Chapter 4: Management Direction

Stepping into the future (Looney Unit of Ozark Plateau NWR). (Credit: Shea Hammond)

Goals, Objectives, and Strategies Overview

Chapter 4 will guide Refuge conservation management for at least the next 15 years. The goals, objectives, and strategies within this chapter were developed as a result of a long process of defining and understanding Refuge issues and determining sustainable solutions that address the various needs and values of the environment and the community through multiple meetings, conferences, and other methods of communication with the public and various partners and agencies within the Ozark Plateau.

In this chapter, the Refuge outlines its priorities by defining long-term goals that align with Ozark Plateau National Wildlife Refuge's purposes. In order to achieve these goals, it defines measurable and attainable objectives to be accomplished within the lifetime of this Plan, as long as staffing and funding are available. Following each objective, a rationale is articulated stating why this objective is necessary, and specific strategies are outlined to provide specific examples, ideas, and/or actions in order to meet the objective.

Ozark Plateau NWR organized its management into four broad goal categories including the landscape-level context, wildlife habitat & population management, visitor services, and infrastructure & administration. Throughout the chapter, the Refuge highlights the necessity of working with multiple partners across the landscape in order to achieve its goals. In addition to articulating the future management direction in each objective and subsequent strategy, the core planning team also found it important and useful to identify and include which potential partners the Refuge could work with to realistically accomplish them. For a full list of Ozark Plateau NWR's current and potential partners, see Chapter 5, Table 5-1.

Adaptive Management

Even though the objectives and strategies in this chapter are specifically articulated to guide future management, the Refuge acknowledges that the future remains uncertain. Understanding ecological interactions on the Refuge, anticipating effects of a changing climate, knowing how to prevent and respond to the threat of white-nose syndrome, recognizing that there are gaps in available data, and anticipating changes in funding make future management planning quite difficult and complex. For this reason, the Refuge will use this chapter merely as a guide to stay on track with its overall goals and with intent to achieve current objectives, however, the most effective approach to resource management over the long-term is an adaptive one. Adaptive management is a management style in which the effectiveness of management actions is frequently monitored and evaluated, and future management is modified as needed based on the results of this evaluation or other relevant information as it becomes available. Ozark Plateau NWR will use adaptive management and implement Strategic Habitat Conservation (SHC) on a landscape-level throughout the lifetime of this CCP in order to most effectively prevent extinction and ensure continuing existence of federally listed threatened and endangered (T&E) Ozark cave species, and prevent the need for future listing of species of concern in the Ozarks.

Bloodroot; also known as "GiGa UNa(s)TeTlv" in Cherokee. (Credit: Shea Hammond)

Refer to the table of contents for a brief overview of the four long-term goals and subsequent short-term (15-year span) objectives that provide the context for the future management direction of Ozark Plateau NWR.

4.1 Goal 1: Landscape-level Context

Collaborate with multiple partners to implement Strategic Habitat Conservation on a landscape-level in order to prevent extinction and recover federally listed threatened and endangered Ozark cave species as well as prevent the need for listing other Ozark species of concern.

Dedicated partners. (Credit: Steve Hensley)

4.1.1 Objective 1: Continue Building Landscape-Level Partnerships.

Throughout the lifetime of this CCP, continue building and strengthening partnerships at a landscape-level on public and private lands, crossing state and regional boundaries, with private landowners, conservation organizations, universities, state agencies, Tribal Nations, Landscape Conservation Cooperatives (LCCs), and other federal agencies to collaborate on addressing conservation issues and solutions, conducting research, sharing technical expertise, educating the public, assisting in land conservation management activities, and leading conservation-related conferences, with the primary objective of preventing the extinction of and recovering federally-listed cave species and preventing the need for listing other species of concern.

> **Rationale:** Although acquiring additional lands and conservation easements from willing sellers for the Refuge itself is the most secure means for protecting habitat for federally-listed cave species and other species of concern, purchase of all areas necessary for the

recovery of these species is not feasible due to the amount of area they would require. For example, Ozark big-eared bats are known to forage within up to a 5-mile radius (Clark et al., 1993) and gray bats forage within a 20-mile radius of caves (LaVal et al., 1977). Furthermore, maternity colonies, hibernacula, and foraging habitat occur in multiple states and Service regions. For example, Sally Bull Hollow Unit lies within one mile of the Arkansas Stateline and Service Region 4 (Southeast). Gray bats migrate between Oklahoma maternity sites and hibernacula in northern Arkansas (Region 4) and southern Missouri (Region 3) (see also Goal 1, Objective 2). Additionally, more than 97% of all lands in Oklahoma are privately-owned (ODWC, 2005). On a landscape level, landowners are essential in maintaining or restoring habitat conditions and protecting cave sites to assist with the overall prevention from extinction and recovery of federally listed threatened and endangered Ozark cave species as well as the need for listing other species of concern.

Maintaining current partnerships, always seeking opportunities for new partners, and continuously building relationships with a variety of landscape-level stakeholders remains to be essential in order for the Refuge to acquire and conserve its lands and enter into conservation easements or agreements from willing sellers, monitor and research, protect and restore habitat, share information about resources, conduct environmental education, and reduce Ozark habitat loss and fragmentation.

A summit brings together landscape-level partners for sustainable management of Ozark ecosystems. (Credit: Shea Hammond)

Strategies:

- Work beyond the Refuge boundaries with multiple stakeholders throughout the ecological landscape (private landowners, private conservation organizations, state agencies, Tribal Nations, LCCs, and other federal agencies)
- Contact partners on an ongoing basis to gather and share information and/or ideas in meetings, conferences, webinars, luncheons, etc.
- Lead and/or participate in conservation research and/or education projects that involve multiple partners across boundaries on the landscape-level
- Continue to be involved in the Ozark Summit and other large meetings/conferences with multiple collaborators
- Continue to take a leadership role in the Greenway of the Cherokee Ozarks

- Take a leadership role, present data, and share concerns, questions, and successes in other important landscape-level conservation-related conferences
- Coordinate with partners for conservation easements and conservation agreements
- Educate landowners about incentives such as the Service's Partners for Fish & Wildlife Program, Section 6 of Endangered Species Act, NRCS Healthy Forest Reserves Program, and others and assist with implementation to help private landowners implement natural resource management actions that are complementary with goals of the Refuge
- Provide opportunities for citizen science groups/projects to engage in refuge or off-refuge conservation efforts
- Partner and collaborate with nongovernmental organizations (NGOs) to assist with EE/interpretation programs, coordinating/leading large conservation-related conferences, habitat management, land acquisition, conduct research, monitor, and to share knowledge
- Work closely with private businesses to encourage environmentally-sound business practices
- Collaborate and contract with universities to work together on various research and monitoring projects, assist in coordinating/leading large conservation-related conferences, provide educational opportunities, and to share knowledge
- Coordinate conservation goals/projects with city, county, state, tribal and other federal representatives
- Continually show appreciation, respect, and gratitude to all staff, partners, Friends, and volunteers for their time, energy, and contributions to conservation (verbally, in letters or awards, and by hosting banquets, potlucks, retreats, etc.)

4.1.2 Objective 2: Coordinate Across Service Regions to Better Manage Federally Listed Ozark Cave Species on a Landscape-Level.

Within the lifetime of this CCP, Ozark Plateau NWR will continue Service-wide coordination across state lines and Service regional boundaries to implement Strategic Habitat Conservation on a landscape-level through adaptive management. The purpose is to prevent extinction and help recover all federally listed threatened and endangered Ozark cave species and prevent the need for listing others by protecting and managing important surface and subterranean aquatic and terrestrial habitat as prescribed in the species' recovery plans.

Rationale: The distribution of the federally listed threatened and endangered Ozark cave species (Ozark big-eared bat, gray bat, Indiana bat, and Ozark cavefish) that Ozark Plateau NWR was established to protect and recover, cross several state and Service Regional boundaries. Therefore, in order for the Refuge to achieve its purpose of assuring the continuing existence and aiding in the recovery of federally-listed

Cave management collaboration. (Credit: Steve Hensley)

endangered and threatened Ozark cave species, it is necessary to implement landscape-level SHC by working across state, federal, and tribal borders with in Oklahoma, Missouri, Arkansas, and Kansas and Service Regions 2, 3, 4, and 6.

Ozark Plateau NWR has taken steps within its own Region (2) to implement SHC. Aside from building and maintaining strong partnerships across the landscape-level with various landowners, conservation organizations, cities, universities, state, tribal and other federal agencies, in 2005, Ozark Plateau NWR was authorized to expand its acquisition area from about 3,000 acres up to 15,000 acres in seven counties in northeast Oklahoma. These partnerships and acquisition of land and conservation easements from willing sellers has lead the Refuge further in accomplishing conservation objectives. However, to fully implement the recovery tasks of protecting essential habitat as identified in the recovery plans for the Ozark big-eared bat (1995), gray bat (1982), Indiana bat (1983; draft 2007), Ozark cavefish (1989), and Ozark cave crayfish (1996), it will be necessary to acquire land and/or conservation easements from willing sellers across state and FWS Regional boundaries into Arkansas, Missouri, and Kansas. This is specifically addressed in Recovery Task 1.4 of the Ozark Big-Eared Revised Recovery Plan. This task can be accomplished by expanding Ozark Plateau NWR's authority to acquire and manage land across these boundaries or by establishing similar new refuges in these various states and Service regions dedicated to protect and manage federally listed cave and karst species.

Ozark Plateau NWR has a unique conservation location because the Refuge lies in northeast Oklahoma near state borders of Missouri, Arkansas, and Kansas, which correspond to the Service Regions 2, 3, 4, and 6 (see Chapter 2, Figure 2-2). Currently, Logan Cave NWR in northwest Arkansas protects an important federally listed gray bat, Ozark cavefish, and Ozark cave crayfish cave and is managed as a satellite of Holla Bend NWR, in Region 4 of the Service. Similarly, Cavefish NWR in southwest Missouri was established to protect the federally listed Ozark cavefish and Pilot Knob NWR in south central Missouri was established to protect an important federally listed Indiana bat hibernaculum; both are managed as satellites of Mingo NWR in Region 3 of the Service.

Management of these satellite cave refuges is challenging due to a lack of dedicated staff and funding as well as unique wildlife and habitat needs. Consequently, over a number of years there has been a cooperative effort among Holla Bend NWR, Mingo NWR, and Ozark Plateau NWR to work together to plan and implement SHC cave and karst management practices on a landscape level on and surrounding these refuges. This cooperation has been beneficial for accomplishing some recovery tasks for Ozark federally listed cave species through adaptive management; however, no formal management agreement is currently in place to ensure that it continues. In addition, Ozark Plateau NWR, Logan Cave NWR, Cavefish NWR, and Pilot Knob NWR are very close to southeast Kansas. There is a small portion of the Ozarks in southeast Kansas where a maternity colony of federally listed endangered gray bats have been documented near Pittsburg, Kansas (Hays and Bingman, 1964). To assure that all federally listed Ozark cave resources are addressed, coordination should be maintained with the state of Kansas and the Service's Region 6 as well.

There are significant Service trust resources throughout the Ozarks in these states that would benefit from expansion of the National Wildlife Refuge System in order to facilitate successful SHC on such a landscape-level. Because Ozark Plateau NWR's authorized purpose is to prevent extinction of federally listed Ozark cave species, help assure their recovery, prevent the need for listing additional species, and because the Refuge has dedicated funds and staff with experience in cave and karst management, Ozark Plateau NWR could manage Logan Cave, Cavefish, and Pilot Knob NWRs as additional management units across these state and regional boundaries. Logan Cave would be most practical because of its proximity to existing units of Ozark Plateau NWR. However, because of the expertise in cave resource management by a number of partners in Missouri and Arkansas, SHC could also be accomplished across state and regional borders by establishing new refuges similar to Ozark Plateau NWR in Regions 3 and 4. In addition, this would foster local, state, and regional support. These two potential new refuges and Ozark Plateau NWR would work closely together across political boundaries to protect and manage a number of Service cave and karst trust resources on a true landscape level in the Ozarks. Details on management logistics on such a large landscape scale regarding staffing and funding would need to be coordinated among Service Regions 2, 3, 4, and 6.

Strategies:

- Coordinate with the state of Arkansas and FWS Region 4 to manage Logan Cave NWR as a unit of Ozark Plateau NWR or in cooperation with Ozark Plateau NWR
- Coordinate with the state of Missouri and FWS Region 3 to manage Cavefish NWR and Pilot Knob NWR as units of Ozark Plateau NWR or in cooperation with Ozark Plateau NWR

- Coordinate with the state of Kansas and FWS Region 6 for Ozark Plateau NWR to cooperatively manage federally listed Ozark cave species
- Establish new acquisition areas within the landscape-level of Arkansas, Missouri, and Kansas and Service Regions, 3, 4, and 6 to include a larger range of all federally listed Ozark cave species (such as the Ozark big-eared bat, etc.) as addressed by the recovery tasks presented in their recovery plans

4.1.3 Objective 3: Acquire Lands within Approved Acquisition Area.

Within the length of this CCP, take a Strategic Habitat Conservation approach to prioritize land acquisition within the approved acquisition boundary of up to a total of 15,000 acres of Refuge land utilizing fee title acquisition, conservation easements and/or agreements from willing sellers with private landowners, conservation organizations, state agencies, Tribal Nations, and other federal agencies to address Ozark habitat loss, fragmentation and to accomplish the Refuge goals at a landscape-level.

Ozarks landscape – Adair County. (Credit: Steve Hensley)

Rationale: Some timber harvesting in the region involves the clearing of forested areas and converts them to cattle and other agricultural uses, resulting in the loss of mature tree forests, increasing understory growth, increasing water runoff, and decreasing groundwater recharge. Mining operations near the Refuge remove trees and reduce habitat for bat foraging and other species. Current and projected agricultural uses on the landscape result in a patchwork mosaic of open rangelands, further fragmenting the Ozark forests. The region is also experiencing increasing road and right-of-way construction and other infrastructure development.

Increased urban and agricultural development and commercial uses of water decreases both surface and groundwater quality and quantity. In a northeastern Oklahoma study, Bidwell et al. (2010) showed that caves and species within the caves were exposed to contaminants including pesticides, antibiotics and other pharmaceuticals, fragrances, and other plasticizers. Potential sources of water contaminants include sewage lagoons, municipal and industrial wastewater treatment outflows, septic systems, mining operations, runoff from landfills, confined animal feeding operations, roads, and agriculture (Aley, 1990; 1999).

The construction of reservoirs over the years has resulted in the loss of some Ozark caves and riparian forests in the ecoregion. Some caves near the reservoirs are flooded periodically, depending on rainfall and lake levels because of hydropower generation and flood control operations, making them inaccessible and uninhabitable by bats. Land acquisition could prevent similar negative effects from occurring in the future.

Strategies:

- Build trust and long-term relationships and enter into conservation easements and agreements with willing landowners
- Collaborate with energy companies, local universities, Oklahoma Department of Wildlife Conservation (ODWC), Tribal Nations, United States Geological Survey (USGS), Service Ecological Services (ES), and other partners to identify and delineate important migration routes to determine important migration and wildlife corridors utilized by resident and migratory bats, birds, and other species as an SHC approach to prioritize potential land acquisition sites (see Goal 1, Objective 7)
- Work with partners to develop a habitat suitability index model to determine optimum forest and cave habitat requirements for Ozark big-eared bats, gray bats, cavefish, and cave crayfish. Use as an SHC approach to prioritize potential land acquisition sites, according to findings from this model.
- Use geological records and work with knowledgeable individuals and organizations such as local chapters of the National Speleological Society (NSS) to search for and assess new important caves within the Ecoregion, used by federally listed cave species and species of concern (see Goal 2, Objective 4)
- Delineate recharge area of cavefish and crayfish caves and use as a SHC approach to prioritize potential land acquisition sites (see Goal 2, Objective 5)
- Once 15,000-acre limit has been acquired within the approved acquisition area, explore the feasibility and need to expand into other areas and/or to acquire additional acreage (a Land Protection Plan would need to be developed)

4.1.4 Objective 4: Implement Climate Change Monitoring & Mitigation Program.

Collaborate with interdisciplinary partners within the first 5 years of the CCP to conduct research and monitoring of climate changes and effects of climate changes on the habitat and wildlife representative of the Ozark Highlands Ecoregion, as well as actively lead efforts in climate change mitigation through use and education of energy-efficient management operations and sustainable infrastructure to last throughout the length of the CCP and to be continued as long as climate change poses a threat to federally listed T&E and native species.

Service staff measuring a guano pile. (Credit: Steve Hensley)

Rationale: Secretarial Order 3289 establishes a Department of the Interior-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on Tribal Nations, the land, water, ocean, fish and wildlife, and cultural heritage resources that it manages. It also promotes climate change mitigation through the use of renewable energy and reduction of the carbon footprint in management operations. The Service has also recognized the challenge of how to protect its wildlife and habitats in a changing climate (see 2010 *Climate Change Strategic Plan* and the 2011 *Conserving the Future* vision document of the Refuge System for more information).

The Refuge would like to know more about how climate change is currently affecting and will affect its habitats and species. Data provided by Climate Wizard (www.climatewizard.org, accessed June 2010) indicates that within the area of the Refuge the temperature is expected to warm by about 5 degrees F, while moisture is anticipated to decrease between now and 2050. Changes in climate in and around caves may affect their suitability for different bat species (Newson et al., 2009). Changes in temperature and rainfall patterns may affect both the timing and the availability of insect prey for bats (Newson et al., 2009). It has also been observed on the Refuge that there are temporal variations on migration and birthing of Ozark big-eared bats and gray bats, however, more literature is needed to document this. Warmer and drier conditions may affect surface and groundwater availability, fire regimes, and shift hardwood forests north and produce more woodland savannah conditions within the Refuge acquisition area. Because of the unprecedented scope of affected landscapes, the Service must work together with other federal, state, tribal and local governments, LCCs and private landowner partners, to develop landscape-level strategies for understanding and responding to climate change impacts.

In addition, considering sustainability on all Refuge management levels (habitat and wildlife, infrastructure, administration) such as using renewable energy sources, energy-efficient appliances, and water conservation systems will not only reduce or offset carbon emissions, but will also reduce cost to the Refuge in the long-run. It could also be a great opportunity to be a sustainable living model for visitors and partners.

Strategies:

- Sequester carbon by acquiring up to 15,000 acres of land that already have large, continuous stands of native oak-hickory forests and preserving them (see Goal 1, Objective 3)
- Partner with universities to determine the best locations to implement a long-term data logger program to collect air temperature, humidity, light, cave rock temperature, groundwater elevation, and cave stream temperature data at cave, surface and groundwater locations on and surrounding each unit every fifteen minutes or every hour everyday year-round
- Install permanent weather stations at the Looney, Boy Scout, and Sally Bull Hollow Units, and any appropriate new areas acquired to establish baseline climate information and measure trends over time
- Work with university partners to monitor the known maternity colonies and hibernacula annually as a tool for measuring changes of duration and seasonal occurrence to identify potential effects of climate change (conduct an exit count as the bats emerge from the cave at night to forage using night vision optics, thermal videography, and infrared videography; take guano pile measurements in the fall or winter to estimate colony size; perform acoustic monitoring to gain insight on use of Refuge tracts and caves by bat species)
- Work with cooperative landowners, NGOs, universities, state agencies, Tribal Nations, USGS, Service Inventorying & Monitoring (I&M) and other federal agencies to develop a monitoring program and conduct surveys of invertebrates, herpetofauna, fish, birds, and mammals in the Ozark forest, cave, and aquatic habitats as a tool to identify effects of climate change on Refuge wildlife species
- Identify and delineate migration corridors of bat, bird or other wildlife species (see Goal 1, Objective 7)
- Share and present data, surveys, and research with landscape-level conservation partners, organizations, states, Tribal Nations, and federal agencies, as appropriate for climate change findings and mitigation
- Assist in organizing, leading, or presenting information at landscape-level climate change-related conferences
- Install solar panels on the Looney Unit and potentially on any newly acquired or developed buildings, if amount of sun is appropriate, to offset carbon and rely mostly on alternative energy sources
- Use energy-efficient heating and cooling system and appliances (geothermal heating and cooling system, insulation, stove, refrigerator, dishwasher, on-demand hot water, washer and dryer) on all Refuge buildings
- Install a rainwater collection system at the Looney Unit and the Guess House for irrigation purposes

- Use a water filtration system at the Mary & Murray Looney Education & Research Center (MMLERC) and all Refuge buildings to reduce energy and waste associated with bottled water

4.1.5 Objective 5: Implement Water Quantity & Quality Monitoring & Management Program.

In the Ozarks, water is an extremely valuable resource for both terrestrial and subterranean wildlife. (Credit: Shea Hammond)

Within five years of this CCP, and in collaboration with municipalities, local universities, Service Environmental Contaminants branch of ES Oklahoma Field Office, USGS and other partners, monitor both surface and groundwater quality results at least every 5 years on- or off- Refuge streams and caves and any new caves acquired, measuring contaminant levels and determine how they affect federally listed cavefish and other cave species. Implement a water quantity monitoring program to establish baseline data on trends in water levels by recording water flows at least every two years in Refuge hydrologically-connected caves and streams and those associated with any new areas acquired. Based on monitoring results, subsequently take appropriate management actions, working alongside landscape-level partners, to remediate water issues.

Rationale: In the northern part of the Refuge acquisition area, abandoned lead and zinc mines (Tri-State Superfund Site [the former Tar Creek Superfund Site]) have contaminated surface and groundwater resources. Increasing deforestation and conversion to urban and agricultural land uses in the region is also increasing the volume of water run-off and decreasing the capability of the watershed to filter this run-off. Unfiltered water contains a higher volume of both contaminants and nutrients, such as nitrogen, phosphorus, metals, pesticides, pharmaceuticals, and plasticizers.

Habitat degradation and pollution due to these agricultural activities and development pose serious risks not only to the groundwater quality but are primary threats to aquatic cave fauna such as the threatened Ozark cavefish (Crunkilton, 1984; Culver et al, 2000; Graening and Brown, 2003; USFWS, 2010). The karst environments (i.e. a landscape that is underlain by limestone and caves, sinkholes, springs, and other features and that

has special drainage characteristics due to the greater solubility of limestone) in which the cavefish occur, are highly vulnerable to groundwater pollution. Contaminated surface water can enter the groundwater systems rapidly in karst areas as it passes through sinkholes and cracks and crevices in the ground surface, losing streams (i.e. a stream with a bed that allows water to flow directly to the groundwater system), or fractured limestone under thin layers of permeable soils. These karst features provide for only minimal natural filtration processes. Once underground, the subterranean network of caves and conduits also allow for additional rapid water movement. Groundwater in karst areas can travel as quickly as a few thousand feet to over a mile per day. Degradation of sensitive, underground habitats used by the cavefish can, therefore, occur rapidly. These characteristics of karst ecosystems make the underground environment relatively fragile and highly susceptible to disturbances (Green et al. 2006).

In addition, the quantity of surface and groundwater of the aquifer surrounding the Refuge is being affected by agriculture and increasing urbanization. Impervious surfaces and man-made drainage systems are preventing surface water to seep through the ground and recharge the aquifer in the natural manner that it used to. There has also been an increase in water consumption due to an increasing population in growing urban areas nearby. These contributing factors are lowering surface and groundwater levels, which consequently affect subterranean and aquatic habitats and their respective species on the Refuge and surrounding areas.

Strategies:

- Acquire lands with caves and/or recharge areas or enter into agreements with willing sellers for conservation easements (up to 15,000 acres) to protect groundwater recharge areas for caves, riparian zones for surface streams and springs, and other areas and implement appropriate watershed management (see Goal 1, Objective 3)
- Work with USGS to install small water quality measurement devices (semi-permeable membrane), submerge them in cave water, springs, or other groundwater sources, and streams; leave them for one month, send results to a laboratory for analysis, monitor, and schedule this procedure to re-occur every 5 years in Refuge and hyrologically-connected streams (such as Spavinaw Creek), and caves, (including January-Stansberry, Duncan Field, Crystal caves), as well as off-Refuge (Twin, McGee, Long's, Jailhouse caves) and other acquired or appropriate cave discoveries to measure contaminant levels and determine how they affect cavefish
- Install water quantity devices permanently, to record data constantly, reviewing results every two years to establish baseline data on water levels and identify trends in water levels in January-Stansberry, Duncan Field, Crystal, Twin, other new caves acquired, and any other important caves within the landscape-level

- Work with and educate landowners in implementing private land incentive programs such as the Service's Partners for Fish & Wildlife Program, Section 6 of Endangered Species Act, NRCS Healthy Forest Reserves Program, and others. Assist with implementation to help private landowners implement water resource management such as sustainable forest management practices to enhance natural water filtration in surrounding caves and aquifers, construction of fencing along streams and riparian areas to control access by cattle, restoration of riparian vegetation, and to educate them on their influence on groundwater quality.
- Contract with private companies, universities, and the USGS to map groundwater recharge areas within the acquisition area, in and around all Refuge units, including private lands, specifically where cavefish are present (see Goal 2, Objective 5)
- Consult with adjacent landowners about any illegal grazing issues and remove any illegal dump materials
- Periodically sample prey insects in foraging areas, guano in summer caves, and surrogate bat species to monitor pesticide amounts that may be affecting T&E species and identify source of any pesticides
- Work with landowners, city, county, state, Tribal Nations and other governmental agencies to implement appropriate road construction and maintenance that reduces amount of sedimentation
- Partner with local municipalities and water authorities to share information about water levels and water quality affecting the Refuge, including federally listed species and species of concern
- Coordinate and share surface water quality monitoring information of Spavinaw Creek with the City of Tulsa and the State of Oklahoma environmental and water resource agencies
- Work closely with private businesses to promote sound environmental management practices that affect groundwater and surfacewater levels and quality
- Promote development of local watershed councils, stream teams, and citizen science groups to address local concerns through collaboration and education
- Explore the feasibility of acquiring water rights

4.1.6 Objective 6: Assist with White-nose Syndrome Research, Monitoring, Prevention, and Recovery.

Throughout the duration of this CCP, implement the most current actions recommended by leading researchers, scientific organizations, and agencies in order to monitor and prevent the spread of white-nose syndrome (WNS) on all bat species on- and off- Refuge, as well as implement actions to facilitate the recovery of impacted species. In addition, throughout the lifetime of this CCP, educate and inform the public about what WNS is, how it is affecting bats, and how people can help prevent it from spreading to the Refuge and other caves.

WNS-affected bat, New York. (Credit: Ryan von Linden)

Rationale: WNS is a disease, caused by the fungus *Geomyces destructans*, responsible for unprecedented mortality in cave-hibernating bats in the northeastern and central U.S and eastern Canada (Lorch et al, 2011). This previously unknown disease has spread very rapidly since its discovery in January 2007, and poses a considerable threat to cave-hibernating bats throughout North America. More than 5 million hibernating bats have died since 2007 (Froschauer, 2012). Biologists with state and federal agencies and organizations across the country are still trying to figure out how to minimize the spread and impacts of the disease and recover impacted populations. To date, seven bat species are known to be affected by the disease: gray bat *Myotis grisecens*, the little brown bat *M. lucifugus*, eastern small-footed bat *M. leibii*, Indiana bat *M. sodalis*, northern long-eared bat *M. septentrionalis*, big brown bat *Eptesicus fuscus*, and the tri-colored bat *Perimyotis subflavus*. Four of these species, (gray, the northern long-eared, big brown, and tri-colored bats) occur on areas managed by the Refuge. Although the fungus *Geomyces destructans* was found on a cave myotis in northwestern Oklahoma in 2010, the disease WNS has not yet been documented on the Refuge. However, scientists predict that WNS will continue to spread, making it even more critical to address the issue in a future management direction.

Strategies:

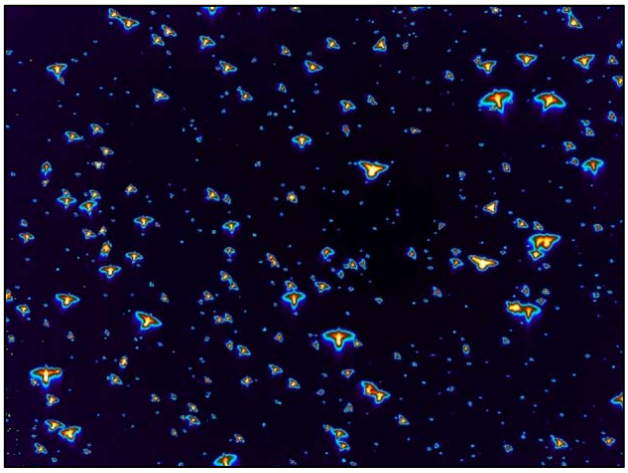
- Acquire lands with caves and/or recharge areas or enter into agreements with willing sellers for conservation easements (up to 15,000 acres) to increase protection of cave resources and monitor caves of WNS (see Goal 1, Objective 3)
- Coordinate and partner with caving organizations, NGOs, universities, state agencies, Tribal Nations, USGS, and other federal agencies to implement a permanent monitoring program in forests and caves on- and off-Refuge to monitor for WNS and determine which bat species are being affected by it
- Partner with caving organizations, laboratories, state and tribal agencies in Oklahoma, Missouri, and Arkansas, USGS, and ES to track movement and occurrence data of WNS for each bat species, search for bat mortality in caves, collect data on soil and cave substrate samples, and search for physical signs of WNS-affected bats
- Coordinate with wildlife health organizations, zoos, universities, state, Tribal Nations, ES and other agencies to assist in the recovery of impacted species and

implement effective mitigation strategies, (i.e., environmental manipulations, vaccines, captive management program, etc.) to reduce or eliminate *G. destructans* from affected bats or sites, as they are identified

- Collaborate with academic, scientific, and wildlife conservation partners to take an active role in participating in various WNS research projects using Refuge resources
- Share, report, and compare findings with NGOs, researchers, universities, state, tribal, and federal partners including national participating diagnostic laboratories for WNS
- Conduct genetic sampling to identify which populations are genetically isolated, by comparing nuclear and mitochondrial DNA among bats from essential maternity caves to assist in WNS research (Weyandt et. al., 2005)
- Identify and monitor important roost trees, caves, and foraging habitats of bat species that have been known to be affected by WNS (i.e. northern long-eared, big brown, and tri-colored bats, etc.)
- Coordinate and partner with caving organizations, other NGOs, public, private, and home schools, universities, Tribal Nations, states, and other agencies to conduct public outreach regarding WNS by visiting schools, discussing the issue with local landowners, producing exhibits at the MMLERC and at festivals, conferences, and schools, and include information on WNS in environmental education and interpretation programs
- Increase cave monitoring, especially as more lands are acquired (up to 15,000 acres), and utilize law enforcement (LE) support to assist when needed, to prevent the potential spread of the fungus by unauthorized entry
- Maintain and continue construction of cave gates to control access to caves and prevent the potential spread of the fungus by unauthorized entry
- Investigate the feasibility and necessity of installing motion- and light-activated alarms inside all essential maternity and hibernacula caves, and do so when and where deemed feasible. The alarms would notify Refuge staff and LE of any intruders and would record occurrences.
- Identify and delineate migration corridors of bat, bird or other wildlife species (see Goal 1, Objective 7)
- Share and present data, surveys, and research with landscape-level conservation partners, NGOs, states, Tribal Nations, and federal agencies, as appropriate for the prevention of and recovery from WNS of all bat species
- Implement all other actions under the most current WNS National Plan (Plan is available online at http://www.fws.gov/whitenosesyndrome/pdf/WNSnationalplanMay2011.pdf), as it is updated, and WNS Response Plan for the State of Oklahoma (http://www.wildlifedepartment.com/wildlifemgmt/Oklahoma_Response_Plan_WNS.pdf)

4.1.7 Objective 7: Identify Migration Routes/Habitat Corridors.

Implement monitoring and research projects in collaboration with energy companies, local universities, ODWC, Tribal Nations, USGS, Service ES, and other landscape level partners to identify important migration routes and habitat corridors utilized by resident and migratory bats, birds, and other species within 5 years of the CCP's approval.



Thermal image of purple martins. (Credit: University of Oklahoma Animal Migration Research Group)

Rationale: These research projects are necessary to acquire more information on migration routes, which could be beneficial for future conservation planning efforts. Identified migration routes could inform SHC planning of land acquisition. In order to understand how climate change affects migratory routes utilized by various species, the routes must first be identified and delineated. Knowledge of migratory routes would also be beneficial during early planning stages of development projects in order to minimize the impacts to migratory species. Wind energy farms on migration routes, for example, cause mortality in migratory bird and bat species due to direct strikes and barotrauma from turbine blades (Johnson et al, 2002). Additionally, due to the spread of and devastating effects caused by WNS, identifying migration routes will be critical to cave ecosystem conservation efforts at the landscape-level.

Strategies:

- Collaborate with multiple landscape-level partners and take an active role in participating in various wildlife migration corridor identification research projects on- and off- Refuge
- Utilize various methods (i.e., conduct acoustic route monitoring, banding, tagging, and using radio transmitters, radar technology, and other technology) to identify migration corridors of bat, bird or other wildlife species
- Use GIS to delineate high risk areas based on identification of migration corridors
- Conduct genetic sampling to identify which populations are breeding, by comparing nuclear and mitochondrial DNA among bats from essential maternity caves (Weyandt et. al., 2005)
- Participate in ES project reviews, when necessary, of any proposed wind farms or other development projects in the ecoregion

- Share and present data, surveys, and research with landscape-level conservation partners, organizations, states, Tribal Nations, and federal agencies, as appropriate

4.2 Goal 2: Wildlife Habitat & Population Management

Protect, enhance, conserve and restore Ozark natural caves, springs, streams, aquifers, wetlands, watersheds, forests, and groundwater recharge areas to prevent extinction and recover federally listed cave species as well as prevent the need for listing other native species including migratory birds and other species of concern in the Ozarks to promote natural species diversity on a landscape-level.

4.2.1 Objective 1: Protect, Enhance, and/or Restore Forested Habitat.

Over the lifetime of this CCP, protect, enhance, and/or restore approximately 4,038 acres (and up to 15,000 acres of approved acquired land) of upland and riparian forested habitat to conditions believed to exist prior to European settlement on- and off- Refuge in order to improve the overall health of the forest ecosystem, enhance opportunities for foraging, provide movement corridors, and offer watershed protection for the benefit of migratory birds, bats, and other cave species. Desired forest conditions include a moderately-stocked, healthy forest that is able to naturally regenerate, with a well-developed understory dominated by native grasses and forbs, with a small shrub and woody component.

Prescribed fire on the Looney Unit to restore forest to its natural conditions. (Credit: Shea Hammond)

Rationale: Early descriptions of the Ozark region of Oklahoma described the presence of grass-covered savannahs and open woodlands with an abundant understory of grasses, wildflowers, and other herbaceous plants (Heikens, 1999). However, since European settlement, suppression of the natural fire regime has led to overcrowded forest

conditions. In addition, many fragments of forest were cut for commercial logging. As a result, today's remaining forest areas mostly consist of exceedingly high densities of even-aged stands with an excessive fuel load and a lack of well-developed understory. Current conditions not only lead to unnatural and uncontrollable wildfires, but they are also not ideal for native vegetation and wildlife to thrive as they once had. Forest habitat restoration measures (such as prescribed fire, thinning, native planting, etc.) that mimic the historic fire regime and maintain a natural mosaic of plant communities representative of the ecosystem will reduce the risk of unplanned, high-intensity wildfires while also supporting a greater diversity of native flora and fauna. In addition, continuing to implement natural disturbances will help to increase ecosystem resiliency to climate change (Tartowski, et. al., 1997).

The authorized purpose of Ozark Plateau NWR is to prevent extinction of federally listed endangered and threatened Ozark cave species, help in their recovery, and reduce the need for future listing of species of concern in the Ozarks. Restoring habitat on and surrounding the Refuge to conditions that promote a more open, and regenerating, mature forest condition (e.g., basal area of 50-60 sq. ft.) is anticipated to provide an enhanced foraging environment and abundant food source for the Ozark big-eared bat, and protect important flight corridors for gray bats. Another purpose of Ozark Plateau NWR is to protect large continuous stands of mature Ozark forest essential to interior forest nesting migratory birds such as tanagers, warblers, and flycatchers that must nest some distance from an edge. The forest also plays an important role in preventing degradation of water quality in caves used by the Ozark cavefish and other rare aquatic cave fauna such as the Oklahoma cave crayfish. Because surface water enters groundwater systems rapidly in karst areas, degradation of sensitive underground habitats used by the cavefish can occur rapidly. Large stands of healthy forest provide natural infiltration and percolation, reducing the amount of sediment, pesticides, and nutrients that might otherwise enter water bodies from surface run-off. In order to implement SHC to sufficiently increase habitat diversity on a landscape-level to prevent extinction of these listed cave species, it is important that mature Ozark forest is restored and maintained, and that management practices adapt to the species' habitat requirements, as they are identified. (USFWS [BABO HFRP], 2010).

Strategies:

- Use SHC planning to establish wildlife corridors to connect tracts of Ozark hardwood forest or to connect Ozark forest with other habitat types such as riparian forest, other large tracts of continuous stands of Ozark forest, and other protected lands (e.g., National Forest, State wildlife management areas, tribal lands, etc.) through land acquisition and entering into conservation easements and/or agreements

- Acquire lands or enter into agreements with willing sellers for conservation easements (up to 15,000 acres) to manage and/or restore acquired lands to appropriate habitat (i.e. mature oak-hickory forest habitat) (see Goal 1, Objective 3)
- Verify the accuracy of existing data regarding forested habitats (including flora surveys) and trends in populations of species affected by this habitat (i.e., Ozark big-eared bat, Gray bat, Ozark cavefish, Ozark cave crayfish, migratory songbirds, woodland moths, Ozark chinquapin, etc.). Maintain and update databases, standardize data collection methods, and perform data collection in consistent intervals to ensure proper health and management of forest ecosystem.
- Utilize information, as peer-review literature becomes available, to guide adaptive management strategies toward most appropriate forest conditions and high quality habitat possible for the benefit of federally listed cave species and migratory birds
- Work with Service I&M on GIS projects to identify and map the distribution and the condition of forest, woodland, and savannah habitats on- and off- Refuge to establish baseline conditions on a landscape-level
- Work with partners to evaluate the effectiveness of various forest management strategies (e.g., prescribed fire, midstory thinning as a tool to diversify forest structure to increase understory vegetation) and use adaptive management accordingly
- Work with and educate landowners in implementing programs such as the Service's Partners for Fish & Wildlife Program (see http://www.fws.gov/partners/) and the NRCS Healthy Forests Reserve Program to help private landowners enhance habitat surrounding caves by teaching them how to implement adaptive sustainable forest management practices (i.e. maintain their land in oak-hickory forest, encourage groups of landowners to work together to manage habitat for hunting leases or hardwood timber production, restore Ozark oak-hickory forest on non-utilized pastures or crop fields, and provide cost-share funding to install fences to control cattle grazing within this habitat type, provide cost-share for educational programming of habitat conservation and management for the public and private landowners, etc.)
- Preserve, maintain, and/or restore forested and/or cave habitats as per formal and informal agreements with private landowners, The Nature Conservancy (TNC), Land Legacy, NSS, the City of Tulsa, Oklahoma Scenic Rivers Commission, ODWC, Tribal Nations, Natural Resource Conservation Service (NRCS), Grand River Dam Authority (GRDA), Army Corps of Engineers, Ozark National Forest, and other organizations or agencies
- Update outdated agreements and develop additional formal conservation agreements where possible to ensure the preservation, maintenance and/or restoration of forested and/or cave habitats
- Support cooperative efforts between utility companies, cities, counties, research institutions, Tribal Nations, and other government agencies to develop best

management practices and management recommendations to minimize the impact of road, pipeline, and utility line construction, and the impacts of right-of-way maintenance practices

- Distribute informational materials with guidance on adaptive sustainable forest management practices and recommendations to landowners, utility companies, Tribal Nations, and other governmental agencies (reassess/update and redistribute when possible)
- Develop and/or distribute educational materials for schools and landowners that highlight the value (i.e., ecological and economic) of the ecology of hardwood trees and Ozark forests
- Respond to wildland fire based on objectives within Habitat Management Plan (HMP) and Fire Management Plan (FMP) while considering ecological, social, and legal consequences of the fire. Coordinate response to wildland fire with all affected agencies/tribes/cooperators regardless of the jurisdiction at the ignition point. Initial response to human-caused wildfires will be to suppress the fire at the lowest cost with the fewest negative consequences with respect to firefighter and public safety. Unplanned natural ignitions may be managed to achieve HMP and FMP objectives when risk is within acceptable limits.
- Continue to implement FMPs for Looney Unit and Sally Bull Hollow Unit for forest restoration to maintain open understory, reduce fuel loads, foster mature oak-hickory or oak-hickory-pine overstory, and increase understory diversity through prescribed fire burns on approximately 400 acres per year in 3 to 5 year rotations
- Develop a FMP for all Refuge Units, including burn plans and a training program for Refuge staff, to increase the use of prescribed fire to one-third of the Refuge's total acreage per year including future acquired lands (approximately 1,300 acres in 2012), in 3 to 5 year rotations.
- Partner with private contractors, local fire departments, Oklahoma State University, the Oklahoma Department of Agriculture, Food and Forestry – Oklahoma Forestry Services, Tribal Nations, National Park Service, the Forest Service, and Service personnel from Wichita Mountains NWR in order to receive firefighting support with prescribed burns on and adjacent to Refuge lands
- Seek and utilize forest management assistance programs to expand partnerships and funding opportunities for management on and adjacent to Refuge lands (e.g., Wildland-Urban Interface Program, which provides financial aid to local fire departments in order to receive firefighting support for prescribed burns)
- Increase the number of agreements with surrounding private landowners for prescribed fire to burn up to 1/3 of the total Refuge adjoining lands on a 3 to 5 year rotation by working with partners (i.e. local fire departments, Oklahoma State University, the Oklahoma State Forestry Division, tribal entities, NRCS, National Park Service, the Forest Service, etc.) to perform outreach and increase communication

- Keep construction to a minimum of any new roads or infrastructure on all Refuge Units, unless necessary (for example, for new Headquarters site or as access roads on newly acquired lands are needed)
- Define Refuge boundaries for public awareness and to increase LE capabilities by contracting surveyors to survey and mark all unsurveyed and unmarked boundaries on the Refuge, using permanent metal boundary markers, and maintaining/repairing existing boundary gates and markers
- Reintroduce blight-resistant Chinquapin (*Castanea ozarkensis*) (http://www.ozarkchinquapin.com/)
- Work with partners to develop a habitat suitability index model to determine optimum forest and cave habitat requirements for Ozark big-eared bats, gray bats, cavefish, cave crayfish, and other representative species and employ the best adaptive management practices to meet these requirements

4.2.2 Objective 2: Protect, Enhance, and/or Restore Aquatic Habitat.

Over the lifetime of this CCP, through outreach efforts, stronger partnerships and implementation of watershed and groundwater recharge area management practices, protect, enhance, and/or restore surface and subterranean aquatic habitats, on- and off-Refuge, used by federally listed cavefish, and species of concern cave crayfish, and other aquatic species in order to achieve sustainable population trends of these species.

Cave crayfish residing in Twin Cave. (Credit: Steve Hensley)

Rationale: Conventional agriculture run-off and increasing urban development result in contaminated surface water, which freely enters groundwater with limited natural filtration in areas of karst topography such as in the Ozarks, adversely affecting cavefish, cave crayfish, and other species. In addition, abandoned lead and zinc mines of the Tri-State Superfund Site in the northern part of the Refuge acquisition area have contaminated surface and groundwater resources. Increasing deforestation and conversion to urban and agricultural land uses in the region increases the volume of water run-off and decreases the capability of the watershed to filter this run-off. Unfiltered water contains a higher volume of both contaminants and nutrients, such as nitrogen, phosphorus, metals, pesticides, pharmaceuticals, and plasticizers. Degradation of habitat and water quality has been identified as a major threat to aquatic cave species (USFWS Cavefish 5-year Review, 2010).

Agriculture and increasing urbanization also affects the quantity of surface and groundwater of the aquifer surrounding the Refuge. Impervious surfaces and man-made drainage systems are preventing surface water to seep through the ground and recharge the aquifer in the natural manner that it used to. This is lowering groundwater levels, which affect subterranean and aquatic habitats on the Refuge and surrounding areas. An increase in water consumption due to an increasing population in nearby urban areas is also contributing to lower surface and groundwater levels.

Strategies:

- Use SHC planning to establish wildlife corridors to connect tracts of springs, gravel bottom streams, riparian forests, rivers, wetlands, etc. with other habitat types such as wet caves or other protected lands (National forests, State wildlife management areas, tribal lands, etc.) through land acquisition and entering into conservation easements and/or agreements
- Acquire lands or enter into agreements with willing sellers for conservation easements (up to 15,000 acres) to implement appropriate watershed management to protect groundwater recharge areas for caves, riparian zones for surface streams and springs, and other areas
- Work with and educate landowners in implementing programs such as the Service's Partners for Fish & Wildlife Program (see http://www.fws.gov/partners/) and the NRCS Healthy Forests Reserve Program to help private landowners enhance aquatic habitats by teaching them how to implement adaptive sustainable land and water management practices (i.e. maintain or restore natural riparian or forest habitats along streams or within recharge areas, promote importance of native flora species and removal of non-native/invasive species, implement appropriate forest management practices to control water run-off such as burning, provide cost-share funding to construct fencing along streams and riparian areas to control access by cattle, provide cost-share for educational programming of habitat conservation and management for the public and private landowners, etc.)
- Preserve, maintain, and/or restore aquatic and/or cave habitats as per formal and informal agreements with private landowners, TNC, Land Legacy, NSS, the City of Tulsa, Oklahoma Scenic Rivers Commission, ODWC, Tribal Nations, NRCS, GRDA, Army Corps of Engineers, Ozark National Forest, and other organizations or agencies
- Develop additional formal conservation agreements where possible to ensure the preservation, maintenance and/or restoration of aquatic and/or cave habitats
- Support cooperative efforts between utility companies, cities, counties, research institutions, Tribal Nations, and other government agencies to develop best management practices and management recommendations to minimize the impact of road, pipeline, and utility line construction, and the impacts of right-of-way maintenance practices on surface and subterranean aquatic habitat

- Develop and distribute informational materials with guidance on adaptive sustainable land and water management practices and recommendations to landowners, utility companies, Tribal Nations, and other governmental agencies (reassess/update and redistribute when possible)
- Develop educational materials and programs for schools and landowners that highlight the value (i.e., ecological and economic) of the ecology of aquatic habitats (rivers, wetlands, streams, springs, wet caves, etc.) of the Ozarks
- Keep construction to a minimum of any new roads or infrastructure on all Refuge Units, unless necessary (for example, for new Headquarters site or as access roads on newly acquired lands are needed)
- Remove and rehabilitate or replace culverts and road crossings with new structures that do not create barriers to fish
- Work with local universities, USGS, Service Contaminants, Water Resources, and other Service personnel to implement a permanent water quality and quantity monitoring program (see Goal 1, Objective 5)
- Partner with local municipalities and water authorities to share information about water levels and water quality affecting the Refuge, including federally listed species and species of concern
- Contract with private companies, NGOs, the USGS, and Service personnel to map groundwater recharge areas within the acquisition area, in and around all Refuge Units, including private lands (see Goal 2, Objective 5)
- Define Refuge boundaries for public awareness and to increase LE capabilities by contracting surveyors to survey and mark all unsurveyed and unmarked boundaries on the Refuge, using permanent metal boundary markers, and maintaining/repairing existing boundary gates and markers
- Reduce Refuge use of herbicides and other pesticides in floodplains, riparian areas and cave recharge areas
- Work with landowners, city, county, state, Tribal Nations and other governmental agencies to implement appropriate road construction and maintenance that reduces amount of sedimentation
- Protect wetlands and/or floodplains as they are acquired within the acquisition boundary
- Work with Service I&M and other partners such as NSS to develop inventorying & monitoring programs to evaluate overall health of aquatic habitats and resources in order to evaluate and guide Refuge adaptive management actions
- Use historic literature and field studies to determine probable historic distribution and aquatic conditions, in conjunction with a landscape-level evaluation of location and distribution of surface and subterranean aquatic habitat types
- Work with Service I&M and other partners such as NSS to verify the accuracy of existing data regarding aquatic habitats (including flora surveys) and trends in

populations of representative species, maintain and update databases, standardize data collection methods, and perform data collection in consistent intervals to ensure proper health and management of aquatic ecosystems

- Work with Service I&M and other partners such as NSS on GIS projects to identify and map the distribution and the condition of aquatic habitat on the Refuge to establish baseline conditions
- Work with partners to develop a habitat suitability index model to determine optimum aquatic habitat requirements for Ozark cavefish, Oklahoma cave crayfish, Delaware County cave crayfish and other species as needed, and employ the best adaptive management practices to meet these requirements
- Share results of ecological monitoring and studies to land and water use planners, and conservation and scientific agencies
- Explore the feasibility of acquiring water rights

4.2.3 Objective 3: Provide Undisturbed, Safe, and Protected Cave Habitat.

Provide undisturbed, safe, and protected cave habitat by eliminating cave vandalism incidents throughout the length of this CCP for the benefit of natural resources, bat species, and other cave species on-Refuge and off-Refuge. This will be accomplished by implementing the Federal Cave Resources Protection Act and working with landowners, conservation organizations, state agencies, Tribal Nations, and other federal agencies.

Belles Bluff cave gate. (Credit: Steve Hensley)

Rationale: Human disturbance and vandalism are the leading factors in the degradation of cave habitats and decline in bat populations. In recent years, people have vandalized cave gates, destroyed and removed cave formations, modified passageways, littered, graffitied, and damaged the caves with smoke from fires. The Refuge routinely repairs cave gates about three or four times per year due to vandalism and unauthorized entry. Disturbance of hibernating bats causes the loss of critical fat stores and increases the probability of starvation during winter, while disturbance at maternity roosts can result in a loss of young (Tuttle, 1979). Protection of caves from human disturbance and destruction are identified as the most important recovery need of the three federally listed

cave species known to occur on the Refuge (USFWS Ozark big-eared Bat Recovery Plan, 1995; USFWS Gray Bat Recovery Plan, 1982 ; USFWS Ozark Cavefish Recovery Plan, 1989).

Strategies:

- Acquire lands or enter into agreements with willing sellers for conservation easements (up to 15,000 acres) to protect and/or restore cave habitat and habitat surrounding caves (i.e., riparian recharge areas, oak-hickory forest, grasslands, etc.) (see Goal 1, Objective 3)
- Work with and educate landowners in implementing programs such as the Service's Partners for Fish & Wildlife Program (see http://www.fws.gov/partners/), NRCS Healthy Forest Reserves Program and NSS cave management projects to encourage a controlled entry policy to avoid disturbance to cave habitat and its respective species
- Protect and/or restore cave habitats as per formal and informal agreements with private landowners, TNS, Land Legacy, NSS, the City of Tulsa, Oklahoma Scenic Rivers Commission, ODWC, Tribal Nations, NRCS, GRDA, Army Corps of Engineers, Ozark National Forest, and other organizations or agencies
- Develop additional formal conservation agreements where possible to ensure the protection of cave habitats
- Support cooperative efforts between utility companies, cities, counties, research institutions, Tribal Nations, and other government agencies to develop best management practices and management recommendations to minimize impacts to cave habitat and cave species of road, pipeline, and utility line construction, and the impacts of right-of-way maintenance practices
- Develop and distribute informational materials to landowners, utility companies, Tribal Nations, and other governmental agencies with guidance on how to protect cave and karst resources (reassess/update and redistribute when possible)
- Develop educational materials and programs for schools and landowners that highlight the value (i.e., ecological and economic) of the ecology of cave and karst habitats, the need to protect these environments, and highlight protection methods
- Work with the NSS and their local chapters (grottos) and other partners to identify unknown caves (see Goal 2, Objective 4)
- Work with local cavers, NSS, universities, and other partners to map known caves on- and off-Refuge in order to inform the Refuge staff of overlying landowners and to help identify outreach efforts
- Maintain confidential information regarding cave locations on-Refuge and off-Refuge to protect cave fauna, as required by the Federal Cave Resources Protection Act

- Work with Service I&M and other partners on performing biological inventory within caves and tracking data of location and biological composition of known caves
- Work with the NSS and their local chapters (grottos) and other partners to eliminate injuries, illnesses and fatalities in caving and at the same time effectively protect all life that visits or resides within cave environments
- Control access to Refuge caves susceptible to disturbance by constructing appropriately designed gates that allow bat passage (especially for those that host or that have the potential to be occupied by federally listed threatened and endangered species such as Ozark big-eared bat, gray bat, and Ozark cavefish)
- Work with GRDA, TNC, ODWC and ES to increase Section 6 of Endangered Species Act funding and other types of funding for cave gating projects and land acquisition
- Work with landowners, volunteers, caving organizations and other NGOs, the State, Tribal Nations, and other federal agency staff to build, maintain, and repair approximately 50 cave gates on- and off-Refuge, and others as they are needed
- Monitor all cave gates to determine their effectiveness regarding adequate bat use and assess maintenance needs (deterioration due to humid cave environments, vandalism, illegal entry, etc.)
- Delineate all cave recharge areas that have not yet been delineated to identify and/or protect from sources of contamination (e.g., human disturbance, pollution, CAFO, illegal grazing issues, illegal dump materials, etc.). This will guide Refuge prioritization of conservation efforts (e.g., identify stakeholders that the Refuge needs to communicate with and establish a partnership and/or an agreement to mitigate recharge area disturbance) (see Goal 2, Objective 5).
- Post signs prohibiting entry at cave locations and continue the policy of maintaining confidentiality of cave locations
- Increase LE presence and monitoring of caves by Refuge staff and a LE officer based at Sequoyah NWR who would dedicate part of his or her time to working for Ozark Plateau NWR, to include routine visits once every three months or variable by season based on bats' use of the cave
- Define Refuge boundaries for public awareness and to increase LE capabilities by contracting surveyors to survey and mark all unsurveyed and unmarked boundaries on the Refuge, using permanent metal boundary markers, and maintaining/repairing existing boundary gates and markers
- Keep construction to a minimum of any new roads or infrastructure on all Refuge units, unless necessary (for example, for new Headquarters site or as access roads on newly acquired lands are needed)
- Limit the use of adding new man-made fire breaks in order to prevent creation of additional trails and/or off-road vehicle access that may provide access to or near caves

- Install and develop alarm systems and/or infrared video cameras at essential maternity and hibernacula caves on- and off-Refuge to deter and detect cave vandalism
- Also, see strategies in Goal 1, Objective 6 regarding WNS

4.2.4 Objective 4: Locate Additional Caves.

Throughout the life of this CCP, locate additional important caves, defined as "a naturally occurring void, cavity or recess that occurs beneath the earth's surface or within a cliff or ledge, and includes limestone and sandstone talus caves", utilized by federally listed cave species (i.e. Ozark big-eared bat, gray bat, Ozark cavefish, etc.) and other cave species of concern within the Ozark Highlands of Arkansas, Oklahoma, and Missouri (Ozark Big-Eared Bat 5-year Review, 2008.).

Entrance to January-Stansberry Cave on the Looney Unit. (Credit: Richard Stark)

Rationale: The measures most important to conserve listed cave species include obtaining and utilizing knowledge of the cave locations used by the species in order to limit human disturbance to occupied caves and protect known caves and surrounding foraging areas from habitat degradation and loss. Essential information, such as the location of caves used by listed species, is often incomplete. For example, numbers of Ozark big-eared bats estimated from summer maternity counts are larger than those found in winter hibernacula counts. This indicates there are likely major hibernacula being used by this species but that have not yet been located. Locating additional caves and other karst features could help the Refuge take a SHC approach to identify target areas for future acquisition.

Strategies:

- Partner with local cavers, NSS, universities, Tribal Nations, USGS, Service I&M, and others to map full subterranean extent of known caves to identify all surface cave entrances (which may lead to other unidentified caves)
- Map searched and unsearched geological areas that are conducive to cave formation on- and off-Refuge in order to inform Refuge staff of overlying land use and prioritize areas to be searched in the future

- Coordinate with local landowners and perform public outreach to identify unknown cave sites on private lands
- Coordinate with volunteers, cave and geological experts, NSS, universities, Tribal Nations, and other willing partners to locate additional caves within the Ecoregion by "ridge walking", which includes walking along faults, contacts, depressions, springs, sinking streams and/or other appropriate geological areas which may lead to potential cave locations (Ashbrook, 1996)
- Investigate the use of technology such as satellite and aerial imagery (to look for features indicative of having a cave opening), thermal imagery (to locate potential hot or cold zones), radio telemetry (track bats to unknown roost sites), and others
- Increase partnerships with TNC, Land Legacy, Bat Conservation International (BCI), NSS, other organizations, and Tribal Nations by going to meetings, working on joint cave mapping and identifying projects, and contracting through cost-share or joint funding to assist them with their projects

4.2.5 Objective 5: Delineate Recharge Area of Cavefish and Crayfish Caves.

Within the lifetime of this CCP, work with private landowners, environmental consultants, NGOs, universities, Tribal Nations, state and other federal agencies to delineate the groundwater recharge area of all known cavefish and crayfish caves that have not yet been delineated on or around the Refuge.

Cavefish. (Credit: Dr. Art Brown)

Rationale: The recharge area of caves (i.e., the area that contributes water to a cave) used by the Ozark cavefish can be extensive (e.g., 20 square miles) (USFWS [BABO HFRP], 2010). The Ozark cavefish is considered the most adapted of all the cavefish for cave life due to well-developed sensory papillae. They tend to occur in caves with groundwater recharge (as opposed to caves that rely on surface water sources), and generally are acknowledged to be a groundwater obligate. Therefore, knowledge of a cave's recharge area will help the Refuge identify potential hazards and sources causing ecosystem health issues (i.e., human disturbance, pollution, petroleum production, confined animal-feeding operations (CAFO), grazing issues, illegal dump materials, etc.) and subsequently, will inform which surface areas the Refuge needs to focus its restoration and conservation efforts. In addition, this would help the Refuge to reprioritize which stakeholders they need to establish new partnerships and/or agreements with.

Strategies:

- Work with private landowners, NGOs, universities, Tribal Nations, USGS, Service Regional Hydrologist, I&M, & Contaminants personnel and other partners to assist in delineation process (outlined in strategies below)
- Identify all landowners in determined and potential recharge zones and seek permission to perform delineation process
- Use fluorescent-dye tracing to determine recharge areas, general directions of groundwater flow, minimum and maximum groundwater travel times in days and miles from losing streams as a result of dye tracing
- Determine relationship between surfacewater drainage basins and groundwater basins
- Produce map of watershed area based on results of the dye tracing (http://www.nh.nrcs.usda.gov/technical/Publications/Topowatershed.pdf)
- Acquire lands, conservation easements, and/or enter into agreements with willing landowners (up to 15,000 acres) in determined and/or potential recharge zones (see Goal 1, Objective 3)

Cluster of Ozark big-eared bats. Hurricane Creek, July 2008. (Credit: Richard Stark)

4.2.6 Objective 6: Inventory & Monitor to Advance Scientific Knowledge Regarding Federally Listed Cave Species and Species of Concern.

Throughout the lifetime of this CCP, work with interdisciplinary partners including private landowners, conservation agencies, universities, Tribal Nations, state and federal agencies to establish an inventory & monitoring program to conduct scientific research in order to advance and share information and knowledge regarding the ecology of federally listed cave species and cave species of concern that occur on and off the Refuge.

Rationale: The Refuge was established to prevent extinction of and recover federally-listed Ozark cave species, which include the Ozark big-eared bat, gray bat, Indiana bat, and Ozark cavefish. The Refuge also currently protects nine species of concern to

prevent the need for future listing. The nine species of concern on the Refuge include the Oklahoma cave crayfish and Delaware County cave crayfish. Currently, there is little known about these Ozark cave species; their habitat requirements, genetics, effects of climate change, and how WNS will affect cave ecosystems. The Refuge would like to address scientific knowledge gaps regarding forest, surface, and cave habitat requirements and breeding ecology of cave species occurring on the landscape-level to better assess and manage for their needs. In addition, there is also a need to contribute to current scientific research regarding identification of genetic diversity and population dynamics of Ozark cave species. This genetic research would help conservation partners understand how climate change and WNS impact different cave species, as well as help to identify undetermined cave species. Increasing scientific data by monitoring, researching, and sharing information at the landscape-level is essential in order for the Refuge to be able to implement the best management practices to meet the needs of federally listed cave species and ensure their continuing existence.

Strategies:

- Coordinate with partners such as TNC, Land Legacy, BCI, NSS, universities, Tribal Nations, NRCS, USGS, and other organizations through challenge cost-share funding for joint projects, ESA Section 6 funding, tribal and state wildlife grants, and other funding where available, to address research needs
- Survey existing literature, reports, and museum records for historic distributions, abundances and habitat affinities of T&E and/or species of concern to assess baseline conditions for future monitoring and examine potential causes of population declines
- Work with local universities, USGS, Service Contaminants, Water Resources, and other Service personnel to implement a permanent water quality and quantity monitoring program (see Goal 1, Objective 5)
- Contract with private companies, NGOs, the USGS, and Service personnel to map groundwater recharge areas in and around all Refuge Units, including private lands, within the acquisition area (see Goal 2, Objective 5)
- Partner with local municipalities and water authorities to share information about water levels and water quality affecting the Refuge, including federally listed species and species of concern
- Continue to participate on cave fauna bio-inventory projects on Refuge units and private lands, such as the Ozark Subterranean Biodiversity Project, with volunteers, TNC and other NGOs, universities, state agencies, Tribal Nations, USFS, NPS, and other agencies, maintaining a scheduled monitoring program in which specific caves (approximately 5 per year) are inventoried on a five-year rotation with species identified by the Refuge to monitor cave resources
- Continue to partner with the private landowners, NSS, TNC, GRDA, the City of Tulsa, universities, the ODWC, Tribal Nations, and federal agencies to monitor

bat activity and population trends annually by using exit surveys, thermal and infrared videography of bat emergence, acoustic monitoring, radio telemetry monitoring of foraging, migration and other movements, guano measurements within maternity and other caves, and hibernacula counts

- Establish permanent, stationary acoustic monitors, both inside and outside of caves, on all Units determined necessary to record bat calls and identify which bat species use which caves and at what time(s) of the year
- Install permanent cameras in the January-Stansberry Cave and/or other appropriate caves to monitor bat activity to provide additional scientific information (i.e., seasonal use of the caves by the bats, observe bat behavior, etc.) and monitor human disturbance. In addition, these cameras could provide online web-streaming during the maternity season for interpretation purposes twenty-four hours per day.
- Identify and monitor important roost trees, caves, and foraging habitats of bat species that have been known to be affected by WNS (i.e. northern long-eared, big brown, and tri-colored bats)
- Implement climate data loggers program (see Goal 1, Objective 4) and develop an I&M program to monitor existing cave habitat conditions trends and determine bat cave habitat preferences
- Utilize radio tracking, a permanent mobile and stationary acoustic survey program, transects, insect surveys, guano dissection, vegetation surveys, and other methods on and around the Refuge to determine listed and non-listed foraging bat species presence and distribution, roost trees, foraging habitat preferences, habitat conditions that affect foraging ecology, and monitor trends overtime. Work with Service I&M to create a database documenting these results and use data to guide adaptive management to maintain and/or restore forest habitat and other bat foraging habitats.
- Assess the effects of forest and cave management practices (i.e. prescribed fire/thinning, etc.) on species' habitat selection, foraging, movement, breeding behavior and population trends
- Work with partners to develop a habitat suitability index model to determine optimum forest and cave habitat requirements for Ozark big-eared bats, gray bats, Ozark cavefish, Oklahoma cave crayfish, Delaware County cave crayfish and other federally listed species and species of concern as needed, and employ the best adaptive management practices to meet these requirements
- Partner with universities, state agencies, Tribal Nations, federal agencies and others to initiate research projects to identify bat migration periods and location of corridors
- Partner with universities, state agencies, Tribal Nations, federal agencies and others on a landscape-level to perform a population viability analysis in order to determine self-sustaining population targets for Ozark big-eared bats, gray bats and Ozark cavefish

- Continue partnering with Oklahoma State University and other scientific organizations to perform genetic research on- and off- Refuge of bat, crayfish, cavefish, and other cave species to identify undetermined cave species, determine population dynamics, identify genetic diversity, etc. by comparing nuclear and mitochondrial DNA samples
- Perform annual monitoring count surveys of cavefish and cave crayfish to understand population trends
- Work with landowners, conservation agencies, universities, Tribal Nations, and scientific agency partners to develop research projects to record and monitor the distribution, abundance, habitat preference, and breeding ecology of Ozark cavefish
- Share and present data, surveys, and research with landscape-level conservation partners, organizations, states, Tribal Nations, and federal agencies, as appropriate for the recovery of federally listed cave species

4.2.7 Objective 7: Inventory & Monitor to Advance Scientific Knowledge Regarding Migratory and Resident Non-T&E Species.

During the 15-year life of this CCP, work with partners to conduct surveys of all wildlife species that occur on the Refuge and within potential acquisition areas and establish an inventorying & monitoring program to advance and share scientific knowledge by researching non-T&E species' population trends, density, distribution, and habitat preferences.

Swabbing tri-colored bats for WNS. (Credit: S. Catchot)

Rationale: Non-T&E bat species and many other non-T&E native species occur frequently on the Refuge; however, the Refuge is just beginning to collect information on these species. Most likely, there are at least fourteen non-T&E cave-dwelling species at Ozark Plateau NWR (USFS: Ozark-Ouachita Highlands Assessment, 1999). In order for the Refuge to adapt management strategies to meet the needs of its native species, it must first assess population trends, density, distribution, habitat conditions, and examine the relationships between this data in order to understand what habitat conditions most resident native species prefer. Monitoring these non-T&E species over time will help guide conservation efforts on specific habitat types and fulfill the Refuge's mission of preventing the future listing of any species. In addition, WNS remains a threat to T&E

species, species of concern, as well as non-T&E species. More baseline information regarding all species affected by or that affect bat populations could be valuable to assist in efforts to address WNS.

Strategies:

- Coordinate with partners such as BCI, Land Legacy, TNC, NSS, universities, Tribal Nations, NRCS, USGS, and other organizations through more challenge cost-share funding for joint projects, ESA Section 6 funding, tribal and state wildlife grants, and other funding, where available
- Work with local universities, USGS, Service Contaminants, Water Resources, and other Service personnel to implement a permanent water quality and quantity monitoring program (see Goal 1, Objective 5)
- Contract with private companies, NGOs, USGS, and Service personnel to map groundwater recharge areas within the acquisition area, in and around all Refuge Units, including private lands (see Goal 2, Objective 5)
- Continue to participate on cave fauna bio-inventory projects on Refuge units and private lands, such as the Ozark Subterranean Biodiversity Project, with volunteers, TNC and other NGOs, universities, state agencies, Tribal Nations, the USFS, NPS, and other agencies, maintaining a scheduled monitoring program in which specific caves (approximately 5 per year) are inventoried on a five-year rotation with species identified by the Refuge to monitor cave resources
- Survey existing literature, reports, and museum records for historic distributions, abundances and habitat affinities of non-T&E species to assess baseline conditions for future monitoring and examine potential causes of population declines
- Work with cooperative landowners, NGOs, universities, state agencies, Tribal Nations, USGS, Service I&M and other federal agencies to develop a monitoring program and conduct surveys of invertebrates, herpetofauna, fish, birds, and mammals to identify and document all wildlife species occurring on all units of the Refuge, potential acquisition areas, and with cooperating adjacent landowners (compile a species list)
- Perform annual monitoring count surveys of all non-T&E cavefish and mark recapture of cave crayfish to understand population trends
- Continue to partner with the private landowners, NSS, TNC, the GRDA, the City of Tulsa, universities, ODWC, tribal governments, and federal agencies to monitor bat activity, habitat preference, and population trends annually of non-T&E species (tri-colored bats, Northern long-eared bats, big brown bats, etc.) by using methods such as exit surveys, thermal and infrared videography of bat emergence, acoustic monitoring (see strategies below for more specifics), radio telemetry monitoring of foraging, migration and other movements, guano measurements within maternity and other caves, and hibernacula counts

- Establish permanent, stationary acoustic monitors, both inside and outside of caves, on all units determined necessary to record bat calls and identify which bat species use which caves and at what time(s) of the year
- Utilize radio tracking, a permanent mobile and stationary acoustic survey program, transects, insect surveys, guano dissection, vegetation surveys, and other methods on and around the Refuge to determine listed and non-listed foraging bat species presence and distribution, foraging habitat preferences, habitat conditions that affect foraging ecology, and monitor trends overtime. Work with I&M to create a database documenting these results and use data to guide adaptive management to maintain and/or restore forest habitat and other bat foraging habitats.
- Continue partnering with Oklahoma State University, other universities, and other scientific organizations to perform genetic research on- and off- Refuge of bat, crayfish, cavefish, and other cave species to identify undetermined cave species, determine population dynamics, identify genetic diversity, etc. Conduct genetic sampling to identify which populations are genetically isolated, by comparing nuclear and mitochondrial DNA samples.
- Work with landowners, scientific organizations, universities, state agencies, Tribal Nations, and federal agencies to identify timing and location of migration routes and corridors of non-T&E species (i.e. bear, butterflies, Neotropical birds, bats, fish, grotto salamanders, etc.)
- Identify and monitor important roost trees, caves, and foraging habitats of bat species that have been known to be affected by WNS (i.e. northern long-eared, big brown, and tri-colored bats)
- Assess the effects of forest and cave management practices (i.e. prescribed fire/thinning, etc.) on non-T&E species' habitat selection, foraging, movement, and breeding behavior and population trends
- Share and present data, surveys, and research with landscape-level conservation partners, organizations, states, Tribal Nations, and federal agencies, as appropriate for the conservation of natural ecosystems within the Ozarks

4.2.8 Objective 8: Inventory & Monitor Migratory and Resident Bird Species Utilizing the Refuge and Surrounding Landscape.

Throughout the lifetime of this CCP, work with partners such as bird conservation organizations, universities, state, tribal, and federal agencies to survey all bird species using the Refuge and surrounding

Indigo bunting in the night on Ozark Plateau NWR. (Credit: Shea Hammond)

landscape. Develop an inventorying & monitoring program to better understand habitat requirements of these migratory and resident bird species, and finally adapt Refuge management accordingly, based on their conservation needs.

Rationale: The Refuge is located on the western edge of the Ozarks ecoregion and near the eastern edge of the Tallgrass Prairie Ecoregion, resulting in a "crossover" of eastern and western bird species found on the Refuge. Therefore, conservation of these migratory bird habitats is extremely critical, especially in the wake of increasing habitat degradation and fragmentation due to residential, commercial, and industrial development. In addition, one of the purposes of Ozark Plateau NWR's establishment is to protect large continuous stands of mature Ozark forest essential to interior forest nesting migratory birds such as tanagers, warblers, and flycatchers that require nesting some distance from an edge. The Refuge has developed strategies in accordance with protection and management recommendations of the Central Hardwood Bird Conservation Region (Partners in Flight).

Strategies:

- Implement recommendations from the Partners in Flight Plan (such as retain large mature tracts of forest, maintain/promote growth of native grasses and understory vegetation, restore the role of fire, maintain water quantity, quality and vegetation along streams and riparian areas, protect high quality riparian habitat, manage and restore degraded stretches, restore natural flows and flooding regimes, etc.) (see http://www.partnersinflight.org/cont_plan/default.htm)
- Maintain continuous stands of mature oak-hickory for interior forest Neotropical nesting birds (see Goal 2, Objective 1)
- Use prescribed fire to promote ideal nesting/foraging habitat in Ozark forests for bird species (see Goal 2, Objective 1)
- Continue the policies of limited public use activities to minimize disturbance on Refuge lands for the benefit and wellbeing of resident and migratory birds
- Survey existing literature, reports, and museum records for historic distributions, abundances and habitat affinities of migratory and resident bird species to assess baseline conditions for future monitoring and examine potential causes of population declines
- Work with landowners, bird conservation organizations, state agencies, tribal nations, and federal agencies to identify migratory bird species occurring near or on the Refuge during the spring and fall (compile a species list)
- Work with landowners, bird conservation organizations such as the National Audubon Society, universities, state agencies, Tribal Nations, and federal agencies to conduct seasonal nesting studies as well as MAPS banding of birds once a month for six months each year on the Refuge to gather additional data on

migration corridors, paths, origins and destinations, as well as population data trends

- Coordinate with Partners in Flight National Audubon Society, other bird organizations, universities, and other partners on migratory bird conservation management including research such as identify the quantity, quality and spatial configuration of available habitat, link habitat condition and population response, and anticipate future habitat conditions, in order to identify habitat requirements and set and achieve population objectives for priority landbirds of the Central Hardwood Bird Conservation Region
- Share and present data, surveys, and research with landscape-level bird conservation partners, organizations, states, Tribal Nations, and federal agencies, as appropriate

4.2.9 Objective 9: Map, Monitor, Research, and Implement Adaptive Management to Assess and Control Invasive Non-native Flora.

Throughout the lifetime of this CCP, determine the extent of non-native invasive flora on and surrounding the Refuge by mapping, monitoring, and conducting research to better understand the scale of the problem and address the issue through adaptive management solutions.

Invasive, Sericea lespedeza.
(Credit: Chris Evans of River to River CWMA)

Rationale: Non-native invasive plants alter natural habitat conditions, which consequently affect native wildlife species. Evaluation of invasive and exotic plants that are detrimental to native flora and fauna species and maintenance of natural biodiversity is very important to the Refuge for the overall health and function of natural ecosystems within the Ozarks. The Refuge must continue working with its partners to assess the extent and threat of non-native invasive flora on and around the Refuge, as well as adapt management actions, if necessary, to control and maintain them. Some non-native invasive species which may outcompete and displace native plants within hardwood forests and/or riparian areas of the Refuge include: Sericea lespedeza, tall fescue, Chinese privet, Japanese honeysuckle, Johnson grass, kudzu, beefsteak plant, Nepalese browntop, mimosa trees, and others. A vegetation survey from 2003 found that 8.7% of all plant species occurring on the Sally Bull Hollow Unit of the Refuge were non-native flora (Hayes). A survey is needed to assess and map the distribution of non-native species on all units of the Refuge in order to effectively inventory and monitor as well as manage them. These invasive plant species

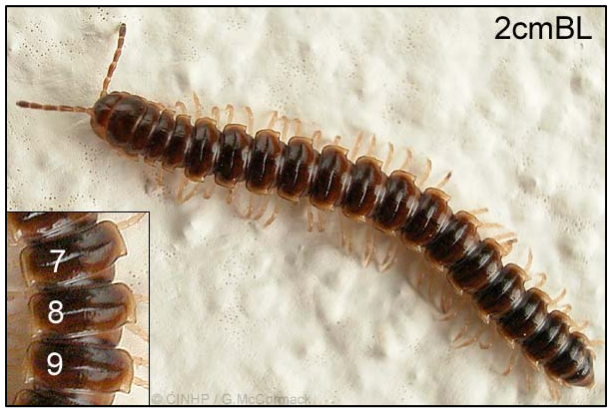
may have some effect on bat's prey, including moths and other insects; however, no research has been done on this. Songbirds and migratory birds depend on native plants, shrubs, and trees for nesting, perching, and hosting a multitude of insects for prey. Consequently, non-native invasive flora also affects bird niches. In addition, exotic tree pathogens are affecting native chestnuts and flowering dogwood, which may also be altering forest structure and diversity.

Strategies:

- Coordinate with partners such as the City of Tulsa and Land Legacy for funding for non-native/invasive plant management (i.e., invasive plant removal, plantings, prescribed burning, limited herbicides application, etc.)
- Promote cost-share or incentives programs for private landowners and Tribal Nations to encourage them to control invasive and exotic species on adjacent lands
- Work with partners such as landowners, NGOs, universities, state agencies, Tribal Nations, and federal agencies to identify, document, and monitor all plant species (native and non-native) and map distribution of these species occurring on the all units of the Refuge
- Identify which non-native flora species are causing the greatest (negative) impact to T&E species, species of concern, and/or representative species
- Develop and implement management strategies (in an Integrated Pest Management Plan) to control non-native species causing greatest impacts to ecosystem in order to meet Refuge objectives (such as the use of prescribed burns, the application of minimal herbicide spot treatments, and removal of invasive plants with mechanical treatments including hand tools, chainsaws, and mowing with a tractor) (See also Goal 2, Objective 1)
- Reintroduce chestnut blight-resistant chinquapin (*Castanea ozarkensis*) (http://www.ozarkchinquapin.com/)
- Work with Service I&M to develop a monitoring program to evaluate the effectiveness of these control measures and to assess the ecological impacts caused by the use of chemical herbicides and prescribed burns
- Develop educational programs and materials about the ecological damage caused by invasive and exotic vegetation and introduced plant diseases and give practical examples of prevention of spreading and eradication methods

4.2.10 Objective 10: Map, Monitor, Research, and Implement Adaptive Management to Assess and Control Invasive Non-native Fauna.

Determine the extent of non-native invasive fauna on the Refuge to better understand the scale of the problem and address the issue through adaptive management solutions. The Refuge would evaluate the ecological damage done by exotic fauna species, identify the exotic species causing the greatest impact to important native flora and fauna species, develop control or management plans (e.g., trapping, hunting, etc.), monitor the effectiveness of these control measures, and coordinate with and educate private landowners, state agencies, Tribal Nations, and federal agencies to encourage them to control invasive and exotic species.



Hothouse millipede, a potential threat to native cave species. (Credit: G.McCormack / CINHP)

Rationale: The Refuge is concerned about the increasing number of feral hogs, an exotic fauna species that have been found to forage in oak-hickory or oak-hickory-pine forest on and around the Refuge. Feral hogs compete with native wildlife and destroy habitat used by native species. In addition, they damage riparian habitat and reduce bank stabilization in bottomlands. Feral hogs are currently found on the Sally Bull Hollow Unit in Adair County and moving north toward Delaware and Ottawa Counties, where the Refuge has four units. Feral hog hunting occurs year round on private lands, state lands, and tribal lands, however, currently, the Refuge does not allow any hunting. The Refuge would like to permit hunting of nuisance feral hogs, pending the development of an Integrated Pest Management Plan.

In addition, the Refuge recognizes that feral cats prey on bats and migratory birds. Feral cats are currently found on most Refuge units, although the Refuge does not currently document feral cat occurrences.
The Refuge is also concerned about the hothouse millipede, another exotic species abundantly occurring on the Refuge. They may compete with native cave species as consumers of limited energy sources within caves. This species should be studied further to assess its impacts on cave species.

Introduced predatory fish in Ozark streams, such as trout, compete with native fish and may also compete with and forage on cavefish and cave crayfish and other aquatic species.

Strategies:

- Promote cost-share or incentives programs for private landowners and Tribal Nations to encourage them to control invasive and exotic fauna species
- Work with landowners, NGOs, cities, universities, states, Tribal Nations, and federal agencies to identify (survey), document, and monitor all non-native wildlife species occurring on and near the Refuge including feral hog, feral cat, hothouse millipede, and non-native fish populations
- Work with landowners, NGOs, cities, universities, states, Tribal Nations, and federal agencies to conduct studies to evaluate impacts of non-native fauna species (where scientific data is lacking, i.e., hothouse millipede) on cave, stream, riparian forest, bottomland and upland forest communities
- Identify and prioritize the non-native species causing the greatest (negative) impacts to native T&E species, species of concern, and/or representative species on and near the Refuge
- Develop and implement management strategies (in an Integrated Pest Management Plan) to control non-native species causing greatest impacts to ecosystem in order to meet Refuge objectives (such as biological pest control, minimum use of pesticides, trapping, spaying, neutering, hunting, etc.) in cooperation with county personnel
- Work with Service I&M to develop a monitoring program to evaluate the effectiveness of these control measures and to assess the ecological impacts caused by the use of biological pest management, chemical pesticides (if used), and trapping/hunting, and use adaptive management accordingly
- Develop educational programs and materials about the ecological damage caused by invasive pests and non-native wildlife species

4.3 Goal 3: Visitor Services

Provide safe, high quality, compatible, wildlife dependent use opportunities for visitors, students, and nearby residents, to give them an understanding of the importance and value of Ozark cave, spring, aquifer, stream, wetland, watershed, groundwater recharge areas, and forest wildlife habitat conservation efforts.

Environmental education community circle at the Looney Unit. (Credit: Shea Hammond)

4.3.1 Objective 1: Establish a Friends Group and Increase Volunteers.

Within the lifetime of this CCP, establish an official Friends group and recruit and support additional volunteers to assist in management and outreach activities.

> **Rationale:** Currently, the Refuge has approximately 25 individuals as part-time, non-resident volunteers and maintains a relationship with approximately 10 to 15 organizations, including several hundred individuals, that offer volunteer services and labor for Refuge management activities such as cave mapping, cave gates construction/ repair/maintenance, environmental education (EE), interpretation, invasive plant removal, trail maintenance, litter and trash cleanup, cabin renovation and maintenance, chimney repair, 2010 Ozark Summit administration and support, research and citizen science, and

wildlife inventorying and monitoring. This adds up to approximately 5,000 to 10,000 person hours total per year. However, increased support is needed to meet all future management objectives as stated in this chapter of the CCP. An official Friends group not only could play a major role in outreach, land acquisition, EE, interpretation, and getting community members more informed and involved, but they could help fundraise for some of these Refuge projects. Currently, the Refuge does not have an official Friends group established.

Salamander food availability study. (Credit: Shea Hammond)

Strategies:

- Coordinate with unofficial Friends group volunteer members, current partners, and other members in the community to encourage the formation of an organized and official Friends group
- Perform outreach to local landowners, NGOs, schools, universities, and Tribal Nations to increase part-time, non-resident volunteers to approximately 10,000 to 20,000 person hours per year
- Train Friends and other volunteers to perform their job/role in a safe, quality, and efficient manner to include citizen science, EE, interpretation, outreach, cave, stream, and forest management, cave rescue and perform other actions as needed
- Work with the Tulsa Regional Oklahoma Grotto, the local chapter of the NSS, and other grottos to maintain a volunteer program to assist with cave mapping, clean up, cave gate construction, and biological surveys
- Continue to work with Ozark Tracker Society volunteers to design and lead EE programs on the Refuge
- Keep Friends and other volunteers “in the loop” on current issues and solutions regarding karst and cave management and other Refuge resources
- Continually show appreciation, respect, and gratitude for Friends and volunteers (verbally, in letters and awards, and by hosting dinners, parties, banquets, etc.)

4.3.2 Objective 2: Increase Public Awareness via Outreach.

Throughout the lifetime of this CCP, utilize a variety of outreach methods to increase public awareness of the ecological importance of Ozark caves, karst environments, aquatic habitats, and forests and the species that live within them, in addition to awareness of the National Wildlife Refuge System, the existence of Ozark Plateau National Wildlife Refuge and its purposes, and opportunities to engage in its wildlife-dependent uses.

Hoppin' on the social media bandwagon. (Credit: wizmarketings.com, 2012)

Rationale: Increased urbanization in northwest Arkansas and in northeastern Oklahoma is having detrimental effects on natural resources of the Ozark ecoregion. Most people are not conscious of their direct impacts to the land, water, and air, and how those, in turn, affect themselves. Many people in the area are also unaware of the large and delicate Ozark caves and groundwater aquifer (subterranean) ecosystems and native wildlife species that lie underneath their feet. The Refuge recognizes that making people aware of their local environment and their connection to it, is an important first step. Aside from this, in the past, the Refuge has not offered many public use opportunities in order to focus on wildlife management and protect its fragile cave and karst resources. However, as stated throughout this whole CCP, the Refuge certainly cannot manage to protect these resources alone. It will require various types of partnerships on a landscape-level, in addition to public support and involvement. The Refuge has spent a great deal of time performing outreach with surrounding landowners and State, Tribal, and Federal agencies to successfully cooperate on land conservation efforts. However, most people in the region are unaware of the existence of Ozark Plateau NWR. Public outreach is vital in order to make people aware of who Ozark Plateau NWR is, what the Refuge is doing and why, and lastly, how the public can contribute to its conservation efforts or participate in one of its wildlife-dependent uses. Gaining public support will not only help the Refuge achieve its goals, but will also help the National Wildlife Refuge System achieve its mission.

Strategies:

- Update and maintain Refuge websites and create a Facebook page (http://www.fws.gov/southwest/refuges/oklahoma/Ozark/; and http://www.fws.gov/refuges/profiles/recEdMore.cfm?ID=21645) to inform the public of current and upcoming visitor use/conservation project volunteer opportunities, including Refuge contact and location information (while cave

locations continue to remain confidential, stating that there is a no-entry cave policy due to concerns about WNS)

- Use social media and blog sites to connect to the public regarding current and upcoming visitor use/conservation project opportunities, share any "fun facts"/news/updates, and provide a virtual space that inspires story-telling of outdoor experiences in the Ozarks
- Create and email e-newsletters updating the public what current projects are going on at the Refuge, including personal stories, upcoming programs/activities, and "fun facts" about cave species and other species on the Refuge
- Create and distribute fliers/brochures to advertise visitor services opportunities at Ozark Plateau NWR
- Design and distribute promotional materials including merchandise (shirts, hats, flashlights, headlamps, coffee mugs, water bottles, etc.) to promote the Refuge and its resources
- Inform visitors as to why there is at present a no-entry cave policy due to concerns about WNS
- Encourage visitors to "spread the word" about their experience visiting the Refuge
- Visit local public, private, and home-school K-12 classes to teach about Ozark Plateau NWR's conservation efforts and encourage teachers and kids to visit the MMLERC for EE and interpretive programs
- Coordinate and partner to conduct public outreach regarding WNS by visiting schools, discussing the issue with local landowners, producing exhibits at the MMLERC and at festivals, conferences, and schools, and include information on WNS in EE and interpretation programs
- Develop educational materials (pamphlets, posters, handouts, etc.) for landowners, schools, educators (i.e., State Park interpreters), and the general public that highlight the value (i.e., ecological and economic) of the ecology of hardwood trees and Ozark forests, aquatic/riparian areas and aquifers, caves, and bats
- Develop and distribute informational materials with guidance on adaptive sustainable land, cave, and water management practices and recommendations to landowners, utility companies, Tribal Nations, and other governmental agencies (reassess/update and redistribute when necessary)
- Work with partners to distribute educational materials about the ecological damage caused by invasive and exotic species (flora, fauna, and introduced plant diseases), while offering practical methods to prevent spread and/or control

4.3.3 Objective 3: Collaborate to Increase Program Opportunities for Environmental Education.

Throughout the life of this CCP, continue collaborating with many NGOs and partner agencies to increase opportunities for place-based environmental education (EE) programs. These programs would be offered by special use permit only and follow curriculum utilizing Refuge resources including on-site, field-based classes and experiences at the Mary & Murray Looney Education & Research Center (MMLERC) and in Ozark forests, riparian areas, and karst environments. EE programs would be taught to approximately 50-100 people per week, with 3-4 visits per week in spring, fall, and summer, and approximately 10-20 people per week with 1-2 visits per week in winter.

Learning natural deer tanning techniques at the MMLERC. (Credit: Shea Hammond)

Rationale: Increased urbanization in northwest Arkansas and in northeastern Oklahoma is having detrimental effects on natural resources of the Ozark ecoregion. Most people are not conscious of their direct impacts to the land, water, and air, and how those, in turn, affect themselves. Many people in the area are also unaware of the large and delicate Ozark caves and groundwater aquifer (subterranean) ecosystems and native wildlife species that lie underneath their feet and how they are connected to them. EE programs on Ozark Plateau NWR are crucial in order for both urban and rural people of this region to have an opportunity to experience a connection to and understand the importance of their local ecosystems, and be able to pass on that knowledge to future generations. The Refuge was also established with the purpose to "…provide important environmental educational opportunities identifying the need for protecting fish and wildlife and other karst resources of the Ozarks". In addition, during scoping, many locals and Tribal Nations expressed interest in having more EE programs on the Refuge.

Strategies:

- Continue to conduct EE programs on the Looney Unit, by permit only, in cooperation with multiple local partners such as local residents, NGOs, public, private, and homeschools, cities, universities, state agencies, Tribal Nations, and other federal agencies and continue to foster various EE partnership opportunities as they become available

- Continue to write grants, oversee contracting, and do all that is necessary to provide funding to its partnering NGOs in order to provide all EE programming and staffing needs
- Develop a complete Visitor Services Plan within the life of the CCP
- Engage in the planning, development, leadership, and evaluation of EE programs in order to determine effectiveness of current programs and better design future EE programs regarding Ozark Plateau NWR resources
- Provide logistical support and assist partners in program instruction
- Provide material support, including field guides and other Ozark resource references, audio-visual equipment, and ensuring the proper functioning of the MMLERC for EE programs
- In conjunction with EE partners, develop curriculum and workbook documents for current and future EE programs
- Partner with NGO, Ozark Tracker Society to provide monthly Ozark Nature Connection Series programs at a low cost to the public at the MMLERC and in Ozark forests, riparian areas, and karst environments. These programs are designed to facilitate "deep nature-connection" (see Appendix H) via inquiry-based/mentorship pedagogy, which fosters a strong kinship between students and their environment, by utilizing a curriculum that focuses on primitive skills such as ethno-botanical knowledge, edible/medicinal identification/properties, tincture-making, bird language, primitive fire-making, primitive camping, "coyote mentoring" programs, increasing comfort in the wild (nature journaling, hazards identification), tracking (scat, tracks identification), tanning deer-hides, bow drill/hand drill-making, primitive shelter-making, and wilderness survival skills.
- Collaborate with additional partners to assist in sponsoring and leading other EE programs including, but not limited to: Boy Scouts of America (eagle scout projects, badges), Girl Scouts of America (badges), Campfire USA (cave safety, cave/karst biology week), the Missouri Chimney Safety Council (continuing education credits), TNC (wildlife identification, native seed collection education programs), Blue Thumb (water quality education monitoring program), and NSS/BCI (cave gate construction education), Wooten Woods (bird language, music and nature), 8-Shields Institute (art of mentoring), Greenway of the Cherokee Ozarks (local EE programs), CyberTracker (GIS/tracking skills), Wilderness Awareness School (connecting to nature/wilderness awareness), Land Legacy (conservation easement education and resources of Spavinaw Creek), ODWC (game wardens provide hunting education for licensure program), and NRCS (conservation easement education and resources of Spavinaw Creek)
- Develop programs with Blue Thumb, Land Legacy, and other NGOs as well as City of Tulsa, OWRB, Oklahoma Conservation Commission, and Oklahoma Department of Environmental Quality to utilize the Looney Unit as a water quality testing site (Spavinaw Creek, cave streams/springs, etc.) to conduct programs for youth to educate them about water quality and how that affects their

drinking water supply and wildlife, especially federally listed cave species and species of concern.

- Coordinate with local public, private, and home-school K-12 classes to utilize the Refuge and MMLERC for EE to provide quarterly programs that meet state curriculum standards
- Coordinate with participating universities (see Chapter 5, Table 5-1 for complete list) to conduct field-based collegiate-level classes, field trips on-site, and learning survey techniques using Refuge resources or in cooperation with adjacent landowners who allow the classes on private lands
- Work with educational partners to provide a Teacher Continuing Education and General Education Credits Program on the Refuge
- Partner with Tribal Nations to provide tribal-hosted EE programs from a Native American cultural perspective for native youth and adults in their native language and English to share information regarding cultural and natural resources, local ethno-botanical knowledge, and healthy living and cooking using native/natural edible plants
- Collaborate with master gardeners and master naturalists to lead EE hands-on gardening programs on growing traditional foods and herbs (seeds provided by Cherokee Nation) in raised garden beds and landscape design using native plants (aesthetically-pleasing landscape, while also benefitting native wildlife such as birds and pollinators). MMLERC would also be utilized as a quarterly training and meeting site.
- Work with partners such as Wooten Woods, universities, Tribal Nations, and other professional artists of the community to offer curriculum-based art/EE programs to engage people with nature via the arts (outdoor music, photography, film-making, creative writing, basket-weaving, painting, dramatic arts, etc.)
- Conduct some EE programs off-site regarding karst and cave resources for private landowners, local schools, 4H groups, scouts, county officials, and Tribal Nations, etc.
- Incorporate discussions of WNS in EE programs (what it is, how it's affecting bats and entire ecosystems, and suggestions for prevention)
- Incorporate climate change discussions into EE curriculum (climate change awareness, how may it affect the wildlife and vegetation on the Refuge, etc.)
- Install photography blinds and primitive overlook areas on the Looney Unit (see Goal 3, Objective 7) or other units as deemed appropriate
- Develop curricula and conduct training for Service and other partner agencies' staff on effective EE methods based on "coyote mentoring" techniques (see Goal 4, Objective 1)
- Establish an official Friends group to assist in EE coordination/instruction

4.3.4 Objective 4: Collaborate to Promote and Conduct Interpretation Programs.

Throughout the life of this CCP, continue collaborating with many NGOs, tribes, and partner agencies to promote and conduct interpretation programs for approximately 25 people per month on-site at the Looney Unit, and five to several hundred people per month off-site (schools and events) in order to connect people to the natural world around them, especially the Ozark cave, karst, and forest resources representative of the Ozark Highlands ecoregion.

Boy interpreting nature in his journal. (Credit: Shea Hammond)

Rationale: Increased urbanization in northwest Arkansas and in northeastern Oklahoma is having detrimental effects on natural resources of the Ozark ecoregion. Most people are not conscious of their direct impacts to the land, water, and air, and how those, in turn, affect themselves. Many people in the area are also unaware of the large and delicate Ozark caves and groundwater aquifer (subterranean) ecosystems and native wildlife species that lie underneath their feet and how they are connected to them. Interpretation programs on Ozark Plateau NWR are crucial in order for both urban and rural people of this region to have an opportunity to experience a connection to and get a sense of the importance of their local Ozark ecosystems, and be able to share that experience with future generations.

Strategies:

- Continue to conduct interpretation discussions and programs on the Looney Unit, by permit only, and off-site, in cooperation with multiple local partners such as local residents, TNC, Land Legacy, Ozark Tracker Society, NSS, BCI, Becoming an Outdoors Woman, Boy Scouts of America, Girl Scouts of America, Campfire USA, Indian Nation and Tulsa Audubon Society, Blue Thumb, Oklahoma Academy of Science, the Wildlife Society, American Fisheries Society, Wilderness Awareness School, homeschoolers, local public and private schools, zoos and museums, Rogers State University, Northeastern State University, University of Arkansas, OSU, John Brown University, University of Oklahoma, ODWC, Oklahoma Department of Tourism and Recreation, Arkansas State Parks,

Tribal Nations, Natural Resource Conservation Service (NRCS), and other partnership opportunities for interpretation, as they become available

- Provide interpretive programs (aside from introductory interpretive discussions for most EE groups that visit the Refuge) that include short interpretive hikes and discussions that primarily interpret natural and cultural information regarding the Ozark ecoregion, karst ecosystem, geology, water resources, Native American cultural/paleo resources, ethnobotanical plants, federally listed T&E species, especially bats and other cave species, species of concern, game and nongame species, migratory birds (including bird language) and cave technology demonstrations (anabat acoustic detectors, real-time infrared and thermal videography, night vision, etc.)
- Develop a complete Visitor Services Plan within the life of this CCP
- Engage in the planning, development, leadership, and evaluation of interpretive programs in order to determine effectiveness of current programs and better design future programs regarding Ozark Plateau NWR resources
- Provide material support, including field guides and other Ozark resource references, audio-visual equipment, and ensuring the proper functioning of the MMLERC for interpretation programs
- Conduct visits off-site to local K-12 schools, (i.e. make presentations on bats during the Halloween season) to host interpretive talks using video, power point presentations with many visual photographs of Refuge resources, anabat acoustics, night vision, thermal videography, and/or table information booths (sometimes to include real-time thermal videography)
- Provide interpretive talks to other off-site venues or events, including civic centers, organizational meetings, state park events, festivals/fairs (Illinois River Festival), wildlife expos (Wildlife Expo in Central Oklahoma), and tribal pow-wows, using video, power point presentations with many visual photographs of Refuge resources, anabat acoustics, night vision, thermal videography, and/or table information booths (sometimes to include real-time thermal videography)
- Create a partnership with the City of Tulsa to develop an interpretive program focusing on Spavinaw Creek resources and the Tulsa water drinking supply
- Collaborate with master gardeners and master naturalists to lead interpretive programs on growing traditional foods and herbs (seeds provided by Cherokee Nation) in raised garden beds on MMLERC grounds, while discussing the benefits of landscaping using native plants (aesthetically-pleasing landscape, while also benefitting native wildlife such as birds and pollinators)
- Work with partners such as Wooten Woods, universities, Tribal Nations, and other professional artists of the community to offer interpretive opportunities to engage people with nature via the arts (music, craft-making, creative writing, basket-weaving, painting, dramatic arts interpretation, etc.)

- Promote sustainability on-site by showcasing green technologies and sustainable-living methods (i.e., solar panels to offset carbon, energy-efficient heating and cooling system and appliances, rainwater collection system for irrigation, permaculture gardening, drinking water filtration system, etc.) and incorporate these into interpretive talks regarding sustainability
- Incorporate discussions of WNS in interpretation talks (what it is, how it's affecting bats and entire ecosystems, and suggestions for prevention)
- Incorporate climate change discussions into interpretive talks (what is climate change, how may it affect the wildlife and vegetation on the Refuge, etc.)
- Install photography blinds and primitive overlook areas on the Looney Unit (see Goal 3, Objective 7) or other units as deemed appropriate
- Develop model (display) showing interconnectivity of ground and surface water at the MMLERC
- Develop a display on cave history, including historic cave photographs, caving equipment, cave maps, and cave exploration and ecology at the MMLERC
- Create other limited interactive displays of native plants and flowers (for identification and information) and other limited interpretive information
- Install limited interpretive signage on the nature trail at Looney Unit
- Stream a live video from the "bat cam" online, using a remote, fixed camera filming bats from the exterior of the caves at the maternity site during emergence and of bats from the interior of caves and/or pre-filmed and edited videos
- Establish an official Friends group to assist in leading interpretive talks/hikes

4.3.5 Objective 5: Promote Opportunities for Wildlife Observation & Photography.

Throughout the life of this CCP, promote opportunities for wildlife observation and wildlife photography on the Looney and Sally Bull Hollow Units, and on more acquired lands, as suitable, of Ozark Plateau NWR forests, streams, and limestone formations and their respective wildlife.

Rationale: Wildlife observation and photography on Ozark Plateau NWR is important in order for both urban and rural people of this region to have an opportunity to connect to nature, observe and appreciate the natural resources of the Ozarks including cave, karst, forests, and streams, and to be able to share that experience with others. Wildlife observation and wildlife photography are conducted at Ozark Plateau NWR because they are existing, compatible refuge uses and are identified as vital wildlife-dependent priority public uses for the National Wildlife Refuge System.

Strategies:

- Create opportunities for wildlife observation and photography (guided and by permit only), also within EE or interpretation programs, to view and/or photograph Ozark Plateau NWR's diverse habitats (i.e., Refuge forests, streams, and caves) and wildlife (i.e., migratory birds, sightings of mammal, fish, reptile, amphibian and insect and observing [not photographing] bat emergence from exterior of caves)

Interpreting bird language on Ozark Plateau NWR. (Credit: Shea Hammond)

- Allow wildlife observation and photography on the Looney Unit and the Sally Bull Hollow Unit, once its boundaries are surveyed and marked (open to the public by walk-in access only, at all times of the year aside from hunting season)
- Develop a complete Visitor Services Plan within the life of this CCP
- Explore other opportunities for wildlife observation and photography on newly acquired lands that are compatible with Refuge purposes
- Install photography blinds and primitive overlook areas on the Looney Unit (see Goal 3, Objective 7) or other units as deemed appropriate
- Establish an official Friends group to assist in promoting wildlife observation and photography opportunities

Bow hunter taking his aim. (Credit: Paul Tessier/iStockphoto)

4.3.6 Objective 6: Collaborate with ODWC to Provide Hunting Opportunities.

Within 5 years of the approval of this Plan, collaborate with the Oklahoma Department of Wildlife Conservation (ODWC) to allow walk-in, open-access hunting, according to state regulations, adjacent to the state Ozark Plateau Wildlife Management Area (WMA) on the Sally Bull Hollow Unit of the Refuge.

Rationale: Currently, the Refuge does not allow hunting. However, during scoping, many members of the public and the ODWC expressed interest in having the Refuge open up hunting of Oklahoma State game species

(including deer, turkey, squirrels, quail, and rabbits), in accordance with State regulations. The ODWC requested specifically that the Refuge explore hunting opportunities on the Sally Bull Hollow Unit, adjacent to its Ozark Plateau Wildlife Management Area, which is also open for hunting. As long as the Refuge ensures that hunting will not affect the continuing existence and recovery of federally listed T&E cave species and the sustainability of other native wildlife populations, Ozark Plateau NWR has agreed to develop a step-down Hunt Plan to allow walk-in only access of this wildlife-dependent use, on the Sally Bull Hollow Unit adjacent to the State's hunting area (Ozark Plateau WMA).

Strategies:

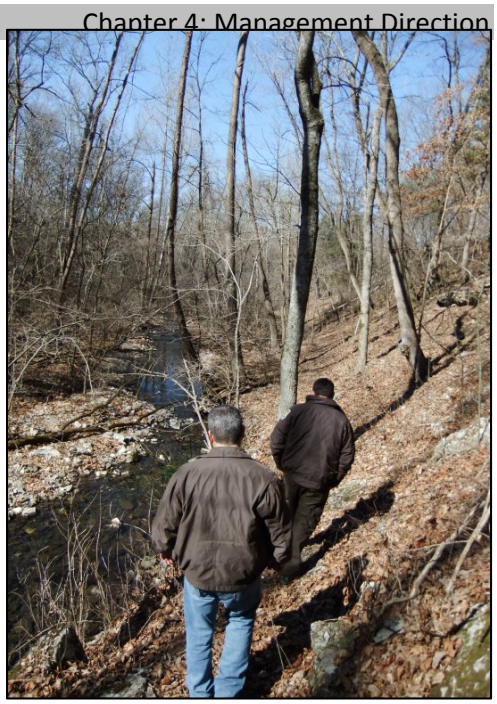
- Contract surveyors to survey and mark the Sally Bull Hollow Unit
- Develop a Hunt Plan in collaboration with the ODWC to include details and impacts analysis of allowing walk-in only, open access hunting on the Sally Bull Hollow Unit, according to State regulations. The Hunt Plan would include hunting seasons, animals to hunt, arms/tools allowed, and stipulations, such as distance from caves, etc.
- Once hunting is allowed, inventory and monitor federally listed cave species on the Sally Bull Hollow Unit to identify whether this public use is causing any adverse effects
- If necessary, modify hunting regulations in cooperation with the ODWC to ensure that Refuge objectives are met
- Evaluate the feasibility of allowing hunting on other areas of the Refuge as lands are acquired (such as in the case of acquiring migratory waterfowl habitat, etc.)
- Develop a complete Visitor Services Plan within the life of this CCP

4.3.7 Objective 7: Create More Hiking/Nature-viewing Opportunities.

Within 5 years of this CCP, create more hiking/nature-viewing opportunities and install overlook areas for an anticipated increase in visitors to participate in place-based education programs by establishing and improving 2.7 miles of primitive trails on and around the perimeter of the Mary & Murray Looney Unit.

Rationale: Hiking trails are not adequate for the current number of people visiting the Refuge for EE and interpretation programs, let alone the amount of those anticipated in the future. Establishing more trails will make it safer for people to walk and will prevent damage to soils and vegetation. The trail from MMLERC to the pavilion is a paved path that has deteriorated and needs to be repaved. The path from the parking area to the MMLERC also needs to be an improved gravel walkway, approximately 3-feet wide, designed for heavy foot traffic. The remaining trails will be "primitive". Creating and

maintaining "primitive" trails will provide a basic pathway within its natural surroundings, without involving much heavy trail construction or maintenance. In addition, establishing overlook areas and photography blinds will provide additional opportunities for visitors to connect with nature.



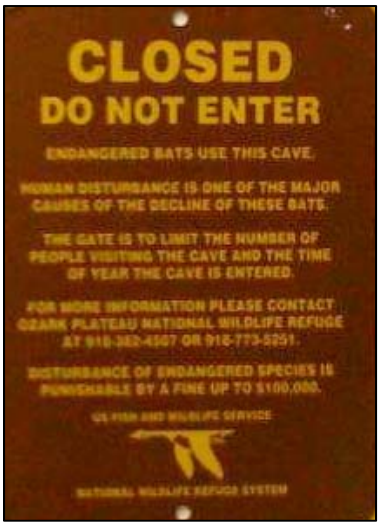
Primitive nature trail next to the cave stream on the Looney Unit. (Credit: Sarah Catchot)

Strategies:

- Establish a 0.25-mile mostly primitive trail to connect the MMLERC Pavilion/Spavinaw Creek trail to the maintenance shop trail (move old concrete, some boulders)
- Build a new 2-mile primitive trail (no clearing or removing of trees or large shrubs, however some boulders may need to be removed and some small creek-crossing bridges may need to be built) around the perimeter of the Looney Unit to connect to the MMLERC-Pavilion-Spavinaw Creek trail, the maintenance shop trail, and the parking area trail
- Repave the 0.1-mile concrete path from the MMLERC cabin to the pavilion
- Improve the 0.25-mile trail with gravel from the Looney maintenance shop to the MMLERC
- Improve the 0.1 mile primitive trail with gravel from the parking/camping area on top of the hill down to the MMLERC to ensure safety
- Install 3 primitive overlook areas on the Looney Unit perimeter trail, to use as stopping points for wildlife observation and photography, environmental education, and interpretation
- Install photography blinds on Looney Unit, or other units as deemed appropriate
- Maintain and reassess primitive trails annually at the end of winter/early spring

4.3.8 Objective 8: Design and Display Refuge Signs.

Throughout the lifetime of this CCP, work with the Division of Visitor Services to design and display Refuge signs marking pertinent visitor location areas on the Looney Unit nature trails, on the outside and inside of the MMLERC, near the maintenance shop, and at the new Refuge Headquarters site.



Sign posted at Ozark Plateau NWR caves. (Credit: S. Catchot)

Rationale: The Refuge does not currently have any public signs posted, except for outside of caves stating that they are closed to the public. The Refuge does not post any public signs that are not deemed absolutely necessary in order to maintain discretion of their unit locations and to keep caves confidential. Nevertheless, signage on the Refuge will need to be improved throughout the lifetime of this CCP as needed, especially to accommodate the increase of EE programs at the MMLERC. Many visitors get lost when visiting the Refuge and signage could help orient them. However, the Refuge will not post these signs until the MMLERC is completely secured (alarm system, permanent staffing, safes, etc.). Other interpretive signage on Refuge nature trails could provide a higher quality experience for EE and/or interpretation programs.

Strategies:

- Construct a sign at the MMLERC to say “Mary & Murray Looney Education & Research Center”
- Construct MMLERC sign at the county road entrance, when MMLERC is sufficiently secure
- Establish a Refuge Headquarters sign, once the new Refuge Headquarters is built/established
- Continue to maintain resources confidentiality by not posting public use signs at all other Unit entrances and/or on public access roadways
- Install limited interpretive signage on the nature trail at Looney Unit
- Install signs at all cave entrances to prohibit public entry and inform them about white-nose syndrome

4.3.9 Objective 9: Survey and Mark Refuge Boundaries.

Throughout the lifetime of this CCP, assure that all Refuge boundaries and their respective gates and fences are maintained and repaired, and that all unsurveyed and unmarked Refuge boundaries are properly surveyed and marked, while continuing to maintain the confidentiality of resources by not posting public use signs at unit entrances and/or on public access roadways.

Rationale: The Refuge must identify and mark their boundaries in order to know their physical limitations between adjacent private or public lands for performing management activities. This also increases public awareness of where refuge lands occur, which can help increase Refuge LE capabilities. Currently, there are over 60 miles of unit boundaries with a total of over 4 miles of fencing and 11 gates, that are maintained and

repaired by Refuge staff. Only two of the Refuge units have been completely surveyed and marked. The table below (table 4-1) shows an assessment of current Refuge boundary needs and infrastructure to maintain.

Table 4-1. Refuge Boundary Assessment (2012)

Refuge Unit	Boundary	Surveyed?	Marked?	Fencing?	Gates?
Looney	>1.37 mi.	X	X	X	2
Liver	3.14 mi.	X	X	-	1
Potter	3.09 mi.	X	X	-	1
Sally Bull Hollow	15.42 mi.	-	-	-	4
Gittin Down Mountain	3.87 mi.	-	-	-	-
Varmint	1.24 mi.	-	-	-	-
Boy Scout	1.93 mi.	-	-	-	1
Beck	2.99 mi.	-	-	X	3
Eucha	2.51 mi.	-	-	-	-

Strategies:

- Contract surveyors to survey all unsurveyed unit boundaries on the Refuge
- Install permanent boundary markers (standard metal post and sign) on all unit boundaries
- Maintain and repair existing gates, fencing and markers
- Construct a new road gate on the access road at the Beck Unit for access to the Krause House and on the MMLERC access road

4.4 Goal 4. Refuge Infrastructure & Administration

Provide administrative support and appropriate facilities required to ensure that Refuge goals and objectives are met through effective landscape conservation management of Ozark habitats, fish and wildlife, and visitor services and for the primary purpose of preventing extinction and recovering federally listed threatened and endangered Ozark cave species.

4.4.1 Objective 1: Ensure Workforce and Volunteer Training and Safety.

Ensure all staff, Friends, and volunteers are properly trained to perform their job in a safe, quality, and efficient manner.

Rationale: Ozark Plateau NWR's management depends on the assistance of various interns, partners, contractors, Friends, and volunteers. In order to support the safety, wellbeing, and role of each contributor, the Refuge must ensure that each individual is properly trained, feels prepared, and knows the appropriate safety procedures for their job/task, especially if it involves caving.

Who ever said caving was easy? (Credit: Steve Hensley)

Strategies:

- Implement Ozark Plateau NWR's Station Safety Plan, Cave Safety Plan, and perform "job hazard analysis", when appropriate, to identify risks and recommended protective measures for Refuge operation, including caving activities
- Create program to train fire departments, local chapters of NSS, and state and federal law enforcement agencies, as well as Refuge staff on cave safety, search & rescue, and first-responder medical training
- Train Friends and other volunteers to perform their job/role in a safe, quality, and efficient manner to include citizen science; EE; interpretation; outreach; cave, stream, and forest management; cave rescue; and perform other actions as needed
- Keep staff, Friends, volunteers and partners "in the loop" on current issues and solutions regarding karst, stream, forest, and cave management and other Refuge resources
- Develop curricula and conduct training for Service personnel and partners focusing on cave, karst, stream, forest, and bat management, using methods such as anabat acoustic detectors, infrared and thermal videography, mist-netting techniques and bat identification, cave gate construction, aquatic species surveys, recharge area delineation, and other resource management techniques
- Develop curricula and conduct training for Service and other partner agencies' staff on effective EE methods based on "coyote mentoring" techniques (Young, et. al., 2010) that effectively accomplish goals associated with Connecting People With Nature (CPWN) and Youth in the Great Outdoors (YGO), using the Ozark resources as a vehicle and example. Coordinate curricula with Region 2 Regional Office Division of Visitor Services and NCTC. Training would be Refuge-based due to the proximity of four states, four FWS regions, the Ozark ecoregion common to all four states/regions, and other unique landscapes and facilities.

4.4.2 Objective 2: Protect and Survey Historical, Archeological, and Paleontological Sites.

Over the lifetime of this CCP, protect known and survey newly discovered historical, archeological and paleontological sites on the Refuge.

Rationale: There are many historical sites on Ozark Plateau NWR. For example, there is a wagon trail between Sallisaw and Tahlequah, which runs through the Potter Unit, as evidenced by old bridge abutments. This trail was main thoroughfare for local travelers, prior to the development of roads and highways. Crystal Cave on the Potter Unit was a commercial cave used for local dances in the 1920s. There is an old rock dam on the Potter Unit that was constructed to provide swimming opportunities dating back to pre-1916. In addition, cabins and infrastructure on the Looney Unit have historical significance to the caving community in the Ozarks because they were used by many caving experts to explore the first private cave preserve, January-Stansberry Cave, which was later donated to the Refuge (Graening, 2011). Short-faced bear, tapir, and dire wolf remains have been discovered in Refuge caves. Arrowheads, spear points, grinding stones, and other Native American tools used by the Caddo and Osage Tribes during pre-settlement times and also by tribes after they were relocated to Oklahoma, have been found on and near the Refuge. With the help of its partners, the Refuge would like to learn more about these known sites and discover additional historical, archeological, and/or paleontological sites to better understand the history of the land and its people and animals.

Comparison between a Short-faced bear, Kodiak bear, and Black bear. (Credit: carnivoraforum.com/ "boldchamp")

Strategies:

- Keep sites confidential (from public) and increase LE (from Sequoyah NWR) to provide security to known sites
- Partner with university faculty and/or students, Sam Noble Museum of Natural History archeologists, Tribal Nations, SHPO, and others to conduct archeological surveys to preserve and perform studies on known sites and any newly discovered sites
- Partner with university faculty and/or students, Sam Noble Museum of Natural History paleontologists, SHPO, Tribal Nations, and others to conduct paleontological surveys to preserve and perform studies on known sites and any newly discovered sites

- Partner with Oklahoma Historical Society, university faculty and/or students, SHPO, Tribal Nations, and others to conduct historical surveys to preserve and perform studies on known sites and any newly discovered sites
- As new sites are discovered, contact appropriate partners to learn and understand historical context and significance

4.4.3 Objective 3: Establish a Refuge Headquarters and Visitor/Education Center Site.

Within the lifetime of this CCP, construct a new building or purchase an existing building for a Refuge Headquarters incorporating a Visitor/Education Center, on a newly acquired site, close to the MMLERC. This site would provide a centralized office for approximately 10 anticipated staff members as well as provide a location for the public to visit and engage with Refuge staff.

Rationale: Currently, there are three full-time Refuge staff members, one Wounded Warrior, one SCA, and one part-time SCEP.

Refuge Headquarters is currently located at the MMLERC, which provides only one office and is primarily used for limited-use EE and interpretation programs. Due to limitations on office space at these headquarters, each of these staff members works out of either the Oklahoma ES Office in Tulsa, the MMLERC (Refuge), and/or Sequoyah NWR. This makes management coordination challenging due to the lack of a centralized Headquarters space. This situation also increases staff travel time, decreasing actual work time. In addition, in order to meet this CCP's objectives and strategies, additional staff is needed, including land management for acquisition of up to 15,000 acres of land. A centralized Headquarters space will make Refuge staff coordinate and communicate better and work more efficiently.

The incorporation of a Visitor/Education Center with this Headquarters site would provide general public access to the Refuge, as well as a quality educational experience for visitors to learn more about the Refuge's purpose, resources, and public use programs.

Strategies:

- Acquire up to 15,000 acres of land and conservation easements from willing sellers within the approved acquisition boundary (see Goal 1, Objective 3)
- Acquire buildings that could be retrofitted for a Headquarters/Visitor Center site
- Assess acquired lands near the Looney Unit for potential building sites
- Retrofit/remodel and/or build new Headquarters/Visitor Center site with adequate office and administrative space for anticipated staffing and general public access within the lifetime of this CCP

4.4.4 Objective 4: Renovate and Repair the MMLERC.

Within 5 years of this CCP, improve the Mary & Murray Looney Education & Research Center (MMLERC) through renovation and reparation work to provide a quality, comfortable, accessible, and low-carbon footprint education site for all visitors.

"Mary & Murray Looney Education & Research Center", a.k.a., "MMLERC". (Credit: Shea Hammond)

Rationale: The current MMLERC and its associated facilities need improvement. Originally, this cabin was used as a private summer resort from the early 1950s. The location of the cabin is a true gem that lies within a beautiful natural setting within the Ozark Highlands, providing a great space for the Refuge to use as an education and research center. The cabin is surrounded by crystal springs flowing from large caves from upland to bottomland forests through mature oak, hickory, and pine trees and into Spavinaw Creek, a turquoise rocky bottom Ozark stream that crosses the boundary of two states, two Service regions and provides drinking water for the city of Tulsa. Nevertheless, due to the cabin's antiquity, the design is inefficient, the building materials have deteriorated, and standards have subsequently changed overtime. The Mary & Murray Looney cabin had been abandoned for at least 10 years prior to Refuge restoration efforts. During this time, the interior and exterior of the building and the surrounding grounds have deteriorated. Initial renovation has already taken place inside the main MMLERC building so that it functions adequately for the Refuge Headquarters, housing for staff, volunteers, and/or guests, along with hosting multiple EE programs. Additional restoration, however, is still required to make the building more energy-efficient, water conservation-friendly, ADA accessible, secure, as well as to ensure adequacy of plumbing and electrical systems. The MMLERC's concrete grounds and walkways must also be repaired for safety. And lastly, the pavilion structure needs to be renovated in order for it to be utilized as part of the MMLERC.

Strategies:

- Assure that all work orders are entered into SAMMS and update when necessary
- Renovate the roof
- Insulate the basement and attic
- Renovate the cabin exterior (replace logs and grout, seal the exterior, paint exterior trim, and repair the retaining wall behind the cabin)
- Renovate flooring of porch and ensure porch railing meets safety standards
- Renovate front door to be handicap accessible
- Renovate one bathroom in the MMLERC to include an accessible entrance and shower
- Install monitored alarm system in cabin
- Replace plumbing system, if necessary
- Replace electrical system, if necessary
- Replace propane gas lines, if necessary
- Install energy-efficient exterior storm windows
- Maintain water filter for drinking water to reduce energy and waste associated with bottled water
- Remove small cabin building (but retain existing fireplace) adjacent to MMLERC and replace with a 800 sq. ft. outdoor pavilion studio space (partially open, partially covered), that would also bridge the stream in a previously-disturbed site
- Install rainwater collection system for irrigation of the ethno botanical garden and landscaped areas surrounding Refuge buildings
- Collaborate with master gardeners and master naturalists to build raised garden beds and to re-landscape with native plants around the MMLERC, using permaculture methods
- Install solar panels on area with the most sunlight on the Looney Unit, to offset carbon and rely mostly on alternative energy sources
- Use energy-efficient heating and cooling system and appliances (geothermal heating and cooling system, insulation, double pane windows, stove, refrigerator, dishwasher, on-demand hot water, washer and dryer) on all Refuge buildings
- Maintain energy-efficient heating and cooling air duct systems and appliances
- Install audio/visual technology (i.e. ceiling-mounted projector, etc.) for modern methods of teaching EE programs (i.e., power points, etc.)

4.4.5 Objective 5: Improve and Widen Access Roads and Parking Areas.

Within 5 years of the CCP, improve and widen necessary access drives and parking area surfaces with gravel to prevent an increase in visitation from causing damage to the vegetation on the sides of the roads, help control soil erosion, and prevent flat tires.

Sawney Road on Ozark Plateau NWR. (Credit: Steve Hensley)

Rationale: To get to the MMLERC, there is a MMLERC public access drive, which is currently 0.25-miles, unpaved and unimproved (dirt/rock), with a gate. There is an unpaved parking area (power cut easement), between the entry gate and MMLERC, for approximately 10 vehicles. Excess parking is available near the maintenance shop, next to the Guess House (150 yards). With the anticipation of an increase in visitation to the Looney Unit, the Refuge needs to widen the MMLERC access drive (on previously disturbed areas/previously wide areas) for cars to pass without having to drive up on the roadside soil/vegetation. In addition, road and parking area surfaces need to be improved with gravel to allow for a better established parking area, which will prevent visitors from parking in the grass, on the side of the road, and will help control soil erosion. In addition, Refuge staff needs a wider access road to the Beck Unit shop in turn-around area for Staff vehicles and trailers.

Strategies:

- Investigate Federal Highway Administration funding opportunities
- Work with Refuge personnel to widen the MMLERC access drive by 2 feet and improve with gravel, including parking area
- Work with Refuge personnel to improve road with gravel from county road to maintenance shop (next to Guess House) on the Looney Unit
- Improve parking area surfaces with gravel at both the overflow parking, near maintenance shop, and parking on top of MMLERC road
- Work with Refuge personnel to improve 0.3 miles of gravel road on the Beck Unit for Refuge management access
- Improve and/or maintain roads on newly acquired lands, where necessary

4.4.6 Objective 6: Construct Building Facilities Associated with Maintenance.

Looney Maintenance Shop. (Credit: Shea Hammond)

Within the lifetime of this CCP, use or construct appropriate building facilities and infrastructure to perform essential Refuge maintenance.

Rationale: Current maintenance facilities are inadequate. The Refuge needs additional maintenance facilities in order to store and maintain Refuge vehicles, supplies, and equipment used for management operations.

Strategies:

- Build additional 50’x100’ metal building on concrete pad maintenance shop at new Headquarters site
- Construct an additional decontamination and storage facility/structure at the new Headquarters location to decontaminate caving equipment in accordance with the Service’s WNS decontamination guidance (http://www.fws.gov/WhiteNoseSyndrome/index.html)
- Construct a separate ventilated building located next to maintenance shop at new Headquarters site for hazardous materials storage
- Outfit these facilities with appropriate maintenance equipment, heat, insulation, electricity, appropriate plumbing, lighting, etc.
- Construct a new fueling station for Refuge vehicles and equipment at new Headquarters location
- Reconstruct existing pole barn on the Beck Unit, near the Krause House
- Maintain all maintenance facilities and supplies

4.4.7 Objective 7: Provide Housing for Refuge Staff, Interns, Volunteers, Researchers, and Educators.

Throughout the lifetime of this CCP, provide adequate housing (Looney cabin, bunk housing, field house, RV pads, etc.) for volunteers, researchers, interns, educators, and Refuge staff while they are contributing to Refuge management, research, and education.

(Credit: Shea Hammond)

Rationale: The MMLERC only provides one bedroom used by volunteers, researchers, interns, educators, Refuge staff, and other guests. There are small cabins on private lands near the Potter Unit that may be available on a limited basis for Refuge volunteers, researchers, interns, educators, and Refuge staff. However, use of these would require landowner notification and may not always be vacant. The Refuge would like to provide more housing opportunities for the current number and future increase of volunteers and partners the Refuge has to work with in order to fully implement Refuge management. Housing for Refuge staff is currently limited to one house on the Looney Unit. Additional housing to accommodate an increase in Refuge staff will also be needed.

Strategies:

- Utilize MMLERC cabin to provide one guest room for volunteers, researchers, interns, educators, and/or Refuge staff
- Once new Headquarters is established, convert existing Refuge office to a second guest room at the MMLERC for volunteers, researchers, interns, educators, and/or Refuge staff
- Utilize Guess House on Looney Unit for long-term housing for Refuge staff and/or volunteers, researchers, interns, educators
- Construct and/or purchase two new residences (one staff, one volunteer/student) adjacent to the new Headquarters building location
- Construct two RV pads for volunteers at the new Headquarters site, to include utilities
- Construct an additional RV pad for a volunteer on the Looney Unit, adjacent to the maintenance shop next to the Guess house, to include utilities
- Include facilities for volunteers (lounge, kitchen, showers, etc.) in the site plan for the new Headquarters facility
- Once agreement with Leslie Krause is terminated (via donation), renovate Krause residence and use for staff/volunteer/student housing
- Maintain all Refuge housing

Cave salamander (Eurycea lucifuga).
(Credit: Shea Hammond)