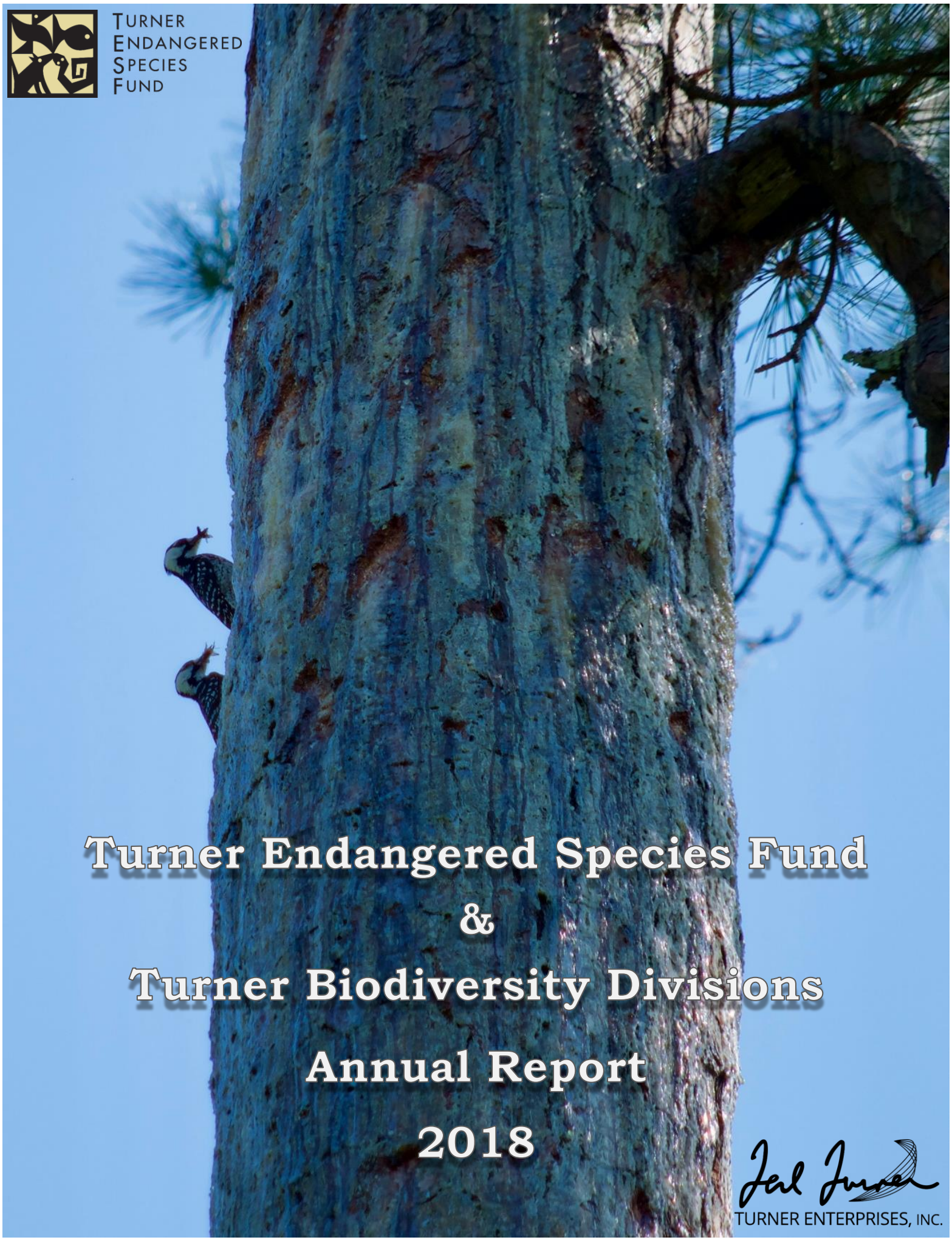
TURNER
ENDANGERED
SPECIES
FUND
Turner Endangered Species Fund
&
Turner Biodiversity Divisions
Annual Report
2018
TURNER ENTERPRISES, INC.

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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

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All photos not otherwise marked are TESF/TBD photos.

Cover photo: *2018 marked the 20th anniversary of TESF's red-cockaded woodpecker recovery program at the Avalon Plantation.*

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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 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.

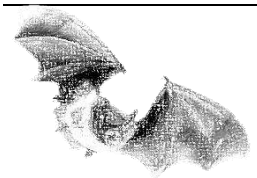
CHENEY GARDNER: Media and Outreach Coordinator, TESF. ***cheney.gardner@tedturner.com*** – Cheney joined TESF in 2016 as the media and outreach coordinator for an education project to advance wolf recovery to Colorado. She attended UNC-Chapel Hill, where she received a degree in journalism after being 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.

Conservation and restoration of native species on Turner properties helps to maintain healthy, functional landscapes …and their essential ecological processes.

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, TNC
- KDWPT
- USFWS

Project Funding – TESF, TBD, KDWPT, USFWS

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.

Strategies – Population surveys, WNS monitoring, and habitat management and improvement will be accomplished through collaboration with current state, federal, and NGO partners while restricting access to caves used by bats will limit the potential for the human-caused spread of WNS.

Supporting Rationale for Objective – WNS, an epizootic disease caused by the fungus *Pseudogymnoascus destructans*, 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. 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 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 2018 – In late March TESF and KDWPT biologists surveyed three Z Bar caves to identify and count hibernating bat species and to collect samples to determine if WNS was present. One bat (cave myotis; Fig. 1.1), in one cave (Rattlesnake Cave), was symptomatic and was subsequently collected and tested. Results confirmed the bat had WNS. The vast majority of bats that occupy the caves at the Z Bar are migratory (Mexican free-tails) and current research suggests the species is not affected by the disease. We will continue biannual hibernating bat surveys at the Z Bar to determine the impacts the disease is having on resident, hibernating bat populations.

Fig. 1.1. Cave myotis with WNS in Rattlesnake Cave, Z Bar Ranch, KS.

Visual population surveys at Merrihew Cave indicate a late August bat population of 115,200 bats living in the cave which translates into >1,500 lbs. of insects eaten every night.

Dr. Laura Kloepper conducted field research at the bat caves on the Armendaris in June 2018, continuing her ongoing project investigating the echolocation adaptations of bats in groups. Kloepper's team, which included researchers from Oxford University, UK, and the University of Notre Dame, also began a new project characterizing the predatory behavior of Swainson's hawks on bats. Additional work included entering the cave to determine an overall health assessment of the colony. At the beginning of June, bat populations were 10% lower than expected at the Armendaris caves. Kloepper contacted Carlsbad biologists, who observed the same population reduction at their location. By the middle of June, populations had returned to expected levels, indicating a delay in the migration of the bat colony. By the end of June healthy newborn bats were evident in the cave. The population of bats appeared healthy with no observable signs of WNS.

Proposed Future Activities and Considerations – It is likely bat populations on all Turner properties will eventually be exposed to *P. destructans*. Currently, there is no treatment for the disease and preventing exposure of bats on Turner properties to the fungus is not practical since transmission is primarily from bat to bat. What we can do for bats living on Turner properties is to limit the potential for humans to transmit WNS by enforcing decontamination protocols for those entering Turner caves, ensuring human activities around bat caves are not detrimental to bat populations, improving existing bat habitat, and improving the overall understanding of bat ecology and behavior through collaborative research and education efforts.

2. BLACK-FOOTED FERRET

Mustela nigripes

ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologist
Dustin Long

Conservation Problem – The near extinction of the black-footed ferret was a direct result of the range-wide decline of their primary prey item – prairie dogs (*Cynomys* spp.). The range-wide loss of prairie dogs, and by extension the black-footed ferret, is attributable to: the invasive disease sylvatic plague (*Yersinia pestis*) and prairie dog eradication programs and habitat fragmentation.

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, 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.

Strategies – The foremost range wide challenge facing black-footed ferret recovery is plague. TESF will assist in efforts to mitigate or prevent the impacts of the disease by supporting and implementing innovative plague management research on Turner properties.

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. Due to the failure of ferrets to survive and reproduce during drought years, and the likelihood that droughts will become more frequent and severe, in 2013 we decided to withdraw from ferret releases for 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). 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.

Supporting Rationale for Objective – Black-footed ferrets are an obligate predator of prairie dogs and prairie dogs historically required bison grazing throughout a large portion of their historic range in order to persist; hence, the black-footed ferret project is a natural fit for many Turner properties and provides the opportunity to merge commodity production and native species conservation and restoration in a single cause. Black-footed ferret habitat restoration objectives on Turner properties can be found in Section X of this annual report.

Project Activities in 2018 – In 2018 the black-footed ferret population at Bad River collapsed in response to a plague epizootic which swept through the prairie dog population. The SPV applied in late 2017 was not effective in preventing or limiting the spread of the disease. In contrast, those areas dusted with Deltamethrin persisted through the epizootic. It remains unclear why the SPV failed to protect the prairie dog population, although the timing of the application may have been a factor.

Proposed Future Activities and Considerations – As demonstrated at Vermejo and Bad River, ferret recovery is inextricably linked to prairie dog conservation and active plague management. Currently there are two options available to mitigate the disease on prairie dog colonies: (1) dust the inside of prairie dog burrows with an insecticide (Deltamethrin) which kills fleas (which serve as the vector for plague), and (2) distribute the SPV on colonies to vaccinate the prairie dogs that eat the bait against the disease. In 2018, we employed both plague mitigation options on Turner properties with only the Deltamethrin application proving itself effective.

In 2019 we hope to participate in the production and field trials of a new plague mitigation tool called 'FipBits'. FipBits will use the same bait matrix as the SPV, but instead of a plague vaccine the active ingredient in the bait will be fipronil (e.g., Frontline®). We hope to help with the production of FipBits by producing the bait in TESF's Bozeman lab, and to perform field trials at Bad River.

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 (*Yersinia pestis*), 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 long-term objective for Gunnison's at Vermejo is to establish a 3,000 – 5,000-acre complex in the mountain meadows surrounding Castle Rock and Bremmer Park. In the short-term, once Gunnison's have reoccupied > 2,000 acres in the complex, we will begin plague mitigation efforts (sylvatic plague vaccine, FipBits, or similar products) and release ferrets.
- At Bad River we will increase the coverage of the ACRA colonies to 3,000 – 5,000 acres using one of the plague mitigation tools listed above.
- At the Z Bar we will continue to investigate methods to increase colony coverage to 1,000 acres at which time we will release ferrets.

Strategies – At Vermejo and Bad River prairie dog restoration efforts hinge on finding an affordable and efficacious tool to mitigate plague. At the Z Bar, where robust vegetative growth often dampens colony growth, we will investigate the use of fire and seasonal bison grazing to stimulate colony growth.

Supporting Rationale for Objective

Prairie dogs (Fig. 2.1) are exquisitely sensitive to plague (Fig. 2.2) and the disease is the primary conservation concern at most black-footed ferret restoration sites including Vermejo and Bad River. Until recently, the only way to mitigate plague was to dust prairie dog burrows with a pulicide to kill fleas which serve as the vector for the disease. This method of plague control is expensive and labor intensive but generally effective; however, there have been instances where colonies have succumbed to plague after having been dusted (e.g., Bad River in 2012) and recent studies suggest that in long dusted areas (> 8 years) fleas have begun to develop resistance to the pulicide.

Recently, federal and state agencies, and NGOs have investigated two additional approaches to plague mitigation. The first is a sylvatic plague vaccine (SPV), which is delivered to prairie dogs through small bait pellets (i.e., prairie dogs that eat the bait pellets are vaccinated against plague; Fig. 2.3). The second plague mitigation tool in development, dubbed "FibBit", uses the same bait matrix as the SPV but with fipronil – a common insecticide applied to pets – as the active ingredient. Prairie dogs that consume a FipBit bait receive a small dose of fipronil which kills the fleas that serve as the vector for the disease.

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

Fig. 2.2. Black-tailed prairie dog Plague mortality in 2018 at Bad River Ranches, SD.

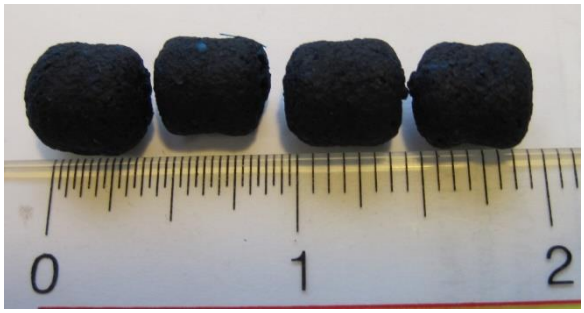


Fig. 2.3: Sylvatic plague is the primary concern related to prairie dog conservation. An experimental method to mitigate the impacts of plague is to vaccinate prairie dogs against the disease using peanut butter flavored baits infused with a plague vaccine. The baits are delivered at a rate of 50 baits 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 engender as much controversy in the American west as prairie dogs. Many landowners view prairie dogs as competitors for a limited grass resource whose presence represents an immediate threat to their livelihood; conservationists view prairie dogs as a keystone species whose presence on the landscape meets the specific habitat requirements of numerous imperiled species. The TESF seeks to find that balance where prairie dogs and associated ecological processes and species assemblages exist in harmony with, and compliment, for-profit endeavors.

Currently, prairie dogs occupy ~3% of their historical range. This significant 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 range wide 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. In total, prairie dog acreage on Turner properties has grown from 725 acres to a maximum of 16,290 acres.

Project Activities in 2018 – In 2018 the black-tailed prairie dog populations at Z Bar and Vermejo Park remained fairly stable at ~ 420 and ~10,000 acres, respectively, while Gunnison's at Vermejo increased slightly to cover ~1,000 acres. The black-tailed prairie dog population in ACRA, which continues to struggle with plague, ended the year at ~ 300 acres scattered over four colonies.

In early 2017 the black-tailed prairie dog complex in ACRA covered ~ 1,800 acres and supported an estimated 22,000 prairie dogs. At that same time the TESF and four other ferret release sites secured a NFWF grant to implement field testing of SPV at the landscape level (> 500 acres; Fig. 2.4). This landscape level treatment was predicted to be the last step in a 10-year process of refining the distribution and licensing of the product. Unfortunately, and for reasons which remain unclear at this time, in 2018 the SPV failed at two of the five sites, including in ACRA, resulting in significant losses of prairie dogs at those locations.

Fig. 2.4. Applying the SPV with a "3-shooter" attached to the front an ATV.

Prairie dog colonies on the Z Bar covered 420 acres in late 2018, a loss of 29 acres from 2017. The largest Z Bar colony, which has been subjected to growing season grazing, grew 4% in 2018. Results from our fertilizer-grazing study suggest that applying fertilizer to the perimeter of colonies to encourage bison grazing in those areas is not an effective method to stimulate colony expansion. What was effective in stimulating colony growth, and what accounts for the 4% growth on the largest colony in 2018, was a prescribed burn followed by bison grazing on the perimeter of that colony.

Proposed Future Activities and Considerations – The future of prairie dog populations at Vermejo and Bad River rests solely on the efficacy and affordability of plague mitigation. Based on the results of 2017-2018's SPV application in ACRA there are questions regarding the vaccine's efficacy which, in combination with the costs (estimated to be $25/acre/year), leaves us uncertain whether SPV is a viable option for future plague mitigation on Turner properties. What does look promising for Turner prairie dogs are the results from recent FipBit trials in MT and AZ. Preliminary data suggests flea loads are reduced to < 1 flea/prairie dog, 9 months after application. Additionally, the cost of FipBits is predicted to be less than $1/acre/year.

In 2019 we will continue to investigate the use of prescribed fire and bison grazing to stimulate colony expansion at the Z Bar. If conditions are suitable, we will burn ~ 100 acres along the perimeter of the largest colony, allow bison to graze the recently burned area, and measure the colony growth in response to these two treatments.

3. BOLSON TORTOISE

Gopherus flavomarginatus
ESA listing: ENDANGERED

PROJECT STATUS
Ongoing

Principal biologists
Chris Wiese
Scott Hillard

Conservation problem – Population decline and contraction of the bolson tortoise range due to collection for food as well as habitat loss. Recent estimates suggest that fewer than 2,000 bolson tortoises remain in the wild. Our bolson tortoise recovery efforts have produced ~500 new bolson tortoises to date, thus contributing a significant boost to worldwide bolson tortoise numbers.

Listing status
- Listed as Endangered under the ESA
- Listed as Endangered under Mexican Wildlife Law
- IUCN Red List Status: Critically Endangered (Rhodin et al, 2011; van Dijk et al., 2014)

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
- 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 – We will use the captive population 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, and exhibit: a male to female ratio of around 1:1, stable or positive population growth, and evidence of reproduction.

Project Background – To prevent the extinction of bolson tortoises in the wild, we are working to establish free-ranging populations on the Ladder and Armendaris ranches in New Mexico. These ranches lie at the northern tip of the species' prehistoric range. The largest and rarest of the six North American tortoise species, the bolson tortoise once ranged throughout most of the Chihuahuan desert, but its current range now comprises only a small area in north central Mexico where the states of Durango, Chihuahua, and Coahuila meet. Due to a suite of political, social, economic, and safety issues, the current status of the bolson tortoise in the wild is largely unknown. The last population survey, conducted in the 1980s, estimated a population of fewer than 10,000 animals. However, continued habitat degradation and loss make it likely that this number has since decreased.

Our starting point for the bolson tortoise reintroduction project was a group of 30 bolson tortoises that were collected and bred over a period of nearly 40 years by a private individual in Arizona. This collection was donated to TESF in 2006: 26 adults (plus 7 hatchlings) were moved from Arizona to the Armendaris to serve as a captive breeding colony for our reintroduction program. Four tortoises (2 males, 2 females) were donated to the LDZG, where they are on exhibit. Successful breeding programs on the Armendaris and at the LDZG have hatched over 800 new tortoises since 2006. Hatchlings and juveniles are kept on native forage in outdoor, predator-proof enclosures until they are large enough to be released (about the size

of the native box turtle, or ~100 mm shell length). Tortoise growth rates depend both on the weather and 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 – providing shelter for myriad other species of mammals, birds, reptiles, and insects.

Project Activities in 2018

Current status of the bolson tortoise project

Our captive bolson tortoise population has 28 adults that serve as the founders for all juveniles produced by the project. To date, we have produced over 840 hatchlings, and as of fall 2018, 537 of these juvenile tortoises were confirmed to be alive, 206 had died, and 66 were unaccounted for and their status unknown. During the period 2012-2018, 164 larger juveniles (shell length > 100 mm) have been equipped with transmitters and moved from predator-proof to predator-accessible enclosures. 118 (72%) of these transmittered juveniles were confirmed to be alive in 2018.

Notable events in 2018

The bolson tortoise project reached important milestones in 2018:

- 83 hatchlings added to the captive population.
- Collaborated with El Paso Zoo to sex bolson juveniles that were hatched from natural nests; the majority were found to be female.
- Hosted Dr. Bob Murphy and Dr. Taylor Edwards and helped them obtain samples for sequencing of the bolson tortoise genome.
- Hosted Dr. Dennis Bramble and Dr. Howard Hutchison, who are studying the relationships between different members of the *Gopherus* species, and their historical distributions.

Captive Breeding Program

Captive adults and subadults

The captive bolson tortoise group on the Turner Ranches consists of 24 adult bolson tortoises: 13 females and 11 males (Table 3.1). An additional 4 tortoises (2 males, 2 females) reside at the LDZG in Carlsbad, NM. In 2018, a new breeding pair was established at the El Paso Zoo. It consists of a large male (EP, found feral in El Paso in 2011) and a large adult female ("Abby Q") that was acquired from the Albuquerque BioPark in February of 2018. EP and Abby Q have not yet produced any offspring. The El Paso Zoo also houses two subadult tortoises that were transferred to the El Paso Zoo from the Turner Ranches in 2010. Lastly, three bolson tortoise subadults from the Turner group were loaned to the Turtle Conservancy in 2017. They reside at the Behler Center in Ojai, CA.

Table 3.1. Adult and subadult tortoises in the 2018 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	Female	Abby Q (adult)
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: adult tortoises

Our approach to managing the adult breeding colony is to be as hands off as possible. We survey this captive group once or twice a year in the spring and in the fall but otherwise leave them alone. Water is provided 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 2018. However, we do continue to intensively manage adult females during nesting season (April – July) to collect eggs each year.

Hatchling production

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.

2018 Egg collection

In 2018, we continued to use a combination of radiography, weight monitoring, and direct observations to determine number and maturity of eggs carried by each female tortoise. This work was also key to timing the transfer of females to an enclosure where nests could be protected while the eggs developed in the ground.

Table 3.2 summarizes the eggs produced and collected (and hatchlings hatched) for each of the adult female tortoises in the Turner group. The tortoises produced a total of 29 clutches in 2018. We collected 28 of the 29 clutches, but Tortoise K deposited her first clutch in the ground before we could keep track of it. We left 12 clutches in the ground for most of the incubation period in 2018, and only transferred the eggs to incubators a few days before we expected them to hatch. We artificially incubated 14 clutches as described below. These 14 clutches were either dug up from natural nests (8 clutches) or were obtained by induced oviposition (6 clutches). Finally, we had 2 clutches that received both treatments, i.e., about half the eggs were incubated in the ground and half the eggs were moved to incubators.

A total of 83 hatchlings emerged from 125 eggs left in the ground or placed in incubators in 2018. All females contributed to this reproductive record (Table 2).

Egg incubation

The locations of nests that were left in the ground were marked so we could find them again, and the eggs were protected with a 1' x 1' mesh to prevent accidental excavation. The nests were also outfitted with HOBO dataloggers to record incubation temperatures. Nests were excavated a few days before they were expected to hatch. A total of 8 nests had live hatchlings or pipping eggs by the time they were excavated.

Table 3.2. Egg production and hatching success in 2018 for each female in the Turner group.

ID	No. of eggs in successive clutches (1^{st} / 2^{nd} / 3^{rd})	No. of eggs recovered & incubated	No. of offspring produced	Hatching success rate
1	5 / 5 / -	10	5	50
2	4 / 3 / -	7	4	57.1
4	5 / 4 / 4	13	10	83.3
A	6 / 6 / 5	17	12	70.6
F	4 / 4 / -	8	4	50
G	9 / - / -	9	3	33.3
J	5 / 4 / -	9	6	66.7
K	4 / 4 / 2	6	6	100
L	3 / 7 / 6	16	13	81.2
P	3 / 3 / -	6	2	33.3
S	5 / 5 / -	6	3	50
T	4 / 5 / -	9	9	100
X	4 / 6 / -	9	6	66.7
Total	**61 / 56 / 17**	**125**	**83**	**-**
Mean	**4.7 /4.3/1.3**	**9.6**	**6.4**	**64.8**

For clutches that were not incubated in the ground, eggs were distributed into 4 incubators and held either at 29˚C to generate males, or at 32˚C to generate females. Eggs remained in the incubators until shortly before hatching, at which point they were 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 absorb residual yolk.

Sexing young tortoises

We collaborated with the El Paso Zoo to sex young tortoises using endoscopy and thus determine the results of our artificial incubation regime. In June of 2018, we used endoscopy on both artificially incubated tortoises as well as ten hatchlings that had emerged from natural nests in 2016. We concluded that all ten naturally-nested individuals were female. Together with previous results, that nine of ten tortoises we had found in the adult enclosures in 2009 and 2010 were male, this result shows that eggs incubated in natural nests in this part of New Mexico can produce both male and female tortoises. This is an important finding as it alleviates concerns about potential problems with temperature-dependent sex determination for Bolson tortoises raised in the northern portion of their prehistoric range.

Hatchlings

Following 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 also generated a photographic record for each hatchling and drew a drop of blood for banking.

A total of 83 tortoises hatched from incubated eggs on the Armendaris in 2018, bringing the total number of tortoises produced by our captive adults to over 800 since project inception. In addition to the 83 hatchlings emerging from known nests or artificially incubated, we also found 3 unmarked small tortoises in the adult enclosure. These animals most likely hatched from nests we did not collect in 2017. All three "found" hatchlings were added to the group of 2018 hatchlings and were transferred to headstart enclosures.

Hatching success rates

Overall hatching success rates vary widely 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 8 years (Table 3.3), and ranges from 53 to 69.4%. The 2018 hatching success rate was slightly above 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
2018	83	125	9	64.8
Mean	**71.4**	**117.4**	**20.6**	**61.4**

Over the past few years, we maximized the number of bolson tortoise juveniles produced to enable the implementation of the next phase of our conservation program – establishing wild populations. A number of factors, including age, size, and number of reproductive years, contribute to the fecundity of each individual female. The number of offspring produced per female, and the number of offspring from each female currently alive, varies nearly 5-fold.

Juvenile headstarting

The strategy of headstarting is 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 while providing ample forage and summer-like temperatures.
- Holding juveniles in covered, predator resistant outdoor enclosures.
- Provisioning tortoises with supplemental food (mostly native forage) and water as needed.
- Surveying juvenile tortoises twice a year (spring/fall) to monitor growth rates and health.

Since 2006, our captive population has grown to about 600 adult and juvenile tortoises in the population at the end of 2018.

Juvenile tortoises were managed in headstart enclosures in 2018 with supplemental feeding and watering. Headstart pen maintenance includes grass-clipping and weeding to remove non-forage plants from the enclosures. Wild globemallow plants and wild grape leaves were harvested from the Turner ranches and provided in the enclosures 3-5 times a week for supplemental feeding.

Tortoise Surveys and Health Checks

We surveyed tortoises in the spring and fall. These health checks revealed that, overall, the juvenile and adult bolson tortoises on the Ladder and Armendaris ranches are in good or excellent health. Health and growth data provide 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 2018.

During growth surveys, we measure tortoise weight, as well as shell length, width, and height. These measurements allow the calculation of growth rates, which are our first

line of defense against problems such as malnutrition, dehydration, and disease. We found ~530 juvenile tortoises alive and well, but could not locate 77 individuals (23 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 32 individuals in 2018. Although this number might appear high, the overall survivorship of bolson tortoise juveniles in our project is around 70%, which is much higher than the 1-3% survivorship reported for wild populations.

Deaths in 2018

We experienced higher than normal rodent-induced mortality during the winter of 2017-2018. The animals that were affected were the smallest juveniles, which either sustained visible shell damage or died of the injuries. Young tortoises were attacked in three different locations: in two stock tanks, and inside the headstart pen. None of these locations have had problems with rodents before. We stepped up our rodent-trapping efforts for the winter of 2018-2019.

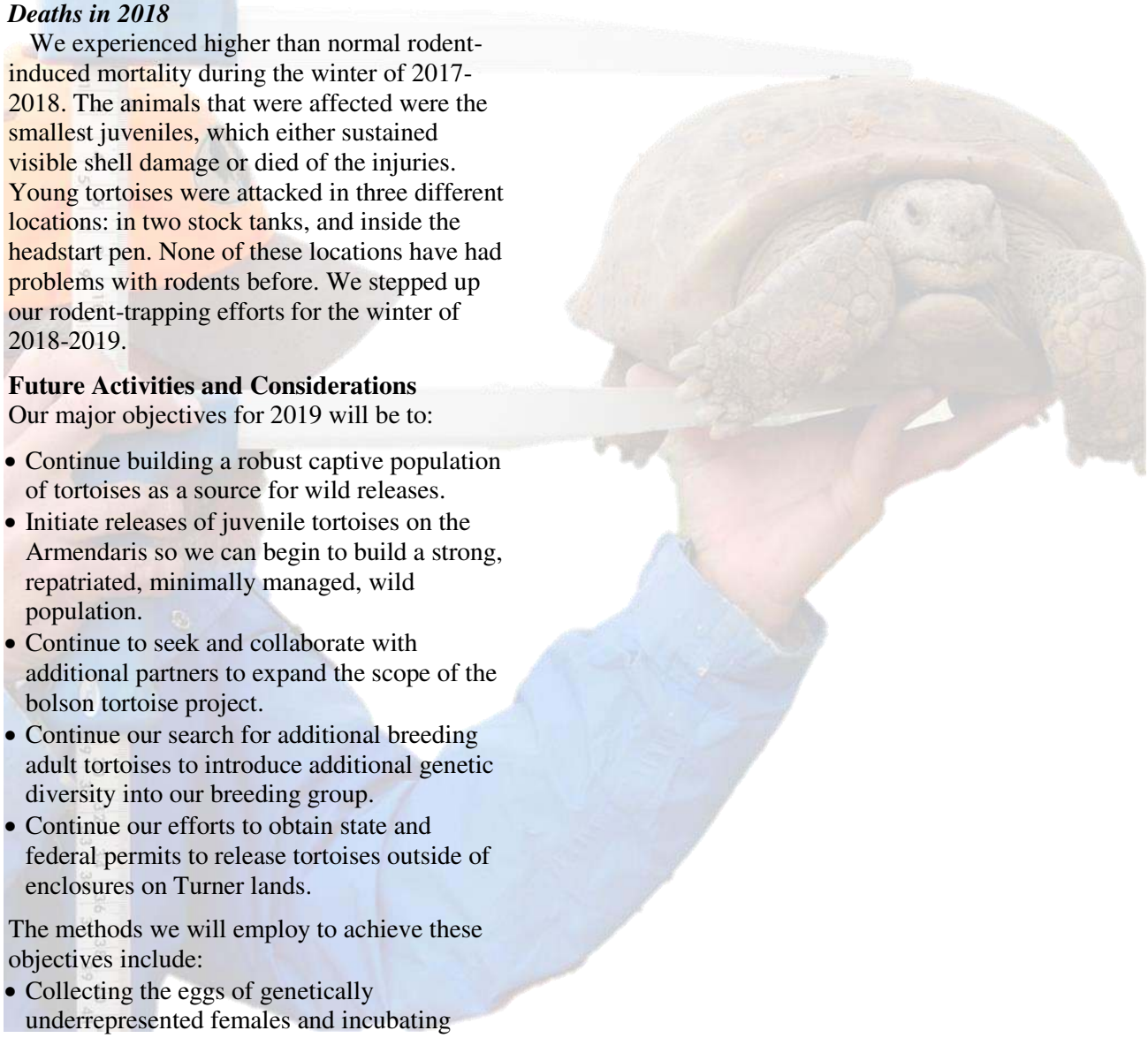
Future Activities and Considerations

Our major objectives for 2019 will be to:

- Continue building a robust captive population of tortoises as a source for wild releases.
- Initiate releases of juvenile tortoises on the Armendaris so we can begin to build a strong, repatriated, minimally managed, wild population.
- Continue to seek and collaborate with additional partners to expand the scope of the bolson tortoise project.
- Continue our search for additional breeding adult tortoises to introduce additional genetic diversity into our breeding group.
- Continue our efforts to obtain state and federal permits to release tortoises outside of enclosures on Turner lands.

The methods we will employ to achieve these objectives include:

- Collecting the eggs of genetically underrepresented females and incubating them to ensure continued robust hatchling production. We plan to leave a large portion of the eggs to develop in natural nests.
- Surveying the tortoise population at least once a year.
- Increasing forage availability in headstart pens by harvesting plants from the environment.
- Enhancing available forage
- Transferring juveniles to predator-accessible enclosures to free up space in the headstart pens.
- Monitoring released juveniles to track survivorship and movements.



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. Jamie Voyles (UNR)

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.

Project Background

TESF has worked in partnership with the USFWS, and the NMDGF to conserve the CLFs on the Ladder Ranch since 2001. The conservation value of the Ladder Ranch's

62,950 ha of diverse habitat in New Mexico cannot be overstated. As home to the last, large CLF population in New Mexico, the Ladder Ranch plays a crucial role in the survival of this species. The ranch is one of four CLF Management Areas within the Mimbres-Alamosa CLF Recovery Unit (Figure 4.1). From a broader conservation perspective, the Chihuahuan Desert Ecoregion is a WWF Global 200 Priority Ecoregion, conservation of which will help maintain a broad diversity of Earth's ecosystems, and the Ladder Ranch itself is recognized as a Key Conservation Area by The Nature Conservancy. Numerous factors are involved in the range-wide decline of this species, including: disease, nonnative species invasions, habitat degradation, and an increase in the severity and duration of drought events. Perhaps in response to reduced natural habitat availability and drying climatic conditions, CLF have been found to naturally colonize man-made livestock water tanks.
This behavior motivated us to adapt these tanks for use as escape-proof CLF refugia. These serve the purpose of temporary holding facilities for small, putatively unique populations that are at high risk of extirpation in the wild.

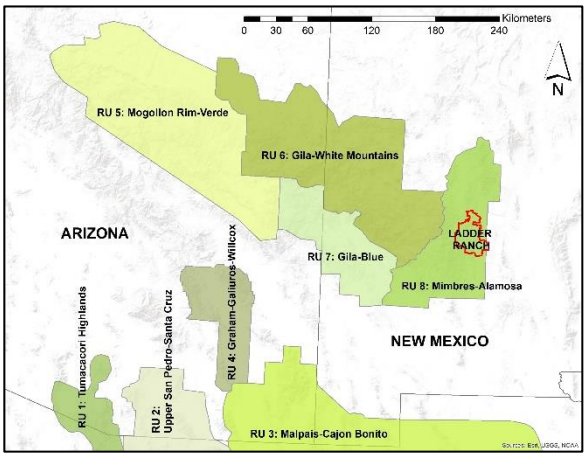


Fig. 4.1. The Ladder Ranch is a CLF Management Area within Recovery Unit (RU) 8.

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 2018

Wild population monitoring

We monitored all known sites occupied by wild CLF during 2018. 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 and frogs have tested positive for *Bd*.

Habitat actions on the Ladder Ranch

- Full pond renovation at Artesia: Removed all cattail and installed pond liner.
- Removed the majority of cattail from Johnson.
- Removed some cattail from N. Seco.
- Tested herbicide on cattail at LM Bar.

Table 4.1. Minimum CLF counts at wild Ladder Ranch sites in 2018.

Site Name	Minimum Counts EM	TP	MM	AD
[a]Circle 7	0	10	20	15
[a]Emrick Spring	0	0	0	0
[b]Davis (Lower)	1	10	8	24
[b]Davis (Upper)	3	10	5	56
[b]N. Seco	38	50	41	155
[b]Pague	36	100	69	43
[b]LM Bar	6	20	19	45
[b]Fish	5	10	12	11
[b]Johnson	69	10	250	285
[b]S. Seco	0	0	0	1
[b]S. Seco tinaja	1	50	2	1
[c]Artesia	9	10	34	9
[d]Cave Creek	0	>100	27	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		

Captive refugia program

During 2018, we translocated CLFs into the captive refugia tanks designated for use by the USFWS (Table 4.2). Additionally, we took South Well offline. All frogs were captured and moved to Wildhorse.

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 2018.

Refugia	Pop.	EM	T	AF
Antelope	Seco	-	-	-
No. 2	Seco	-	80	87
Seco Well	San Fran	-	-	-
Fox	Animas	7	13	-
Avant	Beaver Cr.	-	-	-
Wildhorse	Cuchillo	0	31	42

Overall, refugia tanks designated for both Ladder Ranch and USFWS use produced 63 viable egg masses in 2018 (Table 4.3).

Table 4.3. Egg masses detected in captive refugia in 2018.

Refugia	No. Egg Masses	No. Viable
Antelope	1	1
Seco Well	21	21
Wildhorse	23	23
Fox	9	9
No. 2	9	9
Avant	0	0
No. 16	0	0

Captive breeding: ranarium program

In 2018, 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. CLFs in ranarium cages during 2018.

Cage No.	Source population	No. ♂/♀	Date of entry
1	Open	-	
2	Open	-	
3	Beaver Cr. X	2/0	3/29/11
	Diamond Cr.	0/2	11/2/15
4	ASDM/Kerr	2/0	4/26/12
	N. F. Negrito	0/1	9/18/12
	Divide/LM	1/1	5/6/13
5	Diamond Cr.	2/0	11/2/15
	Beaver Cr.	0/2	3/29/11
6	Blue Cr.	3/1	6/16/14
		0/1	5/1/15
		0/2	11/2/15
7	Moreno Spr.	1/0	6/28/12
	Moreno Spr.	4/1	10/17/12
	Moreno Spr.	0/2	10/29/13
8	Open	-	
9	Las Animas	4/2	6/13/13
	Cave Cr.	1/4	6/13/15
KEY: Cr. = Creek W.S. = Warm Springs Spr. = Springs LM = Long Mesa Metas = metamorphs			

There are ten tadpole rearing tanks in the ranarium, which can hold around 1,000 tadpoles each. In 2018, 44 viable egg masses were transferred from adult cages to tadpole tanks (Table 4.5). Tadpoles from these masses were released into the wild, or into captive refugia holding tanks in consultation with the USFWS (Tables 4.5 & 4.6).

In 2018, the Ladder ranarium produced over 9,000 tadpoles. These tadpoles were released to wild or captive sites across New Mexico on both public and private lands.

Table 4.5. Ranarium egg mass production and management in 2018.

Cage	Source Pop.	# Egg Mass	Egg Mass Laid on	TP Exit Date	TP transferred to
4	San Fran	1.5	4/14/18	6/21/18	Reserve, NM
		0.5	6/3/18	6/21/18	
5	Diamond X Beaver	2	4/8/18	7/31/18	Black Canyon
		1	5/9/18	7/31/18	
		2	6/16/18	7/31/18	
		1	7/19/18	10/9/18	
		0.5	8/12/18	10/9/18	
		1	8/21/18	10/9/18	
		1	9/4/18	10/9/18	
		1	9/9/18	10/9/18	
6	Blue	1	4/18/18	6/7/18	Garcia Tank (JER)
		2	6/14/18	10/4/18	
		1	6/16/18	10/4/18	
		2.5	7/1/18	10/4/18	
		2	7/25/18	10/4/18	
		3	8/14/18	10/4/18	
7	Moreno	1	5/9/18	7/20/18	East Tank, Bear Mountain Lodge
		1	6/3/18	7/20/18	
		1	6/14/18	7/20/18	
		2	7/24/18	10/9/18	
		1	8/14/18	10/9/18	
		1	8/28/18	10/9/18	
9	Animas	1	4/10/18	6/4/18	Cave Creek, Fox
		1	5/10/18	7/12/18	
		1	5/17/18	7/12/18	
		1	6/3/18	6/4/18	
		1	6/7/18	6/8/18	
		1	6/14/18	6/15/18	
		1	7/4/18	8/13/18	
		1	7/6/18	8/13/18	
		1	7/15/18	8/13/18	
		1	7/30/18	7/30/18	
		3	8/26/18	8/27/18	
		1	8/28/18	8/30/18	

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

Table 4.6. Production and disposition of offspring produced at the ranarium in 2018.

Date	Source	EM	TP	Meta	Release type
6/4/18	Animas	1	411	-	W
6/4/18	Animas	1	-	-	W
6/7/18	Blue	1	450	-	C
6/7/18	Animas	1	-	-	C
6/15/18	Animas	1	-	-	C
6/21/18	San Fran	2	161	-	W
7/12/18	Animas	2	723	-	W
7/20/18	Moreno	3	1852	-	W/C
7/31/18	Beaver x Diamond	5	585	5	W
7/31/18	Animas	1	-	-	C
8/13/18	Animas	3	13	-	C
8/27/18	Animas	1	-	-	C
8/27/18	Animas	2	-	-	W
8/30/18	Animas	1	-	-	W
10/4/18	Blue Cr	10.5	2066	5	C
10/9/18	Beaver x Diamond	4.5	1869	2	W
10/9/18	Moreno	4	1307	3	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

Drought Study

We collaborated in an ongoing study with Jamie Voyles (UNR) on a federally funded project to investigate climate and disease dynamics in amphibian *chytridiomycosis*. At the Ladder ranarium, we maintained 9 mesocosm tanks (Fig 4.2), with 40 tadpoles in each, that simulated different drought treatments. Once these tadpoles metamorphose, they will be sent to UNR for *Bd* exposure. We had hoped that all tadpoles would metamorphose by October 2018 but that did not occur. In November, we raised the mesocosm water levels back up to the starting level of 40cm to overwinter the tadpoles.

Fig. 4.2. Drought/disease experiment tanks at the Ladder ranarium.

Sperm Cryopreservation

In May of 2018, a team from Mississippi State University and the Ft. Worth Zoo came out to collect sperm from both wild and captive frogs (Fig. 4.3). The goals were to see if (1) Sperm can be collected and preserved from CLF, and (2) whether the collected sperm may be used to conduct successful IVF in captive females. Overall everything was a success: we achieved good fertilization rates using the frozen/thawed sperm, however, many tadpoles died during development. We hope to continue working with the group to refine the methods.

Fig. 4.3. Sperm collection and preservation.

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.

Objectives – 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. Chupadera Springsnails.

Strategies – Our approach to providing a more secure future for CSS is founded on four basic tenets: 1) secure and improve CSS habitat at Willow Spring, 2) maintain the existing CSS population at Willow Spring, 3) continue with existing habitat and population monitoring programs as a means to understand CSS life history, and 4) establish a CSS refuge population at the Albuquerque BioPark.

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. Willow Spring.

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. Quarterly surveys since 2017 have indicated a robust CSS population with some seasonal fluctuations.

Project Activities in 2018

In 2018 we continued quarterly CSS population (Figs 5.4 & 5.5) and habitat surveys at Willow Spring. Since fencing out cattle in late 2017 the physiochemical properties at the spring have stabilized and the total wetted area around the spring run (i.e., springsnail habitat) has increased. In addition, the increased dampness around the spring has benefitted native sedges and rushes to the exclusion of the once dominant and non-native Bermuda grass (*Cynodon dactylon*). Willow Spring surveys over the last year suggest a CSS population of 2,243,700 individuals with the majority of these individuals occupying a 40-meter stretch along the lower end of the spring.

In late 2018, TESF and the Albuquerque BioPark Aquatic Conservation Center finalized a $10,000 agreement with NMGF to begin the process of developing the facilities and expertise necessary to maintain imperiled New Mexico springsnail species in captivity. The first endangered springsnail species to be included in the refuge program will be the Chupadera springsnail.

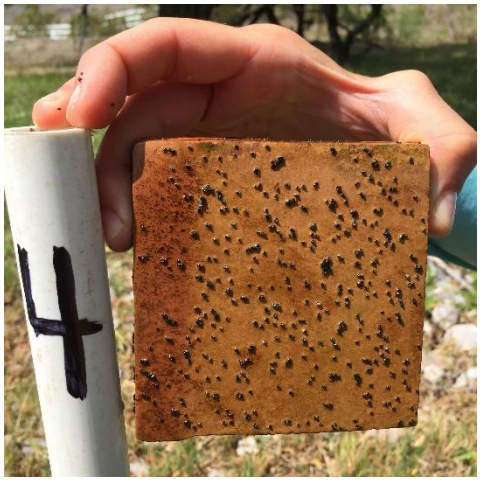


Fig. 5.4. Chupadera springsnail population monitoring.

Fig. 5.5. Chupadera springsnail population monitoring.

Proposed Future Activities & Considerations

In the coming years we will continue with quarterly CSS population and habitat surveys and in the process attempt to observe or infer life history milestones. By early 2019 we will have constructed aquariums at the Albuquerque BioPark Aquatic Conservation Center which we will then inoculate with spring water and substrate and soon after two surrogate springsnail species collected from Alum Spring in the Gila Wilderness. We will monitor the two surrogate springsnail species throughout the year and if there is evidence to indicate the replicated aquarium habitat is suitable and the population is self-sustaining, we will begin the administrative process necessary to bring CSS into captivity.

6. EASTERN INDIGO SNAKE

Drymarchon couperi

ESA listing: THREATENED

Conservation Problem – Eastern indigo snakes are listed as threatened under the Endangered Species Act, having suffered declines due to a variety of factors:

- habitat loss through construction, logging, and agricultural activities,
- removals from the wild for the pet trade,
- gassing of gopher tortoise burrows by rattlesnake hunters,
- loss of underground refuges (i.e. gopher tortoise burrows) on the landscape as a result of gopher tortoise population declines.

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.

Project Activities in 2018

To inform the decision-making process of whether to proceed with a long-term eastern indigo snake recovery program at the Avalon Plantation, which involves restoring gopher tortoises to the landscape, we assembled a comprehensive, science-based review of our eastern indigo snake strategy, including recommendations for restoring indigo snakes to Avalon. An abbreviated version of this report follows.

REPORT AND RECOMMENDATIONS FOR RESTORING EASTERN INDIGO SNAKES TO AVALON

Goal – Restore a viable population of about 75-100 eastern indigo snakes to the Avalon Plantation to contribute towards federal recovery objectives for the species. To achieve this goal, there are several major objectives that must be accomplished:

- Restore gopher tortoises to 1,000 acres of Avalon Proper – at a target density of about 2 tortoises/acre – to create eastern indigo snake winter habitat.
- Reintroduce indigo snakes to a 15,264-acre reintroduction site that incorporates Avalon's St. Joe, St. joe "420", Proper, and Magnolia management units.
- Work with Avalon Plantation personnel to minimize impacts on quail hunting.
- Develop a Candidate Conservation Agreement with Assurances for gopher tortoises and a Safe Harbor Agreement for indigo snakes to provide regulatory certainty for management of the property.

Project Mandate

Over the past 40 years, Ted has consistently demonstrated a desire to restore indigo snakes to his properties. He pioneered an early effort by releasing indigo snakes on St. Phillips Island in the 1980s (Fig. 6.1), but they gradually disappeared until last sighted in 2007. These snakes failed to establish due to the island's small size (4,680 acres) and insufficient habitat. Ted then tasked TESF with recovering indigo snakes in 2007. We developed a strategy for recovering indigo snakes on the Avalon Plantation, which Ted approved in 2011, 2013, 2014, and 2016.

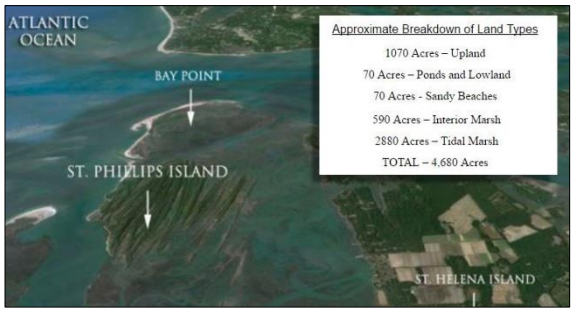


Fig. 6.1. Seventeen indigo snakes (10 adults, 7 juveniles) were released on St. Phillips Island in the 1980s in the first effort to reintroduce the species to a Turner property.

Indigo Snake Habitat Requirements

The eastern indigo snake is a wide-ranging predator closely associated with xeric upland longleaf pine-wiregrass habitats, and the burrows of gopher tortoises, which may inhabit these upland areas. This association is especially pronounced in the northern portions of the species' range (north of Gainesville, FL). Indigo snake populations have continued to decline since federal listing in 1978 (USFWS 2008). These declines are primarily attributed to habitat loss and degradation caused by development, fire exclusion, agriculture, and conversion of native longleaf pine habitats to commercial plantations of off-site pine species (USFWS 1978, 2008).

Gopher tortoise burrows, along with other underground shelters, are used by indigo snakes as protection from temperature extremes, fire, and predators, and may also be used for foraging, shelter prior to ecdysis, and nesting (Landers and Speake 1980, Moler 1992, Stevenson et al. 2003, Hyslop 2007, Hyslop et al. 2009). The association of indigo snakes with tortoise burrows is especially pronounced from late fall through early spring, which includes the indigo snake's breeding season from October–February (Speake et al. 1978, Diemer and Speake 1983, Hyslop et al. 2009). Evidence suggests that indigo snakes may spend on average approximately 76% of their time underground, (Hyslop et al. 2009) and that tortoise burrows may be a limiting factor for indigo snakes in the northern portion of their range (Diemer and Speake 1983, Hyslop et al. 2009). Outside of the breeding season, and during their period of greatest activity with respect to movements and foraging, indigo snakes may use a variety of other habitats, including pine flatwoods, mixed pine-oak forests, bottomland forests, and other freshwater wetlands (Speake et al. 1978, Landers and Speake 1980).

The general seasonal pattern of indigo snake movements between xeric uplands in winter and low-lying wetlands in summer mean that this species depends on large, intact, protected landscapes that contain a diverse matrix of habitat types. Indigo snake home ranges can therefore be very large, with a recent study estimating annual home range sizes of 82 to 3,776 acres (average = 887 acres) for wild indigo snake individuals in the northern part of their range (Hyslop et al. 2014).

Project Location

The 30,000-acre Avalon Plantation is one of the finest quail hunting plantations in the Southeast, with 16 quail hunting courses covering an area of 10,439 acres (Fig. 6.2). This is also Ted's only property with the potential to support indigo snakes. A 15,264-acre area that incorporates 14 quail courses could serve as an indigo snake reintroduction site (Fig. 6.3) due its sufficient size and suitable mix of dry uplands and wet lowlands (Fig. 6.4) – although there are currently too few gopher tortoises for it to qualify as an indigo snake reintroduction site. Achieving the indigo snake recovery mandate therefore first requires restoring gopher tortoises to Avalon Proper.

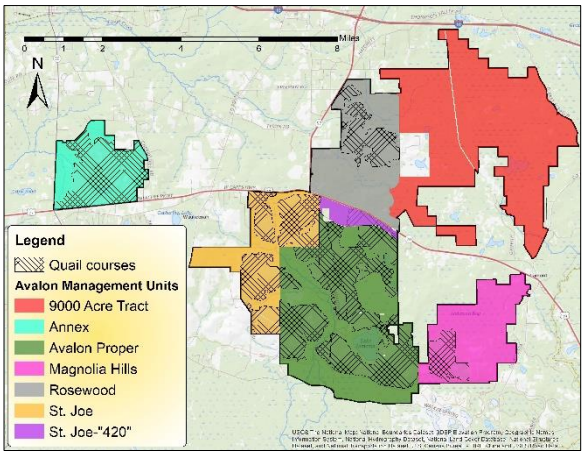


Fig. 6.2. The management units that comprise the Avalon Plantation, and the distribution of the 16 quail hunting courses that collectively cover 10,439 acres of the property.

Nexus of Quail and Gopher Tortoise Management, and the Conservation of Biological Diversity

Since the 1960s, quail numbers have declined substantially in the Southeast due to changes in land use and the reduction of frequent fire on the landscape. To illustrate this decline, around 7 million wild quail were harvested annually in Georgia and Florida in the 1960s compared with fewer than 100,000 today.

Dedicated land stewardship and the application of quail management on properties like Avalon have helped quail populations rebound in recent years. Creating quail habitat also benefits other imperiled species, and privately-owned quail lands are often a bastion for threatened species. With over a million acres of private lands in the Southeast managed for quail, and Avalon itself contributing 10,439 such acres, there is a considerable conservation value associated with Turner quail management.

Private lands will play an increasingly important role in determining the fate of rare species in Florida. For example, over 80% of gopher tortoise habitat is in private or corporate hands, and therefore the status of this species, and by extension that of eastern indigo snakes, is largely dependent upon land management decisions made by private landowners.

Quail and gopher tortoises are natives of the longleaf pine forests that once dominated the landscape of the Southeast. Avalon's intensive quail-centric management mimics the 1 to 3-year fire regime that historically maintained the fire-climax community of an open-canopied pine forest with diverse understory vegetation needed by both quail and tortoises. From an ecological perspective, gopher tortoises are a particularly important member of this ecosystem – they excavate burrows that serve as refuges for over 300 species of vertebrates and invertebrates, and they are an effective grazer of the foliage and fruits of the lowest plant strata making them important seed dispersers with a key role in maintaining herbaceous diversity in the pine-grassland ecosystem. We believe it is important to acknowledge that quail and tortoises are part of the same ecological community and that managing for both will improve the resiliency of Avalon's ecosystem.

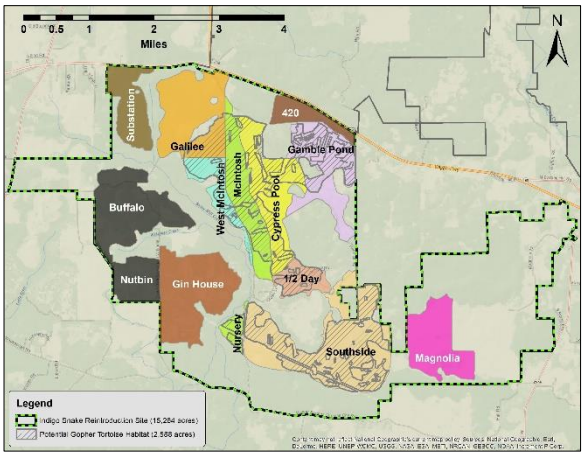


Fig. 6.3. The 14 quail hunting courses (filled colored polygons; text labels indicate course name) covering a total area of 7,585 acres, and potential gopher tortoise habitat (gray hatched polygons) within the proposed 15,264-acre indigo snake reintroduction site (black-green dashed line). White quail course labels represent courses that do not overlap with potential gopher tortoise habitat. Black quail course labels indicate courses that overlap with potential gopher tortoise habitat.

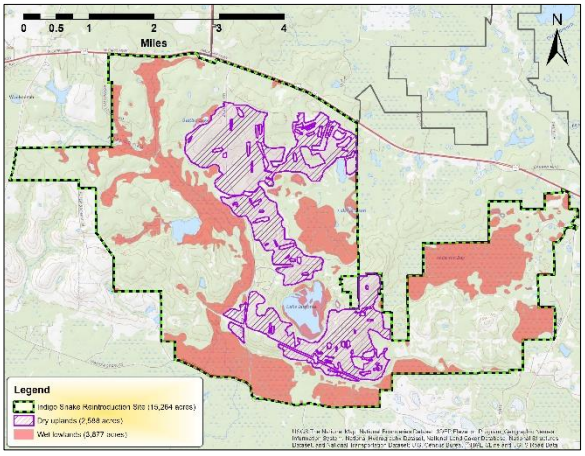


Fig. 6.4. Proposed indigo snake reintroduction site, showing the distribution of winter (dry uplands) and summer (wet lowlands) indigo snake habitat. The dry uplands shown represents only potential habitat since there are currently too few resident gopher tortoises within these areas to support indigo snakes.

Project Background & Activities

Collaboration with The Orianne Society

The Orianne Society initiated a broad-based approach for eastern indigo snake recovery that involved the creation of the Orianne Center for Indigo Conservation (OCIC) in 2012. The OCIC uses captive-breeding to produce indigo snakes for reintroduction.

In 2014, TESF collaborated with Dr. Chris Jenkins, Chief Executive Officer of The Orianne Society, at the Avalon and Nonami

plantations to evaluate the potential of these properties to contribute towards indigo snake recovery. We concluded that only Avalon Proper had sufficient potential to serve as an indigo snake reintroduction 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 15,264-acre indigo snake reintroduction site, with lowland wetlands comprising around 20% of the total area, thus meeting indigo snake reintroduction site criteria. Despite the presence of 2,588 acres of suitable dry uplands in this area (Fig. 6.4), there are currently insufficient gopher tortoises to provide indigo snakes with crucial winter habitat.

Annex Gopher tortoise restoration

In 2013 and 2014, we surveyed the Annex and mapped the burrow locations (Fig. 6.5) of the small remnant tortoise population. An assessment of the occupancy status of these burrows indicated that a minimum of 136 gopher tortoises occupied the Annex (Table 6.1). To restore a viable tortoise population at the Annex we implemented a series of recovery measures from 2014-2017: An *Unprotected Recipient Site* (Fig. 6.5; Table 6.1) was established, three temporary soft-release pens were constructed by Avalon staff, and we implemented translocations of Incidental Take Permitted (ITP) tortoises (Box 6.1). This effort had 4 objectives: **(i)** restore a viable Annex population; **(ii)** save tortoises from entombment by development; **(iii)** develop our expertise and build partnerships; and **(iv)** set the stage for indigo snake reintroductions at Avalon Proper.

Tortoises translocated to Avalon riding out Hurricane Michael with the biologists before their soft-release at the Avalon Nursery on October 10th, 2018.

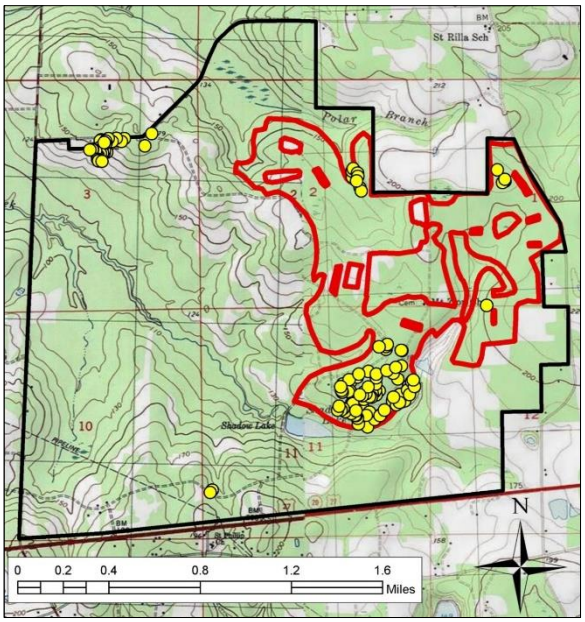


Fig. 6.5. The Avalon Annex's remnant gopher tortoise burrows (yellow points) that were mapped in 2013/14. An *Unprotected Recipient Site* (red polygon) was designated in 2014 to receive translocated tortoises from development sites in Florida with ITP permits.

Avalon Proper Gopher Tortoise Restoration

In 2013, we examined the suitability of Avalon Proper for gopher tortoises. Soil type is one of the most important factors that determines habitat suitability; tortoises require xeric, well-drained, sandy soils that facilitate burrow construction. We used data from the Natural Resources Conservation Service Web Soil Survey to evaluate Avalon's soils profile. Soils acceptable for gopher tortoise occupancy have the following characteristics: **(i)** moderately well-drained to excessively well-drained, and **(ii)** depth to water table of 45 cm or greater (FWC 2017).

In 2013 and 2014, we surveyed Avalon Proper for tortoise burrows to identify the extent of the gopher tortoise population. An assessment of the occupancy status of located burrows indicated at least eight tortoises were present on Avalon Proper (Table 6.1).

Table 6.1. The number of burrows found in 2013/2014 on Avalon Proper and Annex management units (MUs). Burrows were categorized as Active or Inactive, and the number of these that were occupied (O), empty (E), or undetermined (U).

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

Box 6.1. Gopher Tortoise 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.

Tortoises relocated to a recipient site must be "soft-released" within a temporary enclosure for a minimum period of six months There are three recipient site categories that offer potential avenues for relocating gopher tortoises to private lands:

Long-term Protected (LTP) Recipient Sites - The LTP system is a market-based approach that mitigates the impacts of development on gopher tortoises by requiring developers to pay to have tortoises relocated out of harm's way to designated LTP sites before any land clearing or development occurs on their habitat. With the designation of an LTP Site at Avalon, TESF would receive remuneration from developers (e.g. $500/tortoise) for accepting tortoises at the LTP Site. Establishing an LTP site at Avalon would require a habitat management plan and a perpetual easement. Additionally, LTP 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, an 800-acre LTP site on Avalon Proper that requires $20/acre per year for management would require an endowment of $400,000 (see Table 3). This may be fully funded up front or incrementally funded as tortoises are 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.

Short-term Protected Recipient Sites - These involve less stringent requirements in terms of the placement of an easement and financial assurances, although there are some enforceable protection commitments. However, this type of recipient site is less likely to receive tortoises given FWC mitigation fees that provide a ten-fold economic incentive for developers to use Long-term Recipient Sites.

Unprotected Recipient Sites - Provides relocated tortoises protection for at least two years and requires 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. Avalon currently has two unprotected recipient sites: Annex Recipient Site and Nursery Recipient Site which together have received 558 ITP tortoises since 2014.

In 2016, we carried out intensive surveys across 800-acres of Avalon Proper to determine extant tortoise populations levels. During this fine-scale survey work, we found 23 abandoned burrows and 20 potentially occupied burrows (Fig. 6.6). This survey included a detailed examination of the 50-acre Nursery site which, in consultation with Avalon management, was selected as Avalon Proper's first ITP tortoise recipient site (Fig. 6.6). During the Nursery survey, we mapped the extent of potentially occupied and abandoned tortoise burrows. We then worked with FWC to designate this 50-acre Nursery area as an *Unprotected Recipient Site* for the relocation of ITP tortoises (Fig. 6.6; Box 6.1). With the help of Avalon staff, we constructed three soft-release pens, and translocated 142 tortoises to this site from 2016 to 2018 (Fig. 6.7). The integrity of each temporary pen was maintained for a year after its last tortoise was added, then removed.

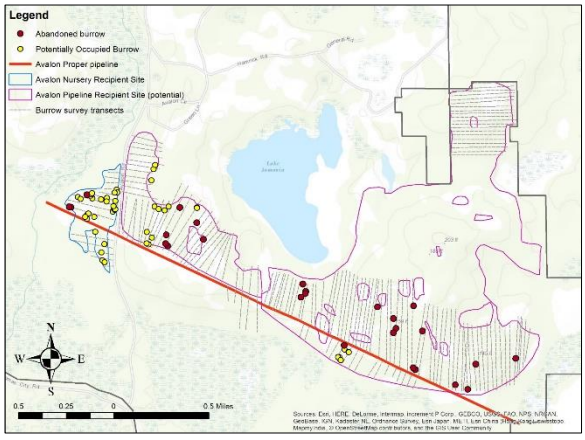


Fig. 6.6. Part of Avalon Proper was surveyed in detail using transects in 2016. The 50-acre Nursery ITP Recipient Site, and a suggested second recipient site (i.e. Avalon Pipeline Recipient Site) are shown.

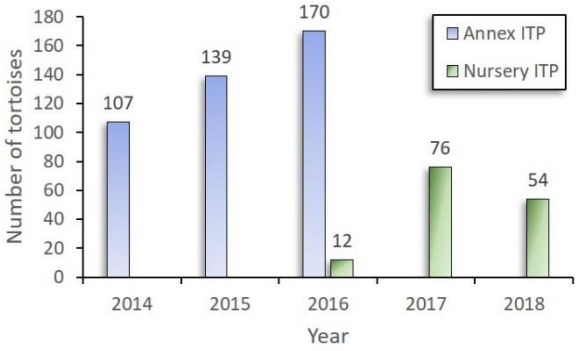


Fig. 6.7. Number of ITP gopher tortoises translocated to *Unprotected Recipient Sites* on the Avalon Annex (Annex ITP) and Avalon Proper (Nursery ITP) from 2014-2018.

With successful restoration of gopher tortoises to the Nursery area, we have made encouraging progress towards restoring the species to 1,000 acres of Avalon Proper, and rebuilding Avalon's capacity to support indigo snakes. There are over 2,500 acres of dry uplands on Avalon Proper which already meet FWC's criteria for desirable gopher tortoise habitat (Table 6.2). This is therefore an exceptional area for restoring Avalon's tortoise population that would contribute to the security of the species in Florida. Our next step will be to work with Avalon's managers to identify additional areas of Avalon Proper to reach our goal of a 1,000-acre tortoise restoration area on this part of the property.

During planning work for expanding Avalon Proper's gopher tortoises beyond the Nursery, we reviewed the various recipient site options (Box 6.1). Our previous success with translocating ITP tortoises to the Annex and Nursery, and the ethical considerations of aiding in the rescue and relocation of these doomed ITP tortoises, mean that this strategy should play a role in expanding Avalon's tortoise population. However, we suggest diversifying our approach to restore tortoises across 1,000 acres at a quicker pace. This could be achieved by supplementing the *Unprotected Recipient Site/ITP* model with the *Long-Term Protected (LTP) Site* (Box 6.1) approach, which has the capacity to translocate relatively more tortoises on an annual basis, thereby facilitating a more rapid restoration of indigo snake habitat. Our goal involves restoring tortoises to at least 1,000 acres of Avalon Proper, and we recommend implementing a combined ITP: LTP approach at a ratio of 1:4, in which 200 acres of Avalon Proper is designated as an ITP recipient site, and 800 acres as an LTP site (Table 6.3). It is important to note that these ITP and LTP recipient sites need not be contiguous, and there is a great deal of flexibility in their placement within Avalon Proper's 2,500 acres of potential tortoise habitat. Similarly, the arrangement of temporary soft-release pens used within these recipient sites to hold relocated tortoises for a 6-month period may be large or small, and would be positioned in consultation with Avalon managers to reduce interference with quail management operations.

Table 6.2: Desirable criteria thresholds for gopher tortoise habitat within gopher tortoise restoration areas (FWC 2017).

SITE CHARACTERISTIC	DESIRABLE CRITERIA
Size	> 250 acres
Soil	> 130 cm (51.6 in) DWT
Habitat	> 50% herb cover < 40% canopy cover No improved pasture
Maximum Allowable Gopher Tortoise Density	Four tortoises per acre

Table 6.3: Recommended strategy, with estimated major costs and revenues, for implementing gopher tortoise restoration at Avalon Proper (using a combination of 80% LTP and 20% ITP approach) to form part of a larger indigo snake reintroduction site at the Avalon Plantation.

Location	Indigo snake Reintroduction Site	Tortoise ITP Site	Tortoise LTP Site	[1]Tortoise Stocking Density	No. of Tortoises	[2]Trust Fund Endowment	[3]LTP Revenue	Net Revenue
Avalon Proper	15,264 acres	200 acres	800 acres	2/acre[§]	2,000	$400,000	$800,000	$400,000

[1] = The number (#) of tortoises is based on: Target Stocking Density * Total Tortoise Site (ITP+LTP) acreage for each scenario. The maximum tortoise stocking density for areas with *desirable* habitat that is permitted by FWC is four tortoises/acre (Table 2).

[2] = The estimated size of the trust fund that assures funding for the long-term management of gopher tortoise habitat within the LTP site is based on an estimated $20/acre annual management costs and assumes a 4% rate of return (e.g. (800 acres*$20)/0.04).

[3] = The revenue generated under each option is calculated using an estimate of $500/ LTP tortoise. This would be a one-time payment to Avalon/TESF for receiving tortoises – once LTP target tortoise stocking densities are met no more revenue would be generated.

§ = Lower proposed stocking density to ameliorate concerns associated with tortoise burrows on Avalon Proper's quail courses.

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, TBD, WAFWA, USFWS

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.

Strategies
- Prescribed fire to improve brood rearing habitat and control woody vegetation. Pastures 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 (Fig. 7.2). 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 2018 – While lesser prairie-chicken sightings at the Z Bar continue to increase, it is unlikely the ranch supports a breeding population. We are fairly certain of this because the annual lek surveys performed by the TESF, WAFWA, and the TNC over the past five years have not detected any leks on the ranch. Additionally, in 2018 TESF made the additional effort to determine prairie-chicken populations on the Z Bar by establishing and monitoring artificial leks (Fig. 7.3) at three sites reported to have been used by prairie-chickens in the past.


Fig. 7.3. Artificial lesser prairie-chicken lek used to verify chicken populations and as a means to congregate the few widely scattered individual birds on the property.

Each artificial lek contained six male decoys, a large speaker transmitting a recording from a "booming ground", and four game cameras arranged to photo capture any chickens attracted to the site. No prairie-chickens were detected on the artificial leks in 2018. Having confirmed with relative certainty the Z Bar does not support a breeding population of lesser prairie-chickens we will begin the process of critically evaluating habitat and population trends to determine whether conditions support translocating prairie-chickens to the ranch.

Results from WAFWA's 2018 lesser prairie-chicken habitat surveys indicate the Z Bar continues to make good progress in restoring habitat. For example, in each of the last four years the ranch has surpassed predicted habitat values. In 2018 we continued to improve and expand lesser prairie-chicken habitat by removing trees using a "ball and chain" (Fig. 7.4-7.6) and prescribed fire.


Fig. 7.4. Six foot "ball and chain" used to remove tree carcasses in the Z Bar uplands in 2018.

Fig. 7.5. Before treatment with "ball and chain" in 2018.

Fig. 7.6. After treatment with "ball and chain" in 2018.

There remains, however, one habitat component--brood-rearing habitat—which may be population limiting at the ranch. To remedy this shortcoming, we petitioned and received permission from WAFWA to increase bison grazing in 2019 which, in combination with an increase in prescribed fire, should result in an increase in that specific habitat type.

Proposed Future Activities & Considerations

The direction of the lesser prairie-chicken project at the Z Bar hinges on whether we are able to document reproduction and an increase in the population over the coming years. Existing habitat evaluation metrics suggest the habitat requirements for the species have been met at the Z Bar, yet the population remains low. Determining why the population remains low—whether due to vegetative composition, vegetative community structure and arrangement, distance from source populations, or a combination of the aforementioned factors, or others—will be examined.

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.

Strategies – We will increase pollinator habitat through milkweed plantings and habitat management. At the Z Bar and Bad River, we will collect local milkweed seeds and broadcast those seeds in unoccupied suitable habitat. At Avalon we will collect swamp milkweed seeds,

germinate them in plug pots and plant them in unoccupied suitable habitat.

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.

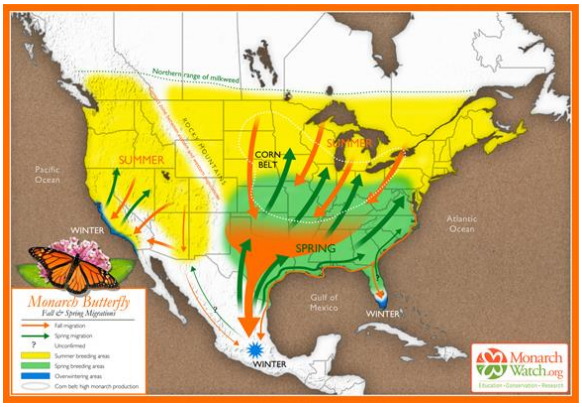


Fig. 8.1. Monarch butterfly migration routes.

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 2018

The local ecotype milkweed planting efforts at Bad River and Avalon, which began in 2016, produced seed pods for the first time in 2018. Some of these pods were collected and prepared for plantings in the spring of 2019.

Locally collected showy milkweed seeds were planted at three locations in the Z Bar wetlands while monarch butterfly surveys at the Z Bar resulted in 1.25 monarch sightings per hour (Fig. 8.4). Upland milkweed surveys at the Z Bar indicate one milkweed stem every 75.6 square meters, or approximately 2,267,599 milkweed stems at the ranch. Four milkweed species were identified on the survey plots and an additional four were noted off the plots. At Bad River we identified two species of milkweed and established showy milkweed at 12 new locations.

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 anticipated. Experimenting with different milkweed species, habitats, and propagation techniques often resulted poor survival. Data collected in 2018 suggests one cause of poor survival appears is browsing on young and vulnerable milkweed stems by bison. Future plantings at Bad River and the Z Bar will focus on areas inaccessible to bison.

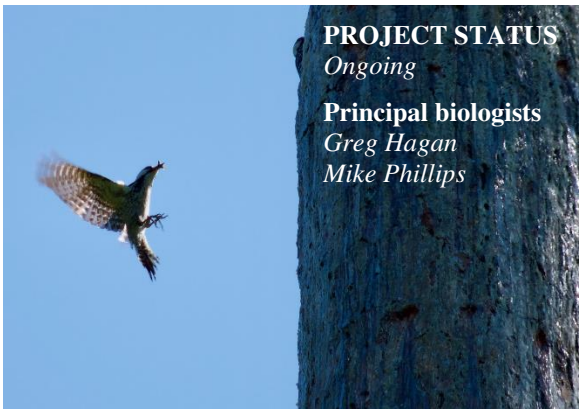
Fig. 8.4. Monarch butterfly larvae on showy milkweed in the Nebraska Sandhills.

Proposed Future Activities and Considerations – Through trial and error we have developed what we believe is a reasonable approach to expanding existing milkweed populations and reintroducing 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 and spreading seed collected from that ranch into those areas. For rare or extirpated milkweed species we will continue to establish new populations using plug plantings.

9. RED-COCKADED WOODPECKER

Picoides borealis

ESA listing: ENDANGERED



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 6 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 20 active groups, 4 inactive groups, and 1 abandoned group by the end of 2018 (Fig. 9.1); the highest number of active clusters on Avalon since project inception.

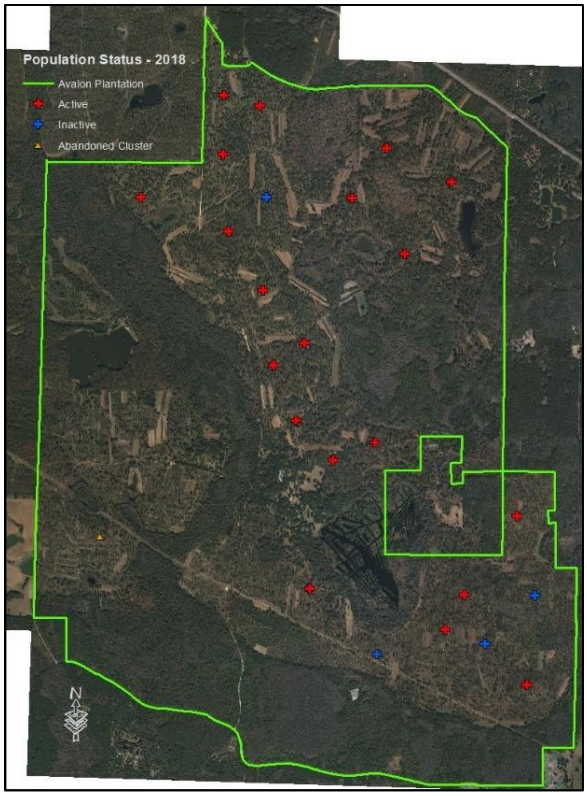


Fig. 9.1. Results of 2018 RCW cluster surveys at Avalon Plantation.

Project Activities in 2018

Cluster Status - Each cluster was monitored throughout the year, usually in January, March, June, and October. Monitoring checks are used to ensure each cluster has the minimum of 4 suitable cavities and for activity status (active or inactive), breeding status and demographics. In addition, more comprehensive surveys where completed in December for evidence of new cavity trees or damage or loss to previously known cavity trees. A total of 25 RCW clusters where located on the property: 20 active, 4 inactive, and 1 abandoned cluster (Fig. 9.1). As previously noted, this represents the highest number of active clusters on the property to date.

Supplemental Cavities – We lost three active cavity trees due to severe lightning and wind events. We therefore installed supplemental cavities in the three affected clusters to maintain a minimum of four cavities per cluster. All clusters/cavities were inspected following any significant weather event.

Cavity Tree management – Cavity tree management focuses on identifying and protecting all cavity trees (artificial and natural) from prescribed fire and minimizes any potential threat from other land management activities. All cavity trees (active, inactive and abandoned) are marked and mowed in advance of burning. A Timber Ax attached to a New Holland TV145 tractor was used for all mowing. This combination worked perfectly – minimal soil disturbance and zero soil compaction. There were enough fine fuels (pine needles, grass, etc.) remaining post mowing, the prescribed fire harmlessly burned under the cavity trees. This approach to fuel management allows the fire to maintain a contiguous burn throughout the area, while ensuring the protection of cavity trees. Approximately 50 acres (2 acres/cluster) were mowed in mid-February in advance of the burn season. All cavity trees were marked (pink flagging) throughout the property prior to mowing and the burn season. No cavity tree mortality or scorch was detected in mowed clusters.

Prescribed Fire – Approximately 60 – 65% of the property was burned in March – April 2018. This is critical in maintaining the open fire forest the RCWs require and limit any hardwood encroachment.

A RCW attending a nest in an active natural cavity on the Avalon Plantation

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 CPW.
- WCT are a Species of Greatest Conservation Need by MTFWP.
- Both subspecies have been petitioned for ESA listing, 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
NMDGF, CPW, MTFWP, USFS, USFWS, BLM, TU.

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

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)
- 2019 US Forest Service ($5,000)
- 2019 Partners for Fish and Wildlife ($65,000)

Table 10.1. Progress towards completing the 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 – Range-wide conservation agreements among management agencies and non-governmental organizations 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 non-governmental organizations; 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 risks inherent with large-scale native trout restoration. 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 in 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 ESA using the following strategy:

- Selection of reintroduction sites encompassing a large geographic area with high quality and diverse habitats to support 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 prevent their 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 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 listing under the ESA 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.

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, 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 United States.

Project Progress

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). 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 restored WCT population from 2012-18 showed that the numbers increased rapidly post-treatment and is now similar to pre-treatment population abundance and average size. 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 on the east side 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 historic 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. 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 between 180 and 360 mm. Anglers are now pursuing WCT in the river and reporting their catches to FWP. In 2016, anglers reported catching WCT in the river as far as 37 km downstream of Cherry Creek.

A Candidate Conservation Agreement with Assurances (CCAA) regarding the Cherry Creek project was signed in 2009. This established that if TBD allowed WCT to be restored 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 incidental take of WCT that may occur during regular ranching or recreational activities if the species was 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.

2018 Cherry Creek Activities – After reaching an all-time high abundance in 2015, electrofishing at long term monitoring sites in 2018 indicated that WCT numbers remain higher than the pretreatment average. A typical fish in Cherry Creek is about 180 mm (7.5”), consistent with the long-term average (Fig. 10.1). Conservative estimates put the population at a minimum of 50,000 fish. Not surprisingly then, anglers reported high catch rates on Cherry Creek in 2018. 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, although this work was scaled back in 2018. 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 will be published in 2019. TBD maintained a partnership with University of Idaho to assist with genetic analyses. Yellowstone National Park requested, and was granted permission to collect WCT eggs from Cherry Creek for restoration projects in the park.

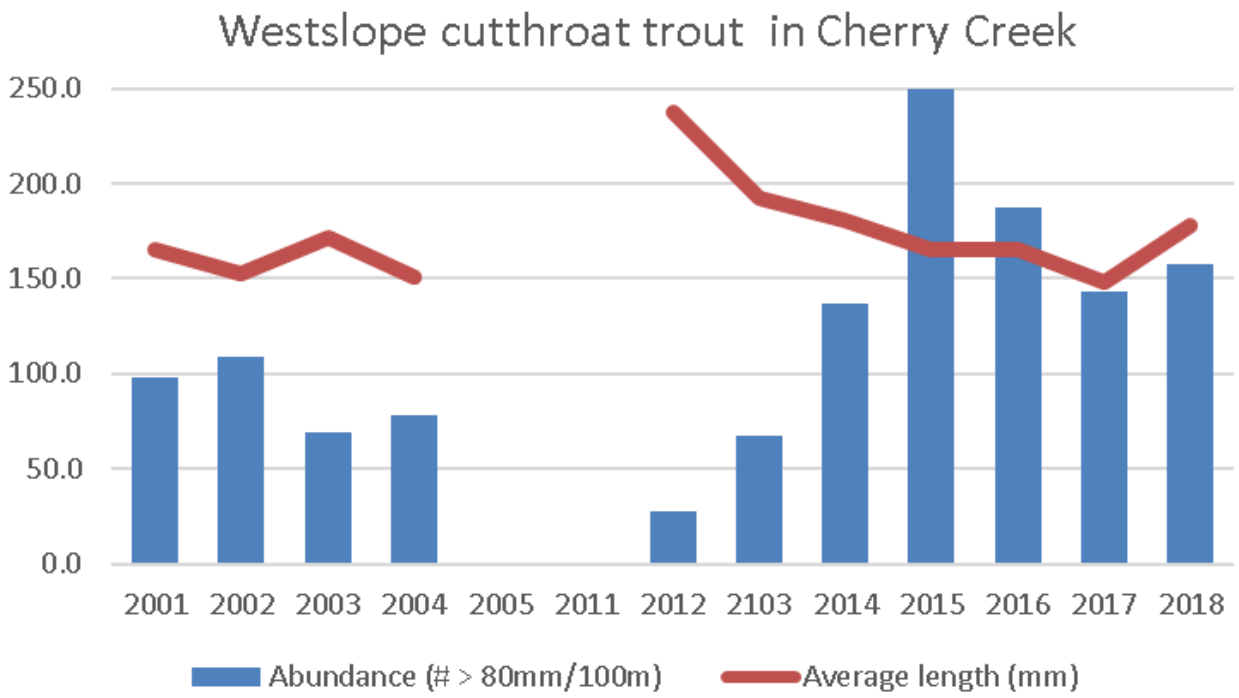


Fig. 10.1. The average number and size of all trout >80 mm (3") at time of capture per 100 m sampling reach in Cherry Creek pre- and post- treatment.

Costilla Creek – The Costilla Creek Native RGCT Project on Vermejo Park Ranch (VPR) in New Mexico and Colorado is the most ambitious watershed renovation project ever initiated on behalf of any cutthroat trout to date, encompassing approximately 175 km of stream habitat (60% on VPR, 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 2nd 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 within their historical range.

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.

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) despite three different rotenone applications since 2002 (Fig. 10.2), 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 VPR should the species become listed under ESA.

2018 Costilla Creek Activities – We continued to focus on RGCT population recovery in the reservoir and lower portions of streams treated for the last time in 2016. Approximately 338,000 RGCT were stocked in the project area in 2018. A large portion of these were age-0 fish put into Costilla Reservoir (~266,000), but additional age 0-2 fish were stocked into lower Costilla and Casias creeks (Table 10.2).

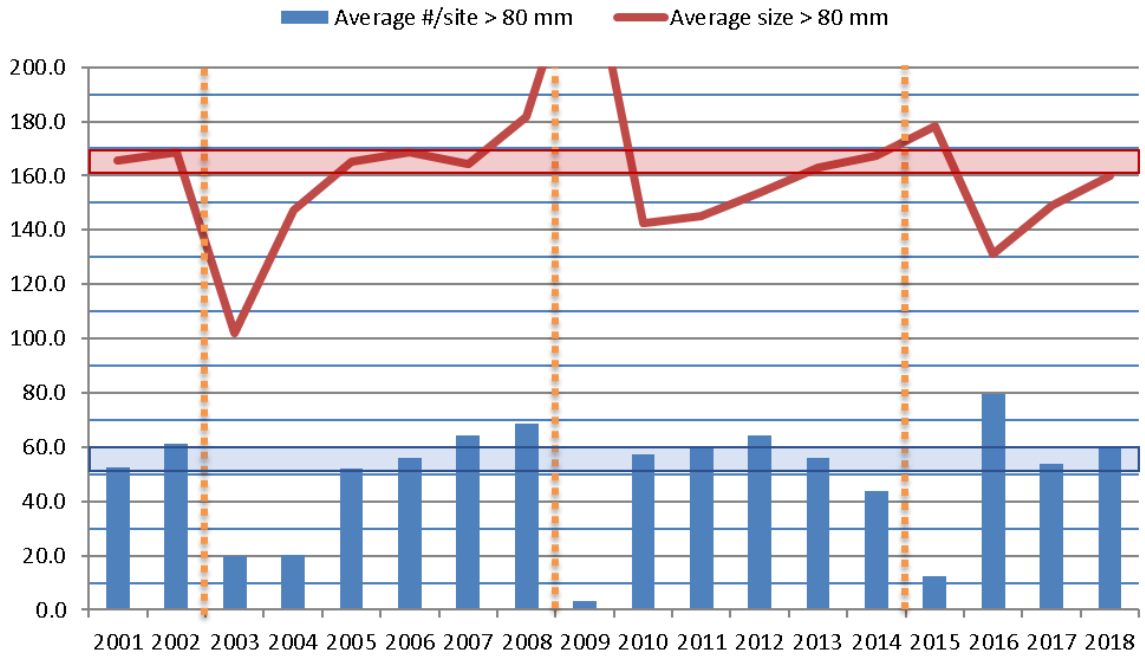


Fig. 10.2. The average number and size of all trout > 80 mm (3") at time of capture per 100 m sampling reach in upper Costilla Creek. This area has been treated with piscicide three times (dotted lines): 1) original treatment in fall 2002; 2) treatment in fall of 2008 to remove rainbow hybrids that were accidently stocked by NMDGF; and 3) treatment in fall of 2014 to remove Colorado River cutthroat trout. The graph shows how the trout population has returned to the expected number and size (red and blue shaded based on historical averages) each time after treatment.

Table 10.2. Rio Grande cutthroat trout stocking in Costilla watershed in 2018.

Date	Water	Mean Total Length (in)	Age	Number Stocked
4/26/2018	Costilla Reservoir	3.5	1	16,342
5/2/2018	Casias Creek	9.2	2	796
	Costilla Creek	9.2	2	802
8/21/2018	Casias Creek	1.5	0	39,800
	Costilla Creek	1.5	0	20,000
	Costilla Reservoir	1.5	0	250,000
	Upper Costilla Creek	1.5	0	10,000
			Total	**337,740**

Guides and guests reported that angling was good in the project area in 2018 even though the population is still recovering in the reservoir and lower stream reaches. Population monitoring continued in the upper portions of the watershed and the data continue to show that fish abundance and size have recovered to pre-project levels (Fig. 10.2). No non-native trout were detected during population monitoring with electrofishing and environmental (e)DNA samples also did not detect any non-native trout presence, providing additional evidence that the treatments were successful. Permitting for removal of the temporary fish barriers installed to facilitate treatment was completed and barrier removal will begin in 2019.

Vermejo River – This is the only project in the *Cutthroat Trout Initiative* where aboriginal 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 1 rainbow trout (from Leandro Creek in 2015) were removed from the watershed 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 fishing lakes via overflow. A focused effort was made in 2017 to detect and remove rainbow and hybrid rainbow *x* cutthroat trout from Leandro Creek. In 2017 a 15 km section of Leandro Creek was intensively shocked to remove all brook trout, as well as any other fish 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. VPR has been encouraged to monitor lake water levels more closely and screen lake outlets to prevent escape. TBD is working with VPR 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 or hybrid 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.

In 2017, TBD and VPR 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 normal XY male offspring. A successful outcome could provide an alternative to chemical removal of brook trout.

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 New Mexico Partners for Fish and Wildlife (US Fish and Wildlife Service) to construct ten ½ mi long x 8 ft high exclosure fences along sections of the upper Vermejo River. The fences are designed to 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 of improvements inside the exclosures is underway and includes vegetative photo points, water temperature measurements, fisheries surveys, and macroinvertebrate collections.

2018 Vermejo River Activities – It was a very low water year in the Vermejo watershed. To prevent escapement of rainbow trout into the Vermejo River, VPR fabricated and installed fish screens on the outlets of Munn and Bernal lakes (Fig. 10.3).

Fig. 10.3. Newly installed fish screens on Munn Lake outlet.

Monitoring was conducted throughout the drainage in 2018 and TBD crews removed four additional suspected hybrid rainbow x cutthroat trout from the watershed. Vegetative photo points, water temperature measurements, fisheries surveys, and macroinvertebrate collections were conducted to assess the impacts

of the 10 riparian exclosures. A proposal was submitted to USFWS to build two more grazing exclosures along Leandro Creek. TBD was excited to see a large beaver dam on Ricardo Creek inside one of the first two exclosures built in 2014. A culvert fish barrier was installed on Leandro Creek to isolate upper Leandro Creek to facilitate the YY brook trout study (Fig. 10.4). A graduate student from NMSU collected pre-stocking fish data and then YY brook trout were stocked into Leandro Creek above the barrier.

Fig. 10.4. Culvert barrier on Leandro Creek.

Las Animas Creek **–** This project was undertaken to restore the native fish community (i.e. RGCT, Rio Grande sucker, and Rio Grande chub; *see Rio Grande sucker and chub project*) to the upper 48 km of Las Animas Creek. Approximately half of the project area is located on the Ladder Ranch, with the remainder on the Gila National Forest. All three species are of conservation concern and have been petitioned for listing under ESA (RGCT were determined to be not warranted for listing in 2014). This project has experienced administrative and political delays since its conception in 1998; however, more 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 multiple, 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. Limited numbers of 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, NM Department of Game and Fish and TBD have decided not to conduct a rotenone treatment to remove the longfin dace. A 2016 watershed assessment indicated that instream habitat is sufficiently recovered to support a small population of RGCT.

2018 Las Animas Creek Activities – Electrofishing surveys in 2018 continued to confirm the extirpation of non-native hybrid trout and native Rio Grande sucker due to the 2013 Silver Fire, as well as the robust recovery of non-native long fin dace and a slower recovery of native Rio Grande chub in Las Animas Creek. NMDGF stocked another 150 RGCT from Canones Creek into upper Las Animas Creek on the Gila National Forest in May 2018, in addition to the 48 stocked in 2017. This will provide an important replicate and genetic reservoir for that population. TBD captured and moved 325 Rio Grande suckers from Palomas Creek on the Ladder Ranch into two locations on Las Animas Creek to re-found the extirpated sucker population. Sixty Rio Grande chub were also stocked into Las Animas Creek to supplement the recovering chub population.

NF Spanish Creek **–** WCT are nearly extinct in the Gallatin River watershed. Restoring WCT to ~ 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 historical 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 EA process. A public scoping letter was published in early 2016 and an EA was drafted. The EA was

approved by MTFWP in July 2017 and USFS in February 2018. Design of a fish barrier to protect the restored WCT population was completed in 2016, and the bid for construction was $430,000. Fundraising efforts for the barrier raised sufficient funds from eight partners: NFWF, MT Future Fisheries, Western Native Trout Initiative, USFS, TBD ($40,000 of total), TU, Northwestern Energy, and the MTTF.

2018 NF Spanish Creek Activities **–** TBD continued to gather pre-treatment baseline information using electrofishing surveys at standard sampling sites to map fish distributions throughout the watershed. The $430,000 fish barrier was constructed in August and September by Bairco Construction of Lovell, WY. Several logistical planning meetings were held with USFS and MTFWP. Initial piscicide treatments are scheduled start in August 2019.

Greenhorn Creek **–** This 32-km project area, including the NF and SF of Greenhorn Creek, was successfully treated with rotenone in July 2013 and 2014. 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 2016, Greenhorn Creek was stocked via a wild transfer of 315 adults 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. Once a viable population of WCT recovers, this project will represent the largest population of WCT in the Ruby River watershed.

2018 Greenhorn Creek Activities **–** An annual inspection was conducted on the Greenhorn fish migration barrier. In August of 2018 Greenhorn Creek was stocked for the third consecutive year (315 fish in 2016; 318 fish in 2017) via a wild transfer of 50 adult fish from six remnant populations of WCT in the upper Missouri River Basin. No additional introductions are planned unless future population monitoring indicates a need for additional fish. No population monitoring was conducted in 2018, but TBD is funding a graduate student through The University of Montana to look at genetic diversity and population demographics in Greenhorn Creek starting in 2019.

Green Hollow Creek **–** To reduce disease and competitive pressures on the Green Hollow II Arctic grayling conservation brood stock, TBD has 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 program shifted from reduction to elimination in anticipation of reintroducing WCT to upper Green Hollow Creek (above Green Hollow Reservoir II), with removals conducted as scheduling allows. The number of fish removed to-date is 14,857, and annual catch has been less than 100 individuals for the past three years; down from a high of over 3,500 fish in 2012. Efforts will continue 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.

2018 Green Hollow Creek Activities **–** Limited effort was spent capturing brook trout. Only 28 fish were removed.

Proposed Future Activities and Considerations – Over the past decade, TBD has developed both capable partnerships and considerable field expertise that, with a little luck, 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 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 18 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 the Turner organization can be proud of.

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 Recogntion
- 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. 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 four years (2015-2018), 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.

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

TBD staff introduced grayling into lower Cherry Creek (below Cherry Falls and outside of the WCT restoration project area) in 2016 and 2017. A total of 25,000 fertilized eggs were stocked into lower Cherry Creek using remote streamside incubation (RSI) devices. RSIs improve hatching success and allow larval grayling to volitionally leave the incubator and enter the stream habitat (Fig. 11.2).

Fig. 11.2. RSIs with grayling eggs placed in an irrigation ditch alongside lower Cherry Creek.

Project Activities in 2018

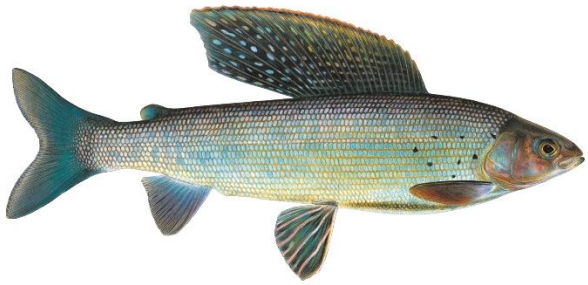
To prepare for the annual spring grayling spawn at Green Hollow II, we netted and held several hundred grayling in early May. 205 females were spawned on May 10th, producing an estimated 264,880 eggs for grayling restoration in southwest Montana and Yellowstone National Park (Fig. 11.3). There continues to be concern that there are too many grayling in the pond, resulting in smaller females and fewer eggs. Post-spawn abundance was estimated at 2,269 individuals, significantly higher than the target population of 1,300. Similar to 2015-16 approximately 208 fish were moved into lower Green Hollow Creek after the egg take.

Fig. 11.3. Grayling egg take at Green Hollow II in spring 2018.

TBD staff introduced another 20,000 grayling eggs into lower Cherry Creek (below Cherry Falls and outside of the WCT restoration project area) via remote stream-side incubation (RSI) devices. To provide the hatching grayling a more accommodating habitat and higher chance at survival once they left the RSI's, the RSI's were placed in a flowing irrigation ditch rather than on the stream bank, which is more typical. After flowing in the ditch for some distance below the RSI's, the water and newly hatched grayling were diverted back into the creek. The ditch experiment worked well and will be used again in the future (Fig. 11.2).

Modest electrofishing monitoring efforts in the spring and fall of 2018 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. TBD staff caught a large male grayling near the rifle range on a fly rod.

Proposed Future Activities and 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.

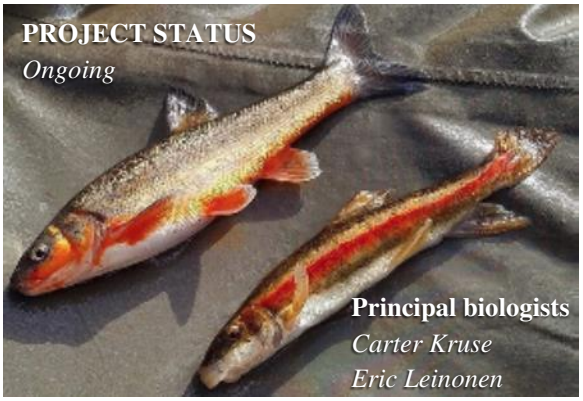


Eyed grayling eggs ready to be placed into the RSI's. Eyed eggs have been held in a fish hatchery long enough (about 10 days) for the eye of the fish embryo to develop. This is the best time to place the eggs in the incubators.

12. RIO GRANDE SUCKER and CHUB

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

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



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

Conservation Problem – Range-wide declines of both RGS and 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 CPW.

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

Project Partners
- NMDGF
- CPW
- 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 – 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 abundant 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 sampled in Costilla Creek (tributary to Rio Grande) on Vermejo Park Ranch. We are unsure if this is because the elevation is too high, or if extirpation occurred due to predation by non-native trout (now restored to native Rio Grande cutthroat trout).

In summer 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 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 UNM to investigate genetic diversity of these isolated RGS populations. 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). 2017 monitoring showed that RGC were starting to recover in Las Animas Creek, but RGS still could not be found. RGS or RGC remained absent in Seco Creek; but good numbers of both species were sampled in Palomas Creek. NMDGF approved a TBD proposal in 2017 to translocate RGC and RGS from Palomas Creek back into Seco and Las Animas creeks.

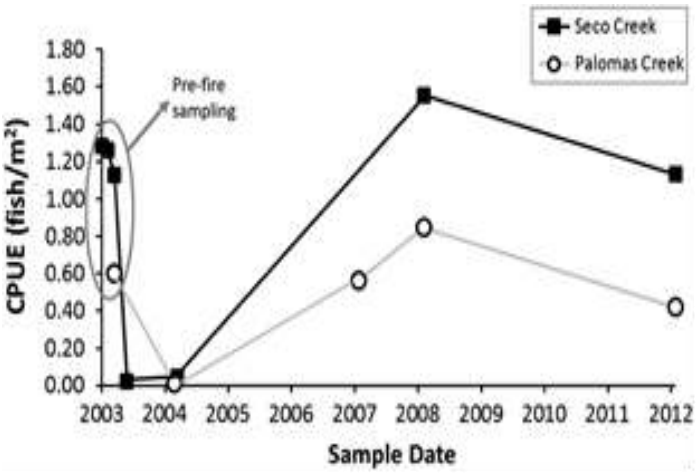


Fig. 12.1. RGS and RGC density estimates before and after fires that burned in the drainages of Seco and Palomas creeks in 2003.

In 2016, TBD received a State Wildlife Grant from NMDGF to develop environmental DNA markers for use in 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, Missoula, to develop and test the eDNA markers. 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. These results will assist resource managers in efficiently detecting species presence and identifying the current range of RGS and RGC.

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

Project Activities in 2018 – In June 2018, electrofishing surveys confirmed the 2017 findings reported above. Good numbers of RGS and RGC in Palomas Creek allowed TBD to captured and translocate 225 RGS from Palomas Creek to Seco Creek, and another 325 from Palomas Creek to Animas Creek (100 stocked below irrigation weir; 225 above weir; Fig. 12.3). Approximately 200 RGC were also translocated, including fish from two steel water storage tanks at Artesia and N. Seco Well (Table 12.1). Genetic samples (fin clips) were collected from the translocated fish in order to monitor genetic diversity.

RGS have not yet been stocked in Costilla Creek as field work focuses on finishing the native cutthroat trout work and TBD considers the appropriate source population for RGS to be stocked into Costilla Creek.

Proposed Future Activities and 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 again be collected and transferred from Palomas Creek and steel storage tanks into Seco and Las Animas creeks in 2019.

Costilla Creek on Vermejo Park Ranch was recently chemically renovated and stocked with Rio Grande cutthroat trout (*see cutthroat trout project*). 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 introduction is successful.

Fig. 12.3. Former Ladder Ranch Manager John Hurd stocking Rio Grande suckers into Las Animas Creek in June 2018.

Table 12.1. RGS and RGC translocations in 2018.

		Source Populations		
Recipient Site		Palomas Creek	Artesia Tank	N. Seco Tank
Seco		225 RGS/30 RGC	22 RGC	36 RGC
Las Animas Upper		225 RGS/2 RGC	--	--
Las Animas Lower		100 RGS/30 RGC	23 RGC	35 RGC

13. WOLVES

13a 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 – Contribute to recovery of Mexican Gray Wolf populations in the wild in the US and Mexico.

Objective – During the next five years, TESF will continue to support Mexican Gray Wolf recovery by providing a captive facility on the Ladder Ranch that houses up to 25 wolves at any one time, including breeding pairs and wolves transitioning between the wild population and captivity. The Ladder Ranch facility will respond to the needs and overall project goals set by the USFWS and the Species Survival Plan on an annual basis.

Strategies – As a member of the Mexican wolf species survival plan (SSP), we adhere to the management guidelines that standardize captive management in both the US 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. These include: 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 critically 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 (i.e., we feed only once or twice a week, and we spend as little time as possible inside the wolf pens during husbandry and maintenance).

Project Background – Mexican gray wolves (MGW) are a distinct subspecies of gray wolves that roamed most of the southwestern US and portions of Mexico until they were functionally eradicated in the wild through aggressive government-sponsored predator control measures. By the time the Mexican gray wolf was listed as endangered under the ESA in 1976 it was on the verge of extinction. Wildlife biologists captured the last five wolves remaining in the wild and began a captive breeding program. As a result, the subspecies is now secure in captivity.

Reintroductions of MGWs into the Blue Range Wolf Management Area (BRWMA) that spans portions of eastern Arizona and western New Mexico began in 1998, and reintroductions in Mexico began in 2011. About 110 wolves were free-ranging in the BRWMA and ~25 in Mexico in 2017.

Supporting Rationale for Objective – The Ladder Ranch has been actively involved in Mexican Gray Wolf recovery since 1997, beginning 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 to the wild by providing pre-release care and acclimatization for animals eligible for release to the wild. The LRWMF also assists with specific management needs associated with reintroductions in the Blue Range Wolf Recovery Area by serving as a "halfway house" between the wild and traditional holding facilities (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 140 different wolves have passed through the LRWMF facility.

Project Activities in 2018

***Wolves housed at the LRWMF in 2018*.** A total of 15 different wolves were held at the LRWMF in 2018, with a maximum of 14 at any one time. The studbook identification numbers (and a brief synopsis of the history) of the wolves housed at the Ladder Ranch during 2018 are summarized in Table 13a.1. Wolf movements are summarized in Table 13a.2. Notes on individual wolves can be found below.

Feeding, Observation, Transfer, Health Check

Feedings: Mexican gray wolves held at the LRWMF are 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. These are protein-rich and also suitable for all life stages. Prey animals (mule deer, oryx, elk, rabbits, and bison) are mainly provided as meat scraps and/or bones salvaged from road-kill or from hunts on the Armendaris and Ladder Ranches and are sporadically fed as supplemental food.

Water: The water that supplies the wolf pens is first pumped from a warm spring in Animas Creek into a 5,000-gallon holding tank by a piston pump. Water from the holding tank is then used to fill (by gravity) smaller holding tanks (500 or 2,500 gallons, respectively), which in turn are used to provide water to the wolves in one or two 50-gallon tubs placed in each wolf pen. Furthermore, we installed and used a drinker (shallow and close to the ground) in pen 1 to give the pups access to water (they cannot reach the water in the 50-gallon troughs; all wolves in pen 1 were seen using the drinker). The 50-gallon tubs are cleaned and/or topped off regularly to ensure that all wolves have access to fresh water at all times. In addition, we occasionally treated the water in the secondary holding tanks with very dilute bleach (> 1:2,000, which is the dilution used to treat well-water for human consumption) to prevent algal growth.

Observations: We observed animals from the blind on a regular basis to monitor their overall health, behavior, and wellbeing. In addition, we observed daily (or twice daily) from the blind when wolves first arrived at the facility, during the breeding season, and around putative whelping times. 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.

Health Checks: All wolves received thorough health checks, vaccinations, and anti-parasite medication before arriving at the LRWMF. Similarly, all wolves leaving the LRWMF in 2018 received deworming and anti-parasite medication (ivermectin, revolution, and/or

Table 13a.1 Wolves housed at the Ladder Ranch Wolf Management Facility in 2018.

Wolf ID	Sex	Birth Date	Arrived at LRWMF on	LRWMF pen	Eligible for release (R) or translocation (T)?	Transferred from
M1384	M	~ 4/15/14	2/9/16	4	No	BRWRA
Notes: M1384 was moved to the LRWMF from the SWMF in 2016. M1384 was introduced to F1538 in April 2018 for companionship. Because M1384's brother is F1538's sire, these two were not allowed to breed in 2018. M1384 was transferred to the California Wolf Center in 11/2018, where he was introduced to his new mate for the 2019 breeding season.						
F1538	F	5/10/16	11/9/17	5, then 4	yes	Sedgwick
Notes: F1538 was transferred from the Sedgwick County Zoo to make room for a new breeding partner for her sire, M1344. F1538's dam died of nasal carcinoma when F1538 was 6 months old. F1538 was introduced to M1384 in April 2018 for companionship. M1384's brother is F1538's sire, so these two were not allowed to breed in 2018.						
M1400	M	4/17/15	11/9/17	3	yes	EWC
Notes: M1400 was introduced to F1431 in December of 2017. They were allowed to breed for 2018, but they did not produce pups. In December 2018, M1400 was introduced to his new mate for the 2019 breeding season, F1633 (see below).						
F1431	F	5/9/15	12/1/1717	3	yes	Wolf Haven
Notes: F1431 was introduced to M1400 in December of 2017. They were allowed to breed for 2018, but they did not produce pups. F1431 left the Ladder Ranch in November 2018 to be united with her new mate.						
M1336	M	~ 4/15/13	12/4/17	1	yes	SWMF
Notes: M1336 was removed from the wild in early 2016 because he was paired with his sister. He was paired with a captive female for the 2016 breeding season, but the pair did not produce pups. M1336 was paired with F1323 for the 2017 breeding season. They produced 4 pups, 2 of whom survived. F1323 whelped a litter of 6 pups in May 2018. M1336 and his pack were moved back to the SWMF in November 2018.						
F1323	F	4/23/13	12/4/17	1	yes	SWMF
Notes: F1323 was born in Mexico and came to the US in December 2015. She was initially paired with M1228 at the SWMF for the 2016 breeding season. This pairing did not produce pups. F1323 was paired with M1336 for the 2017 breeding season. They produced 4 pups, 2 of whom survived. F1323 whelped her second litter (six pups) in May 2018. F1323 and her pack were moved back to the SWMF in November 2018.						
M1602	M	5/22/17	12/4/17	1	yes	SWMF
Notes: M1602 entered the LRWMF as a 6-month-old pup with his parents and littermate brother. He was moved to the SWMF in November along with the rest of his pack but he and his littermate brother were transferred to their new forever home at the Living Desert Museum in Palm Desert, CA shortly thereafter.						
M1603	M	5/22/17	12/4/17	1	yes	SWMF
Notes: M1603 entered the LRWMF as a 6-month-old pup with his parents and littermate brother. He was moved to the SWMF in November along with the rest of his pack but he and his littermate brother were transferred to their new forever home at the Living Desert Museum in Palm Desert, CA shortly thereafter.						
Mp1815	M	5/15/18	–	1	yes	
Notes: Mp1815 (formerly 1794) was born at the LRWMF on May 15, 2018, as one of six pups. He was moved to the SWMF in November 2018 along with the rest of his pack.						
Fp1816	F	5/15/18	–	1	yes	
Notes: Fp1816 (formerly 1789) was born at the LRWMF on May 15, 2018, as one of six pups. She was moved to the SWMF in November 2018 along with the rest of her pack.						
Fp1817	F	5/15/18	–	1	yes	
Notes: Fp1817 (formerly 1790) was born at the LRWMF on May 15, 2018, as one of six pups. She was moved to the SWMF in November 2018 along with the rest of her pack.						
Fp1818	F	5/15/18	–	1	yes	
Notes: Fp1818 (formerly 1791) was born at the LRWMF on May 15, 2018, as one of six pups. She was moved to the SWMF in November 2018 along with the rest of her pack.						

Table 13a.1. continued…

Wolf ID	Sex	Birth Date	Arrived at LRWMF on	LRWMF pen	Eligible for release (R) or translocation (T)?	Transferred from
Fp1819	F	5/15/18	–	1	yes	
Notes: Fp1819 (formerly 1792) was born at the LRWMF on May 15, 2018, as one of six pups. She was moved to the SWMF in November 2018 along with the rest of her pack.						
Fp1820	F	5/15/18	–	1	yes	
Notes: Fp1820 (formerly 1793) was born at the LRWMF on May 15, 2018, as one of six pups. She was moved to the SWMF in November 2018 along with the rest of her pack.						
F1633	F	5/11/17	–	3	yes	Wolf Haven
Notes: F1633 is a good genetic match for M1400. She arrived on the Ladder Ranch in December 2018 to be paired with M1400 for the 2019 breeding season in the hopes that they produce pups for cross-fostering.						

Table 13a.2 Summary of wolf movements into and out of the Ladder Ranch Wolf Management Facilities in 2018. We started the year with 6 adults and 2 yearlings. Six pups were born at the facility in 2018. Twelve wolves moved out in mid-November, and one wolf joined the two remaining wolves at the Ladder in mid-December. Thus, three wolves were housed at the facility at the end of 2018.

Wolf #	Pen	Birth date	Trans to LR	Trans out LR	Origin	Destination	Eligible for release or translocation?	
M1384	4	~15 Apr 2014	09-Feb-16	15-Nov-18	SWMF	CWC	yes (MX)	wild-born
F1538	5	10-May-16	9-Nov-17		Sedgwick			born at Sedgwick
M1400	3	17-Apr-15	9-Nov-17		EWC			born at EWC
F1431	3	9-May-15	1-Dec-17	15-Nov-18	Wolf Haven	SWMF		born at Wolf Haven
M1336	1	~April 15, 2013	4-Dec-17	15-Nov-18	SWMF	SWMF	yes	wild-born
F1323	1	23-Apr-13	4-Dec-17	15-Nov-18	SWMF	SWMF	yes	born at Ju Aragon
M1602	1	22-May-17	4-Dec-17	15-Nov-18	SWMF	SWMF	yes	born at SWMF
M1603	1	22-May-17	4-Dec-17	15-Nov-18	SWMF	SWMF	yes	born at SWMF
mp1815	1	15-May-18	N/A	15-Nov-18	LRWMF	SWMF	yes	born at LRWMF
fp1816	1	15-May-18	N/A	19-Nov-18	LRWMF	SWMF	yes	born at LRWMF
fp1817	1	15-May-18	N/A	15-Nov-18	LRWMF	SWMF	yes	born at LRWMF
fp1818	1	15-May-18	N/A	15-Nov-18	LRWMF	SWMF	yes	born at LRWMF
fp1819	1	15-May-18	N/A	15-Nov-18	LRWMF	SWMF	yes	born at LRWMF
fp1820	1	15-May-18	N/A	15-Nov-18	LRWMF	SWMF	yes	born at LRWMF
F1633	3	11-May-17	18-Dec-18		Wolf Haven		yes	born at Wolf Haven

praziquantel) before their departure from 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 2018 were current on their vaccinations and treatments.

Oral ivermectin treatment for heartworm prevention: We continued a regimen of once-a-month oral ivermectin treatment of all wolves to prevent heartworm. We followed the protocol developed for and approved by the MGW SSP. Briefly, full-strength ivermectin is first diluted 1:250 with propylene glycol. For every 10 lbs. of wolf, 1 ml of the diluted ivermectin is then mixed with thawed canine logs (for example, for a wolf weighing 60 lbs., we would mix 6 ml of diluted ivermectin into one log). The wolves are fed the medicated wolf log on a regular feeding day, followed by the remaining amount of untreated food on the following day.

Semen collection: All male wolves present in the facility (M1384, M1400, M1336, mp1602, and mp1603) were captured and processed for semen collection on February 8, 2018. The semen collections were performed by Dr. Cheryl Asa and Karen Bauman, and were overseen by Dr. Susan Dicks (Fig. 13a.1).

Fig. 13a.1. Semen collection crew. Left to right, back row: Melissa Woolf (former TESF wolf caretaker, 1997-2007), Maggie Dwire (Assistant Wolf Recovery Coordinator, USFWS); middle row: Dr. Cheri Asa (St. Louis Zoo, Canid reproductive specialist), Dr. Susan Dicks (DVM, USFWS wolf biologist); bottom row: Dr. Chris Wiese (current TESF wolf caretaker), Tricia Rossettie (TESF 2018 wolf tech), Colby Gardner (USFWS wolf biologist), Melissa Kreutzian (USFWS wolf biologist), Scott Hillard (TESF volunteer), Sherry Barrett (Mexican Wolf Recovery Coordinator, USFWS), Karen Bauman (St. Louis Zoo, Canid reproductive specialist).

Breeding season: Two pairs of wolves were introduced (F1431 and M1400) or remained together (F1323 and M1336) at the LRWMF during the breeding season 2018, in the hopes that one or both pairs would produce pups that could be cross-fostered into the wild in 2018.

Pair 1: M1400 and F1431. In previous years, captive wolf pairs were observed to breed later than wild pairs, with pups born in early to mid-May in captivity – compared to mid-to-late April in the wild. To synchronize the timing of wolf births in captivity more closely with whelping in the wild, on January 31, 2018, F1431 received "ovuplant" hormone treatment (in the form of an implant placed subcutaneously in the inner thigh) to stimulate ovulation. She was then reunited with M1400 and allowed to breed naturally.

Ovuplant implants are routinely used to stimulate ovulation for artificial insemination (mostly in horses, but also in canines). Ovulation usually occurs within 2 weeks of insertion of the implant (as monitored through progesterone levels in AI procedures). Within a few days of receiving the implant, F1431 showed typical (late-stage) breeding behaviors (stopping in front of the male to allow him to sniff her genitals, tail averting, etc.). However, M1400 initially showed no interest in breeding. Brief breeding ties were eventually observed on February 20, 21, and 23, about three weeks after F1431 received the implant. We tried to remove F1431's implant one week later on February 28, 2018. However, the implant could not be found – it most likely had disintegrated. A test of F1323's progesterone levels (an early indicator of potential pregnancy) revealed levels of progesterone that were low (~ 6 ng/dl vs the desired 20 ng/dl) but not incompatible with pregnancy. However, the ovuplant implant is known to suppress progesterone levels in canines, and our reproductive specialist advisors (Dr. Bruce Christensen and Dr. Cheryl Asa) were concerned that successful pregnancy in the presence of the implant occurs in only four out of ten pregnancies in dogs. Since we could not remove the implant, it was suggested that we supplement F1431 with daily progesterone (in the form of a 100 mg pill mixed into her food) to support her putative pregnancy. To facilitate

this, we temporarily moved F1431 to an adjacent pen so she would be in visual, auditory, and olfactory contact with her partner (M1400), but we could feed (and medicate) her separately. Daily progesterone treatments began on March 3, 2018. We caught F1431 again on March 29 to draw blood for a relaxin pregnancy test and to move her back to the pen that she and M1400 had previously occupied. Following the advice of the SSP's animal behavior specialist, Dr. Susan Lindsay Lindacker, we moved M1400 into the service area of the same pen so we could continue to treat F1431 with progesterone (if she was pregnant) while the pair would be in closer contact. The test results arrived on April 3 and showed that F1431 was not pregnant. At this point, we discontinued the daily progesterone treatments and reunited F1431 and M1400. Observations during the time F1431 may have whelped if she were pregnant confirmed that she did not den up.

Pair 2: M1336 and F1323. This pair had successfully bred the previous year and had produced 4 pups, two of whom survived and were with their parents during the 2018 breeding season. F1323 and M1336 were again allowed to breed naturally in 2018. F1323 had been observed to breed late the two previous years, in mid or late March. Consistent with those observations, F1323 and M1336 were observed to tie on March 13, 14 and 15 – nearly a month after F1431/M1400. F1323 began to look pregnant in late April, and was seen digging among the boulders in her pen. She seemed restless and uncomfortable during the day on May 15, 2018 (her calculated due date), and was observed to enter the den in the early evening. She was not seen during the next day. Instead, the yearlings were observed to explore the opening of the den. F1323 emerged from the den on May 17, visibly smaller than she had been two days earlier. We surmised that she whelped her pups on or around May 15, 2018. We left the den undisturbed, but on day 7 managed to photograph a pile of pups and determine that there were six pups. This number was confirmed three weeks later when we used trail cams to catch the first glimpses of the pups emerging from the den.

Births in 2018

F1323 and M1336 produced six pups at the Ladder Ranch Wolf Management Facility on May 15, 2018 (Box 13a.1). The litter consisted of one male pup (studbook number 1794; later reassigned SB# mp1815) and five female pups (studbook numbers 1789, 1790, 1791, 1792, and 1793 – later reassigned SB#s 1816-1820). We hoped to catch all pups for the first time on June 27, 2018 (at 6 weeks of age) to give them their first set of vaccines, dewormer, and PIT tag identifications. However, the pups were in a den too deep for humans to reach and we had to reschedule the initial capture.

We managed to catch two pups for the first time two weeks later, at 8 weeks of age (on July 10, 2018). Both pups were female. During the next attempt to catch all pups, at 10 weeks of age (on July 25, 2018), we managed to catch four pups. Again, all pups were female and none of them had a PIT tag. We had all six pups in hand simultaneously for the first time for their 12-week checkup on August 7, 2018. At this point it became clear that at least one pup from the July 10 capture must have been recaptured on July 25, and one pup had eluded us during both previous captures, as the August 7 capture revealed 5 female and one male pup. We suspect that the pup we initially assigned SB#1794 had lost the first PIT tag we inserted, which is why we did not identify her during the July 25 (re)-capture.

All pups received booster vaccines on August 28, September 27, and November 15, 2018.

Five of the six pups, plus their yearling brothers and both parents, were transferred to the Sevilleta Wolf Management Facility on November 15, 2018. The last pup had eluded capture that day by diving into a hidey-hole. We caught fp1816 three days later and transferred her to the Sevilleta to reunite her with the rest of her family.

Deaths **–** There were no deaths at the LRWMF in 2018.

Releases – There were no releases of LRWMF wolves in 2018.

Box 13a.1. The Ladder's 2018 Wolf Pups

At 1-week of age, the ears and eyes of wolf pups are still closed…

…. but by 3-weeks of age, the pups can see and hear.

By the time they reach 8-weeks, the pups area looking much more wolf-like – with very big ears!

The pups have a special visitor for their 12-week check-up; Michelle Lujan Grisham, then gubernatorial candidate for the 2018 election – now governor of New Mexico – lends a hand to the wolf team.

Facilities – We upgraded the secondary water holding tank on the north hill (which supplies pens 1, 2, and 3) by replacing the old white 1,000-gallon tank that had sprung a leak with a new, dark green, 2,500-gallon tank. The dark green tank color prevents algae from growing in the tank. We also installed drinkers in pen 1 and pen 3.

Off-site Activities and Outreach **–** We attended the annual SSP meeting in Brookfield, IL, in July 2018.

Proposed Future Activities and Considerations – As one of only three pre-release facilities in the country, and the facility closest to the wild BRWMA population, the SWMF, and Mexico, the LRWMF plays an important role as a transitional facility for wolves that are being transferred between captivity and the wild. This includes wild wolves that need to be moved to captivity due to livestock depredations, as well as releases of captive-bred wolves to support the wild population.

Cross-fostering is a technique in which very young pups (less than 10 days old, i.e. before they can see or hear) from genetically desirable captive wolf pairings are swapped or introduced to denning wild wolf parents. This technique eliminates concerns of captive-born wolves habituating to humans because pups are introduced to the wild prior to their being able to perceive sights and sounds. Cross-fostering has been used successfully to increase the genetic diversity of red wolves in North Carolina (Waddell et al., 2002), and has also been tested in European gray wolves (Scharis and Amundin, 2015). Moreover, it has been used successfully in 2014, 2017, and 2018 to place captive-born MGW pups into the den of a wild wolf pack that was known to rear young that avoid conflict with humans (USFWS, 2015, 2017).

Because the Mexican wolf holding facilities are currently at capacity, not all captive wolves are allowed to breed. In turn, this means that not all wolf-holding facilities participate in the breeding program. Breeding pairs are carefully chosen using several criteria, including genetics, compatibility, and need. Mexican gray wolves produce pups only once a year: they generally breed in February or March and whelp 2-6 pups in April or May. For 2019, the LRWMF will hold one breeding pair 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 MGW in the Southwest. In 2019, 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 (for example, annual meetings).

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USFWS, 2015. http://www.fws.gov/southwest/es/mexicanwolf/CEBRWRA.cfm

Waddell W, Behrns S, Lucash G, McLellan S. 2002. Intraspecific fostering in the red wolf (*Canis rufus*). Poster presentation at Defenders of Wildlife Carnivores, Monterey, California.

13b 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 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 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 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 of living with wolves on a working landscape will be shared by conducting tours for visiting guests.

Supporting Rationale for Objective

Uncertainty over the ecosystem impacts of wolves fosters 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), before it split into two packs. The ranch practices an ecologically sustainable management style which also benefits the persistence of large carnivores. We can 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 our 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 recovery and management. With delisting imminent, we shifted our focus in 2010 to wolves on the Flying D. Wolves first established themselves on the ranch in 2002. In 2011, they were at their highest numbers before splitting into two packs. Both packs made use of the entire ranch (over 113,000 acres) and the bordering forest. Both bison and elk numbers are monitored by the Flying D ranch manager and Montana Hunting Company. In addition to understanding wolves and their effects on ranched bison and wild elk, we have participated in two ongoing studies on the ranch. Both anthrax (*B. anthracis*) and brucellosis (*Brucella abortus*) affect ungulates and potentially carnivores through scavenging.

Project Activities in 2018

Wolf population – Despite the loss of the Tanner Pass pack in 2016, the wolf population was back to 24 individuals by summer 2018 (Fig. 13b.1). The Beartrap pack produced 10 pups this year. Using MTFWP criteria, which uses Dec. 31st survey data as the annual abundance metric, our highest visual count at the end of 2018 was 18 individuals (Fig. 13b.1). The Beartrap pack uses the entire ranch, as well as neighboring properties to the north. Four known wolf mortalities occurred in 2018: Three were legally killed during the harvest season, and the fourth (SW036F), collared in 2017, was shot, but we were unable to determine if this was a legal "wounded loss" or an" illegal take".

We were permitted by MTFWP to capture and radio collar one wolf and deployed a GPS collar. A black 4 to 6-year-old female (SW039F) (Fig. 13b.2) was collared September 14. Our goal is to gain insight on how often the Beartrap pack leaves the ranch and, by acquiring cluster

locations, increase chances of finding ungulate carcasses. The collar is programmed to last ~3 years. From September 14 through December 31, 2018 we have acquired 108 days of locations (6 locations/night) equaling 648 total locations.

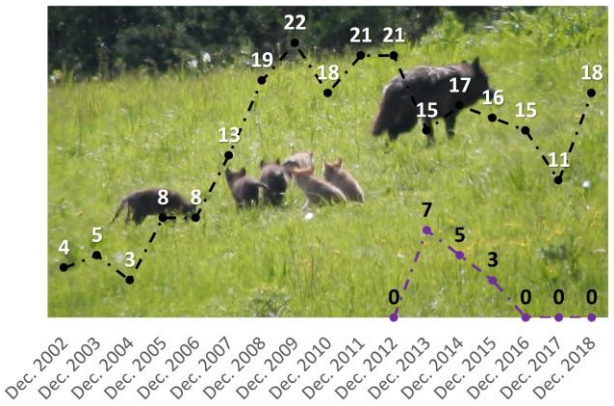


Fig. 13b.1. Minimum number of wolves in the Beartrap (black line) and Tanner Pass (purple line) packs from 2002 to 2018.

Fig. 13b.2. A 4-6-year-old female, (SW039) was caught on the ranch in 2018 and now wears a GPS collar.

Food habits

Of the 1,214 carcasses investigated since monitoring began in 2010, 403 were documented as predator kills. 289 were attributed to wolves, with the remainder categorized as coyote (78), mountain lion (9), bobcat (2), bear (6), and unknown predator (18).

Bison are the dominant ungulates on the Flying D, numbering around 3300-5400 individuals. With a bison population almost twice as large as that of elk, we assume that encounter rates between bison and wolves are higher than between elk and wolves. However, wolves are more successful at killing elk, or are actively selecting elk to prey upon (Fig. 13b.3).

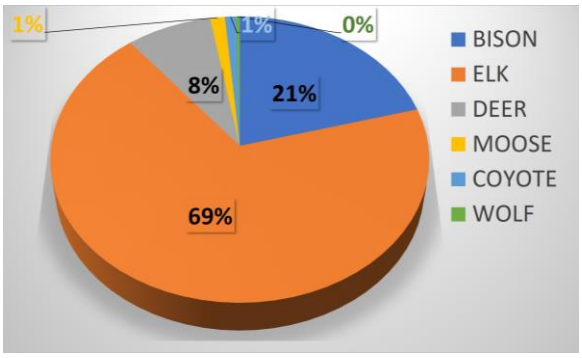


Fig. 13b.3. Percentage of wolf kills by prey species.

Eight years of scat data was analyzed from 2010-2017. Elk were the main food source for wolves, which was consistent with our kill data (Fig. 13b.4). Deer were also an important food source but because of their small size, are much harder to find. Bison hair was visually identified between adult and bison calves less than ~ 4 months of age (i.e., red calves). Red calf hair was detected in only 2% of wolf scats, suggesting that this livestock type is not readily predated by wolves.

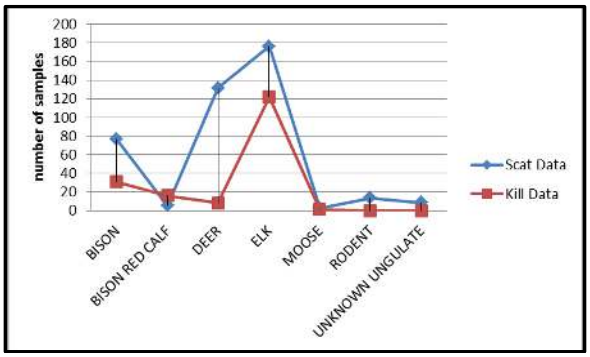


Fig. 13b.4. Comparison of wolf scat data to observed verified wolf kills.

Prey Vulnerabilities

A generalization of wolf-prey systems is that wolves tend to select prey that are disadvantaged (e.g., young, old, sick/injured). Environmental traps, maternal behavior and herd health also influence an animal's predation risk.

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 one of the last

fat resources the body utilizes. Healthy bone marrow is white, firm, and waxy, while malnourished or diseased animals have marrow that is red, solid and slightly fatty. In advanced starvation, marrow is red/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" (Fig. 13b.5). From marrow collected from 234 wolf-killed elk, deer and moose, 72% were in marginal to poor health.

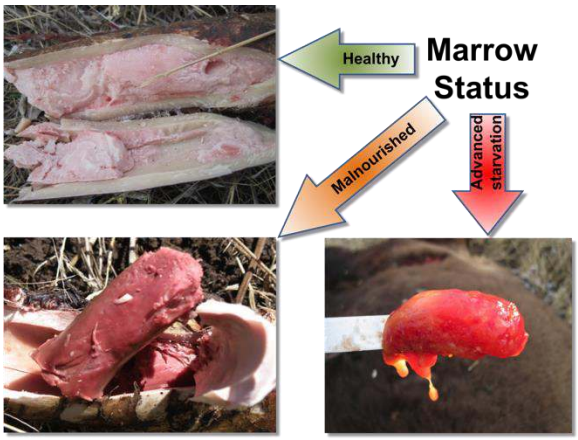


Fig. 13b.5. Femur marrow helps determine the condition of prey species.

Another vulnerability is compromised hooves and legs. Of the 332 elk carcasses investigated, 43 had visible deformities, and 35 of these were killed by wolves (Fig. 13b.6). After boiling the legs, we detect the calcification and arthritis that has developed (Fig. 13b.7).

Fig. 13b.6. Examples of elk legs with visible and varying deformities.

More data is needed to determine if this is related to injury or other causes. In addition, we have begun to collect and boil legs from all elk mortalities, regardless of visible injury to the hoof or legs, to determine if there are any differences between predator kills and elk that die from other causes.

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

Education – Information dissemination is important as we learn more about wolves on the ranch. In 2018, we conducted 12 tours and talks on the Flying D totaling ~98 since 2010. We also share our population estimates with MTFWP and data with both the Anthrax and Brucella projects. Finally, we continue to produce monthly and annual reports on wolf activities and food habits.

Proposed Future Activities and Considerations – With the newly deployed GPS collar, we look forward to learning how often the Beartrap pack leaves the ranch, (Fig. 13b.8)., and, measuring the success of finding carcasses using cluster data.

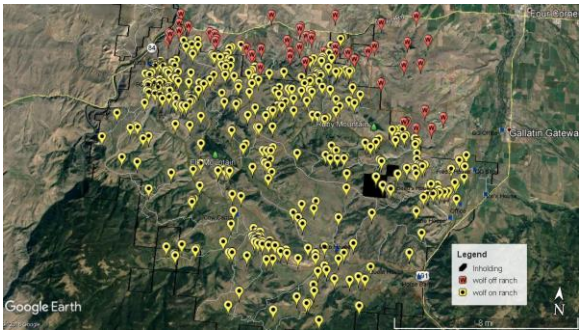


Fig. 13b.8. Yellow balloons show locations of the collared female (SW039) on the Flying D. Red balloons indicate locations north of the FDR boundary and indicate the female off the ranch ~26% of the time in 2018 (September-December).

13c 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.

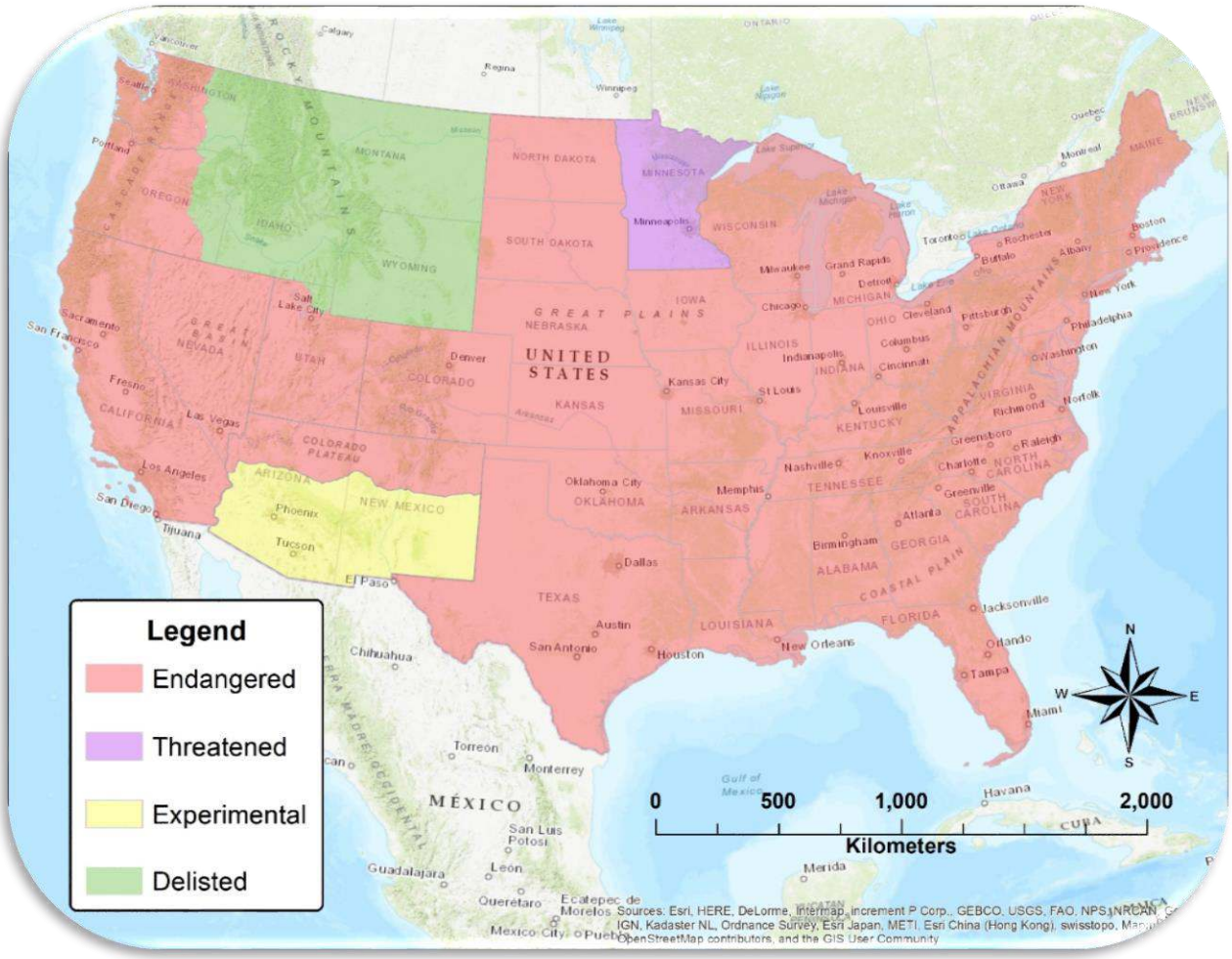
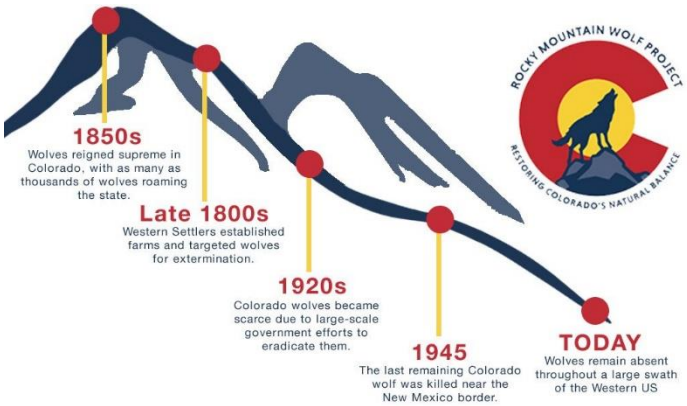


Fig. 13c.1. Listing status of *C. lupus* in the conterminous United States.

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.

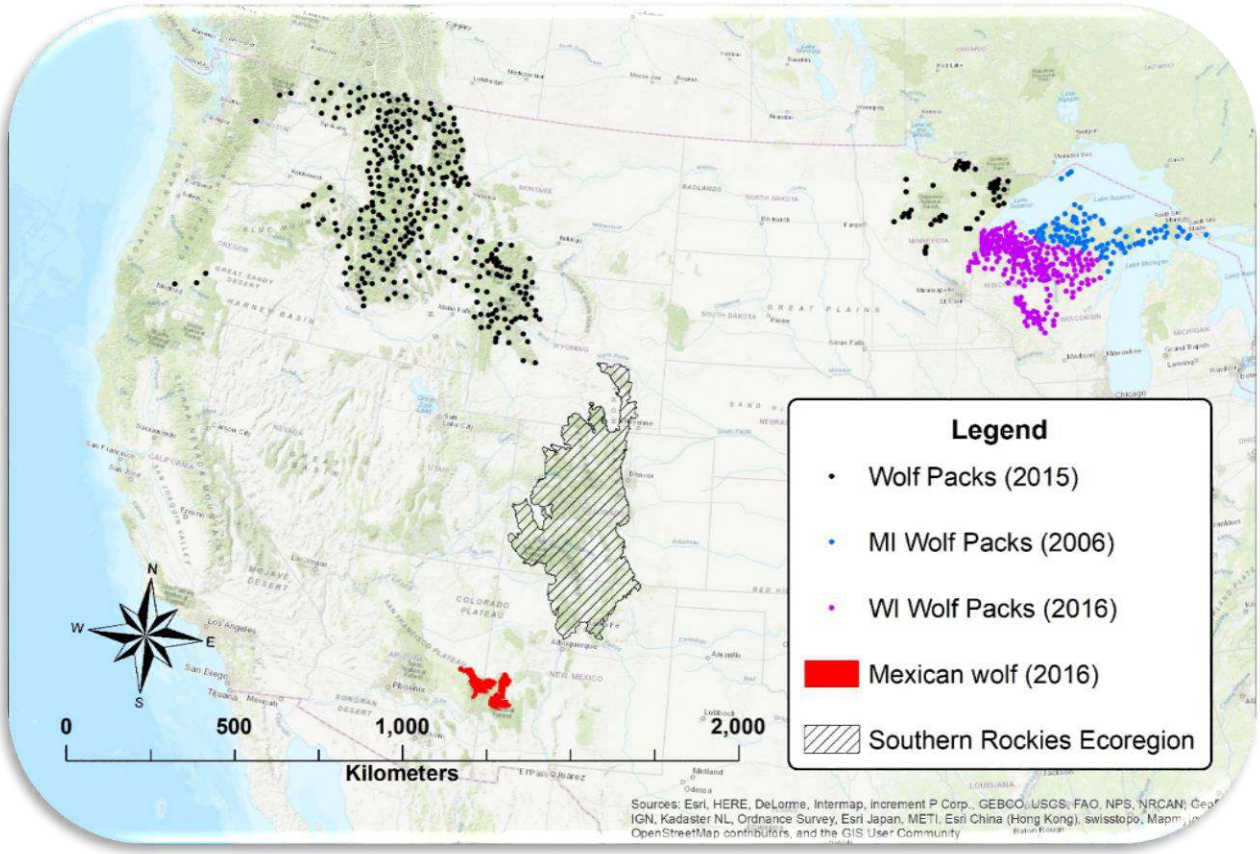


Fig. 13c.2. Distribution of wolf packs, estimated during the period 2006-2016, in the conterminous U.S. relative to the Southern Rockies Ecoregion. Wolf pack locations were obtained from relevant state gray wolf annual reports and georeferenced using ArcGIS 10.0. Michigan (MI) wolf packs represent 2006 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).

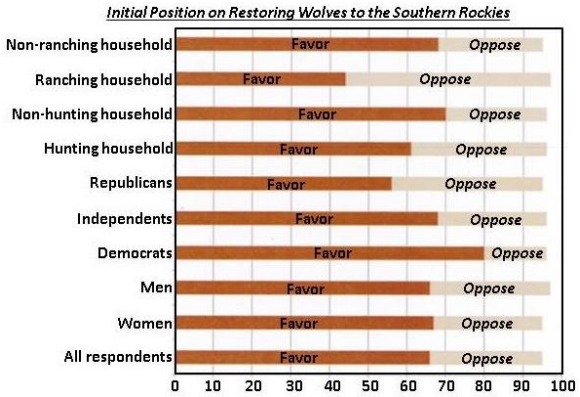


Fig. 13c.3. Results of a 2001 public opinion survey revealed widespread support for restoring wolves to the Southern Rockies. Source: Decision Research, 2001.

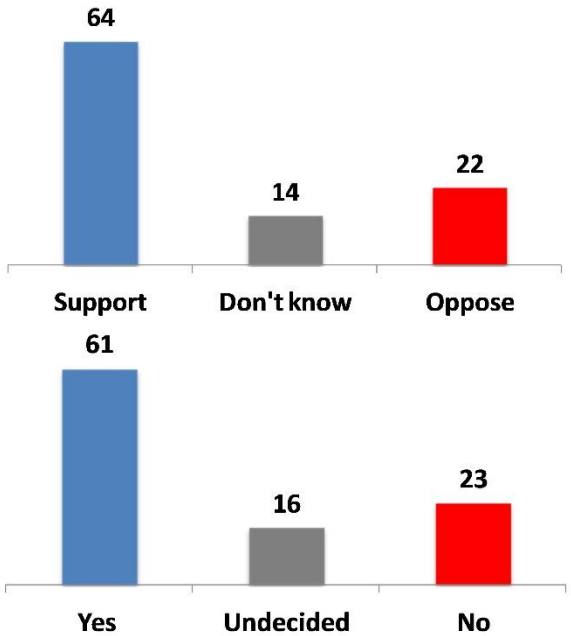


Fig. 13c.4. Results of a 2014 poll measuring support and opposition for reestablishing wolves in western Colorado (top panel), and support (yes) or opposition (no) for a combined wolf restoration ballot measure (bottom panel).

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 2018

In 2018, the Rocky Mountain Wolf Project coalition established itself as a force determined to create a future for wolves in Colorado. We've grown into a robust coalition of 27 esteemed biologists, 27 leading conservation groups and countless wildlife advocates, all committed to engaging Coloradans about the reality of co-existing with wolves. From film screenings to new partnerships, from crowdfunding campaigns to museum exhibits, we invested heavily in spreading our message and growing our support base. As we move into 2019, we know that having a growing intensity of support will be critical in furthering our cause. Below are the highlights from 2018.

2018 Event Highlights:

Co-Existence Panels in Denver and Colorado Springs – Along with Defenders of Wildlife, the RMWP hosted a screening of *Canis Lupus Colorado* and panel discussion at the Denver Zoo and Pikes Peak Center for the Performing Arts in Colorado Springs on January 22 and 23. The panel included Delia Malone, the Wildlife Chair of the Rocky Mountain Chapter of the Sierra Club; Greg Hill, the Project Coordinator of the Wood River Wolf Project; and Jonathan Proctor, the Rockies and Plains Director of Defenders of Wildlife. Each panelist brought extensive experience and insights to discuss the past, present and future for wolves in Colorado.

Wilderness Workshops in Aspen and Carbondale, CO (Fig. 13c.5) – Science team member Mike Phillips was invited by the Aspen Center for Environmental Studies (ACES), Roaring Fork Audubon and Wilderness Workshop to speak on wolf recovery in the Roaring Fork Valley of Colorado on February 7 and 8. The Carbondale and Aspen events, titled "Naturalist Nights: A Biologist's and Senator's Look at Wolf Recovery and Conservation," drew a range of community members –from ranchers to biologists to conservation novices – and engendered emotion on both sides of the debate. As a reminder, the "Living With Wolves" photo exhibit – which was reproduced for the RMWP to include Colorado-specific panels – resides at the Aspen Airport.

Fig. 13c.5. Mike Phillips spoke about the feasibility, viability and desirability of restoring wolves to Colorado to a packed crowd in Carbondale, CO as part of the Wilderness Workshop Naturalist Night series.

Panel Discussion and Film Screening at in Buena Vista and Western State University

The RMWP, represented by Michael Wilson of the Revival Project, the California Wolf and Wildlife Center, and Defenders of Wildlife, spoke at the GARNA (Great Arkansas River Nature Association) meeting in Buena Vista. The evening provided an important opportunity to talk with around 50 citizens on both sides of the issue, including a number of ranchers and hunters.

In conjunction with Western State Colorado University's Wildlife Society, the RMWP, Defenders of Wildlife and the California Wolf Center also held a film screening and panel discussion in Gunnison, CO. There were over 60 attendees, many of them ranchers.

According to Michael Wilson:

"From the outset, the room was literally split with wolf-supporters on one side of the room and those opposed on the opposite side. Though everyone was extremely respectful during the

films and presentations, conversation became a little edgy during the Q & A. Those opposed were quite vocal, which stimulated some conversation back and forth.

At the end of the Q & A and during the wrap up of the event I was pleased to see both sides of the room stick around to speak with one another, with many who were opposed approaching the panel speakers and having respectful conversations. Though there were a few outliers who were clearly opposed and will remain so, many just want to be a part of the process, make sure their concerns are heard, and ensure that we stay true to our word."

W.O.L.F. Gala and Old Firehouse Books Talk with Nate Blakeslee and Rick McIntyre (Fig. 13c.6)

Old Firehouse Books in Fort Collins hosted *American Wolf* author Nate Blakeslee and Yellowstone fixture Rick McIntyre for a talk the evening before the W.O.L.F. Sanctuary Gala in Fort Collins. The RMWP was asked to discuss the opportunity for wolves in Colorado.

Fig. 13c.6. RMWP volunteers Krisztina Gayler and Marije TerEllen represented the RMWP at the W.O.L.F. Sanctuary gala alongside American Wolf author Nate Blakeslee and Yellowstone legend Rick McIntyre.

"Get Wild to Save Wild" in Boulder (Fig. 13c.7) – RMWP tabled at the "Get Wild to Save Wild" Earth Day event in Boulder. This community-based initiative was designed to create a dialogue about the importance of our natural world, as well as provide resources for individual action. The event was sponsored by Fjallraven, Upslope Brewing, and Zeal Optics, among other local companies. At the event, the Project was able to interact with over 200 attendees.

Fig. 13c.7. RMWP volunteers Marije TerEllen, Logan Thome and Cheney Gardner tabled at the Boulder Earth Day event "Get Wild to Stay Wild." They encouraged attendees to spin the RMWP prize wheel and howl with a wolf pack.

Durango Earth Day events and Children's Parade (Fig. 13c.8) – Volunteers from WolfWood Refuge and the RMWP tabled for Earth Day, including introducing passersby to WolfWood's nine-week-old guardian-in-training, Gideon. They also attended the 2018 Earth Day Children's Parade & Climate March in Durango.

According to Lynne Bruzzese, a volunteer for WolfWood Refuge and the RMWP:

"The photos show some of our "wolf pack" comprising kids costumed in wolf masks and ears, parents wearing ears, the giant alpha wolf wearing WolfWood's full-body costume, and the signs we made with photos of real wolves on one side and the RMWP logo on the other. The wolf pack literally howled during the entire parade."

Fig. 13c.8. Volunteers from the RMWP and WolfWood Refuge tabled at the Durango Earth Day event and marched in the Children's Parade and Climate March

Peak Area Leadership in Science Workshop

On May 5, the RMWP presented at the Peak Area Leadership in Science (PALS) workshop in Colorado Springs, which facilitates professional development opportunities for secondary science teachers. This workshop was dedicated to current Colorado wildlife issues, specifically reintroducing the gray wolf.

Delia Malone, an ecologist and member of the RMWP, spoke to 38 educators about why Colorado needs wolves and the research that supports coexistence. The International Wolf Center then Skyped in to talk to the teachers about secondary school curriculums the Center has developed. Finally, the teachers traveled to the Colorado Wolf and Wildlife Center.

"Magic Restored" Event in Colorado Springs

On Friday, June 8, Darlene Kobobel, Rick Silverberg, Tammy Smith and the team at the Colorado Wolf and Wildlife Center hosted an event at the Antlers Hotel in Colorado Springs. "Magic Restored: Reestablishing the Gray Wolf to Western Colorado" featured science team member Mike Phillips as the keynote speaker and considered the past, present and future of wolves in our state.

The event saw the participation of a CWWC ambassador animal and brought in over 250 Coloradans from across the state. It also featured an auction filled with items donated by coalition partners, including Fishpond outdoor products and jewelry from Kezha Hatier-Reiss. Through the auction, we were able to raise ~$2,000, bringing the event total raised to ~$6,300.

AREDAY Summit – RMWP ambassadors traveled to Aspen June 19-24 for the Aspen Business Luncheon and the American Renewable Energy Summit (AREDAY). Mike Phillips spoke at the Aspen Business Luncheon on June 19 and introduced the Project to about 40 members of the Roaring Fork business community.

From there, the RMWP hosted a table all four days at AREDAY. The Annual Summit brings together over 100 cross-sector speakers and includes a film festival and concert. The RMWP, represented by science team member Mike Phillips, was invited to deliver a keynote address on the final day of the summit. Mike led the audience in a group howl and was joined onstage by ambassador wolf Shaya, accompanied by Michelle Smith of the Colorado Wolf and Wildlife Center.

RMWP was also invited to speak before the summer concert series on Snowmass Mountain. Hundreds of Coloradans came out for the concert and, before the music started, heard from Mike Phillips. Again, Mike was joined on stage by ambassador wolf Shaya and led a group howl.

Outdoor Retailer Summer Market (Fig. 13c.9)

The RMWP was selected to take part in the Outdoor Retailer Summer Market July 23 – 26 at the Colorado Convention Center in downtown Denver. The outdoor industry expo is the largest in the country and brought together 85,000 industry professionals from 1,400 global brands. Through the Outdoor Retailer expo, we were able to interact with brands like Patagonia and Yeti that could be important in building out our relationship with the outdoor community in Colorado.

Fig. 13c.9. The RMWP was selected to table at the Outdoor Retailer Summer Market.

Native American Fish and Wildlife Society (Fig. 13c.10) -- On August 16, Barry Noon spoke at the Native American Fish and Wildlife Society meeting in Ignacio, CO, which provided an opportunity to share our message with an important segment of the Colorado public. The Native American Fish and Wildlife Society (NAFWS) was part of the 32nd Annual Southwest Regional Conference hosted by the Southern Ute Indian Tribe and assists Native Americans and Native tribes with the management of fish and wildlife resources.

News

wawéchuwiini (8) August 17, 2018

Tribes celebrate natural resources

By McKayla Lee
The Southern Ute Drum

The Native American Fish and Wildlife Society (NAFWS) returned to Ignacio, Colo. for their 32nd Annual Southwest Regional Conference that was hosted by the Southern Ute Indian Tribe. This year's conference started on Monday, August 13 and ended Thursday, August 16. The NAFWS is a non-profit organization that assists Native Americans and Native tribes with the assistance and management of fish and wildlife resources.

To officially welcome the participants, Southern Ute Chairman Christine Sage attended the opening ceremony of the conference and encouraged everyone to establish working ties and significant networks that would benefit them and the Native populations they serve, as well as the resources they protect.

The conference this year emphasized the theme of "Strengthening our values by reconnecting to the land" by coordinating workshops, exhibitions and meetings in a full four-day agenda.

This regional meeting brought tribal officers and management together to work alongside one another in an effort to educate and advise the general welfare of various fish and wildlife organizations.

In addition to the workshops, the conference offered hands on learning experiences that combined traditional classroom learning with outdoor field sessions that helped individuals to become even more involved with the different aspects of natural resource management.

Southern Ute Chairman Christine Sage welcomes the NAFWS on Monday, Aug. 13 in the Sky Ute Casino Resort.

Southern Ute Councilwoman and Treasurer Lorelei Cloud stands while the national anthem is sung at the opening ceremony on Monday, August 13.

"I am honored to share my knowledge and skills to the Native American youth in attendance today," Southern Ute Wildlife Fishery Biologist Ben Zimmer-man stated about his time spent with the youth out at Scott's pond on Wednesday, Aug. 15.

Youth were one of the many focuses this year, to get them even more engaged, the Mescalero Tribe and the U.S. Forest Service teamed up with Southern Ute Wildlife. Together they helped youth from varying tribes absorb information about water sampling and surveying fish, vegetation and birds, while out at Scott's Pond.

When they weren't spending the day in work sessions, conference participants were encouraged to partake in the various shoot competitions that were hosted by the Southern Ute Tribal Rangers and the Wildlife Resource Management Division.

"For a number of years, the archery shoot hasn't been included and so this year I thought it would be a good idea to bring it back," Southern Ute Wildlife Biologist, Arun Johnson stated about the Friendly Archery Shoot Competition that was held this year at Ernest "Mue" Pinnecoose's property.

Overall, the conference was a time to remember that, by protecting tribal sovereignty through managing resources that balance economic development, tribes will create new ways to engage and positively impact the youth.

Southern Ute Bear Dance Chief Matthew Box gave a presentation and sang songs for the NAFWS from the Bear Dance ceremony.

Jace Carmencros smiles for the camera while bear dancing on Tuesday, August 14 in the Multi-Purpose Facility.

Southern Ute veteran Rod Grove makes some quick conversation with Tom Alires before the opening ceremony begins on Monday, Aug. 13.

Fig. 13c.10. Science team member and CSU professor Barry Noon spoke at the 32nd Annual Southwest Regional Conference in Ignacio, CO, which was hosted by the Southern Ute Indian Tribe.

History Colorado Lecture Series (Fig. 13c.11)

On September 17, RMWP science team member and University of Colorado-Denver professor Diana Tomback, along with Tom Wolf, co-author of the recent reprint of Arthur Carhart's *Last Stand of the Pack*, presented at the History Colorado Center's Dynamic Colorado lecture series. The two-part event, "A Call to Restore the Gray Wolf to Colorado," was attended by 260+ people and was warmly received by the audience and History Colorado Center organizers.

Fig. 13c.11 Author Tom Wolf and RMWP science team member Diana Tomback delivered two lectures as part of the History Colorado Center's Dynamic Colorado series. The lectures were warmly received by the audience, who left with information about the Project.

Elk Fest in Estes Park (Fig. 13c.12) – For the third year in a row, the RMWP tabled at Elk Fest in Estes Park, Colorado, just outside of Rocky Mountain National Park at the end of September. This annual event celebrating the beginning of fall and elk bugling season attracts thousands of attendees and heavy foot traffic for the RMWP. The Colorado State University (CSU) chapter of the RMWP helped man the booth, along with a CSU policy communications class that was polling attendees to better understand existing knowledge about wolves in the state.

Fig. 13c.12. The Rocky Mountain Wolf Project, represented in part by the Colorado State University Chapter, tabled at Elk Fest in Estes Park, CO, where they were able to interact with thousands of attendees.

Colorado State University and Otter Creek Events (Fig. 13c.13) – Also in September, science team member Mike Phillips traveled to Fort Collins, Colorado to present as part of a departmental seminar to 75+ Colorado State University (CSU) faculty members, students and interested members of the public. While on campus, Mike was also able to meet with the senior members of the CSU RMWP student chapter.

Mike was also invited to represent the RMWP at a gathering of 20+ of the senior leaders of the Colorado conservation community hosted at coalition member Johnny Le Coq's Otter Creek ranch. The meeting was co-convened by senior RMWP conservation advisors Johnny Le Coq and Eric Washburn and considered options for ensuring the health and integrity of Colorado's great public wildlands, including wolf restoration. We hope that we will be able to deepen our relationship with the critically important hunting and angling community and count many as allies as the Project progresses.

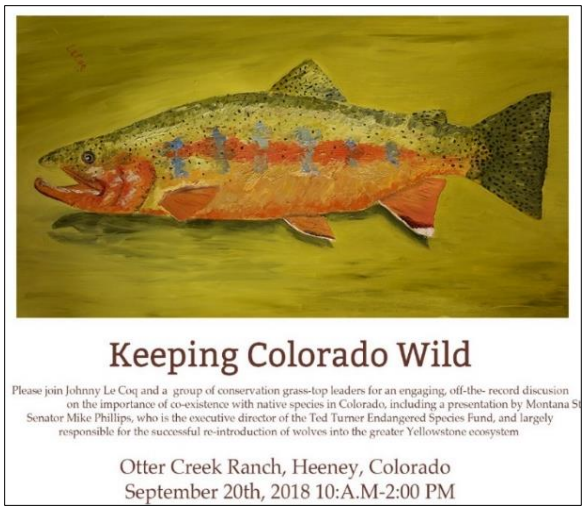


Fig. 13c.13. Science team member Mike Phillips delivered a lecture organized by the wildlife biology department at Colorado State University before representing the RMWP at a gathering of some of the leaders of the Colorado conservation community organized by RMWP conservation advisors Johnny Le Coq and Eric Washburn.

International Wolf Symposium (Fig. 13c.14)

The RMWP, represented by science team member Mike Phillips, was invited to play an integral role in this year's International Wolf Symposium in Minneapolis, MN. Volunteers for the Project tabled throughout the four-day event, talking to attendees about the need to restore wolves to Colorado and selling merchandise developed for the RMWP.

The Symposium featured a line-up of esteemed and experienced wolf biologists, including David Mech, who has studied the species for 60 years, Doug Smith, who spoke on the success and challenges in Yellowstone, and Mike Phillips, who presented "The Last Great Wolf Restoration: Colorado" at the dinner banquet on Saturday, Oct. 13. After delivering his address, Mike was greeted with a standing ovation by the nearly 500 attendees of the conference, a sure sign of the deep support for the Project within the biological community.

Fig. 13c.14. The Rocky Mountain Wolf Project was invited to the International Wolf Symposium in Minneapolis, MN. Volunteers tabled at the four-day event, which included nearly 500 participants, and science team member Mike Phillips spoke at the Saturday night banquet on "The Last Great Wolf Restoration: Colorado."

Outdoor Retailer Winter Market (Fig. 13c.15)

In early November, the RMWP took part in the Outdoor Retailer Winter Market (OR). This event, the largest such expo in the world, took place in the Denver convention center and allowed the Project the opportunity to reach Colorado's broad outdoors community and engage a fleet of new volunteers. Those who tabled for the RMWP at Outdoor Retailer included: Ashly Blanc of Boulder Strategies; the leaders of the Colorado State University (CSU) RMWP Chapter; representatives from two leading outdoor brands that learned of the Project through our participation in the Outdoor Retailer Summer Market; a hunter and conservationist from Boulder; and a couple of regular RMWP volunteers.

Durango Wolf Symposium

On November 29, eight wolf experts and nearly 450 local residents gathered at Fort Lewis College in Durango, Colorado for the Durango Wolf Symposium. This all-day event aimed to encourage thoughtful, public conversation about wolf restoration with all stakeholders, including but not limited to ranchers, sportspersons coexistence specialists and Native American tribes. Specific objectives included disseminating science-based information about wolves and dispelling existing myths, engaging Coloradans about the reality of co-existing with wolves, demonstrating ways to mitigate the effects on hunters, ranchers, and others concerned about wolves, and cultivating interest among Coloradans in returning wolves to the great public wildlands of the western half of the state. The event also included a sold-out tour of Wolfwood Refuge and viewing of the award-winning Living with Wolves documentary at the Southern Ute Museum.

Howling for a Keystone Predator

Music and science aligned this year as two forces gathering around a call to reintroduce gray wolves to Colorado. The Rocky Mountain Wolf Project worked with musical group Lost Walks on their debut album, "Wolf, Woman, Man." The artistic endeavor merged with a campaign to build support among Coloradans for reintroducing wolves, which were hunted out of the state in the 1940s. The coalition is making a science-based argument for how wolves could boost local ecosystems and pointing to 17 million acres of public land in Western Colorado near the San Juan Mountains that could host a pack. –*EM*

Fig. 13c.15. The Rocky Mountain Wolf Project participated in the Outdoor Retailer Winter Market Expo in Denver, where volunteers were able to interact with Colorado's outdoors community. The RMWP was featured in the Outdoor Retailer Winter Magazine.

Crowdfunding Campaign (Fig. 13c.16) – The RMWP, aided by our 28 conservation partners and numerous advocates, successfully matched a $55,000 pledge to raise $110,000 through our first crowdfunding effort this April.

The effort launched April 3 with an email (below) to our 22,385 members and ran until May 6. The overall program was guided by the theme "The Strength of the Pack" which encouraged people to join the Rocky Mountain Wolf Pack by donating and sharing the project. Contribution gifts were offered throughout the campaign to spur donations.

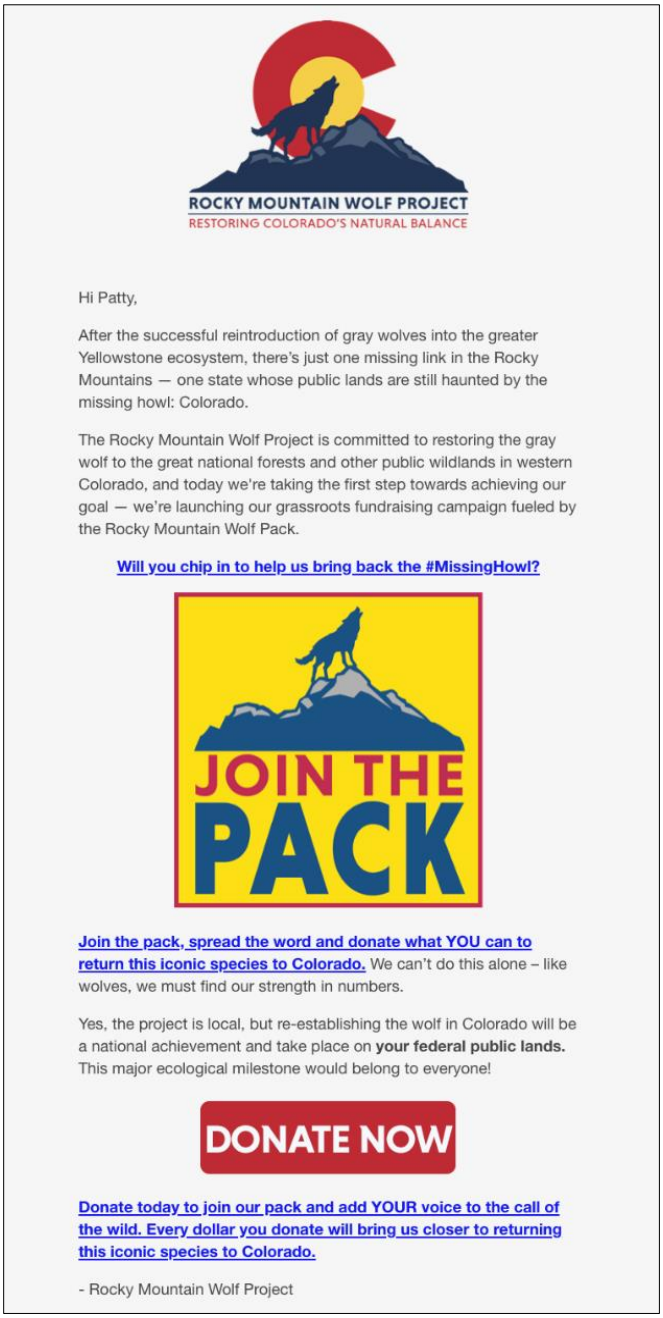


Fig. 13c.16. The Rocky Mountain Wolf Project successfully matched a $55,000 pledge to raise a total of $110,000 through our first crowdfunding campaign. The campaign launched with the "Join the Pack" email.

Living with Wolves Exhibit:

Living with Wolves Exhibit at the Southern Ute Museum (Fig. 13c.17) – The "Living with Wolves" exhibit opened at the Southern Ute Museum in Ignacio, Colorado on August 14. The exhibit documents the experience of National Geographic photographers Jim and Jamie Dutcher as they lived with a wolf pack in Sun Valley, ID. The exhibit provides a general introduction to gray wolves, their behavior and relationship to humans. This custom version contains an introduction to Colorado and a call to action with the RMWP. Because of the unique placement of the exhibit, an introductory panel covering the Ute creation story (which is symbolized by a wolf) has been added.

The Museum hosted a reception on August 16, where more than 200+ members of the community came for a walk-through and the chance to visit with an ambassador wolf from Wolfwood Refuge.

Fig. 13c.17. The Living with Wolves exhibit debuted at the Southern Ute Museum in Ignacio, CO on August 13. The exhibit was adapted to include a new panel about the Southern Ute creation story. The Museum also hosted an opening reception that was attended by more than 200 community members, many of them from the Southern Ute tribe, and featured an ambassador wolf from Wolfwood Refuge.

Living with Wolves Exhibit at the Museum of Boulder (Fig. 13c.18) – On Friday, December 7, RMWP launched the "Living with Wolves" photo exhibit at the Museum of Boulder at Tebo Center. In addition to the award-winning photos, the exhibit includes new interactive additions like a podcast and video booth, a full-scale mural and 3-D printed skulls.

Nearly 300 Coloradans attended the debut, which was co-hosted by the RMWP, the Endangered Species Coalition, Defenders of Wildlife, Rocky Mountain Wild and Living with Wolves and also included a meet and greet with an ambassador wolf from W.O.L.F. Sanctuary in Fort Collins. Governor Elect Jared Polis brought his family the following day. The exhibit will run through May 20, 2019.

Fig. 13c.18. The "Living With Wolves" exhibit debuted at the Museum of Boulder on Friday, November 7. The exhibit, which included new Colorado-specific panels, was updated with interactive additions like a podcast booth and 3D skulls. The opening party was attended by over 285 people and included live music, a photo booth and live mural painting.

Film Screening Highlights:

Wild and Scenic Film Festival (Fig. 13c.19)

Canis Lupus Colorado was selected to screen on January 25 at the prestigious Wild & Scenic Film Fest, which calls itself a "Call to Action" where "*film*-goers are transformed into a congregation of committed activists, dedicated to saving our increasingly threatened planet." The Denver screening, hosted by Rocky Mountain Wild at the Denver Film Festival's SIE Film Center, was sold out, with the nearly 200 participants enjoying six selected films from the festival's full line-up, including *Canis Lupus Colorado.*

Fig. 13c.19. Above is the poster for the Wild & Scenic film fest, which selected Canis Lupus Colorado to screen across the country, including in Denver.

Lyons Film Festival – In March, the RMWP films were featured at the Lyons International Film Festival in Lyons, CO. "Canis Lupus Colorado" closed the festival Friday and Saturday night, and was featured on the festival t-shirt and program.

Banff Mountain Film Festival – Volunteers from the Great Old Broads for Wilderness and Rocky Mountain Wild also tabled at a Banff Mountain Film Festival World Tour screening in Durango, CO on March 16 and 17. The volunteers answered questions, signed up supporters, sold books, distributed RMWP brochures and stickers, and showed "Chorus of Colorado" on a continuous loop to the sold-out crowd.

Telluride Mountainfilm Festival – Over Memorial Day weekend, the RMWP, Defenders of Wildlife, and Wolfwood Refuge traveled to Telluride, CO for Mountainfilm festival. *Meet the Real Wolf* was accepted to screen three times over the course of the festival, including the Kidz Kino, which attracted around 500 viewers.

In addition to screening *Meet the Real Wolf,* the RMWP tabled Friday and Saturday in the park off Main Street and, thanks to Wolfwood Refuge, was able to introduce festival goers and locals to real (ambassador) wolves.

Mountainfilm for Students – The festival directors were "inspired and motivated" after seeing *Meet the Real Wolf* and the award-winning animated short film was selected to appear as part of Mountainfilm on Tour.

The Mountainfilm on Tour season runs August through May. The film will screen in conservation specific playlists during the tour season, but festival organizers feel that *Meet the Real Wolf* can best be used as part of the Mountainfilm for Students K -12 program.

According to the festival organizers:

"Wherever and whenever Mountainfilm is on tour, our mission to educate and inspire reaches beyond theater audiences. With the cooperation of our host-sponsors, we aim to connect with local schools and youth groups by providing free educational film screenings.

Films in these [Mountain Film for Student] playlists include education materials developed by teachers to align with national standards. These educational materials are downloadable and include filmmaker and subject interviews, discussion questions, activities and more aimed at engaging students and instructors in dialogue and in-depth exploration of identified topics."

In addition to screenings, the RMWP was asked to contribute interviews and background materials that will be provided to educators as discussion guides and lesson plans to continue the conversation outside of the classroom and deepen the impact of our message.

This is an exciting opportunity for the RMWP to reach students and screening

attendees across the world. In 2017, Mountainfilm for Students reached about 22,000 students over the course of approximately 150 screenings. We will continue to monitor screenings and attendance numbers.

Crested Butte Film Fest (Fig. 13c.20) – RMWP was invited to participate in a panel at the Crested Butte Film Festival that followed a screening of the new film, "The Trouble with Wolves," which considers the breadth of conversations surrounding wolf restoration.

The 55-minute film was followed by an informational session including the filmmaker, wolf advocate Michelle Smith and her ambassador wolf Shaya, and Karin Vardaman, a biologist for Rockies and Plains Program for Defenders of Wildlife. The panelists spoke about the historical significance of wolves in Colorado, as well as opportunities for a future reestablishment of the species.

Fig. 13c.20. Members of the Rocky Mountain Wolf Project coalition were invited to join a panel at the Crested Butte Film Festival following the screening of the film, "The Truth about Wolves."

National Geographic Your Shot Campaign "The Tale of Two Wolves" – The National Geographic Your Shot campaign "The Tale of Two Wolves" launched on February 26 with the full support of the RWMP coalition. Led by artist Asher Jay, the month-long assignment asked photographers to help revitalize and reimagine the wolf by using "science-telling" to paint a more accurate picture of this iconic predator – and its future in Colorado.

The Your Shot assignment was the first coordinated effort by the coalition to take the inspiring message of Colorado wolf restoration global, and resulted in the submission of 1,905 photos from around the world.

Asher Jay writes in her opening essay:

"I encourage people to submit images that creatively bring the narrative of the "wolf" into focus from a unique cultural, political, ecological, emotional or conceptual perspective. Think of yourself as a public relations agent, and the wolf as your client. He has had a bad reputation for hundreds of years for no fault of his own and needs your help in restoring public faith in his true character and context for being."

Arts Partnerships:

Lost Walks Band Collaboration

Denver musical "supergroup" Lost Walks contacted the RMWP about a two-night benefit concert at the Bakery music warehouse on February 9 and 10. This collective of musicians, dancers and visual artists came together to tell the story of the wolf in an unconventional way: through a rock opera. Their debut album "Man, Woman, Wolf" was inspired by a trip to the Colorado Wolf and Wildlife Center and was positively reviewed by Colorado Public Radio.

The RMWP again partnered with the band on July 6. The show took place at the Civic Center McNichols Building and was sponsored by Denver Arts & Venues as part of their Cultural Partner Program.

In December, the band performed at the "Wolf, Woman, Man, Beer" event at the LFX Filmworks and Event space in Denver. The show included a unique partnership with two Denver breweries, Ratio Beerworks and TRVE Brewing, and ticket holders were able to sample brews coordinated to specific songs.

Artist Valerie Rose – The RMWP began working with Carbondale-based artist Valerie Rose on a series of custom artworks for fundraising needs and event invitations.

Valerie created the "Wolf Will Reappear" mural at the Museum of Boulder. The mural took over 20 hours to complete and Val captured the process through a time-lapse video. She also created the celestial-inspired wolf poster that was used as a donor gift in our Christmas giving campaign (Fig. 13c.21).

Fig. 13c.21. Carbondale, Colorado-based artist Valerie Rose has become an important part of the coalition in 2018 and completed the popular "Wolf Will Reappear" mural at the Museum of Boulder.

Media Coverage – The RMWP and the movement to reintroduce wolves to Colorado has begun to spur statewide and national conversation. As expected, there is vigorous discussion on both sides of the debate, but our intention is to educate those "on the fence" using the messaging that proved effective in our polling. We are confident that the true story of the wolf and its role as an important part of Colorado's past and future will prove captivating and convincing.

The Durango Herald. Feb. 13, 2018.
Allen: What Pro-Wolf Introduction Factions are Telling You and What They are Not
(https://durangoherald.com/articles/208569)

"The argument that wolves must be returned to their "once native ranges" is unrealistic, as man is here now in large proportions; man must manage wildlife."

The Durango Herald. Feb. 20, 2018.
Albert: Humans Need Managing, Not Wolves
(https://durangoherald.com/articles/209738-albert-humans-need-managing-not-wolves)

"It is disappointing that the CEO of the Rocky Mountain Elk Foundation [Allen] so disparages the return of the wolf to everywhere the elk are. Perhaps he doesn't realize that elk and wolves evolved together for millennia. That the very majesty and athleticism of elk are due to the pressure of predation and resultant selection of faster, stronger, smarter animals."

The Durango Herald. Feb. 21, 2018.
Sykes: Wolves Belong in Colorado
(https://durangoherald.com/articles/209909-sykes-wolves-belong-in-colorado)

"I'm from Northeast Oregon where wolves first entered the state and where the largest number now live. After nine years, elk herds haven't shown a decline…My county had seven confirmed [cattle] losses [due to wolves] from 40,000 cows last year. Wolves belong in Colorado. I wish they had been there when I lived in Durango nearly 40 years ago."

Aspen Daily News. Feb. 26, 2018.
Wolf Policy Must Be Based on Fact
(https://www.aspendailynews.com/opinion/letters_to_editor/wolf-policy-must-be-based-on-fact/article_c382e890-1aaa-11e8-86ab-07dfbeac6296.html)

"It is disingenuous to state that opponents of wolf reintroduction base their beliefs solely on myth while wolf advocates use only facts as suggested by Senator Phillips of Montana. The real myth is that anyone could believe that wolves would return to Colorado, to 5.5+ million people, to a landscape crisscrossed with roads and trails, and to outdoor recreation on steroids, and not have negative consequences."

Boulder Weekly. Feb. 1, 2018.
Will Coloradans Free Wolves on The State's Public Lands?
(https://www.boulderweekly.com/news/will-coloradans-free-wolves-states-public-lands/)

"A 2013 poll found 70 percent of Coloradans favor bringing wolves back to the state so perhaps it's not too much to say the reintroduction of wolves to Colorado is the democratic thing to do. And considering the ongoing assault on our environment, Colorado needs wolves more now than ever."

The Durango Telegraph. Dec. 20, 2018.
Wolf Symposium Shared Science
(https://www.durangotelegraph.com/opinion/soap-box/wolf-symposium-shared-science/)

"Colorado ranchers, tough as their wolf-country brethren, have a soft spot: love of their animals. It's time for us to expand our love beyond humans and domestic animals to the wild ones. Our greatest wildlife biologist, Aldo Leopold, also a forester and farmer, saw it most clearly: only the mountain has developed a broad enough perspective to listen objectively to that howl."

The Durango Telegraph. Dec. 6, 2018.
Wolf Symposium Left Ranches Out in the Cold
(https://www.durangotelegraph.com/opinion/soap-box/wolf-symposium-left-ranchers-out-in-the-cold/)

"If Wolf Symposium organizers intend to continue the conversation, they need to provide facts and balanced perspectives. When it comes to wolves, farmers and ranchers definitely want to be part of the conversation because, according to La Plata County Farm Bureau President Charly Minkler, "When it comes to wolves, if we're not at the table, we're on the menu."

The Durango Telegraph. Dec. 13, 2018.
Ranches Miss Point of Symposium
(https://www.durangotelegraph.com/opinion/soap-box/ranchers-miss-point-of-symposium/)

"The Wolf Symposium provided credible scientific data that can be used to restore balance to our natural landscapes. Ranchers can participate in this dialogue for the benefit of all. The letter writers [above] cherry-picked the information, and speaker Tom Compton, representing ranchers, also deliberately used misleading information to distort the truth… Instead of griping and offering stiff opposition, ranchers could provide useful insight into dialogue leading to the successful reintroduction of wolves in Colorado."

The Durango Herald. Nov. 29, 2018.
Forum Examines Past and Future of Wolves in Colorado
(https://durangoherald.com/articles/252610)

Tom Compton said he was primarily concerned with the economic impact wolves would have on ranching families. Ranches in Western Colorado are largely small, family operations working on low profit margins, he said. "We deal with predation on almost a daily basis, and if we add an apex predator to that mix, it could be the straw that breaks the camel's back."

The Durango Herald. Dec. 6, 2018.
We do have Room for Wolves in Colorado
(https://durangoherald.com/articles/253596)

"States with wolves see wildlife populations and forest habitats improve with the more balanced ecosystem. Millions of people and tens of millions of livestock currently coexist with wolves.

Wolves aren't cold-blooded killers; they are simply necessary predators. It's time that we listen to the facts, not the fear and fiction. With minimal risk and your support, we can make room for wolves in Colorado."

Merchandise and Gifts Campaign

In 2018, the RMWP developed new merchandise, including:

- Logo t-shirt
- T-shirt printed with Asher Jay watercolor
- Logo hat
- Poster of watercolor by Aspen artist Laurie McBride (Fig. 13c.22)
- Copies of *Awakening Spirits: Wolves in the Southern Rockies*
- Logo and photo stickers
- RMWP logo patches

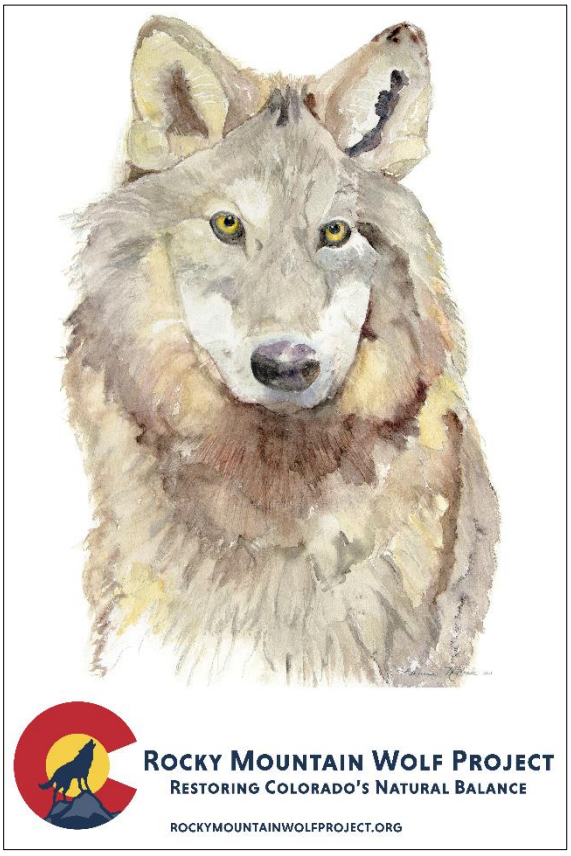


Fig. 13c.22. Poster of watercolor by Aspen artist Laurie McBride.

The RMWP merchandise was critical in pulling off our second gifts campaign, where we were able to net $3,440 and send out 100 pieces of custom merchandise, including t-shirts, hats, signed copies of *Awakening Spirits* and posters, to donors around the world. The success of the gifts campaign, both as a means of raising money and distributing our logo and message globally, has established this effort as one worth repeating regularly.

Website Metrics

The RMWP digital presence continued to grow rapidly in 2018, with now over 50,000 email subscribers, almost $100,000 raised within the year and a strong social media following.

Email Listserv:

- Total contacts: 51,519
- Open rate: 24%
- Click-to-open rate: 10.5%
- Emails sent: 1,414,105 (compared to 297,781 sent in 2017)

What does this mean? Our emails are highly engaging and driving good action.

Fundraising:

- Dollars Raised: $97,239
- # of contributions: 2,223
- Average contribution: $43
- We raised $.11 per person per email.

For comparison, 2017 numbers:

- Dollars raised: $9,906
- # of contributions: 189
- Average contribution: $52

Social Media:

- Facebook: 9,073 followers
- Twitter: 443 followers
- Instagram: 2,494 followers

We had 8,809,087 impressions on Facebook since launch, including:

- Paid page impressions: 476,955
- Organic page impressions: 2,047,092
- Viral Page Impressions: 6,285,040

Blog Posts:

Top Posts by Views

BLOG POST	PAGE VIEWS
9 Myths about the Gray Wolf You Shouldn't Believe	3,452
Building Bridges With The Ambassador Wolf	2,270
Interview With an Artist – Valerie Rose	1,275
Interview With an Expert – Mike Phillips	904
A Gray Wolf's Devotion to Family	581

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, 52 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 that time, only 5 of 18 collared lions using the mountains have been removed due to predation on sheep (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 2011-2018.

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]
09/2018	78	41	2	9	-	2	4	8	5	26	G[13]
10/2018	179	75	-	25	-	-	-	-	2	79	A[?]

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 2014-2018.

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; recaptured 11/8/2018	Dead - hunter harvested 3/14/2019 along Rio Grande near Bernardo, NM (+34.489188, -106.796454). Incidentally recaptured and released on 2/8/2017. Recaptured and collar exchanged 11/01/17. Recaptured and collar exchanged on 11/8/2018	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-M11	6/26/2018; recaptured 9/26/2018	Dead - removed due to DBS depredation on 09-26-18. Killed in snare.	3 ewe/lamb, 2 ram
AR-F01	3/6/2014, recaptured 2/6/2015	Unknown - 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	Unknown - 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.	
AR-F06	10/12/2018	Alive - using Fra Cristobals and riparian corridor	
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 2018 – We assisted NMDGF with two sheep surveys in 2018 - one ground survey in September when a minimum of 78 sheep were counted, and one aerial survey in October when a minimum of 179 sheep were observed. In late 2017, and continuing into 2018, we documented suspicious mortalities of 4 collared sheep (3 ewes/1 ram). These sheep were 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 five other desert bighorn rams and two gemsbok (*Oryx gazella*) harvested by hunters in the Fra Cristobal mountains in 2018. The ram mortality tested positive for *Mycoplasma ovipneumoniae*, which is a bacterium that can cause pneumonia. Four out of the five hunter harvested rams also tested positive for mycoplasma and one gemsbok tested positive for exposure to epizootic hemorrhagic disease (EHD), but all hunter killed animals otherwise appeared healthy when harvested. An estimated 15% of the Fra Cristobal bighorn population perished due to disease exposure in 2018, hence the lower population counts. We are currently working with NMDGF to monitor and investigate any suspected disease-caused morbidity or mortality of wildlife within the Fra habitat area. Five bighorn rams were harvested by licensed hunters during the 2018-19 season.

We detected three new lions using the Fra Cristobal mountains in 2018. We captured and collared two new lions; one male (ARM11) and one female (ARF06). We recaptured one male lion (ARM07) to exchange collars. One male lion (ARM11) was removed for killing multiple sheep (Table 14.2).

From 2014 through 2018, more than 72,000 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 1,135 GPS point clusters, or potential lion kill or feeding sites. Of these, 729 were confirmed to be kill sites. Mountain lion diet composition is diverse, with 31 different prey species being consumed (Fig. 14.1), ranging from carp (*Cyprinus carpio*, *n*= 49) to gemsbok (*Oryx gazella*, *n*= 32). Approximately 45% of the combined confirmed lion diet is comprised of small prey items (less than 15 kg), however mule deer (*Odocoileus hemionus*, *n*= 216) are the most selected prey species at 30%. Desert bighorn sheep comprise approximately 4% of the diet (32 documented kills).

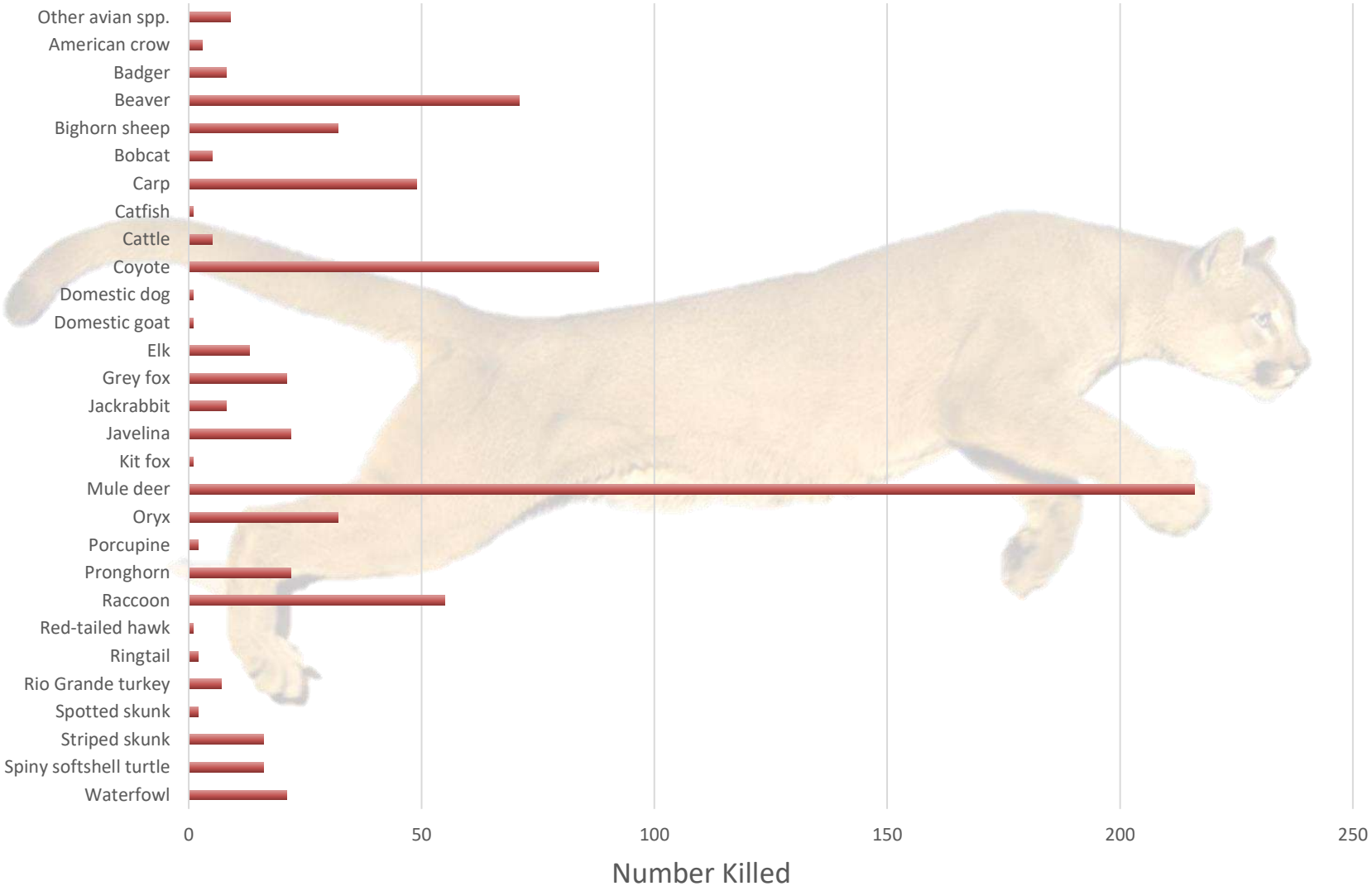
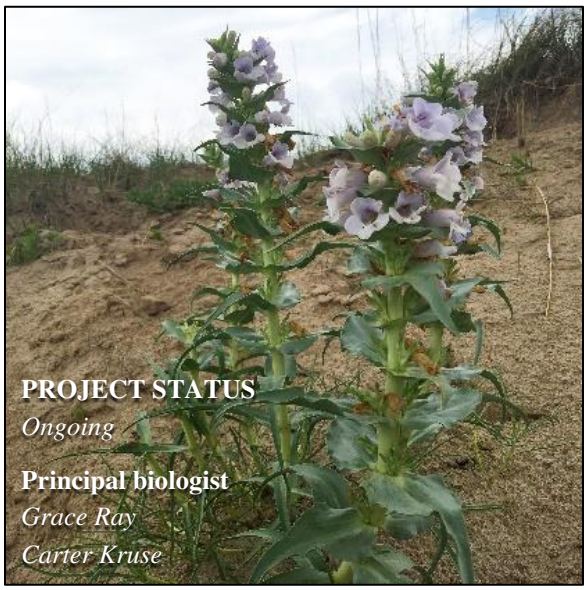


Fig. 14.1. Confirmed mountain lion kills from 2014 – 2018.

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 14.1: Blowout Penstemon Habitat Description

Example of advancing blowout habitat

Landscape view: grazed and un-grazed comparison

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.

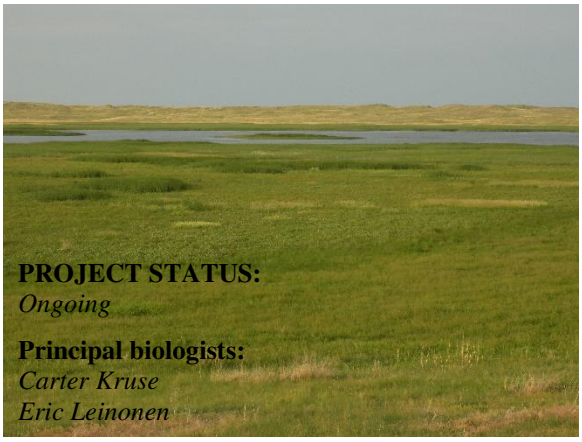
Blowouts have decreased dramatically in abundance since the time of settlement. With the control of wildfires and more controlled grazing, areas of bare sand are today uncommon in the Sandhills. Because of this, blowout penstemon cannot compete in the well-established Sandhills grasslands (Nebraska Game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

Project Activities in 2018 – TEI employees conducted vegetation monitoring of the pasture after one year of extended bison grazing. The methodology utilized to collect baseline vegetation data was repeated by using the 3 established 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. The project pasture was split roughly in half to increase the density of bison grazing and to further speed up the habitat enhancement process. TBD met on site with project partners to assess progress towards developing penstemon habitat. The group concluded that penstemon seedling transplanting will likely occur in fall 2019 or 2020, with a portion of the direct seeding taking place early spring 2019.

Proposed Future Activities & Considerations

Year 3 of 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. The first round of penstemon seeding will occur in early spring of 2019, and penstemon plantings will take place post-bison grazing once the appropriate conditions are met (either fall of 2019 or 2020). Yearly grazing activity will continue throughout the course of the project while taking into consideration the seasonal life-cycle of the blowout penstemon.

16. SANDHILLS FEN AND WETLAND HABITATS



Conservation Problem – The Nebraska Sandhills cover some 12.75 million acres of the Central Mixed Grass Prairie ecosystem. The six Turner Ranches in the Sandhills comprise 3.2% of the region. The Sandhills prairies are a vast area of grass covered sand dunes interspersed with interdunal depressions and valley bottoms. Many valley bottoms intersect relatively shallow groundwater gradients, resulting in "wet meadow" habitats that are productive moist grasslands, fens, wetlands, or lakes and ponds supporting a wide diversity of plant and animal species. The area is the second most productive waterfowl region in North America. Streams originating in the Sandhills are unique in their mostly groundwater origins, lack of tributary network, and flow stability, as surface precipitation readily percolates into the sand and shallow groundwater system. Approximately 66% of the recharge for the Ogallala aquifer occurs in the Sandhills. The Sandhills region is relatively unimpacted overall and represents perhaps the most intact grassland system remaining in world.

Productive wet meadow habitat in the Sandhills are often intensively managed for grazing and haying. A common management practice is development of drainage ditches that remove surface water and/or lower the shallow subsurface water table to improve access for livestock and machinery (Fig. 16.1). Although the Sandhills are relatively intact overall, wet meadow and wetland habitats in the region have been disproportionately impacted for production purposes. Fens, which are special groundwater fed, peat-filled wetlands, are often associated with shallow groundwater areas at the head of stream valleys or upper ends of wet meadows and wetlands. Great Plains fens often support diverse and regionally unique (glacial relict) flora. Sensitive or rare plants associated with wet meadows and fens include prairie white fringed orchid (federally and state listed threatened species) tall cotton-grass, bog bean, marsh marigold, spike muhly, and bog aster. Because of ditching and draining which can lower groundwater levels and ultimately change the hydrology of wetland and fen habitats (leading to decomposition of peat and invasion by non-native species), Sandhills fens, and the communities associated with them, continue to decline in extent and condition. Generally, fen habitat is considered critically imperiled.

Fig.16.1. Drainage ditch in Capp Valley wet meadow, Spikebox Ranch, Nebraska.

Project Locations
Gordon Creek, McMurtry Ranch
Headquarters Meadow, McMurtry Ranch
Tennessee Valley, Fawn Lake Ranch
Sandy Richards Creek, Fawn Lake Ranch
Four Corners Lake, Fawn Lake Ranch
Snake River, Deer Creek Ranch
Capp Valley, Spikebox Ranch

Project Partners
- US Fish and Wildlife Service (USFWS)
- Nebraska Game and Parks (NGP)
- Sandhills Task Force (STF)
- Natural Resources Cons. Service (NRCS)

Goals – Restore the natural hydrology and fen, wetland, and wet meadow habitats and their associated native plant communities in impacted valley bottoms on Turner Sandhills ranches. Contribute information on Sandhills fen restoration to the scientific community to improve our understanding of these habitats and opportunities for restoration.

Project Background – Sandhills Ranch managers and TBD biologists recognize both the negative ecological impacts and positive production benefits of existing drainage ditches found on some of the Turner Sandhills ranches. Significant consideration has been given to where TBD, working with project partners, can restore fen and wetland habitats without significantly impacting production goals. An initial project list (see Project Locations, above) has been identified.

The Gordon Creek project was the first, and to-date only, meadow restoration project completed on Turner Sandhills ranches. This project, completed in 2015, restored approximately 3 miles of impaired creek channel and over 400 acres of wet meadow and wetland habitat (Fig. 16.2). It is the largest stream restoration project ever completed in the Sandhills.

Fig. 16.2. Gordon Creek project area.

In 2017, TBD visited other priority restoration areas with project partners and potential contractors, and it was agreed that Capp Valley, a relatively straightforward ditch-fill project, would be the next project implemented. A topographic survey of the project area necessary for design criteria was completed by NRCS in 2017.

Project Activities in 2018 – A project design for the Capp Valley project was completed by NRCS in early 2018. Northern Underground of Sheridan, WY, submitted a $55,700 bid for the project. A required wetland delineation was completed, and 404/401 permit applications were drafted. These federal and state certifications, respectively, are necessary for dredge and fill in wetland habitats. The project was scheduled for implementation in late summer 2018 but delayed due to permitting and funding issues.

PUBLICATIONS IN 2018

Hoogland, J. L., D.E. Biggins, N. Blackford, D.A. Eads, **D. Long,** M.R. Rodriguez, L.M. Ross, S. Tobey, and E.M. White. (2018). Plague in a Colony of Gunnison's Prairie Dogs (*Cynomys gunnisoni*) Despite Three Years of Infusions of Burrows with 0.05% Deltamethrin to Kill Fleas. Journal of Wildlife Diseases, 54(2), 347-351.

Phillips, M. K. 2018. 2017 Mexican wolf recovery plan: really good on anti-wolf politics, really bad on pro-wolf science. International Wolf 28: 13-15.

Phillips, M.K. 2018. Keeping every cog and wheel. Op-ed, Durango Herald, April 7.

Phillips, M.K. 2018. A biologist's perspective on wolf restoration. Op-ed, Aspen Times, March 25.

Phillips, M.K. 2018. A biologist's perspective on wolf restoration. Op-ed, Sopris Sun, March 20.

PRESENTATIONS IN 2018

Asher, V. 2018. "Wolves, Bison, and Elk: Tension Between Conservation and Commerce Across a Wild, Working Landscape" International Wolf Center Symposium, Minneapolis, MN, October 11-14.

Phillips, M. K. 2018. A biologist's and senator's look at wolf recovery and conservation. Evening lecture as part of the Naturalist Nights series hosted by Aspen Center for Environmental Studies, Wilderness Workshop, and Roaring Fork Audubon. Carbondale, CO. February 7.

Phillips, M. K. 2018. A biologist's and senator's look at wolf recovery and conservation. Evening lecture as part of the Naturalist Nights series hosted by Aspen Center for Environmental Studies, Wilderness Workshop, and Roaring Fork Audubon. Aspen, CO. February 8.

Phillips, M. K. 2018. Nature's archstone: restoring the gray wolf to western Colorado. Lecture to Conservation Biology students from Canisius College, Buffalo, NY. Delivered in Bozeman, MT. February 20.

Phillips, M.K. 2018. RMWP: a call to arms. Invited Presentation, Southern Rockies Conservation Alliance. American Mountaineering Museum, Golden, CO. March 12.

Phillips, M. K. 2018. Wolf Restoration to the Southern Rockies: A Call to Arms. Gathering of Social Media Influencers. Bozeman, MT. April 13.

Phillips, M. K. 2018. Wolves are Not Angels or Devils: Just a Choice. Invited Whole School Lecture, McCallie Preparatory School, Chattanooga, TN, April 16.

Phillips, M. K. 2018. Strange Bedfellows: Politics, Science, and Climate Change. Invited Lecture, Three Advanced Placement Environmental Sciences Class, McCallie Preparatory School, Chattanooga, TN, April 16.

Phillips, M.K. 2018. Magic restored: re-establishing the gray wolf to western Colorado. Invited lecture for Colorado Wolf and Wildlife Center, Antlers Hotel, Colorado Spring, Colorado. June 8.

Phillips, M.K. 2018. Restoring the gray wolf to Colorado: an overdue conversation. Invited lecture for Aspen Business Luncheon, Mountain Chalet, Aspen, Colorado. June 20.

Phillips, M.K. 2018. Conservation biologists and politicians: necessarily one and the same. Invited plenary lecture for Wildlife for All: Re-envisioning State Wildlife Governance. Southwest Environmental Center & Western Wildlife Conservancy, Albuquerque, New Mexico. August 14-16.

Phillips, M.K. 2018. Wolves and woodpeckers, snails and trout: a private effort to redress the extinction crisis. Invited plenary lecture for 2018 annual meeting of The Wildlife Society, Cleveland, OH. October 7-11.

Phillips, M. K. 2018. The last great wolf restoration: Colorado. Invited banquet address for International Wolf Symposium: wolves in a changing world. International

Wolf Center, Minneapolis, MN. October 11-14.

Phillips, M. K. 2018. Mexican wolf recovery plan: a debate of merits. Invited debate participant for International Wolf Symposium: Wolves in a changing world. International Wolf Center, Minneapolis, MN. October 11-14.

Phillips, M. K. 2018. Nature's Arch Stone: Restoring the Gray Wolf to Western Colorado. Keeping Colorado Wild Conference, Otter Creek Ranch, Heeney, CO. September 20.

Phillips, M. K. 2018. Nature's Arch Stone: Restoring the Gray Wolf to Western Colorado. Wildlife Department Faculty Seminar, Warner College of Natural Resources, Colorado State University, Fort Collins, CO. September 21.

Phillips, M. K. 2018. Conservation Biologists and Politicians: Necessarily One and the Same. Wildlife Department Brown Bag Seminar, Warner College of Natural Resources, Colorado State University, Fort Collins, CO. September 21.

Phillips, M. K. 2018. The future of conservation translocations: a political perspective. Invited Plenary Participant. 2nd International Wildlife Reintroduction Conference. Lincoln Park Zoo, Chicago, IL. November 16.

Phillips, M. K. 2018. History of Wolf Recovery. Wolf Symposium, Biology Department, Fort Lewis College, Durango, CO. November 29.

Phillips, M. K. 2018. Woodpeckers and Desert Sheep, Tortoises and Snails: The World's Most Significant Effort to Save Creation). Biology Department Brown Bag Seminar, Fort Lewis College, Durango, CO. November 29.

EXTERNAL SERVICE IN 2018

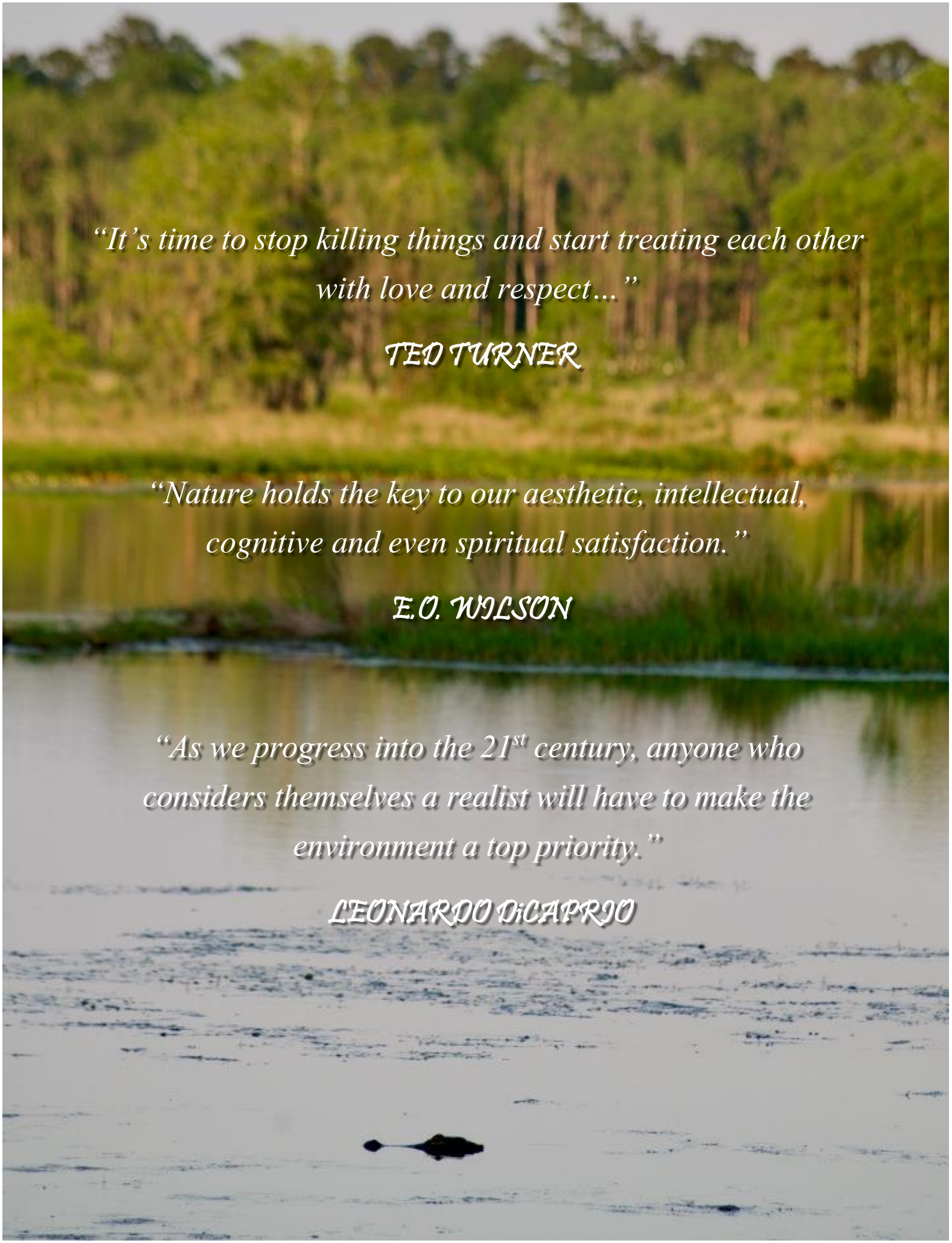
Asher, V. Carcass-Camera Trap Study – We are working with the University of Florida's Anthrax project using cameras on carcasses to understand ungulate/scavenger visitations over the long term and that relationship for disease transmittal. A graduate student has been assigned to the study with a completion date for her masters in May of 2019.

Asher, V. Mexican wolf/Livestock council - We continue to hold a seat on the Mexican Wolf/Livestock Council to assist in technical support related to compensation for depredations and proactive measures to avoid wolf livestock conflicts in the southwest.

Asher, V. American Kestrel Partnership – 2018 is our fifth year that nesting boxes have been placed on the ranch. Of the ten boxes deployed we continue to have a >33% average of occupation and fledgling success. This year we partnered up with the Audubon Society and banded 9 chicks.

ACRONYMS & ABBREVIATIONS

ACES = Aspen Center for Environmental Studies
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
CO = Colorado
CPW = Colorado Parks and Wildlife
CSS = Chupadera springsnail
CSU = Colorado State University
CT = Cedar Tank
DEA = Draft Environmental Assessment
DNR = Department of Natural Resources
DPS = Distinct Population Segment
EA = Environmental Assessment
eDNA = Environmental DNA
EHD = Epizootic Hemorrhagic Disease
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
ISU = Idaho State University
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
LTP = Long-Term Protected
MGW = Mexican Gray Wolf
MOU = Memorandum of Understanding
MI = Michigan
MN = Minnesota
MSU = Montana State University
MT = Montana
MT FF = Montana Future Fisheries
MTFWP = Montana Fish Wildlife & Parks
MTTF = Montana Trout Foundation
MVP = Minimum Viable Population
NAFWS = Native American Fish and Wildlife Society
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
NWE = Northwestern Energy
NWR = National Wildlife Refuge
OCIC = Orianne Center for Indigo Conservation
ODWC = Oklahoma Department of Wildlife Conservation
OR = Oregon
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
STF = Sandhills Task Force
SWMF = Sevilleta Wolf Management Facility
TBD = Turner Biodiversity Divisions
TEI = Turner Enterprises, Inc.
TNC = The Nature Conservancy
TESF = Turner Endangered Species Fund
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
UT = Utah
VPR = Vermejo Park Ranch
WAFWA = Western Association of Fish and Wildlife Agencies
WCT = Westslope cutthroat trout
WA = Washington
WI = Wisconsin
WLA = Western Landowners Alliance
WMA = Wildlife Management Area
WNS = White-nose syndrome
WNTI = Western Native Trout Initiative
WPM = Western pearlshell mussel
WWF = World Wildlife Fund
WY = Wyoming



"It's time to stop killing things and start treating each other with love and respect…"

TED TURNER

"Nature holds the key to our aesthetic, intellectual, cognitive and even spiritual satisfaction."

E.O. WILSON

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

LEONARDO DiCAPRIO