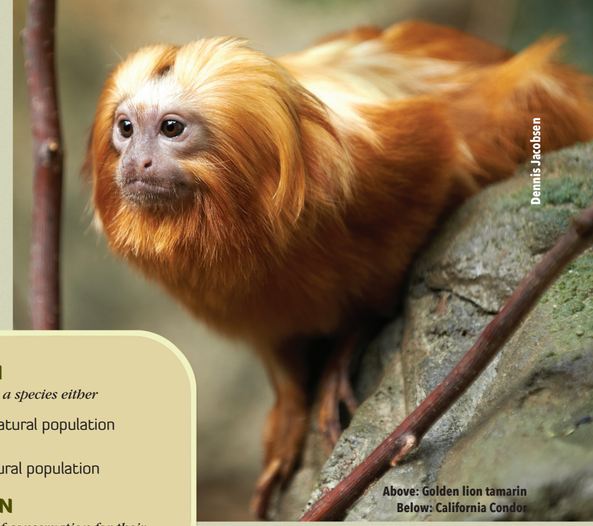
OR

Ex-situ – in human care, outside of their natural population

INDIRECT CONSERVATION

Work with people to educate them about the importance of conservation for their lives, and what they can do to help plants and animals in the wild.

Thankfully, today's efforts generally follow the *One Plan Approach,* wherein conservation partners work in concert to choose species that can benefit from ex-situ conservation, and to coordinate this work with in-situ efforts. Of course, zoos still care for and breed species that have no relationship to direct conservation, but instead sustain the animal populations they use to engage their visitors in the conservation stories told by their exhibits. However, this results in a reduction of space available for species that may be of higher conservation priority. Zoo professionals are constantly reminded of this and our need to be judicious in



Dennis Jacobsen

Above: Golden lion tamarin
Below: California Condor

George Lamson

Rhonda Spencer

Leopard frog

Max Earey

Left: Arabian oryx
Below: Regent honeyeater

Agmani Photo Agency

Rhonda Spencer

Tarahumara frog

how much space is dedicated to species not directly related to conservation work. Despite this challenge, zoos have helped many species avoid extinction, including the American bison, Przewalski's horse, Corroboree frog, Panamanian golden frog, eastern bongo, regent honeyeater, Bellinger river turtle, golden lion tamarin, and Amur leopard.

Athough it took a while for the *One Plan Approach* to become the norm, the conservation work of the ASDM followed this highly collaborative method long before it was in vogue. With rare exception, the species ASDM chose to work with were well-known to need conservation measures. And the type of work we did, whether short-term rescue/salvage or longer-term holding and breeding, came about through requests by our conservation partners. Moreover, ASDM's recognition and advocacy for protecting habitat has resulted in a number of biological preserves within our region, offering protection to a wider range of species contained within such preserves. ASDM has helped secure a better future for many species like Mexican wolves and a great number of desert fishes and riparian amphibians and reptiles.

Additionally, the AZA's new approach to conservation, "Saving Animals from Extinction" (SAFE), has identified a number of Sonoran Desert region species, affording us the opportunity to work directly with like-minded zoos and aquariums. SAFE focuses the collective expertise within AZA-accredited zoos and aquariums and leverages their massive audiences to save species. It protects threatened animals, builds on established recovery plans, prioritizes collaboration among AZA member institutions, implements strategic conservation and stakeholder engagement activities, and measures and reports conservation progress.

Currently, ASDM collaborates on two SAFE species – the vaquita and the monarch butterfly. For vaquita, ASDM contributed funding toward AZA's effort to help rescue this nearly extinct porpoise, including an unsuccessful attempt to bring a few animals into captivity. Funds also went to support vaquita research and monitoring as well as public engagement in the U.S. The Museum also participates by educating visitors about the plight of vaquita and the importance of choosing sustainable seafood in the Warden Aquarium and Stingray Touch exhibits, as well as through special events, such as World Ocean's Night. Frankly, and sadly, none of this has been impactful for the vaquita due to complex factors. The Museum is turning its attention to supporting organizations in the northern Gulf of California, like CEDO (Intercultural Center for the Study of Deserts and Oceans) which is working to empower local communities to develop sustainable fisheries, and perhaps help prevent the next extinction.

The monarch butterfly is AZA's newest SAFE Species. The Museum hosts trainings for citizen scientists who learn to identify and tag monarchs. We also sell larval food plants (milkweeds) at our plant sale each year and educate visitors about the monarch through butterfly walks. The Museum works with

Monarch butterfly

school and community gardens to include plants for pollinators as well as for people. Over the next year visitors can look for more information about monarchs as we refresh the signage in our pollinator gardens.

A Fish is a Fish, or is it? A Cautionary Tale...

When species are on the brink of extinction, knowing how to care for and breed them is of critical importance. Generally, it's better to acquire this knowledge long before it is needed (before a species is rare), but this isn't always possible. Perhaps nowhere is this more obvious than with the vaquita, a species with fewer than 10 individuals left. Unfortunately, husbandry for this species was never established and now it is too risky to bring them into human care (one already died during an attempt). Had zoos and aquariums figured this out before, maybe we would be having a different conversation about this species' future.

Similarly, the Yaqui catfish is almost gone. Perhaps not as dire as vaquita, the only native catfish west of the continental divide is endangered and declining. How hard could it be to breed catfish to help augment their population? Catfish farmers do it every day. It turns out that all catfish are not the same. Yaqui catfish have not yet revealed their reproductive secrets to scientists at ASDM or other organizations, underscoring once again, how husbandry and breeding need to be established for species much earlier. It's not enough to know how to breed a porpoise, we need to know how to breed and keep the porpoise known as vaquita.

This is why working with a wide variety of species can have value beyond what is needed at any given moment. It can provide us with knowledge and skills that increase chances of success should the time come where only a few animals are left, and we are weighing the pros and cons of bringing them under human care. This has been the case with ASDM's work with 'true' (family Ranidae) frogs. Long ago, ASDM established husbandry and breeding for regional true frogs (Tarahumara and leopard frogs), which led to firsts in captive breeding and successful rearing practices that we were able to share with other organizations. Now, biologists here and elsewhere can have greater confidence that captive breeding will work for true frogs, resulting in a greater number that can be returned to the wild and a much better chance of long-term survival of the species.

Other species that have been brought back from the brink with the help of zoos are the Arabian oryx (from 11, to more than 1000 in the wild), black footed ferret (from 18 to about 400 in the wild) and California condor (from 22 to about 300 in the wild). Each of these species has even more individuals under human care around the world as part of breeding and reintroduction programs. Equally important are efforts to restore and protect habitat, and to work with communities to create benefits for living in harmony with wildlife. Zoos are one important part of this new "Ark" for endangered species being built by people around the world.

Jane Rix

Above: Young Amur leopard...
Right: Black footed ferret

Rhonda Spencer

Jay Pierstorff

FACES OF CONSERVATION:

Desert Museum Staff Saving Species in the Wild

Robin Kropp
Education Specialist

Allison Bryan with a Harris's hawk during Raptor Free Flight. Harris's hawks are doing very well in urban areas. One of the many tips for living in harmony with urban raptors one can learn during the Raptor Free Flight program is how to prevent electrocutions by equipment on power lines.

Courtney Christie: Herpetology, Ichthyology and Invertebrate Zoology (HIIZ) Keeper

Courtney Christie attributes her career choice to her childhood love of pet snakes, tortoises, and "a few fuzzy things." Courtney is a passionate learner. Her first degree was in government and public policy from the University of Arizona, but after a few years, she realized that she really wanted to work directly with animals. She went back to school for a second degree in Ecology and Evolutionary Biology. Courtney made time during school to volunteer and intern at wildlife organizations, a prerequisite for people who want jobs in this field. One of those internships was at the Desert Museum, which opened a door to temporary, part time, and finally a full-time position. She had truly found her niche! One of Courtney's favorite parts of the job is working with Sonoyta mud turtles. "I really enjoy this because I am learning so much about the turtles. They are elusive and charismatic." (Whoever said that small, scaly creatures aren't charismatic?!?)

Project Species: Sonoyta mud turtle

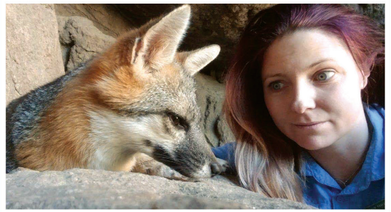
Sonoyta mud turtles are dark brown, medium-sized aquatic turtles with

webbed feet and sensory barbels on their chins. A subspecies of Sonoran mud turtle, they live only in Quitobaquito Spring in Organ Pipe Cactus National Monument and in four isolated populations along the Río Sonoyta in Sonora, Mexico. As aquatic turtles native to the hottest, driest part of the Sonoran Desert, they are already extraordinary. They are also increasingly rare, as groundwater pumping, surface water diversion, and 20 years of drought have reduced their tenuous habitat. Sonoyta mud turtles were listed as Endangered in 2017. With this listing, state, federal and University biologists mobilized to protect their habitat and stabilize their population in the U.S. Mexican biologists are also working to protect the species in Sonora.

The Desert Museum was first enlisted to keep a rescue population of Sonoyta mud turtles while Quitobaquito Spring underwent needed repair and remediation in 2005. We learned a great deal about how to care for these turtles. Today we keep an assurance population, like turtles in the bank. If something were to happen in the wild, these turtles could be bred to repopulate the habitat. A recent census at Quitobaquito showed some 200 turtles in the pond, so there is no current mandate to breed them. Park officials continue to monitor water levels in the pond, especially in light of planned pumping of water from nearby wells for border wall construction.

We house most of the turtles in separate quarters, but four live in an outdoor habitat built by the Arizona Game and Fish Department to replicate wild conditions. Two years ago, three babies hatched here, the very first in human care! HIIZ staff see a lot of potential to study best practices for breeding these rare turtles in this space, including experimenting with various substrates for egg-laying.

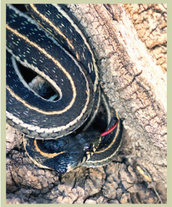
"Besides a few researchers who have a couple of individuals in their care, we are the only institution that holds Sonoyta mud turtles. The information we collect about diet and behavior complements observations of researchers in the field. We are the keepers of practical, hands-on knowledge. And since climate change is expected to bring long-term drying to the region, putting additional pressure on turtles and their habitat, we are the ones who will keep them going."



Desert Museum animal Curators and Keepers work in three departments: Mammalogy and Ornithology (which cares for mammals and birds), Animal Experiences (which includes Raptor Free Flight and the Interpretive Animals used by docents and educators) and the Herpetology, Icthyology and Invertebrate Zoology Department (which takes care of reptiles, amphibians, fish and invertebrates).

Clare Steinberg: Herpetology, Ichthyology and Invertebrate Zoology (HIIZ) Keeper

Clare Steinberg was a Keeper from 2017 to 2019. Clare's passion is to combine conservation, science, and education, and it all started with her love of pet lizards as a child. She really appreciated her time at ASDM, "This place is so special because you do zookeeping but get to see all the animals and plants in the context of where they live, and see the relationships."



Project Species: Mexican Garter Snake

Mexican garter snakes live in ciénegas (wetlands) and riparian (stream/river) ecosystems from central Mexico into Arizona and New Mexico. They rely on permanent water and dense vegetation where they eat fish, frogs, toads, lizards, and small mammals. The Mexican garter snake is a threatened species that has declined throughout its range due to degradation and loss of its aquatic habitat and predation by introduced exotic species such as bullfrogs.

The Museum has been part of efforts to restore and preserve populations of these unique snakes in the southeastern Arizona borderlands through captive breeding since 2006. We partner with the Arizona Game and Fish Department (AZGFD) and the US Fish and Wildlife Service (USFWS) who provide the Museum with individuals to help maintain genetic diversity within our breeding population. AZGFD biologists also choose release sites for the offspring.

Special Care Considerations for Animals Bred for Conservation:

Since Mexican garter snake offspring will be released to the wild, we carefully house and screen them to protect them against diseases. HIIZ staff also consider other factors to give offspring destined for release the best chance at success. It is difficult to recreate a complex riparian ecosystem in a greenhouse, but keepers vary the environment so that the animals learn to adjust to the dynamic conditions they will experience in nature. Since there is high mortality among young reptiles in the wild, the captive-bred youngsters help augment the wild populations. To date, ASDM has produced over 100 young garter snakes for this program.

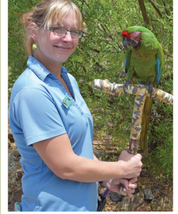
Why Is Our Work With Mexican Garter Snakes Important?

Conservation of reptiles and amphibians doesn't draw as much attention as large, charismatic mammals, but the Desert Museum makes a significant impact on saving biodiversity by working with these smaller species. Keepers maintain detailed records on behavior, diet, and health of the animals so that their successors or other agencies can learn best practices for breeding and housing protected species. The long-term husbandry knowledge we gather is valuable to the success of future programs.

Clare's enthusiasm for her work said it all. "I love the idea that I am contributing to the health and conservation of species in the wild. The garter snake project is just one piece of conservation of entire Arizona riparian systems. Conservation of the garter snake connects to conservation of Chiricahua leopard frogs, extermination of invasive bullfrogs, and reintroduction of native species. The people who do ex-situ work cannot look at any species in isolation."

> "I love the idea that I am contributing to the health and conservation of species in the wild."

Leopard frog



Keepers are keenly aware that their work with collection animals is connected to conservation in the wild, both directly and indirectly through education. It's serious, demanding and rewarding work, but you can also catch them having fun!

John Wiens: Botany Department Nursery Horticulturalist

John Wiens, a self-described plant nerd, fell for plants when he was given his first cactus at age 6. In college, he took a botany class, and knew he had found his calling. He has been at ASDM since 1985, where he operates an on-site nursery, propagating and maintaining plants for exhibits, plant sales and research. His passion for Sonoran Desert plants has helped him forge an encyclopedic knowledge of the region's flora. He has written several scientific publications and articles on native plants and landscaping in the southwest. For John, the Museum has been the right venue for putting his knowledge into the practice of conservation.

The Modern-Day Botanist and the Museum: Protecting Biodiversity

In his early tenure at the Museum, John was encouraged by senior staff scientist Tom Van Devender to study the flora of the Silverbell, Waterman, and Ragged Top Mountains northwest of the Desert Museum. Harkening the botanical explorers of the 19th century, John logged countless hours finding new species and drawing a complete picture of their unique plant communities. He published his first flora – a detailed list of the plants in a given area –

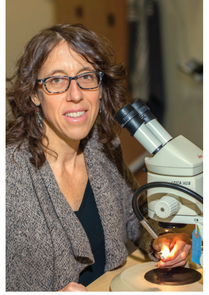
in 1991, and continued his studies, mapping endangered cacti and other species.

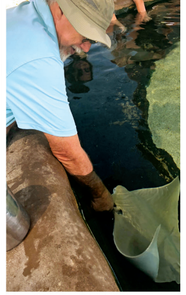
John's published floras, along with nearly two decades of work by the Museum science team of Van Devender, Gary Nabhan, Mark Dimmitt, and others, underscored the importance of the region's biodiversity. This inventory of ecological and geological diversity led to the establishment of Ironwood Forest National Monument in 2000. John recounts with pride how "This collaboration of individuals, organizations, and government agencies can benefit everyone by protecting rich biodiversity and recreational resources in perpetuity."

Understanding Future Change:

"Another reason floristic surveys are important," John says, "is that they give us a baseline to monitor changes in the future." With climate change, for example, climate models predict that our region will experience increased temperatures and changes in precipitation patterns. Climate data from the last several decades reflect these trends: over the last twenty years, annual rainfall has decreased in the Tucson area, while average temperatures have increased almost 2°F. What kind of impacts will this have on regional ecology? Scientists have predicted that in mountains, increased temperatures and decreased precipitation will lead to plant communities shifting uphill. Baseline studies can be combined with repeat surveys to elucidate changes and corroborate or refute predictions.

> "This collaboration of individuals, organizations, and government agencies can benefit everyone by protecting rich biodiversity and recreational resources in perpetuity."





The Museum is unlike most zoos its attention to the conservation of plants, habitats and cultural knowledge, as well as animals.

Revisiting Whittaker, Fifty Years Later:

Many Tucson residents are familiar with the drive up to Mt. Lemmon in the Santa Catalina Mountains, where in less than an hour you traverse desert, grasslands, and oak woodlands, and arrive in the cool, evergreen forests on the summit. Precipitation increases and temperatures decrease with the ascent, and the plants reflect these conditions. In 1963, the ecologist Robert Whittaker and his colleague William Niering performed a detailed study of the plants growing at different elevations along the Catalina Highway. This data set provided a snapshot of the elevations where common plant species were found over five decades ago.

In 2013, John, along with Museum Director Emeritus Dr. Richard Brusca, and a team of ecologists and entomologists, replicated the Whittaker study. Their findings confirmed the model predictions – many plants' lower elevation boundaries had significantly shifted upward. Climate science often works with models, but these depend on ground-truthing with observations in the field.

Future Contributions to Conservation:

The Botany department contributes to field conservation in other ways as well. They work with the USFWS to edit species survival plans for regional endangered plants and house rare species. One, the Huachuca water umbel, is a semi-aquatic plant with limited distribution in endangered wetlands in southeastern Arizona. The Museum maintains a population of these plants that can be used to restore this species in Pima County's protected wetlands. (You can see leopard frogs hiding among its fuzzy, filamentous tendrils in the shallow stream in our Life on the Rocks exhibit.) Other endangered plant species we maintain include Pima pineapple cactus, Kearney's blue star, Cochise pincushion cactus, and Nichol's Turk's Head cactus. We even recently provided some potted Pima pineapple cacti to an organization in California to train endangered-species-sniffing dogs to be able to locate these plants in the field.

John and the Botany team, along with partners at the Huntington Gardens, near Pasadena, CA, recently did field surveys of three uncommon oaks, the Ajo oak, Toumey oak, and Palmer oak. These plants have limited distributions and can easily hybridize, so finding pure specimens is a challenge. Decades old surveys had placed these species in a variety of locations, but the team's recent work confirmed that the vulnerable Ajo oak is only found in a few spots in the mountains in Organ Pipe Cactus National Monument. Leaf bud material was collected for micropropagation, and an Organ Pipe biologist was able to send seed for Museum staff to propagate. Seedlings have been sent to the Huntington and other arboreta. As climate change threatens to move species like the Ajo Oak upwards, there may be nowhere for them to go. With this work, the species are not lost forever.

> As climate change threatens to move species like the Ajo Oak upwards, there may be nowhere for them to go. With this work, the species are not lost forever.

Museum Keepers, Botanists and Scientists participate in research on animal husbandry, invasive species biology, horticulture, endangered plants, native bees, Sonoran Desert natural and cultural history, and phenology (the timing of life cycles of plants and animals).

Kim Franklin, Ph.D.:

Conservation Research Scientist

As a kid, Kim loved to camp, hike and explore nature. She always knew that she wanted to become a scientist and work toward conservation goals. After completing her undergraduate work, she joined the University of Arizona's Insect Science program for her PhD. Her research took her to Sonora, Mexico where she surveyed insect biodiversity. Tasked to map the extent of buffelgrass pastures using satellite imagery, she became aware of buffelgrass as a huge environmental problem. "An astounding amount of area in Sonora had been cleared and planted with buffelgrass for pasture." North of the border, this invasive weed was converting the Sonoran Desert to a savannah by choking out native vegetation and charring it with deadly fire – permanently changing our landscape. Her dissertation research focused on ants as indicators of ecosystem health in buffelgrass pastures and un-invaded desert. But, she realized, "It is very hard to be an academic scientist and want to see your work contribute to solutions in your lifetime. There was no time to waste with buffelgrass' threat to Sonoran Desert biodiversity." Hired as a new research scientist at ASDM in 2011, she has helped chart a course for effective solutions and established the Museum as the lead for buffelgrass management efforts throughout Pima County.

Some of the most important conservation work at zoos is fostering connections with nature and empathy for animals among the 700 million people who visit zoos and aquariums world-wide each year. Most of our Keepers interact with Museum guests every day and hope to instill a desire to protect wildlife and wild places.

The Power of the CWMA: Collective Work Means Action

For the last decade, stakeholders in Pima County gathered under the Southern Arizona Buffelgrass Coordination Center (SABCC) to confront buffelgrass' threats to ecosystems and public safety. When Kim joined the science team, she participated on SABCC's board and buffelgrass working group. SABCC had built a coalition of land managers, utilities, agencies and non-profits, poised to take on this wide-spread multijurisdictional challenge. The Museum backed Kim when she volunteered to take the lead. She spent the first six months just talking to different players to better understand their needs and the challenges they face. This underscored the importance of "bringing people together so they don't feel like they are working in isolation, because that is hopeless."

With funding from the National Fish and Wildlife Foundation, she founded the Sonoran Desert Cooperative Weed Management Area (CWMA). CWMA's are partnerships that collectively manage invasive plants in a geographic area. Buffelgrass is this CWMA's primary focus – "It's the weed that brings us all together" – but the CWMA also confronts other important invasive species. Quarterly meetings unite local, state, tribal and federal land managers, Davis-Monthan Air Force Base and other military installations, as well as academics, agencies, non-profits, utilities, businesses, and volunteers who dig up buffelgrass. "This diverse group of people comes together to talk about buffelgrass and collectively tackle 'How do we solve this problem?' We actually have a long coffee break in the middle so people can connect – it's the only time of the year that people get to see each other. We share information on treatments, actions, grant opportunities, priorities, and funding strategies." This helps Kim target where management efforts can be most effective.

"A lot of times we are most successful when the community comes to us and tells us what it needs." She recently took a six hour tour with City of Tucson Department of Transportation to look for places with high fire risk. Now she understands the complexities of rights of ways and alleys, what DOT responsibilities are, and how they accomplish them.

The battle with buffelgrass will never be completely won, but cumulative victories that protect our desert are possible. Success is measured in the number of acres treated, in saguaros saved from fire, in slopes once dense with the invader restored to their diverse Sonoran Desert vegetation. For Kim, the most gratifying part of her work is mobilizing people and helping to influence the direction her community takes with conservation. "As an academic, I never thought I would be able to talk to decision makers like the mayor, council members, county supervisors or department heads and help them see buffelgrass' ability to transform our desert into a completely different ecosystem. But we are making progress. People comprehend the extent of the problem and want to help." Therein lies reason for hope in the trenches.

Charles T. Peden

Buffelgrass threatens to transform the Sonoran Desert into a fire-prone savannah.

> "A lot of times we are most successful when the community comes to us and tells us what it needs."

Matchmaking at the Museum

Catherine Bartlett
Education Manager

Why zoos breed, why they don't, and the Desert Museum as a leader in animal affairs

Joni Bessler

Young black tailed prairie dogs "greet-kissing".

But first, some Zlingo (Zoo Lingo)

TAG, Taxon Advisory Group: "TAGs examine the conservation needs of entire taxa and develop recommendations for population management and conservation based upon the needs of the species and AZA-accredited institutions."- Association of Zoos and Aquariums (AZA). TAGs develop action plans and specify the optimal way to manage populations. There are 45 AZA TAGs ranging from snakes to raptors to elephants.

SSP, Species Survival Plan: SSPs "...strive to manage the ex-situ populations of select and typically threatened or endangered species."- AZA. SSPs develop a Breeding and Transfer Plan for each species to ensure a healthy and genetically diverse population. There are currently over 500 Species Survival Plans.

Studbook Keeper: An individual that works directly with TAG and SSP Programs to maintain accurate records of all individual animals in an ex-situ population and serve as an expert for the species. They monitor and track all births, deaths, and transfer information.

Please, make it make sense!

Ok! As an example, the Felid TAG oversees all cat breeding programs, including the Ocelot SSP for which there is an individual Studbook Keeper in charge of breeding recommendations. The Museum participates in 14 SSPs.


Alex Wild


Manny Rubio


Ernest Cooper


Arlen Good

From left to right and top to bottom: Hercules beetles, male and female; Dung beetle; Arizona bark scorpion with scorplets; Mesquite bug; Tony Palmer with Western Hercules beetle grubs. Cutout below: Vinegaroon.


Ray Redstone


Richard Fitzer


James Tullar

From left to right and top to bottom: common chuckwalla; common chuckwalla; Renée Lizotte with San Esteban chuckwalla; San Esteban chuckwalla, with juvenile.

SSPs at the Desert Museum	Fish: northern lined seahorse Reptiles: San Esteban chuckwalla, Rio Fuerte beaded lizard Birds: roadrunner, burrowing owl Mammals: bobcat, ocelot, puma, Mexican grey wolf, North American porcupine, javelina, bighorn sheep, white-nosed coatimundi, North American river otter

Local care with a global focus

What does the Museum breed and why?

Zoos collaborate with wildlife managers to maximize sustainability of rare species in the wild, which sometimes involves captive breeding. Animals that have known husbandry and that have self-sustaining populations are especially attractive. As a conservation institution, the Museum minimizes the need to take animals from the wild for exhibits and education. How are those decisions made, and by whom? Read on to learn what it takes to maintain a hummingbird population, where bighorn sheep lambs travel to, and why even our beetles receive veterinary care.

1) We breed to minimize wild collecting

Tony Palmer is the lead invertebrate keeper and a deeply committed conservationist of every animal, especially those with six (or more) legs. As an invertebrate keeper, he is in a position to collect and showcase dozens of arthropod species (animals with exoskeletons including insects, spiders, and crustaceans) from the Sonoran Desert region. But, he explains, he doesn't want to collect from the wild, which is a paradigm shift for the bug world. For context, southern Arizona is a hotspot for bug biodiversity and people come to the deserts and Sky Islands to collect animals from the wild to display in museums and zoos throughout the country. Popular local arthropods include desert blonde tarantulas, Hercules beetles, sunburst diving beetles, and of course, the colorful and showy giant desert centipede. However, repeat collecting over the years may take its environmental toll. "People assume these animals will always be there. Well, once upon a time people thought a passenger pigeon would always be here, too" explains Tony. So, he's tinkering behind the scenes and studying the life cycles of arthropods in the hopes he can crack their secret code and produce more in-house. "If I have to collect, I try to get a male and female to figure out their lifecycles, just in case. If one day it's going extinct, I will be there. And I can help."

Take, for example, his work with vinegaroons. Vinegaroons are sought-after display arthropods due to their size, their gentle demeanor, and their overall 'wow' factor. These 2-3 inch-long arachnids (a group of eight-legged arthropods including spiders and scorpions) look like a mix between a scorpion and a puppy. Ok, personal biases aside, they are cute animals that can be handled and have a secret weapon: they emit acetic acid from their rear ends when startled. Imagine a spray of vinegar out their straw-like 'butts' and it's pretty apparent why educators and entomologists love to interpret them to students. However, they have been notoriously difficult to breed and raise in captivity and thus, vinegaroons are collected from the wild every summer by people across the country. Tony used his background knowledge, his education, and his instinct as a keeper to try something new. One of his vinegaroons had offspring and he's raising them in a controlled experiment. Half have been overwintered in a hibernaculum (cold room) and encouraged to undergo a period of diapause (a slowing down period during the winter months) while the other half have been kept 'awake' for growth. Why? He wants to see their whole lifecycle. "I want to be there when it's born. You see day one through adulthood and you know everything about it. It's comforting to me". He separated the population to see if an induced cool, wetter period will make a difference for their mortality rate. He likes to think big picture, and think like a bug by giving them what they'd naturally experience in the wild. And, if Tony can successfully breed and raise vinegaroons in captivity, he'll make the individuals available for free to other institutions. By offering sustainably raised animals, he'll not only foster a sense of community in the entomological world, but directly and positively impact the delicate desert ecosystem the Museum strives to conserve. The results so far are useful: the vinegaroons in the Hibernaculum are looking healthier overall. Other breeding projects in the works include jewel beetles, giant hairy scorpions, sunburst diving beetles, and the hard to find Arizona unicorn mantis. What's next? Millipedes, less common scorpions, amblypygids, and tiger beetles, among other projects.

> *"If I can't breed it in captivity, I don't want it."*
> - Tony Palmer, M.S.

Beyond breeding, Tony, alongside an excellent veterinary care team at the Museum, have been developing innovative approaches for invertebrate health, including veterinary check ups and pioneering medical procedures. He's developed treatment plans for centipedes, scorpions, and tarantulas with Dr. Audrey Siegrest, former veterinarian for the Museum and Dr. Erica Giles of Arizona Exotic Animal Hospital. They've had success treating infected beetle larvae for nematodes, have researched endocrinology of scorpions to find a medicine that encourages molting, and even looked into a grub of a Hercules beetle that had a prolapsed anus. That kind of concern, care, and attention to detail has cemented Tony's leadership in the world of invertebrate zoologists, and makes him a stand out zookeeper by any measure. I asked Tony why he cares so deeply about these creatures. "The funny thing about Arizona is that there aren't any invertebrates that aren't snails or mussels listed [on the Endangered Species List]. But I know there are things that should be. Beetles, butterflies, invertebrates are disappearing out from under our noses and nobody cares. Nobody is spending money or trying to conserve them because why? They're just bugs". I respectfully disagree with Tony that nobody cares. He cares, as does the Desert Museum. And because of him, a new generation will, too. He pauses, then continues: "I practice. I puzzle. I figure things out. It's fun to solve mysteries. It's fun to tinker and fail. Because then I finally succeed".

2) We breed to keep lizards in the bank

An assurance population of resilient reptiles

"Chuckwallas are really cool animals. They're large, they're relatively tame (you can handle them carefully) and they're gentle giants in terms of lizards. They're veggie-sauruses and have adorable babies. Most people don't think of reptiles as being cute, but they are!"- Renee Lizotte, M.S., Keeper II, HIIZ

Renee's been working with the endangered San Esteban chuckwallas for over two decades. In the beginning, we used paint to identify individual lizards, but technology has advanced and now we use microchips. What hasn't changed is ASDM's role in the conservation of these large lizards and its commitment to their survival, dating back to the 1970s.

There are multiple outdoor enclosures behind-the-scenes at ASDM that contain about 30 chuckwallas total. They're fed "chop" (a mix of kale, cilantro, and parsley and might include seasonal treats like prickly pear fruit) during the warmer months, which can take up to an hour to prepare daily. Twice a year each lizard is caught from the enclosure to receive a vet check during the biannual "chuckwalla round up". This is to assess the health and condition of each lizard. Biometrics like weight, snout-vent length, and tail length are measured to see how they're growing. Their bodies are inspected for signs of dehydration, malnutrition, or mites and treated accordingly. Last year was a boomer-breeding year: the museum welcomed 18 hatchlings from two different sets of parents!

Renee, in addition to other dedicated herpetologists and veterinarians like Dr. James Jarchow, have directly contributed to this lizard's survival. Janice Johnson, a long-time keeper for the Museum (who sadly passed away in 2016), was with the program since the species addition to the SSP and had campaigned for it to be included. She was the program's Studbook Keeper for nearly 20 years and her enthusiastic commitment kept the breeding at ASDM running healthily for decades. Since the program's start, 337 San Esteban Chuckwallas have hatched in our care.

In the wild these lizards are found on Isla San Esteban, a roughly 15 square mile island in the Gulf of California that also hosts spiny tailed iguanas, sea birds, and unfortunately, introduced rats. The lizard population plummeted when ravenous rodents hopped off ships and chowed down on chuckwalla eggs. Now their population has bounced back in the wild but the Desert Museum holds this assurance population in case of


Christopher Gardiner


Joni Besseler


Rhonda Spencer


Rita Petcu


Jacobo Otero


Jay Pierstoff


elhill

From left to right and top to bottom: male bighorn sheep; juvenile black tailed prairie dogs; juvenile bighorn sheep; baby ocelot receiving veterinary checkup; Atlantic cownose stingrays; Lauren Takerian with stingray.
Cutout below: male Costa's hummingbird.

From left to right and top to bottom: juvenile ocelot; female broad-billed hummingbird in nest; Anna's hummingbird babies in nest.

catastrophe. They are not currently in trouble, but the isolated population could become susceptible to invasive species, disease, or climate change. Additionally, retaining their Endangered Species designation prevents the chuckwallas from being in the US pet trade market. Due to the dangers to the species, the Desert Museum has stock to reintroduce to the wild, ie, "lizards in the bank." The Desert Museum was instrumental in establishing this species in US zoos, so if you see one elsewhere, there's a 99% chance it came from the Desert Museum.

With a representative lizard (Wilma) working as an ambassador animal in our educational collection, hundreds of school children meet and get to touch a chuckwalla annually. Research shows that up close animal encounters deepen an individual's empathy, increase the chance of wanting to protect that species, and build awareness about wildlife and wild places. It's possible that Wilma has been touched by, and inspired, the next leader in conservation right here in southern Arizona. It's also possible that this future leader is currently an elementary school student who recently regaled their caretakers with stories of their field trip to the Desert Museum. It's quite possible that this young conservationist is reading over your shoulder right now.

3) We breed to keep animals on display, here and elsewhere

Keeping Stingrays Sustainably

At Stingray Touch visitors are welcome to be touched by Atlantic cownose stingrays, feed them shrimp and smelt, and interact with stingray care volunteers and keepers. Lucky visitors might get to witness an enrichment training session, that is, a time when keepers interact with the stingrays and offer novel experiences like swimming through hula-hoops or puzzling their fishy food out of a chew toy. It's a dynamic exhibit that brings a bit of the ocean to the desert. It wouldn't be possible without partnerships though, and the Desert Museum has been working closely with the Phoenix Zoo, where these stingrays were born, in addition to Odysea and Sealife Aquariums. This collaborative group is named S.O.S: Stingrays of Sonora. Since 2016, knowledge about training, medical concerns, diets, and public interactions has been shared freely between the institutions, which keeps the animals as healthy as possible.

So healthy in fact that it might soon be breeding time for the stingrays in Tucson. According to Lauren Takerian, Keeper II and stingray lead, there will be signs of growth, more noticeable graspers on the males, and "love nibbles" will start to appear on females. Not to worry she assures, it's normal behavior and they are amazing healers because their cells and tissues regenerate quickly. Females will gestate one baby for 10-12 months (quite long really, for a fish), and the pup will be born on exhibit. The Museum will then decide how many pups to keep in order to sustain the exhibit and how many will be transferred to other institutions. Phoenix Zoo was beyond generous with their time, knowledge, and animals. Our Stingray Team is excited to pay that forward to another zoo or aquarium.

> *"I grew up in Tucson and got a Wildlife Conservation Degree from University of Arizona. I've always loved fish but I also love the desert. How many chances do I get to do both? It's a dream job."*
>
> - Lauren Takerian, Keeper II, Herpetology, Icthyology and Invertebrate Zoology

Popular prairie dogs and beautiful birds:

breeding in enclosures

Historically the Museum's prairie dog coterie has had anywhere from a handful of rodents to upwards of thirty at a time. Sometimes they breed, sometimes they don't, and sometimes they're even put on birth control. If needed, keepers sprinkle powdered birth control on favorite food items like corn for the females to ingest. If a male gets it, it does not affect him. The coterie has been augmented from other zoos over the years (it keeps the genetics fresh) and when the Museum has a surplus, individuals go to other AZA-accredited institutions.

Another ever-alluring exhibit is the Hummingbird Aviary. Visitors often wonder if these birds breed, and if so, where do they go? The answer is yes-- each bird is banded for identification (the flying jewels each wear jewelry) and zookeepers are well aware of who is coupling up each season. The exhibit averages 6-10 babies a year and the Museum decides how many to keep and ships the rest to other AZA facilities such as the Strong Museum of Play, Fairchild Gardens in Florida, and closer to home, the Phoenix Zoo. How are hummingbirds transported? "Carefully." quips Shawnee Riplog-Peterson, Curator of Mammalogy and Ornithology. With paperwork and permits vetted, keepers prepare to collect the hummingbirds from the exhibit. It's easiest during their early morning torpor (sleepy slow time). They're then each packaged into their own flight container complete with food and a small light (it keeps them awake) and then loaded into the cargo of a plane. They're first class travelers, too, as animals are loaded on and off before anything or anyone else. While passengers are shuffling down the airplane aisle finding seats, the hummingbirds are already situated below sipping a sweet in-flight nectar cocktail. Fun fact- zoo animals are often transported via passenger planes so next time you take a flight, imagine a wolf, bear, or rattlesnake beneath you! It's a mid-air menagerie.


Monica Lara

4) We breed for species survival

There's nothing better than a successful birth, and the Museum has been privileged to enjoy bighorn babies and ocelot offspring in recent years. Both species were encouraged to couple as per their SSP plans. Over the years the Museum has welcomed 14 lambs, many of which have been born on exhibit with visitors observing in awe. Our current male bighorn sheep has sired 6 of those lambs. The progeny have been transferred to The Living Desert, LA Zoo, and the Phoenix Zoo among others. Currently, the bighorn sheep at the Museum are on contraceptives because there is no need for more in the AZA community. To be clear, says Riplog-Peterson, "our lambs have not gone into wild populations here in Tucson or elsewhere." They stay within AZA-accredited facilities and are given the care SSPs require.

In addition to the regular demanding duties of the Mammalogy and Ornithology team, in the past few years our stellar zookeepers have been working on an instrumental project behind the scenes: caring for endangered ocelot kittens. Two kittens, separated by about a year, are half siblings (same mother). The first father is our own male at the Museum and the second is Principe, a male at the Houston Zoo whose semen was collected and frozen in 2010. The Ocelot SSP oversees approximately 95 ocelots at 52 North American zoos and the Desert Museum's female was selected as a candidate for artificial insemination. These monumental births don't happen by accident: they represent years of hard work and husbandry knowledge shared among colleagues in addition to strong partnerships. A collaboration with the Cincinnati Zoo & Botanical Garden's Center for Conservation and Research of Endangered Wildlife and El Paso Zoo led not only to a successful birth at the Museum but two kittens (half siblings to ours) at the El Paso Zoo.

How do we measure success?

Whether it's one animal or one hundred, a birth is a win for wildlife. Captive propagation of animals reduces the need for wild-caught animals to exist in zoos, museums, and aquariums. Each year the Desert Museum welcomes hundreds of insects, dozens of fish and frogs, a handful of hummingbirds, and frequently a bighorn sheep lamb or ocelot kitten. Each of those births helps contribute to the conservation of that species. The Desert Museum's husbandry expertise has helped safeguard animals from extinction. Stéphane Poulin, Director of Collections and Exhibits, compared the Desert Museum's breeding efforts with the fight to control buffelgrass. "If you give up, you know what's going to happen. We have to try. It's rare that we have a sense of accomplishment in this work but when I see a frog or snake, I know I helped."

What's the ultimate goal? What do we hope to accomplish in say, 10 years? Shawnee Riplog-Peterson said it best: "In ten years I hope not to be needed. I hope not to be part of a project because it means the populations are stable. But 10 years is a small chunk of time. Realistically, our goal is to keep helping animals both in our care and in the wild."

CHALLENGE Choice & Play

ANIMAL ENRICHMENT

Adapted from ASDM News Summer 2019

While ASDM animals are at work helping to save their species and habitats in the wild, their individual health is of primary importance. Thanks to dedicated zookeepers and veterinary staff, every animal resident—from mountain lions and prairie dogs to scorpions and beetles—receives top-notch veterinary care, extending their lives long beyond what most experience in the wild. Psychological health is just as important. Enrichment activities create variety, and challenge our animals to solve problems, just as they would in the wild. Giving animals choice and control, and allowing them to flex their muscles—both physically and cognitively—prevents frustration and boredom, and enhances their overall health.

PRACTICE MAKES PERFECT

The primary goal of enrichment is to create novel psychological experiences. Just like humans, each individual animal has different skills and needs, requiring unique enrichment activities. As you can imagine, with more than 230 different species at the Desert Museum, a great deal of trial and error goes into finding effective ways to create engaging experiences. Zookeepers and volunteers are continually thinking of new ideas, always with consideration for an animal's natural behaviors and safety. For example, we know that wolves heavily depend on their advanced sense of smell for hunting. We can replicate aspects of the experience for them by introducing deer scent into their habitat. This encourages the wolves to sniff around for prey and is one of many ways to stimulate natural behaviors.

There are several types of enrichment, each intended to elicit different behaviors, and often targeting different senses. Zookeepers and/or veterinarians record, rate, and review all enrichment sessions to keep track of whether reactions are positive, negative, or neutral. It should be noted that an adverse reaction isn't necessarily bad; the goal is for animals to have a natural range of experiences. For instance, a snake's shed skin might be placed in the packrats' environment. Interactions with a predator's scent may not be pleasant for the packrats, but it is certainly something they would encounter in the wild. That said, not all enrichment activities replicate experiences animals would have in their natural environments. Some are quite novel, as you'll soon read!

Mexican wolf exploring a new scent.

NEW TWISTS ON OLD BEHAVIORS

Javelina are, surprisingly, quite the "artists." If you can believe it, the animals enjoy pressing their noses against canvases covered in non-toxic paint to create their own artistic masterpieces! Painting enrichment is designed to mimic the act of rooting in the ground with their noses for food. Likewise, if you've ever spotted empty cardboard boxes in an exhibit, have no fear—we haven't lost track of the recycling! Our trash truly is like treasure to many of the small mammals, reptiles, and birds at the Desert Museum. Rattlesnakes love exploring boxes, slithering around until they find just the perfect napping spot. Phone books, a nearly extinct human creation, are favorites of parrots. The animals wouldn't encounter these objects in the wild, but adding them to their habitats provides hours of enrichment.

CHANGE OF SCENERY

While some animals benefit most from having different objects introduced into their habitats, others enjoy a little change of scenery. Parrots in our Interpretive Animal Collection get excited when they get to go on walks through the grounds with zookeepers and trained volunteers to interact with different people. Even the more introverted species benefit from going out and about. Reptiles, for instance, are given access to their very own enrichment courtyard that's loaded with different textures, materials, and spots to hide. Some reptiles are content to explore the courtyard on their own, but others, such as tortoises and Gila monsters, sometimes prefer interacting with each other in their yard.

This pumpkin was stuffed with treats for the black bear.

PLAY DATE?

One common misconception among people is that all animals would be happier with a playmate or two in their enclosures. While this is true for some animals, it is not true for others, who are naturally solitary. Black bears, mountain lions and river otters are examples of animals that spend most of their lives alone, unless they are mothers raising young. It would be stressful and dangerous to introduce another animal into their territory.

EYE ON THE TARGET

Some enrichment is better classified as behavioral rather than environmental. Many activities are designed to help zookeepers and veterinarians better and more easily care for the animals. Target training is a perfect example of this type of enrichment. Mountain lions and bobcats, for instance, can be trained to follow "targets," which are small balls at the end of long sticks. The cats are taught to move to where the stick is pointed, thus helping zookeepers transfer them from one area to another or into a crate if necessary. Anyone who has ever tried getting a housecat into a carrier will appreciate the time, energy, and frustration the zookeepers must save themselves—and the animals—with target training!

Many people are surprised to learn that fish are also target trained. This is especially helpful at feeding time in

Our river otter with a new toy.
A favorite game is to swim around balancing a toy on its head.

With more than 230 different animal species at the Desert Museum, a great deal of trial and error goes into finding effective enrichment for each.

This Valentine's message came with special treats for the bobcats.

mixed-species habitats where slow feeders co-mingle with voracious eaters. In this case, certain fish are conditioned to move to a specific area in their habitat when a target is presented. The fish's behavior is reinforced with a food reward and, before you know it, the fish have been trained to feed in a specific location so that everyone is guaranteed a full belly at the end of mealtime.

MEAL TIME

Many other food related activities can be used as enrichment. In the wild, animals are not presented with perfectly prepared meals, and that's not necessarily best when in human care either. It's both physically and mentally stimulating for an animal to have the opportunity to make an effort to get their meal. Food puzzles similar to those available for domestic dogs and cats are a great tool. Food is sometimes hidden around the animals' habitats so they have the opportunity to forage. Zookeepers and volunteers also make papier-mâché items with food inside, giving the animals the chance to tear it open. It is often observed that when in human care, if an animal is given the challenge to use their skills to access food, such as with a food puzzle, and that same food item is readily available, they will choose the option that requires an effort.

HELPING US HELP THEM

Cats and other mammals are "crate" trained, parrots are "t-perch" trained, and birds of prey are "glove" trained. Teaching birds and mammals these behaviors is not only mentally stimulating for them, but it is extremely helpful when zookeepers or veterinarians need to examine an animal or move it from one habitat to another. Luca, one of our military macaws has learned to spread his wings on command. While this display is certainly beautiful and elicits plenty of oohs and ahhs, the behavior actually serves a practical purpose as it allows us to see the condition of his feathers.

Along the same line, Strawberry the black bear has learned how to present her forearm for a blood draw, and the mountain lion, Cruz, has learned to navigate to a specific spot in his night holding area to present his tail for the same purpose. The goal of this type of training is twofold: the animals benefit from mental stimulation and treatment is far less invasive than if veterinarians needed to use anesthesia to perform these checkups.

HOW YOU CAN GET INVOLVED

If you'd like to directly contribute to the psychological health of the Desert Museum's animals, please consider making a donation online at desertmuseum.org/support. Be sure to select "Animal Care & Enrichment" under the designation and your donation will help create experiences to keep animals happy!

Clockwise from top left: Spiders get some environmental enrichment with holiday décor; the stars of the Sonoran Animal Spotlight presentation experience some novel items at the holidays; grass substrate enrichment for a desert tortoise; a tarantula meets a pumpkin for Halloween; a red-tailed hawk pulls apart this home-made toy; fresh grass provides new textures and hiding places for a mountain king snake.

Conservation Learning at the Zoo

MARIE LONG
Associate Director of Conservation Education & Science

Photography by Jay Pierstorff, unless otherwise noted

Petr Kalouse

Clockwise: The Ocotillo Restaurant serves sustainable seafood and local and native food choices; Colors of Nature summer camp participants; Junior Docent with Western screech owl; summer campers at Cat Canyon; Museum Explorers summer campers learning about buffelgrass; black-tailed prairie dog; Packrat Playhouse exhibit during construction. Cutout on page 22: Male Costa's hummingbird. Cutout below: young ocelot.

WHAT IS YOUR FIRST RECOLLECTION OF THE NATURAL WORLD? This is the first question I pose when I teach interpretation to our new docents. Recollections of the natural world shared by adults typically include a childhood memory of playing outside near their homes, camping, visiting a city park, or a school field trip to a museum, garden, zoo or aquarium. These special places, discovered in childhood, are remembered decades later because they sparked our curiosity, ignited our imagination, fostered play, and helped us begin to connect with a larger, more wild, world. Zoos and aquariums continue to offer important spaces to learn and connect with nature. These institutions are also working to inspire conservation action by providing interpretive messages and learning resources for our visitors. The ultimate goal is for our sites to be conduits for people across the globe to become conservation stewards through the educational experiences we provide. Through love, appreciation, understanding and action we can help protect the animals, plants and landscapes we value and treasure.

According to Inger Andersen, Director General of the International Union for Conservation of Nature (IUCN), more than 700 million visitors pass through the gates of zoos and aquariums throughout the world each year. These institutions have an unrivalled platform to engage the public in conservation. Research indicates that when visitors understand that zoos and aquariums are working to save animals in the wild, their support of global conservation initiatives increases.

WHY DO ZOOS AND AQUARIUMS MATTER? is an important question to ask not only ourselves, but our guests and community members. Over the last 100 years, the role of zoos has evolved drastically, and today zoos are expected to be leaders in the field of global conservation. Zoos connect not only to their local communities, but also to a world network to tackle everything from the biodiversity crisis to ocean pollution, invasive species, and climate change. Zoos and aquariums across the country can collectively accomplish a wide array of conservation goals when they work together. One example is the *'Saving Animals from Extinction'* (SAFE) initiative where AZA institutions have identified endangered animals for which they believe collective action on conservation and education can make a difference (see p. 4).

In 2007, the Arizona-Sonora Desert Museum, along with 9 other AZA accredited sites, participated in a 3 year nationwide study of the impacts of a visit to a zoo or aquarium funded by the National Science Foundation. Results of the *Why Zoos and Aquariums Matter* (WZAM-3) study provided important insights into zoo and aquarium contributions to public understanding of animals and conservation. The findings also improved zoos' capacities to provide meaningful and effective conservation education programming.

"VISITS TO ACCREDITED ZOOS AND AQUARIUMS PROMPT INDIVIDUALS TO RECONSIDER THEIR ROLE IN ENVIRONMENTAL PROBLEMS AND CONSERVATION ACTION, AND TO SEE THEMSELVES AS PART OF THE SOLUTION."

Why Zoos & Aquariums Matter: Assessing the Impact of a Visit to a Zoo or Aquarium
Falk, John, E. Reinhard, C. Vernon, K. Bronnenkant, J. Heimlich, N. Deans
Association of Zoos and Aquariums, 2007

KEY RESULTS FROM THE STUDY INCLUDED:

- Visits to accredited zoos and aquariums prompt individuals to reconsider their roles in environmental problems and conservation action, and to see themselves as part of the solution.

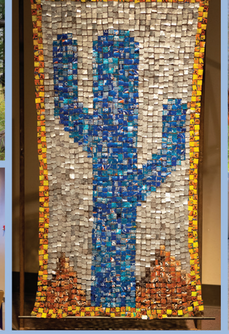
- Visitors believe zoos and aquariums play an important role in conservation education and animal care.

- Visitors believe they experience a stronger connection to nature as a result of their visit.

- Visitors bring with them a higher-than-expected knowledge about basic ecological concepts. Zoos and aquariums support and reinforce the values and attitudes of the visitor.

- Visitors arrive at zoos and aquariums with specific identity-related motivations and these motivations directly impact how they conduct their visit and what meaning they derive from the experience.

HOW IS THE ARIZONA-SONORA DESERT MUSEUM USING THE SURVEY RESULTS? The Museum is in the process of creating an *Interpretive Plan* that incorporates these results into all aspects of the museum experience, from education and interpretive programs, to newsletters, exhibit signage, the website, and social media communication. This plan recognizes that our visitors and other audiences come with their own prior knowledge and motivations that shape their interactions with the Museum. In our conservation communications, we strive to meet visitors where they are, and move them along a continuum toward conservation action. Because of their visits, we hope museum guests will reconsider their role in environmental problems and solutions. Three examples of this include the Seafood Watch Program, 'Save our Saguaros' campaign and youth leadership opportunities.



Clockwise: Earth Campers on Mount Lemmon; Junior Docents' Blue Saguaro tapestry made from recycled cans; Stingray Touch exhibit with sustainable fish cart; Cool Summer Nights presentation. Cutout below: Monarch butterfly.

Left to right: Stingray Touch exhibit; Museum Explorers campers on a walk; Cave exhibit. Cutout below: Hooded Oriole.

SEAFOOD WATCH: Docents and stingray volunteers at Stingray Touch and the Warden Aquarium educate guests about the Seafood Watch Program. This program, out of Monterey Bay Aquarium, provides wallet-sized cards and a downloadable app that lists "best choice," "good alternative," and "avoid" seafood selections. Consumers can collectively discourage unsustainable fishing practices by purchasing sustainable seafood and asking their local stores and restaurants to carry these items. The Desert Museum and our food service provider, Craft Culinary Concepts are proud supporters of this initiative and serve sustainable seafood to our animals and at our restaurants.

INVASIVE SPECIES: The Desert Museum has launched the 'Save our Saguaros' campaign, working with partners across Pima and Maricopa Counties to bring attention to the threats of buffelgrass. This invasive plant is changing our desert landscape to a sea of grass. It out-competes native plants for space, nutrients, and water and is an existential threat to iconic plants like saguaros. As buffelgrass replaces native vegetation, there is also less nutrition for desert animals. Buffelgrass also brings fire to landscapes that are not adapted to deal with it, threatening native plants and animals as well as human structures and recreational sites. Tucson citizens are taking action by joining buffelgrass pulls, educating their Home Owners Associations and organizing their own backyard pulls throughout the community. Native gardening and the creation of backyard habitats are helping to restore the landscape as well. For more information see pages 11-12 of this issue.

YOUTH CONSERVATION LEADERSHIP: According to the AZA Education Committee, AZA-accredited zoos and aquariums are unique venues for students to engage in problem-solving and critical thinking, with important opportunities for real-life applications. Like museums, science centers, and nature centers, AZA-accredited zoos and aquariums primarily use informal education to engage learners of all ages. Informal education, or free-choice learning, gives the visitor choice and control over their experience, leading to motivation, persistence and other personalized learning outcomes. Research by our colleagues at the Ocean Project has shown that children and youth are the most effective conservation educators, not only informing, but inspiring changes in behavior.

On the conservation education forefront, the Museum has expanded its Laurel Clark Earth Camp (a summer camp inspired by the Columbia Space Shuttle Astronaut of the same name) to a school-year program for high school students. The new program, funded by the National Forest Foundation, Arizona Game and Fish Department and private funders, is designed for urban youth in Tucson, to introduce them to the mission and the value of public lands. In this coming school year, the Museum will be working with students and teachers in TUSD's Career and Technical Education Program.

AMERICANS SPEND ONLY 5% OF THEIR WAKING LIVES IN SCHOOL. THE REST OF LEARNING HAPPENS OUTSIDE OF SCHOOL.

The Museum's Junior Docents have also taken on the task of educating visitors about the problem of single-use plastics, and good alternatives. With participation by visitors, they created an innovative art piece, "The Blue Saguaro", a tapestry made from small squares cut from aluminum cans. This beautiful artwork sparks questions about the connections between the ocean and our desert. Junior Docents use the interpretive opportunity to explain how we can help protect the oceans and deserts by refusing and replacing single-use plastic to revive our ecosystems. They have been recognized for their work by the Ocean Heroes program, and presented their work at a conference in British Columbia.

AZA SITES CAN BE LEADERS IN INFORMAL EDUCATION. Americans spend only 5% of their waking lives in school. The rest of learning happens outside of school. As outdoor classrooms and living laboratories, where interdisciplinary presentation of information is inherent to education programming, zoos and aquariums are ideal places to launch life-long learners. AZA-accredited zoos and aquariums have robust education programs staffed by experienced educators who align their teaching with formal and informal education standards. Desert Museum Educators visit about 10,000 school children throughout the Tucson community annually. Another 20,000 children visit the Museum on field trips. Recently, the Flowing Wells Unified School District made the decision to integrate Desert Museum outreach programs and field trips into their 5th and 6th grade curricula to help engage their students more deeply with life science skills and concepts, and the Museum is excited to work with them this year.

WHAT MOTIVATES YOU? Another key result of the *Why Zoos and Aquariums Matter* study was a new approach to understanding our audiences based on their motivations for visiting. Based on their answers to a series of questions, visitors could be grouped into one of five categories: Explorers, Facilitators, Professionals/Hobbyists, Experience Seekers and Rechargers. Zoos and other informal institutions are using the knowledge of these audience motivations to develop relevant, impactful, and enjoyable experiences for our guests.

RECENTLY, THE FLOWING WELLS UNIFIED SCHOOL DISTRICT MADE THE DESISION TO INTEGRATE DESERT MUSEUM OUTREACH PROGRAMS AND FIELD TRIPS INTO THEIR 5TH AND 6TH GRADE CURRICULA TO HELP ENGAGE THEIR STUDENTS MORE DEEPLY WITH LIFE SCIENCE SKILLS AND CONCEPTS.

EXPLORERS are curiosity-driven and seek to learn more about whatever they might encounter. Children are almost always Explorers. Over the last few years, the Museum has been adding hands-on experiences designed especially for children to explore the natural world. Adult Explorers tend to spend more time at zoos and aquariums than other visitors, and get involved as volunteers. The Desert Museum has expanded the Volunteer and Internship Program, creating many new volunteer positions to allow broader participation by over 600 volunteers.

FACILITATORS are guests who focus primarily on sharing their experience with others, often parents or grandparents sharing the experience with children. The Museum's new family focused exhibits include Stingray Touch, where children and adults can make personal connections with stingrays, learn about ocean conservation and make a conservation pledge. Packrat Playhouse is another new experience specifically designed for families, offering an indoor (air-conditioned) play space allowing families to discover the desert through the eyes of a packrat. Adult family




Left to right: Cactus Garden demonstrates the beauty of native and arid-adapted plants; Earth Campers assisting the Coronado National Forest; bat-ear interactive exhibit in the cave. Cutout below: Boojum.

Left to right: Docent, Ellen Gurewitz with Western screech owl; Warden Aquarium conservation wall. Cutout below: man in maze.

and friend groups also visit together, many with strong social motivations. The Museum now has a wider selection of after-hours events throughout the year designed to provide more social experiences for adults.

The Desert Museum serves our **PROFESSIONAL/HOBBYIST** visitors by providing in-depth classes and interpretation, books in the Giftshop and online, and through our volunteer programs, mineral and plant sales and the arts. For example, Mineral Madness weekend showcases and sells minerals for amateur and expert collectors, and inspires young collectors with family friendly mineral activities. The Art Institute offers classes connecting students directly to conservation through the visual arts. Feedback from art student evaluations has shown that almost half of the participants sign-up for an art class with no specific interest in learning about the Sonoran Desert or conservation. However, after they experience the immersive curriculum, they gain new knowledge, appreciation and understanding of the Sonoran Desert region. Surveys indicate that these classes are directly impacting their views on the importance of conservation efforts happening throughout the region.

EXPERIENCE SEEKERS are attracted to our site by the high profile of the Desert Museum as one of the top 10 museums and public gardens in the United States, as rated in various polls over the last decade. When designing exhibits, staff is cognizant of these groups who are often eager for photo opportunities. Major renovations have occurred with the cactus and agave gardens, which are showstoppers when the plants are in bloom, along with the new addition of Boojum Hill, a garden that interprets the photogenic Vizcaino subdivision of the Sonoran Desert. Educational photo opportunities have been incorporated into exhibits to provide take-home memories. A few examples include bat ear display in the Earth Sciences Center, Stella the stingray in the Stingray Touch Exhibit and vulture's wingspan in the Vulture Culture exhibit.

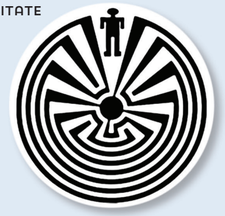
"CONSERVATION EDUCATION IS THE PROCESS OF INFLUENCING PEOPLE'S ATTITUDES, EMOTIONS, KNOWLEDGE, AND BEHAVIORS ABOUT WILDLIFE AND WILD PLACES. THIS IS DONE THROUGH THE EFFORTS OF SKILLED EDUCATORS AND INTERPRETERS, WHO USE A VARIETY OF TECHNIQUES, METHODS, AND ASSESSMENTS TO RECONNECT PEOPLE WITH THE NATURAL WORLD."

–International Zoo Educator Association

Last, but not least, survey results indicated that some zoo guests are visiting our sites to **RECHARGE.** They are seeking contemplative and restorative experiences. Several years ago there was an opportunity to create a new garden in the place of an outdated bird exhibit. Before moving forward, staff reflected on the results of the *Why Zoos and Aquariums Matter* study, and realized the museum did not provide a specific space for visitors with this motivation. The idea of creating a "man-in-the-maze" garden bubbled up from discussion, and the exhibit team invited Tohono O'odham tribal elders and community members to be part of the planning process. They were instrumental in guiding and providing exhibit design recommendations.

Elders explained that the "man-in-the-maze" symbolizes a life journey, and that we are all on the same path to the center, where we hope for peace and serenity. The symbol appears in the basketry of the Tohono O'odham of Arizona and Sonora, Mexico. O'odham basket weavers often refer to the design as the floor plan to the house of their creator, I'itoi, also known as Elder Brother. Another common O'odham interpretation views the individual moving along the path on a personal journey, gaining knowledge along the way. Tohono O'odham elders recommended that the Museum create a labyrinth garden incorporating local stones and medicinal plants. Upon completion, Tohono O'odham elders blessed the site at the opening. Over the years, plants have matured, and many visitors have discovered and enjoyed the Labyrinth garden. It is a hidden treasure at the Desert Museum, where visitors can seek refuge to reflect, meditate or ponder their journey in life.

OVER THE YEARS, PLANTS HAVE MATURED, AND MANY VISITORS HAVE DISCOVERED AND ENJOYED THE LABYRINTH GARDEN. IT IS A HIDDEN TREASURE AT THE DESERT MUSEUM, WHERE VISITORS CAN SEEK REFUGE TO REFLECT, MEDITATE OR PONDER THEIR JOURNEY IN LIFE.



CONTINUING THE CONVERSATION-WHY ZOOS & AQUARIUMS MATTER PART 3

Zoos, gardens and aquariums continue to learn from one another and their guests about how to make the most positive collective impacts on our global ecosystem. The Desert Museum recently participated in another national survey "Why Zoos & Aquariums Matter-Part 3" to better understand how zoos and aquariums teach important STEM (science, technology, engineering and math) concepts with an eye toward improving existing programs. The Desert Museum incorporates STEM and STEAM (adding the arts) in education programs. One example of a STEAM program is *Colors of Nature*, a summer camp run in parternship with the National Optical-Infrared Astronomy Research Laboratory. The class explores color through art and science, everything from learning why flowers have the colors they do, to how bees see, and making original art using chemistry and optics.

The current WZAM-3 project aims to help zoos and aquariums understand their niche in a larger learning ecosystem so that we can focus our messaging where it is most likely to be effective. Research tells us that simply learning about a conservation issue does not change behavior. We are still learning how zoos and aquariums can best participate in larger societal efforts to foster sustainable behavior.

ZOOWISE is another multi-institutional collaborative focused on measuring visitor learning at zoos. It focuses on learning about biodiversity and actions to protect biodiversity. Their recent findings are that zoo visitors make significant gains in understanding of both

Left to right: Grey fox getting ready for art class; the Desert Museum Art Institute offers hundreds of classes each year; children chipping away at fossils at the Ancient Arizona exhibit. Cutout below: Mountain lion.

the concept of biodiversity and what they can do to protect biodiversity. These knowledge gains appear to persist and even improve over two years following the zoo visit. Much more research is needed in this young and complex field of study in order to fully understand the impact of a visit, and how to design it to encourage and empower visitors to live in better harmony with nature. The Desert Museum will be joining the ZooWise program next year, with funding support from the Flinn Foundation.

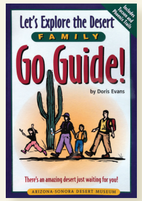
CONSERVATION LEARNING THROUGH ACTION. Based on evaluations with guests and community members, we are striving to create more opportunities to participate in conservation research and action for the public. Community members and volunteers can be part of the solution with the Southwest Monarch Study, where volunteers tag monarchs and collect data to better understand migration patterns. Community groups are organizing buffelgrass pulls to control this invasive species and students and volunteers are collecting bees to create a baseline inventory of species. We have found that when guests have an opportunity to see science in action, they are more likely to ask about it, want to learn more and participate. We also have launched a few interpretive games as a test to engage guests about important conservation messages. Junior Docents interpret bycatch during Cool Summer Nights with a fun and interactive game that brings attention to unsustainable fishing practices and instills action with visitors who can choose to eat sustainable seafood. You might also catch our buffelgrass board game on grounds sometime!

AS A LEARNING INSTITUTION, WE WILL TRY NEW APPROACHES OVER THE NEXT SEVERAL YEARS, GUIDED BY THE LATEST RESEARCH AND BEST PRACTICES, TO ASSURE THAT THE MUSEUM IS EVEN MORE OF A SOURCE OF CONSERVATION INSPIRATION AND KNOWLEDGE FOR OUR VISITORS IN THE FUTURE.

INTRINSIC IMPACT RESULTS

In another project funded by the Flinn Foundation, The Desert Museum is working with WolfBrown Cultural Consultants to measure the impacts of a visit via exit surveys. These are helping us better understand our current audience, the drivers for their visits, and the messages they are taking home. We have learned that visitors leave the Desert Museum with a deeper appreciation for the Sonoran Desert and feeling more connected to the natural world. They are inspired to spend more time in nature, be more thoughtful about their environmental impacts, and learn more about the environment. We have also learned that many visitors are not gaining conservation knowledge that they feel they can use in their own lives. There could be several reasons for this, for example, maybe people didn't come with this motivation, maybe they already had a high level of conservation literacy, maybe they came from a very different place with different conservation issues and needs, or maybe we do not do a good job of providing this information. As a learning institution, we will try new approaches over the next several years, guided by the latest research and best practices, to assure that the Museum is even more of a source of conservation inspiration and knowledge for our visitors in the future.

Continue your *conservation learning* with these titles:

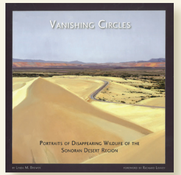


Let's Explore the Desert Family Go Guide!
Doris Evans
New Lower Price $9.95

This inviting book is for families that want to make the most out of their desert excursions. It begins with some basic information on how to prepare for a trip into the desert, followed by tips that assure a safe and enjoyable desert experience. It then addresses questions that the author, an environmental educator, commonly hears during her work with children. Rather than giving direct answers to these questions, she provides clues so that children can discover on their own and thereby become more aware of patterns and interrelationships found in nature.

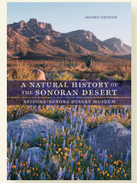
Gardening for Pollinators in the Desert Southwest
Mrill Ingram,
watercolors by
Vera Ming Wong
$3.95

For many of us, encounters with nature begin in the backyard. This brochure aims to inspire everyone, from the dedicated gardener and the environmental educator to the occasional flower-sniffer, about the possibilities of bringing desert wildlife in for a visit. The publication includes a four-color illustration of a desert pollinator garden and detailed information, including plant lists, on how to garden in order to attract hummingbirds, butterflies, bees, and even bats.



Vanishing Circles: Portraits of Disappearing Wildlife of the Sonoran Desert Region
By Linda M. Brewer
Foreword by Richard Leakey
New Lower Price $12.95

Vanishing Circles is a richly illustrated volume documenting an important museum exhibition and showcasing the beauty and diversity of species rapidly disappearing from the Sonoran Desert Region. Although the underlying premise of Vanishing Circles is bittersweet, this is a stunning, enjoyable book that works on several levels. The sheer beauty of nature is expressed through the individual composition, design, and virtuosity of leading artists; natural history details on each subject further illuminate the elegance of those animals, plants, and places; and biographical information is provided for each artist. These elements, along with conservation information, reference lists, and a glossary make Vanishing Circles a well-rounded introduction to the Sonoran Desert Region. Best of all, Vanishing Circles follows in the path of the famous Arizona Highways magazine, taking readers off the beaten path and into a world that most mortals never see.



A Natural History of the Sonoran Desert, 2nd Edition
Edited by Mark Alan Dimmitt, Patricia Wentworth Comus, and Linda M. Brewer
$39.95 Soft cover; 590 pages

The landscape of the Sonoran Desert Region varies dramatically from parched desert lowlands to semiarid tropical forests and frigid subalpine meadows. Covering southeasternmost California, much of southern and central Arizona, most of Baja California, and much of the state of Sonora, Mexico, it is home to an extraordinary variety of plants and animals. A Natural History of the Sonoran Desert takes readers deep into its vast expanse, looking closely at the relationships of plants and animals with the land and people, through time and across landscapes. This new edition adds chapters on the Sky Islands, Sea of Cortez, desert pollinators, and conservation issues.

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