VOL.2 | 2016

THE SCIENCE OF Saving Species

SAN DIEGO ZOO GLOBAL

INSTITUTE FOR CONSERVATION RESEARCH

Plants in Crisis: THE GOOD NEWS

Plants are some of the most beautiful life-forms on Earth. Vital to our existence, they provide food, shelter and clothing as well as clean the air, water, and soil.

As a conservation organization, San Diego Zoo Global has taken a bold move with its focus on saving the world's animals and plants from extinction. We are implementing new technology-based initiatives, including advanced conservation genetics, which can be incorporated into the Zoo's conservation toolbox to save plants.

–John Clark, Ph.D.

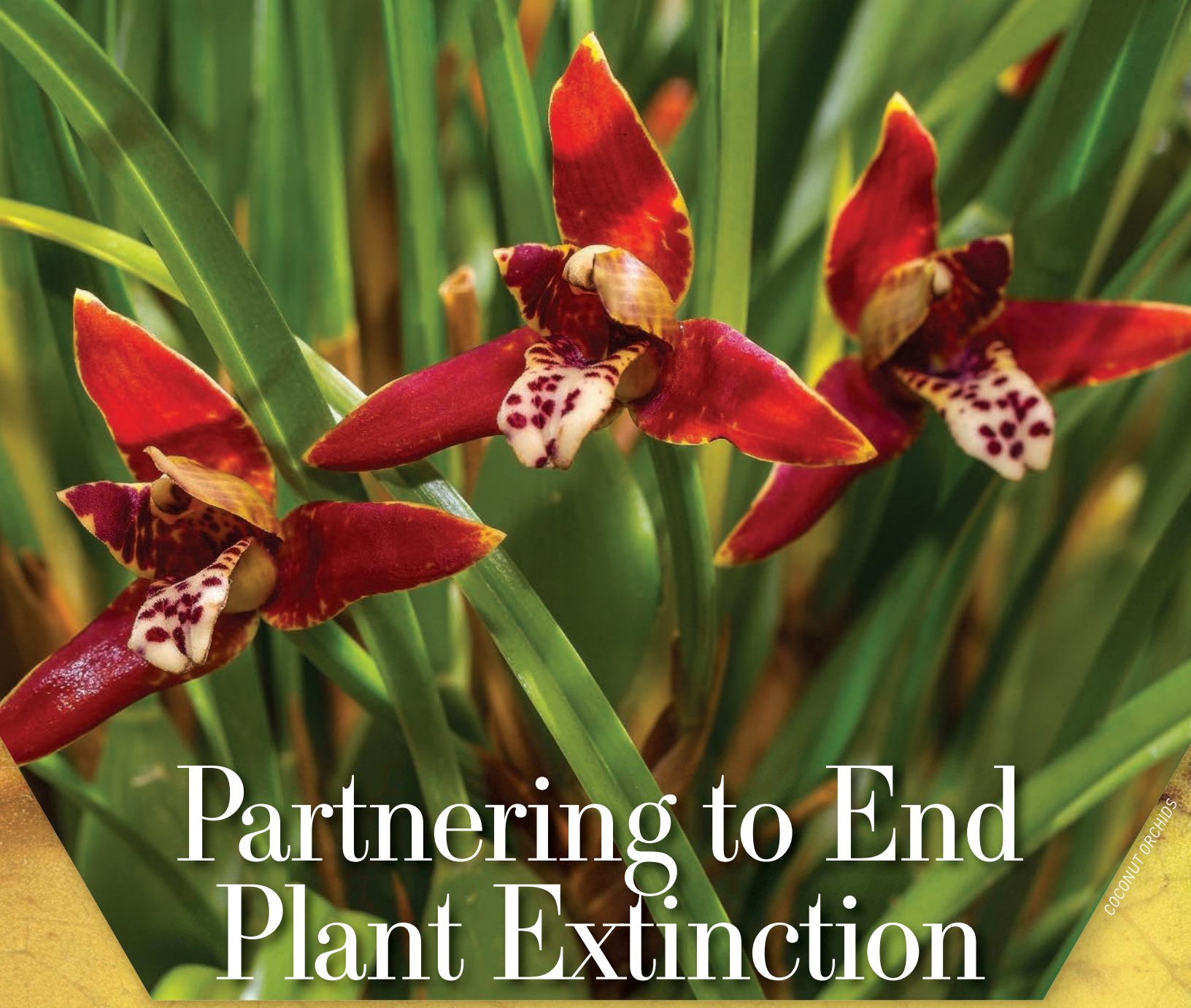
A New Plant Partnership

Early in 2016 San Diego Zoo Global announced a new partnership with the Center for Plant Conservation, formerly based in St. Louis, Missouri, which enhances the efforts of both organizations to preserve the world's plants. "There is no better place for us to consolidate, focus, and expand our efforts than here in San Diego," said John Clark, Ph.D., in his dual role as president of the Center for Plant Conservation and director of Plant Conservation at San Diego Zoo Global. "The Zoo and Safari Park are home to one of the most extensive collections of plants anywhere in North America—many of them imperiled—as well as a team of talented and enthusiastic scientists and horticulturists working with plants and their conservation." Dr. Clark will lead the Center's national efforts to save endangered plants by bringing them into cultivation or seed banks and will provide strategic direction for our plant research programs, plant collections, and Native Plant Seed Bank.

How You Can Help

Our field research teams all over the world rely on the generosity of donors like you to help achieve San Diego Zoo Global's vision to lead the fight against extinction. To learn ways you can help, please call Maggie Aleksic at 760-747-8702, option 2, ext. 5762, or email **maleksic@sandiegozoo.org**.

ON THE COVER: Seeds from a germination test for coyote melon *Curcubita foetidissima*.



COCONUT ORCHIDS

Partnering to End Plant Extinction

By John Clark, Ph.D., Director of Plant Conservation, and President/CEO, Center for Plant Conservation

THE WORLD WOULD CERTAINLY BE A DIMINISHED PLACE WITHOUT RHINOS, GIANT PANDAS, AND TIGERS, BUT WITHOUT PLANTS, ALL THE WORLD'S ANIMALS—INCLUDING HUMANS—WOULDN'T EXIST. PLANTS PROVIDE FOOD, SHELTER, AND CLOTHING AS WELL AS CLEAN THE AIR, WATER, AND SOIL. THEY ARE SOME OF THE MOST BEAUTIFUL LIFE-FORMS ON EARTH AND ALSO VITAL TO OUR VERY EXISTENCE.

Despite their central role in sustaining life, many of the world's plants are threatened with extinction. Researchers at Kew Gardens in London, England, identified at least 80,000 plant taxa that could go extinct by the next century—that's one-fifth of the world's plant species. To put this in perspective, there are more endangered plants than there are species of all the world's fishes, amphibians, reptiles, birds, and mammals combined. These are daunting numbers, yet we at San Diego Zoo Global believe that our vision to end plant extinction will be achieved through exemplary efforts and key partnerships, both locally and internationally.

Recently, San Diego Zoo Global enlisted a new partner in our fight to end extinction: the Center for Plant Conservation (CPC), where I am also the president and CEO. Founded in 1984 at Harvard University, CPC is a nonprofit organization dedicated to saving plants from extinction through collaborations and advocating scientific expertise in conservation. CPC's core focus is to coordinate conservation efforts among leading botanical gardens and arboreta to ensure the long-term survival of many of the rarest plants in North America.

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OUR GOAL IS TO BE A GLOBAL MODEL FOR PLANT CONSERVATION

Continued from page 2

In January 2016, San Diego Zoo Global became the 40th CPC Participating Institution, as well as the new National Headquarters for CPC. Now based at the Zoo's Institute for Conservation Research, we are working to advance our shared goals to end plant extinction in many ways:

VIBRANT COLLABORATIONS across political boundaries are key to ending extinction. We are working in San Diego County to bank seeds from the numerous plant species facing extinction here. Our local efforts are part of a statewide network in California, the California Plant Rescue Program, which in turn meets global targets set by the Millennium Seed Bank at Kew Gardens. This is just one example of how strategic partnerships maximize conservation efforts for plants.

PROGRESSIVE SCIENCE is also needed to save plants. We are implementing new technology-based initiatives, including advanced conservation genetics, to save plants. Discussions are under way on how advanced genomics tools, including transgenics, can be incorporated into the Zoo's conservation toolbox. This is an exciting new frontier for our plant conservationists.

WELCOMING THE CPC NATIONAL HEADQUARTERS

to San Diego Zoo Global creates more opportunities for collaboration throughout existing and new networks while also providing an opportunity to showcase plant conservation to Zoo and Park visitors. As a premier botanical center, San Diego Zoo Global is in a unique position to reimagine plant conservation science. In conjunction with animal conservation genetics and other research, the Zoo offers an unparalleled opportunity to discuss how genetics can enhance plant conservation on a species level, targeting propagation and preservation techniques to maximize plant diversity and abundance.

Committed to ending plant extinction, we are poised to advance collaborations between new and enthusiastic partners who share our vision. Our goal is to be a global model for plant conservation, not only saving plants in North America but also inspiring many others to save plants around the world. With 80,000 plant species at stake, nothing less will be enough.

1 IN 5
PLANT SPECIES WORLDWIDE
is threatened with extinction.

Losing a biodiverse ecosystem can translate to
10 TO 100
times the cost of maintaining it.

San Diego County is recognized as a biodiversity hotspot, WITH **1,500+** native plant species.

California Plant Society lists
368 PLANT SPECIES
as rare in San Diego County.

83
GLOBALLY IMPERILED PLANTS
occur in San Diego County:
74 flowering plants,
3 conifers,
1 lichen, 2 liverworts,
& 3 moss species.

San Diego County is home to
37
PLANT SPECIES
listed as threatened or endangered.

OVER 140
PLANT SPECIES
are recognized as endangered or species of concern by San Diego County.

A CLOSER LOOK AT THE CPC

CPC Participating Institutions, including San Diego Zoo Global, work collectively to manage the CPC National Collection of Endangered Plants, a living conservation collection of nearly 800 of the world's rarest plants. CPC National Collection plants are maintained in seed banks and in cultivation. Some CPC Participating Institutions, like San Diego Zoo Global, employ advanced technologies, including tissue culture and cryopreservation, to grow and maintain rare plants.

Although a tremendous success, the CPC National Collection currently contains less than a quarter of North America's endangered plants and represents a tiny fraction of the world's plants facing extinction. To ramp up this effort nationally and expand it on an international scale, San Diego Zoo Global and the CPC are now working jointly on a strategic plan for plants that details how we will lead the fight against extinction, individually and collaboratively.

IT IS EASY TO OVERLOOK A GLOBALLY IMPERILED ECOSYSTEM, COASTAL SAGE SCRUB, IN OUR OWN BACKYARD. YET THIS UNIQUE HABITAT IS HOME TO 15 SENSITIVE PLANT SPECIES AS WELL AS 21 BIRD SPECIES AND 4 REPTILE SPECIES OF SPECIAL CONSERVATION CONCERN. IT SUPPORTS A VARIETY OF CHARISMATIC MICROFAUNA, INCLUDING THE SOUTHERN GRASSHOPPER MOUSE AND THE PACIFIC SLENDER SALAMANDER, ALONG WITH RARE AND BEAUTIFUL PLANTS LIKE SAN DIEGO THORNMINT. AS A RESULT OF HUMAN DEVELOPMENT, COASTAL SAGE SCRUB IS NOW SEVERELY THREATENED, OCCUPYING LESS THAN 10 PERCENT OF ITS FORMER RANGE. PROTECTING AND IMPROVING COASTAL SAGE SCRUB IS AN IMPORTANT GOAL OF SAN DIEGO COUNTY'S MULTIPLE SPECIES CONSERVATION PROGRAM.

Giving Coastal Sage Scrub

Several years ago, our Plant Conservation team partnered with the City of San Diego, the San Dieguito River Valley Conservancy, the San Dieguito River Park, California Department of Fish and Wildlife, and California State Parks to preserve and enhance a 94,000-acre wildlife corridor at Lake Hodges, along the San Dieguito River. This corridor connects the urban coast to the inland mountains, so it is critical in encouraging migration of plants and animals between coastal sage scrub habitat patches.

One natural occurrence we can't always predict or contain is fire, and the Lake Hodges area experienced three separate fires in the last three decades. Although coastal sage scrub is capable of recovering from infrequent fire, when fire occurs more often than every 30 years, the area suffers degradation. Coastal sage scrub plants require fire-free periods to regenerate or reseed. Fire-scarred land is susceptible to invasion by exotic invasive annual grasses, but it can recover with restoration. To promote resilience to climate change and prevent encroachment by invasive plants, our team is working with partners to restore coastal sage scrub along the San Dieguito River. These restoration efforts benefit the ecosystem and also a variety of rare plants and animals, including the coastal cactus wren and the federally threatened California gnatcatcher.

Our restoration steps included an array of experimental plots and seeded areas. Beginning in 2015, we planted an astounding 20,000 plants of eight shrub species across four locations. We purposely selected drought-tolerant and fire-resistant species to improve restoration success and resilience of the native plant community. We designed our experiment to test whether the degree of community resilience to fire and invasion by exotic species varies with species composition and individual plant traits. In addition to planting shrubs, we sowed seed from 32 species. To establish our transplants during the first dry season, we watered them periodically and removed nonnative invasive species in our plots.

One year following installation, we were thrilled to see that 87 percent of our transplants survived. However, fully restoring an ecosystem takes a long time. Over the next decade, we plan to monitor survival of the transplanted species, germination of seeded species, and percent cover of native and exotic species. We will consider our restoration a success if we improve the abundance and percentage of ground covered by native species in comparison to exotic species.

In the best of circumstances, nature can bounce back from disturbance, although the multi-pronged threat from fire and invasive species coupled with drought may mean that we risk losing coastal sage scrub habitat forever. At Lake Hodges, we work hard to help end extinction by promoting recovery of a diverse and healthy coastal sage scrub ecosystem.

I was headed to a career as a professor, but everything changed when I met the rare Arizona leatherflower and its impending potential threat from timber harvest. I never looked back. Since then I have researched dozens of endangered plant species to provide solutions toward preventing their extinction.

–Joyce Maschinski, Ph.D.

A Helping Hand

By Joyce Maschinski, Ph.D.,
Senior Scientist,
Plant Conservation, and
Chief of Science,
Center for Plant
Conservation

Banking on the Future of Plants

Behind the scenes at the San Diego Zoo Institute for Conservation Research are collections of rare plant species held in our Native Plant Seed Bank. We conserve seeds of both rare and important restoration species before they are lost in the wild. The generous support of donors has greatly aided in the success of these projects, and to date over 700 seed collections have been made. Given the importance of their precious contents, seed banks represent an invaluable cornerstone for conservation research and an assurance for the future—we are definitely banking on the future of plants.

Seeds have a finite life span—and they can't simply be placed in a freezer and forgotten. Healthy, properly desiccated seeds can be stored reliably at low temperatures for many years.

PHRAGNIPEDIUM KOVACHII

PAPHIOPEDILUM HANGIANUM

PAPHIOPEDILUM VIETNAMENSE

PAPHIOPEDILUM TIGRINUM

Plant Rescue Center: ORCHID THIEVES BEWARE!

By Janette Gerrity,
Senior Horticulturist,
San Diego Zoo

WHEN A *PAPHIOPEDILUM STONEI* WAS CONFISCATED at the U.S. border in 2001, it was labeled "unidentified" and sent to the San Diego Zoo's Plant Rescue Center. Then when this orchid bloomed, our horticulture staff was able to determine the species was *stonei (right)*. First discovered in Borneo in 1862 by plant collectors, this orchid is now endangered because of poaching. But this would not be the last time *P. stonei* was confiscated and sent to the Zoo, which opens up a much wider conversation about plant conservation efforts worldwide.

Often when we talk about wildlife trafficking, the focus is often on animals and animal parts, with the rarest ones in danger of being poached and sold on the black market. At San Diego Zoo Global, we are dedicated to leading the fight against extinction. To support this vision, we formed a Wildlife Trafficking Task Force that collaborates with the U.S. Fish and Wildlife Service (USFWS) and other conservation organizations. But how does that apply to orchids, those beautiful and exotic flowers—and why do we need a Plant Rescue Center at the Zoo to protect them?

Collecting plants illegally is nothing new. Since the early 19th century, orchid hunters and obsessed collectors have coveted specimens from the plant family Orchidaceae. Recent books and films, such as *The Orchid Thief, Orchid Fever, and Adaptation*, featured protagonists and their escapades to possess the rarest orchid. But these are really stories about poachers and their illegal smuggling practice that can wipe out entire rare orchid species in order to command the highest black market price of these bizarre and gorgeous flowers. With habitats diminishing around the globe, this demand for the rarest orchids puts additional pressure on wild populations.

Today, there are regulations in place—established by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), a treaty upheld by many governments—and customs officers in

place at U.S. ports and border crossings to inspect plant shipments. Now in its role as a leading conservation organization, San Diego Zoo Global is notified when plants or animals are confiscated at the U.S.-Mexico border or at any other port of U.S. entry. But plants didn't always have these protections.

In 1978, after orchids, cycads, cacti, and succulents were torn from native habitats and offered for sale to international collectors, the Plant Rescue Center Program was established by USFWS in response to this crisis. In April 1988, San Diego Zoo applied for designation as a Plant Rescue Center and assumed responsibility for plants illegally imported into the United States, some of the most beautiful contraband in the world.

We're happy to say this orchid rescue program is a success. Compared to shipments of orchids in the 1990s—when hundreds of plants were arriving annually—in 2014 we received only three orchids, and in 2015 we received only one. Finally people understand that transporting any orchid species across international borders without permits is a crime. Here at the San Diego Zoo we will continue promoting this message with our beautiful orchid collection and continue propagating rare species when they are identified. As orchids have gained international protection, the Zoo's Orchid House is a growing force in the fight to end plant extinction. For our horticulture team, saving orchids can be compared to saving endangered species like giant pandas: we don't want to lose a single one on our watch.

Safe Havens For Orchids

THE ORCHID RESCUE PROCESS BEGINS WHEN THE U.S. FISH AND WILDLIFE SERVICE ENFORCES CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES REGULATIONS:

1. Each international plant shipment requires phytosanitary and CITES permits—without these, they can be confiscated at the border.
2. U.S. border officers consult with foreign officials in each country from which confiscated orchids are exported, informing them of an illegal importation.
3. Confiscated plants are assigned to a Plant Rescue Center, such as the San Diego Zoo, to be maintained as a unit for a 30-day waiting period. This gives the country of origin time to request the return of these plants.
4. Finally, the plants may be displayed, propagated, and adopted by the Plant Rescue Center into that organization's collection. Over the years, many bundles, cuttings, and seeds have found safe haven in the Zoo's greenhouses.
5. Under USFWS rules, these plant specimens may never be traded or sold.

"Many people are unaware that transporting plants across international borders requires permits. Plants have the same protection as animals. You know not to take a giant panda out of China, but do you know not to take an orchid out of Costa Rica?"

–Janette Garrity, Senior Horticulturist

Conservation Achievements

HONORS AND AWARDS

Dr. Debra Shier, Brown Endowed Associate Director of Applied Animal Ecology, was honored with the 2016 Pritzker Environment and Sustainability Education Fellowship at the University of California, Los Angeles. Candidates are selected based on their commitment to providing innovative, forward-thinking education focused on the environment and sustainability.

Dr. Oliver Ryder, Kleberg Director of Genetics, was appointed as a Member of the Center for Microbiome Innovation at the University of California, San Diego. The Center draws together interdisciplinary teams of researchers to promote understanding of microbiomes, the constellations of microorganisms that live within and around humans, other species, and in the environment.

HIGHLIGHTED PUBLICATIONS

Miller, J. S., P. P. Lowry II, J. Aronson, S. Blackmore, K. Havens, and **J. Maschinski.** 2016. Conserving biodiversity through ecological restoration: the potential contributions of botanical gardens and arboreta. *Candollea* 71: 91-98.

This paper highlights the range of knowledge and skills found in botanical gardens and arboreta for accomplishing ecological restoration, designing succession strategies, propagating plants for reintroduction, educating others, and serving as advocates for ecological restoration as part of a new paradigm of sustainability.

Owen, M. A., J. L. Keating, S. L. Denes, K. Hawk, A. Fiore, J. Thatcher, J. Becerra, S. Hall, and **R. R. Swaisgood**. 2016. Hearing sensitivity in context: Conservation implications for highly vocal endangered bear species. *Global Ecology and Conservation* 6: 121-131.

This highly collaborative zoo-based study examined hearing sensitivity in the giant panda within the context of the species' use of vocalizations for social interactions. A thorough understanding of acoustic ecology in pandas is important for understanding the potential impacts of noise disturbance.

White, C. L., M. J. Forzan, **A. P. Pessier**, M. C. Allender, J. R. Ballard, A. Catenazzi, H. Fenton, A. Martel, F. Pasmans, D. L. Miller, R. J. Ossiboff, K. D. Richgels, and J. L. Kerby. 2016. Amphibian: A case definition and diagnostic criteria for *Batrachochytrium salamandrivorans chytridiomycosis. Herpetological Review* 47: 207-209.

In 2013, a new species of chytrid fungus, Batrachochytrium salamandrivorans or Bsal (literally "salamander eater") was described as the cause of mass mortality events of European newts. This publication reports on task force recommendations for the recognition and diagnosis of Bsal should it arrive in North America.

Gifts & Grants

THE INSTITUTE FOR CONSERVATION RESEARCH IS GRATEFUL FOR INVESTMENTS IN PLANT CONSERVATION:

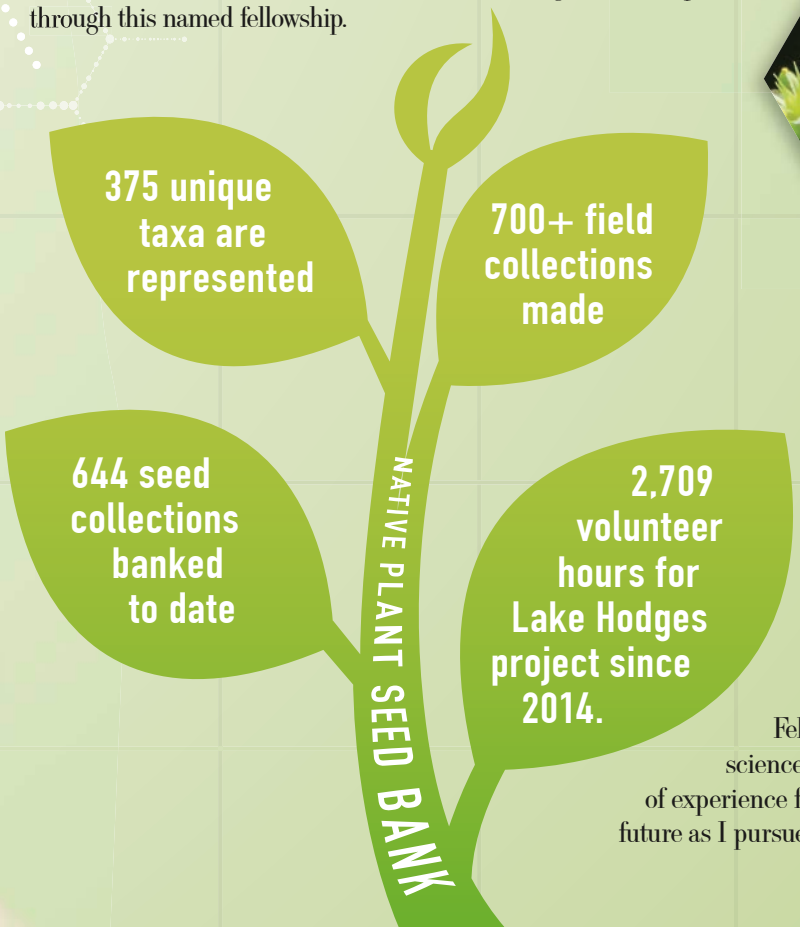
Planting the Seeds of a Memorial Gift

For 10 years, the Conrad Schlum Charitable Trust has assisted our efforts in conservation research by sponsoring an annual Schlum Fellowship in Plant Conservation. The fellowship honors the memory of the late Conrad Schlum, a passionate plant lover and tree-planting enthusiast from Southern California.

Our 2015 and 2016 Schlum Fellow is Joseph Davitt, an area native who, like Mr. Schlum, has a passion for plants and habitats. The scope of Joe's work includes locating, gathering, curating, and banking seeds in our Native Plant Seed Bank and conducting post-storage germination tests, focusing on rare plants of San Diego County. Joe and his mentor, Stacy Anderson (herself a former Schlum Fellow), have a target list of 26 populations of native plant species to monitor and collect seed from, should they grow as expected. The list includes the very beautiful, but very endangered, Mexican flannelbush, *Fremontodendron mexicanum*. This rare shrub with showy yellow-orange flowers has only two extant populations and is thought to have less than 100 individual living plants. Collecting and banking taxa like San Diego thornmint, San Diego barrel cactus, and the iconic Torrey pine tree help provide assurances against extinction. We thank the Schlum Charitable Trust for their role in conserving rare native plants through this named fellowship.

Stacy Anderson and Joe Davitt, Native Plant Seed Bank scientists, are collecting seeds from the short-leaved Dudleya brevifolia.

Above: Mexican flannelbush, *Left:* Dudleya brevifolia



A Fellow for All Seasons

We are grateful to the Foundation for Sustainability and Innovation (FSI) for having sponsored an FSI Summer Fellow for six years and an FSI Spring Fellow for the past two years. The Foundation has helped the Plant Conservation Division meet its ambitious goals in this way by sponsoring a 12-week fellowship that provides a budding plant ecologist with a wonderful opportunity to lay the groundwork for a career in plant conservation. Henry Cen, our 2016 FSI Spring Fellow, learned habitat restoration techniques, conservation science, and everyday life skills. Said Henry, "I have gained a lot of experience from this fellowship, and I know it will benefit me in the future as I pursue a career in research."

APPLIED ANIMAL ECOLOGY

Our field team reintroduced 50 endangered, zoo-bred Pacific pocket mice to the wild for the first time, creating a new population of this coastal Southern California native species.

BEHAVIORAL ECOLOGY

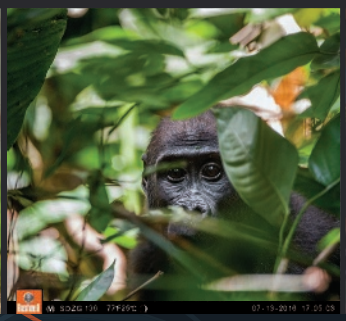
Our Central Africa Program team captured the first-ever video footage of the elusive gorillas inhabiting Cameroon's Ebo forest, including three juveniles and a pregnant female.

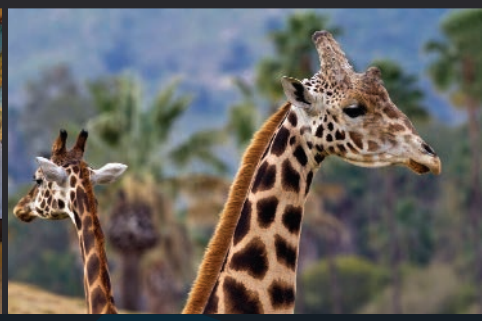
CONSERVATION EDUCATION

We facilitated a conservation education strategic planning workshop in Kenya for Lewa Wildlife Conservancy, Save The Elephants, Grevy's Zebra Trust, Giraffe Centre, Ewaso Lions, and other key partners.

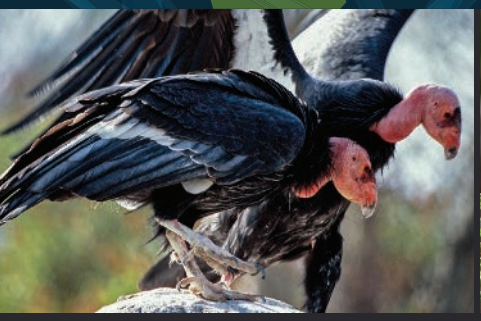
CONSERVATION PARTNERSHIP DEVELOPMENT

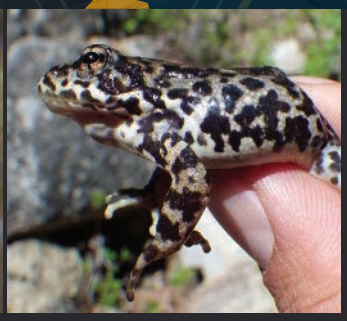
With Kenya's Loisaba and Namanyuk conservancies, we launched a giraffe monitoring program involving camera trapping, antipoaching patrols, and community engagement.





WHAT'S News





GENETICS

Our geneticists received funding to generate a high-quality genome assembly of the genetic region associated with chondrodystrophy in California condors that will help guide future management decisions.

PLANT CONSERVATION

We hosted the national meeting of the Center for Plant Conservation, with staff giving presentations on rare plant seed banking, coastal sage scrub restoration efforts, and our Tecate cypress field gene bank.

REPRODUCTIVE PHYSIOLOGY

Exceptional work by our mountain yellow-legged frog team this year resulted in the production of over 1,500 tadpoles, including more than 400 from a critically endangered population presumed to be extinct in the wild.

WILDLIFE DISEASE LABORATORIES

We received funding from the U.S. Fish and Wildlife Service to provide expert guidance in evaluating the health and connectivity of a large population of desert tortoises in Nevada.

THE SCIENCE OF Saving Species

SAN DIEGO ZOO INSTITUTE FOR CONSERVATION RESEARCH

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