

Conservation Success on a Landscape Scale: Leslie Canyon National Wildlife Refuge.

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Abstract- *There are a multitude of innovative strategies available to land managers that can help facilitate landscape-level conservation in the face of expected changes in human population growth, increasing temperature, shifting rainfall patterns, and weather extremes. A good example involves Leslie Canyon National Wildlife Refuge in Cochise County, Arizona. Here, the U.S. Fish and Wildlife Service (Service) has worked effectively with others to expand protection, conservation, and species recovery activities beyond the 2,765 ac (1,119 ha) Refuge owned by the Service, extending those efforts onto an additional 20,471 ac (8,284 ha) of privately owned land. Strategies included a combination of: 1) originally delineating an adequate Refuge acquisition boundary to provide for conservation opportunities at a watershed scale; 2) monitoring and assessing the impacts of potential groundwater withdrawal within the watershed upstream from the Refuge; 3) acquiring, holding, and maintaining conservation easements on lands within that acquisition boundary; 4) formalizing a Safe Harbor Agreement with the neighboring landowners to help implement recovery activities for six federally-listed threatened and endangered species; and 5) seeking and providing funding opportunities that help enable landscape enhancement activities such as erosion control, grassland and wetland restoration, and fish and wildlife reintroductions. The success of these cost-effective efforts serves as a model by those who desire to collaborate in conserving similarly situated landscapes.*

INTRODUCTION

The Rio Yaqui Basin is a large riverine system, which drains portions of southeastern Arizona and southwestern New Mexico in the United States (U.S.), and eastern Sonora and western Chihuahua in Mexico. These rivers flow southwesterly where they eventually join and empty into the Sea of Cortez near Ciudad Obregon, Sonora. The entire basin is approximately 28,185 mi² (73,000 km²), and less than 2% of the entire basin is in the U.S. Dynamic geological events have played a major role in shaping these areas of southeast Arizona, catching and storing crucial water, and helping determine the biological diversity present. The portion of the Rio Yaqui headwaters in Arizona supported unique fish and wildlife, including eight native fish species (USFWS 1994). These are the Mexican longfin dace (*Agosia* sp.), Mexican stoneroller (*Campostoma ornatum*), beautiful shiner (*Cyprinella formosa*), Mexican roundtail chub (*Gila minacae*), Yaqui chub (*Gila purpurea*), Yaqui sucker (*Catostomus bernardini*), Yaqui catfish (*Ictalurus pricei*), and Yaqui topminnow (*Poeciliopsis occidentalis sonoriensis*). Six of these species were found nowhere else in the U.S., and five of these are listed as threatened or endangered species in the U.S. and/or Mexico (USFWS 1994). The biological diversity of a minor portion of the Rio Yaqui watershed in Arizona, now protected as National Wildlife Refuges, is further demonstrated by the documentation of at least 416 species of plants (NPS 2016), 343 birds, 67 mammals, 43 reptiles, and 13 amphibians occurring here. Wilson (2016) describes the rugged Madrean mountain chains of Mexico and the Sky Island heights of the southwestern U.S. within which the Refuges lie as one of the best places in the Earth's biosphere due to the diversity of species supported, and identifies the importance of habitat corridors as one way of lessening the impact of climate change on such biodiversity.

The natural diversity within the region has been severely affected by past human uses, including vegetation clearing, unfavorable historic grazing practices, overuse of groundwater by pumping, stream incision and channelization, and other actions (USFWS 1994). Water development and pumping of underground aquifers constitute the greatest threat to survival of Yaqui fishes (USFWS 1994), followed by the negative impacts of non-native species, topsoil erosion, and resulting stream siltation and aggradation. The area continues to be imperiled by numerous influences, including the threats imposed by altered climate resiliency (Halofsky et al. 2018). This paper discusses a suite of strategies that have been successfully used over the past 40 years to conserve natural resources, facilitate transition of diverse ecosystems to a warmer climate, promote partnerships, and enhance and augment collaborative conservation on a broad scale across a portion of the landscape.

Responding to the need to preserve remaining wetland habitats, and to sustain and recover rare fish, Leslie Canyon (Tract 20) was acquired on May 31, 1988 and established as a 1,240 ac (502 ha) unit of the San Bernardino NWR (SBNWR) in Cochise County, Arizona. A Preliminary Project Proposal for designating the Leslie Canyon portion of SBNWR as a separate unit of the National Wildlife Refuge System was approved on August 25, 1992, and Leslie Canyon National Wildlife Refuge (LCNWR) became established during the summer of 1993. In partnership with others, the U.S. Fish and Wildlife Service (Service) administers the Refuge, which is integral to helping maintain a large healthy intact landscape through a combination of several innovative methods. Some of these include acquiring, holding, and maintaining conservation easements totaling about 20,471 ac (8,284 ha), establishment and oversight of the 24,585 ac (9,949 ha) Leslie Canyon Watershed Safe Harbor Agreement, and conducting associated environmental compliance related to endangered species protection and recovery (Figure 1).

CONSERVATION EASEMENTS

Conservation easements are a unique tool to provide environmental protection on private lands, with the goal of tying together existing protected areas, grasslands and riparian areas within a broader working landscape (Rawoot 2017). In general, conservation easements restrict subdivision, building development, and other land uses that would potentially harm the property's value as fish and wildlife habitat. In exchange for giving up certain development rights, the landowner receives a cash payment that reflects the property's appraised development value, which is a significant part of the land's overall value. The Conservation Easement Program administered by the Service is a voluntary program where willing landowners are paid a percentage of their property's fair market value by the Service for the purchase of the property's farming and/or development rights in perpetuity. Easement acquisition typically focuses on the protection of lands having existing habitat conditions that are considered valuable to fish and wildlife (conservation values), and the program is a cost effective way to ensure protection and conservation of landscapes without the federal government actually owning the land. As privately owned land, the property covered by the easement continues to be subject to property taxes and other local regulations.

Service planners recognized the importance of protecting a watershed large enough for protecting, and supporting the purposes of, the proposed Refuge. The Preliminary Project Proposal therefore strategically identified an acquisition boundary for LCNWR that encompassed about 25,000 ac (10,117 ha), including most of the immediate Leslie Creek watershed outside of designated National Forest lands. This relatively large "Refuge acquisition boundary" was visionary in providing the Service opportunities to pursue habitat protection and conservation of fish and wildlife in a broader watershed that maximized connectivity across the gradient of elevations using a variety of methods, including purchase through fee title and purchase of conservation easements within the established boundary. It is important to recognize that the purchase of a conservation easement by the Service follows the same realty process required for a fee title purchase of land, and cannot be pursued unless the desired land is within an approved designated Refuge acquisition boundary.

Leslie Canyon was acquired through fee title by the Service with the help of The Nature Conservancy, a non-governmental conservation organization, that was able to more quickly purchase property from the willing seller and then hold the parcel in trust until fee title purchase by the Service was ultimately accomplished under authority of the Endangered Species Act (ESA) of 1973, as amended. In 1994, another non-governmental organization, The Conservation Fund purchased an additional 1,200 ac (486 ha) within the acquisition boundary and donated the land to the Service as an addition to the Refuge (Tract 21), which eventually totaled 2,765 ac (1,119 ha) with the acquisition of 324.76 ac (131 ha) (Tract 23) as part of a land trade between the Service, J.A. Varela, and the C.J. Bennett Trust. This relatively small portion of the much larger landscape within the Refuge acquisition boundary was particularly valuable to the Service because it encompassed a perennial stream that supported Yaqui chub, Yaqui topminnow, Chiricahua leopard frogs (*Lithobates chiricahuensis*), and a rich riparian corridor that sustained a diversity of plants and animals. Sale of the land to these conservation organizations (for ultimate transfer to the Service) was possible, in part, because the private landowner viewed the federally-listed endangered species that occupied the property as potential liabilities to his ranching operation. He feared the possibility of serious consequences related to the ESA in restoring species at risk, which



U.S. Fish & Wildlife Service
Leslie Canyon National Wildlife Refuge
 Cochise County, Arizona

Land Status

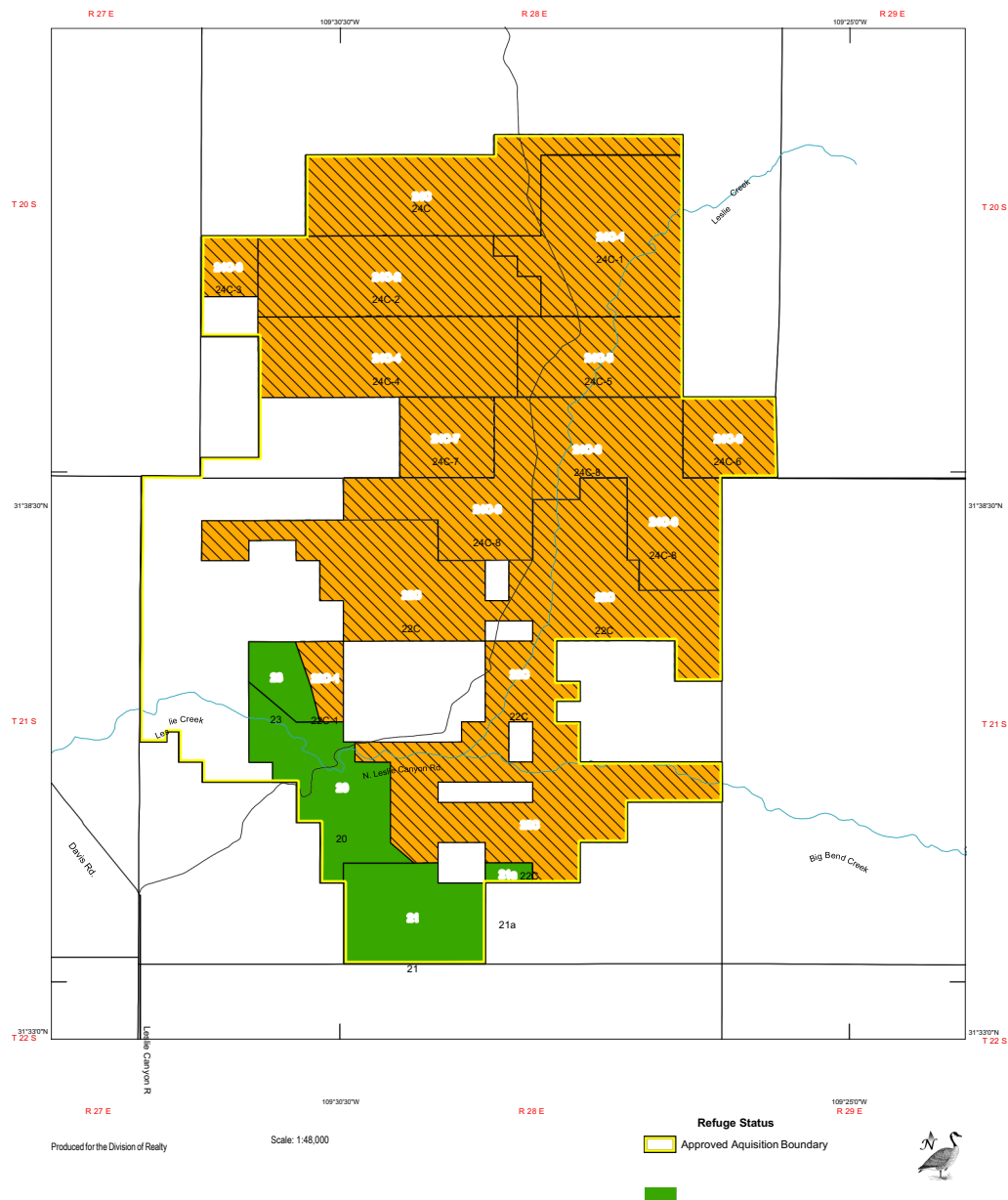


Figure 1. Land Status Map of Leslie Canyon National Wildlife Refuge, Cochise County, Arizona. The 25,000-acre (10,117-ha) approved acquisition boundary was crucial in providing the Service opportunities to pursue habitat protection and conservation on a watershed-based landscape scale that included purchase of 2,765-acres (1,119-ha) through fee title, purchase of 20,471-acres (8,284-ha) of conservation easements, and establish a 24,585-acre (9,949-ha) Safe Harbor Agreement.

might prevent his desired use of the land for ranching. The potential for such restriction was unlikely (Malcom and Li 2015).

Recognizing the conservation values associated with both the 99-Bar Ranch and the Bar-Boot Ranch, the Service contacted the landowners to identify and discuss potential protection strategies for the properties. These conversations were particularly timely and critical because portions of one of the ranches were undergoing a sale at the time and included the risk of possible development by any new landowner. The Malpai Borderlands Group, a local coalition of conservation-minded ranchers having a global reputation for collaborative conservation, stated their support for protecting the ranches using conservation easements if the concept was agreeable to the current landowners or if a conservation-minded buyer could be identified. The Service had already developed a positive trust relationship with the Malpai Borderlands Group, and the group's support for the proposed Refuge acquisition boundary positively influenced local opinion and public acceptance of Service involvement.

The 99-Bar Ranch is located immediately upstream from LCNWR and lies between the Swisshelm Mountains and Pedregosa Mountains at an elevation ranging from about 4,650–5,600 ft (1,417-1,707 m). The ranch consists of 11,585 ac (4,688 ha), including 7,345 ac (2,972 ha) of deeded lands and 4,240 ac (1,716 ha) of State lease lands. The property is dedicated to livestock production, and it has historically run a 400 head cow herd on State lease and deeded lands. The ranch also has an annual 400 animal unit grazing allotment (for a six-month period) on its USDA Forest Service permit.

Negotiations with the owner of the 99-Bar Ranch to purchase a conservation easement on the property continued for several years. It stalled repeatedly primarily due to the landowner's frustration with the process and his unwillingness to completely trust the federal government. Following the terrorist attacks against the United States on September 11, 2001, the landowner more vigorously pursued the sale of a conservation easement, fearing the country might soon be at war with terrorists and anticipating federal land acquisition funding might quickly become unavailable. The 99-Bar Ranch Conservation Easement (Tract 22C) was therefore purchased September 26, 2001, with the purpose of assuring the ranch, located immediately upstream and adjacent to LCNWR, would be retained in its current condition to provide for a diversity of wildlife habitat, maintenance, and enhancement of watershed health, education, livestock grazing, and limited residential uses. The conservation easement encumbers about 7,031 ac (2,845 ha) of the deeded lands on the ranch (which excluded some existing developed lands), of which 6,952 ac (2,813 ha) have a non-development restriction. Service funding was available for acquisition of the conservation easement only because the ranch was within the approved LCNWR acquisition boundary (Rawoot 2017).

Following the Service's purchase of the conservation easement on the 99-Bar Ranch, the owners of the adjacent upstream Bar-Boot Ranch observed and evaluated the negotiation and subsequent interactions between the Service and the 99-Bar Ranch landowner and contacted Refuge staff during 2002 to inquire about the possibility of entering into a conservation easement purchase agreement regarding their Bar-Boot Ranch. The Bar-Boot Ranch is located in a high valley lying between the 7,140 ft (2,176 m) elevation Swisshelm Mountains to the west and a southern portion of the 9,854 ft (3,003 m) elevation Chiricahua Mountains to the east. It is located about 15 mi (24 km) upstream from LCNWR, and adjoins portions of the Coronado National Forest on the east, and the 99-Bar Ranch on the south.

The Ranch consists of about 25,940 ac (10,498 ha), originally including about 13,713 ac (5,550 ha) of deeded lands, 640 ac (259 ha) of State Grazing Allotment, 424 ac (172 ha) of Bureau of Land Management grazing allotment, and 11,163 ac (4,518 ha) of U.S. Forest Service grazing allotment. The property is dedicated to livestock production, grassland and wetland habitat restoration, research, and associated activities. The ranch can support up to about 825 cattle on an annual basis.

The Bar-Boot Ranch was owned by conservation-minded philanthropists, whose efforts at ecosystem restoration utilizing headwater erosion control are well known in the Southwest and recognized by many regional conservationists. The ranch is dedicated to maintaining a variety of conservation values of substantial importance to the ranch owners and to the Service. Over several years, the owners have restored this ranch and other properties in the region and made improvements to the watershed and rangelands, both to enhance livestock production and ecosystem health. Land appraisals for the Bar-Boot Ranch were completed during 2004, and the Bar-Boot Ranch conservation easement, totaling about 14,000 ac (5,666 ha), was ultimately purchased in increments (Tracts 24C and 24C 1-8) as federal funding became available, with acquisition of the final tract occurring during 2011.

Both conservation easements help ensure survival of native fish and wildlife on a landscape scale while providing for normal livestock ranching operations and watershed restoration activities to continue on the ranches. The easements limit division, subdivision, and surface development on the ranches' private fee land in perpetuity while encouraging their traditional ranching and watershed restoration activities to continue. By limiting subdivision and surface development in the upstream reaches of the Leslie Creek watershed, the easements help assure continuation of the water supplies historically available to sustain native fish, wildlife, and plants, including federally-listed threatened and endangered species, found downstream on LCNWR.

Through these two conservation easements, the landowners and the Service agreed to prevent any use of the properties that would significantly impair or interfere with conservation values, and to confine use of the properties to activities consistent with the purpose of the easements. The Service was also granted certain rights, including limited rights to enter upon the ranches each year to monitor compliance with and otherwise enforce the terms of the easements, to prevent any activity or use on the properties that is inconsistent with the purposes of the easements, and to require the restoration of such areas or features of the property that may be damaged by any activity or use which are contrary to the purposes of the easements. While both easements essentially prevented housing development, and protected endangered fish by protecting the ecological integrity of the watershed immediately upstream from LCNWR, they also specifically identified some reserved rights and listed several prohibited uses which are itemized in the deeds. Reserved rights included the right to: carry on ranching, educational, and ecotourism operations on the entire properties; maintain, repair, and construct the agricultural improvements necessary to facilitate livestock grazing operations; continue all manner of identified residential use and enjoyment of the building and grounds within the existing residential zones and within the identified future development zones; expand existing buildings and to construct additional residences within the existing residential zones; construct, maintain, or replace a residence, guesthouse, associated outbuildings, and individual domestic wells within future development zones; engage in recreational uses, such as hunting, that will not negatively impact conservation values; engage in wood-cutting; and other rights.

Prohibited uses included: construction or placing of buildings, permanent camping accommodations, mobile homes, or billboards, except those identified as reserved rights; expanding irrigated pasture; developing commercial enterprises inconsistent with protection of the property's conservation values; altering the ground surface or natural vegetation; dumping environmental contaminants or hazardous waste; introducing invasive non-native species; pumping groundwater for other than on-site residential and agricultural use associated with livestock grazing on the properties; storing and using biocides and chemical fertilizers other than those identified as reserved rights; and utilizing off-road vehicular travel except as reasonably necessary to facilitate ranch operations.

Both ranches are dedicated to livestock production, yet they also inherently support a variety of substantial conservation values. These values include maintaining a healthy watershed characterized by productive bottomland giant sacaton (*Sporobolus Wrightii*) grassland which supports numerous breeding and wintering grassland-dependent birds; maintaining existing riparian vegetation composed of important ash-willow-cottonwood habitats along the southwestern end of Leslie Creek supporting numerous neotropical migratory birds; maintaining free-flowing water at the southwestern end of Leslie Creek which provides habitat for breeding Chiricahua leopard frogs and endemic invertebrates; and maintaining classic Chihuahuan Desert upland slopes of various aspects which support many plant and animal species. The landscape protected by conservation easements supports a large number of mammal species, and recent jaguar (*Panthera onca*) photographs have been captured by remote trail cameras in this geographic area. The portion of Leslie Creek on LCNWR located below the historic rock dam constructed by the Civilian Conservation Corps is largely supported by the watershed on these two ranches and provides perennial aquatic habitat for breeding Mexican longfin dace, Yaqui topminnow, and Yaqui chub.

SAFE HARBOR AGREEMENT

Because many threatened and endangered species occur primarily or exclusively on private land, it is often critical to involve private landowners in conservation and recovery efforts. Many landowners want to help conserve these species on their property, but are concerned about potential land use restrictions they perceive could occur if listed species begin to colonize or expand their numbers as a result of conservation efforts. Due to these concerns, some landowners may limit land and water management practices that would otherwise enhance and maintain habitat for listed species. To address these kinds of concerns and to provide landowners with both management flexibility and regulatory certainty, the Service developed the “Safe Harbor Agreement Program.” A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-federal property owners whose actions contribute to the recovery of a species listed as threatened or endangered under the ESA through a net conservation benefit to the covered species. The agreement is between the Service and cooperating non-federal property owners. The regulatory basis for the agreement is codified in the Service’s Safe Harbor Agreement final policy (64 FR 32717), final regulations (64 FR 32706), and amendments (69 FR 24084) and implements the intent of the parties to follow the procedural and substantive requirements of section 10(a)(1)(A) of the ESA.

The Service first establishes a “baseline” status for the species on the private property, and then identifies the conservation benefits undertaken by the landowner that will contribute to the recovery of the listed species on non-federal lands. Examples of conservation benefits might include reducing habitat fragmentation; maintaining or restoring existing habitats; increasing the connectivity of otherwise isolated habitats; creating buffers for protected areas; stabilizing or increasing the number or distribution of listed species; and developing or testing new habitat management techniques. The specific conservation measures identified in the Leslie Creek SHA identified the goals of maintaining the integrity of the Leslie Creek Watershed, expanding the geographical distribution of the covered species, and preserving or enhancing the genetic diversity of the covered species (USFWS 2008b). In return for the conservation benefits accomplished by the landowner, the Service issues an “enhancement of survival” permit that provides formal assurances that the Service will not require severe restrictions to current land use and management practices, or require any additional management actions by the landowner without their consent. The enhancement of survival permit allows incidental take of threatened and endangered species that could result from actions taken by the landowner, and allows habitat modifications by the landowner intended to return the property to conditions agreed upon as baseline. Additionally, when the agreement’s term ends, the participating landowner may use the property in any otherwise legal manner that ensures that it stays at or above the baseline conditions initially established at the beginning of the agreement. The enhancement of survival permit covers ongoing land use activities, watershed improvement activities, and species related management and monitoring activities.

The Leslie Canyon Watershed Safe Harbor Agreement (Agreement), initiated by Service staff in 2004, was completed and approved during September 2008. Participants of the Agreement include the Service and owners of the 99-Bar Ranch and the Bar-Boot Ranch, and the Agreement encompasses about 24,585 acres (9,949 ha) upstream from LCNWR within the approved Refuge acquisition boundary. Land ownership within the area covered by the Agreement is approximately 15% State Trust Land and about 85% privately held land. A small area of less than 1% consists of small parcels of Federally-owned land administered by the Bureau of Land Management (BLM) and these parcels are not covered by the Agreement (USFWS 2008b). The purpose of the Agreement is to implement recovery activities for six federally-listed species: the federally-listed threatened Chiricahua leopard frog; endangered Yaqui chub; endangered Yaqui topminnow; threatened Yaqui catfish; threatened beautiful shiner; and endangered Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*). The SHA further ensures the continued existence of these species in the Leslie Canyon watershed and provides incentives and assurances to the private landowners during the 50-year duration of the Agreement and associated section 10(a)(1)(A) enhancement of survival permit.

Maintenance of the watershed and connectivity among all the elevations present on the landscape are crucial to the goal of protecting the wetland habitats covered by the Agreement (Halofsky et al. 2018; Taylor et al. 2005). Watershed integrity is maintained through the implementation of various watershed improvement projects, including erosion control activities, restoration of grassland and wetland habitats, and other riparian and hydrologic improvements. An expanded geographic range helps species recovery by increasing the total number of individuals of each covered species

and helps prevent the loss of populations through localized disturbances such as drought, fire, flood, or disease (Beissinger and McCullough 2002). The expanded range also reduces the risk of extinction because species are spread over a larger geographic area, therefore making the overall population less susceptible to risks. Conservation measures help provide for the natural expansion of covered species into habitats in the upper watershed, and have allowed for the introduction of Yaqui chub, Yaqui topminnow, beautiful shiner, and Chiricahua leopard frogs into previously unoccupied habitat on the private properties. Yaqui catfish and Huachuca water umbel have not been introduced onto private lands because suitable habitats do not currently exist for these species within the covered area. Additionally, the introduction of Chiricahua leopard frogs has been complicated by the presence of American bullfrogs, (*Lithobates catesbeiana*), an invasive species and predator to leopard frogs at some otherwise suitable wetland sites in the covered area. Maintenance of genetic diversity is important to preventing the potential for biological compromises (deformities, loss of resistance to pathogens) that can occur through inbreeding (Hedrick and Kalinowski 2000; Leberg and Vrijenhoek 1994; Thornhill 1993). The goal of preserving or enhancing genetic diversity is accomplished through regular population supplementation of Yaqui chub, Yaqui topminnow, and beautiful shiner within the covered area.

The owners of both properties were excellent conservation partners, and they worked together with Refuge staff for several years prior to establishment of the Agreement to coordinate erosion control projects, brush control, groundwater monitoring, and fish and wildlife monitoring on the ranches. Additionally, as described above, the Service had previously established conservation easements on both ranch properties, and with the Agreement in effect, cooperation increased the recovery of native plants, fish, and wildlife. Project activities have included enhanced livestock management (stock tank maintenance), vegetation treatments (using prescribed fire to maintain native grasslands, and using herbicide treatment to control juniper invasion of grasslands), control of invasive wildlife species (American bullfrog removal), enhancing corridors and wildlife movement (replacing existing fences with “wildlife-friendly” fencing), and biological monitoring of groundwater levels and fish and wildlife populations. Annual reporting of management activities, removal of invasive species, and reintroduction of covered species is accomplished through the Refuge’s annual narrative report.

WATER MONITORING

The earliest and most profound effects of a changing climate are expected for water resources, and such changes are expected to reduce fish habitat and negatively affect riparian vegetation and wildlife (Halofsky et al. 2018). Leslie Canyon NWR relies on surface water and ground water to sustain the riparian habitat which supports populations of federally-listed endangered plants, fish, amphibians, and birds, among other species. Ensuring that the Service had in-stream flow water rights on Leslie Creek was deemed essential for the survival and recovery of native fish and critical for the conservation of wetland habitats on the Refuge. Leslie Creek is a flashy, desert fluvial system. Though thunderstorms can create very large flow events, the base flow of the stream is very low. The native fish and surrounding ecosystem rely on the base flow for survival. To guard against anthropogenic depletion of this flow, in 1993 the Service applied for in-stream flow water rights, which received no opposition during the public review and comment period, and were granted by Arizona Department of Water Resources (ADWR). These numbers (Table 1) were derived from a statistical analysis of the mean daily discharge record from a U.S. Geological Survey (USGS) gauge located on Leslie Creek near the upstream end of LCNWR adjacent to the Lewis Monument. This gauge has been operational from 1970-1977 and from 1982-present. A mean of the median monthly daily flow was used to derive the base flow requirements of the Refuge.

Understanding the relationship between stream discharges in Leslie Canyon and groundwater levels within and adjacent to the Refuge is crucial to managing this important habitat. To help determine and document this relationship, groundwater level monitoring has been conducted on the Refuge since 1998, and on the adjacent private lands since 2002, and pressure transducers maintained throughout the watershed provide data to compare to discharge records from the USGS stream gauge on LCNWR. This comparison provides insights into the relationship between surface water and groundwater.

In general, stream flows resulting from precipitation events measured at the USGS gauge in Leslie Canyon, cannot be correlated to predictable responses at individual wells within the Leslie Creek watershed (USFWS 2008a). In addition,

it appears that large-scale local precipitation events that recharge ground water only in the northern section of the watershed show a muted and delayed response in the lower basin near and within the Refuge, whereas precipitation

Table 1. Monthly In-Stream Flow Water Right (33-96176) for Leslie Creek at Leslie Canyon National Wildlife Refuge. Discharge in cubic feet per second (cfs) and acre feet per month. This water right is essential for the survival and recovery of native fish on the refuge.

Month	Discharge	
	(cfs)	(ac ft/month)
January	0.62	38.3
February	0.54	33.0
March	0.53	32.6
April	0.52	32.2
May	0.45	27.5
June	0.35	21.8
July	0.34	21.0
August	0.59	36.4
September	0.63	38.7
October	0.74	45.3
November	0.81	49.9
December	0.70	43.3
acre feet/year = 419.90		

events that are local to the southern section of the watershed show a quicker response in ground water levels within and near the Refuge. Furthermore, it appears that high magnitude floods of brief duration in the southern watershed result in changes to ground water levels that are small in scale and quickly recede (USFWS 2008a).

Data analysis has suggested that, during times when ground-water levels are less than 10 ft below land surface, the USGS gauge accurately measures ground-water discharge to Leslie Creek during times of no precipitation. However, during times when ground-water levels are greater than 10 ft below land surface, the USGS gauge acts to measure surface water flows from precipitation events that may originate in any portion of the watershed that are of a large enough magnitude to cause flowing water to reach the location of the gauge (USFWS 2008a). The data show that LCNWR does not experience flows through Leslie Canyon that meet the Refuge's State of Arizona Permitted Water Right on a regular basis. Because actual flows are generally less than those permitted to the Refuge, it is important that no new water permits be granted in the watershed that could further deplete the already limited water resources.

WATER RIGHTS

In an effort to learn more about the groundwater conditions and trends within the Leslie Creek watershed, a monitoring well was installed in 1997 at the upstream end of LCNWR. Equipment in this well has allowed constant monitoring and recording of shallow groundwater levels at the site since January 1998. The data (Table 2) provides additional information concerning groundwater and surface water relationships in the watershed, and has increased an understanding of the hydrology of Leslie Creek. Existing data shows tremendous fluctuation of groundwater levels between years, with late 2006 and early 2007 showing a tremendous upsurge in the groundwater level, during which marshland conditions existed at the upstream end of Leslie Canyon. All of 2010, 2011, and 2012 showed dangerously low groundwater levels, threatening the maintenance of riparian vegetation and aquatic habitat. Ground water levels at Leslie Canyon during all of 2012 were the lowest ever recorded, and Leslie Creek did not flow during that year. Fish, frogs, and tadpoles were salvaged and relocated to other wetlands as Leslie Creek became dry, and hundreds of velvet ash (*Fraxinus velutina*), Arizona walnut (*Juglans major*), and Goodding's willow (*Salix gooddingii*) died during this time period after already declining from several years of extended drought. Since 2013, the groundwater level has generally continued to rise

again, but still experiences periodic severe fluctuations, and is influenced primarily by the volume of winter precipitation received in the watershed and by massive precipitation events occurring in the upper watershed during summer months.

Table 2. Leslie Canyon National Wildlife Refuge Groundwater Levels (in feet) 1998-2017. Measured from Top of Casing at Upstream Monitoring Well (ND = no data). Monitoring is Essential in Documenting Hydrologic Trends, Defending In-Stream Flow Water Rights, and Providing Early Warning of Forthcoming Drought Conditions.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
cfs												
1998	7.44	7.25	7.02	ND	7.75	ND	8.92	ND	ND	8.49	8.44	8.37
1999	8.68	9.28	9.71	10.10	10.60	11.4	ND	7.90	8.12	7.35	6.48	5.99
2000	5.74	5.60	5.31	5.44	5.96	6.78	7.00	7.74	8.25	5.90	5.29	4.89
2001	4.48	4.40	4.29	4.31	4.55	4.97	5.11	5.52	5.91	6.12	6.21	6.37
2002	6.85	7.33	7.93	8.74	9.46	10.26	11.32	9.40	9.69	9.19	8.30	7.64
2003	6.95	6.68	6.66	6.93	7.96	9.08	9.86	10.04	10.70	11.08	10.76	10.23
2004	9.72	9.52	9.60	9.90	10.73	11.90	12.82	12.96	14.36	15.44	15.55	15.61
2005	15.03	14.27	14.12	14.26	14.59	15.11	16.69	13.10	10.58	4.91	4.26	4.45
2006	5.25	6.04	7.07	8.12	9.60	10.76	12.83	10.43	4.32	2.90	2.78	2.85
2007	3.11	3.45	3.41	4.08	4.65	5.28	6.54	6.78	7.15	8.17	8.43	8.65
2008	9.42	10.01	10.57	11.01	11.78	12.59	11.75	11.08	6.87	5.19	5.10	5.35
2009	5.66	5.90	6.18	6.65	7.75	9.40	10.37	11.80	13.19	14.10	14.62	15.27
2010	15.94	16.12	16.66	16.75	17.17	17.50	17.77	16.37	17.21	17.91	18.09	17.94
2011	17.47	17.14	17.16	17.02	17.50	17.97	18.25	18.66	19.01	Dry	Dry	Dry
2012	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
2013	ND	14.08	ND	14.07	14.46	14.70	14.93	14.40	13.37	12.76	12.02	11.74
2014	11.08	10.85	10.70	10.58	10.44	10.43	10.32	10.28	10.19	9.83	9.46	9.31
2015	9.13	8.94	8.82	8.74	8.67	8.59	5.57	5.51	8.50	8.48	8.48	8.45
2016	8.53	8.57	8.62	8.67	8.77	8.88	9.02	9.20	9.40	9.66	9.99	10.28
2017	10.63	10.93	11.17	11.40	11.60	11.92	12.13	1.17	2.44	2.87	3.15	3.36

continued to rise again, but still experiences periodic severe fluctuations, and is influenced primarily by the volume of winter precipitation received in the watershed and by massive precipitation events occurring in the upper watershed during summer months.

In addition to the single monitoring well located at the upstream end of LCNWR, pressure transducers were installed in various upstream monitoring wells throughout the watershed on private land during March 2002 and at four monitoring wells along the east Refuge boundary during 2005. Some of the pressure transducers have since been removed from the wells for a variety of reasons, and currently four wells are continuously monitored in the Leslie Creek watershed (Bar-Boot Ranch, LCNWR Upstream, LCNWR Middle, and LCNWR South Well). This long-term well monitoring effort provides important information that helps document groundwater level trends throughout the watershed that supports the perennial portion of Leslie Creek on the Refuge. The well and provides useful early warnings to forthcoming drought conditions. Such warnings allow more timely Service management actions, including fish and tadpole salvage, in anticipation of a pending loss of aquatic habitat.

WATER RIGHT PROTEST AND RESOLUTION

During June 2008 the Service received a Public Notice Summary Notification from ADWR identifying three separate applications filed by the 99-Bar Ranch Ltd. Partnership to appropriate public water (Nos. 33-96794, 33-96795, and 33-

96796) and acquire a total of 465.77 ac-ft of water per year, with a storage capacity of 58.1 ac-ft to irrigate 200 ac (81 ha). Refuge staff had been notified by owners of the ranch nearly two years earlier that they would be applying for a surface water right, which they felt was necessary to support habitat restoration work they were planning on their ranch. The landowners proposed to build earthen berms across badly incised portions of the upper Leslie Creek flood plain to prevent further erosion and force floodwaters to spread out across the flood plain to “irrigate” giant sacaton grassland, as it did historically. As described above, Service staff had been working for several years to investigate the hydrology of the Leslie Creek watershed, and a large amount of information had been collected to identify ground water and surface water relationships in the watershed and to analyze the implications of additional water rights in the basin. This long-term monitoring information became extremely useful in assessing the potential threat of the 99-Bar Ranch water right applications in regard to Refuge objectives for recovering federally-listed threatened and endangered species. Because surface flows in Leslie Creek are generally less than those permitted to the Refuge, it is crucial that any new water permits granted in the watershed do not increase depletion of existing water resources, and cause further injury to endangered fish populations. Therefore, the Service filed a protest to ADWR regarding the 99-Bar Ranch application based on concerns that there was not enough water in the system to support the Refuge water right in addition to the new water right applied for by the 99-Bar Ranch. Increased communication between the parties, facilitated by Refuge staff, helped generate a better understanding of the limited hydrologic resources within the watershed supporting the ranches, and promoted resolution and a greater interest in landscape restoration projects.

Ultimately, following a thorough review of the data collected and published by the USGS regarding daily flow conditions for the Leslie Creek watershed, the Service determined that the total volume of water use requested could impair the United States Permit to appropriate public water for LCNWR. The total annual volumes of water that have been measured at the USGS gauge (#09537200) on the Refuge between 1996 and 2007 showed extremely low values, and it was clear that proposed water diversions by the 99-Bar Ranch in the amounts being requested would exceed the amount of water that has been available in the Leslie Creek watershed in seven of the preceding 12 years. A December 2008 letter from the Service to the ranch owners outlined these concerns and identified a proposed resolution. Based on this analysis, the Service contended that diversions by the 99-Bar Ranch should be limited only to those times when the quantity of water in Leslie Creek was in excess of the Service’s water right, in accordance with the doctrine of prior appropriation.

Essentially, 99-Bar Ranch could only divert water during times when the USGS Leslie Creek gauge denoted daily flow values that meet (or exceed) the Refuge’s existing water right. Furthermore, the Service recommended that the 99-Bar Ranch water right applications should be adjusted from a request of 465.77 ac-ft to 80 ac-ft per annum, with total storage of 10.8 acre-feet. Once this modification was accepted by the 99-Bar Ranch owners, the Service officially withdrew its protest with ADWR and the permits were modified in accordance with a settlement agreement between the Service and the 99-Bar Ranch Ltd. Partnership. The water right agreement between the Service and the 99-Bar Ranch provided continuing opportunities to enhance wetland habitat on private lands and to manage and protect federally-listed threatened and endangered species throughout the entire watershed rather than the focus being limited to just the Refuge. It provided the impetus for the Service and the landowner to demonstrate and engage in active collaborative conservation efforts previously articulated only in planning documents.

As described above, the Leslie Creek Watershed SHA between the Service and both the 99-Bar Ranch and Bar-Boot Ranch had been approved in September 2008, and the Agreement now provided opportunities to introduce populations of threatened and endangered species into wetlands on private land without any associated ESA risks to the landowners. Habitat work on the 99-Bar Ranch could be used to prevent upland erosion, and could provide additional wetlands for Chiricahua leopard frogs and Yaqui fish species. Both landowners remained interested in such reintroduction efforts, and understood how the conservation easements, multi-species SHA, and habitat restoration work throughout the landscape could benefit their individual ranch properties and livestock operations. Mosquito control by topminnows was of particular interest to the owner of the 99-Bar Ranch, as the threat of West Nile virus spreading from mosquito bites had recently reached Cochise County.

CONSERVATION FUNDING OPPORTUNITIES

The strength of existing partnerships between the Service and private landowners in the Leslie Creek Watershed has helped identify, justify, and enhance opportunities for conservation partners to fund and complete on-the-ground conservation on private lands. The first collaborative funding opportunity within the Leslie Creek Watershed included a 2001 Partners for Fish and Wildlife Project involving \$25,000 of cost-shared work (\$13,000 Service funding and \$12,000 private funding) on the 99-Bar Ranch to enhance grasslands and associated wetland areas. Habitat restoration work involved the repair of old water diversion structures, which help spread water during flood flows, rebuilding dikes, and restoring water holding depressions which act as silt traps. These structures were originally built during the 1940s, but the dikes and holding ponds had eroded and water was no longer infiltrating into the ground as designed. Such infiltration is the key to perennial water flow on the Refuge which is dependent upon the shallow groundwater to supply stream flow in Leslie Creek.

During 2006, a \$30,000 Challenge Cost Share Agreement (50:50 match) between the Service and the Bar-Boot Ranch was funded to accomplish watershed restoration activities also focused on repairing and constructing earthen water diversion structures on the property which helped stabilize and restore habitat conditions throughout the larger watershed. Some funding programs are designed specifically to assist species recovery on private lands that influence adjacent national wildlife refuges and federally-listed species. One such federal program is the Service's Cooperative Recovery Initiative (CRI), and during 2014 the Service funded the \$330,525 "Cooperative Recovery Initiative Project Associated with Recovery of Federally-listed Species in Southeastern Arizona." This project included \$120,000 targeted for habitat conservation projects on the Bar-Boot Ranch, and the landowner contributed additional private funds to help complete projects.

Overall conservation outcomes for this CRI project included improved watershed function that expanded secure habitats for Rio Yaqui fishes and other native aquatic and terrestrial species. Benefits to listed aquatic species included additional, larger, and more secure populations that will prevent extinction and increase recovery potential. Invasive brush control in upland habitat assisted with native grassland restoration throughout the area, and benefitted populations of all grassland dependent species in the watershed by: promoting grasslands and the environmental conditions that existed prior to invasion by mesquite and juniper; helping limit the elevated perches used by predatory species (e.g. ravens) that limit nesting success of grassland birds; encouraging an ecosystem dominated by native grasslands and the associated invertebrate species utilized as food by migratory and resident birds; and by promoting a more natural low flame length fire regime which benefits about 70 grass species utilized by migratory birds and other wildlife in this area. In addition, this landscape-scale watershed enhancement project benefitted all wetland dependent species within the action area by: increasing the availability of seasonal and permanent water; by providing sanctuary areas during drought periods by increasing the overall quality and quantity of groundwater; and by lessening the potential for erosive scouring of flood plain grasslands during extreme runoff events.

CONCLUSIONS

The variety of strategies used to help promote collaborative conservation in the Leslie Creek Watershed have been successful. They are protecting the watershed to ensure adequate flows for Leslie Creek; preserving the natural diversity and abundance of fauna and flora and securing self-sustaining populations; promoting the preservation, restoration, enhancement, and recovery of federally-listed threatened and endangered species; perpetuating the migratory bird resource; and are preserving important cultural resources.

The conservation strategies have helped prevent landscape fragmentation and the drainage and desiccation of wetlands. They have also protected fish and wildlife habitat from potentially detrimental human disturbances such as concentrated housing and agricultural development, mineral exploration, introduction of non-native species, harmful water diversion, topsoil erosion, grassland deterioration and shrub expansion, and have helped buffer the impacts of a warming climate by maintaining an unobstructed transition of important ecosystem components across a gradient of elevations.

All of this was accomplished through purposeful strategies conducted by willing participants, and these strategies interacted with, and in many ways relied upon, one another for success. Inventory and monitoring of fish, wildlife, and plant populations helped identify an ecologically important landscape. Conservation strategies for protecting that landscape included establishing an appropriately sized acquisition boundary within which multiple options for conservation could be achieved, including purchasing of conservation easements and fee-title Refuge lands. Conservation easements were negotiated and finalized to limit subdivision and surface development on the private property in perpetuity while encouraging traditional ranching and watershed restoration activities to continue. The easements restrict uses that would potentially harm the property's value as fish and wildlife habitat, or potentially impact the downstream Refuge in negative ways. These easements support landscape-scale conservation outcomes, in part, because those engaged in establishing them are prioritizing resources and values with landscape-scale significance (Rawoot 2017). Long-term groundwater monitoring and data analyses provided information that enhanced decision making in perfecting, establishing, and defending water rights to protect conditions necessary to support federally-listed species. A Safe Harbor Agreement further ensures the continued existence of these species in the Leslie Canyon watershed and provides landowner incentives and assurances throughout the duration of the Agreement. Viewing the region more as a single large landscape rather than as individual parcels within the watershed has helped participants identify, justify, and enhance opportunities to fund and complete on-the-ground conservation within that landscape. Promoting landscape-scale projects that enhance the private ranches and the Refuge provides habitats for a multitude of species and has helped allow the continuance of a working landscape, which is important in this rural setting. Monitoring continues to support informed decision making and compiling, and interpreting historical and current hydrologic data provides recognition of trends and improves the predictability of future conditions upon which managers must be able to favorably respond.

The effectiveness and expense of working on conservation projects in isolation from one another can be prohibitive. All the partners invested in the Leslie Creek watershed are in a better position as a result of their combined accomplishments, and fewer objectives could have been achieved without individuals choosing to work together. The present loss of some active partners can hopefully be remedied through the progressive establishment of additional trust relationships. Many of the conservation strategies implemented here have potential applications to additional settings, and can be integrated by others into regional conservation planning efforts within landscapes that may be similarly situated.

Despite many years of collaborative partnerships, there are risks to long-term conservation inherent to the innovative activities occurring in the Leslie Creek watershed, and some of these threats have already been realized. For example, while the perpetual conservation easements originated with willing landowners, conditions surrounding land ownership, personal interest, and financial security can change conservation partnerships and management cooperation. The 99-Bar Ranch sold during 2014 and the new owners do not appear to be actively interested in landscape-scale conservation. They did not sign into the existing Safe Harbor Agreement, and are not currently engaged with the Service in cooperative conservation projects. Ownership of the Bar-Boot Ranch was impacted during 2016 by personal relationship difficulties between the joint owners, and the ramifications of splitting their interests also potentially jeopardizes the continuation of landscape-level conservation activities due to changes in financial obligations and other reasons.

Finally, even with the innovative actions taken to plan and proactively manage for threats to climate resiliency and implement solutions intended to minimize the anticipated negative effects of a warming climate, continued drought and average temperature increases are impacting the overall water balance, fire regime, and function of the Leslie Creek watershed. These accelerating threats may exceed plans or actions undertaken by the Service or by private landowners. As a result, habitat is being altered beyond the ability of some fish, wildlife, and plants to respond or adapt rapidly enough to survive in the short-term. The reintroductions of some species have not endured lasting success because wetlands are no longer supported by the changing climatic conditions. Active, long-term, management is required to maintain habitats and populations of fish and wildlife that are constantly at risk from accelerated drought, fire effects, and invasive species. The resiliency of the habitats that support unique species is in danger of being altered beyond repair.

Next steps by the Service to help protect and conserve the watershed include continuing to develop strategies to protect threatened and endangered species during prolonged drought periods, and working with private landowners to

encourage the continuity of landscape scale conservation activities within the basin (USFWS 2013). Additionally, it remains crucial for the Service to continue working with the BLM to withdraw the mineral interests on LCNWR fee title lands to preclude any future filing of claims on the mineral estate currently under the administration of that agency.

These cooperative efforts between the Service and environmentally sensitive landowners have provided tremendous opportunities to secure crucial upland and wetland habitats, introduce and maintain self-sustaining fish and wildlife populations, and coordinate the completion of land restoration activities across a greater landscape. Slowly, through these efforts, the land and its associated fish and wildlife are recovering from historic exploitation and inattention.

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REFERENCES

- Beissinger, S.R.; McCullough, D.R. (eds). 2002. Population viability analysis. The University of Chicago Press, Chicago, Illinois. 577 p.
- Charnley, S.; Sheridan, T.E.; Sayre, N.F. 2014. Status and Trends of Western Working Landscapes. *In*: Charnley, S.; Sheridan, T.E.; Nabhan, G.P., (eds): *Stitching the West Back Together: Conservation of Working Landscapes*. Chicago, IL: The University of Chicago Press. pp. 13-32.
- Halofsky, J.E.; Peterson, D.L.; Ho, J.J.; Little, N.J.; Joyce, L.A. (eds). 2018. Climate change vulnerability and adaptation in the Intermountain Region. Gen. Tech. Rep. RMRS-GTR-375. Fort Collins, Colorado, Department of Agriculture, Forest Service, Rocky Mountain Research Station. 513 p.
- Hedrick, P.W.; Kalinowski, S.T. 2000. Inbreeding depression in conservation biology. *Annual Review of Ecology and Systematics*. 31:139-162.
- Leberg, P.L.; Vrijenhoek, R.C. 1994. Variation among desert topminnows in their susceptibility to attack by exotic parasites. *Conservation Biology*. 8(2):419-424.
- Malcom, J.W.; Li, Ya-Wei . 2015. Data contradict common perceptions about a controversial provision of the U.S. Endangered Species Act. *Proceedings of the National Academy of Sciences of the USA*. 112(52):15844-15849. <http://doi.org/10.1073/pnas.1516938112>.
- Rawoot, D.N. 2017. Conservation easements in the Madrean Archipelago: Landscape-scale strategy or random acts of conservation? Thesis. Tucson, AZ: School of Natural Resources and the Environment, University of Arizona. 68 p.
- Taylor, M.F.J.; Suckling, K.F.; Rachlinski, J.J. 2005. The effectiveness of the Endangered Species Act: A quantitative analysis. *BioScience* 55(4):360-367.
- Thornhill, N.W. 1993. *The Natural History of Inbreeding and Outbreeding: Theoretical and Empirical Perspectives*. University of Chicago Press, Chicago, Illinois.
- U. S. Fish and Wildlife Service. 1994. Yaqui Fishes Recovery Plan. U.S. Department of the Interior, Fish and Wildlife Service, Albuquerque, New Mexico. 48 p.
- U. S. Fish and Wildlife Service. 1995. San Bernardino and Leslie Canyon National Wildlife Refuges Comprehensive Management Plan 1995-2015. U.S. Department of the Interior, Fish and Wildlife Service, Albuquerque, NM. 114 p.
- U. S. Fish and Wildlife Service. 2008a. Ground Water/Surface Water Relationships and Implications for Water Rights, Leslie Canyon National Wildlife Refuge. U.S. Department of the Interior, Fish and Wildlife Service Division of Water Resources Report. Albuquerque, New Mexico. 27 p.
- U. S. Fish and Wildlife Service. 2008b. Safe Harbor Agreement For ESA-listed Species in the Leslie Creek Drainage, Cochise County, Arizona, Between 99-Bar Ranch, LLC, Bar Boot Ranch, and the U.S. Fish and Wildlife Service. U.S. Department of the Interior, Fish and Wildlife Service, Albuquerque, New Mexico. 67 p.
- U.S. Fish and Wildlife Service. 2013. Threats, Needs, and Recommendations for Leslie Canyon National Wildlife Refuge. Division of Water Resources Report. Albuquerque, New Mexico. 2 p.