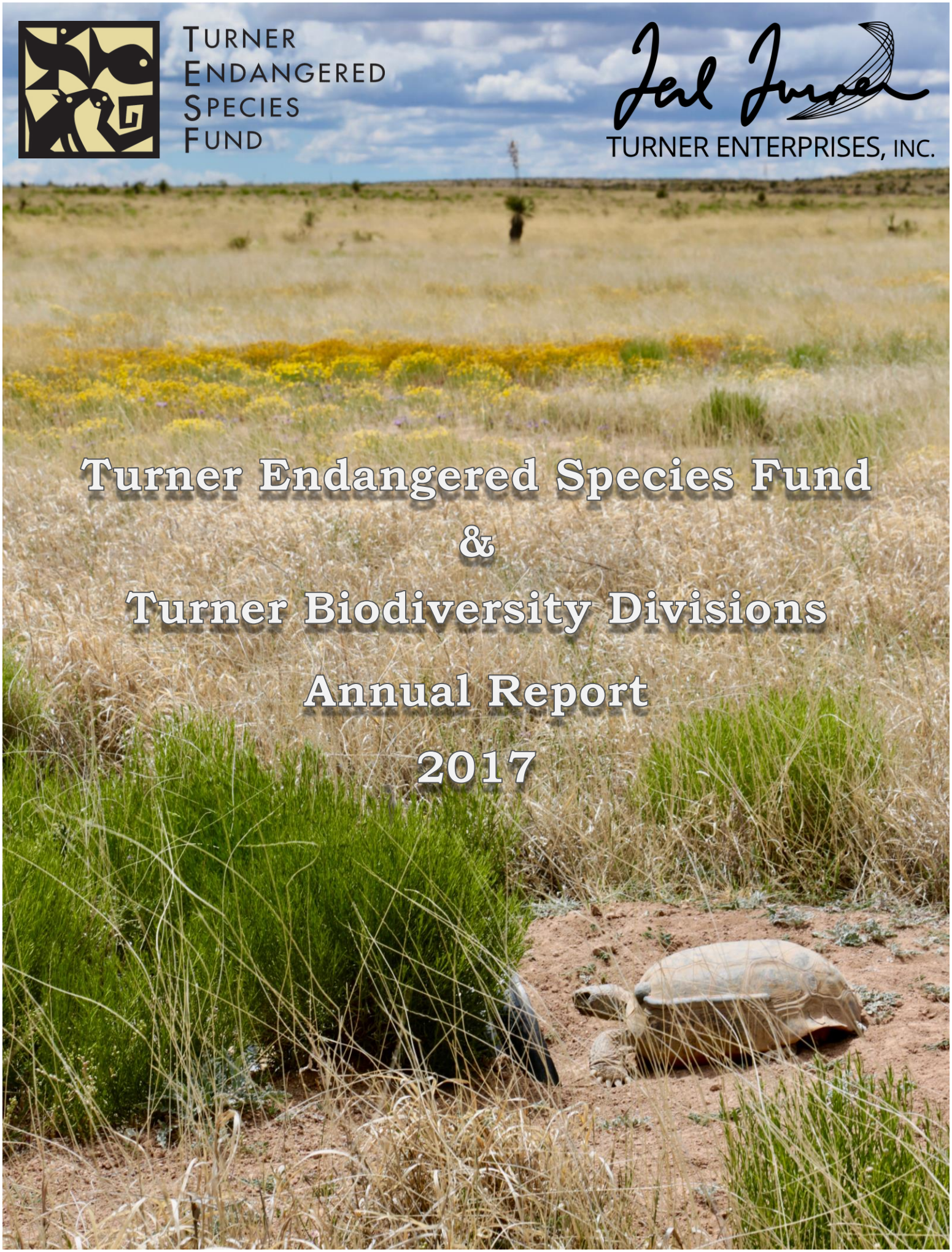
TURNER
ENDANGERED
SPECIES
FUND
TURNER ENTERPRISES, INC.
Turner Endangered Species Fund
&
Turner Biodiversity Divisions
Annual Report
2017

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Annual Report
2017

Magnus McCaffery, Val Asher, Cassidi Cobos, Levi Fettig, Cheney Gardner, Dave Hunter, Carter Kruse, Eric Leinonen, Dustin Long, Hunter Prude, Grace Ray, Chris Wiese, and Mike Phillips

Turner Endangered Species Fund/Turner Biodiversity Divisions
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Suggested citation: McCaffery, M. and M. K. Phillips (Editors). 2018. Turner Endangered Species Fund and Turner Biodiversity Divisions: Annual Report, 2017. Turner Endangered Species Fund, Bozeman MT.

All photos not otherwise marked are TESF/TBD photos.

Cover photo: *An adult bolson tortoise basking near its burrow on the Armendaris Ranch. Photo by Paul Gibbons (Turtle Conservancy).*

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TURNER ENDANGERED SPECIES FUND/TURNER BIODIVERSITY DIVISIONS

Every year tens of thousands of species and attendant ecological actions, fine-tuned by time and place, disappear at the hand of man. These losses strip away the redundancy and certainty of nature and diminish the lives of millions of people. If these trends continue, the world will become a dismal place indeed, with silent springs and hot summers and little left to excite the senses except the weeds. Without doubt, the extinction crisis looms as one of humanity's most pressing problems.

In response to this crisis, Ted Turner and Mike Phillips (background picture) along with Turner's family established the Turner Endangered Species Fund (TESF) and Turner Biodiversity Divisions (TBD) in 1997 to conserve biological diversity by ensuring the survival of imperiled species and their habitats, with an emphasis on private actions and private land.

TESF focuses on species protected under state or federal endangered species laws and is recognized by the U.S. Internal Revenue Service as a non-profit, private operational charity. To complement TESF, TBD operates under the auspices of the for-profit Turner Enterprises, Inc. (TEI), and focuses on vulnerable species that are at slightly less risk. Both organizations work on diverse ecological issues aimed at restoring individual species and their habitats. TEI oversees management of Turner properties in an ecologically sensitive and economically sustainably manner while promoting the conservation of native species.

TESF and TBD implement projects that are multidisciplinary, collaborative, and guided by the principles of conservation biology. These projects routinely employ cutting-edge theory and techniques, and draw from the disciplines of community ecology, population biology, molecular genetics, and evolutionary biology. Success requires working closely with state and federal agencies, universities, other conservation organizations, and zoological institutions. From the beginning, TESF and TBD have believed that wrapping many minds around problems leads to durable solutions. That belief notwithstanding, given the high profile and legal status of the species targeted, working closely with state and federal agencies has been a requisite. From receiving permits to technical advice and support, our relationships with government agencies have been supremely important.

Whether managing extant populations or restoring extirpated populations, the ultimate goal for both TESF and TBD is the restoration of viable populations of imperiled species. Self-sustaining populations of native species are the hallmarks of healthy or at least recovering landscapes.

TESF and TBD have made full use of those provisions of the Endangered Species Act (ESA), and related policies, which promote the involvement of private land in species recovery efforts. For example, we have executed candidate conservation agreements, safe harbor agreements, critical habitat exclusions, and innovative ESA section 10(a)(1)(A) permits. Through such administrative approaches we have advanced novel restoration projects without burdening other land management activities practiced on Turner properties.

Since inception, TESF and TBD have been involved in successful restoration projects for imperiled plants, birds, fishes, mammals, reptiles, an amphibian, and invertebrates. The projects have been of sufficient scope to promote the range-wide security of several species and make important intellectual contributions that advance conservation science and restoration ecology by offering new approaches to fieldwork and novel answers to cardinal questions such as: Restore to what? How does one justify the selection of one species over another? What is the role of research in restoration projects?

Additionally, we are involved in worldwide conservation efforts including Half Earth, Nature Needs Half and the IUCN Private Protected Areas Specialist Group. In addition to advancing successful imperiled species restoration projects, including controversial efforts involving highly interactive species, our work has highlighted the value of strategically located tracts of private land to large scale conservation initiatives that transcend the boundaries of any single property. For example, our work has dovetailed nicely with well-known large-scale reserve design initiatives, including the Yellowstone to Yukon Reserve Design, Southern Rockies Ecosystem Project, and the Sky Islands Wildlands Network**.**

TEAM TURNER

TURNER FAMILY
TESF Board of Trustees

The Turner family is committed to environmental efforts that promote the health and integrity of the planet. Ensuring the persistence of species and their habitats is one such effort that is critical for advancing worldwide peace, prosperity, and justice. The adult members of the Turner family are acutely aware of and keenly supportive of the work of TESF and TBD.

BEAU TURNER: Chairman of the Board of Trustees for TESF; **Vice Chairman of TEI** – Beau oversees wildlife projects, is a Trustee for the Turner Foundation, Inc., and serves on the boards of the Jane Smith Turner Foundation and the Captain Planet Foundation. He is passionate about getting youngsters outdoors and excited about nature. To achieve this, he founded the Beau Turner Youth Conservation Center in Florida.

MIKE PHILLIPS: Executive Director, TESF; Coordinator, TBD. ***mike.phillips@retranches.com*** – Mike co-founded TESF and TBD with Ted Turner in 1997. He received a M.Sc. in Wildlife Ecology from the University of Alaska in 1986. Mike's career focuses on imperiled species, integrating private land and conservation, ecological economics, and socio-political aspects of natural resource use. He was elected to the Montana legislature in 2006 and will hold his state senate seat through 2020.

CARTER KRUSE: Director of Conservation Management, Research and Education, TEI; Senior Aquatics Biologist, TBD. ***carter.kruse@retranches.com*** – Carter joined TBD in 2000. He has a Ph.D. in Zoology from the University of Wyoming. Carter developed the TBD Native Cutthroat Trout Conservation Initiative and administers a variety of projects that include water rights issues, native species conservation, and species management.

DAVE HUNTER: Wildlife Veterinarian, TESF, TEI. ***dave.hunter@retranches.com*** – Dave has served as TEI/TESF veterinarian since1998. He has a Doctor of Veterinary Medicine from Washington State University and is Adjunct Professor at Texas A&M University and Associate Professor at several other universities.

DUSTIN LONG: Senior Biologist, TESF. ***dustin.long@retranches.com*** – Dustin joined TESF in 1998, and leads the black-footed ferret, black-tailed and Gunnison's prairie dog, Chupadera springsnail, lesser prairie chicken and bat projects. Dustin has a M.Sc. in Life Science from New Mexico Highlands University. He lives in Bozeman, MT but spends much of his time at Turner properties in the west and south.

MAGNUS McCAFFERY: Senior Biologist, TESF. ***magnus.mccaffery@retranches.com*** – Magnus joined TESF in 2010. He is lead biologist on the Chiricahua leopard frog and gopher tortoise projects. He is a native of Scotland, where he graduated with a MSc in Wildlife Biology. A passion for ecology and wild places brought him to Montana, where he gained a PhD in Wildlife and Fisheries Biology from the University of Montana.

VAL ASHER: Field Biologist, TESF. ***val.asher@retranches.com*** – Val has served as wolf biologist since 2000. She worked closely with state and federal agencies as a wolf specialist from 2000-2009, and in 2010 began investigating how wolves affect ranched bison and wild elk populations on the Flying D Ranch. Val was part of the capture team in Canada during the Yellowstone/Idaho wolf reintroductions.

CHRIS WIESE: Senior Biologist, TESF. ***chris.wiese@retranches.com*** – Chris joined TESF in 2012. She oversees the bolson tortoise and Mexican gray wolf projects on the Ladder and Armendaris ranches in New Mexico. Chris received her PhD in Cell Biology from the Johns Hopkins Medical School in 1996.

LEVI FETTIG: Senior Biological Technician, TBD. ***levi.fettig@retranches.com*** – Levi joined TESF in 2015 as a seasonal technician working with prairie dogs and black-footed ferrets. In 2018, Levi began working full time with TBD on a variety of projects, including black-footed ferrets, prairie dogs, prairie chickens, fish and amphibians. Levi received a B.S. in Wildlife and Fisheries Science from Valley City State University.

ERIC LEINONEN: Senior Biological Technician, TBD. ***eric.leinonen@retranches.com*** – Eric joined TBD in 2011 as a seasonal member of the Native Cutthroat Trout Conservation Initiative. In 2015 he became a full-time employee, where he works with cutthroat trout and provides support to other projects. Eric received a B.A. in Environmental Science, and a second B.A. in Geography from The University of Montana.

GRACE RAY: Rangeland Ecologist, TEI. ***grace.ray@retranches.com*** – Grace started her position as the Rangeland Ecologist for TEI in 2016. She develops and manages various habitat and species-based conservation projects on the western Turner properties and helps to oversee grazing and rangeland management across 16 key bison properties. She received her M.Sc. in Rangeland Sciences from Oregon State University in 2015.

HUNTER PRUDE: Senior Biological Technician, TBD. ***hunter.prude@retranches.com*** – Hunter began working for TBD on the Armendaris Ranch in New Mexico in 2012, where he collaborates with New Mexico Department of Game and Fish to manage desert bighorn sheep in the Fra Cristobal Mountains. Hunter obtained a B.S. in Natural Resource Management; Wildlife Management from Sul Ross State University in 2011. He is currently pursuing a M.S. in Wildlife Science at New Mexico State University, researching how anthropogenic water sources influence mountain lion behavior and predation in desert bighorn habitat.

CASSIDI COBOS: Field Biologist, TESF. ***cassidi.cobos@tedturner.com*** – Cassidi joined TESF in 2014 and serves as a field biologist on the Chiricahua leopard frog project. She received a B.A. in Wildlife Science from New Mexico State University and is initiating a MS program in Wildlife Management at NM state university.

BARB KILLOREN: Office Administrator, TEI. ***barb.killoren@retranches.com*** – Barb joined TEI in 2001 and assists TESF as office administrator. She manages office operations and provides support to the Executive Director, project managers and field personnel. Barb has a B.S. from the University of Wisconsin, Eau Claire.

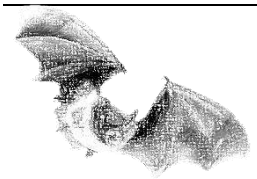
CHENEY GARDNER: Media and Outreach Coordinator, TESF. ***cheney.gardner@tedturner.com*** – Cheney joined TESF in 2016 as the media and outreach coordinator for an education project to advance wolf recovery to Colorado. She attended UNC-Chapel Hill, where she received a degree in journalism after being awarded the prestigious Morehead-Cain scholarship. When she's not in the office, she can usually be found in the mountains, fly fishing, trail running and biking.

ACKNOWLEDGEMENTS

The work of TESF and TBD would be impossible without the support, assistance, and partnerships of numerous individuals and organizations. We would like to thank the TESF Board of Trustees and Turner Foundation for their patronage and deep commitment to the conservation of biodiversity; the ranch and plantation administrators, managers, and staff who go beyond their daily duties to make our projects a success; and our state and federal partners whose collaboration and support of our conservation and restoration programs help to enrich the biodiversity on Turner properties, and give us the opportunity to contribute to broader recovery goals for numerous at-risk species.

Las Animas Creek on the Ladder Ranch hosts a beautiful stand of Arizona sycamores, creating an ideal environment for many southwestern riparian species.

1. BATS



PROJECT STATUS
Ongoing

Principal biologist
Dustin Long

Conservation Problem – Many bat populations in North America have undergone precipitous population declines since the emergence of white-nose syndrome (WNS) in 2006. The WNS epidemic is considered the worst wildlife disease outbreak in recent North American history and threatens to drive some bat species to extinction. Resident, hibernating bats on Turner western properties may soon be affected by WNS.

Listing Status

- USFWS threatened: Northern long-eared bat (*Myotis septentrionalis*)
- USFWS Species of Concern: Big brown bat (*Eptesicus fuscus*); Cave myotis (*M. velifer*); Allen's big-eared bat (*Idionycteris phyllotis*)
- NMDGF Species of Greatest Conservation Need: Allen's big-eared bat (*I. phyllotis*); Spotted bat (*Euderma maculatum*)
- KDWPT Species of Greatest Conservation Need: Townsend's big-eared bat (*Corynorhinus townsendii*);
- ODWC Species of Greatest Conservation Need: Mexican free-tailed bat (*Tadarida brasiliensis*)

Project Location – Armendaris Ranch, NM; Z Bar Ranch, KS/OK

Project Partners

- Laura Kloepper, St. Mary's College
- Ken Brunson, The Nature Conservancy
- Kansas Department of Wildlife, Parks and Tourism
- Matthew Nichols, University of Central Oklahoma

Project Funding – TESF

Goal – Monitor resident and migratory bat populations at the Z Bar and Armendaris Ranches to determine species richness and population trends, document the arrival and impacts of WNS, improve bat habitat, and foster and facilitate innovative bat research and education on Turner properties.

Objective – TESF and its partners will perform biennial summer and winter population and species classification surveys of bat populations at the Armendaris and Z Bar Ranches to document any significant population fluctuations. TESF personnel will collaborate with bat biologist and remain current on bat ecology and through these contacts and information advise and assist ranch managers in improving bat habitat and alleviating threats.

Supporting Rationale for Objective – WNS is an epizootic disease caused by the cold-loving fungus *Pseudogymnoascus destructans* and is the only known disease of concern for bats on Turner properties. Most bat species are relatively long lived (10-15 years) and produce one offspring a year; consequently, bat population growth depends on high rates of adult survival. Bat populations affected by WNS often experience a ~95% loss of the adult population; therefore, bat populations affected by WNS are unlikely to recover quickly. Documenting the arrival of WNS and its impacts on bat populations on Turner properties will play an important role in a larger nationwide effort to track, study, and ultimately minimize the impacts of the disease.

Mexican free-tailed bats make up the majority of bats on Turner properties. While they may not be susceptible to WNS because they migrate rather than hibernate, much remains unknown about the species and its seasonal use of caves on Turner properties. Collaborating with bat researchers at the two ranches will begin to fill in those basic ecological information gaps and offer insight into how best to manage bat populations on Turner lands.

Project Background – The Jornada caves at the Armendaris Ranch are the second largest lava tubes in North America and provide habitat for eight bat species: Mexican free-tailed bat, Pallid bat (*Antrozous pallidus*), Allen's big-eared bat, Yuma myotis (*M. yumanensis*), Townsend's big-eared bat, spotted bat, California myotis (*M. californicus*), and fringed myotis (*M. thysanodes*). The migratory population of Mexican free-tailed bats at Jornada is the largest in New Mexico, and the fifth largest in North America.

The Merrihew, Rattlesnake, and Skunk caves (gypsum cave) at the Z Bar are occupied by at least five bat species: Mexican free-tailed bat, Townsend's big-eared bat, big brown bat, cave myotis, and tricolored bat (*Perimyotis subflavus*). Four of these species hibernate, and all are either federally or state listed. Four caves in the Oklahoma-Kansas Red Hills region were tested for WNS in 2014 and 2016 and all tests returned negative for the disease.

Project Activities in 2017 – Dr. Laura Kloepper continued research with Mexican free-tailed bats on the Armendaris. In summer 2017, she led a team of international students and researchers to the Jornada caves, where she used a zipline, a drone (Fig. 1.1), and a trained hawk to capture acoustic and video data from bats during emergence and early morning re-entry. Her 2017 summer work produced four scientific manuscripts, and her research has been featured in national media. Discoveries from her research may help to improve manmade sonar devices with relevance for national security, driverless cars, and assistive devices for the blind.

Researchers from the University of Central Oklahoma visited the Z Bar Ranch in August. They netted (Fig. 1.2) and collected wing tissue (Fig. 1.3) from Mexican free-tailed bats to determine if they were infected with a parasitic protozoan, *Trypanosoma cruzi,* which can lead to Chagas' disease in humans.

Summer bat population estimates at the Armendaris and Z Bar indicated summer bat populations at the two ranches remained stable at >1,000,000 and ~160,000 bats, respectively.

Proposed Future Activities & Considerations

Bats on Turner properties will likely be exposed to *P. destructans* at some point. There is currently no cure for the disease and limiting exposure to the fungus is difficult since transmission is primarily bat to bat. What we can do is limit the potential for humans to transmit WNS by enforcing decontamination protocols for those entering caves (Fig. 1.2), ensure human actions do not impact populations, improve bat habitat, and advance our understanding of bat ecology through collaborative research and education.

Fig.1.1. The "Chirocopter" uses a microphone (inside white ball) and an infrared camera to record echolocation calls and film the bats as they emerge from and re-enter the lava tubes at the Armendaris Ranch. One question Dr. Kloepper hopes to answer is how the fast flying bats avoid colliding with one another in such crowded conditions.

Fig. 1.2. Collecting Mexican free-tailed bats for disease sampling at the Z Bar Ranch, KS. Note the protective gear being used to prevent the spread of white-nose syndrome.

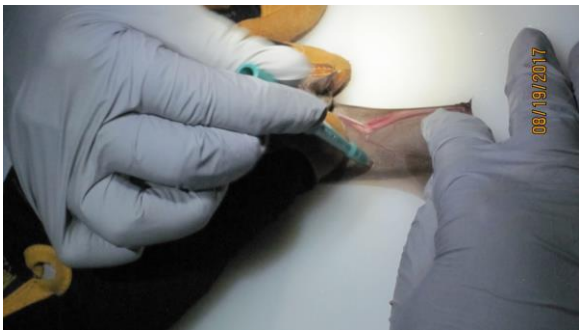


Fig. 1.3. Collecting wing tissue from a Mexican free-tailed bat at the Z Bar Ranch, KS to test for *Trypanosoma cruz. T. cruz* is a parasitic protozoan responsible for Chagas' disease in humans and which uses a biting bug host as a vector to infect mammals.

2. Black-Footed Ferret Habitat:
PRAIRIE DOG MANAGEMENT

Black-tailed prairie dog (*Cynomys ludovicianus*)
Gunnison's prairie dog (*C. gunnisoni*)

ESA listing (both species): NOT LISTED

PROJECT STATUS
Ongoing

Principal biologist
Dustin Long

Conservation Problem – Range-wide decline of prairie dogs due to sylvatic plague, loss of habitat, and human persecution.

Project Locations – Vermejo Park Ranch, NM; Bad River Ranches, SD; Z Bar Ranch, KS

Project Funding – TESF, NFWF

Listing Status – Not listed

Goal – To restore and maintain large, disease-free prairie dog complexes that provide habitat for viable populations of black-footed ferrets.

Objectives – The short-term objective (2017-2019) for Gunnison's at Vermejo is to foster robust colony growth following a recent plague epizootic. During this regrowth period we aim to secure a long-term future for Gunnison's and black-footed ferrets at Vermejo by developing a collaborative relationship with NMDGF and the USFS to establish and maintain a 3,000–5,000-acre Gunnison's prairie dog complex on Vermejo and adjacent public lands. Once Gunnison's have reoccupied >2,000 acres in the Vermejo's Castle Rock complex we aim to apply the sylvatic plague vaccine (SPV) to the colonies and release ferrets.

At Bad River we will apply the SPV to the prairie dog colonies in ACRA from 2017-2019 and monitor the ferrets released there in 2017. The long-term objective is to secure a stable funding source that will allow annual application of the SPV and enable us to expand the existing ACRA prairie dog complex up to 5,000 acres. The short-term objective at the Z Bar is to continue recent growth trends with the long-term objective of developing a 1,000-acre prairie dog complex and releasing ferrets.

Supporting Rationale for Objective

Prairie dogs (Fig. 2.1) play an important ecological role in the western grasslands. As many as 150 species benefit from the unique habitat created by prairie dogs.

Fig. 2.1. Black-tailed prairie dog at Vermejo Park Ranch.

Prairie dogs are extremely sensitive to plague and the disease is the primary conservation concern at ferret restoration sites on Vermejo and Bad River. Until recently the only method of preventing a plague event was to dust prairie dog burrows with an insecticide to kill the fleas that serve as the disease vector. This strategy is expensive and labor intensive but generally effective. However, there have been occurrences of dusted colonies succumbing to plague (e.g., Bad River in 2012), and recent studies suggest that in long-dusted areas (>8 years), fleas can develop pulicide resistance.

To address this conservation concern, agencies and NGOs have developed a vaccine (SPV) which is delivered to prairie dogs via small bait pellets; prairie dogs eat the bait pellets and are vaccinated against plague (Fig. 2.2). SPV lab and field trials have been conducted and the results are encouraging; the next step is to examine the SPV's effectiveness at a landscape scale, which we initiated at Bad River in 2017 and plan to do at Vermejo in 2020.

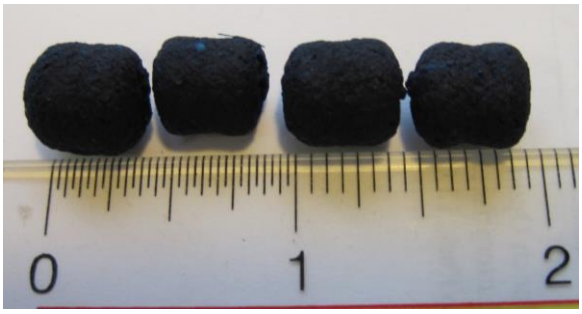


Fig. 2.2: Sylvatic plague is the primary concern related to prairie dog conservation. A new way to mitigate the impacts of plague is to vaccinate prairie dogs against the disease using peanut butter flavored baits infused with a plague vaccine. The baits are delivered at a rate of 50 baits per acre to ensure maximum uptake. Bad River Ranches is one of five sites testing the efficacy of the vaccine at the landscape level.

Project Background

Few species are as controversial in the American west as prairie dogs. Many landowners view prairie dogs as competitors for a limited grass resource whose presence represents a threat to their livelihood; conservationists view prairie dogs as a key species whose presence acts to provide the habitat requirements of numerous other species. We seek to find that balance where prairie dogs can coexist with TEI's for-profit ranching endeavors.

Currently, prairie dogs occupy ~3% of their historical range. This range-wide decline was largely due to poisoning campaigns in the early and mid-20th century. More recently, the invasive disease, sylvatic plague, has been the primary conservation challenge.

Prairie dog restoration on Turner properties began in 1997 with the development of a reliable prairie dog soft-release technique. Using soft-releases, TESF expanded black-tailed prairie dog acreage at Vermejo from 500 acres to 10,000 acres; the ACRA at Bad River from 125 acres to a maximum of 1,800 acres; the Z-Bar from 75 acres to 590 acres; and the Gunnison's at Vermejo from 23 acres to a maximum of 3,900 acres (Box 2.1). In total, prairie dog acreage on Turner properties has grown from 725 acres to a maximum of 16,290 acres. Areal growth of the colonies required the capture and translocation of about 10,000 BTPD and around 5,000 GPDs, establishing over 150 new colonies.

Project Activities in 2017

Vermejo's Gunnison's prairie dog complex continues to recover from 2014 -2015's plague epizootic. Ranch-wide, colony acreage remained at 915 acres, but colonies that are the foci for ferret restoration did increase in size and density. Vermejo's black-tailed colony acreage remained steady at 10,000 acres (Fig. 2.3).

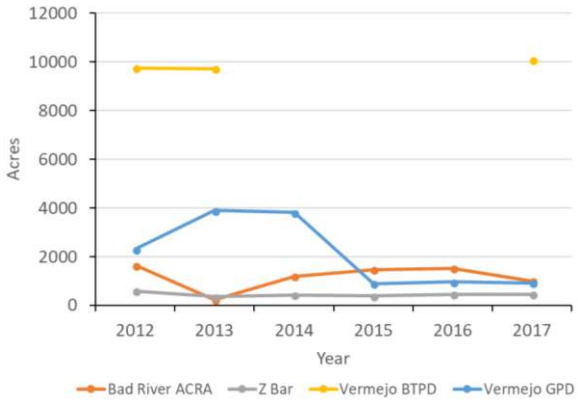


Fig. 2.3: Acreages occupied by prairie dogs at Bad River's ACRA, Z Bar, and Vermejo during the period 2012-2017.

At Bad River, the 12 prairie dog colonies that form the ACRA complex expanded 18% in early 2017, to cover 1,800 acres. We dusted 606 acres of this area, but before we could apply SPV, plague impacted the complex, reducing coverage to 1,000 acres (Fig. 2.3). In December we distributed SPV across 624 acres. To discourage ACRA's prairie dog colony expansion into unwanted areas, vegetative/visual barriers as well as raptor poles were maintained.

At Z Bar, ranch-wide prairie dog colonies contracted 1.5% to cover 450 acres. Z Bar's largest colony, which is being studied to assess the effects of fertilizer and heavy early growing season bison grazing, expanded 7%.

Proposed Future Activities & Considerations

The future of prairie dog colonies at Vermejo and Bad River as ferret habitat rests on the availability and affordability of a plague mitigation technique. Currently, dusting and SPV are too expensive to apply at the scale necessary to support ferret restoration. We have secured funding apply SPV at Bad River through 2019. If SPV costs remain high by 2020 it is unlikely we will have the resources to apply SPV across the necessary 4,000 – 5,000 acres for successful black-footed ferret restoration at the two ranches without additional support.

Box 2.1. Prairie dog complexes on Turner properties.

The largest prairie dog complexes on Turner properties occur at (from top left-clockwise): Bad River Ranches, SD, Vermejo Park Ranch, NM, Z Bar Ranch, KS (all black-tails), and Gunnison's prairie dogs at Vermejo Park Ranch, NM. In general, the Gunnison's at Vermejo and black-tails at Bad River are better suited as black-footed ferret habitat whereas the black-tails at Vermejo and Z Bar probably support more biodiversity.

2. BLACK-FOOTED FERRET

Mustela nigripes

ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologist
Dustin Long

Conservation Problem – Near extinction of black-footed ferrets resulting from a decline in their prairie dogs prey. Prairie dog loss is attributable to sylvatic plague (*Yersinia pestis*), habitat fragmentation, and persecution.

Listing Status

- Endangered under the ESA
- Endangered in SD
- Protected Furbearer in NM

Project Locations – Vermejo Park Ranch, NM; Bad River Ranches, SD; Z Bar Ranch, KS

Project Partners – USFWS, NMDGF, SDGFP, NFWF

Project Funding – TESF, NFWF

Goal – To work with partners to meet black-footed ferret downlisting criteria.

Objective – The black-footed ferret recovery plan requires that a recovery site maintain a minimum of 30 adult ferrets over a 3-year period to meet downlisting criteria. Our objectives involve managing prairie dog colonies (see page 6), the essential habitat of black-footed ferrets, and restoring viable ferret populations to Vermejo, Bad River and Z Bar Ranches that meet or exceed these downlisting criteria.

Supporting Rationale for Objective – Black-footed ferrets are an obligate predator of prairie dogs, and prairie dogs historically required grazing by bison throughout a large portion of their historical range in order to persist. Thus, the black-footed ferret project is a natural fit for many Turner properties and provides the opportunity to complement commercial commodity production with native species restoration.

Project Background – All captive and wild black-footed ferrets can be traced to the last seven wild individuals of the species, captured in Meeteetse, WY and brought into captivity in the mid-1980s. Today, black-footed ferrets remain one of the planet's rarest mammals with a wild population of less than 300 individuals.

Our contribution to ferret recovery began in 1998 with the construction of an outdoor preconditioning facility at Vermejo. Naïve, cage reared ferrets were placed in outdoor pens that simulated a wild environment. Ferrets in these pens lived in active black-tailed prairie dog (*C. ludovicianus*) burrows and were exposed to live prairie dog prey. Here, they honed natural predatory instincts which prepared them the wild. Females bred, whelped and weaned kits in these pens. Ferrets preconditioned or born in outdoor pens, and exposed to live prey, have higher post-release survival rates than those that have not. From 1999-2006, 393 ferrets were preconditioned at Vermejo's facility.

From 2005-2007 at Vermejo, and 2009-2011 at Bad River Ranches, TESF took the next step in preconditioning ferrets by implementing a wild preconditioning approach. At Vermejo, female ferrets and their kits were released onto a 1,000-acre prairie dog colony, surrounded by electric netting to reduce the risk of ferret mortality from terrestrial predators (e.g. coyotes and badgers) as they adjusted to life in the wild. At Bad River, we used a similar strategy, but without electric netting. After 1-3 months of wild preconditioning, ferrets were captured and transported to permanent release sites. Of the ferrets released for wild preconditioning, we recaptured 48% at Vermejo (n=75) and 45% (n=37) at Bad River for transport to permanent release elsewhere.

In 2008, we began year-round ferret releases on black-tailed prairie dog colonies at Vermejo and in 2009 TESF documented the first wild born ferret in NM in over 75 years.

Despite our best efforts to establish ferrets at Vermejo that would contribute to federal recovery objectives—an effort that involved increasing black-tailed prairie dog acreage from 500 acres to over 10,000 acres and releasing 196 ferrets—it became clear from ferret survival rates over a 9-year period, that it was unlikely that Vermejo's black-tailed prairie dog colonies

could support a stable ferret population. Although the ferrets generally did well on these colonies, with reproduction documented when spring precipitation was sufficient to support a robust prairie dog population, these good years were routinely offset by drought years in which prairie dog pup survival rates were below 10%, causing the ferret population to collapse. During these drought years we documented the loss of all female ferrets and their kits, although male ferrets appeared to be largely unaffected by the drought. Due to the failure of ferrets to survive and reproduce during drought years, and the likelihood that droughts will become even more frequent and severe, in 2013 we decided to withdraw from ferret releases in the foreseeable future on black-tailed prairie dog colonies at Vermejo.

2012 marked the first year TESF began ferret releases on the Gunnison's prairie dogs which occupy the high elevation mountain meadows of Vermejo (Fig. 2.4). Since then we have released 59 ferrets in this setting. Historical records indicate 89% of the ferret specimens collected in NM were captured on Gunnison's prairie dogs and one of the last specimens collected in the state was trapped on Vermejo at Castle Rock. Survival and reproduction rates of ferrets living on Gunnison's colonies at Vermejo suggests a population of ferrets that meet de-listing requirements could be established, provided we are able to control sylvatic plague.

Fig. 2.4. Black-footed ferret released onto a Gunnison's prairie dog colony in the mountain meadows at Vermejo.

Project Activities in 2017 – 2017 was an eventful year for protecting ferret habitat and reintroducing ferrets at Bad River. We held public meetings to address concerns related to releasing an endangered species and secured the requisite state and federal permits. A setback in 2017 was the loss of about 800 acres of ferret habitat due to a plague epizootic (see page 7); however, this loss did not warrant postponing the release. In September, we released 19 ferrets–14 juveniles (8m:6f) and 5 adults (1m:4f)–onto the largest prairie dog colony in Bad River's Ash Creek Restoration Area (ACRA; Fig. 2.5). In November, we prophylactically applied the sylvatic plague vaccine (SPV) to 624 acres of the ferret release colony. In mid-December we surveyed release sites and located five individuals.

Fig. 2.5. Bad River Ranches manager, Dusty Hepper, and his family, releasing a black-footed ferret in the ACRA.

Proposed Future Activities & Considerations

As demonstrated at Vermejo and Bad River, ferret recovery is inextricably linked to prairie dog conservation and active plague management. There are currently two options for mitigating the disease on prairie dog colonies: 1) dust the inside of prairie dog burrows with an insecticide which kills fleas (which serve as the vector for plague), and 2) distribute the SPV on colonies which the prairie dogs consume and in turn become vaccinated against the disease. Currently we employ both plague mitigation options on Turner properties.

Looking forward there is reason for optimism. 2017 marked the first year of a three-year study (2017-2019) in which Bad River and four other non-Turner sites applied the SPV to large prairie dog complexes to determine the vaccine's efficacy at the landscape level; up to this point the vaccine has only been applied to small study plots. What we learn from this study about uptake and vaccination rates, herd immunity, and prairie dog population responses to plague exposure will guide not only our work at Bad River but also range-wide ferret recovery efforts.

3. BOLSON TORTOISE

Gopherus flavomarginatus
ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologists
Chris Wiese
Scott Hillard

Conservation problem – Population decline and range contraction due to collection for food and habitat loss. Estimates suggest that fewer than 2,000 bolson tortoises remain in the wild.

Listing status
- Listed as Endangered under the ESA
- Listed as Endangered in Mexico
- IUCN Red List Status: Vulnerable

Project Locations – Armendaris Ranch, NM and Ladder Ranch, NM

Project Partners
- Living Desert Zoo and Gardens State Park in Carlsbad, NM (LDZG)
- El Paso Zoo, El Paso, TX
- San Antonio Zoo, San Antonio, TX
- Turtle Conservancy
- Dr. Jim Jarchow, DVM, Tucson, AZ
- Dr. Vicky Milne, DVM, El Paso Zoo, TX
- Dr. Peter Koplos, DVM, El Paso, TX
- Dr. Taylor Edwards, University of Arizona
- The Appleton Family

Project Funding
- TESF
- Turtle Conservancy
- Mohamed bin Zayed Species Conservation Fund
- Funding and in-kind support from: LDZG, El Paso Zoo, San Antonio Zoo, private donations.

Goal – Establish free-ranging, minimally managed wild bolson tortoise populations in the northern Chihuahuan Desert.

Objectives
Captive population objective **–** During the next 20 years, we will use captive breeding to produce juveniles to build a large captive population of bolson tortoises.

Wild Population objective **–** The captive population will be used to establish up to four wild bolson tortoise colonies on suitable private and/or public lands in the U.S. Each colony will have at least 250 adults, exhibit: a male to female ratio of around 1:1, stable or positive population growth, evidence of reproduction.

Project Background –The largest and rarest of North America's five tortoise species, the bolson tortoise once roamed most of the Chihuahuan desert. Its current range comprises a small area in north central Mexico. Due to a suite of political, social, economic, and safety issues, the current status of wild bolson tortoises is largely unknown. The last population survey, conducted in the early 1980s, estimated a population of fewer than 10,000 animals. However, continued habitat degradation and loss since then makes it likely that this number has since decreased.

To prevent the extinction of bolson tortoises, we aim to establish free-ranging populations on the Ladder and Armendaris ranches in New Mexico. Both ranches lie at the northern tip of the species' prehistoric range. We are also interested in establishing populations at the Sevilleta National Wildlife Refuge in NM and Big Bend National Park in TX.

Our project began with a group of 30 bolson tortoises that were collected and bred by Ms. Ariel Appleton over a period of nearly 40 years in Arizona. 26 adults (+ 7 hatchlings) from this tortoise collection were donated to TESF in 2006 and moved to the Armendaris Ranch to serve as the "Turner Group" captive breeding colony for our reintroduction program. The remaining four tortoises (2 males, 2 females) were donated to the LDZG ("Living Desert Group"). Over the years, the Turner Group has experienced adult mortalities as well as newly-discovered additions, and in 2017 comprised 24 adult tortoises, while the Living Desert Group maintained its original four adults.

Successful breeding on the Armendaris and at the LDZG have hatched over 700 new tortoises since 2006, with hatchlings and juveniles sustained by native forage in outdoor, predator-proof enclosures until they are large enough for release (~100 mm shell length). Tortoise growth rates depend both on the weather and on forage availability. It typically takes between 3 and 6

years for a hatchling bolson tortoise to reach 100 mm.

With their powerful front legs, tortoises dig burrows in which they spend over 95% of their time. The burrows are an important part of a healthy desert ecosystem, as they provide shelter for myriad other species, including mammals, birds, reptiles, and insects.

Project Activities in 2017

2017 status of the bolson tortoise project

The bolson tortoise project (Turner Group + Living Desert Group) comprised 28 adult bolson tortoises in 2017. Since project inception, our captive adults have produced over 700 hatchlings. As of fall 2017, 530 of these juveniles were confirmed to be alive, 156 had died, and 29 were unaccounted for. From 2012-2017, 175 juveniles have been equipped with transmitters and moved from predator-proof enclosures to predator-accessible enclosures. 133 (76%) of these transmittered juveniles were confirmed to be alive at the end of 2017.

2017 successes and milestones

- Soft-release of juvenile tortoises at the Ladder's Wildhorse pasture (Box 3.1).
- Discovery of an adult female that will be added to our breeding program (Box 3.2).
- Rediscovery of a juvenile that had been missing since July 2014 (Box 3.3).

Captive Breeding Program

Captive adults and subadults

With the death in 2017 of an adult male (Tortoise E), the captive population on Turner property now comprises 24 adults: 13 females, 11 males (Table 3.1). Four adult tortoises (2 males, 2 females) are at the LDZG. A large male (EP, found feral in El Paso in 2011) is housed at the El Paso Zoo. EP is not yet part of the breeding program, nor are two subadults that were transferred to the El Paso Zoo from Turner properties in 2010, and a young adult male tortoise named Nemo who will join the El Paso breeding group from a private collection upon completion of exhibit renovations. Overall, all adults and subadults appeared healthy in 2017.

In May 2017, we found a large female bolson tortoise in Albuquerque (Box 3.2). We aim to integrate this tortoise into our breeding program following quarantine and surgery to remove two large uroliths (bladder stones).

Box 3.1. On your marks, get set, …

Table 3.1. Adult and subadult bolson tortoises in the 2017 captive population. LDZG, Living Desert Zoo and Gardens State Park in Carlsbad, NM; TC, Turtle Conservancy.

Tortoise location	Sex	ID
Turner ranches	Female	1,2,4,A,F,G,J,K,L,P,S,T,X
Turner ranches	Male	B,C,D,H,M,N,O,U,W,Y,Z
LDZG	Female	CBF, Mrs. Belaroux (Mrs. B)
LDZG	Male	CBM, Mr. Belaroux (Mr. B)
El Paso Zoo	Male	EP (adult)
El Paso Zoo	Female	07-CB12 (juvenile)
El Paso Zoo	Male	09-F1 (juvenile)
Behler Center (TC)	Male	11-CB81, 11-CB82, 13-CB120

Husbandry strategies: adults

We survey adults biannually, in spring and fall, but otherwise leave them alone. We provide water only in severe drought years, which has happened only once (spring 2013) since the inception of the bolson tortoise project in 2006. Supplemental irrigation was not necessary in 2017. However, we do continue to intensively manage adult females during nesting season (April – July) to collect eggs each year.

Husbandry strategies: Hatchlings

We used three strategies to produce hatchlings as part of our captive breeding objective:

1. Optimize egg production by monitoring female tortoises and collecting eggs near their due date by induced oviposition, or by collecting eggs from natural nests.
2. Incubate eggs in temperature-controlled environments that are safe from predators.
3. Collect hatchlings, mark them with a unique code, and bank blood for genetic studies and paternity testing.

Husbandry strategies: Egg collection

We used a combination of radiography, weight monitoring, and direct observations to determine number and maturity of eggs carried by each female (we would prefer to use ultrasound, but our ultrasound transducer stopped working and we are still waiting for a generous donor to replace it). This work was also key to timing the transfer of females to either a smaller enclosure (to increase the chance of finding the nest) and/or to the "Turtle House" on the Armendaris to induce egg-laying by hormone injection.

Table 3.2 summarizes the eggs produced and collected (and hatchlings hatched) for each of the adult female tortoises in the Turner group. A total of 83 hatchlings emerged from 137 eggs placed in incubators.

Nearly all females contributed to this reproductive record (Table 3.2). One notable exception in 2017 was Tortoise T. It is unclear why Tortoise T did not produce viable offspring in 2017, as she has produced a total of over 55 hatchlings during the past decade.

Table 3.2. Egg production and hatching success in 2017 for each female in the Turner group of the captive population.

Tortoise ID	No. of eggs in successive clutches (1^{st} / 2^{nd} / 3^{rd})	No. of eggs recovered & incubated (2017)	No of offspring produced (2017)	2017 hatching success rate
1	5 / 6 / -	5	4	80
2	4 / 5 / 3	11	5	45.4
4	3 / 3 / -	6	5	83.3
A	7/ 6 / 7	7	2	28.6
F	5 / 5 / 5	15	13	86.7
G	9 / 7 / 7	23	15	65.2
J	5 / 5 / 5	9	5	55.6
K	5 / 5 / 4	9	7	77.8
L	? / 5 / 8	13	11	84.6
P	1 / 4 / -	5	3	60
S	5 / 6 / 7	11	8	72.7
T	1 / 7 / 5	5	0	0
X	12 / 6 / -	18	5	27.8
TOTAL	**62 / 70 / 51**	**137**	**83**	**-**
MEAN	**5.2/5.4/3.9**	**10.5**	**6.4**	**60.5**

Egg incubation

Eggs were distributed into 6 incubators and held at constant temperatures, ranging from 29-32˚C to generate male (cooler temperatures) and female (warmer temperatures) offspring. Shortly before hatching, the eggs were removed from incubators, placed into labeled trays, and transferred to another incubator (the "pipping chamber") in which they stayed for up to two weeks to finish hatching and yolk absorption.

Hatchlings

After complete yolk absorption, hatchlings were weighed, measured, and marked with a unique tag that is attached to the shell with two-part epoxy (the tortoises eventually receive PIT-tags as well, but not until they are much larger). We generated a photographic record for each hatchling and drew a drop of blood for banking.

A total of 83 tortoises hatched on the Armendaris in 2017 (Table 3.2), bringing the total number of tortoises produced by our

captive adults to 757 since project inception. Unfortunately, ten of the hatchlings were found dead in their holding tank in early August. The cause of their demise remains a mystery but was most likely linked to a flash flood and/or lightning. We therefore added a net total of 73 hatchlings to our captive population in 2017.

Hatching success rates

Hatching success rates vary amongst females (Table 3.2), and for a given female from year to year. However, overall hatching success has remained relatively consistent for the last 7 years (Table 3.3), and ranges from 53.4 to 69.4%. The 2017 hatching success rate was about average.

Table 3.3. Hatching success rates of Turner group tortoises since 2010. This rate is the percentage of eggs that hatched from those that were placed into incubators. Eggs not incubated were either lost, broken, or not collected.

Year	No. of eggs hatched	No. of eggs recovered & incubated	No. of eggs not recovered	Hatching success rate
2010	51	78	13	65
2011	50	72	3	69
2012	63	118	10	53
2013	87	126	8	69
2014	96	172	11	56
2015	76	140	32	54.3
2016	54	89	55	61
2017	83	137	44	60.6
Mean	**70**	**116.5**	**22**	**61**

Over the past few years, we have maximized the production of juveniles to facilitate the next phase of our conservation program–establishing wild populations. A number of factors, such as age, size, and number of reproductive years, contribute to the fecundity of each individual female.

Juvenile headstarting (Hatchlings to < 100 mm shell length)

We use headstarting to produce large numbers of tortoises for eventual release by maximizing juvenile survival rates until individuals attain a size that is relatively resistant to predation (~100 mm shell length). This involves:

- Overwintering hatchlings indoors during their first winter; providing food and summer-like temperatures.
- Holding juveniles in covered, predator resistant outdoor enclosures.
- Provisioning juveniles with supplemental food (mostly native forage) and water as needed.
- Surveying juveniles twice a year (spring/fall) to monitor growth rates and health.

Since 2006, our captive population has grown by over 1,000%, with about 600 adult and juvenile tortoises in the population at the end of 2017. The Armendaris and Ladder Ranches currently house most of these individuals.

Management of juveniles in headstart enclosures in 2017 was performed in two stages: (1) keeping hatchling "up" during their first winter while providing summer-like conditions in an overwintering shed, and (2) supplemental feeding and watering of juvenile tortoises (those at least one year of age and not yet large enough for release) in outdoor headstart pens. Headstart pen maintenance includes grass-clipping and occasional weeding to remove non-forage plants from the enclosures. Wild globemallow plants were harvested from the Turner ranches and provided in the enclosures 3-5 times a week for supplemental feeding. While individual growth rates vary between animals, all tortoises appear to be growing at acceptable rates.

Tortoise Surveys and Health Checks

We surveyed tortoises in the spring and fall of 2017. In general, health checks conducted during these surveys revealed that the juvenile and adult bolson tortoises on the Ladder and Armendaris ranches were in good or excellent health. However, the wet winter of 2016/2017 caused several tortoises to emerge with eye infections in spring 2017 that required veterinary attention. Expert veterinary care was provided the El Paso zoo vet staff (Drs. Vikki Milne and Misty Garcia) as well as Dr. Jim Jarchow. Health and growth data provides an opportunity to identify juveniles that might need additional management to attain their full growth potential. The vast majority of tortoises examined were assessed to be in good health and no special treatments were required in 2017.

During growth surveys, we measured tortoise weight, shell length, width, and height. These measurements were used to calculate growth rates, which provide an indication of habitat quality in our tortoise holding facilities. Comparison of growth rates for juvenile tortoises released (with transmitters) into unprotected large enclosures on the Armendaris (CT) or Ladder (LBP) ranches revealed that

growth conditions vary amongst years and between locations. However, there is more variation amongst individuals at the same location than between different locations (Fig. 3.1). Overall, growth rates at both locations are deemed acceptable.

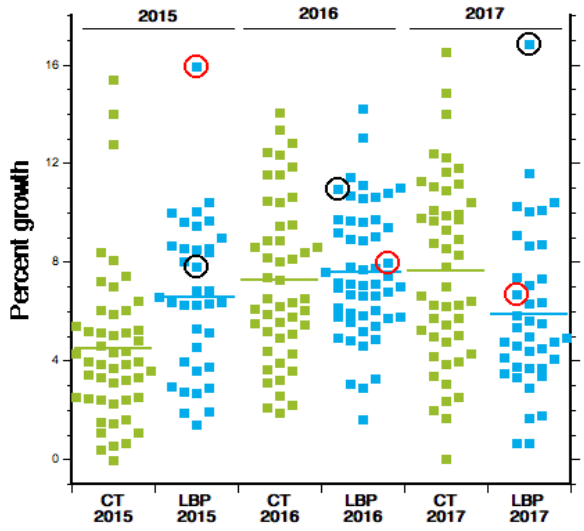


Fig. 3.1. Average growth of individual juvenile tortoises housed at the Cedar Tank pen on the Armendaris (CT) and the Ladder Big Pen (LBP) from 2015 to 2017. On average, LBP tortoises exhibited slightly higher growth rates compared with CT tortoises in 2015, about the same in 2016, and slightly worse in 2017. Red circles indicate an individual whose rate of growth decreased from 2015-2017, while the black circles show an individual whose growth rates increased over this period.

In addition to gaining an understanding of the effectiveness of our husbandry techniques, the growth and health surveys are also our first line of defense against problems such as malnutrition, dehydration, and disease. We found ~ 470 juveniles alive and well but could not locate 53 individuals (26 of whom we have not seen in over a year). This is not unusual as the tortoises are rather elusive. We consider tortoises "missing" until we either find the individual, find evidence of its demise, or have not seen it for three consecutive years (in which case we consider it "fate unknown"). We documented the death of 38 individuals in 2017, bringing the total number of confirmed juvenile deaths since 2006 to 156. Although this number might appear high, the overall survivorship of bolson tortoise juveniles in our project is around 80%, which is much higher than the 1-3% survivorship reported for wild populations.

Deaths in 2017

We had three independent mortality events in 2017 that are worth noting. The first was the discovery of young adult male tortoise (Tortoise E) in April 2017. He was found upside down and had perished by the time he was discovered. It is unclear why he was unable to right himself, or what caused him to flip over to begin with.

The second event affected an unusually large number (14) of transmittered juveniles in the large enclosure on the Ladder Ranch. Most of these were found in burrows that were backfilled by rodent activity, and many showed evidence of rodent chews. It is unclear whether the rodent chews caused the deaths or occurred secondarily, but it is noteworthy that the affected tortoises occupied burrows that clustered near each other. The winter of 2016-2017 was unusually wet, and we suspect that soil microbes attacked the tortoises during their overwinter brumation. In support of this theory, we also found several juvenile tortoises that emerged from winter brumation with eye infections.

The third mortality event affected the young tortoises that had been moved to outdoor stock tanks behind the Turtle House on the Armendaris. Over the weekend of August 4-6, 2017, it appears that the 16 hatchlings living in the stock tank either drowned in a flood or were struck by lightning. By the time they were discovered on August 6, there were no clues left behind that could explain their demise, although we do know that a thunderstorm moved through the area over that weekend.

Bolson tortoise research in 2017

We had two active research projects in 2017. The first, supported by a small grant from the Mohammed bin Zayed Species Conservation Fund (MBZ), was designed to identify potential predators of small bolson tortoises and begin to address the question "how big is big enough for release of tortoises from the headstart pens?" For this study, we outfitted ten juveniles, ranging in size from 70-92 mm, with radio-transmitters and placed them into a predator-accessible area. We found that all ten were still alive and well at the end of 2017. Although we celebrate the fact that the tortoises survived, we remain unclear on the main source of predation of small bolson tortoises. This study will continue in 2018.

The second study was a continuation of research initiated in 2016 to examine the success and sex ratio of bolson tortoise nests left to incubate in the ground (rather than excavating the nest shortly after egg-laying and transporting the eggs to incubators). From preliminary results, we learned three things: (1) eggs left in the ground hatch at a slower rate than artificially incubated eggs (> 100 days in natural nests vs 75-85 days in artificial incubators); (2) hatching success rates for natural nests matches those of artificially incubated eggs at ~ 60%, suggesting that egg transport or hormonal stimulation of egg-laying does not reduce hatching success rates, and (3) viable hatchlings can stay in underground nests for nearly a year; we found four hatchlings from two clutches alive in the nest after 329 (3 hatchlings) and 345 (1 hatchling) days. Unfortunately, these four were part of the group that perished in the stock tank behind the Turtle House in August (see above), eliminating the opportunity to examine their sexes. We plan to examine the surviving naturally-incubated juvenile tortoises in 2018 to determine their sexes. In addition, we plan to repeat and expand the study by adding temperature data loggers to natural nests for the duration of incubation.

Outreach in 2017

We loaned three juvenile tortoises to the Turtle Conservancy for display at the Behler Center in Ojai, CA.

Future Activities & Considerations

Major objectives for 2018 will be:

- Continuing the buildup of captive tortoises as a source for wild releases.
- Initiating releases of juveniles on the Armendaris to start a wild population.
- Collaborating with partners to expand the scope of the project.
- Searching for additional breeding adult tortoises to enhance the genetic diversity of our breeding group.

The methods we will use to achieve these objectives will include:

- Collecting eggs of genetically underrepresented females and incubating them to ensure robust hatchling production. We will also leave a portion of the eggs to develop in natural nests.
- Surveying the tortoise population at least twice a year.
- Enhancing the quantity and quality of forage in headstart pens.
- Exploring the potential of the Armendaris Truett pen to function as a maternity pen.
- Transferring juveniles to predator-accessible enclosures to free up space in the headstart pens.
- Monitoring released juveniles to track survivorship and movements.

The Chihuahuan Desert of the Ladder Ranch

Box 3.2. A tortoise named "Abby Q"

In May 2017, we became aware of a large tortoise housed at the Albuquerque BioPark that a BioPark employee had found walking down the street in Belen, NM in 2004. They had not seen another tortoise like it and labeled it a "sulcata hybrid" (the Sulcata (Africa spurred) tortoise is a large tortoise species that is a popular pet in the US). We examined the tortoise, ascertaining that it was a gravid female, and most likely a bolson tortoise. Genotyping performed by our collaborator, Dr. Taylor Edwards, at the University of Arizona Genome Center, confirmed that the newly named "Abby Q" was indeed a bolson tortoise.

The Albuquerque BioPark generously decided to donate Abby to the bolson tortoise recovery project on the Turner Ranches. Comprehensive health examinations prior to the transfer revealed that Abby has two bladder stones (uroliths) that will need to be surgically removed. The surgery will be performed by Dr. Vikki Milne, DVM, from the El Paso Zoo, and Dr. Jim Jarchow, DVM, from the Orange Grove Animal Hospital in Tucson, AZ, in early 2018, and will involve cutting a window into Abby's plastron to remove the stones. Drs. Milne and Jarchow have successfully performed this surgery before on one of the other large bolson tortoise females in our breeding group (Pancha). Pancha has been laying eggs and has contributed 24 offspring to the project to date.

Box 3.3. CB24

In July 2014, we made the unfortunate discovery that three of our transmittered juvenile tortoises had met an untimely demise only a few months after their transference to the open enclosure on the Armendaris Ranch. For two of these tortoises, we found evidence of predation by a carnivore (coyote, most likely), but for the third we found only its transmitter and no remains. The transmitter was draped over a fallen yucca (red arrow in the picture on the right), an unusual place for a tortoise but a location consistent with the hypothesis that the transmitter was pulled off by a predator. In the absence of a carcass it was impossible to determine what may have happened to this tortoise. So, we hoped that the tortoise might have escaped its predator and would be found alive someday. As the years went by and we failed to encounter this tortoise inside the enclosure, our hopes faded.

However, in September 2017, we found a large juvenile bolson tortoise walking along the road that surrounds the enclosure – on the outside! To our delight, the label we had affixed to its shell years earlier indicated that this was 08-CB24, the tortoise that went missing three years before. Moreover, 08-CB24 looked healthy and robust, having grown from ~120 mm shell length to over 190 mm shell length since we saw it last.

This re-discovery of 08-CB24 is good news on many fronts, as it means that not only can tortoise survive in our care, they can do quite well on their own, too (a necessary prerequisite for the success of any project in which an extirpated species is reintroduced to a habitat). It also suggests that tortoises like to be nearby each other, and wherever 08-CB24 was in the intervening years, she remained near or returned to the nuclear colony. Lastly, healed-over small puncture wounds in her shell show that juvenile tortoises of ~120 mm shell length can withstand a predator attack, which again is good news for the overall success of the tortoise project (as well as for 08-CB24).

What do we think happened to 08-CB24 in 2014? We speculate that the tortoise was picked up by a coyote who played with it long enough to pull off the transmitter, then grabbed the tortoise in its mouth and jumped over the enclosure fence. Once on the outside of the enclosure, the tortoise struggled free, or the coyote accidentally dropped it, or it got interested in something else, or …? Regardless, the tortoise escaped and found shelter before the coyote could kill it. Since tortoise food grows just as well on the outside of the pen as it does on the inside, 08-CB24 had plenty of food to live and grow on.

Thus, 08-CB24's success story gives us further reason to think that re-introducing bolson tortoises to the Chihuahuan desert in New Mexico has a high likelihood of resulting in bolson tortoise populations that will thrive in their prehistoric habitats, thereby ensuring the persistence of North America's largest terrestrial reptile.

4. CHIRICAHUA LEOPARD FROG

Lithobates chiricahuensis
ESA listing: THREATENED

PROJECT STATUS
Ongoing

Principal Biologists
Magnus McCaffery
Cassidi Cobos
Carter Kruse

Conservation Problem – Range-wide decline of Chiricahua leopard frogs (CLF) due to a suite of factors, including:

- Disease
- Invasive species
- Habitat degradation and loss
- Increased drought event severity/duration

Listing Status

- Listed as Threatened under the ESA in 2002
- NM Species of Greatest Conservation Concern

Project Location – Ladder Ranch, NM

Project Partners

- USFWS
- NMDGF
- Dr. Colleen Caldwell (NMSU)
- Dr. Andrea Litt/Ross Hinderer (MSU)

Project Funding – TBD/TESF

Goal – To maintain viable CLF population levels on the Ladder Ranch and to contribute to range-wide recovery of the species.

Objectives

Population Objective - Over the next 10 years, we will ensure CLF occupancy of at least 70% of suitable lentic habitats in at least two major drainages on the Ladder Ranch to maintain a minimum of two CLF populations (comprised of > 1 subpopulations) on the Ladder Ranch. At least one subpopulation in each drainage will exhibit a geometric mean growth rate over a five-year period of $\lambda \geq 1.0$.

Habitat Objective - To indefinitely monitor and manage natural wetlands, stock-water pond habitats, and stream channels in at least two major drainages on the Ladder Ranch (e.g. Seco and Las Palomas creeks) to provide high quality and secure overwintering, breeding, foraging, and dispersal habitat that meets the life history requirements of all life stages of CLFs in to support viable populations on the Ladder Ranch.

Captive Breeding Objective - Over the next 10 years, and in coordination with the USFWS, we will hold adult CLFs from up to nine populations from across the species' range in the captive Ladder Ranch ranarium facility. Adults from each population will be held in isolated population-specific cages and managed to promote breeding. All viable egg masses produced will be managed to optimize successful tadpole emergence, and tadpoles will be reared to late tadpole stage (Gosner 30+) prior to transference to suitable habitat or other captive holding facilities in coordination with the USFWS to assist with this agency's range-wide species recovery objectives.

Captive Holding Objective - Over the next 10 years, we will coordinate with the USFWS to hold captive CLFs from any location within the species' range in up to five artificial refugia sites on the Ladder Ranch (i.e. stock tanks, that will conserve genetically or geographically unique stocks of CLFs in peril (i.e., habitat destruction and disease), or CLFs that require a temporary relocation for their survival (e.g. during a drought that dries a stock tank, a population threatened by ash or sediment flow). Refugia may also serve as a source of egg masses, tadpoles, and adult CLFs for translocation to recovery sites, for augmentation, or to repopulate habitats after environmental disasters. Surplus CLFs from these facilities may also be used for research purposes.

Research Objective - Over the next 10 years, we will work collaboratively with state, federal, and/or academic partners to design and carry out work on at least one research/monitoring project on the Ladder Ranch per year, to inform and support CLF recovery actions and adaptive management. Results from these studies will be used in reports and/or submitted for peer-reviewed publication.

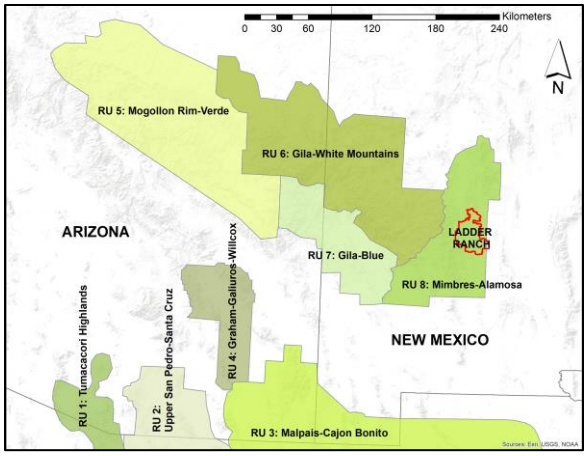


Fig. 4.1. The Ladder Ranch is a CLF Management Area within Recovery Unit (RU) 8.

Supporting Rationale for Objectives

The 62,950 ha Ladder Ranch in Sierra County, NM is recognized in the federal CLF recovery plan as an area with a high potential for successful recovery actions, and as such is designated as a CLF Management Area within Recovery Unit (RU) 8 (Fig. 4.1.).

The ranch supports a large CLF population in both natural wetlands and artificial stock water sites. For the frog to be considered for delisting, the recovery plan mandates that each RU has: (i) at least two CLF metapopulations located in different drainages, and at least one isolated population, that exhibit long-term persistence and stability; (ii) aquatic breeding habitats that are protected and managed; (iii) the additional habitat required for population connectivity, recolonization, and dispersal is protected and managed, and that (iv) causes of decline have been reduced or eliminated, and commitments to long-term management. Specific actions to achieve recovery include: (a) protecting remaining populations; (b) identifying and managing currently unoccupied sites and establishing new populations; (c) augmenting populations; (d) monitoring populations; (e) implementing research to support recovery actions and adaptive management.

Project Activities in 2017

Wild population monitoring

We monitored all known sites occupied by wild CLF during 2017. Minimum count data from this survey work suggests that the Ladder Ranch population remains robust (Table 4.1). However, this population continues to be largely confined to a single drainage (Seco Creek). Our long-term strategy is to improve the likelihood of CLF persistence on the Ladder by augmenting existing populations and expanding the species' distribution through the creation of a network of natural and artificial wetlands. In 2014, we improved wetland habitat in Las Palomas drainage, and translocated CLF into one of these sites. However, since the sites were created Plains leopard frogs have colonized the area.

Table 4.1. Minimum CLF counts at wild Ladder Ranch sites in 2016.

	Minimum Counts			
Site Name	**EM**	**TP**	**MM**	**AD**
[a]Circle 7	2	20	36	15
[a]Emrick Spring	0	10	0	1
[b]Davis (Lower)	5	0	122	98
[b]Davis (Upper)	3	10	52	118
[b]N. Seco	43	>100	30	80
[b]Pague	11	>100	54	75
[b]LM Bar	0	50	33	37
[b]Fish	0	33	37	28
[b]Johnson	28	>100	217	315
[b]S. Seco	1	100	0	3
[c]Artesia	0	50	10	82
[d]Cave Creek	0	0	6	12
KEY: a=Las Palomas drainage b=Seco drainage c=Ash Canyon drainage d=Las Animas drainage		EM=egg mass TP=tadpole MM=metamorph AD=adult		

Habitat actions on the Ladder Ranch:

- Removed cattails at LM Bar to maintain habitat quality for CLF.
- Removed cattails at Artesia to maintain habitat quality for CLF.
- Planted native grasses at Bear Canyon.
- Reinforced the dam at Bear Canyon.

Captive refugia program

We translocated CLFs into one captive refugia tank allocated to the USFWS (Table 4.2).

Table 4.2. Number of egg masses (EM), Tadpoles (T), and adult-form (AF) frogs from various source populations (Pop.) that were stocked into USFWS designated captive refugia tanks on the Ladder Ranch in 2017.

Refugia	Pop.	EM	T	AF
Antelope	Seco	-	-	-
No. 2	Seco	-	-	-
Seco Well	San Fran	-	-	-
Fox	Animas	11	4	2
Avant	Beaver Cr.	3	-	1

Overall, refugia tanks on the Ladder Ranch produced 72 viable egg masses (Table 4.3).

Table 4.3. Egg masses detected in captive refugia in 2017.

Refugia	No. Egg Masses	No. Viable
Antelope	12	12
Seco Well	23	23
South	0	0
Fox	17	17
No. 2	20	20
Avant	0	0

Captive breeding – ranarium program

The ranarium housed adults from eight off-ranch source populations, spanning three CLF Recovery Units, as well as adults from three on-ranch populations (Table 4.4). Egg masses produced in adult cages were transferred to the integrated tadpole rearing facility.

Table 4.4. Adult CLFs in ranarium cages during 2017.

Cage No.	Source population	No. ♂/♀	Date of entry
1	*UNOCCUPIED*		
2	*UNOCCUPIED*		
3	Beaver	3/4	03/29/11
4	*ASDM/Kerr	2/0	04/26/12
	*N. F. Negrito	0/1	09/18/12
	*Divide/LM	1/1	05/06/13
5	Diamond	2/2	11/02/15
6	Blue	3/1	06/16/14
		0/1	05/01/15
		0/2	11/02/15
7	Moreno	1/0	06/28/12
	Moreno	4/1	10/17/12
	Moreno	0/2	10/29/13
8	*UNOCCUPIED*		
9	Animas	4/2	06/13/13
	Cave	1/4	06/13/15

KEY:
Animas = Animas Creek
Diamond = Diamond Creek
Beaver = Beaver Creek
Blue = Blue Creek
* = San Fran Haplotype
Moreno = Moreno Warm Springs

There are 10 tadpole tanks in the ranarium, each with capacity for 1,000 tadpoles. In 2017, 52 viable egg masses were transferred from adult cages to tadpole tanks (Table 4.5). The resulting tadpoles were released in consultation with the USFWS (Tables 4.5 & 4.6).

Table 4.5. 2017 Ranarium: Egg mass production & management.

Cage	Source Pop.	# Egg Mass	Egg Mass laid on	TP Exit Date	TP transferred to
3	Beaver	1	04/30/17	06/23/17	Terry Tank Upper Middle fork, Feedlot
		1	06/12/17	10/07/17	
		1	07/01/17	10/07/17	
		1	07/18/17	10/07/17	
		1	08/03/17	08/04/17	
		1	08/07/17	08/08/17	
		1	08/28/17	10/07/17	
		1	09/07/17	09/08/17	
4	San Fran	1	03/29/17	6/02/17	Reserve, NM
		1	05/08/17	06/23/17	
		2	06/12/17	08/08/17	
		1	08/01/17	09/24/17	
5	Diamond	1	03/28/17	05/25/17	Diamond Creek, Pot Hole tank
		1	04/03/17	05/25/17	
		1	05/04/17	08/29/17	
		1	05/15/17	08/29/17	
		1	06/21/17	08/29/17	
		1	07/22/17	08/29/17	
		1	08/13/17	08/29/17	
		1	09/07/17	10/07/17	
6	Blue	1	05/15/17	06/12/17	Garcia Tank (JER)
		2	06/11/17	06/12/17	
		1	06/26/17	06/30/17	
		2	07/04/17	07/05/17	
		1	07/23/17	09/21/17	
		1	08/02/17	09/21/17	
7	Moreno	2	05/26/17	08/31/17	Upper Mimbres Bear Mountain Lodge
		2	06/25/17	08/31/17	
		1	07/24/17	08/31/17	
		1	08/19/17	08/31/17	
9	Animas	1	03/23/17	06/16/17	Cave Creek
		2	04/14/17	04/20/17	
		1	06/05/17	06/06/17	
		2	06/25/17	08/03/17	
		1	07/01/17	08/03/17	
		1	07/04/17	07/05/17	
		1	07/09/17	07/12/17	
		2	07/23/17	07/24/17	
		1	08/03/17	08/04/17	
		1	08/06/17	08/07/17	
		2	08/22/17	09/01/17	
		1	08/28/17	08/23/17	
		1	09/10/17	09/10/17	
		1	09/25/17	09/26/17	

KEY:
Animas = Animas Creek
Diamond = Diamond Creek
Beaver = Beaver Creek
Blue = Blue Creek
San Fran = San Fran Haplotype
Moreno = Moreno Warm Springs

In 2017, the Ladder ranarium produced over 10,000 tadpoles. These tadpoles were released to wild or other captive sites across New Mexico on both public and private lands.

Fig. 4.3. Metamorph at Gosner stage 43 that was released into Cave Creek on the Ladder Ranch.

Table 4.6. Production and disposition of offspring produced at the ranarium in 2017.

Disposition Date	Source	EM	TP	Meta	Release type
04/20/17	Animas	2	-	-	C
05/25/17	Diamond	2	627	-	W
06/02/17	San Fran	1	236	4	W
06/06/17	Animas	1	-	-	C
06/12/17	Blue	1	966	-	C
06/12/17	Blue	2	-	-	C
06/16/17	Animas	1	69	28	W
06/21/17	Animas	*	4	1	C
06/23/17	Beaver	1	157	10	W
06/23/17	San Fran	1	177	-	W
06/30/17	Blue	1	-	-	C
07/05/17	Animas	1	-	1	C
07/05/17	Blue	2	-	-	C
07/12/17	Animas	1	-	-	C
07/24/17	Animas	2	-	-	C
08/03/17	Animas	3	1,052	-	W
08/04/17	Animas	1	-	-	C
08/04/17	Beaver	1	-	-	C
08/07/17	Animas	1	-	-	W
08/08/17	Beaver	1	-	-	C
08/08/17	San Fran	2	194	-	W
08/23/17	Animas	1	-	-	C
08/29/17	Diamond	5	2,383	15	W
08/31/17	Moreno	6	1,605	-	W
09/01/17	Animas	2	-	-	C
09/08/17	Beaver	1	-	-	C
09/10/17	Animas	1	-	-	W
09/21/17	Blue	2	127	-	C
09/24/17	San Fran	1	290	-	W
09/26/17	Animas	1	-	-	C
10/07/17	Beaver	4	1,665	-	C
10/07/17	Diamond	1	528	-	C

KEY:

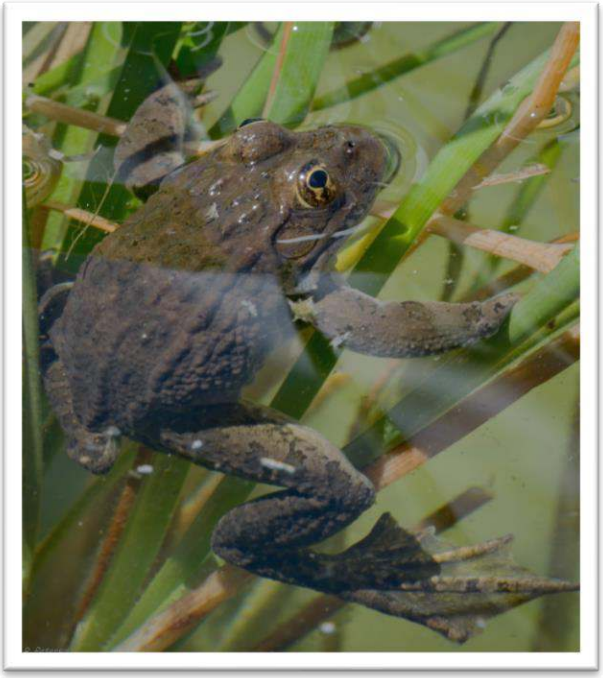
Animas = Animas Creek
Diamond = Diamond Creek
Beaver = Beaver Creek
Blue = Blue Creek
San Fran = San Fran Haplotype
Moreno = Moreno Warm Springs

EM = # of egg masses
TP = # of tadpoles
Meta = # of Metamorphs
W = Wild
C = Captive
* = 2016 EM overlooked. TPs overwintered in adult cage.

Spot recognition and tagging

The spot pattern arrangement on the dorsal surface of CLFs is putatively unique to an individual frog. We are testing this assumption to validate a novel method of individual identification of CLFs. In 2017 we continued the study to determine whether spot-pattern identification (SPI) methods can provide comparable results to the commonly used PIT tagging method (which involves the subcutaneous injection of a small Passive Integrated Transponder chip). To do this, we selected two captive refugia tanks (Fox and No. 2) on the Ladder Ranch in which to perform PIT tagging and SPI techniques. We conducted this work in 2013, 2014, and 2015. Overall, we PIT tagged 153 frogs and recaptured 95 of these animals over the course of the study.

In addition to our own analysis, we have partnered with the USGS to help create software specifically for leopard frog spot identification. For this study, we submitted our database of photographs from our fieldwork, both PIT tagging and spot-pattern images. In addition, we raised 10 tadpoles through metamorphosis to small juveniles in captivity, photographing them each month to study how dorsal spot-pattern may change as the individual grows and ages. Data analysis is ongoing.



A Chiricahua leopard frog on the Ladder Ranch

5. CHUPADERA SPRINGSNAIL

Pyrgulopsis chupaderae
ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologists
Dustin Long
Cassidi Cobos

Conservation Problem – Chupadera springsnails (CSS) are endemic to one spring system and the potential for habitat loss and degradation is very high.

Listing Status
- Listed as Endangered under the ESA in 2012
- NM Species of Greatest Conservation Concern

Project Location – Willow Spring on Highland Springs Ranch (1 mile north of Armendaris Ranch, NM).

Project Partners
- Highland Springs Ranch, LLC
- USFWS
- NMDGF
- Albuquerque BioPark Aquatic Conservation Facility

Project Funding – TESF

Goal – To mitigate threats of extinction and assist USFWS in developing a Recovery Plan.

Objective – We will convene a conservation working group and collect basic Chupadera springsnail (CSS) ecological information to inform development of a Recovery Plan. This will include water quality measurements, determining population status, developing an understanding of species life history, and potential establishment of captive populations.

Supporting Rationale for Objective

The CSS is extremely rare and highly endemic and the potential for extinction is greater than with many other imperiled species (Fig. 5.1). Furthermore, very little is known about the species and currently there is no Recovery Plan to guide conservation efforts or provide downlisting/delisting criteria. The Recovery Plan for two similar species found in New Mexico, the Alamosa (*Tryonia alamosae*) and Socorro (*Pyrgulopsis newmexicana*) springsnail, provide downlisting/delisting criteria which might also be applicable to CSS. If the Alamosa and Socorro springsnail recovery plan is a guide, then downlisting CSS may require (1) a habitat management plan that provides protection for the springsnail and its habitat, and (2) the habitat management plan has been in place for 5 years and demonstrated that the continued existence of the springsnail is assured. Delisting may require (1) protection of the springsnails' habitat in perpetuity and (2) the establishment of additional populations as evidenced by recruitment and persistence over a 5-year period.

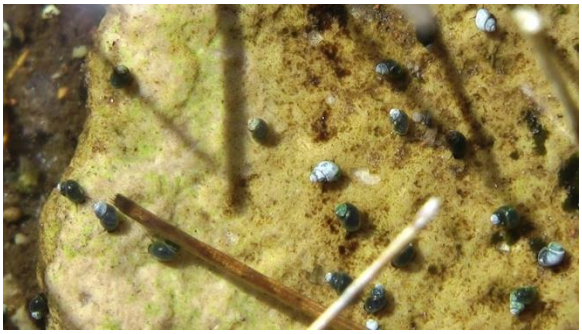


Fig. 5.1. The Chupadera Springsnail lives in a single small spring in south-central New Mexico.

Project Background – The Chupadera springsnail is a small (1-2 mm) freshwater snail (Fig. 5.1) that is endemic to Willow Spring (Fig. 5.2). The springsnail was once also found in a nearby unnamed spring but habitat degradation resulted in the extirpation of that population (Fig. 5.3). The springsnail is considered highly susceptible to extinction given the limited extent of and potential threats to available habitat (1 to 6 feet wide x 115 feet long).

Fig. 5.2. In 2016 TESF erected a barb wire fence around Willow Spring to prevent livestock degradation of the site. Native ungulates will still have access.

Fig. 5.3. Unnamed spring where habitat degradation resulted in the extirpation of the Chupadera Springsnail. Preventing this from happening at Willow Spring is a primary objective of this project.

In 2014, we finalized an agreement with Highland Springs Ranch allowing us access to the Willow Spring–an important development since access to the site by biologists last occurred in 1998. A site visit in early 2015 by the last biologist to visit Willow Spring in 1998 was encouraging. CSS densities appeared similar to those last observed, however, CSS had colonized previously unoccupied habitat further up the spring and water flow from the spring appeared to have increased.

Our approach to providing a more secure future for CSS involves three strategies: 1) secure/improve CSS habitat at Willow Spring, 2) establish a CSS population and habitat monitoring program, and 3) establish a CSS refuge population.

We installed a cattle exclusion fence around Willow Spring in late 2016 (Fig. 5.2). We do not fully understand the impacts of cattle on CSS habitat quality and populations, but we assume both will benefit from cattle exclusion; we are closely monitoring the site to document any changes (compare Fig. 5.2 and 5.4). Also, in late 2016 we established standardized habitat and population survey methods comparable to those used from 1997-1998.

Project Activities in 2017

We performed four CSS population density and habitat surveys at Willow Springs. Results suggest CSS densities have increased 66% since 1997-1998 surveys, while water physiochemical parameters remained unchanged. In August, we documented a pair of CSS mating; an important observation as we document life history characteristics of the species. To minimize extinction risk, we have proposed establishment of CSS refuge populations at the Albuquerque BioPark and Ladder Ranch. To this end, we moved two non-imperiled, surrogate, springsnail species–Gila springsnail (*P. gilae*) and New Mexico hotspring snail (*P. thermalis*)–into tanks at the Albuquerque BioPark to refine husbandry protocols (Fig. 5.5).

Proposed Future Activities & Considerations

We will continue with quarterly CSS population and habitat surveys. In the process, we will attempt to observe or infer life history milestones. The timeline for establishing a refuge CSS population hinges on the whether we are able to maintain and propagate the surrogate springsnail species that we are experimenting with in captivity. In late 2018, we aim to convene a meeting of springsnail biologists from across the southwestern U.S. at the Ladder Ranch to discuss challenges in managing and securing a long-term future for the dozens of imperiled springsnail species in the region.

Fig. 5.4. Habitat for the Chupadera Springsnail has changed in the two years since installing the fence at Willow Spring.

Fig. 5.5. One of two springsnail aquariums established at the Albuquerque BioPark. These hold two non-imperiled surrogate springsnail species to refine husbandry protocols before we move endangered Chupadera springsnails into captivity.

6. EASTERN INDIGO SNAKE

Drymarchon couperi

ESA listing: THREATENED

PROJECT STATUS
Under development

Principal biologist
Magnus McCaffery

Conservation Problem – Eastern indigo snake populations are declining throughout their range. Factors implicated in this decline include:

- Reduction in both distribution and number of gopher tortoise burrows.
- Habitat destruction through construction, logging, and agricultural activities.
- Incidental mortality as a result of being gassed in their burrows by rattlesnake poachers.
- Illegal collection for the pet trade.

Listing Status – Listed as federally threatened under the ESA in 1971. The species is also state listed as threatened in FL and GA.

Project Location – Avalon Plantation, FL.

Project Partners

- USFWS
- Central Florida Zoo's Orianne Center for Indigo Conservation (OCIC)
- The Orianne Society
- FWC

Project Funding – TESF

Goals & Objectives – To contribute to recovery efforts by establishing a viable eastern indigo snake population through snake reintroductions to the Avalon Plantation. To achieve this, our major objectives include:

- Delineate a reintroduction site of at least 5,000 hectares in size.
- Establish a minimum viable population of gopher tortoises within the reintroduction site to satisfy the eastern indigo snake's winter habitat requirements.
- Work with partners to reintroduce eastern indigo snakes at Avalon Plantation.

Supporting Rationale for Objectives

The Avalon Plantation (comprising seven management units: Avalon Proper = 8,326 acres, Annex = 2,480 acres, St. Joe = 3,309 acres, St. Joe "420' = 421 acres, Rosewood = 3,677 acres, 9000 Acre Tract = 8,668 acres, Magnolia Hills = 3,156 acres; Fig. 6.1) is a 30,037-acre quail plantation, which spans around 8% of the land area of Jefferson County in Florida's Panhandle. The property is principally managed for northern bobwhite quail habitat, but also for recreational wildlife hunting, timber production, and imperiled species conservation.

Avalon is part of a well-connected network of conservation lands in the indigo snake's historical range and is situated within a few miles of the County's last official sighting of the species on the Aucilla Wildlife Management Area in 1988 (Fig. 6.2). Neighboring conservation properties in contiguity with Avalon Proper's boundary collectively form a 35,736-acre continuous tract of land managed for conservation. At a broader scale, Avalon is 25 km east of another site where indigo snake reintroduction is being contemplated: the 570,000-acre Apalachicola National Forest. This National Forest is connected to Avalon via a relatively unbroken corridor of public and private conservation lands, many of which have the potential to support eastern indigo snake populations (Fig. 6.2). The proximity to, and high level of connectivity between, Avalon and the Apalachicola National Forest could provide a broad and secure landscape that advances eastern indigo snake recovery.

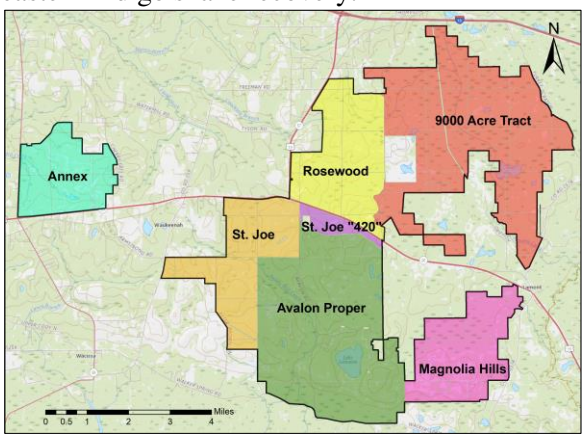


Fig. 6.1. The Avalon Plantation comprises seven management units.

The large size and diverse habitats of Avalon allow for the delineation of an appropriate 6,000 ha indigo snake reintroduction site on the property (Fig. 6.3). This area exceeds by 20% the minimum size requirement for an indigo snake recipient site and includes a matrix of upland and bottomland habitats that indigo snakes need to meet their life history requirements. A small, extant gopher tortoise population on this indigo snake reintroduction site has the potential to be augmented through tortoise translocations, and it could exceed the Gopher Tortoise Council's Minimum Viable Population (MVP) criteria within five years. With a gopher tortoise MVP in place across at least 100 ha (250 acres), Avalon's indigo snake reintroduction site would contain suitable upland habitats for snake overwintering, interspersed with ~ 1,570 ha of bottomlands (Fig. 6.3) to meet the summer foraging needs of a reintroduced indigo snake population.

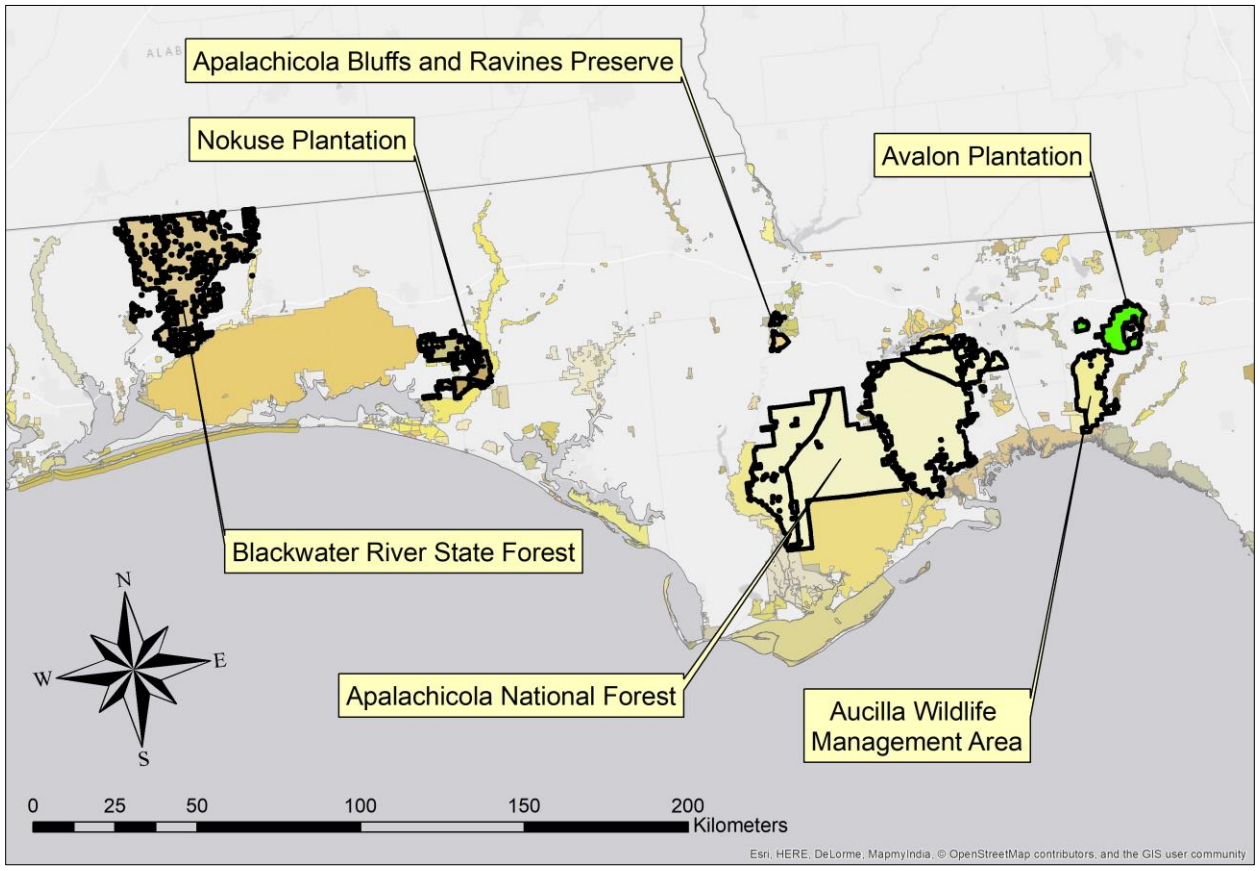


Fig. 6.2. The Avalon Plantation (green polygon) relative to other conservation lands (colored polygons) in the Florida Panhandle. Avalon and colored polygons with bold outlines indicate areas that currently (Apalachicola Bluffs and Ravines Preserve), or have the potential to, contribute towards eastern indigo snake recovery by serving as reintroduction sites.

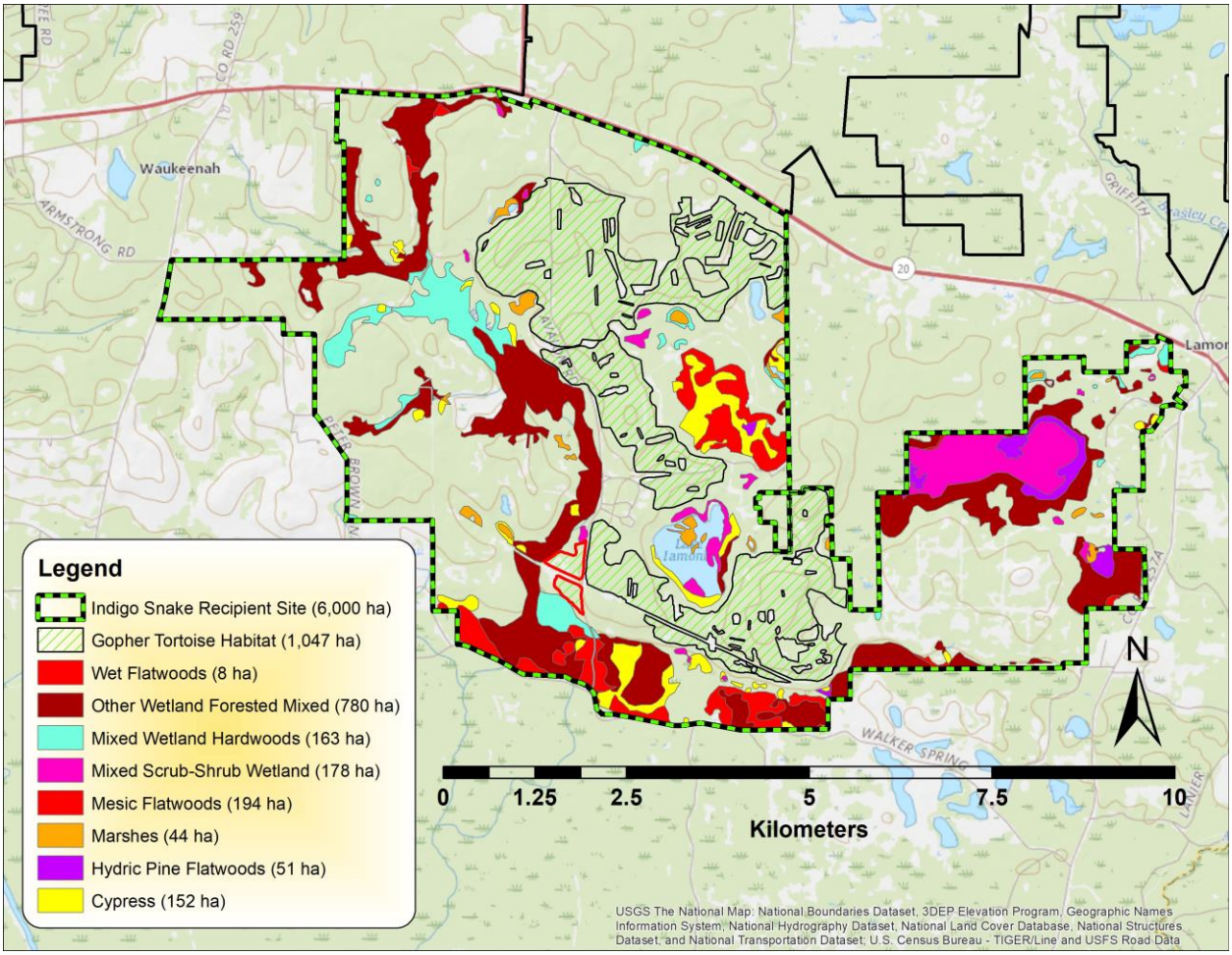


Fig. 6.3: Proposed eastern indigo snake reintroduction site on the Avalon Plantation with the distribution of indigo snake overwintering (Sandy Uplands suitable for gopher tortoises), and summer foraging (lowland/wetland) habitats.

Project Background – The eastern indigo snake is a large, non-venomous snake found in the southeastern U.S. Reaching lengths of almost 9 feet, it is the longest native snake in North America. Prey can include fish, frogs, toads, snakes, lizards, turtles, turtle eggs, small alligators, birds, small mammals, as well as all venomous snake species native to the Southeast. In the northerly portions of their range (north of Gainesville, FL), indigo snakes require upland habitat during the winter, and are reliant on gopher tortoise burrows as a refuge from cold temperatures. In the warmer months, snakes move to shaded bottomland wetland habitats to forage. Increasing pressures on Indigo snake populations include habitat loss, habitat fragmentation and the decline of gopher tortoise communities. Reductions in prey species and an increase in predators (e.g. feral hogs, coyotes, raccoons and fire ants destroying their eggs) also impact their survival.

In 2008 The Orianne Society built a multidisciplinary approach to eastern indigo snake recovery that includes scientific research, habitat restoration, and the creation of the Orianne Center for Indigo Conservation (OCIC).

The OCIC opened in 2012 and is the only captive breeding facility for eastern indigo snakes. Originally established by The Orianne Society for the purpose of breeding indigo snakes for reintroduction programs, the OCIC is now operated by the Central Florida Zoo and Botanical Gardens. Currently a colony of over 100 indigo snakes is managed for genetic and demographic diversity and will be used to fuel reintroductions of the species to suitable reintroduction sites.

Recently, the *Eastern Indigo Snake Reintroduction Committee* drafted criteria for potential reintroduction sites. A major habitat feature identified by the committee was that an indigo snake reintroduction site should support, within its boundaries, a minimum viable population of gopher tortoises.

In 2014, TESF hosted Dr. Christopher Jenkins, Chief Executive Officer of The Orianne Society, at the Avalon and Nonami plantations to evaluate the potential of these properties to contribute towards eastern indigo snake recovery. Based on an appraisal of available habitat, Dr. Jenkins's recommendation was that only Avalon Proper had sufficient potential to serve as an indigo snake recipient site – both Nonami Plantation and the Avalon Annex were considered too small with limited availability of indigo snake summer habitat.

Focusing on Avalon Proper, we delineated a potential 15,000-acre indigo snake recipient site. Lowland wetlands comprise around 20% of the total area (Fig. 6.3), thus meeting indigo snake recipient site criteria. Although large swathes of upland habitat exist that is suitable for gopher tortoises, the lack of a viable tortoise population in these areas means that Avalon Proper currently disqualifies the property from serving as a site for indigo snake reintroductions. However, we calculated that Avalon Proper boasts around 2,588 acres of indigo snake winter habitat that could be restored with restoration of gopher tortoises to these areas (Fig. 6.3).

In 2016, Mr. Turner indicated support for proceeding with restoring indigo snake winter habitat via gopher tortoise translocations across at least 500 acres of Avalon Proper. We set up a preliminary 50-acre recipient area ("Nursery Recipient Site") for Incidental Take Permitted (ITP) tortoises and translocated 12 individuals to the site–kickstarting the reconstitution of indigo snake winter habitat on Avalon Proper.

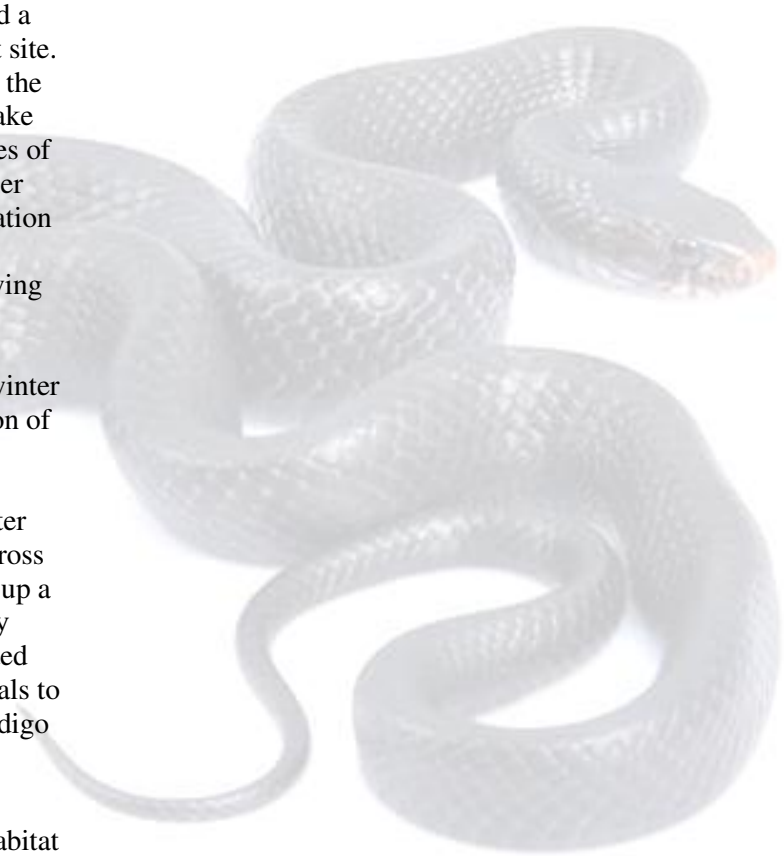
Project Activities in 2017

We continued with indigo snake winter habitat restoration activities, adding a total of 76 ITP tortoises to the Nursery Recipient Site in 2017 (see page 32 for details).

To restore enough gopher tortoises at Avalon to support indigo snakes over the winter months, we conducted planning work and investigated alternative strategies for expanding the gopher tortoise population across a broader area of Avalon Proper (see page 33 for details). We concluded that the most efficient method of gopher tortoise restoration will be to move away from the ITP tortoises, and instead take a Long-Term Protected (LTP; Box 6.1) site approach on Avalon Proper.

Proposed Future Activities & Considerations

In 2018, we will complete a comprehensive, science-based review of our eastern indigo snake strategy and make recommendations for restoring the species to the Avalon Plantation.



6. Eastern Indigo Snake Habitat:
GOPHER TORTOISE RECOVERY

Gopherus polyphemus
ESA listing: CANDIDATE

Conservation Problem – The primary threats to gopher tortoises are habitat destruction, fragmentation, and degradation.

Listing Status – State listed as threatened in Georgia and Florida, and a candidate for listing under the ESA. In the western part of its range, it is listed as threatened under the ESA.

Project Locations – Avalon Plantation, FL

Project Partners
- FWC
- Saving Florida's Gopher tortoises (SFGT)
- Nokuse Plantation

Project Funding – TESF

Goal – Restore viable gopher tortoise population levels to the Avalon Plantation.

Objective – We will restore two viable gopher tortoise populations to suitable habitat (100 ha minimum size) on the Avalon Plantation (one population on the Avalon Annex and one population on Avalon Proper) to restore eastern indigo winter habitat, advance gopher tortoise recovery, and serve as a model for conservation on private lands. These restored populations will ideally exhibit densities of 1 to 2 tortoises/ha (minimum of 0.4 tortoises/ha), will have positive population growth rates ($\lambda > 1.0$), and comprise: a minimum of 250 adults (> 235 mm MCL), variability in size and age structure, a male to female ratio of approximately 1:1, and evidence of juvenile recruitment.

Project Background

Prior to 2008, no formal gopher tortoise surveys, projects, or studies had been conducted on the Avalon Plantation, although tortoises were known to occur on the Avalon Annex portion of the property (Fig. 6.1). In 2008, gopher tortoise burrow surveys were conducted in suitable habitat types on the Avalon Annex. Approximately 578 ha were surveyed, and 257 burrows (both active and inactive) were located during this initial survey (Fig. 6.4).

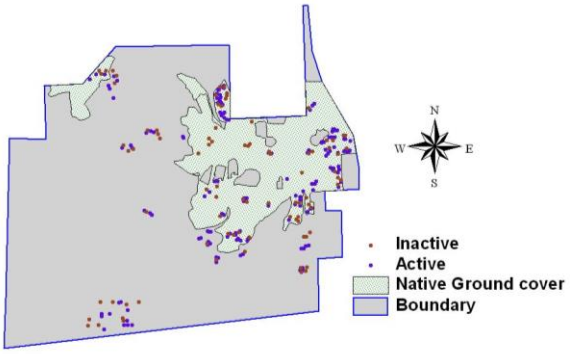


Fig. 6.4. Locations of active and inactive gopher tortoise burrows on the Annex from a survey conducted in 2008.

Five years later, in 2013, we examined the suitability of Avalon Proper (Fig. 6.1) for gopher tortoises. Soil type is one of the most important factors that determines habitat suitability, with tortoises requiring xeric, well-drained, sandy soils that facilitate burrow construction. We used data from the Natural Resources Conservation Service Web Soil Survey (www.soils.usda.gov) to evaluate Avalon's soils profile. We classified soil as being acceptable for gopher tortoise occupancy based on the following characteristics: (i) moderately well-drained to excessively well-drained, and (ii) depth to water table of 45 cm or greater.

In October 2013, we searched Avalon for both active and inactive gopher tortoise burrows, with the goal of identifying tortoise locations beyond the Annex. We found that burrows were predominantly concentrated on the Annex (81 active and 44 inactive), but also identified nine previously unknown active burrows and eight inactive burrows on Avalon Proper (Fig. 6.5).

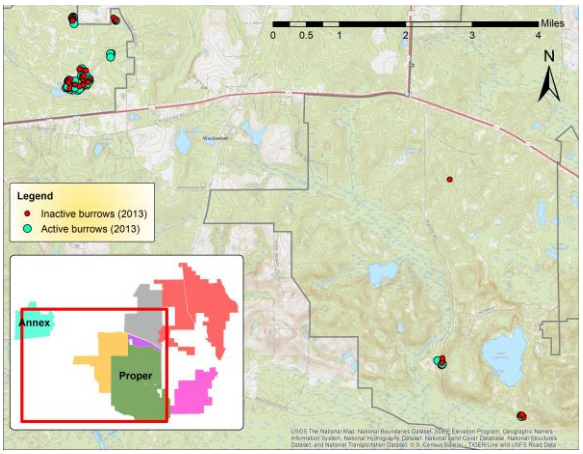


Fig. 6.5. Active and inactive gopher tortoise burrows found across the Avalon Plantation during surveys in 2013.

We continued mapping gopher tortoise burrows in 2014–revisiting known locations and finding previously unknown burrows–and evaluated their occupancy status using a burrow scope. The total number of active and inactive burrows located by our surveys on the Annex was 223 and 81 respectively, while we had found 11 active and three inactive burrows on Avalon Proper (Fig. 6.6). An assessment of the occupancy status of these burrows indicated that a minimum of 136 gopher tortoises occupied the Annex and at least eight tortoises were present on Avalon Proper (Table 6.1)

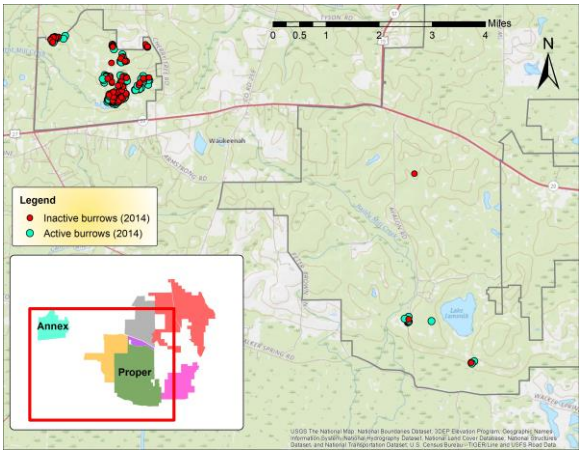


Fig. 6.6. Active and inactive gopher tortoise burrows found during surveys in 2014.

Table 6.1. The number of burrows located in 2014 on the Proper and Annex management units (MUs) of the Avalon Plantation. Each burrow was categorized as Active or Inactive, and assigned an occupancy status of occupied (O), empty (E), or undetermined (U).

MU	Active	Inactive	# O	# E	# U
Annex	223	81	136	99	69
Proper	11	3	8	5	1

We began to bolster the extant gopher tortoise population on the Annex in 2014, and in the process, we assisted with humane relocation of gopher tortoises from incidental take permitted (ITP) sites across Florida where tortoises were at risk of being entombed through development of their habitat. We worked in collaboration with FWC to delineate a 505-acre *Unprotected Recipient Site* on the Annex ("Annex Tortoise Recipient Site (TRA)"; Fig. 6.7). Avalon Plantation staff built two temporary soft-release pens ("North Pen" and "South Pen"; Fig. 6.8) within the Annex TRA, and we worked with SFGT to translocate 107 ITP tortoises into these acclimation pens (see Fig. 6.11). FWC requires that relocated tortoises remain in these temporary pens for 6 – 12 months before pens are removed and the animals are released.

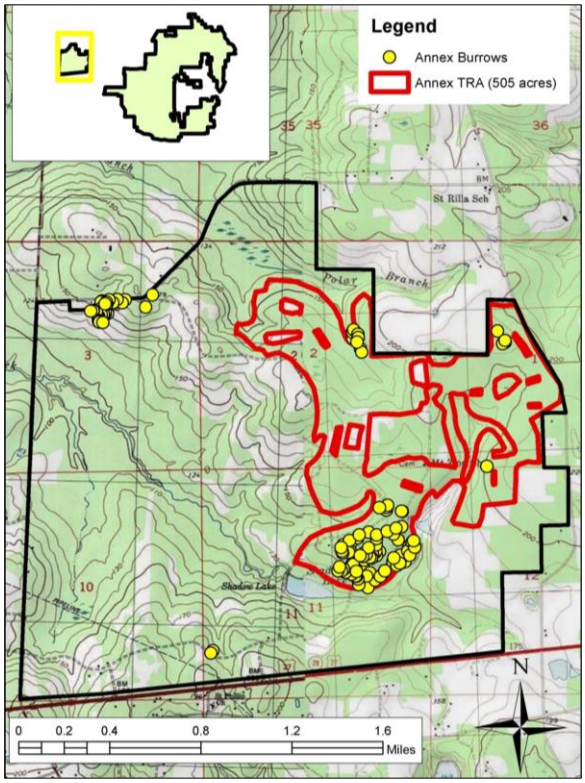


Fig. 6.7. The 505-acre Annex Tortoise Recipient Site (TRA). This *Unprotected Recipient Site* was designated on the Annex to receive translocated tortoises from development sites in Florida with ITP permits.

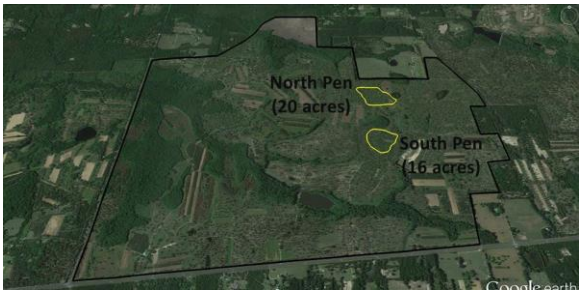


Fig. 6.8. Locations of gopher tortoise acclimation pens (yellow polygons) on the Annex.

In 2015, we continued with ITP tortoise translocations to the Annex TRA. We installed a 52-acre acclimation pen ("2015 Pen") at the Annex recipient site and translocated 139 ITP tortoises to the site (see Fig. 6.11). On June 15th, we removed the two original acclimation pens used for ITP translocations in 2014, and we began to planning work for developing a new ITP recipient site on Avalon Proper.

In 2016, we carried out a 100% burrow survey across an area of around 800-acres in the vicinity of Avalon Proper's utility pipeline easement to determine extant gopher tortoise populations levels. This entailed two TESF biologists walking approximately 60,000 m of transects, spaced around 50 m apart. During this fine-scale survey work, we detected 23 abandoned burrows and 20 potentially occupied burrows in this area (Fig. 6.9).

This 100% survey included a detailed examination of the 50-acre Nursery site which we selected as the plantation's next ITP tortoise recipient site (Fig. 6.9). During this survey, transects totaling 3,450 m were walked to gain a granular understanding of existing gopher tortoise occupation of this 50-acre area. Upon detection of a tortoise burrow, a thorough search of the surrounding area was made to identify and map the extent of potentially occupied gopher tortoise burrows as well as abandoned tortoise burrows (i.e., burrows of tortoise origin, but exhibiting signs of disuse by tortoises either through collapse or having been taken over by another species). We then worked with FWC to designate this 50-acre Nursery area as an *Unprotected Recipient Site* for the relocation of ITP tortoises (Fig. 6.9).

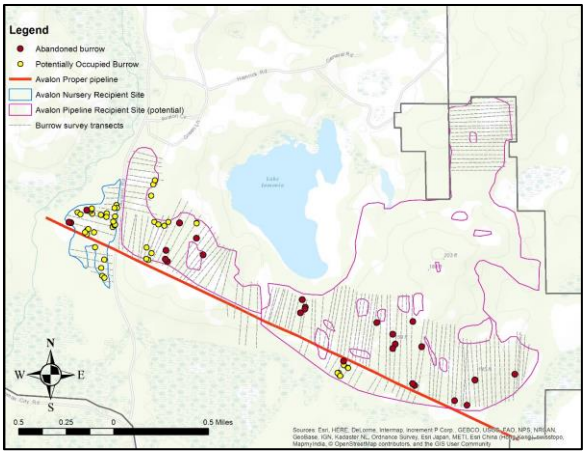


Fig. 6.9. The southern portion of Avalon Proper showing the newly designated (in 2016) 50-acre Nursery ITP Recipient Site, and a potential area for another recipient site (i.e. Avalon Pipeline Recipient Site). 100% burrow surveys were undertaken in these areas during 2016 and all potentially occupied and abandoned burrows were mapped.

Within the Nursery Recipient Site, Avalon Plantation staff installed a 7-acre acclimation pen. We then worked with SFGT and Nokuse Plantation in 2016 to translocate 170 tortoises to the 52-acre "2015 Pen" on the Annex, and 12 tortoises to the new 7-acre pen at the Nursery Recipient Site (see Fig. 6.11).

Supporting Rationale for Objectives

Avalon Proper combined with a small portion of Avalon St. Joe (Fig. 6.1), have around 2,500 acres of potential gopher tortoise habitat (Fig. 6.10), comprising well-drained sandy soils and a pine/grassland vegetation structure maintained by frequent prescribed burns and mid-story hardwood control. Gopher tortoises are absent from the majority of this suitable habitat but it is likely that the species historically occupied this area at greater densities. Reductions in both gopher tortoise range and numbers are due to anthropogenic pressures such as consumption of tortoises as food, 'gassing' burrows to control rattlesnakes, and tortoise collection, as well as habitat loss.

The overall estimated density of tortoises at Avalon is 0.07 tortoises/ha. This is based on the number of potentially occupied burrows (i.e., active and inactive burrows: n = 248) located by TESF surveys within Avalon's 1,600 ha of suitable habitat and assumes a burrow occupancy rate of 50 %. The expert consensus minimum viable population size for the gopher

tortoise is 250 adults of no less than 0.4 tortoises/ha, with: (i) a male-female ratio of 1:1; (ii) evidence of recruitment into the population; (iii) variability in size and age class; (iv) contiguous tortoise habitat of at least 100 ha with no major barriers to tortoise movement. Other viable tortoise populations in the vicinity of Avalon can exhibit densities from 0.7 tortoises/ha to > 2 tortoises/ha, and gopher tortoise experts with working knowledge of the area suggest that a goal of 1 – 2 tortoises/ha (and at minimum 0.4 tortoises/ha) would be appropriate for Avalon.

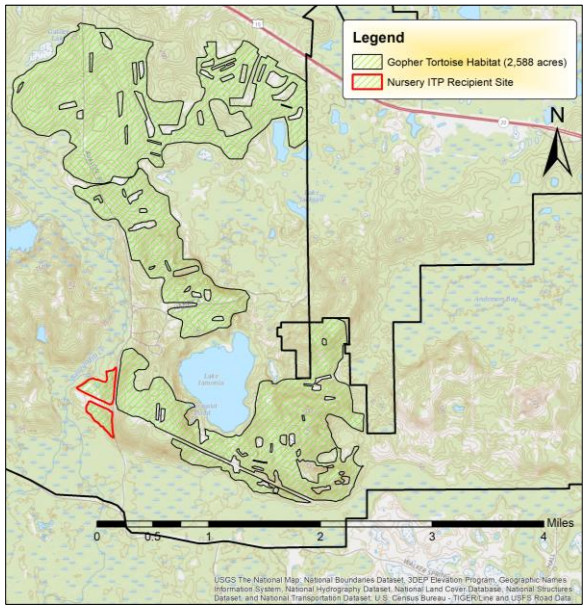


Fig. 6.10. Areas of Avalon Proper that are suitable for gopher tortoises, including the Nursery Recipient Site that received 76 ITP tortoises in 2017.

Restoring viable tortoise populations to Avalon is supported by ecological and conservation considerations. The gopher tortoise is a dominant ecosystem engineer in sandhill, longleaf pine, and shrub ecosystems. Their deep burrows provide habitat for numerous other species. Thus, higher tortoise densities could enhance local biodiversity. Furthermore, gopher tortoises are state listed as threatened in GA and FL, and a candidate for listing under the ESA.

Project Activities in 2017

2017 ITP tortoise translocations

We installed a new 27-acre acclimation pen to complement the existing 7-acre pen at the Nursery Recipient site. We then worked with SFGT and Nokuse Plantation to complete gopher tortoise translocations to the 50-acre Nursery Recipient Site, adding a total of 76 ITP tortoises in 2017 (Fig. 6.11).

Prior to release at starter burrows in both pens, we examined and measured (maximum carapace length, maximum plastron length, mass, plastron concavity, annuli count, examination for parasites and injury) each translocated tortoise. In addition, tortoises that were assessed to have hardened carapaces and sufficient space on their marginal scutes were also given an individual identification number by drilling a unique combination of small holes in the marginal scutes using the marking system shown in (Fig. 6.12). Measurement data from ITP tortoises translocated to the Avalon Nursery recipient area in 2017 are summarized in Table 6.2.

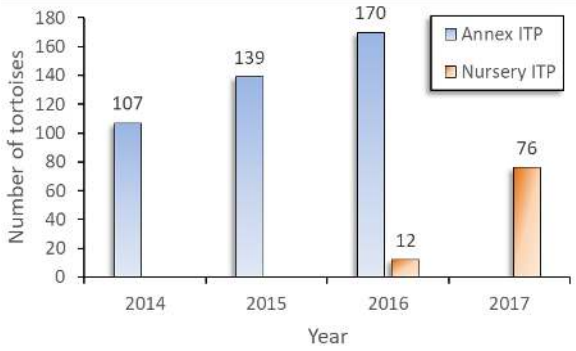


Fig. 6.11. Number of ITP gopher tortoises translocated to ITP recipient sites on the Avalon Annex (Annex ITP) and Avalon Proper (Nursery ITP).

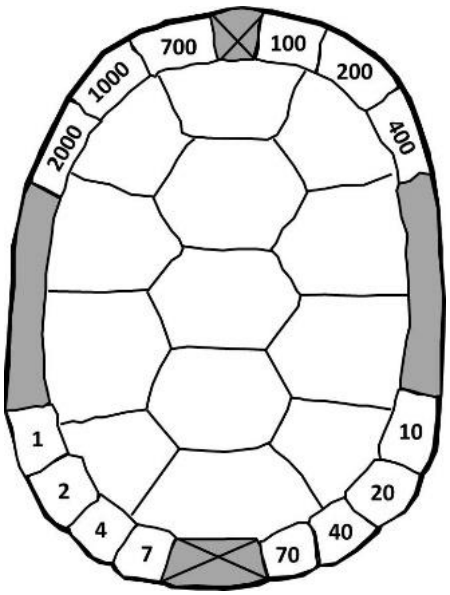


Fig. 6.12. The marking scheme used to give each translocated gopher tortoise (with sufficient carapace hardness and space on marginal scutes) a unique identification number.

Table 6.2. Summary data for gopher tortoises translocated to the Nursery Recipient Site in 2017.

	FWC INCIDENTAL TAKE PERMIT NO.				
	CLA-064	**HER-056**	**HIL-208**	**HER-023**	**OSC-030**
# ♀	4	6	3	3	11
$\bar{x}$ MCL ♀	159	247	215	244	269
# ♂	2	3	2	3	14
♂ $\bar{x}$ MCL	270	257	270	245	278
# Adult SU	-	-	-	-	2
$\bar{x}$ MCL Adult SU	-	-	-	-	236
# LJ	-	-	-	-	7
$\bar{x}$ MCL LJ	-	-	-	-	154
# SJ	4	2	-	4	6
$\bar{x}$ MCL SJ	92	104	-	61	122

KEY:
$\bar{x}$ MCL = average Maximum Carapace Length (MCL) measurement (in mm).
# ♀ = Number of adult females; # ♂ = Number of adult males.
# LJ = Number of large juveniles (> 130 mm MCL). SU.
# SJ = Number of small juveniles (< 130 mm MCL). SU.
SU = Sex unknown

2017 planning work

Avalon Proper has an abundance of potential gopher tortoise habitat (over 2,588 acres; Fig. 6.10). To plan the restoration of gopher tortoises to at least 500 acres of this massive area, we re-evaluated the various recipient site options (Box 6.1). We concluded that the most efficient method of gopher tortoise restoration at Avalon Proper will be to move away from the Unprotected Recipient Site/ITP tortoise model for translocations, and instead take a Long-Term Protected (LTP) Site approach. This change in tack is principally driven by a diminished availability of ITP tortoises for translocation to Avalon, which can be attributed to several factors:

- Only a finite number of ITPs were issued before state permitting rules changed in 2007. Developers must now move tortoises to approved LTP recipient sites, and to cover the costs of their relocation.
- With development increasing throughout Florida, the number of ITPs left unexecuted is dwindling.
- There are more ITP recipient sites (Avalon, Nokuse Plantation, Eglin Air Force Base) which compete for ITP tortoises.
- The process of rescuing ITP tortoises is expensive with average costs ranging from $200 - $300 per tortoise. All ITP rescues in Florida are carried out by *Saving Florida's Gopher Tortoises,* an effort that is supported through grants and donations, with the majority of funding borne by a single ITP recipient property: Nokuse Plantation. With more ITP recipient sites vying for a dwindling number of ITP tortoises, managers must prioritize ITP rescues to their own recipient sites to meet their objectives.

The LTP system is a market-based approach that mitigates the impacts of development on gopher tortoises by requiring developers to relocate tortoises out of harm's way before any land clearing or development occurs on their habitat. Owing to the logistics and specialized permitting involved with LTP tortoise translocations, it is typical for LTP recipient sites to work in partnership with Authorized Gopher Tortoise Agents who provide services that include LTP tortoise excavation, processing, transport, release and monitoring at the LTP recipient site. For example, an Avalon Proper Recipient Site could operate in partnership with an environmental consulting group that have authorized gopher tortoise agents on staff. This consultancy, in collaboration with TESF, would liaise with developers and relocate gopher tortoises to the Avalon LTP site. Designating a portion of Avalon Proper as a LTP site would allow us to rapidly rebuild Avalon Proper's tortoise population, and free up TESF's resources to focus on returning eastern indigo snakes to the plantation. We estimate that using the LTP format would allow Avalon Proper to become eligible to receive indigo snake translocations within approximately 2 years (based on estimated translocation rates of 500-600 tortoises per year.

Under the LTP model, Avalon/TESF would receive remuneration from developers (~$500/tortoise) for accepting tortoises at its LTP site, generating funds to support project costs as well as land management of the LTP site in perpetuity.

Proposed Future Activities & Considerations

In 2018, we will continue to work towards designating an area of at least 500 acres on Avalon Proper as a recipient site for gopher tortoise translocations.

Box 6.1. Recipient Site types.

Prior to June 2007, the Florida Fish and Wildlife Conservation Commission (FWC) did not require relocation or removal of gopher tortoises prior to construction activities, and landowners seeking to develop land in Florida could obtain an incidental take permit (ITP) to authorize take (e.g. through entombment in burrows) of gopher tortoises. Since 1991, FWC's ITP program allowed the destruction of around 100,000 gopher tortoises. A developer that obtained an ITP prior to June 2007, but delayed development activities, is not required by law to relocate tortoises. The private group, "Saving Florida's Gopher Tortoises", headed up by Carissa Kent, works to rescue gopher tortoises from these development sites that have grandfathered-in ITPs.

New regulations were adopted in June 2007, whereby gopher tortoises in Florida are now relocated from occupied habitat that is slated for development, and translocated to FWC-certified recipient sites. These recipient sites generally charge a market-driven fee for accepting tortoises, creating an opportunity for private landowners to establish a gopher tortoise conservation bank. This is particularly attractive to conservation-minded landowners with no plans for development. There are three recipient site categories that offer potential avenues for relocating gopher tortoises to private lands.

OPTION 1 – Long-term Protected (LTP) Recipient Sites: Must have a ***habitat management plan*** and be protected by a perpetual ***easement***. In addition, long-term recipient sites must have a ***financial assurance*** that, when fully funded, is sufficient to generate annually in interest (at a 4% rate of return) the money needed to fund annual management activities for the LTP recipient site. For example, a 500-acre LTP site on Avalon Proper that requires $20/acre per year for management would require an endowment of $250,000. The trust can either be fully funded up front or incrementally funded such that additional funds are added as each tortoise is received at the LTP site. The initial endowment for an incrementally funded trust should be at least equal to the amount of money required to complete one 2- or 3-year management cycle.

OPTION 2 – Short-term Protected Recipient Sites: These are less stringent requirements in terms of easement placement, financial assurances, and minimum recipient site acreage. However, there are some enforceable protection commitments. FWC mitigation fees provide a ten-fold economic incentive for developers to use Long-term Recipient Sites.

OPTION 3 – Unprotected Recipient Sites: Provide relocated tortoises protection for at least two years and require landowners to maintain suitable gopher tortoise habitat for the duration of the recipient site permit (i.e. 2 years). They do not require a conservations easement, financial assurances, a management plan, or place additional restrictions upon the landowner. We currently have two of these recipient site types on the Avalon Plantation (Annex Recipient Site and Nursery Recipient Site), which together have received 504 Incidental Take Permitted (ITP) tortoises since 2014.

7. LESSER PRAIRIE-CHICKEN

Tympanuchus pallidicinctus
ESA listing: THREATENED

PROJECT STATUS
Ongoing

Principal biologists
Dustin Long
Carter Kruse

Conservation Problem – Rapid, range-wide decline due to habitat loss and fragmentation.

Listing Status – Listed as federally threatened in 2014. This listing determination was vacated by a federal court in 2015, and the species' status is currently under review.

Project Locations – Z Bar Ranch, KS

Project Partners – WAFWA

Project Funding
- TESF/TEI

Goal – Restore ~25,000 acres of the Z Bar mixed grass prairie to a condition suitable for lesser prairie chickens, and to integrate the project into existing bison production and black-tailed prairie dog restoration efforts at the ranch.

Objective – We will increase lesser prairie-chicken numbers at the Z Bar by managing for a diverse landscape mosaic that includes breeding, nesting and brood rearing habitats within close proximity to each other. This will involve:

- Use of fire to improve brood rearing habitat and control woody vegetation. Each pasture will be burned at least once every 10 years.
- Mechanical removal of woody vegetation from the uplands to limit avian predation and improve suitable lesser prairie-chicken habitat.
- Using grazing to produce a mosaic of habitats that include lightly grazed pastures with robust standing vegetation, and heavily grazed pastures with minimal standing vegetation.

Supporting Rationale for Objective

The Z Bar once supported a modest lesser prairie-chicken population with at least 2 lek sites on the ranch (Fig.7.1). The population has since decreased, with only occasional sightings of individuals now reported. WAFWA recommends habitat blocks (i.e. lek complexes) of 21,000 – 25,000 acres to support a viable prairie chicken population. The 42,500 acre Z Bar has sufficient existing and potential habitat to meet that lek complex requirement.

Project Background

The lesser prairie-chicken project at the Z Bar represents one of TESF's newest conservation efforts on Turner properties. Beginning in early 2015 we began to manage 32,525 acres to benefit lesser prairie-chickens through a cooperative 10-year agreement with WAFWA. Central to the agreement is habitat restoration, which includes the removal of woody vegetation from the uplands on 1,949 acres, prescribed fire in each pasture at least once every ten years, and a prescribed grazing plan intended to help create the vegetative mosaic required by lesser prairie-chickens. By year two of the project, we had satisfied all required habitat restoration and grazing requirements (see Figs. 7.2 and 7.3). In March 2016, 41,000 acres of the Z Bar burned in what ended up being the largest wildfire in Kansas history. Ecologically, the Z Bar largely benefitted from the fire as it served to refresh native grasses, increase ecosystem heterogeneity, and eliminate invasive woody brush and trees from the uplands; all to the benefit of lesser prairie-chickens. Because of this wildfire no prescribed burns were performed in 2016 or 2017.

Over the course of this project lesser prairie-chickens have routinely been observed and sightings at the Z Bar appear to be increasing; however, we have yet to verify that lesser prairie-chickens are reproducing on the ranch.

Fig. 7.1. Male lesser prairie-chicken on a lek site. Lesser prairie-chicken surveys are performed during the spring breeding season when males and females congregate on historical "booming grounds" (credit: Dominic Sherony).

Fig. 7.2. An upland site on the Z Bar *before* (in 2012) and *after* mechanical removal of eastern red cedar and prescribed fire.

Project Activities in 2017

While we have met all habitat management requirements outlined in the WAFWA agreement, we continue to improve habitat quality through the removal of trees scattered within or on the periphery of suitable lesser prairie-chicken habitat. The ranch also began to focus bison grazing on historic lek sites to improve their attractiveness to lesser prairie-chickens. We met with WAFWA and KDWPT representatives to discuss potential prairie-chicken translocations to the Z Bar if it becomes necessary to actively re-establish the ranch population. No lesser prairie-chickens were detected on the ranch during spring lek surveys.

Proposed Future Activities & Considerations

If populations remain low in the coming years, with no evidence of reproduction we will begin translocating lesser prairie-chickens onto the Z Bar. Released birds would be fitted with transmitters to track habitat use and perhaps identify factors that may be limiting population establishment and growth.

8. MONARCH BUTTERFLY

Danaus plexippus

ESA listing: STATUS REVIEW

PROJECT STATUS
Ongoing

Principal biologist
Dustin Long

Conservation Problem – The primary threat to monarch butterflies is habitat loss and pesticides.

Listing Status

- Under USFWS Status Review (Listing decision due in June 2019)
- KS: Species of Greatest Conservation Need

Project Location – Z Bar Ranch, KS; Bad River Ranches, SD; Avalon Plantation, FL

Project Partners

- USFWS

Goal – Conserve and restore native milkweed and other wildflower communities to benefit monarch butterflies and other native pollinators.

Objective – To manage for and increase suitable habitat for monarch butterflies and other native pollinators on Turner properties through milkweed (*Asclepias spp.*) and other native wildflower plantings, as well as habitat management. Within five years, we aim to reestablish robust, reproducing populations of swamp milkweed (*A. incarnata*) at the Z Bar and Avalon to include > 500 plants at four sites on each property. At Bad River we will collect seeds from extant showy milkweed (*A. speciosa*) stands and distribute them in recently disturbed areas. We will also determine if showy milkweed is an effective vegetative barrier to black-tailed prairie dog expansion. As these and other milkweed species become established we will provide local ecotype seeds to partners and other landowners who want to improve habitat for native pollinators.

Supporting Rationale for Objective

Most Turner properties lie within the spring and fall migration routes of the monarch butterfly (Fig. 8.1) and can reasonably be expected to support monarch populations with restoration and conservation of milkweeds and

other wildflowers. The Z Bar and the Avalon are particularly well suited to monarch butterfly conservation because both properties support prescribed fire which results in diverse wildflower communities. Both are also located where the first generation of monarchs migrating north from Mexico lay eggs, setting the foundation for the species' multi-generational transnational migration.

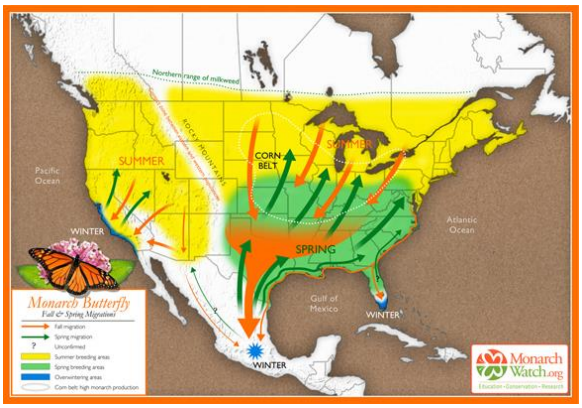


Fig. 8.1. Monarch butterfly migration routes.

All Turner properties have extant populations of milkweed which are beneficial as nectar and pollen sources for native pollinators. However, most of those milkweed populations are sparse and homogenous, and some milkweed species are less desirable than others as host plants for monarch butterflies (Fig.8.2).

Fig. 8.2. Female tarantula hawk (*Pepsis spp.*) feeding on nectar from a broadleaf milkweed (*A. latifolia*) plant at the Z Bar. While not a highly preferred monarch host plant, broadleaf milkweed is a valuable nectar source for monarchs and other native pollinators.

At Avalon and the Z Bar, a highly preferred host plant for monarchs—swamp milkweed—is largely absent, while at Bad River another preferred host plant—showy milkweed (Fig. 8.3)—exists, but in widely scattered and small stands. Why these two preferred host plants are uncommon—particularly swamp milkweed at Avalon and Z Bar—is unknown although it seems likely that it is a legacy of herbicide use at those properties. With assisted colonization and habitat management we aim to increase the suitability of these properties for monarch butterflies and all native pollinators.

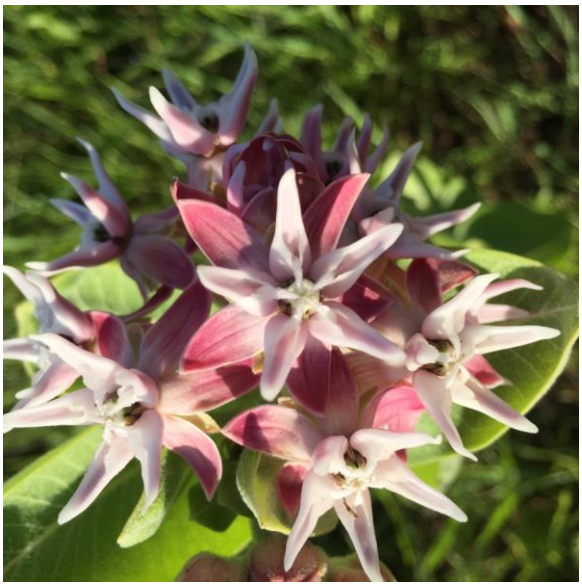


Fig. 8.3. Showy milkweed is ubiquitous throughout the western U.S. and is found on all Turner properties in the Great Plains. Showy milkweed is a preferred monarch host plant and we are attempting to improve existing stand vigor and establish new stands at the Z Bar and Bad River.

Project Background

In response to the unprecedented decline of such an iconic insect, TESF teamed up with federal, state and non-profit partners to initiate multiple monarch butterfly habitat conservation and recovery projects on Turner properties. Central to this effort will be restoring preferred monarch host plants on Turner properties, and adapting management practices to benefit these early successional, disturbance-loving plants.

Beginning in 2015, we began annual milkweed surveys at Avalon, Z Bar, and Bad River to determine species abundance and diversity to guide restoration efforts. Results indicated a robust redring milkweed (*A. variegata*) community but few other species at Avalon, while Z Bar supports the most diverse milkweed community of the Turner properties where nine species were identified–many of which persist in relatively large stands. Both Avalon and the Z Bar support vibrant and robust wildflower communities; a reflection of the

sensible use of prescribed fire on those landscapes. Two milkweed species have been documented at Bad River, with showy milkweed being the most common.

We have investigated two principal methods to increase milkweed diversity and abundance: seed plantings and plug plantings, with the latter showing more promise for restoring an extirpated milkweed species. Plug plantings at Avalon and seed plantings at Bad River originated from local ecotype specimens, whereas the seed and plug plantings at the Z Bar and plug plantings at Bad River were regionally sourced.

Project Activities in 2017

Our efforts to restore milkweed on Turner properties over the past three years has resulted in an increase in milkweed abundance and diversity. However, for the effort involved the results have not always been as successful as we had anticipated. Experimenting with different milkweed species, habitats, and propagation techniques often resulted in poor survival, and in a few instances, failure. Those early failures, along with the recent successes, have provided insight into how to move the milkweed project forward in an effective and efficient manner. In 2017, we focused on:

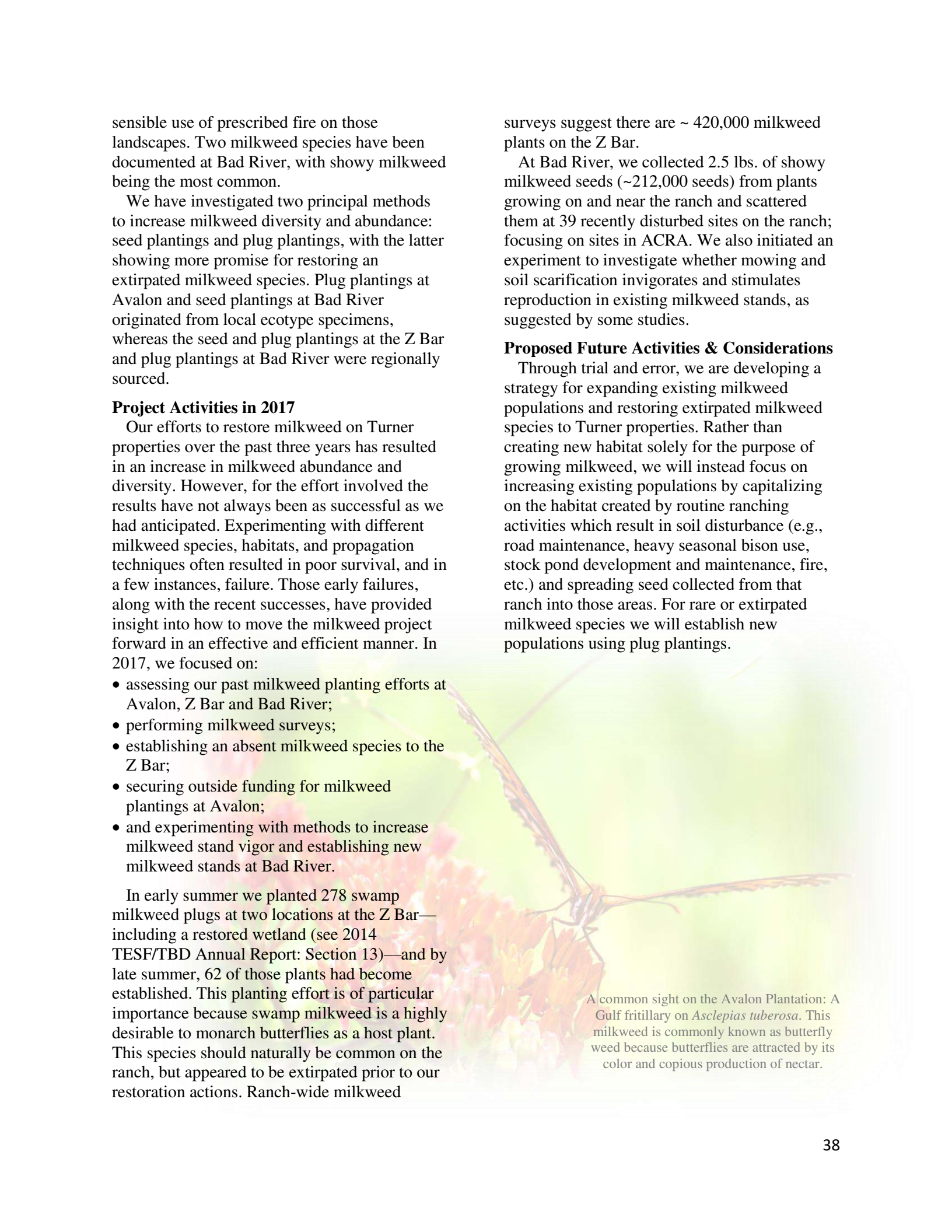
- assessing our past milkweed planting efforts at Avalon, Z Bar and Bad River;
- performing milkweed surveys;
- establishing an absent milkweed species to the Z Bar;
- securing outside funding for milkweed plantings at Avalon;
- and experimenting with methods to increase milkweed stand vigor and establishing new milkweed stands at Bad River.

In early summer we planted 278 swamp milkweed plugs at two locations at the Z Bar—including a restored wetland (see 2014 TESF/TBD Annual Report: Section 13)—and by late summer, 62 of those plants had become established. This planting effort is of particular importance because swamp milkweed is a highly desirable to monarch butterflies as a host plant. This species should naturally be common on the ranch, but appeared to be extirpated prior to our restoration actions. Ranch-wide milkweed surveys suggest there are ~ 420,000 milkweed plants on the Z Bar.

At Bad River, we collected 2.5 lbs. of showy milkweed seeds (~212,000 seeds) from plants growing on and near the ranch and scattered them at 39 recently disturbed sites on the ranch; focusing on sites in ACRA. We also initiated an experiment to investigate whether mowing and soil scarification invigorates and stimulates reproduction in existing milkweed stands, as suggested by some studies.

Proposed Future Activities & Considerations

Through trial and error, we are developing a strategy for expanding existing milkweed populations and restoring extirpated milkweed species to Turner properties. Rather than creating new habitat solely for the purpose of growing milkweed, we will instead focus on increasing existing populations by capitalizing on the habitat created by routine ranching activities which result in soil disturbance (e.g., road maintenance, heavy seasonal bison use, stock pond development and maintenance, fire, etc.) and spreading seed collected from that ranch into those areas. For rare or extirpated milkweed species we will establish new populations using plug plantings.



A common sight on the Avalon Plantation: A Gulf fritillary on *Asclepias tuberosa*. This milkweed is commonly known as butterfly weed because butterflies are attracted by its color and copious production of nectar.

9. RED-COCKADED WOODPECKER

Picoides borealis

ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologists
Greg Hagan
Mike Phillips

Conservation Problem – Population decline due to habitat destruction and degradation.

Listing Status
Listed as endangered under the ESA in 1973.

Project Location – Avalon Plantation, FL.

Project Partners
- USFWS, FWC

Project Funding
- TESF/USFWS Cooperative Enhancement Agreement

Goals & Objectives – Restore at least 20 breeding groups to the Avalon Plantation that can persist with minimal management. Once this is achieved, Avalon will be available as a donor site for translocations to other recovery sites.

Our annual objectives include:
- Restoring abandoned clusters (an aggregate of cavity trees) by providing ≥ 4 artificial cavities per abandoned cluster.
- Establishing recruitment clusters by installing ≥ 4 artificial cavities per recruitment cluster.
- Using fire to maintain RCW habitat suitability.
- Pre-burn mowing (2 acres) around all clusters to protect cavity trees from prescribed fire.

Project Background

RCWs depend on mature pine forest habitat that have longleaf pines averaging 80-120 years old or loblolly pines averaging 70-100 years old. In the last century, RCWs have declined as pine forest habitats changed through timber harvest and agriculture. Pine savannah and open forest encompassed over 200 million acres at the time of European colonization, and longleaf pine communities may have covered 60-92 million of those acres. Today, fewer than 3 million acres remain. RCWs once ranged from Florida to Maryland and New Jersey, west to Texas and Oklahoma, and inland to Missouri, Kentucky, and Tennessee.

RCWs are a cooperative breeding species, living in family groups consisting of a breeding pair, which may also include one or two male helpers (females can also become helpers, but do so at a lower rate than males). The limiting habitat requirement for RCWs is the availability of tree cavities, which the birds excavate in live pine trees. RCWs are the only North American woodpecker to excavate cavities in living trees, with the excavation of a new cavity often taking several years to accomplish. A group of cavity trees occupied by a potential breeding group (an adult female and male, with or without helpers) is termed a cluster, and is the metric used to measure RCW populations.

In 1998, we initiated a collaboration with the USFWS to reintroduce RCWs to the Avalon Plantation. This involved translocating 10 birds per year for five successive years to Avalon, and was the first effort by a private landowner, state or federal agency to reintroduce a population of woodpeckers into an area where there was no remaining extant population.

While the population expanded steadily during the first nine years of the project, during 2007-2009 there were signs that growth was slowing. An assessment of cluster status was undertaken in 2010, where it was determined the population comprised 13 active groups, 2 inactive groups, and 7 abandoned groups (i.e., showing no evidence of RCW activity for 3+ years). An aggressive approach was undertaken to restore the abandoned clusters, establish new recruitment clusters in priority habitat, and cavity tree management. These actions had a positive effect, with the population reaching 19 active groups, 3 inactive groups, and 2 abandoned groups by the end of 2017; the highest number of active clusters on Avalon since project inception.

Project Activities in 2017:

Recruitment Clusters

We established two recruitment clusters in the central portion of the property (Fig. 9.2). These comprised four artificial cavities installed within each recruitment cluster. Each recruitment cluster was placed within 0.4–1.0 km of an existing active cluster and within 1.0 km of each

other. This has proven most effective for previous recruitment cluster establishment. As of December 2017, one of the recruitment clusters (NE recruitment cluster) showed signs of recent activity, with two trees exhibiting fresh resin wells and flakey bark from RCW activity.

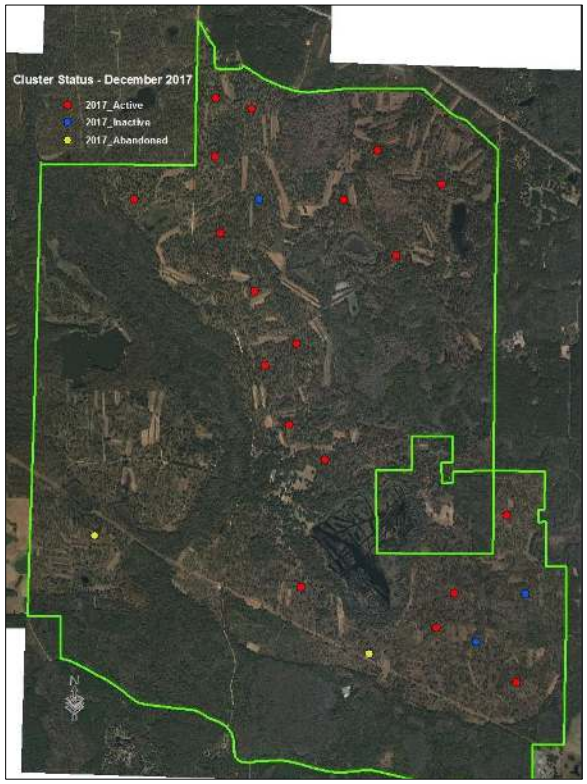


Fig. 9.1. Results of 2017 RCW cluster surveys at Avalon Plantation.

Cluster Checks

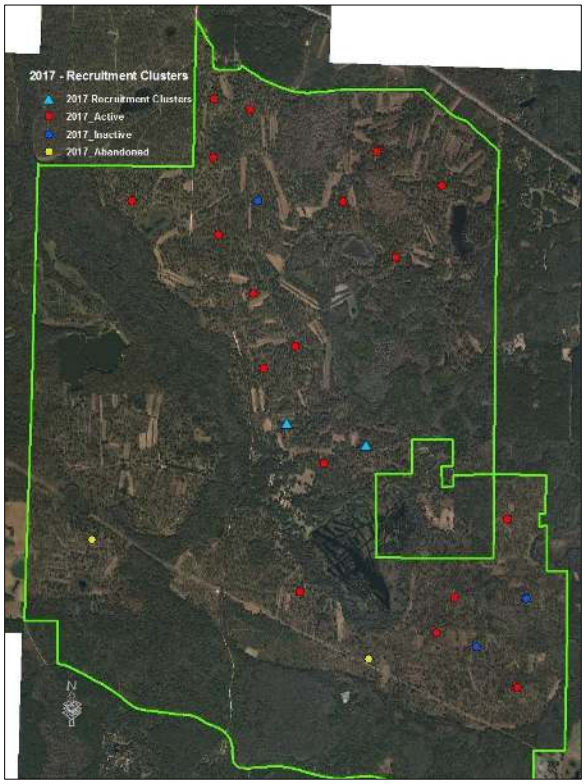
Each cluster was monitored throughout the year, usually in March, June, October, and December. Monitoring checks are used to ensure each cluster has minimum of 4 suitable cavities and for activity status (active or inactive).

Prescribed Fire

Approximately 60 - 65% of the entire property was burned during March and early April 2017.

Comprehensive Cluster Surveys

We implemented comprehensive cluster surveys in October and December 2017. A total of 25 RCW clusters were located on the property (Figs 9.1 and 9.2): 19 active, 1 newly-created recruitment group, 3 inactive, and 2 abandoned. This represents the highest active group total recorded on the property. Moreover, numerous new natural cavity trees (active and inactive) were discovered throughout the clusters. This is a positive sign and demonstrates that Avalon's pine overstory is suitable for the species. As special note, 3 inactive cavity trees, in 2 separate clusters, were blown down as a result of Hurricane Irma in early September.



Cavity and Habitat Management

Cavity tree management focuses on identifying and protecting all cavity trees (artificial and natural) from prescribed fire and minimizes potential threats from other land management activities. Moreover, prior to any activity within or near cluster sites, operators are typically reminded of the location of cavity trees. Typically, cavity trees (active, inactive and abandoned) are marked and mowed in advance of burning. Unfortunately, the needed equipment was under repair in early 2017, and clusters were not mowed in advance of the burning season. This led to a single active tree being scorched during a prescribed burn, causing the tree to become inactive. However, the same tree was found to be reactivated during October cluster checks.

10. CUTTHROAT TROUT

Westslope cutthroat (*Oncorhynchus clarkii lewisi*)
Rio Grande cutthroat (*O. c. virginalis*)

ESA listing (both species): NOT LISTED

PROJECT STATUS
Ongoing
Principal biologists
Carter Kruse
Eric Leinonen

Conservation Problem – Range-wide declines due to competition and introgression with introduced salmonids, but also from habitat degradation and exploitation. Westslope cutthroat trout (WCT) were historically the most widespread cutthroat subspecies, occupying around 90,800 km of streams and rivers of the upper Columbia and Missouri basins of Montana, Wyoming and Idaho. The historical range of genetically pure populations has been reduced by 76%. On the east side of the Continental Divide range reduction has been most dramatic, exceeding 95%. Rio Grande cutthroat trout (RGCT) were historically found in about 10,700 km of habitat in the upper Rio Grande basin of Colorado and New Mexico. The distribution of genetically pure populations of this subspecies has been reduced by 92%.

Listing Status
- RGCT are a Species of Greatest Conservation Need by NMDGF and COPW.
- WCT are a Species of Greatest Conservation Need by MTFWP.
- Both subspecies petitioned for listing under ESA, but found not warranted for listing.

Project Locations (Table 10.1)
Costilla Creek, Vermejo Park Ranch – RGCT
Cherry Creek, Flying D Ranch – WCT
Las Animas Creek, Ladder Ranch – RGCT
Greenhorn Creek, Snowcrest Ranch – WCT
Vermejo River, Vermejo Park Ranch – RGCT
NF Spanish Creek, Flying D Ranch – WCT
Green Hollow Creek, Flying D Ranch – WCT

Project Partners (integral to success)
NMDGF, COPW, MTFWP, USFS, USFWS, BLM, TU.

Grant Funding
- 1999 Partners for Fish and Wildlife ($20k)
- 2003 TU Embrace-A-Stream ($5k)
- 2005 USFW Private Stewardship ($31.3k)
- 2006 NFWF ($100k)
- 2008 MT AFS Resource Action Fund ($2k)
- 2009 Partners for Fish and Wildlife ($35k)
- 2009 NM State Wildlife Grant ($100k)
- 2010 NM State Wildlife Grant ($100k)
- 2010 MT FWP ($5k)
- 2010 US Forest Service ($2.5k)
- 2011 USFS Res. Advisory Council ($20k)
- 2011 MT FWP Future Fisheries ($81,983)
- 2013 Partners for Fish and Wildlife ($24.9k)
- 2014 Partners for Fish and Wildlife ($50k)
- 2015 MT FWP Future Fisheries ($7,080)
- 2015 Partners for Fish and Wildlife ($66k)
- 2016 MT FWP Future Fisheries ($60k)
- 2016 National Fish and Wildlife Fund. ($90k)
- 2017 US Forest Service ($75k)
- 2017 Western Native Trout Initiative ($15k)
- 2017 Northwestern Energy ($75k)
- 2017 Trout Unlimited ($30k)
- 2018 MT Trout Foundation ($5k)

Project Recognition
- 2005 MT AFS – Collaborative Group Award
- 2010 USFS – Collaborative Aquatic Stewardship Award
- 2011 Western Division AFS – Conservation Achievement Award
- 2012 American Fisheries Society – President's Fishery Conservation Award
- 2015 Governor's (NM) Environmental Excellence Award for Wildlife Conservation
- 2016 Sustaining Forest and Grassland Award, US Forest Service Region 1

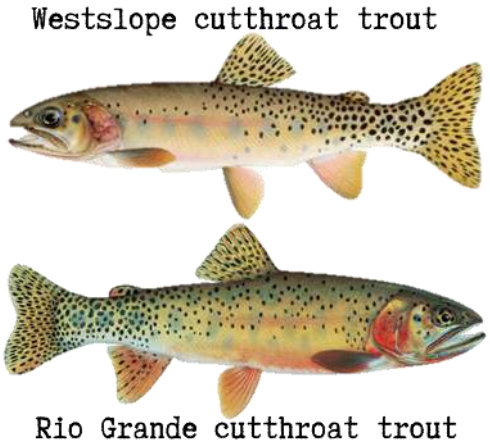


Table 10.1. 2017 Turner Native Cutthroat Trout Initiative						
Catalyze cutthroat trout restoration or conservation activities in 400 km of stream.						
Stream	Ranch	Species	Partners	Size (km)	Type	Status
Costilla	Vermejo	RGCT	NMDGF, CPW, TU, USFS, USFWS	175	Piscicide	Treatment complete (2016) Restocking ongoing Research/monitoring ongoing
Cherry	Flying D	WCT	MT FWP, USFS, WCS, USFWS, MSU, ISU	100	Piscicide	Treatment complete (2010) Restocking complete (2012) Research/monitoring ongoing
Las Animas	Ladder	RGCT, RGS, RGC	NMDGF, USFS	48	Piscicide	Silver Fire eradicated trout (2013) Monitoring habitat recovery Stocking initiated (2017)
Greenhorn	Snowcrest	WCT	MT FWP, USFS, BLM, MT FF	32	Piscicide	Treatment complete (2014) Restocking complete (2017)
Vermejo	Vermejo	RGCT	NMDGF, USFWS, NMSU	45	Electrofishing Piscicide Biological	4- yr removal complete (2014) Chronic removal ongoing Barrier/piscicide planning YY brook trout stocking (2018)
NF Spanish	Flying D	WCT	MT FWP, USFS, NFWF, WNTI, MT FF, TU, NWE	30	Piscicide	Planning and development Fund raising (2017) Barrier construction (2018) Initial treatment (2018)
Green Hollow	Flying D	WCT	MT FWP	4	Electrofishing	Removals ongoing Eradication (95%)

Goal – Restore or enhance self-sustaining populations of native cutthroat trout on Turner Ranches and surrounding landscapes to improve conservation status of subspecies. Contribute information on cutthroat trout to the scientific community to improve our understanding of these subspecies and their conservation status.

Objectives – Over a two-decade period, TBD will lead or catalyze restoration or improvement of native cutthroat trout stocks in 400 km of stream (Table 10.1) within the interior Rocky Mountain west to advance the conservation and recovery of the species, serve as a model for large scale conservation efforts on private landscapes, and contribute to conservation science through innovation, implementation and research in the field. Cutthroat trout restoration and conservation projects will include at least two subspecies of cutthroat trout, be implemented in at least 6 sites, and include at least one meta-population (multiple, connected streams) restoration effort per subspecies. Restored populations will be allopatric and exhibit minimum mean densities of 100 adult (i.e., $\geq$ 120 mm total length) fish per kilometer with successful recruitment (i.e., young-of-year fish or multiple age/size classes present) at least once every three years. TBD will work with state and federal partners to advance species conservation and recovery by implementing research and monitoring opportunities that result in publication of at least five peer reviewed scientific articles.

Project Background – The cutthroat trout is native to the Rocky Mountain and coastal areas of the western U.S. and is classified into as many as 14 subspecies. The seven major inland subspecies of cutthroat trout historically occupied most accessible cold-water environments from Canada to southern New Mexico. However, all subspecies have incurred significant range reductions primarily due to competition and introgression with introduced salmonids, but also from habitat degradation and exploitation. Lahontan (*O. c. henshawi*) and greenback (*O. c. stomias*) cutthroat trout are listed as threatened under the ESA and the other inland subspecies have either been petitioned for ESA listing or are considered species of concern by state and federal agencies. Recovery and conservation efforts are underway for all major subspecies, with many notable successes; however, such efforts are hindered by ongoing non-native invasions, limited opportunities for large-scale projects, social resistance, changing habitat conditions (e.g., climate change), and

past, widespread introductions of cutthroat trout subspecies outside their native ranges.

Range-wide conservation agreements among management agencies and NGOs are in place to guide conservation and restoration activities for WCT and RGCT across jurisdictional boundaries. Objectives outlined in these documents include: securing and monitoring known cutthroat trout populations; seeking opportunities to restore or found new populations, especially over large areas and including private lands; identifying or locating any additional wild populations; coordinating conservation activities among resource agencies and NGOs; and providing public outreach and technical assistance. These range-wide objectives for cutthroat trout conservation are consistent with the mission of Turner Enterprises and fit within the land management framework on the Turner Ranches. Most importantly, the Turner family has been supportive of cutthroat restoration, embracing the inherent risks of implementing large-scale native trout conservation. The TBD program developed a *Cutthroat Trout Initiative* to catalyze cutthroat restoration or conservation activities on 400 km of stream. This is by far the most comprehensive and ambitious private effort on behalf of native cutthroat trout. Efforts to restore or conserve cutthroat trout are underway in seven streams on four ranches. The overall goal is to improve the range-wide status of RGCT and WCT, and prevent listing under the ESA, using the following strategies:

- Using reintroduction sites that encompass large geographic areas and have high quality and diverse habitats capable of supporting robust cutthroat trout populations (with diverse life-history strategies that are able to resist threats such as climate change, catastrophic events, and invasive species).
- Elimination of non-native competitors in the reintroduction site through physical and/or chemical renovation and preventing recolonization.
- Establishment of a self-sustaining population of cutthroat trout large enough to withstand environmental and demographic stochasticity, and likely to persist over the long-term (>100 years) with little or no human intervention.
- Establishment of a monitoring strategy, including relevant research partnerships, that evaluates key project aspects and allows adaptive management of all strategies and methods as the project unfolds, and to improve and guide future efforts.

The Turner organization and ranches are ideally situated to play an important role in cutthroat trout conservation. The Flying D, Snowcrest, Vermejo, and Ladder ranches all contain large, connected sections of high quality cold water stream habitat within the historical range of WCT and RGCT. In conjunction with neighboring public lands these ranches encompass entire stream headwaters, an important consideration when prioritizing and securing restoration sites. Although small restoration projects (e.g., <15 km of stream) are important to preserve presence and genetic variability on the landscape, the cutthroat conservation projects most likely to succeed over the long-term are those encompassing large areas that connect multiple, local sub-populations and allow expression of multiple life histories; thus, inferring a better chance of withstanding localized extinctions and changing habitat conditions.

Through the *RGCT* and *WCT Range-Wide Conservation Working Groups*, TBD has partnered with public agencies and other private organizations to implement two of the largest cutthroat trout restoration projects ever undertaken in the U.S. All seven projects discussed here involve removal or management of non-native trout by physical (e.g., electrofishing) or chemical (e.g. piscicide – antimycin or rotenone) techniques.

Cherry Creek – Planning for the Cherry Creek Native WCT Project on the Flying D Ranch was initiated in 1997. Logistical and legal issues delayed field work (e.g., piscicide application) until 2003. Chemical application was completed in 2010 and restocking by 2014. The project encompasses approximately 100 km of stream habitat and 3 ha of lake suitable for cutthroat trout and is the largest piscicide renovation project ever completed for the purpose of cutthroat trout conservation to date.

Introductions of WCT into Cherry Creek were done primarily by stocking eyed eggs into

remote streamside incubators (RSIs). These eggs came from six sources – Muskrat, Ray, White, and Brays creeks, and the Sun Ranch and Washoe Park hatcheries. Approximately 37,000 eyed eggs were stocked into RSIs from 2006-2010 which resulted in 27,000 surviving fry. Another 8,850 hatchery-reared fry were stocked into the lower portions of the project area (e.g., the Butler Reach), along with about 6,500 age-1 triploid WCT. This was the first time triploid WCT had been successfully produced and stocked into Montana waters. Annual monitoring of the WCT population from 2012-17 showed that the number of fish increased rapidly post-treatment and has achieved a similar pre-treatment population abundance and average size (Fig. 10.1). The WCT population in Cherry Creek exceeds a conservative estimate of 50,000 individuals.

The Cherry Creek project is a significant conservation achievement for WCT east of the continental divide. This project increases the extent of stream occupied by WCT in the Madison River basin from 7 km to over 100 km or from 0.3% of historical occupancy to almost 5%. On an even larger scale, prior to the Cherry Creek project, WCT occupied an estimated 750 km (4.2%) of their historical range in the Missouri River Drainage; nearly all of these populations were in 1st or 2nd order streams, restricted to 8 km of habitat or less, and with flows of 0.08 m^3/s or less. The Cherry Creek project increased occupied habitat by 100 km and included a 4th order watershed with as much as 0.57 m^3/s stream flow. Perhaps more importantly the success of, and lessons learned from the Cherry Creek project has catalyzed several other cutthroat trout reintroduction projects in southwestern MT and across the region. For example, by 2015, WCT occupied an estimated 1,030 km (5.8%) of historical range in the Missouri River Drainage due to restoration activities.

A Candidate Conservation Agreement with Assurances (CCAA) regarding the Cherry Creek project was signed in 2009. This document established that if TBD allowed WCT to be introduced in the Cherry Creek project area, TEI would not be held to additional regulatory obligations if WCT were listed under ESA in the future. Further, the document preemptively permits any incidental take of WCT that might occur during regular ranching or recreational activities if the species were listed.

Five graduate students have worked on the Cherry Creek project and nine scientific articles have been published in the North American Journal of Fisheries Management, Transactions of the American Fisheries Society, and Restoration Ecology. Research and monitoring regarding genetic variability, growth, survival, and movement of the recovering WCT is ongoing.

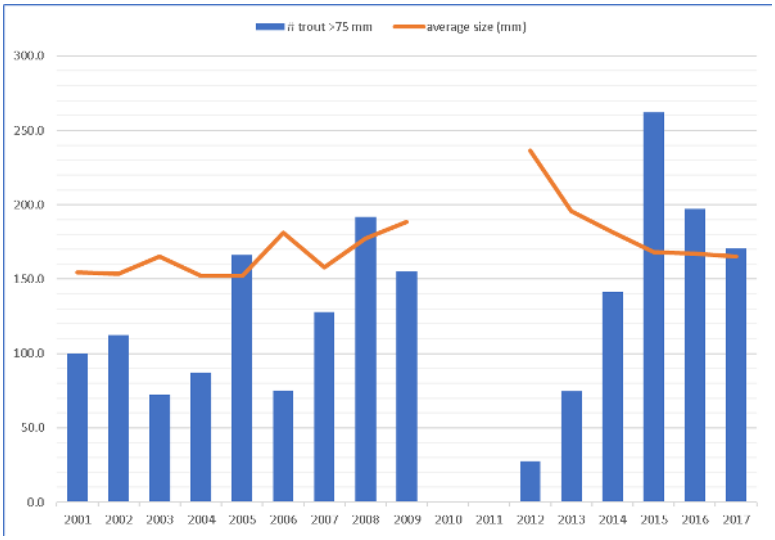


Fig. 10.1. Average number (blue) and size (mm, orange) of trout per 100 m reach of Cherry Creek before (2001-09) and after (2012-17) WCT restoration.

Costilla Creek – The Costilla Creek Native RGCT Project on Vermejo in New Mexico and Colorado is the most ambitious watershed renovation project ever initiated on behalf of cutthroat trout to-date; the project encompasses ~175 km of stream habitat (60% on Vermejo, remainder on Carson National Forest) and 18 lakes (all on Vermejo). Fieldwork on the Vermejo portion of the project was initiated in 2002 and completed in 2016 with the second chemical treatment of Costilla Reservoir. Restocking of RGCT is ongoing. When fully implemented by 2020, the project will represent a 20% increase in the amount of stream occupied by genetically pure RGCT.

This project would not have been initiated without Turner support and is the flagship

restoration effort on behalf of RGCT for the NMDGF. Planning and implementation of the Costilla Project is largely responsible for the development of consistent NM state guidelines regarding the use of piscicides, and for re-development of NMDGF native cutthroat trout hatchery brood stock; both important steps for range-wide conservation of the species.

Population monitoring is conducted on an annual basis and suggests that RGCT populations in the upper portions of the project area are similar in size and abundance to pre-project levels (e.g., upper Costilla and Casias creeks), and are recovering in more recently treated areas (e.g. lower Costilla and Casias creeks, and Costilla Reservoir).

A CCAA regarding the Costilla Creek project was signed in 2013. Similar to the Cherry Creek project, this CCAA document recognizes the conservation actions implemented by TBD on behalf of RGCT and provides operational assurances to Vermejo Park Ranch should the species become listed under the ESA.

Vermejo River – This is the only project in the *Cutthroat Trout Initiative* where indigenous cutthroat trout are known to remain on Turner Ranches. This conservation population of RGCT is threatened by competition with nonnative brook trout (*Salvelinus fontinalis*), hybridization with rainbow trout (*O. mykiss*), and declining habitat quality (e.g., increased stream temperatures and turbidity). In an effort to maintain the population, TBD removed approximately 29,000 brook trout from the upper 36 km of the Vermejo River from 2010-16. More importantly, 20 confirmed rainbow *x* cutthroat trout hybrids and one rainbow trout (from Leandro Creek) were removed from 2010-15. The source of this low-level rainbow trout invasion was unknown, but unscreened fishing ponds on upstream neighbors were initially suspected. Unfortunately, in 2016 an additional five rainbow trout and 15 hybrids were found in Leandro Creek. These fish were almost certainly the result of rainbow trout escaping from Vermejo's guest fishing lakes via overflow. Vermejo Park Ranch has been encouraged to monitor lake water levels more closely and screen lake outlets to prevent escape. TBD is working with Vermejo Park Ranch on a more permanent solution for conservation of cutthroat trout in the Vermejo River, which might include future piscicide renovation. So far, physical removal of non-native trout has helped keep the genetic status of Vermejo River RGCT at least 99% pure, but it is an unsustainable activity over the long-term and a more permanent resolution to the hybridization issue is needed.

Drought cycles and chronic over browsing by wildlife and livestock have negatively impacted the riparian habitat along the upper Vermejo River. Reduced riparian vegetation and limited woody plant recruitment have destabilized banks and impacted water quality to the detriment of native fishes and riparian obligate species. In 2014 and 2015 TBD received $141,000 in grants (50% cost share) from USFWS's New Mexico Partners for Fish and Wildlife to construct ten ½ mile long *x* 8 ft high exclosure fences along sections of the upper Vermejo River. The fences exclude large ungulate grazing. Two exclosures were completed in 2014, four more in 2015, and two additional in 2016. Construction of the final two fences occurred in 2017. Ultimately, the goal is to enhance riparian conditions over the next decade and restore beaver (*Castor canadensis*) to promote long-term riparian health, RGCT persistence, and natural water storage in the upper Vermejo system. Monitoring inside the exclosures is underway, and includes vegetative photo points, water temperature measurements, fisheries surveys, and macroinvertebrate collections.

Las Animas Creek – This project aims to restore the native fish community (i.e. RGCT, Rio Grande sucker, and Rio Grande chub; see Section 12) to the upper 48 km of Las Animas Creek. Around half of the project area is on the Ladder Ranch, with the remainder on the Gila National Forest. This project has experienced administrative and political delays since its conception in 1998, although recent momentum led to a draft environmental assessment (DEA) by the USFS for the project in early 2014. The DEA concluded a rotenone treatment to remove non-native longfin dace (*Agosia chrysogaster*) and hybridized rainbow *x* Yellowstone cutthroat trout from the project area was the best option to restore the native fish community. However, while the DEA was under development, the

138,000-acre Silver Fire burned the entire Gila National Forest portion of the watershed in summer 2013. Subsequent monsoon rains resulted in significant debris, sediment and ash flows, drastically changing the instream habitat. Population surveys in 2014, 2015, and 2016 indicate that the fire and its aftermath killed or displaced most of the fish in the project area. Non-native longfin dace survived in off-channel refugia not impacted by debris flows and are repopulating the project area. Some Rio Grande chub were also observed for the first time, post-fire, in 2016. Hybrid trout and Rio Grande sucker were extirpated by the effects of the fire. Subsequently, NMDGF and TBD decided not to conduct a rotenone treatment to remove the longfin dace. A 2016 watershed assessment indicated that habitat has recovered sufficiently to support a small population of RGCT.

NF Spanish Creek – WCT are nearly extinct in the Gallatin River watershed. Restoring WCT to approximately 30 stream km in upper NF Spanish Creek would be a significant conservation gain and establish an important beachhead for additional WCT restoration in the Gallatin watershed. Currently only 0.5% of the historically occupied stream habitat (1,690 km) in the Gallatin watershed contains genetically pure WCT. The majority of this project is on public land, thus MTFWP and the USFS administered the public scoping and Environmental Assessment (EA) process. A public scoping letter for the project was published in early 2016 and an EA was drafted. Design of the fish barrier necessary to protect the restored WCT population was completed in 2016, and the bid for construction of the fish barrier was $430,000. Fundraising for the fish barrier construction has raised $400,000 to date from nine funding partners: National Fish and Wildlife Foundation, MT Future Fisheries, Western Native Trout Initiative, USFS, TBD, Trout Unlimited, Northwestern Energy, Arctic Grayling Steering Committee, and the MT Trout Foundation. Pre-project planning and data collection continues. Fish barrier construction and piscicide application in headwater lakes will likely occur in 2018.

Greenhorn Creek – This 32-km project area, including the NF and SF of Greenhorn Creek, was successfully treated with rotenone for two consecutive years in 2013 and 2014. The project partners conducted extensive electrofishing and eDNA surveys in 2015 to determine if non-native trout persisted. The detection and removal of a single brook trout delayed introduction of WCT until 2016. In August of 2016 Greenhorn Creek was stocked via a wild transfer of 315 adult fish from six remnant populations of WCT in the upper Missouri River Basin. 318 additional WCT from the same six sources were stocked in 2017. Monitoring of WCT recovery in Greenhorn Creek is ongoing.

Green Hollow Creek – In an effort to reduce disease and competitive pressures on the Green Hollow II Arctic grayling conservation brood stock (see Section 11), TBD has mechanically (i.e., electrofishing) removed brook and rainbow trout from upper Green Hollow Creek since 2003. Since 2006, only brook trout have been captured. In 2010, the focus of the removal program shifted from reduction to elimination in anticipation of reintroducing WCT to upper Green Hollow Creek (above Green Hollow Reservoir II). Removal activities are conducted opportunistically as scheduling allows. The total number of fish removed to date is 14,829 and annual catch has been less than 100 individuals the last two years; down from a high of over 3,500 fish in 2012 (Fig. 10.2). Continued, focused effort will be needed over the next 3-5 years to remove all brook trout from upper Green Hollow Creek. MTFWP is exploring upper Green Hollow as a potential refugia site for Gallatin Drainage WCT stocks.

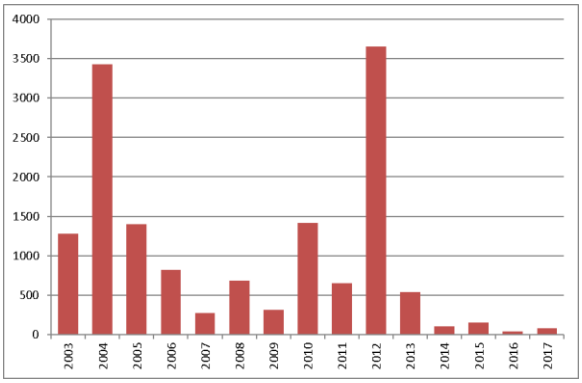


Fig. 10.2. Trout removed using electrofishing from Green Hollow Creek, Flying D Ranch since 2003.

Project Activities in 2017

Cherry Creek **–** After reaching an all-time high abundance in 2015, electrofishing monitoring in 2017 indicated that WCT numbers and average size are moderating and are now approaching levels similar to the pretreatment nonnative trout population (Fig. 10.1). Conservative estimates suggest the population numbers at least 50,000 fish. No non-native trout have been captured in the project area since piscicide treatments were completed in 2010. Monitoring and recapture of tagged fish continues to provide data on survival, movement, growth, and genetic fitness of the population. Several scientific manuscripts are under preparation, including a capstone book chapter, tentatively entitled *Collaborative Eradication of Non-native Trout and Introduction of Native Westslope Cutthroat Trout into 100 km of Cherry Creek, a Madison River, Montana, Tributary* that is scheduled for publication in 2018. TBD maintained a partnership with University of Idaho to assist with genetic analyses. Turner family, friends, and guests report that their angling experience on Cherry Creek was excellent in 2017. MTFWP has conducted annual mark-recapture electrofishing population estimates in a 6.4 km section of the Madison River immediately adjacent to the Cherry Creek confluence since 1967 to monitor naturalized populations of rainbow trout and brown trout (*Salmo trutta*) in the river. Few, if any, cutthroat trout were historically captured in this section. MTFWP began capturing WCT in 2012, and in March 2016, captured 130 WCT that ranged in size from 180-360 mm. Anglers are now pursuing WCT in the river and reporting their catches to MTFWP. In 2016, anglers reported catching WCT in the river as far as 37 km downstream of Cherry Creek.

Costilla Creek **–** 2017 efforts focused on RGCT population recovery in the reservoir and lower portions of streams treated for the last time in 2016. Over 350,000 RGCT were stocked in the project area in 2017. Most of these were age-0 fish put into Costilla Reservoir (~300,000), but an additional 56,000 age 0-2 fish were stocked into lower Costilla and Casias creeks (Fig. 10.3). Guides and guests reported that angling in restored creeks was good in 2017, even though population recovery is ongoing. Population monitoring continued in the upper portions of the watershed where RGCT have already been restocked and the data suggest that fish abundance and size have recovered to pre-project levels. Planning and permitting for removal of the temporary fish barriers installed to facilitate treatment was initiated.

Fig. 10.3. Stocking catchable Rio Grande cutthroat trout into Casias Creek, Vermejo Park Ranch, 2017.

Vermejo River **–** A focused effort was made in 2017 to detect and remove rainbow and hybrid rainbow *x* cutthroat trout from Leandro Creek. This invasion of rainbow trout via overflow from Vermejo fishing lakes (primarily Munn Lake) was first detected with the capture of a single rainbow trout in 2015. An additional five rainbow and 15 hybrids were captured in 2016. In 2017, a 15 km section of Leandro Creek was intensively shocked to remove all brook trout, as well as any other fish, aged two years old or younger (e.g. potential hybrids). With this effort 1,548 brook trout were removed, 560 adult RGCT were captured and released, and 630 young rainbow, cutthroat, and/or hybrid trout were removed. A subsample of 63 young fish (10%) was genetically tested, and 23 were confirmed hybrids. Thus, we estimate that up to 230 cutthroat *x* rainbow hybrids were removed from Leandro Creek. Standard population monitoring was also conducted throughout the Vermejo River drainage in 2017. The final two grazing exclosures were constructed along the river and monitoring inside the other eight exclosures included vegetative photo points, water temperature measurements, fisheries surveys, and macroinvertebrate collections. TBD and Vermejo Park Ranch agreed to a proposal from NMDGF to stock YY brook trout males

into two small creeks (Bernal and Leandro) as part of an experiment to determine if a high proportion of artificially derived YY males stocked into a population can drive it to extinction by producing only XY male offspring. A successful outcome could provide an alternative to chemical removal of brook trout. TBD provided Vermejo with designs for fish screens which were fabricated and installed at Munn and Bernal lake overflows in early 2018.

Las Animas Creek – Electrofishing surveys in 2017 continued to confirm the extirpation of non-native hybrid trout and native Rio Grande sucker. These surveys also continued to show the robust recovery of non-native long fin dace and slower recovery of native Rio Grande chub in Las Animas Creek. Post-fire habitat condition improved sufficiently for NMDGF to stock approximately 48 RGCT from Canones Creek into upper Las Animas Creek on the Gila National Forest in May 2017. This will provide an important replicate and genetic reservoir for that population. Additional stocking of RGCT, as well as repatriation of Rio Grande sucker to Las Animas Creek may occur in 2018.

NF Spanish Creek – TBD continued collecting pre-treatment baseline information in 2017 by electrofishing surveys at standard sampling sites and mapping fish distributions throughout the watershed. The EA for the project was approved by MTFWP in July 2017 and USFS in February of 2018. A bid of $430,000 for barrier construction was received from Bairco Construction of Lovell, WY. Over the past two years, TBD has raised $400,000 from nine different partners to fund barrier construction. TBD's contribution will be $40,000 or 10% of the cost. Barrier construction and initial piscicide treatments will start in August 2018.

Greenhorn Creek – An annual inspection was conducted on the Greenhorn fish migration barrier. In August 2017, Greenhorn Creek was stocked via a wild transfer of 318 adult fish from six remnant populations of WCT in the upper Missouri River Basin (Figs. 10.4 and 10.5). No additional introductions are planned unless future monitoring indicates an additional need.

Green Hollow Creek – Limited effort was spent capturing brook trout in upper Green Hollow Creek in 2017. Disappointingly, 80 fish were captured; twice as many as 2016 (Fig. 10.2).

Proposed Future Activities & Considerations

TBD has developed partnerships and field expertise that should drive the *Cutthroat Trout Initiative* to a successful conclusion. All the cutthroat trout restoration and conservation projects described herein have substantial momentum, and with the exception of work in the Vermejo River, should be completed by 2020. No additional cutthroat trout restoration projects are planned for Turner properties. With the exception of the Bear Trap Creek project, which was removed from consideration for native trout restoration in 2015, TBD has remained committed to the vision established by the *Cutthroat Trout Initiative* over 17 years ago. Our partners appreciate the resources, commitment, experience, and steady hand the Turner organization brings to a project. Successful conclusion of the *Cutthroat Trout Initiative* establishes a legacy that the Turner organization can be proud of.

Fig. 10.4. Restored WCT in Greenhorn Creek.

Fig. 10.5. Restocking locations of WCT in Greenhorn Creek drainage.

11. ARCTIC GRAYLING

Thymallus arcticus

ESA listing: NOT LISTED

PROJECT STATUS
Ongoing

Principal biologists
Carter Kruse
Eric Leinonen

Conservation Problem – Arctic grayling are widespread throughout drainages of the Arctic and northern Pacific oceans; however distinct populations in Michigan (now extinct) and southwestern Montana have experienced significant declines due to competition from non-native trout and habitat alterations. Fluvial arctic grayling in Montana were once widespread in the Missouri River basin above Great Falls. Over the past 100 years, populations have declined in range and abundance and now occupy about 4% of historical range in Montana. Prior to restoration efforts, fluvial arctic grayling in Montana could only be found at low densities in an 80 km reach of the Big Hole River.

Listing Status –Arctic Grayling are considered a Species of Greatest Conservation Need by Montana Fish Wildlife and Parks.

In 2010 the USFWS ruled that the Upper Missouri River Distinct Population Segment (DPS) of Arctic grayling was warranted for listing under the Endangered Species Act but precluded by higher priorities. By August of 2014 the USFWS determined that conservation efforts by federal, state, and private organizations had improved the species status to a point where listing was no longer warranted.

Project Locations
Green Hollow Reservoir II, Flying D Ranch
Willow Creek, Snowcrest Ranch
Cherry Creek, Flying D Ranch
Spanish Creek, Flying D Ranch

Project Partners – MTFWP, USFWS

Project Recognition
- 2014 MTFWP and USFWS – Arctic Grayling Conservation Award

Goals
- Maintain a conservation brood stock of Big Hole fluvial Arctic grayling in Green Hollow Reservoir II to support range-wide restoration.
- Restore self-sustaining populations of arctic grayling on Turner Ranches and surrounding landscapes to improve their conservation status.

Objectives – To manage fluvial Arctic grayling in Green Hollow II in a manner that promotes a healthy grayling brood stock supporting restoration efforts in southwestern Montana. The brood fish will be disease free, average 10 inches in length, and provide at least 250 adult females for spawining and 300,000 eggs for restoration each year. Arctic grayling restoration on Turner Ranches will be implemented in at least two sites, exhibit densities of 20 adult fish (i.e., $\geq$100 mm total length) per km, with successful recruitment (i.e., young of year or multiple age/size classes present) at least once every three years.

Project Background

TEI has been a partner in grayling conservation in Montana since 1998 when Big Hole fluvial arctic grayling were stocked into Green Hollow Reservoir II to establish a brood stock. The brood stock was intended to serve as a genetic reservoir for Big Hole grayling and a source of grayling eggs for restoration projects across southwestern Montana. Over the past 20 years, TBD has provided invaluable assistance towards grayling restoration by managing the reservoir and brood stock population for these purposes. In 2002 a fish barrier was constructed on Green Hollow Creek to prevent grayling from moving into and spawning in the creek channel (Fig. 11.1). Since 2003, TBD has worked to remove non-native trout from the reservoir and inflowing creek (see Section 10 for summary of non-native trout removal in Green Hollow Creek). Each spring TBD staff assist MTFWP with disease sampling and spawning of grayling. Over the past three years (2015-2017), Green Hollow II grayling have provided approximately 750,000 viable eggs for research on reintroduction of grayling in Michigan, restoration projects throughout southwest Montana, and large-scale restoration in Yellowstone National Park.

Fig. 11.1. Newly constructed fish movement barrier on Green Hollow Creek in fall 2002.

Unusually high spring runoff in 2011 deposited large amounts of gravel in the Green Hollow Reservoir II inlet and, despite efforts to disrupt spawning, grayling naturally reproduced below the fish barrier in 2012-15. Beginning in 2016 a bypass system (Fig. 11.2) has been installed annually for about 4 weeks in the spring to prevent spawning in the creek inlet. The wild born progeny from 2012-15 overpopulated the brood pond and resulted in smaller average adult sizes. In 2015 a decision was made to transfer more than 500 of the wild born grayling to lower Green Hollow Creek (below Green Hollow Reservoir I). An additional 536 juvenile grayling were captured and moved during spring trapping activity in 2016. These fish have unrestricted movement into the NF Spanish Creek and, ultimately the Gallatin River, thus represent the first stocking of fluvial Arctic grayling into the Gallatin River system since their local extinction. Additionally, grayling have escaped from Green Hollow II and established a self-sustaining population in Green Hollow Reservoir I. Fish from this population likely have and will continue to escape into NF Spanish Creek, providing a chronic, soft introduction of grayling to the Spanish Creek watershed. MTFWP has confirmed angler reports of grayling caught in the Gallatin River (Fig. 11.3) and Flying D fishing guides also report numerous grayling caught in Spanish Creek. Annual electrofishing surveys have yet to capture a grayling in Spanish Creek and there is no evidence that the fish are naturally reproducing in either location.

Fig.11.2. Bypass pipes installed at Green Hollow Creek inlet to prevent grayling from spawning in 2016. Note barrier (Fig. 11.1) in background.

Fig. 11.3. Grayling caught by an angler on the Gallatin River approximately 4 miles downstream of Spanish Creek.

TBD staff introduced grayling into lower Cherry Creek (below Cherry Falls and outside of the WCT restoration project area) for the first time in 2016. A total of 10,000 fertilized eggs were stocked into lower Cherry Creek using remote streamside incubation (RSI) devices. RSI's improve hatching success and allow larval grayling to volitionally leave the incubator and enter the stream habitat.

Project Activities in 2017

TBD prepared for the annual spring grayling spawn at Green Hollow II by netting and holding several hundred grayling. A record 301 females were spawned on May 7th and produced an estimated 345,730 eggs (Fig. 11.4) for grayling restoration in southwest Montana and Yellowstone National Park.

Fig. 11.4. Grayling egg take at Green Hollow II.

For the second year in a row, TBD staff introduced grayling into lower Cherry Creek (below Cherry Falls and outside of WCT restoration project area) (Figs. 11.5 and 11.6). A total of 15,000 fertilized eggs were hatched in remote streamside incubation (RSI) devices.

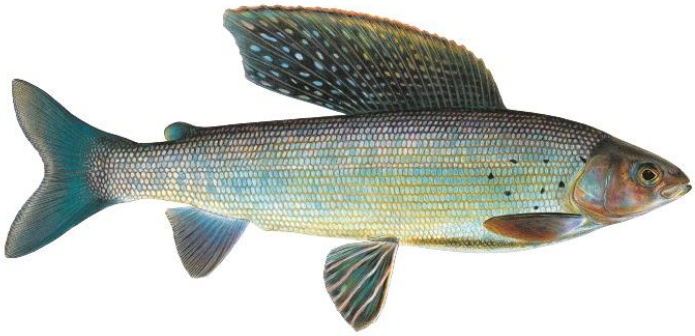
Modest electrofishing monitoring efforts in the spring and fall of 2017 failed to capture grayling in lower Green Hollow, NF Spanish, or lower Cherry creeks. Nevertheless, Flying D fishing guides and MTFWP continue to confirm angler catch of grayling in Spanish Creek and the Gallatin River.

Fig. 11.5. Approximately 1,500 fertilized grayling eggs ready for placement into an RSI.

Fig. 11.6. TBD staff placing fertilized grayling eggs into an RSI battery along lower Cherry Creek.

Proposed Future Activities & Considerations

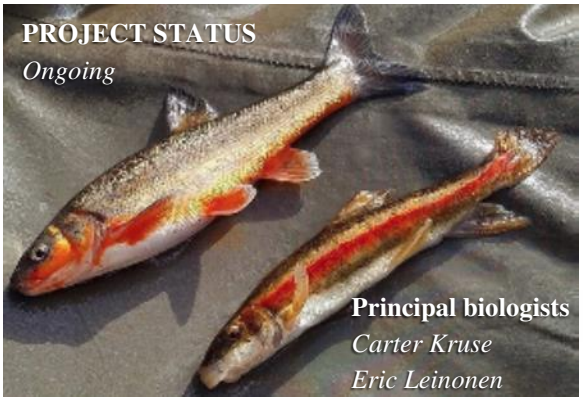
TBD will continue to maintain the Green Hollow II grayling brood stock and assist MTFWP with egg takes each spring. RSI stocking of grayling will continue in lower Cherry Creek until a population is successfully established or such outcome is considered unfeasible. Grayling introductions will be considered in upper Cherry Creek once the recently introduced native westslope cutthroat trout population stabilizes. Annual monitoring will occur in waters where grayling have been introduced.



12. RIO GRANDE SUCKER and CHUB

Rio Grande sucker (*Catostomus plebeius*)
Rio Grande chub (*Gila pandora*)

ESA listing (both species): PETITIONED, MAY BE WARRANTED



Conservation Problem – Range-wide declines of both Rio Grande sucker (RGS) and Rio Grande chub (RGC) have occurred due to habitat and stream flow alterations, predation and competition from non-native fishes, loss of genetic variability, and vulnerability to stochastic events. Once common and widespread throughout the mainstem Rio Grande River and its tributaries, RGS and RGC have become isolated in a few small, headwater streams, primarily due to mainstem impoundments, diversions and water withdrawals on tributaries, and introduced fishes. Consequently, they are at risk of local extirpations from stochastic events such as wildfire, drought, or destructive high flow events. Historical range for both species is poorly defined, so extent of decline is difficult to enumerate. Recent information suggests that RGS occur at only two sites in CO, and < 25 populations in NM. In their 2013 petition to list RGC under the ESA, WildEarth Guardians suggested this species remained in only 25% of its historically occupied habitat in the Rio Grande basin.

Listing Status – Both RGS and RGC were petitioned for listing under the ESA in 2014. The USFWS determined that both may be warranted for listing and is conducting status reviews. RGS are listed as an endangered species in Colorado. Both species are considered Species of Greatest Conservation Need by the NMDGF and COPW.

Project Locations
- Las Animas Creek, Ladder Ranch
- Seco Creek, Ladder Ranch
- Palomas Creek, Ladder Ranch
- Costilla Creek, Vermejo Park Ranch

Project Partners
- NMDGF
- COPW
- USFS
- UNM
- USFS Rocky Mountain Research Station

Grant Funding
2003 NMDGF State Wildlife Grant ($18,000)
2016 NMDGF State Wildlife Grant ($40,000)

Goals

Conserve and restore self-sustaining populations of RGS and RGC on Turner Ranches and surrounding landscapes to enhance the conservation status of both species. Contribute information on RGS and RGC to the scientific community to improve our understanding of these species and their conservation status.

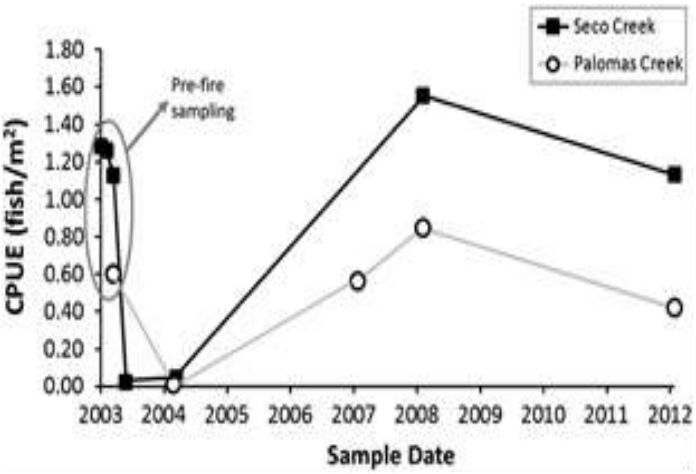
Objectives – TBD will maintain populations of RGC and RGS in at least three streams on the Ladder Ranch. These populations will include at least 500 adults of each species with successful recruitment (i.e., young of year fish or multiple age/size classes present) at least once every three years. Restoration will be attempted at one site at Vermejo Park Ranch (Costilla Creek), include at least 500 adults of each species, and show evidence of recruitment at least once every three years. TBD will work with State and Federal partners to advance the overall species conservation and recovery by implementing research and monitoring opportunities that result in publication of at least three peer reviewed scientific articles.

Project Background – RGS and RGC co-evolved along with Rio Grande cutthroat trout (see Section 10) in the Rio Grande River basin. On Turner properties management and conservation of these two species will be considered and occur simultaneously.

Historically RGS occurred in the Rio Grande (primarily), Mimbres, and Gila drainages. RGC occurred in the Rio Grande, Pecos, and Canadian drainages and an isolated population in the Davis Mountains in Texas. The Ladder and Vermejo ranches contain large, high quality stream habitat within the historical range of RGC and RGS. When purchased by the Turner organization in 1992, three streams on the Ladder Ranch – Palomas, Seco, and Las Animas creeks – contained both RGS and RGC (as reported in early biodiversity reports). These populations were confirmed by TBD during electrofishing surveys in summer 2003. Although all three streams are tributaries to the Rio Grande River and were historically connected, water diversion, mainstem dams, and non-native fish populations have now isolated these populations from each other. RGS or RGC have never been found in Costilla Creek (tributary to Rio Grande) on Vermejo Park Ranch. We are unsure if this is because the elevation is too high or due to extirpation from predation by non-native trout (Costilla Creek now restored to Rio Grande cutthroat trout; see Section 10).

In summer of 2003, two separate fires burned approximately 2,266 and 1,817 hectares of the Gila National Forest in the headwaters of North Seco and Palomas creeks, respectively. Although these fires occurred outside of the boundaries of the Ladder Ranch, summer monsoons resulted in a series of ash and sediment flow events that dramatically affected RGS and RGC in both drainages. In Seco Creek RGS and RGC declined 98% and 80%, respectively. Effects in Palomas Creek were similar. The populations recovered relatively quickly and by 2007-08 densities were similar to 2003 (Fig. 12.1). This severe population bottleneck event led TBD to partner with the University of New Mexico to investigate genetic diversity of these isolated RGS populations. The results of that work were published in the journal Conservation Genetics in 2015.

In summer 2013, the Silver Fire burned 138,698 acres of the Gila National Forest, including large portions of the Las Animas and Seco creek headwaters. Subsequent monsoon rains led to several significant ash and debris flows in these two creeks (Fig. 12.2). Palomas Creek was less affected. Fisheries surveys by TBD from 2014-16 confirmed the extirpation of RGS and RGC from Seco Creek, and the loss of RGS and near extirpation (99% decline) of RGC in Las Animas Creek (Non-native trout were



also extirpated from Las Animas Creek as result of fire associated flow events – see Section 10).

Fig. 12.1. RGS and RGC density estimates before and after fires that burned in the drainages of Seco and Palomas creeks in 2003.

In 2016 TBD received a State Wildlife Grant from NMDGF to develop eDNA markers for detecting RGS and RGC in the environment with a water sample. TBD collected genetic samples from 30 RGC and 17 RGS populations in New Mexico and Colorado, and worked with the National Genomic Center for Fish and Wildlife Conservation at the University of Montana, to develop and test the eDNA markers.

Fig. 12.2. Ash and debris flow in Las Animas Creek in August, 2013 after the Silver Fire.

Project Activities in 2017

Development of the eDNA markers for RGS and RGC was completed and the results of that work were summarized in a Project Completion Report, as well as a draft scientific publication. The field sensitivity trials showed that DNA from a single large chub was detectable in a water sample up to 500 m downstream of the fish location (Fig. 12.3). These results will assist resource managers in efficiently detecting species presence and identifying the current range of RGS and RGC.

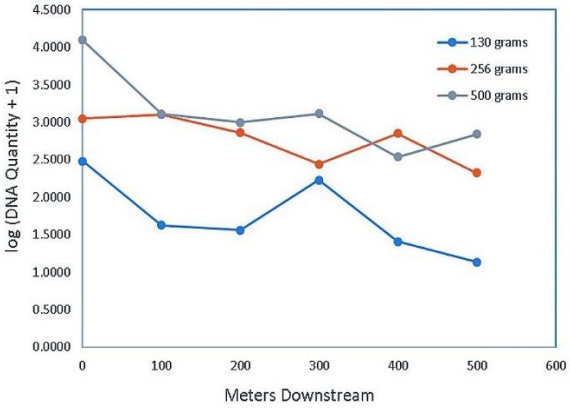


Fig. 12.3. Sensitivity of the RGC eDNA marker to three amounts of RGC.

Annual monitoring in Las Animas, Seco, and Palomas creeks continued to show no RGS or RGC in Seco Creek; no RGS and a very low but recovering RGC population in Las Animas Creek; and good numbers of both species in Palomas Creek.

Proposed Future Activities & Considerations

TBD will continue to monitor RGC and RGS populations on the Ladder Ranch and translocate fish as needed to maintain at least three populations on the Ranch. Wild RGS and RGC will be collected and transferred from Palomas Creek (Fig. 12.4) and steel storage tanks into Seco and Las Animas creeks in 2018.

Costilla Creek on Vermejo Park Ranch was recently chemically renovated and stocked with Rio Grande cutthroat trout (see Section 10). Although within the historic range of RGS and RGC, it is not known if Costilla Creek is too high in elevation to support either species. However, due to limited opportunities for large scale restoration of these species, NMDGF and TBD have proposed to introduce both RGS and RGC to Costilla Creek by 2020. We expect that the warmer habitats in Costilla Reservoir, Costilla Creek above the reservoir, and the lower extent of eastside tributaries will be the most likely to support RGS and RGC if the introductions are successful.

Fig. 12.4. RGS and RGC habitat in Palomas Creek.

13. WOLVES

13(a) Mexican gray wolf *(Canis lupus baileyi)*

ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologists
Chris Wiese
Mike Phillips

Conservation problem – Once common throughout portions of Arizona, New Mexico, Texas, and Mexico, human persecution resulted in the extirpation of the Mexican wolf in the wild. Current challenges include political pressures against wolf releases, illegal shootings, and lack of space for population expansion. Additionally, due to the small founder population, diminished genetic diversity appears to be affecting the fecundity and survival of wolves in the wild. Limited pen space in the captive breeding program restricts the size and reproductive output of the captive population.

Listing Status

- ***Endangered:*** portions of AZ, NM where this wolf subspecies is known to occur: AZ, NM *except –*
  - ***Experimental Population, Nonessential:*** portion of AZ north of I-10 and south of I-40; portion of NM north of I-10 (in west), north of the NM-TX border (in east), and south of I-40 (see Fig. 13c.1)

Project Location – Ladder Ranch, NM

Project Partners

- USFWS
- Mexican Gray Wolf Species Survival Plan

Project Funding

- TESF
- USFWS Cooperative Agreement ($29,000)

Goal – Participate in Mexican gray wolf recovery in southern New Mexico and Arizona.

Objective – Over the next ten years, we will support Mexican gray wolf recovery by maintaining a captive facility on the Ladder Ranch that houses up to 25 wolves, including breeding pairs, family packs, and wolves transitioning between the wild population and captivity. We will respond to the needs and overall project goals set by the USFWS and the Species Survival Plan on an annual basis.

Project Background – Mexican gray wolves (MGW) are a subspecies of gray wolves that roamed most of the southwestern US and portions of Mexico until they were eradicated in the wild through government-sponsored predator control. By the time the MGW was listed under the ESA it was on the verge of extinction. Biologists captured the last five wolves remaining in the wild and began a captive breeding program.

Reintroductions of MGWs into the Blue Range Wolf Management Area (BRWMA) that spans portions of eastern Arizona and western New Mexico began in 1998. About 110 wolves were free-ranging in the BRWMA in 2017.

The Ladder Ranch became involved in MGW recovery in 1997 with construction of the Ladder Ranch Wolf Management Facility (LRWMF). As one of only three pre-release facilities nationwide, the LRWMF plays an important role in the USFWS's implementation of wolf reintroductions by providing care and acclimatization for animals eligible for release to the wild. The LRWMF also assists with specific needs associated with reintroductions to the BRWMA by serving as a "halfway house" between the wild and traditional holding facilities (i.e., zoos and wildlife sanctuaries) for wolves that are removed from the wild for medical reasons or for depredating livestock. The LRWMF is managed collaboratively by TESF and the USFWS. Since we began housing wolves in 1998, over 130 individual wolves have passed through the LRWMF facility.

As a member of the Mexican wolf Species Survival Plan (SSP), we adhere to the guidelines that standardize captive management in both the U.S. and Mexico. The mission of the SSP is to contribute to Mexican wolf recovery through captive breeding, public education, and research. The SSP uses several criteria to determine the eligibility of a wolf for release: genetic makeup in relation to both captive and wild populations (i.e., "surplus" to the captive community and underrepresented in the wild), reproductive performance, behavior, and physical suitability.

It is important that release candidates exhibit natural behaviors, especially fear and avoidance of humans. We therefore take steps to prevent socializing or habituating the wolves housed at the LRWMF to minimize conflict with humans once released into the wild. In accordance with SSP recommendations, we reinforce the wolves' natural avoidance behavior to humans by providing as much privacy and as little disturbance as possible. This includes minimizing the length of time an animal is held in captivity and minimizing contact with humans during husbandry and maintenance events.

Project Activities in 2017

Wolves held at LRWMF in 2017

A total of 11 wolves were housed at the LRWMF in 2017, with a maximum of 8 wolves at the facility at any one time. No wolves were born at the facility in 2017, and there were no deaths at the facility in 2017.

The LRWMF held four wolves for most of 2017. Three of these (M1564, F1031, and F1034) were moved to other SSP facilities in mid-October 2017 to meet up with breeding partners (M1564), or to be better positioned for potential medical needs associated with advanced age (F1031 and F1034). M1384 remains at the Ladder Ranch while we are waiting for his paperwork to be sorted out so he can be transferred to a breeding facility in Mexico.

Table 13a.1. Wolves at the LRWMF in 2017.

Wolf ID (Studbook number)	Arrived at LRWFM from:	Left LRWMF to:
M1384	BRWMA, then SWMF	Still at LRWMF
F1031	WWNP	El Paso Zoo
F1034	WWNP	El Paso Zoo
M1564	BRWMA, then SWMF	NY Wolf Conservation Center
F1538	Sedgwick County Zoo	Still at LRWMF
M1400	Endangered Wolf Center	Still at LRWMF
F1431	Wolf Haven	Still at LRWMF
M1336	SWMF	Still at LRWMF
F1323	SWMF	Still at LRWMF
M1602	SWMF	Still at LRWMF
M1603	SWMF	Still at LRWMF

Food & feeding

Mexican gray wolves held at the LRWMF were fed a combination of foods recommended by the SSP. These are: Mazuri® Exotic Canine Diet (aka "kibble"), Central Nebraska classic canine diet (aka "carnivore logs"), and native prey species. Mazuri® Exotic Canine Diet is a meat-based kibble diet preferred by most zoos that meets the nutrient requirements of all wolf life stages. Carnivore logs are composed predominantly of horsemeat and fortified meat byproducts that are frozen into 5-pound logs (Fig. 13a.1). These are protein-rich and also suitable for all life stages. Native prey animals (mule deer, oryx, elk, and bison) are mainly provided as meat scraps and/or bones salvaged from hunts on the Armendaris and Ladder Ranches and are sporadically fed as supplemental food.

Fig. 13a.1. M1400 enjoys a meal of carnivore logs shortly after arriving at the LRWMF in December 2017.

Observations

We observed LRWMF animals on a regular basis to monitor their health and wellbeing. Informal observations took place during scheduled feedings, where we obtained a visual of animals in the facility and checked for signs of injury or illness. In addition, we made regular use of trail cameras to get close-up views of individual wolves (e.g. Fig. 13a.1).

Health assessments & medical care

All wolves received thorough health checks, vaccinations, and anti-parasite medication before arriving at the LRWMF (Fig. 13a.2). Similarly, all wolves removed from the LRWMF in 2017 received deworming and anti-parasite

medication (ivermectin, revolution, and/or praziquantel) before leaving the facility and received vaccinations as warranted. The goal is to perform health checks and update vaccinations for each wolf once a year (usually done during the cooler months). All wolves in the facility at the end of December 2017 are current on their vaccinations and treatments.

Fig. 13a.2: All wolves receive vaccinations and thorough health checks at least once a year.

Off-site Activities and Outreach

We participated in several off-site activities in 2017, including:

- Wolf captures, transfers, and health checks at the SWMF.
- We attended the annual SSP meeting in Cananea, Mexico.
- Presentations about the Mexican Gray wolf program to ranch guests.
- We assisted with development of the wolf recovery plan for New Mexico that was approved by federal officials in November 2017.
- Val Asher assisted biologists in Chihuahua, Mexico with wolf trapping and collaring fieldwork. A two-year-old male wolf was successfully collared and released (Fig. 13a.3).

Fig. 13a.3. Wild Mexican wolf captured in Mexico is sedated and ready for processing.

Proposed Future Activities & Considerations

In 2018, we anticipate that the LRWMF will hold two breeding pairs whose pups will be valuable to the captive population as well as being candidates for cross-fostering efforts.

In this way, we will continue our strong support of the USFWS-led efforts to recover the Mexican wolves in the Southwest. We plan to continue to serve as caretakers of important wolves, participate in hands-on activities (captures, health checks, transfers, surveys, etc.) and mandatory training sessions, and participate in SSP-related management activities.

13(b) Rocky Mountain gray wolf *(C. lupus)*

ESA listing: DELISTED

PROJECT STATUS
Ongoing

Principal biologists
Val Asher
Mike Phillips

Conservation Problem – Wolves are a polarizing issue, thus limiting expansion of the species current range.

Listing Status

- ***Delisted due to Recovery:*** Northern Rocky Mountain Distinct Population Segment (MT, ID, WY, eastern WA and OR, north-central UT.
- Upon delisting in 2011, wolves became a Species in Need of Management in MT.

Project Location – Flying D Ranch, MT.

Project Funding – TESF/TBD

Goal – To understand the ecology of wolves on a wild, working landscape of the Flying D ranch and inform wolf recovery efforts throughout the species' historical range.

Objective – Over the next five years we will locate and identify predator-killed prey and analyze wolf scats to determine predation characteristics of the resident wolf population on the Flying D ranch. All carcasses will be evaluated for cause of death, body condition and any predisposition to predation by classifying femur marrow and boiling leg bones and jaws to identify arthritis or injuries. During this time, we will monitor the Flying D's wolf population and will work cooperatively with the Flying D ranch manager and Montana Hunting Company to track bison herd health, herd size and the resident elk and deer population. Knowledge of these dynamics and the practicality and utility of living with wolves on a wild, working landscape will be shared by conducting wildlife tours to visiting guests on the Flying D.

Supporting Rationale for Objective

Uncertainty over the ecosystem impacts of wolves continues to foster intolerance for wolves in the west. An abundant prey base on the Flying D allowed the ranch to support what was once the largest pack in MT (24 individuals in 2011) in 2011, before it split into two packs. The ranch practices an ecologically sustainable management style which also benefits the persistence of large carnivores. We can help maintain a healthy wolf population on the ranch by understanding food habits, prey health and the effects wolves have on ranch activities.

Project Background – In 2000, we assigned a TESF wolf biologist to assist the USFWS and later MTFWP, with wolf recovery in Montana. We remain the only private organization ever permitted under the ESA to assist the USFWS with wolf recovery and it was a notable achievement for us to be involved for over 9 years with the daily implementation of wolf recovery and management across southwest Montana. With delisting imminent, we shifted our focus in 2010 to better understand the effect of wolves on the ungulate populations and related commercial enterprises on the Flying D Ranch. Wolves first established themselves on the ranch in 2002. In 2011, they were at their highest number as a single pack before splitting into two packs. Both packs (Tanner Pass and Beartrap packs) made use of the entire ranch (over 113,000 acres) and the bordering forest. The Tanner Pack broke up in 2016. Bison and elk numbers on the ranch are monitored jointly by the Flying D Ranch and Montana Hunting Company. This population monitoring, coupled with wolf prey information collected (Visual or scat) on a near daily basis, provides a platform for understanding the effects of wolves on ranched bison and a native, wild elk herd, both of which have commercial value.

Diseases such as anthrax (*B. anthracis*), mycoplasma (*Mycoplasma* spp.), and brucellosis (*Brucella abortus*) are present and affect ungulates on the ranch, and anthrax and mycoplasma have resulted in significant bison death-loss in the recent past. Disease dynamics have the potential to directly impact carnivores by providing a food resource through scavenging, as well as a declining prey population due to severe disease outbreaks. Because of this carnivore nexus, we continue to participate in two ongoing disease studies concerning anthrax and brucellosis on the ranch. We also continue to assist our Mexican wolf

recovery counterparts in the trapping and handling of wolves in Chihuahua, Mexico and offer technical support to the Mexican Wolf/Livestock Council for Arizona and New Mexico.

Project Activities in 2017

Wolf population

Even with the loss of the Tanner Pass pack in 2016, the wolf population using the Flying D Ranch has remained relatively stable. (Fig. 13b.1). The Beartrap pack produced 7 pups in 2017. They use the entire ranch and occasionally travel through neighboring properties to the north. Three known wolf mortalities occurred in 2017. Two wolves were legally taken during the hunting season when they left the ranch and one 2-3 year old gray male was killed by wolves in the Pole Creek drainage in February.

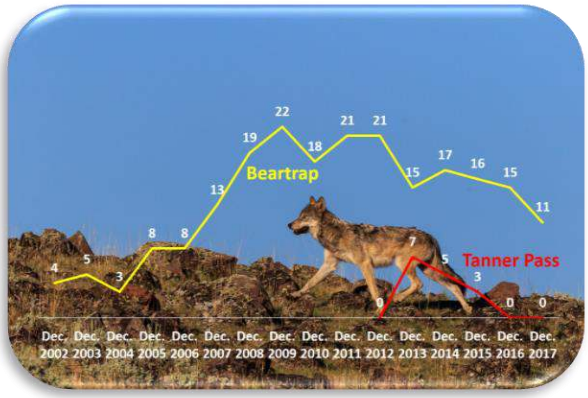


Fig. 13b.1. Number of wolves in the Beartrap and Tanner Pass packs from 2002 to 2017.

We were permitted by MTFWP to capture and radio-collar two wolves. A black two-year-old female (Fig. 13b.2) and a gray three-year-old male were collared in 2017 (this male was legally harvested later in 2017). Our capture permit was renewed in 2018 and we would like to deploy a GPS collar to supplement our collection of wolf food habit data and to determine the Beartrap packs territory boundaries more clearly.

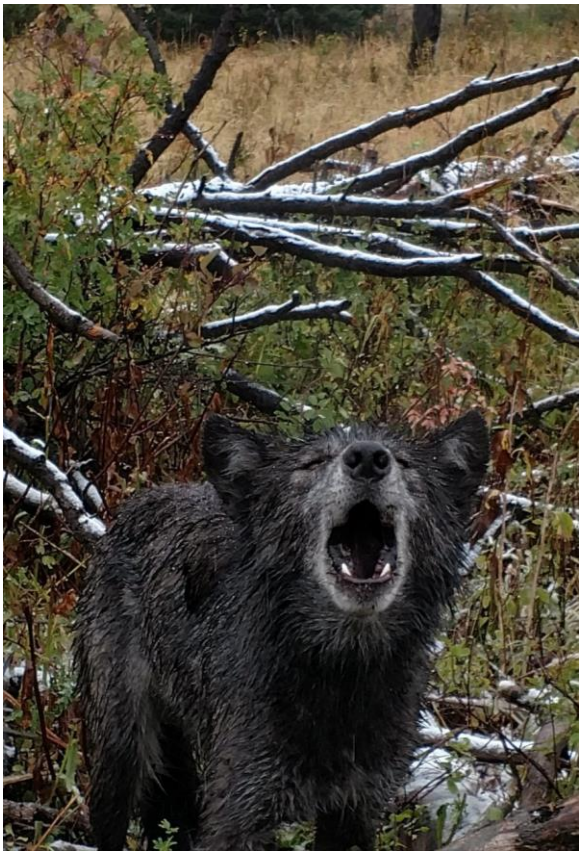


Fig. 13b.2. Two-year-old female wolf, radio-collared on the Flying D in 2017.

Food habits

Of the 1,128 carcasses investigated since 2010, 353 were visually confirmed as predator kills. 256 were attributed to wolves, with the remainder categorized as coyote (n = 64), mountain lion (n = 8), bobcat (n = 2), bear (n = 6), and "unknown predator" (n = 17).

While bison are the dominant ungulates on the Flying D (~ 3,300 to 5,400 individuals over the course of a year), elk represented the majority of confirmed wolf-kills (67%), while bison comprised 22% of wolf-killed carcasses (Fig. 13b.3). With bison almost twice as numerous as elk, we assume that encounter rates between bison and wolves are higher than between elk and wolves. However, wolves appear to be more successful at killing elk, or are actively selecting elk to prey upon.

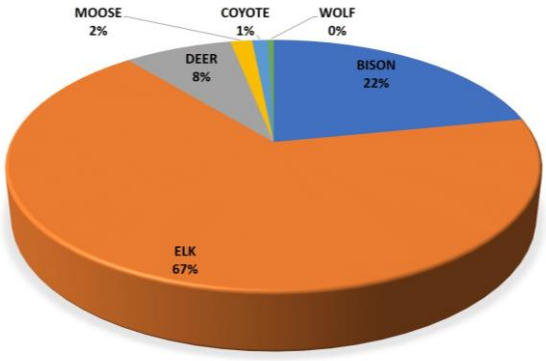


Fig. 13b.3. Percentage of wolf kills by prey species.

To assess how diet information derived from wolf scat dissection compared with visually confirmed wolf-kill data (Fig. 13b.3), we analyzed wolf scats collected on the Flying D during the period 2010-2017. These results indicated that deer (38%) and elk (35%) were the primary prey species consumed by wolves (Fig. 13b.4). We visually differentiated bison hair in the scat samples to evaluate the relative contributions of adult bison and calves less than ~ 4 months of age (i.e., red calves). Bison adults comprised 18% of the diet as detected by the scat analysis, while red calf-hair amounted to only 2% of wolf scats (Fig. 13b.4), suggesting that these young bison are not readily predated by wolves. The discrepancy in the deer constituent of wolf diet confirmed visually (8%; Fig. 13b.3) versus scat dissection (38%; Fig. 13b.4) analysis methods may be due to the relatively small size of this prey species that render their carcasses much harder to find on the landscape before they are wholly consumed.

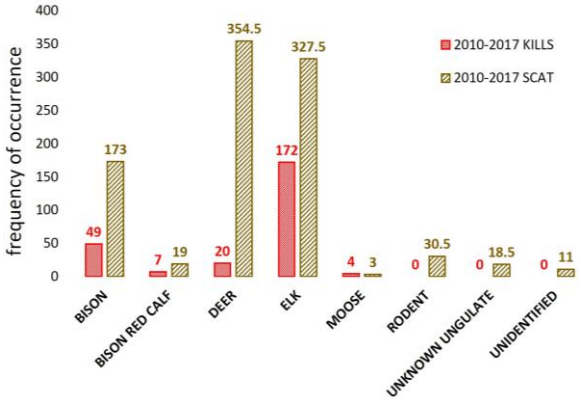


Fig. 13b.4. Comparison of wolf scat data to observed carcasses verified as wolf kills.

Prey Vulnerabilities

A generalization of wolf-prey systems is that wolves tend to select prey that are disadvantaged (e.g., young, old, sick/injured).

We evaluated predisposition to predation using femur marrow of wolf-killed elk and deer. We also examined leg bones for arthritis or abnormalities. Femur marrow is a standard for evaluating bone marrow fat content, as this is one of the last fat resources the body utilizes. Healthy bone marrow is white, firm, and waxy to the touch. In a state of malnutrition or disease, marrow is red, solid and slightly fatty to the touch. In advanced starvation, bone marrow is red to yellow, gelatinous and wet to the touch due to a high water content. Femur marrows of prey species were collected and categorized as "white/waxy", "red/firm" or "red/gelatinous."

Marrow collected from 172 wolf killed elk, deer and moose since 2010 showed that 73% of individuals were in a marginal to poor health condition (Fig. 13b.5).

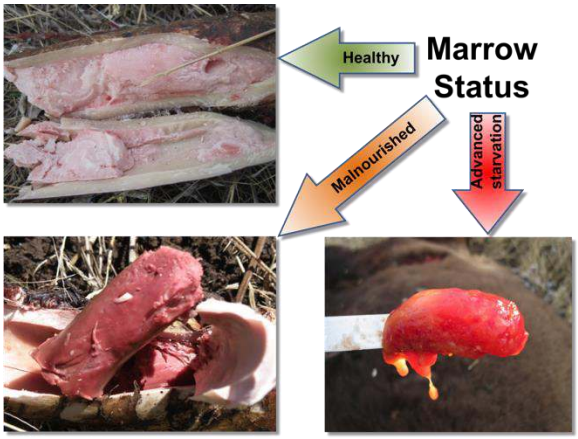


Fig. 13b.5. Femur marrow helps determine the condition of prey species.

Another prey vulnerability is disfigured and/or injured hooves and legs. Since 2010, we have examined 289 elk carcasses that died of various causes; 39 of these animals had visible deformities, with 31 (79%) of them killed by wolves (Fig. 13b.6). Wolves are adept at recognizing lameness, and it is logical that they would test these individuals over one that shows vigor. Once legs have been boiled we can see in more detail the calcification and arthritis that has developed (Fig. 13b.7)

Fig. 13b.6. Elk legs with visible and varying deformities.

Fig. 13b.7. Abnormal front left hoof from bull elk and normal front right from same individual.

Data collection is ongoing to determine if these disfigurements relate to injury or other causes. We collect and boil legs from all elk carcasses, regardless of discernible hoof/leg injury, to assess any differences between wolf kills and elk that die from other causes.

Education

Information dissemination is important as we learn more about wolves on the ranch. In 2017, we conducted 10 tours on the Flying D. We also shared data with MTFWP as well as Anthrax and Brucella researchers. We continue to hold a seat on the Mexican Wolf/Livestock Council to assist with technical support and provide expert information related to compensation for depredations and proactive measures to avoid wolf livestock conflicts in the southwest.

13(c) Rocky Mountain Wolf Project (RMWP)

ESA listing: ENDANGERED

Conservation Problem – Wolf recovery is a divisive issue in the U.S., limiting the species' distribution to about 15% of historical range.

Listing Status (Fig. 13c.1)

- ***Endangered:*** AL, AR, CA, CO, CT, DE, FL, GA, IA, IN, IL, KS, KY, LA, MA, MD, ME, MI, MO, MS, NC, ND, NE, NH, NJ, NV, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV. Parts of AZ, NM, OR, UT, WA: (1) North AZ (north of I-40); (2) North NM (north of I-40); (3) West OR (west of Hwy 395, Hwy 78 north of Burns Junction, west of Hwy 95 south of Burns Junction); (4) Most of UT (south and west of Hwy 84, south of Hwy 80 from Echo to UT/WY border); (5) West WA (west of Hwy 97, Hwy 17 north of Mesa, west of Hwy 395 south of Mesa).
- ***Threatened:*** MN
- ***Delisted:*** Northern Rocky Mountain Distinct Population Segment (MT, ID, WY, eastern WA and OR, north-central UT.
- ***Experimental Population, Nonessential:*** portion of AZ north of I-10 and south of I-40; portion of NM north of I-10 (in west), north of the NM-TX border (in east), and south of I-40.

Project Location – Western Colorado portion of the Southern Rockies Ecoregion (SRE)

Science Advisory Team – E.O. Wilson, Barry Noon, Joel Berger, Kevin Crooks, Phil Cafaro, Marc Bekoff, Mike Phillips, Dave Mech, Rolf Peterson, Doug Smith, John Vucetich, Phil Hedrick, Rich Reading, Bob Wayne, Bridgett vonHoldt, Ed Bangs, Carter Niemeyer, Diana Tomback, Andrew Gulliford.

Project Partners

The Rocky Mountain Wolf Project (RMWP) is a coalition of individuals and organizations—from wildlife biologists to Colorado landowners to conservationists to nongovernmental conservation organizations, including the TESF—dedicated to returning wolves to the public wild lands of western Colorado. Active supporters of the RMWP include:

Project Funding

- Private donations
- TESF
- Foundation grants.

Goal – Provide the public with science-based information about restoring gray wolves to the SRE of western Colorado.

Objective – RMWP will engage in public education and outreach, as well as broad-based coalition building, to catalyze gray wolf restoration to the SRE of western Colorado. This will advance species recovery and serve as a conservation model for restoring other wide-ranging, controversial species.

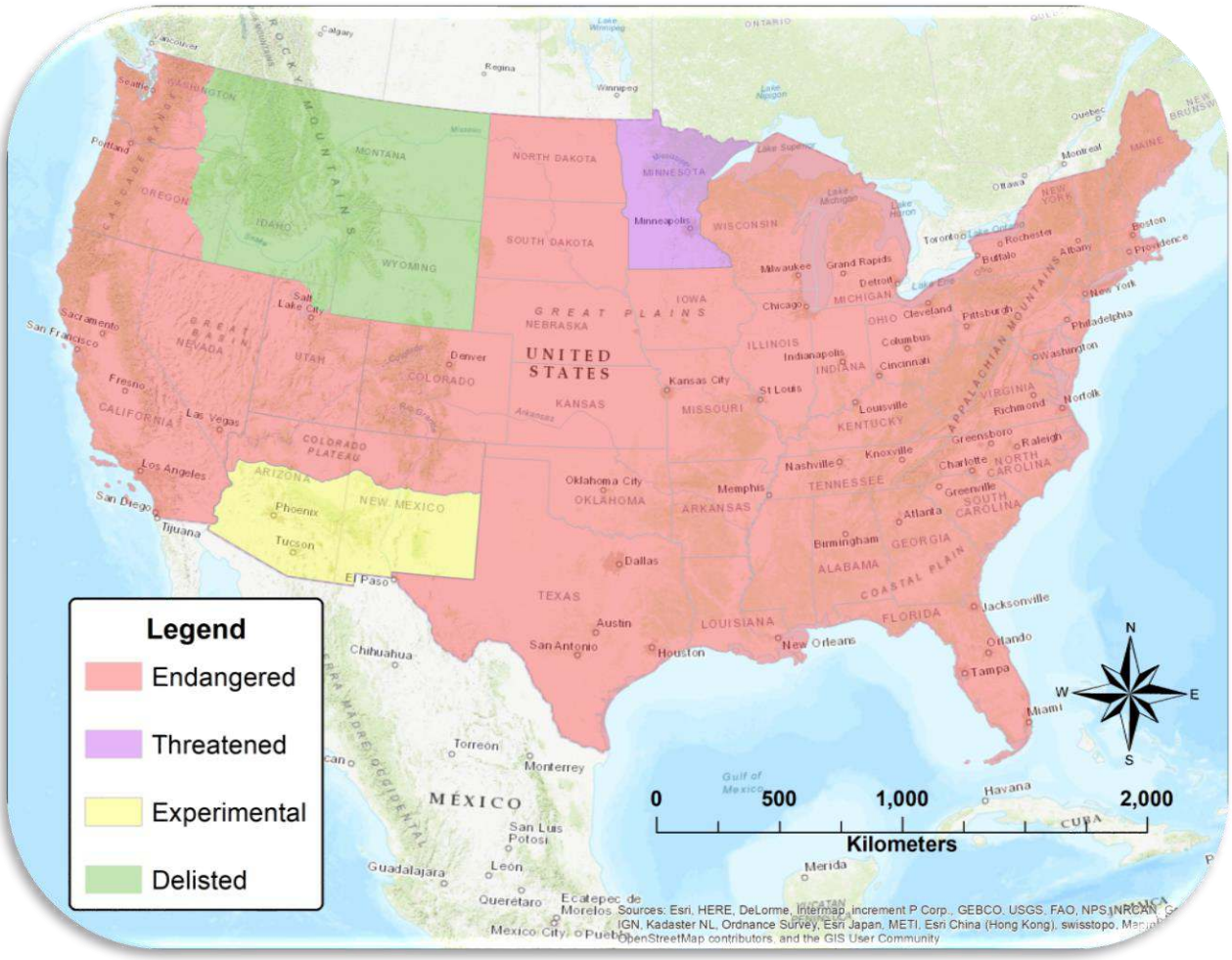
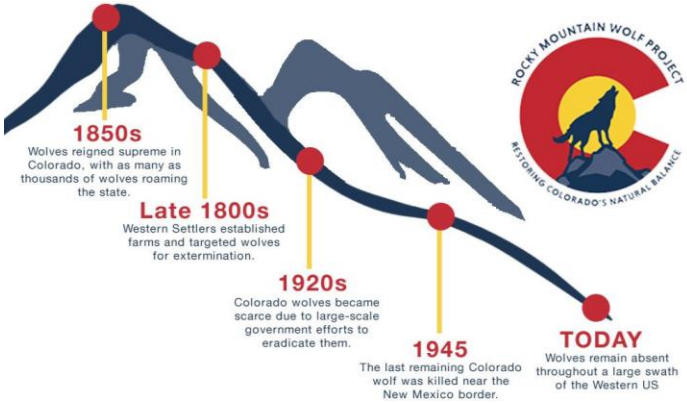


Fig. 13c.1. Listing status of *C. lupus* in the conterminous United States.

Project Background – Wolves historically occurred throughout the U.S., with the species common in Colorado up to the mid-1800s. With human expansion, wolves were exterminated until Colorado's last wolf was killed in 1945 near the New Mexico border.



Over the last few decades wolves have returned to parts of their historical range, with re-establishment in Minnesota, Michigan, Wisconsin, Montana, Idaho, and northwestern Wyoming. Wolf packs are also beginning to gain a foothold in Washington and Oregon.

Despite an improved conservation status, wolf recovery is not complete. No convincing argument about wolf recovery can be put forth without a discussion of restoration to the SRE. Why? Because of widespread public support for the notion, because no other region in the U.S. offers the same expanse of suitable public land not already occupied by the species, and because of the ESA's recovery mandate.

Successful wolf restoration in the northern Rocky Mountains and Great Lake states underscores the practicality of accomplishing the same in the SRE. This is bolstered by research

that showing the SRE's great capacity to support wolf numbers and distributions that would satisfy the spirit and intent of the federal and Colorado endangered species acts.

The SRE is the best remaining area for gray wolf restoration in the U.S. It stretches from central Wyoming, through western Colorado, and into north-central New Mexico (Fig. 13c.2). The Colorado portion of the SRE includes over 17 million acres of public lands with abundant native prey. This is more public land than is available to wolves in the Yellowstone area and central Idaho. This prodigious public land base coupled with robust ungulate populations make western Colorado a motherlode of opportunity for wolf restoration. A viable, self-sustaining, wolf population there would: 1) have at least 250 adult wolves, 2) exhibit stable or increasing population trends over 8 years, 3) be naturally connected with wolf populations elsewhere at a rate not less than 0.5 genetically effective migrants per generation averaged over a period of two successive generations (i.e. eight successive years), and 4) be monitored and managed per a science-based conservation plan implemented by Colorado Parks and Wildlife.

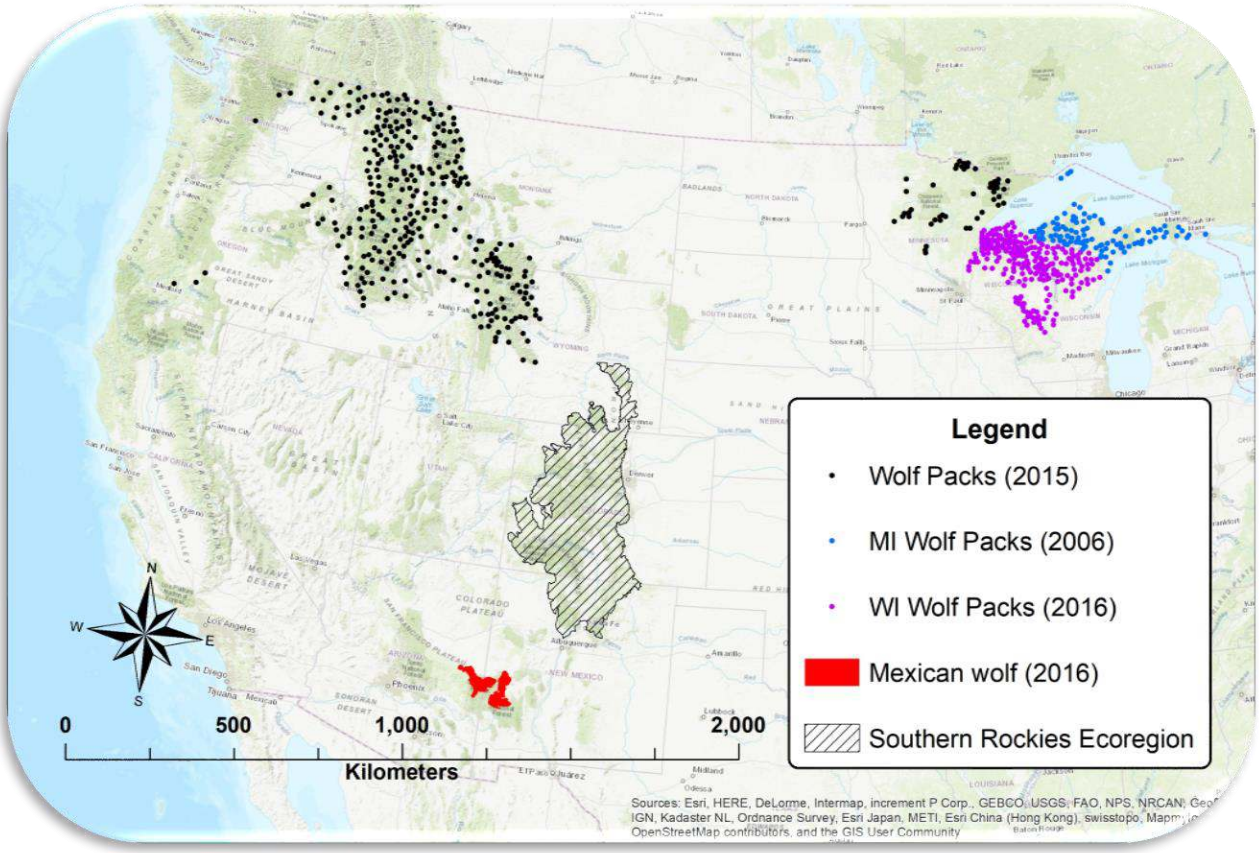


Fig. 13c.2. Distribution of wolf packs, estimated during the period 2006-2016, in the conterminous U.S. relative to the Southern Rockies Ecoregion. Wolf pack locations were obtained from relevant state gray wolf annual reports and georeferenced using ArcGIS 10.0. Michigan (MI) wolf packs represent 2006 data, Wisconsin (WI) pack locations and home ranges for Mexican wolves were recorded in 2016. All other locations in Minnesota, Montana, Wyoming, Washington, and Oregon were georeferenced from pack data collected in 2015. It is estimated that for the wolf packs portrayed, there are approximately 4,000 individual wolves in Great Lakes region, 1,500 individuals in Northern Rocky Mountains, and about 113 Mexican wolves.

Two studies have estimated the SRE's wolf carrying capacity. The first, conducted in 1994, estimated that the SRE's Colorado portion alone could support > 1,000 wolves, while the second used sophisticated modeling to estimate that the entire SRE could support 2,000 wolves.

The public is supportive of restoring wolves to the SRE. A 2001 poll revealed that 71% of Coloradans supported restoration (Fig. 13c.3), with widespread majority support among various demographic groups. A more recent poll of 600 Colorado voters in 2014 revealed continued support for wolf restoration (Fig. 13c.4).

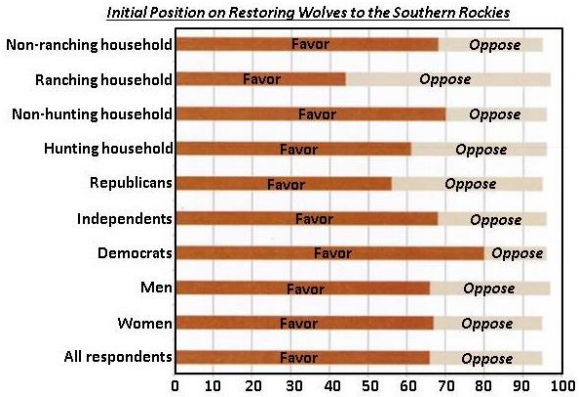


Fig. 13c.3. Results of a 2001 public opinion survey revealed widespread support for restoring wolves to the Southern Rockies. Source: Decision Research, 2001.

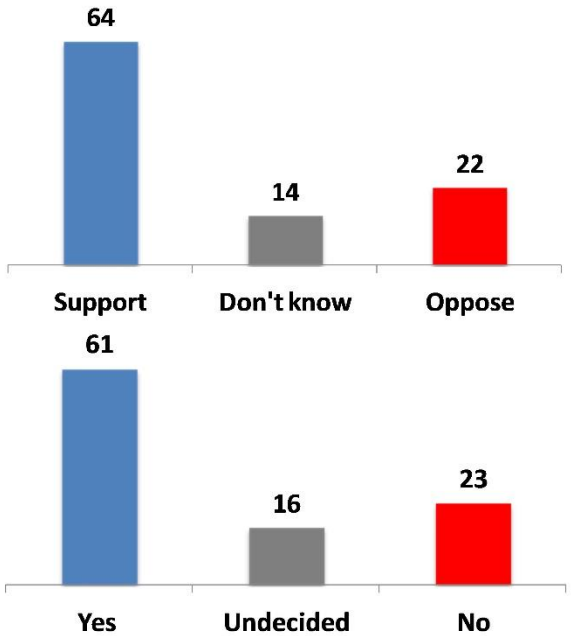


Fig. 13c.4. Results of a 2014 poll measuring support and opposition for reestablishing wolves in western Colorado (top panel), and support (yes) or opposition (no) for a combined wolf restoration ballot measure (bottom panel).

Western Colorado is a vast area of high quality and secure habitat that is mostly located on public land managed for natural resources. Restoring the gray wolf there represents an outstanding opportunity to advance recovery of the species throughout a significant portion of its historical range, as mandated by the federal ESA.

From an ecological perspective restoring wolves to western Colorado would provide nature with grist for recreating a wolf population that stretches from the Arctic to Mexico. Nowhere else in the world has greater potential to achieve large carnivore conservation across such a vast landscape. when considering such a vision, wolf biologist Dr. L. D. Mech concluded:

> *"Ultimately then, this restoration could connect the entire North American wolf population from Minnesota, Wisconsin, and Michigan through Canada and Alaska, down the Rocky Mountains and into Mexico. It would be difficult to overestimate the biological and conservation value of this achievement."*

The work of the RMWP seeks to educate Coloradans, as well as the broader public of the U.S., of the ecological implications of restoring the evolutionary potential of wolves and reestablishing their role as a keystone species throughout the Rocky Mountain west. Evolutionary and ecological restoration of the species will be hindered if wolf recovery remains limited to the northern Rocky Mountain and the Great Lakes states. Wolf reintroductions to western Colorado would represent an important step for restoring the species to a significant portion of its historical range and would pave the way towards species recovery.

By 2013 it was clear that the USFWS did not intend to advance wolf restoration to the area based on the agency's only authority to do so – the federal ESA mandate. Consequently, a non-federal approach is needed.

Project Activities in 2017

RMWP coalition members disseminated science-based information and engaged with Coloradans about co-existing with wolves. We used both strategies to stimulate thoughtful, public conversations about wolf restoration with stakeholders. In addition, RMWP contracted with several organization to advance our project goals, including:

- Fiscal Administration: Tides Center www.tides.org
- Website/social media: Boulder Strategies www.boulderstategiesllc.com
- Films: Grizzly Creek Films www.grizzlycreekfilms.com

January – RMWP kicked off 2017 by compiling background material for the launch of its logo and tagline (Restoring Colorado's Natural Balance; Fig. 13c.5), website, social media platforms, films, and educational exhibit.

Fig. 13c.5. The RMWP's logo and tagline.

February – TESF (on behalf of RMWP) and the Colorado Chapter of the Wildlife Society co-hosted a full-day wolf symposium in Fort Collins. Top scientists talked to 350+ people about wolf biology, ecology, and restoration options of relevance to Colorado.

Following the symposium, RMWP co-sponsored a screening of the documentary *A Season of Predators* and co-hosted, in partnership with Defenders of Wildlife and the Rocky Mountain Chapter of the Sierra Club, a sold-out panel discussion about wolf restoration.

March – RMWP engaged online:

- www.**rockymountainwolfproject**.org
- www.**Facebook**.com/RockyMountainWolfProject
- www.**Twitter**.com/RockyMtnWolf
- www.**instagram**.com/rockymtnwolf/

RMWP's website features its widely acclaimed 90-second video entitled *Chorus of Colorado*. At the end of its first outreach blitz (from late March through May), RMWP had recorded:

- > 18 million digital impressions,
- > 12 million paid ad impressions,
- ~ 6 million organic/viral impressions,
- > 16,000 visits to the website, and
- ~ 6,000 new contacts

April – RMWP participated in Earth Day Texas (in Dallas), the biggest Earth Day celebration in the country, with over 100,000 attendees. During the 3-day event, we premiered our education booth (Fig. 13c.6), and distributed stickers and brochures to hundreds of families and school groups. The booth has since been replicated so that RMWP can participate in simultaneous education and outreach events though 2020.

Fig. 13c.6. RMWP at Earth Day Texas, the biggest Earth Day celebration in the country.

RMWP co-hosted with Defenders of Wildlife and Sierra Club Colorado a screening of *A Season of Predators* and a panel discussion at the Longmont Film Festival. The film and panel discussion won the Audience's Choice "Best Program" award.

May – RMWP celebrated Colorado Endangered Species Week by partnering with Rocky Mountain Wild, the Rocky Mountain Chapter of the Sierra Club, W.O.L.F. Sanctuary, and Defenders of Wildlife to host an event in Boulder that included a film screening and panel discussion.

June – Eighteen conservation groups and over a dozen advocates convened at the History Colorado Center for RMWP's biannual meeting to reflect on the first half of 2017 and to plan for the future.

RMWP participated in the 2017 AREDAY (American Renewable Energy Day) Summit in Snowmass, CO by leading a discussion about wolf restoration (Fig. 13c.7) and premiering two RMWP films: 2½ minute animated short entitled *Meet the Real Wolf*, 18½ minute documentary entitled *Canis Lupus Colorado.* RMWP also participated in AREDAY's 3-day Community Expo by talking with and distributing educational information to thousands of attendees.

Fig. 13c.7. Mike Phillips (TESF) and Tom Winston (Grizzly Creek Films) hosted the premiere of two Rocky Mountain Wolf Project films to attendees at AREDAY 2017. The crowd included global leaders in energy technology and the environment.

RMWP coalition members–Endangered Species Coalition and Center for Biological Diversity–hosted talks in Fort Collins and Boulder. These were well received, with attendees expressing a deep interest for seeing a return of wolves to Colorado (Fig. 13c.8).

Fig. 13c.8. The Endangered Species Coalition and Center for Biological Diversity hosted several important outreach events to advance the wolf's return to western Colorado.

July – *Canis Lupus Colorado*, was selected to screen at the Wildlife Conservation Film Festival in New York City, the America Conservation Film Festival in West Virginia, and the Adventure Film Festival in Boulder. The prestigious Jackson Hole Wildlife Film Festival and the Wild & Scenic Film fest selected *Meet The Real Wolf*, *Chorus of Colorado,* and *Canis Lupus Colorado* for screening.

RMWP coalition members–National Wolfwatcher Coalition, Western Watersheds Project, and the Center for Biological Diversity–participated in the "Speak for Wolves" conference in West Yellowstone, an annual gathering of wildlife advocates to discuss, strategize, and unite to improve wildlife management. They brought RMWP materials and served as ambassadors for the project to conference attendees and park visitors alike.

August – RMWP ran an education table at the Rocky Mountain Folks Festival in Lyons, CO (Fig. 13c.9), and at the Colorado State University Plaza Bazar (Fig. 13c.10) where coalition members began building RMWP's first university campus chapter.

Fig. 13c.9. RMWP connected with 4,000+ Coloradans, who visited the education table to chat, and learn about the wolf skulls, traps, and radio collars on display.

Fig. 13c.10. Laynie Hildebrand (left), CSU student and member of the Colorado State University RMWP Student Chapter, along with Cheney Gardner (TESF) and Michael Wilson from the RMWP coalition at the CSU Plaza Bazaar.

RMWP launched merchandise in the form of a RMWP logo t-shirt in male and female styles (Fig. 13c.11).

Fig. 13c.11. The first t-shirt design for the Rocky Mountain Wolf Project.

RMWP also received the original watercolor that the coalition had commissioned from renowned National Geographic Explorer and artist Asher Jay (Fig. 13c.12). RMW P will use the original and digital version of the watercolor as the focus of fundraising efforts based on merchandise, including t-shirts (Fig. 13c.13).

Fig. 13c.12. Original watercolor by renowned artist and National Geographic explorer, Ms. Asher Jay.

Fig. 13c.13. Asher Jay's watercolor will be used on merchandise for the RMWP, including tee shirts.

September – RMWP engaged in several events: tabled at Boulder's Hometown Fest over Labor Day, participated as a community sponsor for TEDxBoulder (Figs. 13c.14 & 13c.15), reached out to a diverse audience at the Americas Latino Eco-Festival, and tabled at Elk Fest outside of Rocky Mountain National Park (Fig. 13c.16).

Fig. 13c.14. RMWP was a community sponsor of TEDxBoulder – Colorado's largest TEDx event.

Fig. 13c.15. RMWP members howling with the RMWP wolfpack at TEDxBoulder.

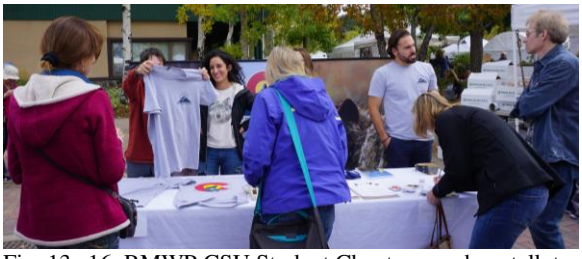


Fig. 13c.16. RMWP CSU Student Chapter members talk to Elk Fest attendees about wolf restoration on National Public Lands day outside of Rocky Mountain National Park. Thousands of park visitors stopped by our table, including many hunters. Most were surprised to learn we don't have wolves in the state but receptive to the idea. One Colorado bow hunter said: ***"I understand the role of predators. It would be so cool to see a wolf when you're out there. It's supposed to be wild."***

RMWP participated in a habitat connectivity retreat with the Great Old Broads for Wilderness, a grassroots organization, led by women, that engages and inspires activism to preserve and protect wilderness and wild lands. The retreat was held in the Rio Grande National Forest and focused on accommodating predators in the Rocky Mountain region. Members of RMWP's science team–Dr. Andrew Gulliford (Western historian), Dr. Barry Noon (wildlife biologist), and Carter Niemeyer (wolf-coexistence specialist; Fig. 13c.17)–spoke on the future of wolves in Colorado. The Grizzly Creek Films production crew also attended, allowing us to capture the voices of Colorado women as they engage on wolf restoration.

Fig. 13c.17. Carter Niemeyer hikes with "Great Old Broads" through wolf habitat in the Rio Grande National Forest during the Southern Rockies Habitat Connectivity retreat organized by the Great Old Broads for Wilderness.

October – RMWP hosted a sold-out presentation featuring Mike Phillips at Fjällräven's flagship outdoor store in Boulder (Fig. 13c.18), and screenings of RMWP's films: *Chorus of Colorado*, *Meet The Real Wolf*, and *Canis Lupus Colorado*. The films were also shown the next day at Boulder's Adventure Film Fest.

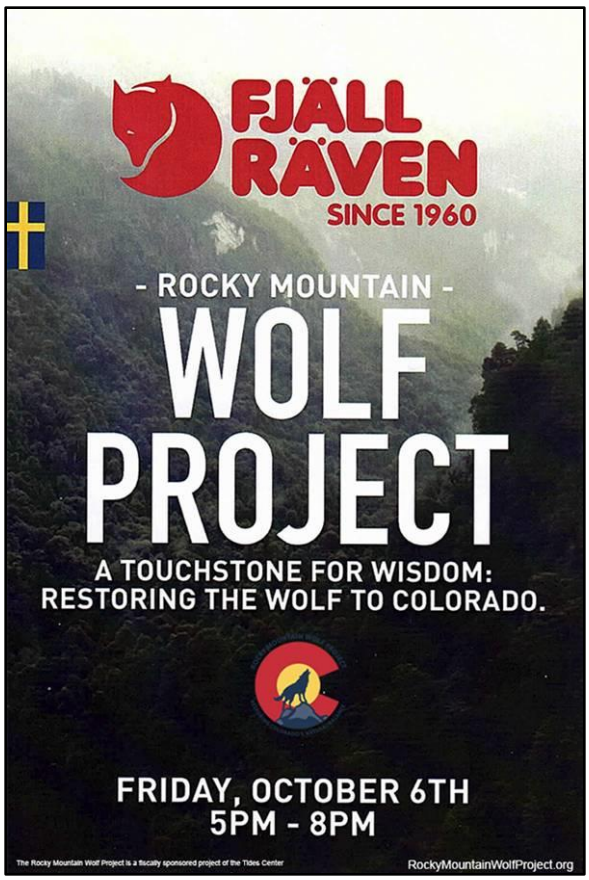


Fig. 13c.18. Poster to advertise the event at the RMWP event at Fjällräven store in Boulder, CO.

Mike Phillips represented RMWP in a podcast interview with Rocky Mountain Wild: producers of an audio tour for people traveling the I-70 mountain corridor. With over 40,000 cars traveling I-70 daily, this project may introduce wolf restoration to thousands of people.

Along with coalition member Living With Wolves, RMWP launched an adaptation of the *Living With Wolves* photo exhibit at the Aspen Airport (Fig. 13c.19). This exhibit showcases the work of award-winning photographers and filmmakers Jim and Jamie Dutcher and was reproduced for RMWP's exclusive use through 2020. The reproduction included three new Colorado-specific panels (Fig. 13c.20) and a 10-ft anatomical drawing of a wolf by National Geographic editor Fernando G. Baptista (Fig. 13c.21). The *Living With Wolves* exhibit will be an effective way of capturing the attention of travelers that pass through the Aspen airport (Figs. 13c.22 & 13c.23). RMWP intends for the exhibit to be displayed at other venues through 2020.

Fig. 13c.19. Promotional poster for the *Living With Wolves* photo exhibit at the Aspen Airport.

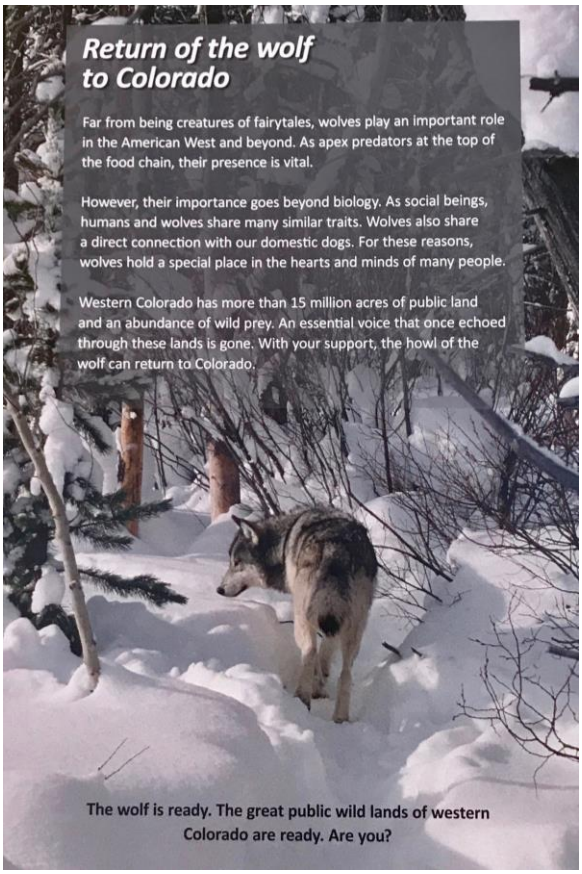


Fig. 13c.20. The *Living With Wolves* exhibit includes panels that specifically consider the wolf in Colorado.

Fig. 13c.21. The *Living with Wolves* exhibit includes a 10-ft drawing of a wolf by National Geographic editor Fernando G. Baptista.

Figs 13c.22 & 13c.23. The *Living With Wolves* exhibit is currently on show at the Aspen Airport where it will pique curiosities and inspire many to support restoring the gray wolf to the great public wildlands of western Colorado.

November – RMWP's coalition members met for the bi-annual gathering at the REI store in Denver (Fig. 13c.24). At the meeting, we took stock of the progress achieved during 2017 and discussed activities for 2018.

Fig. 13c.24. More than 40 members from 24 organizations attended the coalition's bi-annual all-coalition meeting at the REI Denver store on November 13th.

December – RMWP partnered with Twisted Pine Brewery to launch a wolf-themed beer.

With the support of RMWP coalition member, Wolf and Wildlife Conservation Center, a 30-second version of *Chorus of Colorado* aired as a "commercial" for two weeks at Cinemark Tinseltown USA movie theaters in Colorado Springs. It aired before "Star Wars: The Last Jedi" at a time when 75% of the audience was expected to be seated. This "commercial" was on-screen about 68 times/day for a total of 952 runs during the two-week, $1,500 buy.

RMWP collaborated with Crown Publishing Group and the Tattered Cover book store in Denver with a celebration of Nate Blakeslee's new bestseller, *American Wolf* (Fig. 13c.25). Blakeslee spoke with Mike Phillips about the past, present, and future for gray wolves, most notably in Colorado, in front of a packed crowd of over 300 people.

Fig. 13c.25. RMWP at the exclusive release event of Nate Blakeslee's new bestseller, *American Wolf.* The book tells the story of the rise and reign of O-Six, the fabled Yellowstone wolf. Blakeslee spoke with RMWP science team member Mike Phillips on the past, present and future for gray wolves, most notably in Colorado, in front of a packed audience of over 300 people.

Online Media Summary

RMWP worked to maintain a high-profile online presence in 2017 (Fig. 13c.26):

- The website provides well-crafted, free educational materials for kids, adults, and teachers (Fig. 13c.27).
- The website recorded over a million views of *Chorus of Colorado*.
- The website facilitated 25,618 new members to sign up and stay informed (e.g. Fig. 13c.28).
- RMWP had over 7,500 active followers across Facebook, Twitter, Instagram, YouTube, Google Plus, and Pinterest.

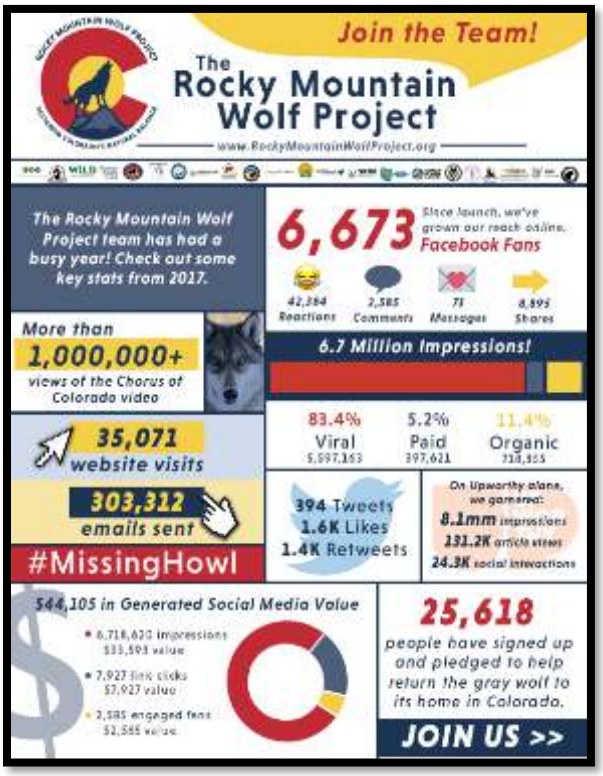


Fig. 13c.26. A summary of RMWP's online and social media impact in 2017.

The digital and social media work by Boulder Strategies was also well received and nominated as a finalist for the highly coveted Reed Awards in four different categories, including:

- Best non-traditional online advertising (for the launch advertising, and particularly the Upworthy and CBS partnership components).
- Best website for a public affairs campaign.
- Best independent campaign logo and banding (in conjunction Grizzly Creek Films).
- Best website overall.

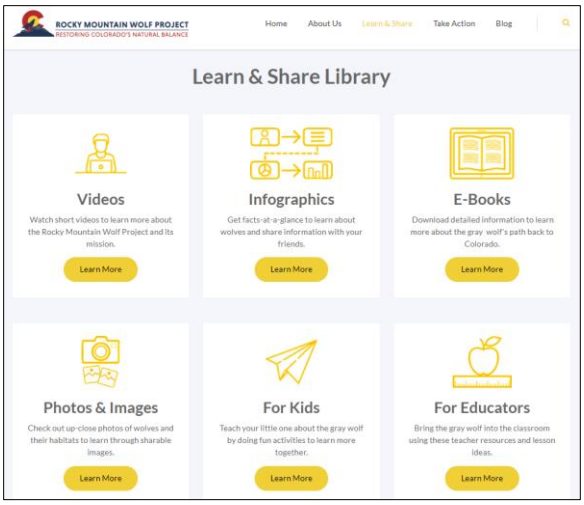


Fig. 13c.27. RMWP's website provides high quality educational materials for kids, adults, and teachers.

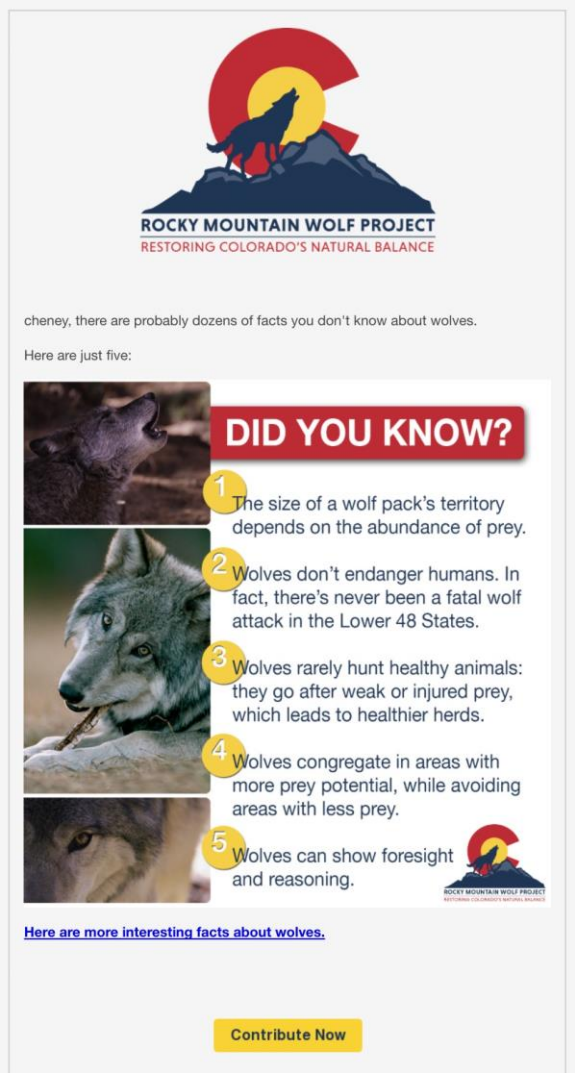


Fig. 13c.28. An example of how RMWP keeps its website subscribers, educated, informed, and engaged via email.

Film Summary

The three RMWP films produced by Grizzly Creek Films were well received. For the prestigious Jackson Hole Wildlife Film Festival, two RMWP films were nominated as finalists: *Meet the Real Wolf* in the category of Best Engaging Youth Film, and *Chorus of Colorado* (Fig. 13c.29) in the category of Best Micro Movie.

Fig. 13c.29. A still from *Chorus of Colorado*¸ Rocky Mountain Wolf Project's widely acclaimed, 90-second blue-chip film by Grizzly Creek Films.

The film, *Canis Lupus Colorado,* was an official selection of the Wild & Scenic Film Festival in Nevada City, CA. The festival's tour reaches 150 cities/events and attracts about 40,000 people. *Canis Lupus Colorado* was shown in several other notable film festivals, including:

- Adventure Film Festival (Boulder, CO),
- Sonoma International Film Festival (Sonoma, CA),
- The American Conservation Film Festival (Shepherdstown, WV),
- Wildlife Conservation Film Festival (New York, NY), and
- DC Environmental Film Festival (Washington, DC).

2017 in Conclusion

RMWP used 2017 to mature into a strong and broad coalition capable of reaching large numbers of citizens in Colorado and across the U.S., executed major outreach and fundraising efforts, and established a useful website and compelling presence across six social media platforms: Facebook, Twitter, Instagram, You Tube, Google+, and Pinterest.

As a result of taking a coalition approach for advancing wolf restoration, RMWP has grown its reach notably–coalition members collectively possess assets that include over 8.5 million dues-paying members, 6.2 million Facebook followers, and staff that dedicate nearly 2,000 work-hours every week to wolf conservation, including many activities that are specific to restoring the wolf to western Colorado.

By the end of 2017, RMWP had become a formidable, strategic, and durable force for advancing wolf restoration by engaging Coloradans with science-based educational material, coupled with productive and respectful conversations on the issue. The successful return of the wolf to western Colorado will represent the last action in a decades-long effort to restore the species to the western U.S. and thus serve as the arch stone for a great wildlife conservation achievement: re-establishment of a much-maligned carnivore from the High Arctic to the northern border of Mexico.

Proposed Future Activities & Considerations

In 2018 RMWP aims accomplish many things, including the release of 13 new short films to highlight issues that are important to Coloradans, such as wolf restoration options applicable to Colorado, and how wolves interact with livestock, big game, and humans.

These "shorts" will be followed by a crowdfunding campaign and will set the stage for broadening and deepening RMWP's education and digital outreach strategy. They will also serve as grist for initiating and buoying a National Geographic "Your Shot" assignment (www.yourshot.nationalgeographic.com).

RMWP will continue to forge ahead on multiple fronts: organizing events, raising funds, collecting partners and supporters, and tactically increasing the coalition's exposure. These efforts have a singular aim: to use education and outreach to restore Colorado's natural balance by re-establishing the gray wolf, a much maligned but indisputably important species, to the great public wildlands of western Colorado.

14. DESERT BIGHORN SHEEP

Ovis canadensis nelsonii

ESA listing: NOT LISTED

PROJECT STATUS
Ongoing

Principal biologists
Charles "Hunter" Prude
Carter Kruse

Listing Status – Desert bighorn sheep ("sheep") were listed as an endangered species in New Mexico in 1980 when fewer than 70 remained statewide. Declines were attributed to disease (transmitted from domestic sheep), overhunting, and habitat changes. Early restoration efforts were hampered by mountain lion predation. With concerted management by NMDGF, including captive breeding, translocation, and mountain lion control, sheep populations recovered sufficiently to down-list the species in 2009, and delist in 2011. The project described herein was integral to the delisting process.

Project Location – Fra Cristobal Mountain Range, Armendaris Ranch, NM

Project Partners – NMDGF, USFWS, NMSU

Goal – Establish a self-sustaining desert bighorn sheep population in the Fra Cristobal Mountains that contributes to improving conservation status of the species in NM.

Objectives

We will work cooperatively with the NMDGF to maintain a desert bighorn sheep population in the Fra Cristobal Mountains that exceeds 300 desert bighorn sheep and includes at least 120 adult ewes. Ideally, 15-20 adult ewes will be translocated from the Fra Cristobal population every 2-4 years to restore, improve, or maintain other populations of sheep in New Mexico. The Fra Cristobal population will support hunter harvest of 6-8 mature rams annually. All mountain lions observed in the Fra Cristobal Mountains will be captured, collared with a GPS transmitter, and tracked to identify habitat use and prey selection. We will work toward cessation of targeted mountain lion management in the Fra Cristobal Mountains by 2025.

Project Background

It is unknown whether the Fra Cristobal Mountain Range on the Armendaris Ranch ever supported native sheep; however, habitat was deemed suitable to support sheep. In a collaborative restoration effort, TESF and NMDGF introduced 37 sheep from the NMDGF captive Red Rock population into the Fra Cristobal Mountains in 1995. An additional seven rams were added to the population in 1997. From 1995 to 2014, 50 mountain lions were captured and removed in the Fra Cristobal mountains. This intensive mountain lion control helped the sheep population to grow to a minimum count of 154 individuals in 2010, and 272 by 2017, including 138 ewes (Table 14.1; population estimate of 300-350 sheep after adjusting for survey sightability), constituting the largest sheep population in the state. Growth of, and emigration by, the Fra Cristobal population resulted in a new sheep population in the neighboring Caballo Mountains by 2006, which now comprises over 100 individuals. With successful establishment of the Fra Cristobal sheep population, collaborative efforts have shifted from recovery (e.g., introductions, intensive monitoring, and intensive predator control) to management and sport harvest of the population. Since delisting in 2011, 47 mature rams have been harvested on the Fra Cristobal Mountains through a public-private partnership with NMDGF. Perhaps more importantly, 79 sheep have been transplanted from the Fra Cristobal's to support sheep restoration and recovery elsewhere in New Mexico.

In 2014, predator control transitioned from the lethal removal of all known mountain lions within the Fra Cristobal mountains to a less invasive strategy of removing only those lions that are documented to kill multiple sheep. Once a mountain lion is documented to have killed three ewes or five total sheep it is subject to removal. Since this change in the predator management strategy, only five of the 16 collared lions using the mountains have been removed for sheep predation (Table 14.2). Substantial information on lion prey selection and diet has been gathered since 2014. Research is currently underway to determine if non-lethal methods can be used to reduce or prevent lion predation on sheep.

Table 14.1. NMDGF Fra Cristobal desert bighorn sheep survey results 2011-2017.

Date	Total	Ewes	Y. Ewe	Lambs	Unk	CI	CII	CIII	CIV	Total Rams	Survey Type & [Time in hours]
05/2011	190	68	7	27		25	20	18	25	88	AG[3.8]
05/2012	72	26	-	24	10	2	6	-	4	12	G[8]
05/2013	111	53g	6	26	5	6	4	10	1	22	G[7]
10/2013	201	76	16	24	3-4	18	31	14	18	81	A[6.1]
05/2015	193	72	8	31	1	15	21	28	17	81	AG[5.4]
10/2015	221	108	10	34	1	10	22	14	22	68	AG[5.4]
12/2016	263	110	-	68	2	2	39	28	13	83	AG[5.3]
05/2017	272	138	7	40	-	14	32	31	10	87	A[5.7]
10/2017	242	112	14	27	-	15	30	36	8	89	A[10]

KEY:

CI = Class I Ram (2-4 years old)
CII = Class II Ram (4-6 years old)
CIII = Class III Ram (6-8 years old)
CIV = Class IV Ram (8-16 years old)
Y. Ewe = Yearling Ewe
Unk = Unidentified age/sex
A = Aerial Survey
G = Ground Survey
AG = Combined Aerial and Ground Survey

Table 14.2. The fate of mountain lions captured and collared 2014-2017.

Animal ID[1]	Capture Date(s)	Current Status/Comments	Confirmed Desert Bighorn Sheep Kills
AR-M01/BM3	6/6/2014	Dead - hunter harvested 1/3/2016. Killed in San Marcial area.	5 prior to collar malfunction on 10/28/2014
AR-M02	6/15/2015	Dead - killed by other lion on 6/30/2015. May have been killed by AR-F02.	
AR-M03	9/28/2015	Presumed Dead - AR-F03 kitten, VHF collar only, collar confirmed to have fallen off.	
AR-M04	10/17/2015, recaptured on 12/09/2015	Dead - complications during NMDGF relocation attempt on 12/09/2015. Was using urban interface prior to recapture.	
AR-M05	11/15/2015, recaptured 5/3/2016 and 10/2/2016	Dead - removed due to DBS depredation on 3/20/17. Snared and euthanized on last kill. AR-F01 was mother.	1 C1 ram, 1 ewe, 5 lamb
AR-M06	10/16/2016	Dead - removed due to DBS predation on 3/27/17. Tracked and shot.	1 ewe, 1 ram, 2 lamb
AR-M07	11/11/2016; recaptured 2/08/2017; recaptured 11/01/17	Alive - incidentally recaptured and released on 2/8/2017. Recaptured and collar exchanged 11/01/17.	2 lambs
AR-M08	2/14/2017	Dead - died of unknown causes 2/24/2107. Carcass found on BDA +33.85303, -106.85861	
AR-M09	3/27/2017	Alive - not using Fra Cristobals; using river corridor and eastern plains, including WSMR	
AR-M10	9/22/2017	Dead - removed due to DBS depredation on 11-15-17. Killed by shooter.	3 ewe, 1 juvenile
AR-F01	3/6/2014, recaptured 2/6/2015	Presumed Alive - recollared on 2/6/2015, collar malfunction, collar dropped off 2/16/2016	
AR-F02	7/1/2015	Dead - died of unknown causes 12/31/2015. Found under water.	
AR-F03	8/12/2015, recaptured 6/6/2016	Dead - malnourishment and intestinal worms	
AR-F04	10/23/2015	Presumed alive - VHF collar only, captured on camera in Jornada Lava Cave on 11/12/2016. Not getting location or kill data.	
AR-F05	11/15/2015; recaptured 03/21/2017	Dead - hunter harvested near San Marcial 4/28/2017. AR-F01 was mother.	
LAD-M07	10/26/2015	Dead - killed by contract trapper on Caballo Mtns around 3/25/2016. Collared by Dr. Travis Perry on Ladder Ranch, observed at camera trap on Armendaris in early November 2015.	4 ram, 1 ewe (last 2 rams were on Caballos)

Project Activities in 2017

We assisted NMDGF with two aerial sheep surveys in 2017–one in May when a minimum of 272 sheep were counted, and one in October when 242 sheep were observed (Table 14.1). TBD staff helped NMDGF capture and translocate 23 sheep from the Fra Cristobal Mountains to the Ladrone Mountains in December (Fig. 14.1). In late 2017, and continuing into 2018, we have documented suspicious mortalities of 4 collared sheep (3 ewes/1 ram). These sheep are part of a group of 30 ewes and rams that were collared in 2016 for a graduate project assessing sheep survey techniques. We were able to collect and conduct histopathological analyses of blood and tissue samples to test for pathogens from the ram mortality, as well as from two desert bighorn rams and two gemsboks (*Oryx gazella*) harvested by hunters in the Fra Cristobal mountains in early 2018. The ram mortality tested positive for *Mycoplasma ovipneumoniae*, which is a bacterium that can cause pneumonia. One each of the hunter harvested rams and gemsbok tested positive for exposure to epizootic hemorrhagic disease (EHD) but appeared otherwise healthy when harvested. We are currently working with NMDGF to monitor and investigate any suspected disease-caused morbidity or mortality of wildlife within the Fra habitat area. Seven bighorn rams were harvested by licensed hunters during the 2017-2018 season.

We detected, captured, and collared three new male mountain lions (ARM08, ARM09, ARM10) in the Fra Cristobal mountains, and recaptured two other lions (ARM07, ARF05) to exchange collars. Three male lions (ARM05, ARM06, ARM10) were removed for killing multiple sheep (Table 14. 2). From 2014 through 2017, more than 65,000 GPS point locations have been collected from collared mountain lions. The spatial data (e.g., movement and habitat use) represented by these GPS locations is currently being analyzed as part of Hunter Prude's graduate degree work. Since 2014, TBD staff have investigated approximately 1,072 GPS point clusters, or potential lion kill or feeding sites. Of these, 682 were confirmed to be kill sites. Mountain lion diet composition is diverse, with 30 different prey species being consumed (Fig. 14.2), ranging from carp (*Cyprinus carpio*, n= 49) to gemsbok (n= 29). Approximately 45% of the combined confirmed lion diet is comprised of small prey items (less than 15 kg), however mule deer (*Odocoileus hemionus*, n= 197) are the most selected prey species at 29%. Desert bighorn sheep comprise approximately 4% of the diet (27 documented kills).

Fig. 14.1. Captured desert bighorn sheep ewes from Fra Cristobal Mountains awaiting transport in December 2017.

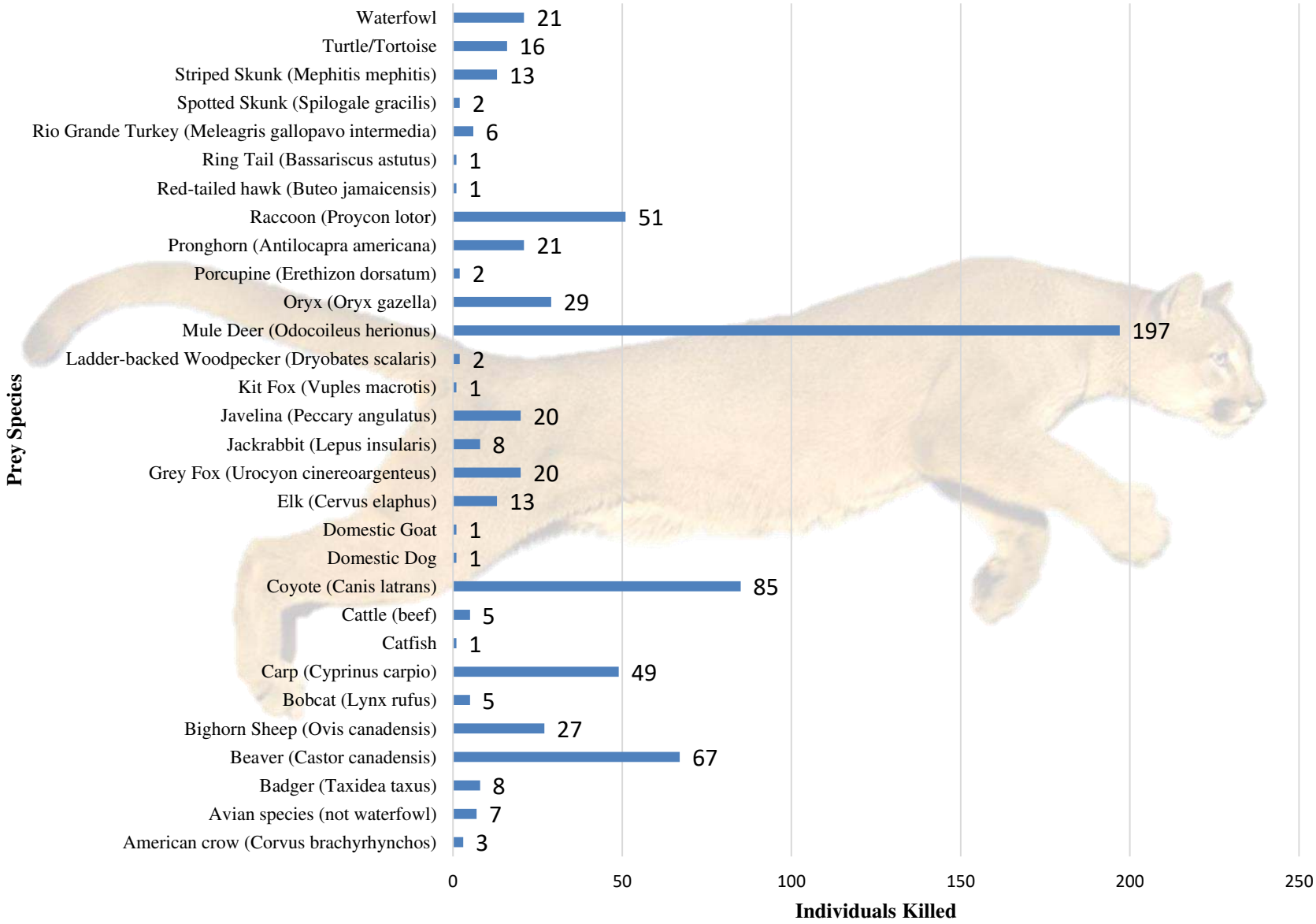
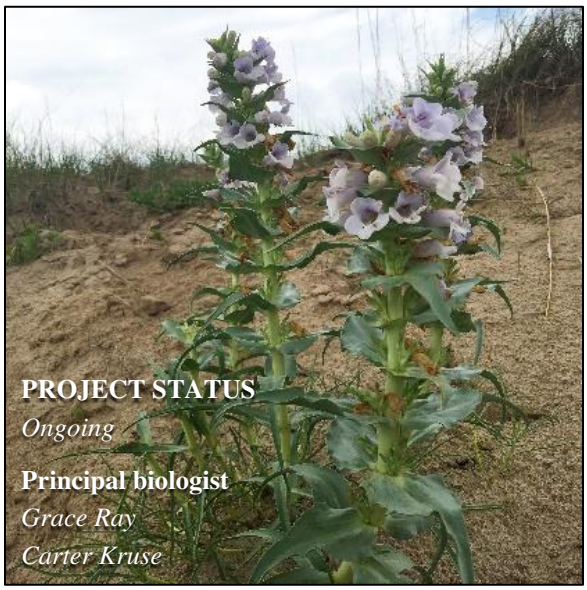


Fig. 14.2. Confirmed mountain lion kills from 2014 – 2017.

15. BLOWOUT PENSTEMON

Penstemon haydenii S. Watson

ESA listing: ENDANGERED



Listing Status – Blowout penstemon is the rarest native plant species in the Great Plains region. Rapid, ecoregional decline of Sandhills open blowout habitat resulted in the near extinction of this species and continues to be a threat as suitable habitat continues to decline. The blowout penstemon was first listed as an endangered species in Nebraska by Nebraska Game and Parks Commission in 1986. The federal government listed the plant under the Endangered Species Act in 1987. The US Fish and Wildlife Service (USFWS) blowout penstemon recovery plan requires a minimum number of 10,000 individuals in at least 5 stable populations for downlisting and a minimum number of 15,000 individuals in at least 10 stable populations for delisting.

Project Locations – Spikebox Ranch, NE

Project Partners

- USFW
- NGPC
- USFS

Project Funding

- USFWS ($10,000)
- NGPC ($5,000)
- USFS ($3,670)

Goal – Work with state and federal partners to reintroduce blowout penstemon to the Spikebox Ranch to establish a viable population that contributes to the recovery and potential downlisting/delisting of the species.

Objective – TBD/TEI and our project partners will utilize focused bison grazing on a Sandhills prairie pasture of the Spikebox Ranch to create >800 acres of ideal habitat (i.e. sand dune blowout and migration) for penstemon reintroduction. Once the desired habitat is achieved, approximately 5,000 seedlings and >10 pounds of seed will be dispersed throughout the pasture. Due to the short-lived nature of the species and the understanding that populations fluctuate drastically on a year-to-year basis, a penstemon population remaining above a minimum population threshold of >300 plants will be considered a stable population.

Project Background – Since the blowout penstemon was listed, the number of acres of suitable blowout habitat has continued to decline due to fire suppression and changes in grazing management practices (see Box 15.1). Numerous penstemon reintroduction projects have taken place across the Sandhills with minimal success, as the acreages dedicated to projects are rarely large enough to support sustainable populations for the long term. Although populations associated with public lands projects are generally more successful, there remains an inherent lack of suitable penstemon habitat large enough to sustain fluctuating populations. Turner Ranches in the Sandhills have a unique ability to utilize bison grazing to promote penstemon habitat on a scale large enough to support yearly population fluctuations as well as provide the acreage necessary for promoting genetic variation and sustainable reproduction. Promotion of penstemon habitat essentially requires "overgrazing" an area to promote sand dune blowout and migration. The Spikebox Ranch has worked with TBD to implement this effort. No other private landowner in the Sandhills has been willing to experiment with decreasing range condition in order to benefit penstemon.

Box 15.1: Blowout Penstemon Habitat Description

Blowout penstemon is found only in open sand habitats, called blowouts, in the Sandhills of north-central Nebraska and the Great Divide Basin in Wyoming. Blowouts are wind excavated depressions on dune tops and often on northwestern exposures. Heavy livestock grazing, fire or drought, singly or in combination, can remove the protective grass cover from dunes. Historically, lightening- and Native American-set fires frequently burned through the Sandhills. Large bison herds also grazed the region. Both fire and grazing removed grass cover and exposed the sand to winds. When the sand was exposed to wind, blowouts formed leaving large, barren depressions.

Along with blowout grass, lemon scurfpea and a few other plant species, blowout penstemon was often one of the first species to establish in newly formed blowouts. Blowout penstemon is a poor competitor, because of this, it is slowly eliminated as blowouts heal and other plant species begin to fill in.

Blowouts have decreased dramatically in abundance since the time of settlement. With the control of wildfires and more controlled grazing, areas of bare sand are today uncommon in the Sandhills. Because of this, blowout penstemon cannot compete in the well-established Sandhills grasslands (Nebraska Game and Parks).

Project Activities in 2017 – TEI employees conducted pre-grazing vegetation monitoring of the penstemon pasture to catalogue the baseline condition of the plant communities. The pasture was divided into 3 grids, each with a dimension of 8x6 (48 vegetation plots per grid). Species composition and vegetative cover classes were collected in each of the 144 plots. Spikebox employees worked to maintain pasture fences and develop livestock watering points, while successfully grazing the pasture with the yearling and cull bison herds. TBD met on site with project partners to assess progress towards developing penstemon habitat.

Proposed Future Activities & Considerations

Yearly vegetation monitoring will take place in June, while bison grazing with cull cow herd will continue throughout the summer and fall as needed until desired habitat conditions are met. Penstemon plantings will take place post-bison grazing once the appropriate conditions are met. Yearly grazing activity will continue throughout the course of the project while taking into consideration the seasonal life-cycle of the blowout penstemon.

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Kruse, C. G. 2017. Genetically Modified Feed Stocks in Bison Production: Is There A Risk? National Bison Association Annual Conference, January 19th, 2017.

Phillips, M. K. 2017. Nature's Archstone: Restoring the Gray Wolf to Western Colorado. Dinner Presentation, October 5, 2017, Rachel's Network, Colorado Fall Retreat, Devil's Thumb Ranch, Tabernash, Colorado.

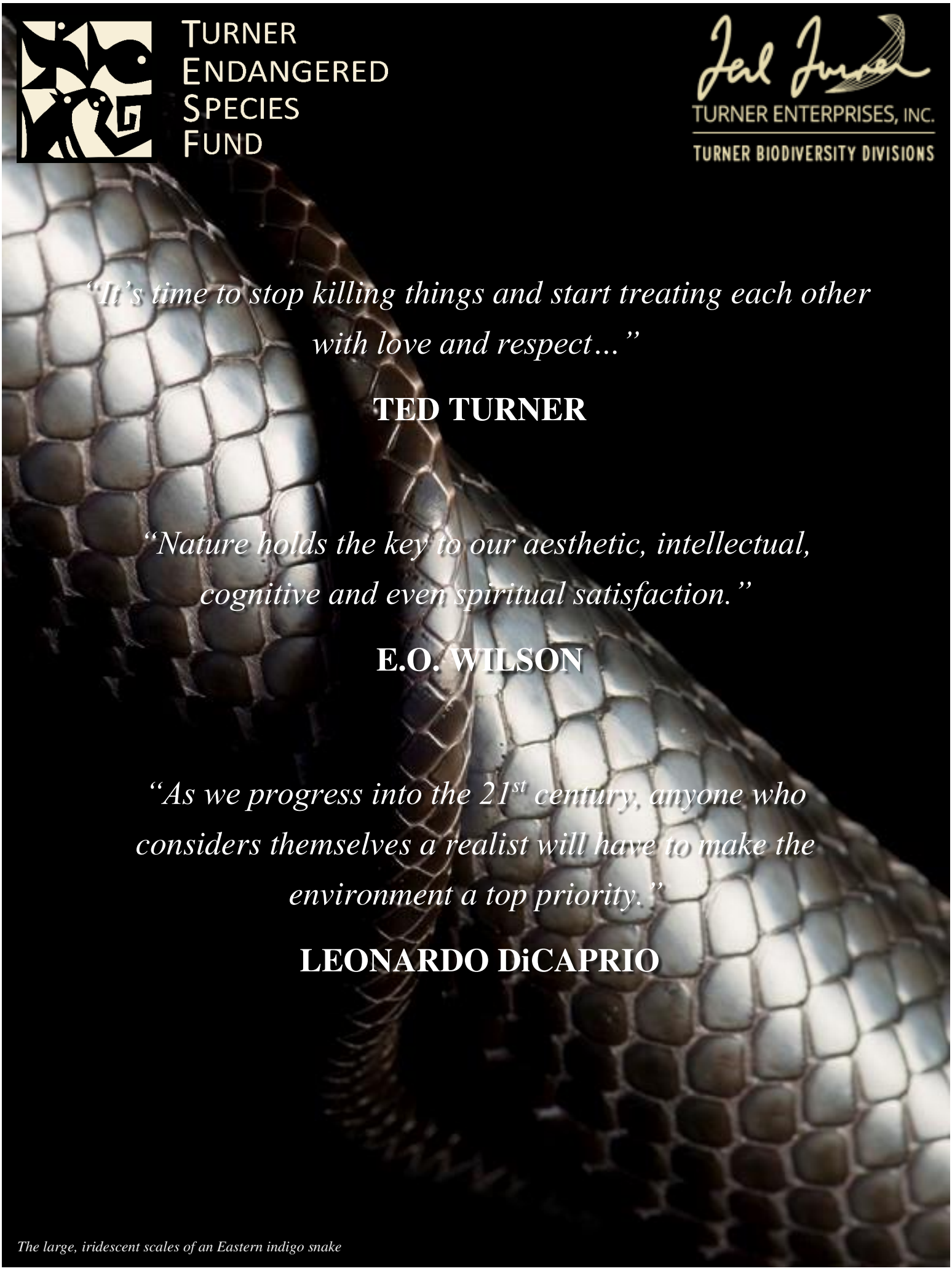
Phillips, M. K. 2017**.** A Touchstone for Wisdom: Restoring the Gray Wolf to Western Colorado. Evening Presentation, October 6, 2017, Fjall Raven, Boulder, Colorado.

Phillips, M.K. 2017**.** History and future of wolf recovery in the U.S. Plenary presentation, 2017 Wolf Symposium, For Collins, CO; co-sponsored by the Colorado Chapter of The Wildlife Society and the Turner Endangered Species Fund. February 15, 2017.

Phillips, M. K. 2017**.** Wolves, Condors, Snails, and Frogs: Private Efforts to Redress the Extinction Crisis. Invited lecture, E.O. Wilson Biodiversity Foundation, Biodiversity Days, Duke University, March 3, 2017.

ACRONYMS/ABBREVIATIONS

ACRA = Ash Creek Restoration Area
AFS = American Fisheries Society
ATP = Armendaris Truett Pen
AZ = Arizona
BKT = Brook trout
BLM = Bureau of Land Management
BRR = Bad River Ranches
BRWMA = Blue Range Wolf Management Area
CA = Conservation Area
CCAA = Candidate Conservation Agreement with Assurances
CLF = Chiricahua leopard frog
COPW = Colorado Parks and Wildlife
CSS = Chupadera springsnail
CT = Cedar Tank
DEA = Draft Environmental Assessment
DNR = Department of Natural Resources
DPS = Distinct Population Segment
EA = Environmental Assessment
eDNA = Environmental DNA
ESA = Endangered Species Act
FL = Florida
FWC = Florida Fish and Wildlife Conservation Commission
GA = Georgia
GADNR = Georgia Department of Natural Resources
GIS = Geographic Information Systems
GLI = Global Landowners Initiative
ID = Idaho
ITP = Incidental Take Permit
IUCN = International Union for the Conservation of Nature and Natural Resources
KDWPT = Kansas Department of Wildlife, Parks, and Tourism
KS = Kansas
LBP = Ladder Big Pen
LDZG = Living Desert Zoo and Gardens State Park in Carlsbad, NM
LHS = Ladder Headstart Pen
LRWMF = Ladder Ranch Wolf Management Facility
LTDS = Line Transect Distance Sampling
MGW = Mexican Gray Wolf
MOU = Memorandum of Understanding
LRWMF = Ladder Ranch Wolf Management Facility
MI = Michigan
MN = Minnesota
MSU = Montana State University
MT = Montana
MTFWP = Montana Fish Wildlife & Parks
MVP = Minimum Viable Population
NE = Nebraska
NGPC = Nebraska Game and Parks Commission
NF = North Fork
NFWF = National Fish and Wildlife Foundation
NGO = Non-governmental organization
NM = New Mexico
NMDGF = New Mexico Department of Game & Fish
NMSU = New Mexico State University
NRCS = National Resources Conservation Service
NWR = National Wildlife Refuge
OCIC = Orianne Center for Indigo Conservation
ODWC = Oklahoma Department of Wildlife Conservation
PIT = Passive Integrated Transponder
RCW = Red-cockaded woodpecker
RGCT = Rio Grande cutthroat trout
RGC = Rio Grande chub
RGS = Rio Grande sucker
RMWP = Rocky Mountain Wolf Project
RSI = Remote Streamside Incubation
RU = Recovery Unit
SD = South Dakota
SDGFP = South Dakota Game, Fish and Parks
SF = South Fork
SFGT = Saving Florida's Gopher Tortoises
SGCN = Species of Greatest Conservation Need
SPV = Sylvatic Plague Vaccine
SRE = Southern Rockies Ecoregion
SSC = Species Survival Commission
SSP = Species Survival Plan
SWMF = Sevilleta Wolf Management Facility
TBD = Turner Biodiversity Divisions
TEI = Turner Enterprises, Inc.
TESF = Turner Endangered Species Fund
TTX = Ted Turner Expeditions
TU = Trout Unlimited
TX = Texas
UNM = University of New Mexico
U.S. = United States
USFS = U.S. Forest Service
USFWS = U.S. Fish & Wildlife Service
VPR = Vermejo Park Ranch
WAFWA = Western Association of Fish and Wildlife Agencies
WCT = Westslope cutthroat trout
WI = Wisconsin
WLA = Western Landowners Alliance
WMA = Wildlife Management Area
WNS = White-nose syndrome
WPM = Western pearlshell mussel
WWF = World Wildlife Fund
WY = Wyoming



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"As we progress into the 21st century, anyone who considers themselves a realist will have to make the environment a top priority."

LEONARDO DiCAPRIO

The large, iridescent scales of an Eastern indigo snake