KEY CAVE NATIONAL WILDLIFE REFUGE SPATIAL HABITAT AND SPECIES PLAN SUPPLEMENTAL DOCUMENT AND ENVIRONMENTAL ASSESSMENT

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Section A. Supplemental Document for the Spatial Habitat and Species Plan for Key Cave National Wildlife Refuge

Chapter I. Introduction

Scope And Rationale

The U.S. Fish and Wildlife Service (USFWS, Service, or We) prepared this Spatial Habitat and Species Management Plan (SHSP), which includes a Supplemental Document and accompanying Key Cave National Wildlife Refuge (NWR or refuge) Map Sheets to serve as the Habitat Species Plan (HSP) for the 1,060-acre Key Cave NWR (see Figure 1), located in northwestern Alabama within the Wheeler NWR Complex (Complex or Wheeler Complex). The refuge's Comprehensive Conservation Plan (CCP) and this SHSP are the primary tools used to guide refuge staff in achieving refuge purposes, objectives, and the National Wildlife Refuge System (NWRS or Refuge System) mission. The CCP and associated National Environmental Policy Act (NEPA) Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the Refuge Complex were finalized in 2007 (USFWS 2007a, b).

We have used the most recent refuge biological information and data, scientific literature, and ecological principles in developing this SHSP and associated EA (Section B) to conserve and protect functional communities of native fish, wildlife, and plants. We view the highest measure of biological integrity, diversity, and environmental health (BIDEH) as those natural habitats and associated wildlife populations that existed under historic conditions before humans altered the landscape. Using scientific reports, conservation partners' professional opinions, and Service wildlife and habitat management expertise, we considered a range of habitat and species management strategies to meet our specific habitat and species goals and objectives, conducted a survey of current refuge habitat conditions, and evaluated the statuses and conditions of key species of management concern.

This SHSP is not a static document, but a dynamic one with a long-term vision. It serves as a guide for the management of refuge habitats on an annual basis. The plan will provide direction for the next fifteen years (2025–2040) and be subject to reviews every five years. It will employ adaptive management principles to assess and modify management activities as required. This dynamic approach ensures that our management strategies remain relevant and effective in the face of changing environmental conditions.

We also have considered and incorporated the role of refuge habitats in international, national, regional, state, and local ecosystem plans. To the extent practicable, we crafted our goals and objectives to be consistent with these plans to assist in attaining the goals and objectives of conservation partners and the larger conservation community in addition to achieving refuge objectives.

This SHSP outlines a comprehensive habitat and species management program, including an overview of the refuge, resources of concern, habitat management goals and objectives, and habitat management strategies to support the wildlife resources of concern.

Legal Mandates

The USFWS administers the NWRS. The Service is an agency under the U.S. Department of the Interior, whose purpose is to conserve the nature of America.

The Service's commitment to safeguarding the nation's fish, wildlife, and their habitats is reflected in its vision statement: "We will continue to be a leader and trusted partner in fish and wildlife conservation, known for our scientific excellence, stewardship of lands and natural resources, dedicated professionals, and commitment to public service. The Service's mission is: "Working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."

The Service is the primary Federal agency responsible for conserving, protecting, and enhancing America's fish and wildlife populations and their habitats. These trust resources include migratory birds, federally listed endangered or threatened species, inter-jurisdictional fish, wetlands, certain marine mammals, and national wildlife refuges. The Service oversees the enforcement of federal wildlife laws and international treaties on importing and exporting wildlife, managing and protecting migratory bird populations, the restoration of national fisheries, the administration of the Endangered Species Act (ESA), and the restoration of native plant habitats. The Service also assists states with their fish and wildlife programs and helps other countries develop conservation programs.

The statutory authority for conducting habitat and species management planning on National Wildlife Refuges is derived from the National Wildlife Refuge System Administration Act of 1966 (Refuge Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Refuge Improvement Act), 16 USC §§668dd - 668ee. Section 4(a)(3) of the Refuge Improvement Act states:

"With respect to the System, it is the policy of the United States that each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established …" and Section 4(a)(4) states: "In administering the System, the Secretary shall monitor the status and trends of fish, wildlife, and plants in each refuge." The Refuge Improvement Act provides the Service the authority to establish policies, regulations, and guidelines governing habitat and species management planning within the Refuge System.

A robust and comprehensive mandate, NEPA ensures our thorough consideration of the impacts of our habitat and species management on environmental and cultural resources in planning Federal actions. This meticulous process, serving as the basis for the development of the SHSP, ensures compliance with NEPA. Habitat and species management of the refuge was outlined and evaluated in the Refuge Complex CCP/EA/FONSI (USFWS 2007a, b). Furthering management outlined in the 1996 Land Protection Plan/EA/FONSI (USFWS 1996) and the CCP/EA/FONSI (USFWS 2007a, b) for Key Cave NWR, the Service is proposing to update and

refine habitat and species management of the 1,060-acre refuge with the proposed SHSP (Section A), including management of the Key Cave NWR cave, grasslands, and oak savanna, as well as a phased conversion of the remaining croplands on the refuge and these effects are analyzed in the EA (Section B). The Proposed Action will refine and update refuge management objectives to serve refuge purposes and goals and adapt management over time.

In conjunction with Key Cave SHSP (Section A) and the associated EA (Section B), the HSP process includes an intra-Service Section 7 Consultation to fulfill the requirements of the ESA; the current Section 7 is incorporated herein by reference. The ESA provides a program for conserving threatened and endangered plants and animals and their habitats, including critical habitat. An ESA Intra-Service Section 7 Consultation was also completed for the 2007 CCP; it is also incorporated herein by reference (USFWS 2007a, b). The Service also recently completed the Programmatic Biological Opinion for Implementation of Forest Habitat Management Practices on the National Wildlife Refuge System in the Southeast Region for Tree Roosting Bats (Bat BO; USFWS 2024) and incorporate it herein by reference. Any forest management conducted on the refuge will operate under the Bat BO (USFWS 2024).

Federal laws also require the Service to identify and preserve its important historic structures, archaeological sites, and artifacts. Our consideration of cultural resources in planning federal actions is also mandated under NEPA. The National Historic Preservation Act (Pub.L. 102–575; 16USC §470) requires federal agencies to locate and protect historic resources archaeological sites and historic structures eligible for listing or listed in the National Register of Historic Places and museum property on their land or on land affected by their activities. It also requires agencies to establish a program for those activities and carry them out in consultation with state historic preservation offices (SHPOs). We must also comply with the Archaeological Resources Protection Act (pub. L. 96–95, 16 USC §470aa-mm), which requires that we protect our archaeological sites from vandalism or looting, engage in consultation, and issue permits for site excavation.

The Service must also comply with the Appropriate Use (603 FW 1, https://www.fws.gov/policy-library/603fw1) and Compatibility policies (603 FW 2, http://www.fws.gov/policy/603fw2.html). The Refuge Manager must first determine that a use is appropriate before undertaking a compatibility review of that use. If the proposed use is inappropriate, the Refuge Manager will not allow the use. A compatible use is one “that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge.” The Refuge Manager may allow or deny any use, even if the use is compatible, based on other considerations, such as public safety, policy, or available funding. Refuge management economic activities, such as commercial timber harvest and cooperative farming, are also subject to compatibility. The compatibility determinations (CDs) included in the CCP (USFWS 2007a, b) are incorporated herein by reference, as is a new Cooperative Farming CD that will apply until the full conversion of existing cropland habitat.

Our SHSP comply with all applicable laws, regulations, and policies governing the management of the NWRS. The Service incorporates by reference a complete listing of all relevant legal

mandates, regulations, and policies that apply to this SHSP located in Chapter 1 and the Appendix of the refuge's CCP (USFWS 2007a, b), see also Appendix A.

Refuge Purposes

See Landscape and Key Cave NWR Overview Map Sheet 1

Refuge Vision

See Landscape and Key Cave NWR Overview Map Sheet 1

Relationship To Other Plans

The Service incorporates by reference a complete listing of all relevant International, national, and regional conservation plans from other federal and state agencies, non-governmental organizations, and Native American Tribes that apply to the refuge covered by this stepped-down SHSP which are in the Wheeler NWR Complex CCP Chapter I: Background and Chapter II: Overview (USFWS 2007a, b) and the associated Map Sheets of this plan.

Chapter II. Background, Inventory and Description of Habitat

The Service incorporates by reference the complete and thorough overview (Chapter II of the CCP) of Key Cave NWR within the Refuge Complex (USFWS 2007a, b). The Map Sheets depict the refuge's location and physical and geographic setting, including climate, topography and hydrology, soils, management unit descriptions, and habitat (see Landscape and Key Cave NWR Overview Map Sheet, as well as the habitat-specific Map Sheets).

Chapter III. Resources of Concern

Resources of concern include species, species groups, and/or communities that support refuge purposes as well as Service trust resource responsibilities (including threatened and endangered species and migratory birds). Resources of concern are also native species and natural, functional communities such as those found under historic conditions that are to be maintained and, where appropriate, restored on a refuge (601 FW 3.10B[1]).

Resources of concern for Key Cave NWR were selected after taking into account the conservation needs identified within international, national, regional, and ecosystem goals/plans; state fish and wildlife conservation plans; recovery plans for threatened and endangered species; and previously approved refuge resource management plans as identified in the Comprehensive Conservation Planning policy [602 FW 3.4 C(1)(e)] as well as Chapter I of this SHSP. Other important species that benefit from the management and habitats of these species and objectives for each are identified on the associated refuge Map Sheets. The species/communities identified as resources of concern from these plans support the following NWRS mandates:

- Support refuge purposes and the NWRS mission;
- Conserve biological integrity, diversity, and environmental health (giving special consideration to rare, declining or unique natural communities, species, and ecological processes within the refuge boundary); and
- Fulfill Service trust resource responsibilities (see Chapter I).

Resources of concern identified for Key Cave NWR are listed by primary habitat type.

Cave

- Alabama Cavefish (*Speoplatyrhinus poulsoni*; Endangered, Critical Habitat)
- Alabama Cave Crayfish (*Cambarus jonesi*)
- Gray Bat (*Myotis grisescens*, Endangered)

Grassland/Early Successional Habitat

- Grasshopper Sparrow (*Ammodramus savannarum*)
- Northern Bobwhite (*Colinus virginianus*)
- Loggerhead Shrike (*Lanius ludovicianus*)
- Mourning Dove (*Zenaida macroura*)

Forest Habitat

- Gray Bat (*Myotis grisescens*, Endangered)
- Northern Bobwhite (*Colinus virginianus*)

Based on habitat types identified on the refuge, we developed a table of resources of concern with their associated habitat types (Table 1). This table also summarizes the habitat structure required by each resource of concern.

Table 1. Key Cave National Wildlife Refuge priority resources of concern with their associated habitat types and habitat structure required by each resource of concern.

Habitat	Priority Resources of Concern	General Habitat Requirements
Cave	Alabama Cavefish	In Key Cave, the Alabama Cavefish occupies pools with silt and rock bottoms and debris washed in from the surface. Pools have little or no flow, some are very deep (to 5 m), and the water is typically clear, but can become cloudy (Kuhajda and Mayden 2001). Guano deposits from the cave's bat maternity colony provide the primary source of nutrients to the cave, directing energy into this aphotic system. To a lesser extent, organic matter also is introduced through sink holes, sinking streams, and seasonal flooding of the cave entrance (USFWS 2007a, b; USFWS 2017).
Cave	Gray Bat	Caves supporting maternity colonies have restricted rooms or domed ceilings (to trap the combined body heat from thousands of clustered individuals), with temperatures ranging 57 to 77 °F (Tuttle 1975, Tuttle and Stevenson 1978)
Cave	Alabama Cave Crayfish	Schuster et al. (2022) described the aquatic habitat for this species in Cave Spring Cave, Alabama, as flat limestone rocks in deep pools up to 1.5 m with little flow and in a few shallow gravel riffles. In Shelta Cave, Alabama, the Alabama Cave Crayfish is found in pools. Kuhajda and Mayden (2001) describe the general aquatic habitat in Key Cave where Alabama Cave Crayfish reside. In Key Cave, the Alabama Cave Crayfish occupies pools with silt and rock bottoms and debris washed in from the surface. Pools have little or no low, some are very deep (to 5 m), and the water is typically clear, but can become cloudy (Kuhajda and Mayden 2001) .

Cave	Alabama Cave Crayfish	Guano deposits from the cave's bat maternity colony provide some portion of the primary source of nutrients to the cave, directing energy into this aphotic system. To a lesser extent, organic matter also is introduced through sink holes, sinking streams, and seasonal flooding of the cave entrance (USFWS 2007a, b; USFWS 2017).
Grassland/Early Successional	Grasshopper Sparrow	Relatively large, contiguous grassland areas of 75 or more acres of intermediate vegetation height, moderately deep litter, and low shrub density to support a breeding population (Herkert 1994, Shaffer et al. 2021, Vickery 2020)
Grassland/Early Successional	Northern Bobwhite	In general, Northern Bobwhites do well in landscapes containing closely interspersed patches of grasses, forbs, vines, and groups of low-growing shrubs and trees (Elmore et al. 2017).
Grassland/Early Successional	Loggerhead Shrike	In general, high-quality landscapes include areas of low-lying grasses and forbs and scattered bare ground interspersed with trees and shrubs.
Grassland/Early Successional	Mourning Dove	Open fields, field edges and grain crops.
Forest	Northern Bobwhite	Northern Bobwhites utilize oak savanna habitat with herbaceous vegetation, low basal area, and open canopy.
Forest	Gray Bat	High-quality landscapes for Gray bats are characterized by forest cover that surrounds and extends between caves that are located near large waterbodies (Tuttle 1979). Forested habitat provides important protection from avian predators. Gray bats typically fly in the protection of forest canopy between caves and feeding areas, and newly volant bats often feed and take shelter in the forest surrounding cave entrances (USFWS 1982).

Cave Resources of Concern

Significance and habitat requirements

Map Sheet 2 provides context for the cave habitat and its priority resources of concern; other species that may benefit from cave management activities are also addressed.

Alabama Cavefish (*Speoplatyrhinus poulsoni*)

The Alabama cavefish is one of the rarest cavefish in North America; it has an extremely localized subterranean range in Key Cave. Key Cave is located on Key Cave NWR with two entrances to the cave located on adjacent Tennessee Valley Authority (TVA) property. Due to its limited range and low abundance within its known distribution, the Alabama cavefish was listed as threatened in 1977 and reclassified as endangered in 1988. It is a primary consumer and, although its diet has yet to be determined, it undoubtedly includes copepods, isopods, amphipods, crayfish, and shrimp. The Gray bat colony within the cave is the primary source of organic matter supporting the invertebrate food resources through the deposition of guano, with additional organic matter introduced into the system through sink holes and sinking streams (USFWS 2017). Although the population of Alabama cavefish appears to be relatively stable, disruptions within the larger recharge area could dramatically alter the status of this species. This species and the fragile aquatic ecosystem it inhabits is sensitive to pollution (especially pesticides), disruptions in the Gray bat colony, water quality, and altered hydrology (Kuhajda and Mayden 2001). By monitoring the Alabama cavefish, Service staff gain insight on the health of the Key Cave ecosystem and the larger aquifer.

Key Cave is the only known location of the Alabama cavefish; Key Cave is designated as critical habitat for the species (USFWS 1990). Most of the cave dependent obligates rely on natural flood cycles, minimal groundwater contamination, heathy invertebrate communities, and nutrient inputs from guano. Lacking primary producers, the existence and integrity of the Key Cave aquatic ecosystem depends on the presence of its keystone species, the Gray bat (USFWS 1990). Guano deposits from the cave's bat maternity colony provide the primary source of nutrients to the cave, directing energy into this aphotic (area of water where there is little or no sunlight; it is formally defined as the depths beyond which less than 1% of sunlight penetrates) system. To a lesser extent, organic matter also is introduced through sink holes, sinking streams, and seasonal flooding of the cave entrance (Kingsbury and Gibson 2012; USFWS 2007a, b; USFWS 2017).

Key Cave is a multi-level, complex cave with just over two miles of linear solution passageways, many of which are inundated throughout the year, and with a groundwater recharge area of approximately 12,800 acres. Water throughout the cave system is slow moving and levels rise and fall with the underlying groundwater table, which corresponds to above-ground conditions and water elevations in Pickwick Reservoir (Ponta et al. 2018, USFWS 2017). Groundwater is recharged mostly from surface water that enters the Cave through sinkholes or seeps, as there are no above-ground perennial streams on the refuge, and just one stream, Sinking Creek, in the recharge area (Milewski et al. 2019; USFWS 2007a, b; USFWS 2017).

The habitat for the Alabama Cavefish is Key Cave. Historically the outflow of Key Cave was Collier Spring, which is now almost completely under Pickwick Reservoir, with only Sometimes Spring is still visibly flowing along the north shore downhill from the mouth of Key Cave. The raised head elevation caused by Pickwick Reservoir has decreased Collier Spring's outflow, and the flows within Key Cave are reduced (Aley 1990). Water from Pickwick Reservoir seldom flows into Key Cave and increased the flow of water in the aquifer. This is seldom, if ever, the case (Aley 1990). Slower flows lead to longer residence of pollutants in Key Cave. Impoundments can also lead to reduction in organic inputs and increased siltation. Because cave ecosystems are stable relative to surface habitats, disruptions such as reduced flows can have severe consequences for its inhabitants (Kuhajda 2004b, Niemiller et al. 2013)

The Alabama cavefish is a small (less than 2.4 inches), troglobitic (i.e., obligate cave-dwelling), blind, non-pigmented fish of the family Amblyopsidae known to occur only in the underground pools of Key Cave. Based on information from other cavefish species, it is likely that the Alabama cavefish feeds on copepods, isopods, amphipods, and small crayfish (USFWS 1990), has a lifespan of five to ten years (Poulson 1963), and reproduces during periods of increased flow, small temperature changes, and increased food availability associated with cave flood events during winter and spring (Poulson 1961, 1963; Poulson and White 1969; USFWS 1990).

The population has been estimated at fewer than 100 individuals and the species is considered the rarest of American cavefish and one of the rarest of all freshwater fish (Alabama Agricultural Experiment Station 1984; Boschung and Mayden 2004; Cooper 1977, 1980; Kuhajda 2004a; USFWS 1990; USFWS 2007a b; USFWS 2017). The Alabama cavefish was designated as threatened by the Service in 1977 and reclassified to endangered in 1988 (USFWS 1988). Population surveys for the Alabama cavefish conducted from 2000 to 2008 indicated the population was stable and reproducing (Kuhajda and Fluker 2010) and again in 2018-2021 (Niemiller et al. 2021, USFWS 2023d) where presence and variable size classes were confirmed. Most pools and all cavefish observations occurred within the eastern half of the cave, although other potentially suitable habitat exists in areas that are difficult to access (USFWS 2017).

Threats to the Alabama cavefish include groundwater degradation due to pollution from agricultural runoff and development, alteration in drainage and hydrological patterns, and lowered groundwater levels (Kuhajda 2004a, b; Trajano 2001, USFWS 1990). In degraded water, bioaccumulation of toxins coupled with an overall decrease in food availability could reduce longevity and reproductive capability of the Alabama cavefish and result in population decline (USFWS 1990). Additionally, the pools inhabited by the cavefish lie in a zone of seasonal oscillation of the water table, where pools that form during highwater become isolated during drier conditions (Trajano 2001). Any reduction of recharge to the aquifer that diverts water or lowers the water table in the cave could severely impact reproductive success of the Alabama cavefish or cause mortality by dewatering pools inhabited by the fish (Kuhajda 2004b).

Several recent studies have monitored water quality and hydrology within Key Cave and have documented the presence of agrochemical and nutrients (Ponta 2018 and Kuhajda et al. 2024). However, the current refuge management program, including current cropland management, has not resulted in documented adverse impacts to this species. Although Ponta et al. 2018

monitored groundwater hydrology within the Key Cave aquifer and Key Cave, little is known about the degree of existing threats to the karst hydrology. Other threats to the species include diminished organic matter inputs and possible competition from the southern cavefish (USFWS 1990).

Alabama Cave Crayfish (*Cambarus jonesi*)

The Alabama cave crayfish is one of six endemic cave dwelling crayfish found in Tennessee River Basin in Alabama. Similar to the Alabama cavefish, it is sensitive to changes in water quality, groundwater recharge and the ongoing development of the recharging region. It has been classified as Priority 2/High Conservation Concern in the state of Alabama (Alabama Department of Conservation and Natural Resources Division of Wildlife and Freshwater Fisheries 2015). It has this designation due to its very limited and disjunct distribution, specialized habitat needs, and vulnerability due to human-caused factors. The Alabama Cave Crayfish is only known from 12 caves globally in six Alabama counties. In Key Cave, the Alabama Cave Crayfish occupies pools with silt and rock bottoms and debris washed in from the surface. Pools have little or no flow, some are very deep (to 5 m), and the water is typically clear, but can become cloudy. In Key Cave the Alabama Cave Crayfish co-occurs with Phantom Cave Crayfish (*Cambarus pecki*) and Cavespring Crayfish (*C. tenebrosus).* Little is known about the life history of this species other than breeding males have been found sporadically in one study and throughout the year in another study in Shelta Cave, Alabama. Similar to the Alabama Cavefish, the population of Alabama Cave Crayfish in Key Cave is threatened by agriculture, urban, and industrial development, a lowered water table, reduced winter flows (cues to synchronize spawning), and acute and chronic water pollution (Kuhajda & Mayden 2001, Kuhajda 2004a,b, Kuhajda 2009a, Henderson et al. 2017, Huryn 2017, Schuster et al. 2022, Kuhajda et al. 2024). Another threat to Alabama Cave Crayfish in Key Cave is the altered water flow through the cave due to the impoundment of the Tennessee River by the Pickwick Reservoir in 1938. Historically the outflow of Key Cave was Collier Spring, which is now almost completely under the reservoir, with only Sometimes Spring is still visibly flowing along the north shore downhill from the mouth of Key Cave. The raised head elevation caused by the reservoir has decreased Collier Spring's outflow, and the flows within Key Cave are reduced (Aley 1990). Analyses of population size, age structure, and longevity are critical for determining the viability of the populations (Huryn et al. 2008). This species is hypothesized to be a generalist compared to the Alabama cavefish, and this may allow it to be a stronger indicator of the quality of the cave's aquatic ecosystem.

Other Species That May Benefit

There are six endemic cave dwelling crayfish found in Tennessee River Basin in Alabama.

Other endemic cave fauna, such as the other species of blind crayfish, *Cambarus pecki,* as well as the copepods, isopods, amphipods, and shrimp found in the cave's aquatic system may also benefit from cave habitat management activities.

Three species of crayfishes are known from Key Cave: the Alabama Cave Crayfish, the Phantom Cave Crayfish *(Cambarus pecki),*and the Cavespring Crayfish (*Cambarus tenebrosus* Hay, 1902).

The Alabama Cave Crayfish and the Phantom Cave Crayfish are Alabama endemics. The Phantom Cave Crayfish, which is restricted to just three caves along the Tennessee River, is currently recognized by the State of Alabama as a species of Highest Conservation Concern (Shelton-Nix, 2017). The Cavespring Crayfish is much more widespread than the other two, ranging from north Alabama north to southern Illinois. In Alabama, it is found in several dozen caves across the Tennessee River valley and in a few caves in the headwaters of the Black Warrior River (McGregor et al. 2018). It is currently recognized by the State of Alabama as a species of Moderate Conservation Concern (Shelton-Nix, 2017).

As their common names imply, the Alabama Cave Crayfish and the Phantom Cave Crayfish are obligate cave dwellers, meaning they lack eyes and body pigment and are restricted to the dark zones of caves; in contrast, the Cavespring Crayfish has eyes, though they are somewhat reduced, and body pigment and is also found outside of caves in springs and in headwater streams with strong groundwater influence.

The Southern Cavefish (*Typhlichthys subterraneus*), has also been found in Key Cave along with the Alabama Cavefish. It is a widespread species and ranges from the Cumberland Plateau and Interior Low Plateaus in north Alabama and northeast Georgia north through Tennessee and Kentucky into extreme southern Indiana. A few isolated populations also exist in Arkansas and Missouri. In 1984, it was given a status of Special Concern in the state due to the susceptibility of its small populations to decimation by catastrophic events (AAES, 1984). It is currently recognized by the State of Alabama as a species of Moderate Conservation Concern (Shelton-Nix, 2017).

Additionally, at least one species each of a troglobitic amphipod, *Stygobromus vitreus* (family Amphipoda), and a troglobitic isopod, *Caecidotea bicrenata* (family Asellidae; originally reported as Asellus alabamensis) (Ponta, 2025).

Refuge Contributions to Habitat/Life Cycle Needs

Management activities that will benefit the Alabama cavefish and cave crayfish, as well as other cave habitat species, include: 1) continuing to manage the refuge's caves for no public access; 2) protecting the cave's primary energy source, the Gray bat; 3) continuing to control erosion and restore upland habitat, where appropriate; 4) monitoring the hydrology on a recurring basis as funding allows; and 5) working alongside conservation partners to protect additional recharge area for the Key Cave Aquifer from future development through additional land acquisition, conservation easements, public education, and other means.

Cave and Forest Resources of Concern

Significance and habitat requirements

Map sheets 2 and 4 provide context for bat species.

Gray Bat (*Myotis grisescens*)

The Gray bat was first listed on the endangered species list in 1976 due to its dramatic population decline presumptuously thought to be due to human disturbances to caves,

excessive pesticide use, declines in insect prey, and cave commercialization (USFWS 2007a, b). Since then, wide population fluctuations of bat abundance have been documented at many maternity sites across the range and significant population increases have occurred in some of the major hibernacula (Martin 2007). This suggests that Gray bat populations have increased and recovered in many areas throughout its range (USFWS 2009). White-nose syndrome is a disease that is one of the biggest threats to bats in North America. It has killed millions of bats. The disease is named for the white fungus, *Pseudogymnoascus destructans* (Pd), that appears on the nose, ears, and wings of hibernating bats. Bats with white-nose syndrome wake more often during hibernation and use up the stored fat reserves they need to survive the winter. Since the introduction of Pd, that resulted in the collapse of many North American bat communities, white-nose syndrome remains a concern for all North American bats.

However, the Gray bat appears to be experiencing lower fungal loads compared to more studied species, which suggests a lower impact by this disease to Gray bats (Hoyt et al. 2021). It is one of the few species of bats in eastern North America that inhabit caves year-round, migrating annually between winter and summer caves (USFWS 2009). Key Cave is a priority (P1) maternity site, and the population appears to be increasing (USFWS 2009). The integrity and existence of the cave's aquatic ecosystem depends on the Gray bat, as the maternal colony is the primary source of organic matter. By protecting this colony, the refuge helps protect the larger ecosystem.

Gray bats inhabit caves year-round, migrating annually between winter hibernacula and summer caves (USFWS 2009). Both sexes usually hibernate together and return to the same sites each summer (Tuttle 2003). Hibernacula typically are less than 100 miles from associated maternity and bachelor colonies, but Gray bats have been recorded to travel hundreds of miles between winter and summer sites (Colatskie et al. 2018, Tuttle 1976a, USFWS 2009). In summer, the range of the species expands outward, into eastern Oklahoma and Kansas, southern Illinois and Indiana, southwestern Virginia, western North Carolina, and northwest Georgia USFWS 2009. Bats at Key Cave hibernate in Fern Cave, which is about 84 miles east of Key Cave along the Paint Rock River, a tributary of the Tennessee River. Fern Cave NWR supports more than 25 percent of the entire Gray bat population (USFWS 1982).

Gray bats breed just prior to entering hibernation (September to October) and females have delayed implantation (Tuttle 1975, 1976b). Suitable hibernacula consist of deep, vertical caves with multiple entrances to provide consistent airflow. Preferred temperatures range from 34 to 39°F, although the bats can tolerate up to around 48°F (Martin 2007, Tuttle and Kennedy 2005, USFWS 2009). Bats emerge mid-April to mid-May (Tuttle 1975, 1976b). Adult females return to their respective maternity caves that support from a few hundred to thousands of individuals and give birth to a single pup in late May/early June; males and non-reproductive females congregate in more peripheral caves within the colonies' summer home ranges (Martin 2007, Tuttle 1976b, Tuttle and Kennedy 2005). Movement by summering bats between caves is considerable (NatureServe 2022). Caves supporting maternity colonies have restricted rooms or domed ceilings (to trap the combined body heat from thousands of clustered individuals), with temperatures ranging 57 to 77 °F (Tuttle 1975, Tuttle and Stevenson 1978). Most maternity

caves also are located within about 0.5 to 2.5 miles from rivers or reservoirs for over-water feeding on insect prey, predominantly mayflies (Tuttle 1976a, Moore et al. 2017).

High-quality landscapes for Gray bats are characterized by forest cover that surrounds and extends between caves that are located near large waterbodies (Tuttle 1979, USFWS 2024). Gray bats feed primarily over water, near the shores of rivers or reservoirs within about sixteen feet of the water's surface, although they also will forage in the forest canopy along river edges (LaVal et al. 1977, USFWS 1982, USFWS 2024). Forested habitat provides important protection from avian predators, such as the Eastern Screech Owl (*Megascops asio*). Gray bats typically fly in the protection of forest canopy between caves and feeding areas, and newly volant bats often feed and take shelter in the forests surrounding cave entrances (USFWS 1982).

The specific habitats required by the Gray bat have restricted its geographic range and resulted in a large proportion of the known population congregating in relatively few caves, which makes the species vulnerable to extinction (Barbour and Davis 1969, USFWS 1982). Of the several thousand caves that occur throughout the species' range, only about five percent of available caves provide suitable conditions (Tuttle 1979). Currently, 98 percent of known Gray bats are estimated to hibernate in just 15 major hibernacula located across northern Alabama and Arkansas, Kentucky, Missouri, and Tennessee (USFWS 2009). Threats to the species include impoundment of waterways; natural disasters, such as cave-ins and flood events; environmental contamination of prey (Clawson 1991, Clawson and Clark 1989, NatureServe 2022, USFWS 1982, 2009); white-nose syndrome; interactions with wind turbines; and environmental changes, such as changes in hydrology and/or cave microhabitats (USFWS 2009).

Other Species That May Benefit

Tricolored Bat (*Perimyotis subflavus),* Northern Long-eared Bat (*Myotis septentrionalis*), and Indiana Bats (*Myotis sodalis*)

The Northern long-eared bat and Indiana bat are listed as endangered, while the tricolored bat is proposed for listing as endangered under the Endangered Species Act. White-nose syndrome is impacting all four bat species. During the winter, tricolored bats roost in caves and mines, although in the southern United States, where caves are sparse, tricolored bats are often found roosting in road-associated culverts. During the spring, summer and fall, tricolored bats are found in forested habitats where they roost in trees, primarily among leaves. White-nose syndrome has led to 90 to 100% declines in tricolored bat winter colony abundance at sites impacted by the disease. Tricolored bats were proposed for listing as endangered as of September 14, 2022.

Northern long-eared bats spend winter hibernating in caves and mines, called hibernacula. They use areas in various sized caves or mines with constant temperatures, high humidity and no air currents. Within hibernacula, surveyors find them hibernating most often in small crevices or cracks, often with only the nose and ears visible.

During the summer and portions of the fall and spring, northern long-eared bats may be found roosting singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags, or dead trees. Males and non-reproductive females may also roost in cooler places, like

caves and mines. Northern long-eared bats seem to be flexible in selecting roosts, choosing roost trees based on suitability to retain bark or provide cavities or crevices. The species has also been found, although less commonly, roosting in structures, such as barns and sheds. Northern long-eared bats use forested areas not only for roosting, but also for foraging and commuting between summer and winter habitat.

The primary factor influencing the viability of the northern long-eared bat is white-nose syndrome; other factors affecting its viability are wind energy mortality, environmental changes, and habitat loss (USFWS 2022). Northern long-eared bat, Indiana bat, and tricolored bat have decreasing population trends (USFWS 2019f, 2021d, 2022c).

During winter, Indiana bats are restricted to suitable underground hibernacula. Most of these sites are caves located in karst areas of the east-central United States; however, Indiana bats also hibernate in other cave-like locations, especially abandoned mines. Currently, the largest known hibernaculum is an abandoned mine in Missouri. Only a small percentage of caves and mines provide the conditions required for successful hibernation.

In summer, most reproductive females occupy roost sites in forested areas under the exfoliating bark of dead or dying trees that retain large, thick slabs of peeling bark. Primary roosts usually receive direct sunlight for more than half the day. Roost trees are often within canopy gaps in a forest, in a fence line, or along a wooded edge. Habitats in which maternity roosts occur include riparian zones, bottomland and floodplain habitats, wooded wetlands and upland communities. Indiana bats typically forage in semi-open to closed forested habitats with open understory, forest edges, and riparian areas. Adult males occupy similar habitats but can use a wider range of roosts compared to females.

The structure of the forest also influences foraging success. Indiana bats tend to favor forests with a diversity of tree species and canopy cover that allows for a mixture of open space for flight and sheltered areas for prey to congregate. Forests with a closed canopy provide essential cover for bats, as they navigate through the understory and capture insects along the forest floor or near the tree canopy. In addition to forests, Indiana bats have also been observed foraging in agricultural areas where insect populations may be abundant, particularly in fields with sparse tree cover or near forest edges (Baerwald & Barclay, 2009).

Biologically intrinsic needs of the Indiana bat include limiting use of fat during hibernation, obligate colonial roosting, high energy demands of pregnant and nursing females, and timely parturition and rapid development and weaning of young. Factors that may exacerbate vulnerability of the Indiana bat because of these constraints include energetic impacts of significant disruptions to roosting areas (both in hibernacula and maternity colonies), availability of hibernation habitat, and connectivity and conservation of roosting-foraging and migration corridors (USFWS 2007b, USFWS 2024).

Potential Refuge Contribution to Habitat Needs

Northern long-eared bats, Gray bat, and tricolored bats occur on the refuge and Gray bat and tricolor bats utilize Key Cave at various times of the year. Indiana bats could potentially occur on the refuge. Northern long-eared bats use snags and loose bark and tricolored bats use leaf

clusters within forested habitat for summer roosts. All three species are associated with roosting and foraging in various types of forest habitat found on Key Cave NWR. The Bat BO will be utilized to conserve and protect these species as appropriate (USFWS 2024).

Tricolored bats are documented using Key Cave as a hibernaculum during winter months. Historically, TVA monitored white-nose syndrome in tricolored bats and conducted annual roost counts; however, the significance of Key Cave to the local population is poorly understood.

Key Cave is considered a Priority 1 Gray bat maternal colony of approximately 36,000 adult females. Recovery criteria for downlisting Gray bats to threatened include protecting ninety percent of Priority 1 hibernacula and documenting stable or increasing populations at seventy-five percent of Priority 1 maternity caves after a period of ten years (USFWS 1982, 2009). Key Cave is among the initial thirty-two designated Priority 1 maternity sites for Gray bats (USFWS 2009). Based on emergence counts, on average, about 20,000 to 40,000 Gray bats over-summer in Key Cave annually (W. Gates, USFWS, Personal communication). Activities that will benefit the Gray bat on Key Cave NWR include: 1) continuing to manage Key Cave for no public access; 2) continuing to monitor the maternity colony annually or bi-annually; 3) maintaining riparian forested habitat; and 4) ensuring the judicious use of herbicides/pesticides on refuge lands.

Grassland/Early Successional Habitat Resources of Concern

Significance and habitat requirements

Map Sheet 3 provides context for the grassland/early successional habitat and its priority resources of concern; other species that may benefit from cave management activities are also addressed.

Northern Bobwhite (*Colinus virginianus*)

The Northern Bobwhite is a non-migratory, upland game bird, native to Canada, the United States, Mexico, and Cuba (Brennan et al. 2020). Over the last several decades, the species has experienced wide-spread population losses attributed to reduced suitable habitat and the intensification of agricultural practices (BirdLife International 2021). The decline of the Northern Bobwhite signifies the loss of an entire suite of fauna adapted to grassland ecosystems, as bobwhites depend both on early and mid-successional habitats that overlap with the needs of many species (The National Bobwhite Technical Committee 2011).

Over the last several decades, populations have suffered major losses from a combination of increased farming practices that destroy fencerow thickets and enlarge field sizes, and the replacement of native bunch grasses with non-native forage grasses; in the region's forests, dense trees and lack of prescribed burns also reduced available bobwhite habitat. Partners in Flight considers the Northern Bobwhite as "a common bird in steep decline" (Rosenberg et al. 2016). Throughout its range, annual state-wide harvests currently number in the thousands, compared to millions of historic harvests (The National Bobwhite Technical Committee 2011). The IUCN Red List lists the Northern Bobwhite as Near Threatened due to moderately rapid

population declines in recent decades (BirdLife International 2021). The species' overall national conservation status is Apparently Secure (G4), but, by state, it ranges from Secure (G5) to Critically Imperiled (G1); in Alabama, bobwhites are considered Secure (G5) (NatureServe 2022).

In general, Northern Bobwhites do well in landscapes containing closely interspersed patches of grasses, forbs, vines, and groups of low-growing shrubs and trees (Elmore et al. 2017). These landscape features provide seasonal foods, as well as concealment, thermal cover, and escape cover for nesting, brood rearing, loafing, and roosting birds (Brennan and Kleberg 2011). Bunchgrass cover is used by bobwhites for nesting; the clumps provide near-ground cover, surrounded by relatively open vegetation for access to and from nests. It also is used by coveys for nighttime roosting, providing the birds quick and clear escape routes from predators. Forb-dominated areas support good foraging and brood habitat, which requires a vegetative structure that offers concealment from predators (dense screening cover above six inches), numerous patches of bare ground for foraging chicks, and an abundance of arthropods on or near the ground (Brennan and Kleberg 2011). Thick woody or herbaceous vegetation serves as escape cover, and isolated or small groups of trees or shrubs provide loafing habitat (Brennan and Kleberg 2011, Elmore et al. 2017).

Bobwhite quail covey home ranges generally average between 20 and 40 acres, with some greater than 80 acres. On a well-managed area, such as through burning, disking, and/or planting, an average density is one covey per 15 acres (Elmore et al. 2017). About 40 to 60 percent of covey home ranges should be in grassland, with abundant forbs, and shrubland or open forest (Brennan and Kleberg 2011, Elmore et al. 2017). Suitable landscapes have: 1) 30 percent or greater native bunchgrass cover six to eight inches in height, greater than six inches in diameter, and distributed at an optimal density of 600 to 700 clumps per acre for nesting and winter nighttime roosting cover; 2) 40 percent or greater food-producing plants such as native forbs like ragweed (*Ambrosia spp.),* partridge pea, foxtail (*Setaria spp.),* goldenrod (*Asteraceae spp.*), and doveweed (*Croton setiger*), or planted crops; and 3) ten to thirty percent or greater brush/shrub cover scattered in patches across the landscape for loafing cover, where no point is greater than one hundred feet from cover. The woody cover should measure three to ten feet above ground and be relatively open at ground-level to permit movement. Patches should be at least at least five to ten feet wide in diameter, although ideally, between 30 and 65 feet wide in diameter (Brennan and Kleberg 2011, National Bobwhite Technical Committee 2020).

While population declines have been significant, the Northern Bobwhite responds well to management (The National Bobwhite Technical Committee 2011). To sustain a viable population of 800 or more individuals in the fall, long-term, requires a minimum of 1,500 acres of suitable quail habitat (Guthery et al. 2000, Terhune et al. 2010, Morgan et al. 2016, Northern Bobwhite Management Team 2020). Management includes resetting plant succession through disturbances such as logging, prescribed fire, and disking (Brennan and Kleberg 2011). Managing Key Cave NWR's open habitats for the Northern Bobwhite will contribute to the larger, local population of this popular game bird.

Mourning Dove (*Zenaida macroura*)

The Mourning Dove is one of the most abundant and widespread terrestrial birds endemic to North America. This species is highly valued by the general public as a common bird watching species and the leading harvested gamebird (Otis et al. 2008). Key Cave NWR provides hunting opportunities for mourning doves among other game species. By managing croplands for Mourning Doves, the Refuge provides hunting opportunities to the local community and provides habitat for other seed eating migratory birds and focal species like the Northern Bobwhite Quail. (USFWS 2007).

Grasshopper Sparrow (*Ammodramus savannarum*)

The Grasshopper Sparrow is a neotropical migratory, obligate, grassland songbird found in open fields and prairie grasslands across southern Canada, the United States, Mexico, and Central America. Northern populations migrate to the southern United States, Mexico, Central America, and the Caribbean. In Alabama, suitable habitats support populations of breeding, resident, and migrating birds (Vickery 2020). Similar to the Northern Bobwhite, the Grasshopper Sparrow has been identified by Partners in Flight as "a common bird in steep decline." Although the species still is widely distributed across its range, numbers have declined by nearly seventy percent since 1970 (Rosenberg et al. 2016). Its overall national conservation status is Secure (G5), but, by state, it ranges from Critically Imperiled (G1) to Secure (G5); in Alabama, Grasshopper Sparrows are considered Vulnerable (G3) (NatureServe 2022). The Central Hardwoods Joint Venture has identified the Grasshopper Sparrow as a species of regional concern (Central Hardwoods Joint Venture 2018), and it is listed as a Bird of Conservation Concern by the Service (USFWS 2021a).

In general, Grasshopper Sparrows require relatively large, contiguous grassland areas of 75 or more acres of intermediate vegetation height, moderately deep litter, and low shrub density to support a breeding population (Herkert 1994, Shaffer et al. 2021, Vickery 2020). The birds generally are intolerant of woodlands (Grant et al. 2004), although they do occupy oak savanna habitats (Rao et al. 2008) and tolerate a moderate degree of shrubby vegetation within grassland habitats (Henderson and Davis 2014, Schneider 1998). They also occasionally use croplands, such as corn (Zea mays), wheat (Triticum spp.), and oat (Avena spp.) fields, although at lower densities than grassland habitats (Faanes and Lingle 1995, Lokemoen and Beiser 1997, Igl et al. 2006, McLachlan 2007, Shaffer et al. 2021). Grasshopper Sparrows forage on patches of bare ground for insects and seeds (Vickery 2020). Nesting takes place in dry, upland sites characterized by native bunch grasses and annual grasses, minimal litter cover, patches of bare ground, scattered forbs, and/or short shrubs (Shaffer et al. 2021). Nests are built in clumps of dead grass or other vegetation. Females are double brooders and lay three to six eggs per nest, which hatch after 11 to 13 days of incubation. Altricial young are fed in the nest for nine days before fledging and remain dependent on adults for three to four weeks (Vickery 2020).

Based on an extensive review of the species habitat needs throughout its range, Shaffer et al. (2021) reported the listed key grassland vegetation characteristics preferred by Grasshopper Sparrows.

- Grass cover of 12 to 95 percent

- Forb cover of 4 to 40 percent
- Shrub cover less than 35 percent
- Average vegetation height of 3 to 65 inches
- Visual obstruction reading of 2 to 31 inches
- Bare ground less than or equal to 38 percent
- Litter cover of 5 to 61 percent and less than 3 inches in depth

Management activities that will benefit Grasshopper Sparrows on the refuge include: 1) keeping larger grassland management units intact, with minimal wind breaks and interruptions with different habitat types; 2) carrying out prescribed burns every two to three years to reduce the build-up of thatch that can inhibit nesting; and 3) mowing fields outside the breeding season (early April – mid July).

Loggerhead Shrike (*Lanius ludovicianus*)

The Loggerhead Shrike, also called the butcherbird or thornbird, is a territorial, predatory bird of the family Laniidae, well-known for storing its prey, such as insects, small mammals, birds, lizards, and amphibians, by impaling it on thorny vegetation or barbed-wire fence. It is the only member of the shrike family endemic to North America and has eleven recognized subspecies (Yosef 2020); the San Clemente Island subspecies (*Lanius ludovicianus mearnsi*) of Southern California has been listed as Endangered since 1977 (USFWS 2020a). The breeding range of the Loggerhead Shrike includes most of the United States and southern Alberta, Saskatchewan, and Manitoba of Canada. Loggerhead Shrikes are year-round residents in the southeastern United States (American Ornithologists' Union 1983), and Alabama supports both resident and wintering birds (Rainer 2020).

The Loggerhead Shrike is another "common bird in steep decline" (Rosenberg et al. 2016). Breeding populations in the northeastern portion of their historical range have become extirpated, and significant population losses have occurred throughout much of their remaining distribution (Loggerhead Shrike Working Group 2018). Over the last several decades, overall population loss estimates are greater than fifty to as high as 75 percent (Rosenberg et al. 2016, Sauer et al. 2020). Declines are attributed primarily to loss of native grassland and early successional habitats from land use changes, degradation, fragmentation, and habitat succession (Luukkonen 1987, Gawlik and Bildstein 1990, Lymn and Temple 1991). An additional current threat in more human-influenced areas is mortality from vehicle collisions (Luukkonen 1987, Blumton 1989), as habitat features used by shrikes, such as barbed-wire fencing and hedgerows, are located along roadways. The Loggerhead Shrike is listed as a Bird of Conservation Concern by the Service (USFWS 2021a). The species' overall national conservation status is Apparently Secure (G4), but, by state, it ranges from Presumed Extirpated (GX) to Apparently Secure (G4); in Alabama, Loggerhead Shrikes are considered Vulnerable (G3) (NatureServe 2022) and are a state-protected species (Alabama Department of Conservation and Natural Resources Division of Wildlife and Freshwater Fisheries 2015). Compared to other

regions within the state, populations in the Tennessee River Valley have experienced significant declines (Rainer 2020).

Loggerhead Shrikes are opportunistic birds, and throughout their breeding and wintering range they occur in both natural and human-influenced open habitats, including native prairies and grasslands, sagebrush desert, farmland, rights-of-way, golf courses, and cemeteries (Micheals and Cully 1998, Dechant et al. 2002, Yosef 2020). The species requires landscapes that provide suitable nesting sites, foraging areas, and hunting perches (Yosef and Grubb 1994); the area also must be large enough to support multiple territories [territories average fifteen to twenty-two acres (Dechant et al. 2002) and as large as 43 acres (Yosef and Grubb 1994)]. In general, high-quality landscapes include areas of low-lying grasses and forbs and scattered bare ground interspersed with trees and shrubs. Trees and shrubs provide nesting habitat and perches for hunting over open habitats (Micheals and Cully 1998, Dechant et al. 2002). Larger trees, such as cedars (*Juniperus spp*.), offer enhanced foraging success through better visibility and are preferred nesting sites (Froehly et al. 2020, Gawlik and Bildstein 1990, Luukkonen 1987). Thorny trees also are used for nesting, as well as impaling stations for prey (U.S. Forest Service 2003, Yosef 2020).

Management activities that benefit Loggerhead Shrikes include maintaining landscapes that contain: 1) at least 90 percent herbaceous ground cover maintained through prescribed burns carried out outside of the nesting season, grazing, and/or mowing, the majority of which (over 80 percent) is usable foraging habitat such as prairie, pasture, grassland, or hay, and for which 18 percent or more is within 60 feet of a hunting perch (Brooks and Temple 1990, U.S. Forest Service 2003); 2) foraging habitat that includes sections of taller grass for supporting vertebrate prey and scattered, thorny shrubs interspersed across the landscape or along fencerows for hunting perches and impaling sites (Brooks and Temple 1990, Dechant et al. 2002, U.S. Forest Service 2003); 3) at least 10 nesting trees between 5 and 33 feet tall per 25 acres; and 4) reduced chemical use on agricultural fields and roadsides to increase prey availability (Dechant et al. 2002, Yosef 2020).

Potential refuge contribution to habitat needs

Key Cave NWR's 20 grassland management units total over 300 acres, the largest of which is 70 acres. Management activities that will promote early successional habitat and will benefit Grasshopper Sparrows on the refuge include: 1) keeping larger grassland management units intact, with minimal wind breaks and interruptions with different habitat types and 2) carrying out prescribed burns every other year to reduce the build-up of thatch that can inhibit nesting. Additionally, providing a diversity in grassland habitat, with shrubs and thickets, and prescribed burning at various frequencies and intensities will benefit Northern Bobwhite and Loggerhead Shrike populations.

Other species with complementary needs

Habitat management objectives and strategies in this plan are focused on the habitat needs of the priority resources of concern. However, an ecosystem management approach to habitat management will result in overall improvement in the health and function of the ecosystem on

the refuge (i.e., BIDEH—Biological Integrity, Diversity, and Environmental Health, 601 FW 3), benefitting many other species, including those for which the Service has legal responsibility under Federal law.

Two-thirds of the habitat on Key Cave NWR consists of early-successional grasslands, savanna, and cropland or old field. Many species that benefit from edge and early successional habitat will benefit from the management objectives and strategies such as prescribed fire, mechanical and chemical treatment. Several species that benefit from this management include Eastern cottontails, White-tailed deer, Eastern Meadowlarks, Horned Larks, Eastern Bluebirds, Northern Harriers, Short-Eared Owls, Field Sparrows, Dickcissels, and potentially Henslow's Sparrows.

Reconciling Conflicting Needs

Multiple Resources of Concern are likely to have competing needs or other refuge programs may conflict with habitat needs of Resources of Concern. The delicate balance required to meet the ecological requirements of various species, while maintaining the integrity of their habitats, demands a nuanced approach. Strategies such as habitat restoration, invasive species management, and adaptive management play crucial roles in minimizing these conflicts. Ultimately, the success of conservation efforts depends on understanding the complex interactions between species and their environments and continuously adjusting strategies to promote ecological health and biodiversity. Conflicts may arise with differing habitat desired condition among grassland bird species. While some species, such as the Eastern Meadowlark, benefit from moderate fire return intervals that allow for the regrowth of grasses without the dominance of shrubs, others, like the Grasshopper Sparrow, prefer shorter intervals that keep vegetation low and sparse. Additionally, species like the Northern Bobwhite and Henslow's Sparrow have more specific needs for the timing and intensity of fire to maintain the right balance of vegetation for nesting and foraging.

To address these conflicting fire needs, land managers often implement mosaic burning, where different areas are burned at different intervals (USFWS 2024). This allows for the creation of a variety of habitats within the same region, supporting a wider diversity of species. For example, some areas might be burned more frequently to maintain low vegetation for species like the Grasshopper Sparrow, while other areas may be burned less frequently to allow for taller grasses and shrubs for species like the Henslow's Sparrow. Additionally, land managers may adjust the timing and intensity of controlled burns to cater to the specific needs of different bird species (USFWS 2024). For example, burning in late winter or early spring can create a more suitable environment for species that nest in tall grasses, while burning during the growing season may better suit species that need sparse vegetation. Monitoring bird populations and vegetation conditions is crucial to determining the effectiveness of fire management practices and adjusting them over time.

The recent programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices will be utilized to minimize impacts, include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations, will be

utilized to address conflicting management actions (USFWS 2024). Additionally, habitat enhancements through these forestry practices are likely to benefit tree roosting bats long-term.

Chapter IV. Habitat Goals and Objectives

For habitats that require active management, goals and objectives were developed in the refuge's CCP, which are directly stepped-down to specific, measurable, achievable, results-oriented, and time-fixed (SMART) SHSP objectives that fulfill the refuge's purposes. The CCP management goals are broad, qualitative statements derived from the established purposes and vision for the refuge and remain unchanged to guide the SHSP. SHSP objectives are directly stepped down from CCP objectives. CCP goals and SHSP objectives pertain to resources of concern identified in Chapter III and can be found on the corresponding habitat management map sheets. Appendix B provides a crosswalk that links the existing CCP objectives to the SHSP; for the SHSP, some objectives from the CCP will remain unchanged, others will be refined, and new objectives will be added. The refuge habitat map sheets contain a specific habitat type and include the listed items.

Refuge Specific CCP Habitat Management Goal(s)

SMART SHSP Objectives (with reference to the CCP objectives from which they are directly stepped-down)

Rationale for Selecting the SMART Criteria

- Resources of Concern and Related Objectives
- Adaptive Management Monitoring Elements, including
- Primary Habitat and Species Response Variables and
- Associated Assessment Methods

Chapter V. Habitat and Species Management Strategies

Habitat and species management strategies are the specific actions, tools, or techniques used to meet specific habitat and species objectives. Strategies are practices that are applied on the ground and will achieve the SMART criteria of the habitat and species management objective. Habitat and species management strategies for each specific habitat type or species can be found on the corresponding habitat and species management map sheets. Each of the individual refuge, habitat-specific map sheets contain habitat and species management strategies including: Potential Strategies and Selected Management Strategies and Unit Prescriptions.

Adaptive Management

The USFWS advocates improving habitat and species management through adaptive management (602 FW 6, https://www.fws.gov/policy-library/602fw6). The Service defines adaptive management as “the rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from refuge research, monitoring, and evaluation of management actions to support or modify objectives and strategies at all planning levels.” As such, it is imperative that the impacts of habitat and species management decisions be regularly evaluated with regard to habitat conditions and wildlife response, and management decisions can then be adapted over time as appropriate to achieve refuge management objectives.

Section B. Environmental Assessment for the Key Cave National Wildlife Refuge Spatial Habitat Species Plan

Introduction

This Environmental Assessment (EA) was prepared by the U.S. Fish and Wildlife Service (Service, USFWS) to evaluate the effects associated with the Proposed Action, implementing a Spatial Habitat and Species Plan (SHSP) for Key Cave National Wildlife Refuge (NWR, refuge) located in northwest Alabama (Figure 1 Section B), and complies with the National Environmental Policy Act (NEPA), Department of the Interior (43 CFR 46; 516 DM 1), and U.S. Fish and Wildlife Service (Service; 550 FW 3) regulations and policies. NEPA requires examination of the effects of proposed actions on the natural and human environment. Appendix A outlines all law and Executive Orders evaluated through this EA.

If adopted, the SHSP will step down the existing Comprehensive Conservation Plan (CCP) for the refuge (USFWS 2007a, b). Appendix B outlines a crosswalk from the existing CCP goals and objectives to the proposed SHSP's refined, updated, and new objectives for the refuge.

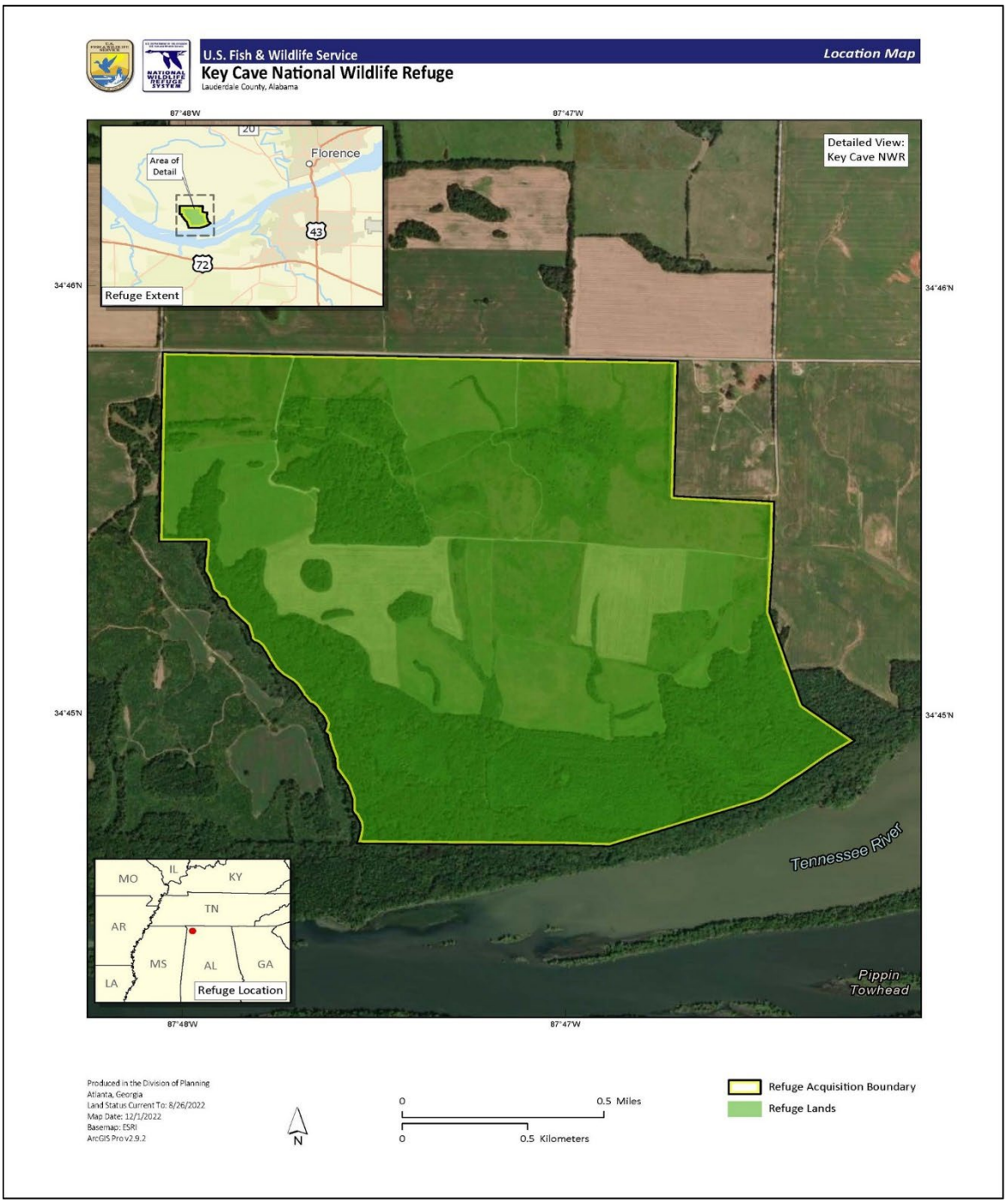
Proposed Action

Management of the refuge was outlined and evaluated in the Wheeler NWR Complex (Complex or Wheeler Complex) Comprehensive Conservation Plan (CCP)/Environmental Assessment (EA)/Finding of No Significant Impact (FONSI) (USFWS 2007a, b). Furthering the management outlined in the 1996 Land Protection Plan (LPP)/EA/FONSI (USFWS 1996) and the 2007 CCP/EA/FONSI (USFWS 2007a, b) for Key Cave NWR, the Service is proposing to update and refine habitat and species management of the 1,060-acre refuge with the proposed SHSP (Section A and Map Sheets), including management of the Key Cave NWR cave, early successional habitat (including grassland and cropland), and forest habitat. The Proposed Action will refine and update existing refuge management objectives to serve refuge purposes and goals and adapt management over time. Resources of concern established through the Natural Resource Prioritization Process (USFWS 2022e) and articulated in the SHSP for the refuge include the:

- **Alabama Cavefish** (*Speoplatyrhinus poulsoni)*
- **Alabama Cave *Crayfish*** *(Cambarus jonesi)*
- **Gray Bat** (*Myotis grisescens)*
- **Northern Bobwhite** *(Colinus virginianus)*
- **Grasshopper Sparrow** (*Ammodramus savannarum*)
- **Loggerhead Shrike** (*Lanius ludovicianus*) **and**
- **Mourning Dove** (*Zenaida macroura*).

The SHSP in Section A was fully developed for implementation based on the Proposed Action, including Mapsheets 1 through 4; Section A and Mapsheets 1 through 4 are incorporated herein by reference.

Figure 1. Location of Key Cave NWR.



A proposed action is often iterative and evolves over time during the planning process as the agency refines its proposal and learns more from the public, Native American Tribes, and other agencies. Therefore, the final Proposed Action may be different from the original. The final decision on the Proposed Action will be made after the conclusion of the public comment period for the draft EA and the SHSP.

Background

National wildlife refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS, Refuge System), the purposes of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the NWRS Administration Act of 1966 (NWRSAA), as amended by the NWRS Improvement Act (NWRSIA) of 1997 (16 USC §668dd et seq.), Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations (CFR), Fish and Wildlife Service Manual, and other pertinent legislation (Appendix A).

The mission of the NWRS, as outlined by the NWRSAA, and as amended by the NWRSIA, is to:

- "... to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans"

The NWRSIA mandates the Secretary of the Interior in administering the Refuge System to:

- Provide for the conservation of fish, wildlife, and plants, and their habitats within the NWRS;
- Ensure that the biological integrity, diversity, and environmental health of the NWRS are maintained for the benefit of present and future generations of Americans;
- Ensure that the mission of the NWRS described at 16 USC §668dd(a)(2) and the purposes of each refuge are carried out;
- Ensure effective coordination, interaction, and cooperation with owners of land adjoining refuges and the fish and wildlife agency of the States in which the units of the NWRS are located;
- Assist in the maintenance of adequate water quantity and water quality to fulfill the mission of the NWRS and the purposes of each refuge;
- Recognize compatible wildlife-dependent recreational uses as the priority general public uses of the NWRS through which the American public can develop an appreciation for fish and wildlife;
- Ensure that opportunities are provided within the NWRS for compatible wildlife-dependent recreational uses; and
- Monitor the status and trends of fish, wildlife, and plants in each refuge.

The purposes of Key Cave NWR are listed.

"... to conserve fish, wildlife, and plants, including those which are listed as endangered species or threatened species..." 16 United States Code (USC) §1534 (Endangered Species Act of 1973)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 USC §742f(a)(4) (National Wildlife Refuge Administration Act of 1966)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 USC §742f(b)(1) (Fish and Wildlife Act of 1956)

Serving NWRS mandates, LPP intent, and refuge purposes, the proposed SHSP will support multiple refuge management goals and objectives articulated in the CCP (USFWS 2007a, b), including those listed.

Goal 1. Fish and Wildlife Population Management. Protect, maintain, enhance, and restore healthy and viable populations of migratory birds, resident wildlife, fish, and native plants, including all federal and state-threatened and endangered species found within northern Alabama in a manner that supports national and international treaties, plans, and initiatives.

Objective 1.9. Shorebirds [including the American woodcock (*Scolopax minor*)]. Within three years of plan approval, increase shorebird management capabilities and monitoring efforts.

Objective 1.13. Grassland Landbirds. Within eight years of plan approval, increase management efforts for grassland dependent landbird species on Key Cave and Wheeler NWRs.

Objective 1.14. Scrub-shrub Landbirds. Within eight years of plan approval increase management efforts for scrub-shrub landbird species.

Objective 1.15. Other Bird Management Issues. Over the 15-year life of the plan, address other special bird-related issues on Complex lands as needed to support Service goals.

Objective 1.17. Amphibians and Reptiles. Within five years of plan approval increase management for improving populations of amphibians and reptiles on Complex lands.

Objective 1.19. State and/or Federal Endangered, Threatened, or Special Concern Species. Over the 15-year life of the plan, protect, inventory, monitor, and conserve imperiled terrestrial and aquatic species.

Objective 1.20. State and/or Federal Threatened, Endangered, or Special Concern Species. Over the 15-year life of the plan, contribute to the stabilization and/or increase of Gray bat populations found within Key Cave.

Objective 1.21. State and/or Federal Threatened, Endangered, or Special Concern Species. Within two years of plan implementation, develop a protection plan to increase conservation efforts for the Alabama cavefish found within Key Cave.

Objective 1.26. Exotic/Invasive/Nuisance Animals. Within 10 years of plan implementation, remove 65 percent of the invasive and nuisance animals from Wheeler Complex lands and waters.

Goal 2. Conduct Habitat Restoration and Management. Protect, maintain, enhance, and restore optimum habitat for the conservation and healthy management of migratory birds, resident wildlife, fish, and native plants, including all federal and state-threatened and endangered species found within northern Alabama in a manner that supports national and international treaties, plans, and initiatives.

Objective 2.1. Impoundments and Shallow Water Areas (SWAs) (including moist soil). Over the 15-year life of the plan, continue efforts to improve and refine the management of impoundments and SWAs on Wheeler and Key Cave NWRs.

Objective 2.2. Agricultural Cropland. Over the 15-year life of the plan, utilize a well-managed farming program to provide food, cover, and resting areas for waterfowl and other wildlife on Wheeler and Key Cave NWRs.

Objective 2.4. Grassland Management. Within six years of plan implementation, promote the establishment of native warm season grassland (NWSG) habitats for the conservation of migratory birds and a natural diversity of wildlife at Wheeler and Key Cave NWRs.

Objective 2.5. Forest Management. Over the 15-year life of the plan, manage forested habitats for priority species and use adaptive management on all Complex lands.

Objective 2.6. Invasive/Exotic Plant Species Management. Within five years of plan implementation, eliminate at a minimum 25 percent of the non-native invasive or exotic plant species from Complex lands.

Goal 3. Provide Resource Conservation and Protection. Provide coordination and cooperation among organizations to enhance effective management and protection of natural and cultural resources within northern Alabama.

Objective 3.8. Water Quality and Quantity Management. Within five years of plan (CCP) implementation, develop and implement a water quantity and water quality monitoring program to ensure that the Wheeler Complex maintains adequate and environmentally safe water supplies to meet the needs of plants, fish, and wildlife, including the natural processes that support these resources (e.g., water levels in ground and surface that support hydric soils).

The refuge provides habitat for seven Federally listed species, including critical habitat for the Alabama cavefish which only occurs in Key Cave. Also as outlined above, another 20 Federally listed mollusk species historically occurred or could potentially occur in the adjacent Tennessee River; however, many have been extirpated, with only 7 of these species likely to occur near the refuge. Some of these species have recently updated information that informs refuge management activities. The Alabama cavefish Recovery Plan was amended in 2019 (USFWS 2019a) and a 5-year review was completed in 2023 https://ecosphere-documents-productionpublic.s3.amazonaws.com/sams/public_docs/species_nonpublish/4105.pdf).

The Indiana bat 5-Year Review was conducted in 2019 (USFWS 2019c). From 2020 to 2022, Species Status Assessment reports were completed for the monarch butterfly (USFWS 2020b), tricolored bat (USFWS 2021b), and Northern long-eared bat (USFWS 2022b). The recent programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices will be utilized to minimize impacts, include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations, will be utilized to address conflicting management actions (USFWS 2024). Additionally, habitat enhancements through these forestry practices are likely to benefit tree roosting bats long-term.

Further, the refuge supports multiple birds of management concern, including migrating and breeding populations. More than 325 bird species migrate through the Mississippi Flyway, which includes the refuge, from breeding grounds in Canada and the northern United States to wintering grounds along the Gulf of Mexico, Central America, and South America (National Audubon Society 2023). Many migratory birds are facing threats and declines, including habitat quality and habitat availability. As outlined in the North American Bird Conservation Initiative's State of the Birds 2020 Report, three billion birds have been lost from the Unites States and Canada, including one in 4 breeding birds; 70 bird species are on the tipping point of being lost; and birds across the United States are showing downward trends in every habitat except wetlands (North American Bird Conservation Initiative 2022). Over time, changing conditions in the landscape are occurring.

The Region of Hydrologic Influence (RHI) for Key Cave NWR is 291.6 square miles and is bisected by the Tennessee River (USFWS 2019b). The increasing human population and human development within the surrounding landscape and in the Key Cave recharge area are impacting natural resources, including the loss and conversion of undeveloped and agricultural lands; changes in the use and intensity of agricultural lands; increasing inputs of fertilizers and pesticides across the recharge area; and water quality, quantity, timing, and flow threats and concerns. Of additional concern is white-nose syndrome, impacting bats and *Batrachochytrium dendrobatidis* (Bd) fungus impacting amphibians. Research, data, and studies are needed to better inform refuge managers, conservation partners, and development decision makers across the recharge area, including water quality monitoring with a range of parameters, identification of connected sinkholes, and identification of other hydrologic connections to Key Cave and its aquifer.

Multiple Federally listed species historically occurred on or near the refuge (see Table 2), however many have since been extirpated.

Table 2.Listed Species and Designated Critical Habitat on or adjacent to Key Cave NWR

SPECIES/CRITICAL HABITAT Species Common Name (Scientific Name)	**STATUS**[1]
Alabama Cavefish (*Speoplatyrhinus poulsoni*), Critical Habitat (Key Cave)	E, CH
Northern Long-Eared Bat (*Myotis septentrionalis*)	E
Gray Bat (*Myotis grisescens*)	E
Indiana Bat (*Myotis sodalis*)	E
Tricolored Bat (*Perimyotis subflavus*)	PE
Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*)	PE
Dromedary Pearlymussel (*Dromus dromas*)	E
Pink Mucket (pearlymussel) (*Lampsilis abrupta*)	E
Sheepnose Mussel (*Plethobasus cyphyus*)	E

SPECIES/CRITICAL HABITAT Species Common Name (Scientific Name)	**STATUS[1]**
Fanshell (*Cyprogenia stegaria*)	E
Spectaclecase (mussel) (*Cumberlandia monodonta*)	E
White Warty-Back (pearlymussel) (*Plethobasus cicatricosus*)	E
Alabama Lampmussel (*Lampsilis virescens*)	EP
Birdwing Pearlymussel (*Lemiox rimosus*)	EP
Clubshell (*Pleurobema clava*)	EP
Cracking Pearlymussel (*Hemistena lata*)	EP
Cumberland Bean (pearlymussel) (*Villosa trabalis*)	EP
Cumberland Monkeyface (pearlymussel) (*Theliderma intermedia)*	EP
Cumberlandian Combshell (*Epioblasma brevidens*)	EP
Oyster Mussel (*Epioblasma capsaeformis*)	EP
Finerayed Pigtoe (*Fusconaia cuneolus*)	EP
Longsolid (*Fusconaia subrotunda*)	T
Shiny Pigtoe (*Fusconaia cor*)	EP
Winged Mapleleaf (*Quadrula fragosa*)	EP
Purple Cat's Paw (Purple Cat's Paw Pearlymussel) (*Epioblasma obliquata*)	EP
Anthony's Riversnail (*Athearnia anthonyi*)	EP
Whooping Crane (*Grus americana*)	EP
Monarch Butterfly (*Danaus plexippus*)	C

[1]STATUS: E=endangered; T=threatened; PE=proposed endangered; PT=proposed threatened; CH=critical habitat; PCH=proposed critical habitat; C=candidate species; EP=experimental population, non-essential

Of the species in Table 1, species known or likely to occur on the refuge are: Alabama cavefish, Northern long-eared bat, Gray bat, Indiana bat, tricolored bat, and monarch butterfly. Species that could likely occur off the refuge in the adjacent Tennessee River include the pink mucket, sheepnose mussel, spectaclecase, white warty-back, Dromedary Pearlymussel and longsolid.

In conjunction with Key Cave SHSP (Section A) and the associated EA (Section B), the SHSP process includes an intra-Service Section 7 Consultation to fulfill the requirements of the Endangered Species Act (ESA); this Section 7 will be incorporated herein by reference. The ESA provides a program for conserving threatened and endangered plants and animals and their habitats, including critical habitat. An ESA Intra-Service Section 7 Consultation was also completed for the 2007 CCP; it is also incorporated herein by reference (USFWS 2007a, b). A programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices also applies to this action in order to minimize impacts include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations (USFWS 2024). This ESA Programmatic Biological Opinion and Consultation is incorporated herein by

reference (USFWS 2024). Additionally, habitat enhancements through these forestry practices are likely to benefit tree roosting bats long-term.

Purpose and Need

The purpose of the development of the SHSP is to refine implementation of the CCP for Key Cave NWR to address changing landscape and natural resource conditions, enhance and adapt refuge habitat and species management, and better serve refuge purposes and management goals.

The need is supported by multiple factors, including addressing management activities, recent updates to information for key resources of concern, changing conditions in the landscape, and limited refuge staff time. It has been nearly 30 years since the LPP/EA/FONSI was finalized (USFWS 1996) and 20 years since the previous acquisition and restoration of croplands (2004). Further, the CCP/EA/FONSI for the refuge was finalized in 2007, which was over 15 years ago (USFWS 2007a, b). Since 2004, with the long-term goal of restoring acquired croplands to grasslands, the Service has been maintaining the remaining 268 acres of croplands in an early successional stage through the use of cooperative farming, awaiting opportunities for restoration, while providing wildlife habitat and public use opportunities.

Alternatives

Several ideas were initially considered and closely evaluated for inclusion in this EA. Two alternatives were fully developed for review: Alternative A, Continue Current Management (No Action Alternative) and Alternative B, Implement the Spatial Habitat and Species Plan (Proposed Action) which steps down and provides specifics for several of the identified goals and objectives outlined in the CCP. The SHSP (Section A and map sheets), which is incorporated herein by reference, was developed for implementation based on the Proposed Action outlined in Alternative B.

Features Common to all Alternatives

Although the alternatives may differ, there are similarities among them as well. These common features are listed below to reduce the length and redundancy of the individual alternative descriptions.

Resource Management

Entry into the cave will continue to be limited to Service personnel and cooperators for the purpose of wildlife surveys and limited research. This is necessary to minimize disturbance to the sensitive aquatic species and the bats. All entry is prohibited from April 15th through September 30th to prevent disturbance to the Gray bat maternity colony. Annual monitoring and maintenance of cave gates and fences will continue.

Compatible Uses

The NWRS Administration Act of 1966, as amended by the NWRS Improvement Act of 1997, states that national wildlife refuges must be protected from incompatible or harmful human activities to ensure that Americans can enjoy Refuge System lands and waters. Before activities or uses are allowed on a national wildlife refuge, the uses must be found to be compatible. A compatible use "…will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge." Wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety." The compatibility determinations (CDs) included in the CCP (USFWS 2007a, b) are incorporated herein by reference, as is a new Cooperative Farming CD that will apply until cropland conversion is complete.

Visitor use and experience

Nearby recreational areas in Alabama include the Seven-Mile Island, Freedom Hills, Black Warrior, Sam R. Murphy, Mulberry Fork, and Lauderdale wildlife management areas; Tennessee Valley Authority's (TVA's) Muscle Shoals Reservation; Joe Wheeler State Park; and Bankhead National Forest. Nearby recreational areas in Tennessee include Laurel Hill Wildlife Management Area, David Crocket State Park, and Devil's Backbone State Natural Area. These areas offer outdoor recreational opportunities, including hunting, fishing, boating, wildlife observation, photography, hiking, biking, and camping.

The refuge provides opportunities for hunting, wildlife observation, photography, hiking, and biking, which will continue under either alternative. Passing through a variety of habitats, including native grasslands, upland hardwoods, and agricultural lands, the refuge has 2.5 miles of roads/trails that are open for hiking and biking. Refuge visitor facilities include: the Grassland Loop Trail, the Oak Woodland Trail, 3 parking lots, and the Main Hunt Area Unit. Hunting regulations are combined with the adjacent Seven-mile Island Wildlife Management Area hunt brochure. Hunting opportunities include dove, rabbits, squirrels, feral hog (*Sus scrofa*), bobwhite quail, woodcock, snipe, raccoon (*Procyon lotor),* and opossum; hunting on the refuge is allowed within specific dates listed in the refuge's hunt brochure. Annual visitation to the refuge is about 7,000, of which 500 are hunting visits. Refuge visitation has remained relatively stable with a small increasing trend in annual visits. Refuge management activities under either alternative will continue to support refuge management goals and objectives in the CCP (USFWS 2007a, b), including visitor use and experience.

Other Management

Under either alternative, all management activities that could affect natural resources, including subsurface mineral reservations, soil, water, and air, or that could affect utility lines and easements, will be managed to comply with all laws and regulations.

Cultural Resources

Under both alternatives, the Service is responsible for managing archaeological and historical sites found on refuge lands. The refuge is home to Key Cemetery, which is thought to have been a slave cemetery (USFWS 2007a, b). The refuge is adjacent to the Seven-Mile Island Archaeological District, which is located in the Tennessee River, and which includes the Perry Site midden, Mississippian culture village site and mound, burials, and artifacts dating back to the Archaic Period. Since cultural resource surveys on the refuge have been limited, additional surveys will be conducted prior to any new construction or excavation on refuge lands to fully satisfy provisions of the National Environmental Policy Act of 1969, and all applicable cultural resource laws and policies. Any potentially negative impacts from habitat management will require review by the Service's Regional Archaeologist and consultation with the State Historic Preservation Office, as mandated by Section 106 of the National Historic Preservation Act. The Service's policy is to preserve these cultural resources in the public trust and avoid any adverse effects wherever possible. Determining whether a particular management action has the potential to affect cultural resources is an on-going process that will occur during the detailed planning stages of every project.

The Service has a legal responsibility to consider the effects of its actions on cultural resources. Under all alternatives, the Service will manage these resources in accordance with public law and agency policy. Individual projects could require additional consultation with the Advisory Council on Historic Preservation and the State of Alabama Historic Preservation Office. Additional consultation, surveys, and clearance will be required where project development is conducted on the refuge or when activities will affect properties that are listed or eligible for listing on the National Register of Historic Places.

Land Acquisition

Service acquisition of tracts adjacent to Service owned lands, properties within the recharge zone, and properties along bat foraging areas will be given priority. Conservation easements and leases can be used to obtain interests necessary to satisfy refuge objectives. The Service can negotiate management agreements with local, state, and federal agencies, and accept conservation easements. The acquisition of private lands is entirely contingent on the landowners and their willingness to participate. Any future land acquisition will be the same under either alternative.

Crop Use for Natural Resource Management

While Alternative B lays out an approach for cropland conversion, continuing to manage a portion of cropland for public use and grassland bird habitat will be incorporated into objectives under either alternative. Additionally, the cooperative farming program will continue until cropland conversion is complete. An objective of providing grain crops through the cooperative farming program includes maintaining desired herbaceous habitats for food and cover at no additional cost to the refuge. From an ecological standpoint, these successional disturbances simply equate to an increase in biodiversity that benefit multiple wildlife species, such as Northern Bobwhite and other grassland birds, Mourning Doves (*Zenaida macroura*), white-tailed deer (*Odocoileus virginianus*), Eastern Wild Turkey (*Meleagris gallopavo*), and invertebrates, primarily from increased foraging opportunities and enhanced nutritional benefit.

Farming and the use of Genetically Engineered Agricultural Crops (GECs) to support habitat and species management by Service on the Complex, including Wheeler and Key Cave NWRs, is also analyzed, tiered, and stepped down from the listed planning and NEPA documents:

- Agricultural crop use was analyzed in the CCP and EA for Wheeler NWR Complex with final decisions detailed in the final CCP and FONSI (USFWS 2007a, b). Related goals and objectives are included in the Complex's CCP (USFWS 2007a, b). The final CCP provides the refuges with specific guidance for implementing refuge management, including:
    - Providing direction for each refuge, including desired future conditions for refuge wildlife and habitat, resource protection, visitor services, and refuge administration;
    - Providing reasoning for Service management actions;
    - Providing consistency with NWRS mission and applicable legal mandates;
    - Ensuring that public uses are compatible with the purposes of the refuge; and
    - Providing justification for staffing, operations, maintenance, and capital improvements.
- The Service's Programmatic EA (PEA) for Use of GECs for Natural Resource Management on National Wildlife Refuges in the Southeastern United States (GEC PEA) and FONSI (USFWS 2020c) described and analyzed the use of GECs on refuges within U.S. Department of the Interior Unified Regions 2 and 4 (IR2&4), which included the Wheeler NWR Complex refuges.

- The GEC PEA provides a thorough evaluation and analysis of the use of GECs on stated NWRs in IR2&4 (Southeast Region) in order to meet wildlife management objectives and achieve the specific goals and objectives outlined in the Wheeler NWR Complex CCP and other national and international conservation initiatives.
- In addition, the GEC PEA also evaluates policies governing these uses on NWRs, such as the Service's Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3, BIDEH), Interior's Pesticide Use Policy (517 DM 1), and the Service's Integrated Pest Management Policy (569 FW 1).

The Service uses a tiered analysis to determine whether a genetically engineered crops (GECs) can be used on a NWR based on the following:

1. U.S. Department of Agriculture, Animal and Plant Health Inspection Service's (APHIS's) specific NEPA analysis and de-regulation or exemption of the GEC;
2. The region's programmatic NEPA analysis of GEC use (GEC PEA, USFWS 2020c);
3. The NEPA analysis of GEC use on the NWR or within the NWR complex tiered from the region's programmatic NEPA analysis of GEC use and through associated NWR planning documents (e.g., CCP/EA/FONSI); and
4. Analysis of whether such GEC use will meet the essentialness requirement of the BIDEH Policy (601 FW 3).

The Wheeler NWR Complex, including Key Cave NWR, only uses APHIS de-regulated GECs in natural resource management on refuge lands meeting the first-tier analysis above. The GEC PEA FONSI concluded that the use of GECs as analyzed presented no significant impacts to the physical, biological, and socio-cultural environments on refuges within the Southeast United States, including the Wheeler NWR Complex and Key Cave NWR (USFWS 2020c). The GEC/PEA/FONSI (USFWS 2020c) serves the second tier above. The EA and FONSI for the CCP for Wheeler NWR Complex (USFWS 2007a, b) will serve the third tier listed above for the use of GECs on the Wheeler NWR Complex to help meet the purposes, goals, and objectives of these refuges. The Wheeler NWR Complex GEC/CatEx/EAS and essentialness documents were completed and approved in December 2020 to allow GEC use for natural resource management on Wheeler NWR Complex (USFWS 2020d) meeting the fourth tier above.

Farming inputs also include pesticide use. The Service relies on the listed four tiers of analysis for the use of pesticides on a unit of the National Wildlife Refuge System.

- Pesticide specific analysis by the U.S. Environmental Protection Agency;
- Pesticide specific analysis through the Service's Pesticide Use Proposal (PUP) process;
- Analysis of pesticide use in general for a specific NWR or NWR complex through an EA/FONSI or Environmental Impact Statement (EIS)/Record of Decision (ROD); and
- Analysis of pesticide use in general through an Environmental Action Statement (EAS) that documents the pesticide use planned for a particular NWR or NWR complex.

The use of pesticides at Key Cave NWR meets these four tiers. Pesticide specific analysis is conducted through EPA's risk assessment process and the Service's PUP process (the first and second tiers above). The 2007 CCP/EA/FONSI included the cooperative farming program for Key Cave NWR; this included analysis of pesticide use in general (the third tier above). This EA for the SHSP and the CD for cooperative farming for Key Cave NWR tiers from the EA/FONSI for the CCP (USFWS 2007a, b) and provides additional discussion, including analysis of impacts (the fourth tier above). Section 7 biological evaluations are completed annually for PUPs. Further, a Section 7 will be included in this EA analysis of the SHSP.

Grassland Management

Managing and enhancing grassland habitat has been ongoing since the refuge's establishment. Approximately 360 acres of croplands have been converted to grassland habitat with a diverse mix of native grasses, forbs, and shrubs with the purpose of managing for grassland-dependent birds such as Northern Bobwhites and Grasshopper Sparrows. Prescribed fire has always been the primary management tool for providing desired habitat conditions. In both alternatives, grassland management using prescribed fire and chemical and mechanical treatments are proposed to continue into the future.

Refuge Revenue Sharing

Refuge revenue-sharing payments are payments made by the Service to counties to offset the loss of property tax payments for those tracts taken off the tax rolls. Payments to Lauderdale County will continue at similar rates under each alternative. If lands are acquired and added to the refuge, the payments will increase accordingly.

Alternative A – Continue Current Management (No Action Alternative)

Under Alternative A, refuge management will continue as outlined in the CCP (USFWS 2007a, b). Active cave habitat and wildlife management will continue to be limited to protection of the cave entrances and limited access to surface and subsurface habitats. Under Alternative A, passive management of the existing 407 acres in forest management units will continue. Cropland management will continue on 268 acres of existing cropland management units with 54 acres (20%) continuing to be left as supplemental wildlife food and to provide for public hunting opportunities. As outlined in the CCP (USFWS 2007a, b), cropland management will continue into the future to maintain these units in an early successional stage until such time as the Service could restore the existing croplands. Active management using prescribed fire on the 360 acres in existing grassland management units will continue for the long-term.

Based on recommendations from the Alabama Comprehensive Wildlife Conservation Strategy, the Wheeler Complex will explore methods to protect lands within the Key Cave high risk water recharge zone close to Key Cave NWR. The Service will work with the partners to explore various methods to protect these resources (e.g., through conservation easements, through technical assistance and advice from the Service to the landowner, and through other methods). At Key Cave NWR, the hunting program will be evaluated annually. Results will dictate if the hunting program should be expanded or reduced. Little to no environmental

education and wildlife interpretation will occur. Visitation will be expected to continue to experience small increases over time.

Alternative B – Implement the Spatial Habitat and Species Plan (Proposed Action)

Under Alternative B, the Service will implement the proposed SHSP, as detailed in the SHSP in Section A and the listed mapsheets, which are incorporated herein by reference.

- Mapsheet 1: Landscape and Key Cave NWR Overview
- Mapsheet 2: Key Cave NWR Cave Habitat Mapsheet
- Mapsheet 3: Key Cave NWR Grassland Early Successional Habitat Mapsheet
- Mapsheet 4: Key Cave NWR Forest Habitat Management Mapsheet

While contributing to other national, regional, and state goals to protect and restore karst habitats and species, refuge management will focus on the achievement of refuge purposes, including to ensure the biological integrity of Key Cave, Collier Cave, and the aquifer common to both caves, and to protect and conserve resources of concern on the refuge, such as the Alabama cavefish, Gray bat, Alabama cave crayfish, Grasshopper Sparrow, Northern Bobwhite, Loggerhead Shrike, and Mourning Dove as well as all other federally listed threatened and endangered species.

Alternative B will refine, update, and replace certain objectives or portions of objectives from the refuge's CCP (USFWS 2007a, b); a crosswalk is provided in Appendix B to clearly outline how the SHSP will update the CCP. Existing CCP goals will remain unchanged (See Background Section Above and Appendix B).

Alternative B will implement the SHSP, which steps down and provides specifics for several of the identified goals and objectives outlined in the CCP without changing the original intent. The focus under this alternative will be to manage, maintain, restore, and protect the refuge's habitats and wildlife species. Wildlife and plant monitoring and inventory activities will be initiated and maintained to obtain the biological information needed to continue current and implement priority management programs on the refuge. Multiple Key Cave NWR SHSP Mapsheets depict future habitat management on the refuge: Overview, Cave Habitat, Grassland Early Successional Habitat, and Forest Habitat. Active management of portions of the existing 407 acres in forest management units will occur under Alternative B.

Also under Alternative B, interim cropland management on 208 acres will be phased out with those 208 acres being converted to grassland habitat incrementally. The acreage in grassland management units will increase under Alternative B from the existing 360 acres to 568 acres following this phase out of croplands. To serve landscape and refuge management goals and objectives, supplemental wildlife food (e.g., sunflowers) under this alternative will be supplied on the remaining 60 acres that were historically cropland to support foraging northern bobwhites and the National Bobwhite Conservation Initiative; foraging mourning doves; and wildlife-dependent public use opportunities, including wildlife observation, photography, and hunting.

Active habitat management will be implemented in 24 units to maintain and enhance 360 acres of grassland; 208 acres will be added to the grassland management units from converted croplands. Forest thinning will occur in four units across 76 acres to convert woodlots to oak savannas. Croplands will be restored in 6 units (208 acres will be converted to grassland) and added to the grassland habitat on all but 60 acres. Conversion to grasslands will occur with a minimum of 25-50 acres per year. The Service will work with landowners and other Federal and state agencies within the recharge zone to protect water quality and quantity within the cave system. Important partners in this effort include Tennessee Valley Authority (TVA), Partners for Fish and Wildlife (USFWS), and U.S. Geological Survey (USGS). Continuous ground water quality monitoring is key to the conservation of the aquatic species utilizing the cave ground water corridors.

To maintain the existing cropland habitat in an early successional stage in preparation for conversion to grasslands, the Service will continue managing croplands until the conversion is complete as outlined in the Cooperative Farming Compatibility Determination and Early Grassland Successional Habitat Mapsheet. The refuge will identify and implement strategies to improve conditions on refuge lands for grassland and forest dwelling birds. The purpose of this effort will be to work with partners to provide a grassland system of sufficient size and carrying capacity to reach regional objectives associated with area-sensitive grassland birds. The Alabama cavefish and crayfish will be monitored to ensure stable populations. A properly trained survey team will perform ocular surveys on a 5-year frequency or at a sampling frequency that will be deemed appropriate. Gray bats will be surveyed once every two years during July by emergence counts.

Opportunities for wildlife-dependent recreation activities such as hunting, wildlife observation and photography, and environmental education and interpretation will continue to be provided.

Stepping down from the CCP and serving goals, objectives, and recommendations from the CCP (USFWS 2007), Gray bat (USFWS 1982, 2009) and Alabama cavefish (USFWS 2017, 2019a) recovery plans and 5-year reviews, Geological Survey of Alabama's (GSA) Groundwater Assessment Program (including GSA 2018), and the Service's Water Resource Inventory and Assessment (USFWS 2019k), the proposed Key Cave NWR SHSP articulates future habitat management objectives to provide further refinement, as listed.

Objective 1.A Cave Objectives

Contribute to the protection and maintenance of the integrity of Key Cave for appropriate abiotic and biotic conditions that are suitable to support a sustainable population of the Alabama cavefish (which is currently estimated to be between 100 to 130 individuals) and protect and maintain the integrity of Key Cave for the listed desired conditions and actions to continue to support a Priority 1 Gray bat maternal colony of approximately 36,000 adult females and to continue to support tricolored bat use.

1.A.1. Minimize groundwater contamination on 1,060 acres by utilizing selected Best Management Practices (BMPs).

1.A.2. Annually monitor water quality in Key Cave, including parameters such as ground water elevation, water temperature, dissolved oxygen, turbidity, nutrients, and pesticides to detect changes in water-quality over time.

1.A.3. Provide maximum protection of the Gray bat maternity colony within Key Cave to foster continued nutrient inputs that provides for micro-invertebrate communities of copepods, isopods, amphipods, and crayfish.

1.A.4. Within 5 years of this plan identify known and suspected sinkholes on the refuge and characterize each's hydrologic function/connectivity to Key Cave.

1A.5. Upon the development of an Inventory and Monitoring Plan, develop standardized protocol and methodology for cave and cavefish monitoring, including pool location, pool depth, species occurrence, species abundance, estimated age/size class, total number of individual surveyors, visual-timed area searches, and method of survey.

1.A.6. As technology advances in molecular science, utilize institutions for genetic sampling (e.g. eDNA) to determine Alabama cavefish population size, reproduction, genetic diversity and other aquatic species diversity.

1.A.7. Coordinate with TVA, USGS, and other partners to minimize disturbance in Key Cave from mid-April through September for Gray bats.

1.A.8. Coordinate with TVA, USGS, and other partners to minimize disturbance in the cave from mid-October through April for the tricolored bat.

1.A.9. Maintain a 0.25-mile protective forested cover buffer around the Key Cave entrance for Gray bat foraging and to minimize alterations in cave air flow and ambient temperature.

1.A.10. Biennially, conduct abundance counts during the summer months for Gray bats and during winter months for tricolored bats within Key Cave utilizing most current standardized protocols and methodology for cave and bat monitoring.

Objective 1.B Recharge Area Objectives

Contribute to the protection and maintenance of the integrity of Key Cave within the larger recharge area landscape and the endemic threatened and endangered species.

1.B.1. Within 5 years of the plan delineate and refine the recharge area.

1.B.2. Maintain a minimum, 300 acres of grassland habitat in native vegetation encompassing nearly 30% of the refuge land base to aid in ground water filtration, erosion reduction, and nutrient cycling.

1.B.3. Maintain 50 ft-wide vegetative buffer strips around cropland edges to aid in ground water filtration and soil erosion stabilization.

1.B.4. Maintain grassland, shrub/scrub, or forested habitat within and adjacent to wetlands, sink holes, and drainages.

1.B.5. In cooperation with Tennessee Valley Authority (TVA), maintain 300 acres of hardwood forests along the Tennessee River and Key Cave entrance, to aid in cave habitat protection, ground water filtration, and soil stabilization.

1.B.6. Annually monitor groundwater quality and quantity, including parameters such as ground water elevation, water temperature, dissolved oxygen, turbidity, nutrients, and pesticides to detect changes over time.

1.B.7. In cooperation with USFWS private lands biologist, support implementing water quality and recharge area protection projects with landowners within the Key Cave recharge area.

Objective 2A. Grassland Habitat Restoration Objectives

Convert 208 acres of cropland on Key Cave NWR to grassland-dominated, early successional habitat with a goal of 25 to 50 acres per year within Units 1 through 12 (See Figure 1 and Table 1. Criteria for Restoration Priority and Figure 1 and Table 2. Tiered Restoration Priority, Mapsheet 3) for grassland-dependent birds, such as the Grasshopper Sparrow, Northern Bobwhite, Dickcissel, and Loggerhead Shrike.

2.A.1. Using a stepwise approach to grassland restoration, convert 25-50 acres annually, evaluating the timeframe, acres restored, and approach every 2 years and adapting management as needed.

2.A.2. Begin immediately, converting cropland units outlined in Table 2 (SHSP Mapsheet 3) from the cooperative farming program into grassland habitat.

2.A.3. Annually thereafter, and adapting as indicated by monitoring, target conversion in accordance with the restoration priorities (SHSP -Table 2).

2.A.4. Prioritize the units to be restored based on restoration criteria in Table 2.

2.A.5. Utilize tools such as the cooperative farming program, grassland initiatives, and partners to assist in restoration.

2.A.6. Incorporate converted units to the prescribed burn program and other appropriate management regimes to maintain and enhance grassland habitats and apply Grassland Habitat Management Objectives.

Objective 2.B Grassland Habitat and Supplemental Wildlife Food Objectives

In units 1, 4, or 12, continue to annually provide minimal supplemental wildlife food sources (e.g., sunflowers) on no greater than 60 acres at Key Cave NWR to support shared Service and Alabama Department of Conservation and Natural Resources (ADCNR) goals and objectives for foraging Northern Bobwhites and the National Bobwhite Conservation Initiative; foraging mourning doves; and wildlife-dependent public use opportunities, including wildlife observation, wildlife photography, and hunting.

2.B.1. For the remaining 60 acres of supplemental wildlife food sources, use minimal inputs of fertilizers and pesticides and maintain borders along field edges with fifty-foot-wide native grass strips.

2.B.2 Work with the ADCNR to determine the most feasible delivery of supplemental wildlife food sources, including evaluating the use of Service staff and/or an agreement with the state.

2.B.3 Continue to maintain Best Management Practices and implement soil conservation practices to protect Key Cave NWR resources, including the cave and aquifer system.

Objective 2.C Grassland Habitat Management Objectives

On an annual basis at Key Cave NWR, manage 30% to 50% of the grassland-dominated, early successional habitat for the listed desired conditions for grassland-dependent birds, such as the grasshopper sparrow (*Ammodramus savannarum*), Northern Bobwhite (*Colinus virginianus*), and loggerhead shrike (*Lanius ludovicianus*).

2.C.1. Provide patches of grassland 75 acres or larger comprised of at least 30 percent native warm-season bunch grasses, such as big bluestem (*Andropogon gerardii),* little bluestem (*Schizachyrium scoparium),* indiangrass (*Sorghastrum nutans*), sideoats gramma (*Bouteloua curtipendula)*, switchgrass (*Panicum virgatum*), and Eastern gamagrass (*Tripsacum dactyloides*), and 40 percent forbs, such as partridge pea (*Chamaecrista fasciculata*) and beggarweed (*Desmodium incanum)* in units 0400, 1100, 0500, 0103, 1201, 0901, 0802, 0803, 0805, 0806, and 0600.

2.C.2. Provide up to 30 percent scattered patches of woody cover (ten feet wide or wider in diameter), including thorny shrubs, such as chickasaw plum (*Prunus angustifolia*) and sumac (*Rhus spp.)* in units 0300, 0201, 0202, 0203, 0102, 1100, 1201, 1300, 1007, 1002, 0904, 0804, 0801, 0702, and 0701.

Objective 2.D Forest Habitat Objectives

In the Oak Savanna and Hardwood Oak units at Key Cave NWR, reduce basal area, retain oak species, and increase herbaceous ground cover (as described below and referenced from: Nelson 2002; USDA 2005, CHJV pers. comm.) using forested thinning, prescribed fire, and other chemical and mechanical methods. Continue to provide a forested buffer in the Hardwood units around the cave and Tennessee River utilizing passive management; however, control invasive species in all units.

2.D.1. In all forest units survey selected plants, fish, and wildlife in forested areas pre- and post-management to monitor the effectiveness of forest management and change.

2.D.2 In units OS-S, OS-N, OS- SE, OS-W, HW-1, HW-2, HW-3, HW-4, Woodlot, and Woodlot 2 convert existing oak woodlots at Key Cave NWR to oak savanna habitat by reducing average basal area to 60 square-feet per acre, favoring white oak (*Quercus alba*) and other more fire-tolerant species with canopy cover ranging from 30-80%. Consider reducing to 40 square-feet basal area.

2.D.3 In above oak savanna units, increase native grass and forb cover and diversity in open areas to aid in savanna establishment.

2.D.4 Maintain shagbark hickory and other loose bark trees.

2.D.5 Provide passive forest management on 300 acres in units OA1, OA2, OA3, CS-1, and Main.

The recent programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices will be utilized to minimize impacts, include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations, will be utilized to address conflicting management actions (USFWS 2024). Additionally, habitat enhancements through these forestry practices are likely to benefit tree roosting bats long-term.

The scope and timeline to meet habitat and species management objectives are outlined in each Mapsheet; however, these activities can be adjusted accordingly to ensure feasibility within existing constraints. For example, the intent for cropland conversion is to incrementally convert 25 to 50 acres of cropland to grassland habitat annually, evaluating the timeframe, acres restored, and approach every 2 years and adapting management as needed. However, grassland restoration is costly, resource demanding, and requires adaptive management based on monitoring of success of previous efforts. Typically, the success of native grass establishment cannot be determined until 2-4 years after planting. In order to achieve success, time and resources are required for not only establishing grassland species but annual maintenance using prescribed fire and herbicide and mechanical treatment in subsequent years.

Adequate levels of refuge staffing and funding are necessary for successful future grassland restoration efforts. As during the grassland restoration process, it is critical that land is maintained in cropland habitat where it can be managed by the cooperative farming program until restoration can happen. Costs and time investments greatly increase in the grassland restoration process if the habitat becomes overgrown and unmanageable. It is most effective if grassland conversion is conducted through an incremental, well planned, strategic process. Therefore, a reduction in resources may prompt the refuge manager to re-evaluate any habitat or species objectives, including cropland conversion, thus implementation of proposed actions will be contingent upon the availability of resources and Full-Time Equivalents. The scope and timeline of these activities will be adjusted accordingly to ensure feasibility within existing constraints.

Affected Environment and Environmental Consequences

This section is organized by affected resource categories, and for each affected resource it discusses both (1) the existing environmental and socioeconomic baseline in the action area for each resource and (2) the effects and impacts of the Proposed Action and any alternatives on each resource. The effects and impacts of the Proposed Action considered here are changes to the human environment, whether adverse or beneficial, that are reasonably foreseeable and have a reasonably close causal relationship to the Proposed Action or alternatives. This EA includes the written analyses of the environmental consequences on a resource only when the impacts on that resource could be more than negligible and therefore considered an "affected resource." Any resources that will not be more than negligibly impacted by the action have been dismissed from further analyses.

The refuge's CCP (USFWS 2007a, b) outlined the affected environment (see Chapter II Refuge Overview) and the refuge's Water Resource Inventory and Assessment (WRIA; USFWS 2019b) depicted the natural setting of the refuge (see Chapter 4 Natural Setting), both of which are incorporated herein by reference. The refuge's CCP and WRIA are available to the public on ServCat at: https://ecos.fws.gov/ServCat/Reference/Profile/1468 and https://ecos.fws.gov/ServCat/Reference/Profile/112110, respectively. The affected environment is updated from the time of the CCP (USFWS 2007a, b) with the information provided in this section; the WRIA (USFWS 2019b); the SHSP in Section A, including the map sheets 1 through 4; and this EA, including tables 2 through 4.

Managed as part of the Wheeler NWR Complex, Key Cave NWR is currently 1,060 acres of land consisting of rolling hills, upland forests, grasslands, and cropland (see Figure 1 in Section B and Mapsheet 1). Currently, approximately 268 acres are in cropland (generally corn, soybeans, or sunflowers) under a Cooperative Farm Agreement (see Mapsheet 3), 360 acres are in early successional fields or native warm season grasses (see Mapsheet 3), 122 acres of former cropland have been planted in hardwoods (see Mapsheet 4), 30 acres of erosion drainages are being restored to grassland or hedgerow habitat (see Mapsheet 3), 75 acres are being converted to an oak savanna (see Mapsheet 4), and the remaining 195 acres consist of upland forested land dominated by oaks and hickories (see Mapsheet 4). The refuge supports key resources of management concern of the Alabama cavefish, Gray bat, tricolored bat, Alabama cave crayfish, Grasshopper Sparrow, Loggerhead Shrike, Northern Bobwhite, and Mourning Dove; and hosts approximately 7,000 annual visitors; 30% of those are hunting and 70% are wildlife observation and photography (RAPP data 2023). Key Cave on Key Cave NWR and adjacent TVA property is the only known location where the Alabama cavefish is found (see Mapsheet 2).

Affected Environment and Effects Common to All Alternatives

Socioeconomic Overview and Impacts

Both alternatives will be expected to have no or negligible impacts to socioeconomics.

Affected Environment and Overview of Potential Adverse Impacts

Table 3 identifies those resources that either don't exist within the project area or will either not be affected or only negligibly affected by the Proposed Action and those resources that may have greater than negligible impacts. Those resources for which the action is not applicable or for which no or negligible impacts will be anticipated are not further analyzed in this EA.

Table 3. Potential for Adverse Impacts from Proposed Action and Alternatives [1]

Resources	Not Applicable: Resource does not exist in project area	No / Negligible Impacts: Exists but no or negligible impacts	Greater than Negligible Impacts: Impacts analyzed in this EA
Wildlife and Aquatic Species	☐	☐	☒
Threatened and Endangered Species and Other Special Status Species	☐	☐	☒
Habitat and Vegetation (including vegetation of special management concern)	☐	☐	☒
Hydrology, Geology, and Soils	☐	☐	☒
Air Quality	☐	☒	☐
Water Quality	☐	☐	☒
Floodplains	☐	☒	☐
Wilderness	☒	☐	☐
Visitor Use and Experience	☐	☒	☐
Cultural Resources	☐	☒	☐
Refuge Management and Operations	☐	☐	☒
Socioeconomics	☒	☐	☐

For each resource of the refuge with the potential for greater than negligible impacts, map sheets 1 through 4 provide more detailed information and tables 4 and 5 provide:

- a brief description of the relevant general features of the affected environment;
- a description of relevant environmental trends and planned actions;
- a brief description of the affected resources in the Proposed Action area; and
- impacts of the Proposed Action and any alternatives on those resources.

Table 4. Affected Natural Resources and Anticipated Impacts

AFFECTED RESOURCE	ANTICIPATED IMPACTS BY ALTERNATIVE
Wildlife and Aquatic Species (See Section A – Supplemental SHSP Document for Resources of Concern; CCP (USFWS 2007); and Mapsheet 1-4) ***Affected Environment Description*** Key Cave NWR provides habitat for a variety of migratory and resident wildlife species. One hundred and sixty-five bird species have been sighted on the refuge. Several grassland-dependent bird species are commonly seen during the breeding season, including Dickcissel, Grasshopper Sparrow, Field Sparrow (*Spizella pusilla*), and Northern Bobwhite. Northern Harriers (*Circus hudsonius)* can be seen flying low over refuge grasslands searching for prey during the winter months and Short-eared Owls (*Asio flammeus*) can also be seen occasionally during the winter. Other commonly seen wildlife species include Eastern cottontail rabbits (*Sylvilagus floridanus mearnsi),* coyotes (*Canis latrans*), White-tailed deer (*Odocoileus virginianus),* Gray squirrels (*Sciurus carolinensis*), Eastern Meadowlarks (*Sturnella magna),* Mourning Doves (*Zenaida macroura*), Horned Larks (*Eremophila alpestris*), and Eastern Bluebirds (*Sialia sialis*). Recently, invasive feral hogs (*Sus scrofa*) have been documented on Key Cave NWR. Many other wildlife species can be found on Key Cave NWR, including a wide variety of invertebrates, amphibians, reptiles, and mammals. ***Environmental Trends and Planned Actions Description*** Key Cave NWR is located in northwest Alabama in Lauderdale County, adjacent to Colbert County. The combined population of the two rural counties in 2021 was 150,131 (93,342 in Lauderdale County and 56,789 in Colbert County). From 1970 to 2021, population in the two counties experienced a 28% increase, which was less than the 46% increase for Alabama over that same time period. The area surrounding the refuge is mostly rural and agricultural, which has been and is expected to continue to be slow to urbanize with the limited population growth. (Based on U.S. Department of Commerce American Community Survey data, Headwaters Economics 2023; see the Socioeconomic Overview and Impacts section above for additional information) The State Wildlife Action Plan (SWAP) provides detailed descriptions of the habitats, assessment of threats to those species/habitats, and conservation actions needed to address those threats. The SWAP recognizes that much of the state is privately owned, and state and federal land management is only a small part of the conservation efforts	**Alternative A** Under the No Action Alternative, habitat management will continue on grasslands and croplands as in the past to support grassland birds and bobwhite quail. Minimal forest management will also continue to occur as possible. Working with partners, the Service will continue to utilize prescribed fire to set back field succession every 2 to 4 years and maintain buffers around field edges and known sink holes and waterways. Cooperative farming will continue to be utilized until the Service is able to convert large acreages to grassland habitat and rotate into the prescribed burning program or convert to other appropriate habitats. Negligible to minor, adverse, temporary impacts will continue to wildlife and aquatic species, including migratory birds, herptofauna, and mammals from continued habitat management. ***Early Successional Habitat Management*** Burning or mowing fields to keep them in a perpetual grassland state will exclude upland species that prefer later successional stages (e.g., shrubland and forestland) from using these fields. However, the refuge provides a variety of successional stage habitats, with grasslands being just one component of a complex habitat matrix. While no single date is best for every species, it is generally agreed that reducing prescribed fire and mowing from April to August allows the majority of bird species to nest and fledge at least one brood (Birckhead et al. 2013, Bollinger et al. 1990, Dechant 2007, Perlut et al. 2006, USDA 2009, Warner and Etter 1989). Additionally, mortality can be reduced from mowing or burning by leaving unmanaged strips within or around the edge of a field (Allen et al. 2019, Tyler et al. 1998). The major effects of prescribed burning on wildlife are mostly indirect yet change in the structure and composition of vegetation impacts availability of food and cover, which directly influences the health, abundance, and diversity of wildlife (USDA 2012). Direct mortality of wildlife from prescribed burning is rare; prescribe burning will continue to be scheduled during periods that are not critical to reproduction and survival of wildlife. Prescribed fire does not necessarily benefit aquatic organisms, but it should not have adverse effects when implemented properly (USDA 2012). Waterways are often used as firebreaks, and when fire enters into a riparian zone, it should not be detrimental since fire is often not carried very well in these moist and humid environments. Plowed or disked areas, roads, and levees also act as firebreaks. Adequate buffers will continue to be maintained between the firebreak and riparian zone to prevent possible sedimentation, which is much more likely to result from a plowed or disked firebreak than under burning in the riparian zone. Indeed, the positive effects of prescribed burning on vegetation and associated wildlife are just as applicable in a riparian zone as in the uplands. Within grassland habitats, fields that are mowed or burned annually or bi-annually will continue to provide habitat for short grass preferring species at the expense of species that prefer less disturbed grassland habitats. Grasslands that are mowed or burned less than annually (e.g., once every two or three years) have taller grasses and more residual material (litter) during years when no mowing or burning takes place. Rotating management of a given tract will continue to keep litter available for species that require it. Some bird species prefer to nest in grasslands with little to no litter, while others prefer areas with more litter (Morgan and Burger 2008). The refuge will continue to provide suitable habitat for both short and tall grass preferring species, and usually no more than one half of the grassland acreage will be managed each year. This spatial and temporal disturbance interspersion is important for providing a variety of grassland cover types across the refuge landscape and ensures that there will be newly managed areas and undisturbed areas within the same habitat mosaic each season (Harper 2007, Herkert et al. 1996). Aquatic systems on the refuge will benefit from improved water quality and decreased sedimentation from the rehabilitation and implementing of BMPs used to enhance the hydrology of the landscape. Freshwater fish and other aquatic species have complementary habitat requirements that will be expected to benefit from the management strategies outlined in this plan. Field preparation and planting cause both beneficial and adverse short-term wildlife impacts, including mortality to small animals and birds from machinery (Erb and Jones 2011, Tews et al. 2013, Deák et al. 2021) and temporary disturbance from the noise and movement of farming equipment. Literature suggests that mammals and birds alter their movements short-term but return to normal activity within a

AFFECTED RESOURCE	ANTICIPATED IMPACTS BY ALTERNATIVE
statewide. Alabama's land and waterscapes are threatened by habitat loss and fragmentation, loss of natural community integrity, impacts from disturbance and exotic species, and lack of adequate protection or information. The SWAP describes the need to limit habitat fragmentation, address degradation, and reduce conversion of habitats from development and agriculture as examples of the major stressors to populations of reptiles, amphibians, and other nongame animals in the state. The SWAP identifies Conservation Opportunity Areas where partners are needed to create opportunities for conservation in identified priority geographic areas. Priority habitats were ranked in this geographic area to create a comprehensive opportunity area with species of greatest conservation need from threats ranging from climate change to direct human disturbance. Examples in the SWAP range are based on species needs and habitat limitations. Examples of threats, such as sand and gravel mining, transportation infrastructure, off-road vehicles, stream modification, feral hogs, pollution, and climate change, apply to many species that occur on the refuge (ADCNR 2016.) Amphibian and reptile conservation and management are of great interest to conservationists due to global declines. Habitat loss, fragmentation, and degradation appear to be the primary factors influencing declines. This group of animals requires quality wetland habitat and their population numbers serve as important indicators of environmental health (Trauth et al. 2004). The Service is unaware of any other environmental trends or planned actions that will adversely impact wildlife and aquatic species, including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for wildlife and aquatic species.	couple of days after limited noise disturbance (Bowles 1995). Mammals and birds also habituate more rapidly to mechanical noise, such as farm equipment, than to direct human activity, such as hunting and wildlife observation (Gabrielsen and Smith 1995). Spring disking alters the wildlife use pattern by temporarily displacing wildlife until vegetative covers regenerate; however, once crops mature, they provide food and cover for wildlife. Disturbed wildlife relocate to avoid management actions and expend more energy than if they had remained at rest. While management actions will have temporary, localized short-term impacts to populations of game and non-game species, associated disturbance will not be a long-term threat to populations because the relocation will be temporary and food is generally not a limiting factor. Most animals will be able to readily replace those energy reserves they use in response to disturbance factors. Soil disturbance will occur when cropland areas are disked during the spring planting season, but these impacts will continue to be lessened by the implementation of no-till and conservation tillage farming methods. It is Service policy that the long-term productivity of the soil is not jeopardized to meet wildlife objectives (601 FW 3, 569 FW 1). Buffer strips adjacent to waterways and sensitive areas help trap sediments and reduce agricultural run-off, thereby protecting water quality. Pesticide use will continue to be minimal on the refuge. Other impacts may include disturbances to wildlife while faming machinery is being operated. Some mortality of non-target (i.e., non-pest) invertebrates, small mammals (e.g., mice, voles), and herptiles could be expected from operation of farm machinery, but the mortality will be expected to be minor. Short-term impacts to native vegetation communities may occur but will be offset by increased productivity of carbohydrate-rich foods for upland bird species, setting back woody encroachment in designated fields to aid in maintaining herbaceous communities, and increasing diversity of plant communities that results in an enhanced combination of native plant and crop forage. Leaving the refuge share of the crop in the field will supplement the availability of forage for wildlife. Passerine birds and various mammals will continue to feed on seed heads/waste grain. Raptors may benefit from exposure of prey when fields are not heavily vegetated. Bobwhite quail populations across the state have declined dramatically since the 1960s and remain near all-time lows. Huntable populations exist on properties where management efforts are focused on intensive bobwhite quail habitat improvement and management [North American Bird Conservation Initiative (NABCI) 2022]. Further, the 2021 State of the Bobwhite Report highlights that the AWFFD "...partners with various agencies, organizations, and private landowners to improve and restore bobwhite quail habitat on public and private lands" [National Bobwhite Conservation Initiative (NBCI) 2021]. The Service will continue and increase grassland restoration and maintenance with appropriate best management practices including, implementation of buffers of drainageways and sinkholes. Further, the Service uses an adaptive management approach with regular coordination, monitoring, and re-evaluation of cooperative farming activities to help ensure that the use continues to meet the requirements of compatibility and support refuge management goals and objectives and that the use does not contribute to any adverse cumulative impacts. Cooperative farming is an existing use of the refuge. Implementation over time has not been shown to have adverse impacts to wildlife, including threatened and endangered species; wildlife habitat, including wetlands, the cave system, and the aquifer; water quality; visitor services; other refuge management programs; cultural resources; adjacent landowners; socio-economics; and public health and safety. Cooperative farming will continue under Alternative A. ***Forest Management*** Centuries of anthropogenic impacts have altered every major forested ecosystem in the southeast such that desired habitat conditions can only be restored or maintained with active forest habitat management. Forest structure and composition have been significantly altered by centuries of prior and/or off-site actions and normal forest function no longer occurs at the frequency and scale necessary to create and maintain desired habitats. Because of the dynamic nature of ecosystems, the impacts of all habitat management, including all forest management, are variable and depend upon many factors, including the complex interaction of biotic and abiotic factors unique to the site at the specific time of treatment and the silvics of the species on site. Little forest management will occur under Alternative A. Wildlife species respond differently to forest management activities that include timber harvest depending on forest type and harvest intensity (Fredericksen et al. 2000). Even within groups of wildlife species (amphibians, reptiles, birds, mammals, etc.) the effects are variable and often species-specific. Many studies have demonstrated the importance of early-successional forest habitat for breeding bird abundance,

AFFECTED RESOURCE	ANTICIPATED IMPACTS BY ALTERNATIVE
	composition, and diversity. Numerous declining forest bird species in Bird Conservation Regions (BCR) are reliant upon forest habitat with dense understory development, historically caused by local disturbances. For example, the Canada warbler, a species of conservation concern, is often found in mature forested habitat where tree gaps allow for the development of localized understory shrub and sapling development (Lambert and Faccio 2005). Forest management to simulate additional tree gaps gives the understory a chance to grow resulting in a positive impact on many bird species. Achieving desired forest conditions moves closer to achieving desired habitat conditions for all species on the refuge. ***Invasive Species Control*** Feral hogs have been destroying habitat and damaging crops on the refuge and in the surrounding area. Observations indicate that the population of feral hogs is increasing at Key Cave NWR. Current efforts to control the feral hogs by Service staff and volunteers have been unsuccessful and damage continues. The minimal animal control methods such as trapping will continue to be tools used to maintain a balance between native wildlife populations and the habitats in which all wildlife species depend. The effects of trapping exotic invasive wildlife species on native wildlife populations will be intended to be positive and negative impacts will be monitored and limited by reducing bycatch of non-target species. **Alternative B:** While minor adverse temporary impacts could be expected during habitat management and restoration activities under the Proposed Action, overall, minor beneficial impacts to wildlife and aquatic species will be expected. Under the Proposed Action, wildlife population monitoring/surveying will occur to assess population status, trends, wildlife habitat associations, and population responses to habitat management. Monitoring and surveys will be conducted for a broad range of species, including: all cave dwelling species; grassland birds; and other resident, migratory, and wintering wildlife. Some surveys will be conducted annually, while others will be conducted only frequently enough to determine population status and trends and response to habitat management. Similar effects described under Alternative A will be expected under the Proposed Action. Populations will be expected to increase with additional actively managed acreages of old field, grassland, oak savanna, and upland forested habitats. Many wildlife species are dependent on grasslands to fulfill some or all of their breeding and foraging habitat requirements. Without grassland habitats across the landscape, these species' populations will significantly decline or disappear altogether. In many areas, grasslands are the first stage in the successional continuum. Without periodic disturbance (e.g., mowing or burning), these grasslands become forb dominated and are eventually taken over by woody species, with a mature forest usually being the final stage in this succession. Increased conversion of cropland units (208 acres) to native grasslands will increase habitat structure for resources of concern. On the remaining 60 acres of agricultural crops for supplemental wildlife food, little to no pesticide and other farming inputs will be utilized. Continuing to maintain no more than 60 acres of supplemental agricultural crops at Key Cave NWR, will continue to support the Northern Bobwhite Conservation Initiative, which has shifted to a landscape scale for bobwhite quail restoration. For the state of Alabama, the 2021 State of the Bobwhite Report summarizes the state's population status. Achieving desired forest conditions moves closer to achieving desired habitat conditions for all species on the refuge and increased management will help increase populations of priority resources of concern. Targeted removal of pests and predators from portions of the refuge will reduce the negative impacts these species have on ecosystem functions. Pest and predator species control has been documented to provide a variety of ecological benefits, including prevention and alleviation of habitat degradation, facilitation of habitat and wildlife restoration, dampening of disease transmission and severity of disease outbreaks among wildlife and between wildlife and humans, maintaining the integrity of infrastructure, and the conservation and enhancement of biological and genetic diversity (Boggess et al. 1990, Organ et al. 1996).

Threatened and Endangered Species and Other Special Status Species (See Mapsheet 2 Cave Habitat)

Affected Environment Description

As previously discussed, the refuge provides habitat for 7 Federally listed species, including critical habitat for the Alabama cavefish which only occurs in Key Cave. Also as outlined above, another 23 Federally listed mollusk species historically occurred or could potentially occur in the adjacent Tennessee River; however, many have been extirpated, with only 7 of these species likely to occur near the refuge. The ones known or likely to occur on the refuge are: Alabama cavefish, Northern long-eared bat, Gray bat, Indiana bat, tricolored bat, Whooping Crane, and monarch butterfly. The ones that could likely occur in the adjacent Tennessee River include the pink mucket, rough pigtoe, sheepnose mussel, spectaclecase, white warty-back, and longsolid.

Alabama Cavefish and Critical Habitat (Key Cave)

Listed as endangered, the Alabama cavefish is only known to occur in Key Cave. While the Cave itself is predominantly on the refuge, the Cave entrances are protected on adjacent Tennessee Valley Authority (TVA) property. The majority of the aquifer and recharge area are not in public ownership; the landscape around the refuge has a variety of overlying land uses and activities, including pasture/hay, cultivated crops, forest, and developed. The species continues to face threats from groundwater degradation, lower groundwater levels, in addition to diminished organic input by bats; these threats coupled with the species' restricted range and small population size increases its vulnerability (USFWS 1985, 2019a). Research and monitoring have shown the Alabama cavefish population to range between 100 and 130 individuals.

Bats – Northern Long-Eared, Gray, Indiana, and Tricolored

The Northern long-eared bat, Gray bat, and Indiana bat are listed as endangered, while the tricolored bat is proposed for listing as endangered under the Endangered Species Act. Northern long-eared bats, occur on the refuge and Gray bat bats and tricolored bats are known to utilize Key Cave at various times of the year. Indiana bats could potentially occur on the refuge. The cave is also a priority one maternity cave for the endangered Gray bat which utilizes the cave during the summer months. Gray bat emergence counts are conducted annually at Key Cave and have averaged 33,400 Gray bats since 1997. Approximately 12,000-13,000 young Gray bats are produced annually by this maternity colony.

Human disturbance is the main reason for the continued decline of Gray bats in caves that are not protected (Tuttle 1979, 1987; Rabinowitz and Tuttle 1980; USFWS 1982; Mitchell 1998; Martin et al. 2000, 2003; Shapiro

Alternative A:

Under Alternative A, impacts to threatened and endangered species and other special status species will be expected to continue to be negligible to minor beneficial.

The 2007 CCP/EA/FONSI (USFWS 2007a, b) analyzed the impacts of the outlined refuge habitat management, including fire, farming for natural resource management, light forest management, and protection of cave resources. The 2007 FONSI for the CCP's EA found that no significant impacts were expected to result from implementation of these management actions. Further, the Section 7 ESA consultation for the CCP and the Section 7 ESA consultations for the annual Pesticide Use Proposals all support the CCP's FONSI (USFWS 2007a, b). Although unlikely, potential adverse impacts to the Alabama cavefish, cave ecosystem, and aquifer could occur from pesticide use from continued 268 acres of cropland management. Additionally, pesticides used in crop production, cropland conversion and woody reduction within grassland habitat have the potential to enter the aquifer. Contaminants and groundwater degradation are listed as concerns by the USFWS (Kuhajda 2004a, b; Culver and Pipan 2009; USFWS 2017). However, cavefish surveys have occurred since the 1970s and are currently recurring every 5 years; populations are assumed to be stable with reproduction based on different size/age classes (USFWS 2017). Water quality monitoring in Key Cave has occurred on several occasions with the most recent sampling occurring in 2023. Elevated nitrates were detected in several pools, but similar to past studies. Traces of herbicide metabolites were also present in water samples, most of which are not being applied on the refuge (Kuhajda et al 2024). Long-term and current monitoring data indicate that continuing current management actions will not be likely to adversely affect the Alabama cavefish, the cave ecosystem, and the recharge aquifer.

Alternative B:

Under the Proposed Action, minor beneficial impacts to threatened and endangered species and other special status species will be expected to occur. Impacts to threatened and endangered species, especially the Alabama cavefish, on the refuge may occur from decreased water quality and disturbance. Because of the juxtaposition of the cropland habitat and agriculture operations on the refuge within the Key Cave recharge area, several evaluations of groundwater quality in Key Cave have been conducted to determine the effect of runoff and groundwater infiltration of nutrients and pesticides from the farming activities. The refuge will continue to monitor water quality, disturbance, and other possible effects of the cooperative farming program to ensure protection of the threatened and endangered species.

Serving NWRS mandates and refuge purposes, the proposed SHSP will support multiple refuge management goals and objectives articulated in the CCP (USFWS 2007a, b), including those listed in Appendix B of SHSP. The Key Cave NWR SHSP Cave Habitat Mapsheet 2 depicts future cave habitat recharge zone; protection of the cave entrance, Alabama cavefish, and other aquatic species; and bat objectives and strategies. The Alabama cavefish and Alabama cave crayfish will be monitored to ensure stable populations. A well-designed survey protocol will be established with a survey frequency that will best predict Alabama cavefish abundance and trends. A properly trained survey team will perform ocular surveys during the winter season. During these surveys, the occurrence of any bats will also be noted. In cooperation with the state and TVA, the Service will support continuing annual Gray bat emergence counts and tricolored bat winter hibernacula surveys. The implementation of management actions outlined in the SHSP, including cave protection, water quality and cave fauna monitoring, and protection of the recharge aquifer will be expected to have positive impacts on the Alabama cavefish population. Continued protection of Key Cave, including restricted entry, will promote positive effects to the cave ecosystem and bat winter hibernacula.

Management actions, including savanna and grassland management and cropland conversion, will be expected to have positive impacts on the federally listed species populations. While the cooperative farming program will be phased out, potential impacts will be minimized by all fertilizer, soil amendment, and pesticide applications following strict requirements, including the approved PUPs' conditions and restrictions, Cooperative Agriculture Agreement and special use permit conditions and restrictions, label and application restrictions, and BMPs. Existing BMPs that will continue include, but are not limited to, vegetative borders around crop field, monitoring and establishing invasive and pest thresholds, and minimizing and adhering to appropriate application rates.

The conversion of 208 acres of cropland will increase native vegetative cover and buffers that protect soil, stabilize sediment, and filter ground water and runoff. Grassland restoration and continuing to provide vegetative buffers especially around wetlands and sinkholes will likely benefit surface and ground water quality. Minimal amounts of herbicides required will be used for management of remaining crops and

and Hohmann 2005; Martin 2007; Sasse et al. 2007; Elliott 2008; USFWS 2009). The Gray bat uses the forested habitat along the river portion of the refuge for foraging during the active season which can occur between March and early November. The tricolored bat uses the cave as a winter hibernaculum and uses the forested habitat of the refuge for foraging and roosting during the active season which can occur between March and early November. The Northern long-eared bat also uses snags and loose bark and the tricolored bat uses leaf clusters within forested habitat for summer roosts. White-nose syndrome is impacting all four bat species. The primary factor influencing the viability of the Northern long-eared bat is white-nose syndrome; other factors affecting its viability are wind energy mortality, climate change impacts, and habitat loss (USFWS 2022b). Biologically intrinsic needs of the Indiana bat include limiting use of fat during hibernation, obligate colonial roosting, high energy demands of pregnant and nursing females, and timely parturition and rapid development and weaning of young; factors that may exacerbate vulnerability of the Indiana bat because of these constraints include energetic impacts of significant disruptions to roosting areas (both in hibernacula and maternity colonies), availability of hibernation habitat, and connectivity and conservation of roosting-foraging and migration corridors (USFWS 2007b). The primary factors influencing the tricolored bat's viability include white-nose syndrome, wind related mortality, effects from climate change, habitat loss, and conservation efforts (USFWS 2021b). Northern long-eared, Indiana, and tricolored bats have decreasing population trends (USFWS 2019c, 2022b). **Freshwater Mussels** • Dromedary Pearlymussel • Orangefoot Pimpleback • Pink Mucket • Ring Pink • Rough Pigtoe • Sheepnose Mussel • Fanshell • Spectaclecase • White Warty-Back • Alabama Lampmussel • Birdwing Pearlymussel • Clubshell	for woody plant removal. Herbicide application methods for woody reduction will favor more selective methods such as stump or foliar treatment as opposed to broadcast applications to reduce excess usage. Additionally, and most significantly, the use of GECs reduces the need for broad-spectrum insecticides required to produce a crop (USFWS 2020c). There could potentially be some adverse effects on individual bats through herbicide use, mulching, or prescribed fire operations. However, the long-term benefits provided by forest thinning and habitat enhancements will be expected to benefit multiple species. Prescribed fire in or adjacent to forest habitat could have the potential to affect bats. Bats can be sensitive to the timing and intensity to fire. High intensity fire in or adjacent to forest habitat and conducted during summer bat roosting has potential to disturb or harm bats and their roosts (Boyles and Aubrey 2006). Likewise, mulching and woody plant reduction near potential roost trees will be minimized within the active season (April 1 to November 15). Pesticides will be used for the purposes of cropland management, cropland restoration, and woody plant reduction. Although known environmentally harmful pesticides such as organochlorines are no longer used, the use of modern insecticides could potentially impact local food sources for bats (Torquetti et al. 2021). However, little information exists on the effects of indirect application of pesticides, specifically those targeting undesirable plants. Although pesticides will be applied during diurnal periods and not directly to bat roosting habitat, there may be possible unknown indirect effects. Minimizing prescribed fire operations and forest management operations outside of the non-active winter periods (November-March) within forest units will reduce any potential impacts caused by these management activities. Because Northern long-eared bats roost underneath bark and under crevices in both live trees and snags during the active season (March-November), fire and forestry practices will avoid or minimize activities in these habitats. Prescribed fire and forestry practices that can be implemented to minimize impacts include reducing fire intensity within forest units, avoiding known bat roosts, and retaining or creating snags during mulching/thinning operations. Minimizing impacts of forestry activities and prescribed fire will be difficult. Under the recent programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices that are recommended to minimize impacts include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations (USFWS 2024). Additionally, habitat enhancements through these forestry practices are likely to benefit tree roosting bats long-term.

• Cracking Pearlymussel • Cumberland Bean • Cumberland Monkeyface • Cumberlandian Combshell • Oyster Mussel • Finerayed Pigtoe • Longsolid • Shiny Pigtoe • Winged Mapleleaf • Purple Cat's Paw **Freshwater Snail** • Anthony's Riversnail While the above-listed mollusks do not occur on the refuge, they historically occurred or could occur in the adjacent Tennessee River; reintroductions of experimental populations could occur near the refuge in the adjacent Tennessee River. In the early 2000s, the USFWS reintroduced many of these mollusks into historical habitat in the free-flowing reach of the Tennessee River. The geographic boundaries of the nonessential experimental populations (NEPs) extended from the base of the Wilson Dam [River Mile 259.4 (414.0 kilometers)] to the backwaters of the Pickwick Reservoir [RM 246.0 (393.6 km)] and included the lower 5 RM (8 km) of all tributaries that enter the Wilson Dam tailwaters. The dromedary pearlymussel is considered extirpated or of unknown status in the wild outside of the Powell and Clinch rivers; in 2018, 8 were recovered live of the original 80 introduced in 2003 to the Tennessee River below the Wilson Dam near the refuge (USFWS 2020e). The orangefoot pimpleback is considered extirpated in the Tennessee River in Alabama (USFWS 2023a). While little quantifiable information is available to estimate total population size for the pink mucket, the species is considered uncommon historically and currently, but stable with a low potential for recovery; the pink mucket in Wilson Dam tailwaters is considered to not be faring well (USFWS 2019d). The ring pink has not been recorded from the Tennessee River since the early 1990s, and the species may already be functionally extinct in the wild (USFWS 2019e). The rough pigtoe is not considered viable due to its limited occurrence and population demographics, and it has a low potential for recovery; it is considered extremely rare in the Tennessee River, however, 18 were found in 2017 and 2018 in surveys in the tailwaters of Wilson Dam after 178 hours of searching (USFWS 2021c).	

The sheepnose mussel has not improved since its listing, has a low potential for recovery, and is likely declining in the Tennessee River Basin (USFWS 2020f). The fanshell is sparsely distributed outside of the Clinch River in Tennessee and Virginia and the Green, Licking, and Rolling Fork rivers in Kentucky, and has a low potential for recovery; all known populations are located within the Ohio River Basin, away from the refuge (USFWS 2019f). The spectaclecase has not improved since listing, has a low potential for recovery, and has an unknown population status in the Tennessee River in Alabama (USFWS 2019g). The white wartyback has low potential for recovery since it has not been observed in most portions of its former range; the only known extant populations are from a reach of the Tennessee River downstream of the Wilson Dam in Alabama and near Savannah, Tennessee (USFWS 2023b). While the Alabama lampmussel has been eliminated throughout a majority of its historical range, the population is stable; the current range does not include the refuge and is the Emory River Watershed in Tennessee and the Paint Rock River Watershed in northern Alabama and southern Tennessee, north of Scottsboro, Alabama (USFWS 2020g). The birdwing pearlymussel population is declining and efforts to reestablish a population below Wilson Dam have been unsuccessful (USFWS 2020h). Historically occurring in Alabama, the clubshell has a low recovery potential and seems to no longer occur in Alabama (USFWS 2019h). Extirpated from nearly all of its historical range, the cracking pearlymussel is declining; the population is believed to be extant only in the Tennessee River Basin in a short reach of the Elk River and in a short reach of the Clinch River, which is not near the refuge (USFWS 2019i). Historically occurring in Alabama, Kansas, Kentucky, Tennessee, and Virgiana, the Cumberland bean population is declining with a low potential for recovery; it is restricted to tributary streams of the upper reaches of the Cumberland River, which is not near the refuge (USFWS 2020i). Within the Tennessee River system, evidence and the scientific community recommend taxonomic changes to combine the Cumberland bean (*Villosa trabilis)* and purple bean (*Villosa perpurpurea*) to be recognized as a single species called the Tennessee bean (*Venustaconcha trabilis*) (USFWS 2020i). The Cumberland monkeyface population is stable with populations in the Powell River in Virginia and Tennessee and Duck River in Tennessee (USFWS 2021d). The Cumberlandian combshell population is stable with extant populations in Kentucky, Tennessee, and Virginia, as well as in part of Bear Creek in Alabama and Mississippi, none of which are near the refuge (USFWS 2019j). Limited to the upper Tennessee River system and the Cumberland River system, the oyster mussel is declining with low potential for recovery (USFWS 2019k). The scientific community	

supports splitting the oyster mussel complex with a new species, Duck River Dartersnapper (*Epioblasma ahlstedti*); the two may be split geographically near the refuge, which will impact which species to be reintroduced near the refuge (USFWS 2019k). The finerayed pigtoe population remains small and localized with low potential for recovery; with extirpation of the species from the Elk River, the Paint Rock River in Alabama is now considered to harbor the most downstream population in the Tennessee River system, which is not near the refuge (USFWS 2022c). The longsolid was once a common and occasionally abundant component of the mussel assemblage across 12 states, which has now decreased to nine states with potential future extirpation of between 3% and 73% of currently extant populations; low numbers of the longsolid will be expected in the Tennessee River around the refuge (USFWS 2022d). Present in Virginia, Tennessee, and Alabama, the shiny pigtoe population is stable with a low potential for recovery; the Alabama population is in the Elk River, which is not near the refuge (USFWS 2021e). The winged mapleleaf has a high recovery potential with extant populations in Minnesota, Wisconsin, Missouri, Oklahoma, and Arkansas (USFWS 2015). Currently occurring in the Ohio River and four of its tributaries, the purple cat's paw has a low potential for recovery (USFWS 2020j). The Anthony's riversnail population has a low potential for recovery; it occupies the Tennessee River from Marion County, Tennessee to Jackson County, Alabama, which is not near the refuge (USFWS 2023c). **Whooping Crane** Efforts to establish and maintain self-sustaining wild populations of Whooping Cranes through reintroduction have been unsuccessful. Viability of the species is impacted by lack of large blocks of suitable habitat, growth of the human population and associated development patterns, climatic factors (especially drought), power and electrical line collisions, impacts of wind energy development and operation, collisions with other vertical structures, and chemical spills. The refuge is along the migration route of the Eastern Migratory Population (experimental population) that migrates between Florida and Wisconsin. The wild whooping crane population has had a small, but steady increase from 15 individuals in 1941 to 543 in 2022. (USFWS 2011). Currently there are no records of whooping cranes occurring on Key Cave NWR. However, 18 winter on Wheeler NWR annually and several utilize other areas in northeast Alabama. The Whooping Cranes that winter in northern Alabama arrive in early November and begin their northern migration in late February-early March. During the winter they consume grains in agriculture fields and forage in wet meadows, shallow wetlands, and along mudflats of the Tennessee River.	

Monarch Butterfly

The monarch butterfly is a migratory insect species that spends part of its life cycle in North America. Due to declining trends, the monarch butterfly is currently considered a candidate species under the Endangered Species Act (USFWS 2020k). The primary drivers affecting the health of the two North American migratory populations are primarily: loss and degradation of habitat (from conversion of grasslands to agriculture, widespread use of herbicides, logging/thinning at overwintering sites in Mexico, senescence and incompatible management of overwintering sites in California, urban development, and drought), continued exposure to insecticides, and changes to environmental condition (USFWS 2020k). Monarch butterflies spend spring and summer in areas of North America and prefer open field and grassland habitats. The primary host plant for the monarch in North America is milkweed. Surveys have not formally been completed to indicate monarch or milkweed presence on the refuge, but monarchs are present throughout northwest Alabama from late August through October and will be presumed to be present on the refuge.

Environmental Trends and Planned Actions Description

The Key Cave recharge area is approximately 20 square miles (12,800 acres) in size and has been home to farming in some capacity for nearly 200 years. Today, 90 percent of the recharge area is in agriculture, predominately row cropped for corn, soybeans, and cotton. Refuge croplands currently account for less than one percent of all agriculture in the recharge area (USDA 2019a, b, and c). Thus, over 99% of the impacts from agriculture in the recharge area of the Key Cave Aquifer on all cave species, and specifically the endangered Alabama cavefish, originate from private lands. Although more water quality work can and should be done, there is little existing data that indicates that agricultural pesticide compounds are detected in the aquifer at levels of taxological concern to aquatic organisms.

The proposed SHSP also will support the Gray bat (*Myotis grisescens*) Recovery Plan (USFWS 1982, 2009) and the Alabama cavefish (*Speoplatyrhinus poulsoni)* Recovery Plan (USFWS 1985, 2019a) and 5-Year Review (USFWS 2017), as well as the Geological Survey of Alabama's (GSA's) Groundwater Assessment Program recommendations (GSA 2018) and the Service's Water Resource Inventory and Assessment (WRIA) needs and recommendations (USFWS 2019b).

The Service is unaware of any other environmental trends or planned actions that will adversely impact threatened and endangered species and other special status species, including the proposed SHSP management actions. No significant adverse or beneficial short-term,

long-term, or cumulative impacts will be anticipated for threatened and endangered species and other special status species.	
Habitat and Vegetation (including vegetation of special management concern) [See Cave Habitat Mapsheet 2, Early Grassland Successional Habitat Mapsheet 3, and Forest Habitat Mapsheet 4) ***Affected Environment Description*** Key Cave NWR contains 1,060 acres of land consisting of rolling hills, upland forests, and early successional habitats. Currently, approximately 268 acres are in row crop production (generally corn, soybeans, or wheat) under a Cooperative Farm Agreement, 360 acres are in early successional fields or native warm season grasses (including big bluestem, little bluestem, indiangrass, sideoats gramma, switchgrass, and eastern gamagrass), 122 acres of former cropland have been planted in hardwoods, 30 acres of erosion drainages are being restored to grassland or hedgerow habitat, 75 acres are being converted to an oak savanna, and the remaining 195 acres consist of upland forested land dominated by oaks and hickories (An additional 16 acres includes refuge infrastructure). The refuge has a prescribed fire program that has a regular burn rotation in order to benefit certain species and their habitats. Observations indicate that the population of feral hogs is increasing at Key Cave NWR with ongoing damage. Key Cave NWR is located in an area of karst topology that has numerous sinkholes and caves that surround the refuge. When the refuge was first established in 1997, it had a 38-acre sinkhole pond on the property. However, the sinkhole has been dry since September 2000, only holding a small amount of water for very short durations. Just south of the property boundary for Key Cave NWR lies the entrance to Key Cave. To the southeast of the refuge lie the entrances to Collier Cave and Collier Bone Cave. All three cave entrances are located on lands owned by TVA. In 1999, two small (1-2 acre) shallow water areas (SWAs) were constructed to capture runoff surface water within grassed waterways. Then during late 2001 and early 2002, a larger (approximately 10 acres) SWA was constructed, which included a 700-foot dike and a 24-inch screw-gate water control structure. These SWAs were designed to provide habitat for waterfowl and other wetland associated wildlife, as well as to aid in erosion control. However, none of the SWAs have held much water since they were constructed. The refuge has reforested approximately 122 acres along the refuge's southern boundary. Native hardwoods, such as White oak, Northern red oak (*Quercus rubra L.),* water oak (*Quercus nigra L*.), Shumard oak (*Quercus shumardii*), cherrybark oak (*Quercus pagoda Raf*), common persimmon (*Diospyris virginiana*), and flowering dogwood (*Cornus florida*	**Alternative A:** Under the No Action Alternative, approximately 268 acres will continue in row crop production (generally corn, soybeans, and sunflowers) under a Cooperative Farm Agreement until such time as they could be opportunistically restored, 360 acres will continue in early successional fields or native warm season grasses (including big bluestem, little bluestem, indiangrass, sideoats gramma, switchgrass, and eastern gamagrass), and the remaining 317 acres will continue to consist of upland forested land dominated by oaks and hickories. The Service will continue to utilize prescribed fire to set back field succession every 2 to 4 years and maintain buffers around field edges and known sinkholes and waterways. Cooperative farming will continue to be utilized until the Service is able to convert large acreages to grassland habitat and rotate them into the prescribed burning program or other appropriate habitats. All of the confirmed sinkholes on Key Cave NWR have extensive buffers, and natural drainageways will be buffered beyond what is required by Service policy (Service's PUP policy requires minimum buffers only when fields are adjacent to water). Additionally, rigorous pesticide use policies will continue to be in place to prevent the use of harmful chemicals that may find their way into the aquifer and harm refuge species of concern. The refuge will continue to serve as a model for environmentally responsible farming practices in the recharge area. Negligible to minor, temporary impacts will continue to migratory birds, herptofauna, and mammals from continued habitat management. Current efforts to control the feral hogs by Service staff and volunteers have been unsuccessful and damage continues; this will be expected to continue. Impacts to habitat and vegetation under Alternative A will be expected to be minor adverse to minor beneficial. **Alternative B:** Under Alternative B, more active restoration, habitat management, and monitoring will occur. Minor beneficial impacts will be expected for habitat and vegetation under Alternative B. ***Grassland Management*** Under the Proposed Action, 208 acres (of the current 268 acres) of cropland will be converted to grassland or other appropriate habitat type with no more than 60 acres provided as supplemental wildlife food resources. Conversion of cropland to grassland will increase prescribed fire, decrease tillage, decrease pesticides used, decrease large equipment impacts, and decrease vegetation disturbance. Overall, impacts to other wildlife and their habitats and impacts to the biological diversity of the refuge will be minor. After prescribed fires, plants regenerate by sprouting, seeding, or both. Most hardwood trees and perennial forbs produce sprouts from buds located at or beneath ground level after their aboveground portions are killed by fire. Grasses vary by species, but most sprout from basal meristems. Many benefits from prescribed fire, such as increased forage for migratory birds and improved conditions for wildlife, depend on changes in the vegetation. To help minimize soil impacts, prescribed fire activities will be targeted to drier periods, and unsaturated soil conditions and the number of trips across the field by haying equipment should be minimized. Mowing activities usually involve the use of heavy farm equipment. Noise from this equipment may directly disturb refuge visitors or wildlife in the area of mowing operations. As noted above, mowing operations may have a negative short-term impact on grassland wildlife. This impact may indirectly affect refuge visitors by reducing the amount of wildlife available for observation during and shortly after mowing activities. Conversely, mowing removes tall vegetation, allowing a broader viewscape for refuge visitors. All of the confirmed sinkholes on Key Cave NWR will continue to have extensive buffers, and natural drainageways will be buffered beyond what is required by Service policy (Service's PUP policy requires minimum buffers only when fields are adjacent to water). Additionally, rigorous pesticide use policies will continue to be in place to prevent the use of harmful chemicals that may find their way into the aquifer and harm refuge species of concern. The refuge will continue to serve as a model for environmentally responsible farming practices in the recharge area. ***Forest Management***

L.), were planted with the help of volunteers. With this reforestation, Key Cave NWR has approximately 317 acres of upland hardwood forests. On Key Cave NWR, a 75-acre oak woodlot is currently being converted to oak savanna habitat to help promote a diversity of wildlife species. An oak savanna forest is a community of scattered oak trees above a layer of grasses and forbs. The trees are spread out so that there is no closed canopy and the grasses and forbs receive plenty of sunlight. It is a transition ecosystem between grassland and woodland environments, so it is an important habitat for both woodland and prairie species. Native warm season grassland restoration has been on-going since the establishment of Key Cave NWR in 1997, including the restoration of acquired croplands to grasslands. Currently, approximately 327 acres of native warm season grasslands consisting of big bluestem, little bluestem, indiangrass, sideoats gramma, switchgrass, and eastern gamagrass are maintained for management of grassland-dependent and early successional species. Prescribed fire is used to maintain the native warm season grasses. Currently at Key Cave NWR, to maintain an early successional stage until restoration, farmers plant approximately 268 acres annually through a Cooperative Farming Agreement in which a portion of the crop remains in the fields as rent. Rent portions and crops grown are similar to the farming program at Wheeler NWR to support a variety of wildlife. ***Environmental Trends and Planned Actions Description*** The Service is unaware of any other environmental trends or planned actions that will adversely impact refuge habitat and vegetation (including vegetation of special management concern), including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for habitat and vegetation (including vegetation of special management concern).	The ability to use forest management as a tool to mimic the natural disturbance paradigm for improving wildlife habitats does rely on creating similar size and timing of disturbance that historically occurred on the landscape (Seymour et al. 2002). For long-term effects of different forest regeneration methods on mature forest birds, less intense harvests had positive effects on more forest bird species than intense harvests and a variety of regeneration methods benefit the most forest birds (Perry et al. 2018). Implementing thinning at intervals across landscape scales to develop different seral stages and stand-structures, while also maintaining unthinned areas for species negatively impacted by thinning, will likely have the greatest positive impact on beta diversity of birds in managed plantation landscapes (Cahall et al. 2013). Maintaining forested buffers near streams and other aquatic resources minimizes long term impacts on water resources and water quality. Road construction, skid trail planning, harvest operation and stream crossings will, at a minimum, follow the BMPs promulgated by the State's forestry agency to minimize the alteration of hydrology and the impacts of siltation on water quality. Harvesting will use existing forest roads whenever possible; construction of new roads will be kept to a minimum. Road decommission will be a standard practice after all forest management is completed. For salamanders, irregular shelterwood treatments following harvests support populations of small vertebrates on the forest floor (Mazerolle et al. 2021). The effects of multiple harvests in a watershed can accumulate over time. Soil disturbance following timber harvest may increase the export of particulate matter and soil nutrients (Bormann et al. 1968, 1974). To reduce the potential for soil impacts, timber harvesting is recommended during late summer and fall when conditions are driest, thus reducing the potential for soil compaction and erosion. Special caution should apply when performing management in areas with hydric, steep, shallow, or easily erodible soils. ***Invasive Species Management*** There is a potential for introduction of invasive plant species onto the refuge from private agricultural machinery used in haying operations (Follak and Essl 2013). Once established, invasive species can become difficult and very expensive to eradicate. Researchers argue that it is better to prevent establishment of an invasive species rather than trying to control it after it has become established (Finnoff et al. 2007). To avoid the potential spread of invasive species onto the refuge, all agricultural equipment will be required to be cleaned to remove potential invasive species seeds and other plant parts before entering the refuge or being moved to different areas of the refuge.
Hydrology, Geology, and Soils *(See Mapsheet 1 Landscape and Key Cave NWR Overview)* ***Affected Environment Description*** Key Cave NWR resides within the Highland Rim section of the Interior Low Plateau called the Tennessee Valley. The Tennessee Valley is characterized by broad, gently sloping areas with semi-karst topography and is underlain by 360-million-year-old Mississippian-aged limestone and shale. It is comprised of two physiographic subdivisions: The Limestone Valley (Red Lands) and the Alluvial Plains. Red Lands have undulating to rolling relief and Alluvial Plains have nearly level to undulating first bottoms and stream terraces (second bottoms) along the Tennessee River.	**Alternative A:** Under the No Action Alternative, minor beneficial impacts will be anticipated from protecting groundwater recharge directly above cave, preventing runoff, retaining sediment, and minimizing non-point source pollution. All of the confirmed sinkholes on Key Cave NWR have extensive buffers, and natural drainageways will continue to be buffered beyond what is required by Service policy (under the Services PUP policy minimum buffers are required only when fields are adjacent to water). Additionally, rigorous pesticide use policies will continue to be in place to prevent the use of harmful chemicals that may find their way into the aquifer and harm refuge species of concern. The use of vegetative buffers along field edges will continue to provide cover for wildlife and reduces erosion and sedimentation in streams, and along with cautious pesticide/fertilizer application, reduces nutrient and chemical runoff. Not allowing fall disking will help prevent soil erosion. Some minor extent of soil surface contamination could occur from fuel or other engine fluids, or pesticide spillage, but operators will continue to be cautious about preventing spillage. The refuge will continue to serve as a model for environmentally responsible farming practices in the recharge area. **Alternative B:**

Key Cave NWR does not have any natural perennial streams that currently flow across the refuge. Before the Service took ownership of the land, several large gullies from years of erosion were present. The Service installed three SWAs, rehabilitated and stabilized the drainage channels to reduce erosion. A 38-acre sinkhole lake once held water on the refuge; however, it has been dry since September 2000. Numerous sinkholes are found near the refuge and are an integral component of groundwater recharge to Key Cave, Collier Cave, and Collier Bone Cave. The Region of Hydrologic Influence (RHI) for Key Cave NWR is 291.61 square miles and is bisected by the Tennessee River. The geology in the area is a karstic limestone that has sinkholes and caves, including Key Cave. The water from Key Cave drains into Pickwick Lake, which is a part of the larger Tennessee River. The average annual precipitation is approximately 56 inches from 1941–2018. The monthly precipitation is less than 5 inches on average (USFWS 2018). In 1990, the Ozark Underground Laboratory conducted a study to determine the underground recharge area for the cave system. The recharge area was divided into four potential risk areas: high hazard, moderately high hazard, moderate hazard, and low hazard (Aley 1990). The refuge resides in the high hazard risk area of the Key Cave aquifer recharge zone. The recharge zone was estimated to be nearly 20 square miles and located in karst topology underlain by Tuscumbia limestone. Surface drainage is poor and essentially all runoff water enters the groundwater system by sub-surface drainage. Only a portion of the water in the Key Cave Aquifer passes through Key Cave. The estimated mean annual discharge from the entire Key Cave Aquifer is approximately 15 to 20 cubic feet per second (cfs). This flow rate is subject to precipitation events and can fluctuate greatly (Aley 1990). Waters from Pickwick Lake seldom, if ever, flow into Key Cave. Instead, waters from Key Cave discharge into Pickwick Lake through Coffee Slough (Aley 1990). Key Cave NWR exists along the northern shore of the Pickwick Reservoir of the Tennessee River and resides within the Limestone Valley physiographic subdivision. It is also underlain by Tuscumbia Limestone, whose weathering has produced many karst features, including numerous springs, sinkholes, and several underground cave systems. There are very few exposures of bedrock except for locations along the bluff line at the margin of the Tennessee River (Aley 1990). Topology is comprised of flat to gently rolling upland terraces with slopes ranging from one to fifteen percent. Elevation of the land surface generally ranges from about 500 to 580 feet above MSL (Kidd et al., 2001). Key Cave lies in a limestone karst area that contains numerous sinkholes and several underground cave systems on the northern bank of the Tennessee River. The karstic limestone plays an integral role in the	Under the Proposed Action, the beneficial impacts for hydrology will be anticipated to increase above the No Action Alternative given the further restoration of cropland habitats and decrease in inputs related to habitat management. Impacts to geology will be expected to be negligible. Minor beneficial impacts will be expected for soils and soil formation processes with restoration of 208 acres of croplands to grasslands. Soil disturbance due to restoration and habitat management activities will be expected to be minor and of short duration. To further reduce potential impacts, the refuge will use BMPs to minimize the erosion of soils, as well as seasonal restrictions. The use of vegetative buffers along field edges will continue to provide cover for wildlife and reduces erosion and sedimentation in streams, and along with cautious pesticide/fertilizer application, reduces nutrient and chemical runoff. Not allowing fall disking will help prevent soil erosion. Some minor extent of soil surface contamination could occur from fuel or other engine fluids, or pesticide spillage, but operators will continue to be cautious about preventing spillage. The interaction of many factors determines the impact of fire on soil, but most evidence indicates that low-intensity prescribed fires have few, if any, adverse effects. Prescribed fires affect soil by both heat transfer and changes in soil physical properties. The most important soil physical characteristic affected by fire is soil structure because organic matter can be lost at relatively low temperatures. Loss of soil structure can increase bulk density and reduce porosity, thereby reducing soil productivity and making the soil more vulnerable to post-fire runoff and erosion. Prescribed burning in the South normally causes little or no detectable change in amount of organic matter in surface soils. In fact, slight increases have been reported on some burned areas.

refuge's geologic features and water resources. The karst in the area creates sinkholes, and created Key Cave, which can be described as a "solutional cave". A "solutional cave", is a cave that has been created through the dissolution of bedrock (limestone) by naturally acidified water seeping through soils and cracks in the bedrock, which erodes the bedrock and creates the cave. The movement of groundwater through karst has properties that are more similar to surface water flow than traditional groundwater flow. Due to the permeability of the karst, the majority of the surface water on the refuge flows into the subsurface water system (USFWS 2007a, b). The refuge lies above what is locally known as the Key Cave Aquifer, which has a recharge area of about 20 square miles. The refuge is located in the area classified as a high hazard risk area, as categorized in the 1990 Aley report, which means there is a high risk of groundwater contamination from surface spills or land use activities with potential water quality impacts (USFWS 2007a, b). The estimated mean annual discharge from the Key Cave Aquifer is about 15 to 20 cubic feet per second (cfs) (Aley 1990). Based on the national aquifer database, the RHI of the refuge overlies portions of two different national aquifers: the Mississippian aquifer and the Southeastern Coastal Plain aquifer system. The "other rocks" indicates either that significant aquifers are absent or that the area is controlled by more local aquifers (i.e., the Key Cave Aquifer in this case). Upland soils derived from the decay of high-grade limestone rock are found on Key Cave NWR (See Mapsheet 1 Landscape and Key Cave NWR Overview for more information). The properties of these soils are closely related to those of the parent rock and are underlain with clay or limestone. The Decatur, Dewey, and Fullerton soil series make up approximately 80 percent of the land acreage on the refuge and have silt loam to silty clay loam textures (Sherard 1971). These soils are moderately to well drained, and the depth to bedrock averages between 25 and 50 feet (Moser and Hyde 1974). Small pockets of the Grasmere series can be found along small drainage ways and in shallow depressions; soils in the Grasmere series drain moderately to poor and have silty-clay loam textures (Sherard 1971). ***Environmental Trends and Planned Actions Description*** The Service is unaware of any other environmental trends or planned actions that will adversely impact hydrology, geology, and soils, including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for hydrology, geology, and soils.	

Water Quality (See Mapsheet 1 Landscape and Key Cave NWR Overview and Milewski et al. 2019) ***Affected Environment Description*** There are 2.81 miles of streams within the acquisition boundary of Key Cave NWR according to the National Hydrography Dataset (NHD). They are either considered to be "artificial paths" or "intermittent". All are unnamed. There are 117 water monitoring stations within the RHI of Key Cave NWR. Twenty-one of the stations do not have any readily available data associated with them. There are only three groundwater wells measuring the groundwater level within the RHI. None of these stations have a long enough record to do an analysis of the groundwater in the area. There are 53 documented stream gage locations in the RHI, but only 5 have data collected since 2010. One of the stations measures daily gage height along the Tennessee River (USGS Site Number 03589500). Twenty-two species within the RHI are listed as threatened or endangered; 14 of these species are located within the acquisition boundary of Key Cave NWR. This includes the Alabama cavefish which is only found in Key Cave NWR. Four waterbodies in the RHI are listed as impaired. They are McKiernan Creek (Wilson Lake), Pond Creek, Big Nance Creek, and Sweetwater Creek. There are 243 facilities that are listed in the National Pollutant Discharge Elimination System (NPDES). The majority (217 facilities) are listed as "Non-Major." The main overall water resource issue of concern for Key Cave NWR is the water quality on the refuge. Five current causes of potential water quality degradation at the refuge have been identified by Milewski et al. (2019), including excess sediment, nutrient pollution, and pesticides associated with past agricultural practices on the site, current agricultural activities on adjacent lands, and water discharge from municipal wastewater treatment facilities into the Tennessee River upstream of the cave. Milewski et al. (2019) also believes the presence of Batrachochytrium dendrobatidis (Bd), a fungus that has been detected at Sauta Cave and Wheeler NWRs and is believed to be responsible for global declines in amphibian populations, especially frogs, will be detrimental to biodiversity in Key Cave. ***Environmental Trends and Planned Actions Description*** According to Milewski et al. (2019), likely the most important threats to water resources at the refuge are associated with urban or industrial development in the future. A proposed 300-acre industrial park approximately 5.5 miles northeast of Key Cave prompted a USGS study that confirmed the existence of a hydraulic connection between Key Cave and the proposed development site (Kidd et al. 2001). Milewski et al. (2019) believe that this possible future development could endanger the cave ecosystem by negatively affecting water availability or water	**Alternative A:** Under the No Action Alternative, current management of habitats, including prescribed fire, invasive species control measures, farming, and some forest thinning, will be expected to continue to have minimal to no effects on water quality and negligible impacts to air quality on the refuge and in the cave system. The Key Cave recharge area is approximately 20 square mile (12,800 acres) in size and has been home to farming in some capacity for nearly 200 years. Today, 90 percent of the recharge area is in agriculture, predominately row cropped for corn, soybeans, and cotton. Refuge croplands account for less than three percent of all agriculture in the recharge area. Thus, over 97% of the impacts from agriculture in the recharge area of the Key Cave Aquifer on all cave species, and specifically the endangered Alabama cavefish, originate from private land. Although more water quality work can and should be done, there is currently no data that exist that indicates pesticide use for restoration and cropland management on refuge lands are negatively affecting the Key Cave aquifer system, despite typical farming practices throughout the Key Cave Aquifer recharge area. All of the confirmed sinkholes on Key Cave NWR have extensive buffers, and natural drainageways will continue to be buffered beyond what is required by Service policy (under the Services PUP policy, minimum buffers are required only when fields are adjacent to water). Additionally, rigorous pesticide use policies will continue to be in place to prevent the use of harmful chemicals that may find their way into the aquifer and harm refuge species of concern. The refuge will continue to serve as a model for environmentally responsible farming practices in the recharge area. Based on the Service's understanding of the studies at Key Cave NWR and surrounding recharge area and according to studies recommendations, the Service determined that the current and proposed management at Key Cave NWR can be employed in a safe, environmentally responsible manner, with minimal risk to the Alabama cavefish, other species, and habitat. Additional information from key studies is listed. 1990 – Delineation and Hydrogeologic Study of the Key Cave Aquifer conducted by Thomas Aley with the Ozark Underground Laboratory (Aley 1990) This study was commissioned by the Service in 1990 and delineated the Key Cave recharge area as 16 square miles in size through the use of dye trace studies. This figure was further refined to 20 square miles in size by the more recent 2018 Hydrogeological Assessment for Key Cave conducted by the Geological Survey of Alabama (GSA 2018). In both studies,it was determined that approximately 90% of the study area was in agriculture. It indicated a 25-foot to 50-foot depth to bedrock of predominantly silt loam and silty clay loam soils. While no pesticide studies were done, it included management recommendations for reducing potential chemical impacts that included installing grassed waterways, buffers to sinkholes, as well as surface management actions which reduce erosion or catch eroded sediments (SWAs). It also promotes low till or no-till farming. The Service has implemented all these recommendations for the refuge. 1996 – Contaminant Analysis of Water and Sediment at Key Cave, Lauderdale County, Alabama conducted by Allen Robison, ES Contaminant Specialist (Robison 1996) As part of a pre-acquisition contaminant survey conducted by the Service, water and sediment samples were collected and analyzed for 20 metals and 78 organic chemicals. Elevated metal concentrations were possibly attributed to a nearby land disposal of sewage sludge which was ultimately terminated due to this and other findings. The only chemical detected was dichlorodiphenyldichloroethylene (p,p'-DDE), a metabolite of dichlorodiphenyltrichloroethane (DDT). This has been attributed to the extensive bat guano deposits found in the cave. No agricultural chemicals were detected. It included recommendations for a future refuge, which were implemented at later dates. It also includes the listed recommendations. Implementation of a regular monitoring program over a 12-month period, with emphasis on storm events, will provide a much better characterization of organic chemical and metal loading to Key Cave.

quality. Reducing the recharge of the area or lowering of the water table could severely impact the endangered Alabama cavefish or kill them outright by drought or low water conditions in the cave pools (Kuhajda 2004b).

In addition to the WRIA of Key Cave NWR (USFWS 2019b) and as analyzed in Milewski et al. (2019), the Service reviewed the best currently available science, including consulting key relevant studies and biologists at the refuge and Ecological Services (ES). The most relevant studies are listed.

- 1990 – Delineation and Hydrogeologic Study of the Key Cave Aquifer conducted by Thomas Aley with the Ozark Underground Laboratory (Aley 1990)
- 1996 – Contaminant Analysis of Water and Sediment at Key Cave, Lauderdale County, Alabama conducted by Allen Robison, ES Contaminant Specialist (Robison 1996)
- 2001 - Use of ground-water tracers to evaluate the hydraulic connection between Key Cave and the proposed industrial site near Florence, Alabama, 2000 and 2001 Water-Resources Investigations Report 2001-4228 By:Robert E. Kidd,Charles J. Taylor,and Victor E. Stricklin (Kidd et al. 2001)
- 2001 - Status of the Federally Endangered Alabama Cavefish, Speoplatyrhinus poulsoni (Amblyopsidae), in Key Cave and Surrounding Caves, Alabama. Bernard R. Kuhajda & Richard L. Mayden (Kuhajda and Mayden 2001)
- 2004 - The Impact of the Proposed Eddie Frost Commerce Park on Speoplatyrhinus poulsoni, the Alabama Cavefish, a Federally Endangered Species Restricted to Key Cave, Lauderdale County, Alabama – Dr Bernie R. Kuhajda (Kuhajda 2004b)
- 2005 - Environmental Contaminants Program On-Refuge Investigation Interim Report – Pete Tuttle, ES Contaminant Specialist and Steve Seibert, Refuge Manager (Tuttle and Seibert 2005)
- 2018 – Hydrogeological Assessment for Key Cave, Lauderdale County, Alabama. Gheorghe M. Ponta, Stuart W. McGregor, and Stephen C. Jones, Geological Survey of Alabama (GSA 2018)
- 2019 Water Resource Inventory and Assessment: Key Cave National Wildlife Refuge, Lauderdale County, Alabama. Milewski, A., Hutcheson, H., Rasmussen, T., Faustini, J., and Moorman, M. Southeast Region. Atlanta, Georgia. 62 pp. + appendices (USFWS 2019b)

- If the Service establishes Key Cave as a National Wildlife Refuge, then implementation of the Southeast Region Integrated Pest Management Program, and associated Pesticide Use Proposal process, will help provide additional protection.

2001 -Use of ground-water tracers to evaluate the hydraulic connection between Key Cave and the proposed industrial site near Florence, Alabama, 2000 and 2001 Water-Resources Investigations Report 2001-4228 By:Robert E. Kidd,Charles J. Taylor, and Victor E. Stricklin(Kidd et al. 2001)

- This dye trace study provides additional background information on the geology and hydrology of the recharge area, specifically attending the groundwater connection between the proposed industrial site and Key Cave.

2001-Status of the Federally endangered Alabama cavefish, Speoplatyrhinus poulsoni (Amblyopsidae), in Key Cave and surrounding caves, Alabama. Bernard R. Kuhajda & Richard L. Mayden (Kuhajda and Mayden 2001)

- This study gives background on species and survey efforts conducted between 1992 and 1997. The study found three different size age classes indicating that recruitment was occurring, and that the population was relatively stable.

2004 - The Impact of the Proposed Eddie Frost Commerce Park on Speoplatyrhinus poulsoni, the Alabama Cavefish, a Federally Endangered Species Restricted to Key Cave, Lauderdale County, Alabama – Dr Bernie R. Kuhajda(Kuhaida 2004b)

- This study provides general background on the recharge area and specifically, impacts of the proposed industrial park on Alabama cavefish.

2005 -Environmental Contaminants Program On-Refuge Investigation Interim Report– Pete Tuttle, ES Contaminant Specialist and Steve Seibert, Refuge Manager (Tuttle and Seibert 2005)

- In this study, biologically available organic contaminants (e.g., organochlorine compounds and polycyclic aromatic hydrocarbons) were sampled with the use of a semipermeable membrane device (SPMD). The SPMDs were left in place for periods of approximately 60 days to enable detection of episodic contaminant events (e.g., rainfall and runoff events). An SPMD was initially deployed in Key Cave on November 14, 2001. The device was deployed approximately two meters below the water surface in the cave. SPMDs were retrieved and replaced on January 23, March 15, May 15, July 15, September 16, and November 26, 2002. This effectively provided continuous water sampling for a period of a little over one year. Because of the transient nature of several of the pesticides, water samples for analysis of the principal pesticides of concern were collected during sampling events occurring within the agricultural growing season in the drainage basin. Finally, nine bat guano samples were collected from areas of high guano deposition. The high nitrate levels are probably attributable to bat guano deposits.

2018 – Hydrogeological Assessment for Key Cave, Lauderdale County, Alabama. Gheorghe M. Ponta, Stuart W. McGregor, and Stephen C. Jones,

Geological Survey of Alabama (GSA 2018)

- This is one of the most recent and probably the most comprehensive and relevant study that we have at hand. The purpose of the project was to establish a water quality baseline and determine aquifer characteristics (beginning to see water level, specific conductance, and temperature patterns) in the Key Cave NWR that may be used by local, state, and federal agencies and citizens to develop, manage, and protect the water resources of the region.
- In this study, as mentioned earlier, the recharge area (referred to as the Key Cave area throughout the report) was revised to encompass an area of approximately 20 square miles. Following are some items of interest that bear consideration.
  - When the groundwater tables rise, guano deposits are inundated, directing some of its energy into the aquatic system. This presumably helps to sustain the aquatic system, while at the same time exposing organisms to DDT metabolites, metals, nitrates, and organochlorine compounds.

The Service is unaware of any other environmental trends or planned actions that will adversely impact water quality, including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for water quality.	• From 1992 to 1997 a status assessment of the Alabama cavefish population was performed, and it was found that the population had appeared to remain stable over a 30-year period through 1997, with as many as 10 to 12 individuals observed during visits (Kuhajda and Mayden 2001). Subsequently a second status survey was performed, and 20 individuals were observed over six visits from 2000 to 2009, with as many as six individuals seen during one visit (Kuhajda and Fluker 2010). They also noted three different size classes, suggesting that the Alabama cavefish was successfully reproducing. • Water samples were collected in November 2017, March 2018, and September 2018. Pesticides, herbicides, and carbon oxygen demand (COD) were analyzed in March 2018 and September 2018. No pesticides or herbicides were found from either of these sampling periods. • The rainy season for the area is November to April, which is outside of the farming season. Most of the area's annual rainfall (51 inches) is recorded during this time. • Typically, rainwater and surface water not influenced by groundwater have a Specific Conductivity (SC) value less than 50 microSiemens per centimeter (µS/cm), if not impacted by nonpoint pollution sources. Overall, SC variability is influenced by differences in temperature, discharge, local geology and soil conditions, and ionic influxes from nonpoint pollution sources. The lowest specific conductance values (145 to 428 uS/cm) were measured during the highest water level elevation recorded (in February and March). The highest conductivity values were measured in September and corresponded to lower water level elevation. By the end of September 2018, after a heavy rain, water level increased abruptly, and the SC dropped instantly from dilution. Shortly after the storm, the SC returned to normal values. It should be pointed out that dissolved carbonate rock, which is prevalent in the recharge area, lends itself to high SC values. • The biochemical oxygen demand (BOD) values were superb (<2mg/L) for both sampling events. • Elevated levels of nitrate and phosphorous were acknowledged as possibly related to the presence of large guano deposits in the cave pool. **Alternative B:** Under the Proposed Action, while refuge management activities will increase, impacts to water quality will be negligible to minor beneficial. Under the Proposed Action, utilizing BMPs and decreasing farming with restoration to native grasses over the next ten-year period will decrease large farm equipment, inputs, and any sedimentation. With increased prescribed burning, the principal concerns for water will be runoff and increases in sediment, nitrate and heavy metal content. When surface runoff increases after burning, it may carry suspended soil particles, dissolved inorganic nutrients, and other materials into adjacent streams and lakes, thus reducing water quality. Prescribed fires typically have a lower intensity, so these effects seldom occur. Generally, a properly planned prescribed burn will not adversely affect either the quality or quantity of ground or surface water. Increase acreages using prescribed fires may contribute to temporary, short-term changes in air quality. Air quality of a regional scale is affected only when many acres are burned on the same day. Local problems are more frequent and occasionally acute because of the large quantities of smoke that can be produced in a given area during a short period of time. Smoke can be managed by burning on days when it will blow away from smoke-sensitive areas. Precautions must be taken when burning near populated areas, highways, hospitals, airports, and other smoke-sensitive areas. Weather and smoke management forecasts are available as a guide for wind speed and direction. Any smoke impact downwind must be mitigated before lighting the fire. All burning will be done in accordance with applicable smoke management guidelines and regulations and the Wheeler NWR Complex Fire Management Plan (USFWS 2021).

Table 5. Affected Refuge Management and Operations and Anticipated Impacts

AFFECTED RESOURCE	ANTICIPATED IMPACTS BY ALTERNATIVE
Land Use ***Affected Environment Description*** Key Cave NWR is located in Lauderdale and Colbert counties in northwest Alabama. Rural in nature, the two counties' land cover breaks down as: 45.82% forest, 34.12% pasture (including pasture, hay, and cultivated crops), 9.34% developed, 5.9% water, 4.65% shrub, and 0.18% barren (Dewitz and U.S. Geological Survey [USGS] 2021). Land ownership in the two rural counties is 87.3% private with federal property comprising 2.6% (of which the Service represents 0.1%) (Headwaters Economics 2023). While this is slightly lower than, but reflective of Alabama (95.1% private and 3.1% Federal), it is higher private land ownership and lower federal land ownership compared to the U.S. (61.1% private and 27.5% Federal) (Headwaters Economics 2023). While farming and forestry activities in the two counties represent about 3% of total employment in the two counties (Headwaters Economics 2023), forest, pasture, and agriculture represent 79.9% of the land cover in the two counties (Dewitz and USGS 2021). (Based on U.S. Department of Commerce American Community Survey data, Headwaters Economics 2023 and the USGS National Land Cover Database, Dewitz and USGS 2021) The 2017 Census of Agriculture outlined, respectively, for Lauderdale and Colbert counties 1,309 and 591 total farms, 210,539 acres and 150,316 acres in farms, and an average farm size of 161 acres and 254 acres. Averaged together, the two counties had, in 2017, 1,900 total farms on 360,855 acres with an average farm size of 190 acres. The 268 acres currently in cropland on the refuge represents less than 1% of the acreage in farms in Lauderdale County in 2017 (210,539 acres) (USDA 2019b, c). ***Environmental Trends and Planned Actions Description*** The Service is unaware of any other environmental trends or planned actions that will adversely impact land use, including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for land use.	**Alternative A:** Under the No Action Alternative, land use and land use trends will remain the same in and around the refuge. **Alternative B:** Under the Proposed Action, the Service will convert 236 acres of cropland habitat which is 0.07% of the total farm acres in the 2 counties and 0.11% of the total farm acres in Lauderdale County. Restoring these acres to grassland will not significantly impact agricultural production in the two counties or even in the one county. However, the increased grassland habitat will play a key role in benefiting bobwhite quail and other grassland birds that utilize the refuge. The Service will also actively work with partners and surrounding landowners within the recharge zone of the cave to restore habitats and utilize BMPs. Under the Proposed Action, impacts to land use will be negligible to minor beneficial for natural resources.
Refuge Management and Operations ***Affected Environment Description*** Key Cave NWR is an unfunded and unstaffed unit; all funding, monitoring, management, and staff to support refuge management come from the Wheeler NWR Complex. Key Cave NWR also works with regional fire staff and Alabama Forestry Commission to manage the prescribed fire program. Under a Cooperative Farming Agreement, 268 acres are grown in agricultural crops and 53 acres are left as wildlife forage. ***Environmental Trends and Planned Actions Description*** The Service is unaware of any other environmental trends or planned actions that will adversely impact refuge management and operations, including the proposed SHSP management actions. No significant adverse or beneficial short-term, long-term, or cumulative impacts will be anticipated for refuge management and operations.	**Alternative A:** Under Alternative A, no change in refuge management or operations will occur. Habitats will be managed as possible and mostly reliant on partnerships. **Alternative B:** Under the Proposed Action, the Service will continue to work with current staff, other Service programs, and partners to implement the prescribed fire program (USFWS 2021), provide 60 acres of supplemental wildlife food, protect lands within the cave recharge zone, and monitor wildlife population responses.

Minimization Measures to Avoid Negative Impacts

Continuing to employ appropriate BMPs, the Proposed Action Alternative will refine and update current refuge management activities to respond to changing conditions in the landscape, enhance refuge habitat and species management activities, and serve refuge purposes and goals.

All confirmed sinkholes on Key Cave NWR have extensive buffers, and natural drainageways will continue to be buffered beyond the Service policy requirement (under the Service's PUP policy minimum buffers are required only when fields are adjacent to water). Additionally, rigorous pesticide use policies will continue to be in place to prevent the use of harmful chemicals that may find their way into the aquifer and harm refuge species of concern. The refuge will use minimal to no agricultural inputs and pesticides once the farming program is reduced to 60 acres.

The Service, TVA, GSA, USGS, and other partners will continue to coordinate to minimize impacts to Key Cave, including minimizing access to pertinent management and monitoring activities at times when impacts will be minimized and restricting public access.

Before conducting forest management projects such as thinning operations or applying prescribed fire, a site-specific prescription will be developed in accordance with the Biological Opinion for Bats (USFWS 2024). The management prescription will minimally identify the refuge's resources of concern and any management constraints (e.g., cultural resources, ESA), describe the forest's current condition, outline the forest's desired future condition, and identify the processes and treatment(s) required to shift toward desired conditions. Additionally, a Section 106 (cultural resources review) and Section 7 (ESA intra-service consultation and use of USFWS 2024) will be completed before the prescription will be approved for implementation. Finally, as applicable (e.g., for a Service contractor conducting forest thinning for the refuge), a Service Special Use Permit will outline necessary stipulations required for the activity to remain compatible and meet refuge objectives. The Refuge Manager will ensure project implementation that specifically supports refuge plans (e.g., CCP, SHSP, Fire Management Plan, Cooperative Agriculture Agreement, and Forest Management Prescription), meets applicable laws and policies, and includes appropriate conservation measures and BMPs.

Cultural resources have not fully been inventoried on Key Cave NWR. Should previously unrecorded cultural resources or human remains be discovered on refuge land, activities will be halted and the Regional Archaeologist and Refuge Manager contacted at once.

Monitoring

The Service will continue to work with partners, particularly TVA, GSA, and USGS, to monitor resources of management concern. The Proposed Action will expand existing monitoring efforts for water quality and quantity, responses by resources of concern to management, and population estimates. To apply adaptive management, specific survey, inventory, and monitoring protocols will be adopted. The habitat management strategies will be systematically evaluated to determine management effects on wildlife populations. This information will be

used to refine approaches and determine how effectively the objectives are being accomplished. If monitoring and evaluation indicate undesirable effects for target, non-target species, and/or communities, then adaptations to the management strategies will be made.

Summary of Analysis

Alternative A – Continue Current Management (No Action Alternative)

Habitat management will continue on grasslands and croplands to support grassland birds and bobwhite quail. Working with partners, the Service will continue to utilize prescribed fire to set back succession every 2 to 4 years and maintain buffers around field edges and known sink holes and waterways. Cooperative farming will continue to be utilized until the Service will be able to convert large acreages to grassland habitat and rotate into the prescribed burning program or other appropriate habitats. Negligible to minor, adverse, temporary impacts will continue to wildlife and aquatic species, including migratory birds, herptofauna, and mammals from continued habitat management.

Under Alternative A, impacts to threatened and endangered species and other special status species will be expected to continue to be negligible to minor beneficial. Impacts to habitat and vegetation under Alternative A will be expected to be minor adverse to minor beneficial. Minor beneficial impacts will be expected for hydrology. No impacts will be anticipated for geology. Negligible to minor adverse impacts will be expected to soils and soil formation processes with continued farming activities. Negligible to minor adverse impacts will be anticipated for water quality, and negligible impacts will be anticipated for air quality. No impacts will be anticipated for land use on and around the refuge. Refuge management activities will remain substantially similar to past management.

Alternative B – Implement Spatial Habitat and Species Plan (Proposed Action)

Alternative B implements the Spatial Habitat and Species Plan (Proposed Action) which steps down and provides specifics to several of the identified goals and objectives outlined in the CCP without changing the original intent. The focus under this alternative will be to manage, maintain, restore, and protect the refuge's habitats and wildlife species.

While minor adverse temporary impacts could be expected during habitat management and restoration activities under the Proposed Action, overall, minor beneficial impacts to wildlife and aquatic species, threatened and endangered species, and other specie status species will be expected. Under the Proposed Action, more active restoration, habitat management, and monitoring will occur. Minor beneficial impacts will be expected for habitat and vegetation under Alternative B.

Under the Proposed Action, the beneficial impacts for hydrology will be anticipated to increase above the No Action Alternative given the further conversion of cropland habitats and decrease in inputs related to habitat management. Impacts to geology will be expected to be negligible.

Minor beneficial impacts will be expected for soils and soil formation processes with conversion of 208 acres of croplands to grasslands. Under the Proposed Action, while refuge management activities will increase, impacts to water quality will be negligible to beneficial, while impacts to air quality will be negligible. Under the Proposed Action, impacts to land use will be negligible to minor beneficial for natural resources. Refuge management and operations will increase under the Proposed Action.

Under the Proposed Action, utilizing best management practices and phasing out the cooperative farming program will decrease cropland acres, agricultural inputs, and sedimentation with the conversion to grassland habitat. With increased acres requiring prescribed fire, the principal water quality concerns will be runoff and increases in sediment, nitrates, and heavy metal content, which will be expected to remain low. Properly planned prescribed fire will not adversely affect the quality or quantity of ground or surface water. Increased acreages requiring prescribed fire may contribute to temporary, discrete changes in air quality. Air quality at a regional scale will be affected only when large tracts are burned on the same day. All burning will be done in accordance with applicable smoke management guidelines and regulations and the Wheeler NWR Complex Fire Management Plan.

Under the Proposed Action, wildlife population monitoring/surveying will occur to assess population status, trends, and population responses to habitat management. Monitoring and surveys will be conducted for a broad range of species including: cave dwelling species, grassland birds, and other resident, migratory, and wintering wildlife. Some surveys will be conducted annually, while others will be conducted only frequently enough to determine population status and trends and response to habitat management.

Populations for priority resources of concern will be expected to increase with additional actively managed acreages of old field, grassland, oak savanna, and upland forested habitats. Increased restoration of cropland units to native grasslands will increase habitat for resources of concern. Management actions including savanna and grassland management and cropland conversion should have no to negligible impacts to the Alabama cavefish population and other rare cave-dwelling populations. Maintaining no more than 60 acres of supplemental agricultural crops at Key Cave NWR will continue to support the Northern Bobwhite Conservation Initiative, which has shifted to a landscape scale for bobwhite quail habitat restoration. On the remaining 60 acres of agricultural crops for supplemental wildlife food, minimal to no pesticides and other agricultural inputs will be utilized.

Managing for desired forest conditions will shift and maintain grassland and forest habitat to support priority resources of concern. Under the recent programmatic biological opinion for the implementation of forest habitat management practices for tree roosting bats, prescribed fire and forestry practices that are recommended to minimize impacts include reducing fire intensity within forest units and avoiding known bat roosts and retaining or creating snags during mulching/thinning operations (USFWS 2024). Targeted removal of invasive species will reduce the negative impacts these species are having on ecosystem functions.

Conclusion

Based on the above analyses, the Service has determined that none of the alternatives considered above will have any significant adverse or beneficial impacts on the human environment. No adverse or beneficial long-term or cumulative impacts will be anticipated under either of the alternatives. As outlined and analyzed above, Alternative B (Proposed Action) best meets the stated purpose and need.

List of Preparers and Coordination

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State Coordination

To serve shared visions, missions, goals, and objectives, the Service and states continue to work closely together to conserve and manage the fish and wildlife resources of the nation under a variety of laws, regulations, and policies. The Service began more detailed coordination with the state of Alabama on Key Cave NWR management activities with the 2007 CCP. Specifically, regarding the SHSP, the Service contacted the state through a scoping letter dated December 9, 2022, to gather initial input; the Alabama Forestry Commission submitted comments during scoping. The Service again contacted the state with a letter to request comments on the EA and SHSP on July 9th, 2025.

Tribal Consultation

The Service and Tribal Nations recognize the need for strong, healthy communication and relationships so that we can work together to improve and enhance conservation of fish and wildlife resources and shared natural and cultural resource goals and objectives. The Service's engagement with and responsibilities to Native American Tribes are guided primarily by doctrines of reserved rights, statutes, treaties, judicial mandates, Executive Orders, Presidential proclamations, and Secretary's Orders. The United States' trust responsibility is a well-established legal obligation that originates from the unique, historical relationship between the United States and Native American Tribes. The trust responsibility consists of the highest moral obligations that the United States must meet to ensure the protection of Tribal and individual Indian lands, assets, resources, and treaty and similarly recognized rights.

The federal government recognizes the valuable contributions of the Indigenous Knowledge (also called Indigenous Traditional Knowledge, Traditional Knowledge, Traditional Ecological Knowledge, and Native Science) that Tribal Nations and Indigenous Peoples have gained and passed down from generation to generation. Indigenous Knowledge combines observations, oral and written knowledge, innovations, practices, and beliefs over long terms and spanning generations, interweaving biological, physical, social, cultural, and spiritual systems. The federal government's consideration and inclusion of Indigenous Knowledge is guided by respect for the sovereignty and self-determination of Tribal Nations, the Nation-to-Nation relationship

between the United States and Tribal Nations and the United States' trust responsibility, and the need for the consent of and honest engagement with Tribal Nations and Indigenous Peoples.

For any particular effort, the Tribal Nation(s) or Indigenous People(s) involved clearly drive whether or not to share Indigenous Knowledge and whether or not their Indigenous Knowledge should be applied in federal contexts; the federal government respects these decisions. Indigenous Knowledge offers critical insight into the historic and scientific significance of an area, providing an important foundation for understanding, analysis, and decision making. Consultation and collaboration with Tribal Nations and Indigenous Peoples are critical to ensuring that Indigenous Knowledge is considered and applied in a manner that respects Tribal sovereignty and achieves mutually beneficial outcomes. Indigenous Knowledge can play a key role in relation to the federal government's planning, analysis, decision making, and compliance under a variety of laws, regulations, and policies, importantly the Endangered Species Act (16 USC §§1531-1544), National Environmental Policy Act (42 USC §§4321 et seq. and 40 CFR Chapter V Subchapter A), Marine Mammal Protection Act (16 USC Chapter 31), Magnuson-Stevens Fishery Conservation and Management Act (16 USC Chapter 38), National Historic Preservation Act (Title 54 USC), and Native American Graves Protection and Repatriation Act (25 USC §§3001-3013).

The Service began coordination with the potentially interested Native American Tribes on refuge management activities with the 2007 CCP. Specifically, regarding the SHSP the Service contacted the potentially interested Native American Tribes through a scoping letter dated December 9, 2022, to engage the Tribes and gather initial input. The Service again contacted the Tribes with a letter to request comments on the EA and SHSP on June 30, 2025.

The 15 Tribes contacted are listed.

- Absentee Shawnee Tribe
- Alabama-Coushatta Tribe of Texas
- Cherokee Nation
- Chickasaw Nation
- Coushatta Tribe of Louisiana
- Eastern Band of Cherokees
- Eastern Shawnee Tribe of Oklahoma
- Jena Band of Choctaw Indians
- Kialegee Tribal Town
- Muscogee Nation
- Poarch Band of Creek Indians
- Seminole Nation of Oklahoma

- Shawnee Tribe
- Thlopthlocco Tribal Town
- United Keetoowah Band of Cherokee Indians

The Cherokee Nation and United Keetoowah Band of Cherokees responded during scoping to provide updated contact information. All the above listed Tribes were then contacted again to provide an opportunity for their review and comment on the EA and SHSP on June 30th, 2025. Two Tribes responded; the Shawnee Tribe concurred that no known historic properties will be negatively impacted by the project and they have no issues or concerns, and the Chickasaw Nation indicated support of the proposal. Both understand that there will be Section 106 consultation if additional infrastructure or ground disturbing activities are identified during the planning process. In the event the Service becomes aware of the need to enforce other statutes, they will be notified under ARPA, AIRFA, NEPA, NAGPRA, NHPA, and Professional Standards.

Public Outreach

Building on the CCP's outreach effort, the Service conducted scoping for the EA and SHSP in January and February 2023. On January 19, 2023, the Service issued a public information bulletin announcing the public scoping period with scoping comments due February 19, 2023. Multiple comments were submitted during scoping by the public, including from the Alabama Forestry Commission, Center for Biological Diversity, Tennessee Aquarium Conservation Institute, and two members of the general public. Scoping comments generally spanned three categories: wildlife and habitat management, visitor services, and planning process. Wildlife and habitat management comments included importance of the Alabama cavefish and listed bats; importance of the cave/karst habitat and related species; importance of sinkholes and flow paths to Key Cave; impacts of agricultural activities and practices; impacts from uses and activities in the recharge area; impacts to the aquifer; removal of commercial agricultural activities and restoration of remaining croplands; restriction on use of pesticides; need for additional water quality data; continued Alabama Forestry Commission prescribed burning program; need for treatment of fire ants; evaluation of the older hardwood stands to ensure adequate numbers of viable oaks for good quality future hardwood stands; continued feral hog control; and establishment of riparian wetlands and moist soil management.

Visitor services comments included continued small game management, limited access to the Key Cave, concern that any additional trails or roads will result in additional vandalism and illegal hunting, and support for additional public use opportunities. On the planning process, one comment suggested that an Environmental Impact Statement was needed. All substantive scoping comments were reviewed in the development and evaluation of the Proposed Action and the EA and in the development of the SHSP.

Public notice was also provided to request public review and comment on the EA and SHSP. Public notice included a Public Information Bulletin and documents posted on the refuge's website, published on June 30th, 2025 for 45 days. Public comments were received by the Service during the public review and comment period from 3 members of the public, and 4

NGOs. All substantive comments received during the public review and comment period were reviewed by the Service in development of a final decision.

Certification

The environmental assessment represents the bureau's good-faith effort to prioritize documentation of the most important considerations required by the statute within the congressionally mandated page limits; this prioritization reflects the bureau's expert judgment; and that any considerations addressed briefly or left unaddressed were, in the bureau's judgment, comparatively not of a substantive nature that meaningfully informed the consideration of environmental effects and the resulting decision on how to proceed.

The environmental assessment represents the bureau's good-faith effort to fulfill NEPA's requirements within the congressional timeline; that such effort is substantially complete; that, in the bureau's expert opinion, it has thoroughly considered the factors mandated by NEPA; and that, in the bureau's judgment, the analysis contained therein is adequate to inform and reasonably explain bureau's decision regarding the proposed Federal action.

HOLLY GABORIAULT

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Appendix A - Other Applicable Statues, Executive Orders, and Regulations STATUTES, EXECUTIVE ORDERS, AND REGULATIONS

Cultural Resources

American Indian Religious Freedom Act, as amended, 42 U.S.C. 1996 – 1996a; 43 CFR Part 7

Antiquities Act of 1906, 16 U.S.C. 431-433; 43 CFR Part 3

Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa – 470mm; 18 CFR Part 1312; 32 CFR Part 229; 36 CFR Part 296; 43 CFR Part 7

National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470-470x-6; 36 CFR Parts 60, 63, 78, 79, 800, 801, and 810

Paleontological Resources Protection Act, 16 U.S.C. 470aaa – 470aaa-11

Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001-3013; 43 CFR Part 10

Executive Order 11593 – Protection and Enhancement of the Cultural Environment, 36 Fed. Reg. 8921 (1971)

Executive Order 13007 – Indian Sacred Sites, 61 Fed. Reg. 26771 (1996)

Fish & Wildlife

Bald and Golden Eagle Protection Act, as amended, 16 U.S.C. 668-668c, 50 CFR 22

Endangered Species Act of 1973, as amended, 16 U.S.C. 1531-1544; 36 CFR Part 13; 50 CFR Parts 10, 17, 23, 81, 217, 222, 225, 402, and 450

Fish and Wildlife Act of 1956, 16 U.S.C. 742 a-m

Lacey Act, as amended, 16 U.S.C. 3371 et seq.; 15 CFR Parts 10, 11, 12, 14, 300, and 904

Migratory Bird Treaty Act, as amended, 16 U.S.C. 703-712; 50 CFR Parts 10, 12, 20, and 21

Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds, 66 Fed. Reg. 3853 (2001)

Natural Resources

Clean Air Act, as amended, 42 U.S.C. 7401-7671q; 40 CFR Parts 23, 50, 51, 52, 58, 60, 61, 82, and 93; 48 CFR Part 23

Wilderness Act, 16 U.S.C. 1131 et seq.

Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq.

Executive Order 13112 – Invasive Species, 64 Fed. Reg. 6183 (1999)

Appendix A - Other Applicable Statues, Executive Orders, and Regulations STATUTES, EXECUTIVE ORDERS, AND REGULATIONS

Water Resources

Coastal Zone Management Act of 1972, 16 U.S.C.

1451 et seq.; 15 CFR Parts 923, 930, 933

Federal Water Pollution Control Act of 1972 (commonly referred to as Clean Water Act), 33 U.S.C. 1251 et seq.; 33 CFR Parts 320-330; 40 CFR Parts 110, 112, 116, 117, 230-232, 323, and 328

Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.; 33 CFR Parts 114, 115, 116, 321, 322, and 333

Safe Drinking Water Act of 1974, 42 U.S.C. 300f et seq.; 40 CFR Parts 141-148

Executive Order 11988 – Floodplain Management, 42 Fed. Reg. 26951 (1977)

Executive Order 11990 – Protection of Wetlands, 42 Fed. Reg. 26961 (1977)

Appendix B. Key Cave National Wildlife Refuge Habitat and Species Plan Objectives Crosswalk

Supporting multiple goals and objectives in the Wheeler NWR Complex CCP, the Spatial Habitat and Species Plan (SHSP, Section A) proposes to update and refine certain existing objectives or portions of objectives, while also providing one sub-goal for needed refinement. Since the refuge was included in a CCP that covered the multiple refuges in the Wheeler NWR Complex (USFWS 2007), some portions of the listed objectives do not apply to the refuge and will remain in place. This crosswalk (Table B.1) outlines the existing applicable objectives, provides replacement objectives (in whole or in part) for Key Cave NWR, leaves shared objectives (in whole or in part) in place for other refuges in the Wheeler NWR Complex, and proposes new objectives for Key Cave NWR; the goals remain unchanged and are provided for reference. Upon a final decision, the management objectives for Key Cave NWR and the Wheeler NWR Complex CCP (USFWS 2007) will be updated as outlined here.

Table B.1. The SHSP refines and updates CCP Objectives.

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	**Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR**	**Remaining Objectives for the other Refuges in the Wheeler NWR Complex**
Goal 1. Fish and Wildlife Population Management. Protect, maintain, enhance, and restore healthy and viable populations of migratory birds, resident wildlife, fish, and native plants, including all federal and state-threatened and endangered species found within Northern Alabama in a manner that supports national and international treaties, plans, and initiatives.	No change	No change
Objective 1.9. Shorebirds (including the American Woodcock). Within three years of plan approval, increase shorebird management	No change	No change

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
capabilities and monitoring efforts.		
Objective 1.13. Grassland Landbirds. Within eight years of plan approval, increase management efforts for grassland dependent landbird species on Key Cave and Wheeler NWRs.	No change	No change
Objective 1.14. Scrub-shrub Landbirds. Within eight years of plan approval increase management efforts for scrub-shrub landbird species.	No change	No change
Objective 1.17. Amphibians and Reptiles. Within five years of plan approval increase management for improving populations of amphibians and reptiles on Complex lands.	No change	No change
Objective 1.19. State and/or Federal Endangered, Threatened, or Special Concern Species. Over the 15-year life of the plan, protect, inventory, monitor, and conserve imperiled terrestrial and aquatic species.	No change	No change
Objective 1.20. State and/or Federal Threatened, Endangered, or Special Concern Species. Over the 15-year life of the plan, contribute to the stabilization and/or increase of	**Refined Objective 1.A: Cave Objective.** Contribute to the protection and maintenance of the integrity of Key Cave for appropriate abiotic and biotic conditions that are suitable to support a sustainable population of the Alabama cavefish	NA

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
Gray bat populations found within Key Cave.	(which is currently estimated to be between 100 to 130 individuals) and protect and maintain the integrity of Key Cave for the listed desired conditions and actions to continue to support a Priority 1 Gray bat maternal colony of approximately 36,000 adult females and to continue to support tricolored bat use. 1.A.7. Coordinate with TVA, USGS, and other partners to minimize disturbance in Key Cave from mid-April through September for Gray bats. 1.A.8. Coordinate with TVA, USGS, and other partners to minimize disturbance in the cave from mid-October through April for the tricolored bat. 1.A.9. Maintain a 0.25-mile protective forested cover buffer around the Key Cave entrance for Gray bat foraging and to minimize alterations in cave air flow and ambient temperature. 1.A.10. Annually conduct abundance counts for Gray and tricolored bats within Key Cave utilizing most current standardized protocols and methodology for cave and bat monitoring.	
Objective 1.21. State and/or Federal Threatened, Endangered, or Special Concern Species. Within two years of	**Refined Objective 1.A:** Cave Objective. Contribute to the protection and maintenance of the integrity of Key Cave for appropriate	NA

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
plan implementation, develop a protection plan to increase conservation efforts for the Alabama cavefish found within Key Cave.	abiotic and biotic conditions that are suitable to support a sustainable population of the Alabama cavefish (which is currently estimated to be between 100 to 130 individuals) and protect and maintain the integrity of Key Cave for the listed desired conditions and actions to continue to support a Priority 1 Gray bat maternal colony of approximately 36,000 adult females and to continue to support tricolored bat use. 1.A.1. Minimize groundwater contamination on 1,060 acres by utilizing selected BMPs. 1.A.2. Annually monitor water quality in Key Cave, including parameters such as ground water elevation, water temperature, dissolved oxygen, turbidity, nutrients, and pesticides to detect changes in water-quality over time. 1.A.3. Provide maximum protection of the Gray bat maternity colony within Key Cave to foster continued nutrient inputs that provides for micro-invertebrate communities of copepods, isopods, amphipods, and crayfish. 1.A.4. Within 5 years of this plan identify known and suspected sinkholes on the refuge and characterize each's hydrologic function/connectivity to Key Cave.	

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	1.A.5. Upon the development of an Inventory and Monitoring Plan, develop standardized protocol and methodology for cave and cavefish monitoring, including pool location, pool depth, species occurrence, species abundance, estimated age/size class, total number of individual surveyors, visual-timed area searches, and method of survey. 1.A.6. As technology advances in molecular science, utilize institutions for genetic sampling (e.g. eDNA) to determine cavefish population size, reproduction, genetic diversity and other aquatic species diversity. **Refined Objective 1.B:** Contribute to the protection and maintenance of the integrity of Key Cave within the larger recharge area landscape and the endemic threatened and endangered species. 1.B.1. Within 5 years of the plan delineate and refine the recharge area. 1.B.2. Maintain a minimum, 300 acres of grassland habitat in native vegetation encompassing nearly 30% of the refuge land base to aid in ground water filtration, erosion reduction, and nutrient cycling. 1.B.3. Maintain 50 ft-wide vegetative buffer strips around cropland edges to aid in ground water filtration and soil erosion stabilization.	

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	1.B.4. Maintain grassland or forested habitat within and adjacent to wetlands, sink holes, and drainages. 1.B.5. In cooperation with Tennessee Valley Authority (TVA), maintain 300 acres of hardwood forests along the Tennessee River and Key Cave entrance, to aid in cave habitat protection, ground water filtration, and soil erosion stabilization. 1.B.6. Annually monitor groundwater quality and quantity, including parameters such as ground water elevation, water temperature, dissolved oxygen, turbidity, nutrients, and pesticides to detect changes over time. 1.B.7. In cooperation with USFWS private lands biologist, support implementing water quality and recharge area protection projects with landowners within the Key Cave recharge area.	
Objective 1.26. Exotic/Invasive/Nuisance Animals. Within 10 years of plan implementation, remove 65 percent of the invasive and nuisance animals from Wheeler Complex lands and waters.	No change	No change
Goal 2. Conduct Habitat Restoration and Management. Protect, maintain, enhance, and restore optimum habitat for the conservation and healthy management of migratory	No change	No change

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
birds, resident wildlife, fish, and native plants, including all federal and state-threatened and endangered species found within northern Alabama in a manner that supports national and international treaties, plans, and initiatives.		
Objective 2.1. Impoundments and Shallow Water Areas (SWAs) (including moist soil). Over the 15-year life of the plan, continue efforts to improve and refine the management of impoundments and SWA's on Wheeler and Key Cave NWRs.	No change	No change
Objective 2.2. Agricultural Cropland. Over the 15-year life of the plan, utilize a well-managed farming program to provide food, cover, and resting areas for waterfowl and other wildlife on Wheeler and Key Cave NWRs.	**Add New Objective 2.A:** Grassland Habitat Restoration Objective. Convert 208 acres of cropland on Key Cave NWR to grassland-dominated, early successional habitat with a goal of 25 to 50 acres per year within Units 1 through 12 for grassland-dependent birds, such as the Grasshopper Sparrow, Northern Bobwhite, dickcissel (*Spiza americana*), and Loggerhead Shrike. 2.A.1. Using a stepwise approach to grassland restoration, convert 25-50 acres annually, evaluating the timeframe, acres restored, and approach every 2 years and adapting management as needed. 2.A.2. Begin immediately, converting cropland units outlined in the SHSP	**Update Objective 2.2. Agricultural Cropland**. Over the 15-year life of the plan, utilize a well-managed farming program to provide food, cover, and resting areas for waterfowl and other wildlife on Wheeler NWR.

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	(Table 2) from the cooperative farming program into grassland habitat. 2.A.3. Annually thereafter, and adapting as indicated by monitoring, target conversion in accordance with the restoration priorities. 2.A.4. Prioritize the units to be restored based on restoration criteria (SHSP -Table 2). 2.A.5. Utilize tools such as the cooperative farming program, grassland initiatives, and partners to assist in restoration. 2.A.6. Incorporate converted units to the prescribed burn program and other appropriate management regimes to maintain and enhance grassland habitats and apply Grassland Management Objective. Add New Objective 2.B: Grassland Habitat and Supplemental Wildlife Food Objective. In units 1, 4, or 12, continue to annually provide minimal supplemental wildlife food sources (e.g., sunflowers) on no greater than 60 acres at Key Cave NWR to support shared Service and Alabama Department of Conservation and Natural Resources (ADCNR) goals and objectives for foraging northern bobwhites and the National Bobwhite Conservation Initiative; foraging mourning doves; and wildlife-dependent public use opportunities,	

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	including wildlife observation, wildlife photography, and hunting. 2.B.1. For the remaining 60 acres of supplemental wildlife food sources, use no to minimal inputs of fertilizers and pesticides and maintain borders along field edges with fifty-foot-wide native grass strips. 2.B.2 Work with the ADCNR to determine the most feasible delivery of supplemental wildlife food sources, including evaluating the use of Service staff and/or an agreement with the state. 2.B.3 Continue to maintain Best Management Practices and implement soil conservation practices to protect Key Cave NWR resources, including the cave and aquifer system.	
Objective 2.4. Grassland Management. Within six years of plan implementation, promote the establishment of native warm season grassland (NWSG) habitats for the conservation of migratory birds and a natural diversity of wildlife at Wheeler and Key Cave NWRs.	**Refined Objective 2.C**: Grassland Habitat Management Objective. On an annual basis at Key Cave NWR, manage 30% to 50% of the grassland-dominated, early successional habitat for the listed desired conditions for grassland-dependent birds, such as the grasshopper sparrow (*Ammodramus savannarum*), Northern Bobwhite (*Colinus virginianus*), and Loggerhead Shrike (*Lanius ludovicianus*). 2.C.1. Provide patches of grassland 75 acres or larger comprised of at least 30 percent native warm-season bunch grasses, such as big bluestem	**Update Objective 2.4**. Grassland Management. Within six years of plan implementation, promote the establishment of native warm season grassland (NWSG) habitats for the conservation of migratory birds and a natural diversity of

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	(*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), indiangrass, sideoats gramma (*Bouteloua curtipendula*), switchgrass (*Panicum virgatum*), and eastern gamagrass (*Tripsacum dactyloides*), and 40 percent forbs, such as partridge pea (*Chamaecrista fasciculata*) and beggarweed (*Desmodium incanum*) in units 0400, 1100, 0500, 0103, 1201, 0901, 0802, 0803, 0805, 0806 and 0600. 2.C.2. Provide up to 30 percent scattered patches of woody cover (ten feet wide or wider in diameter), including thorny shrubs, such as chickasaw plum (*Prunus angustifolia*) and sumac (*Rhus spp*.) in units 0300, 0201, 0202, 0203, 0102, 1100, 1201, 1300, 1007, 1002, 0904, 0804, 0801, 0702, and 0701.	wildlife at Wheeler NWR.
Objective 2.5. Forest Management. Over the 15-year life of the plan, manage forested habitats for priority species and use adaptive management on all Complex lands.	**Refined Objective 2.D:** Forest Habitat Objective. In the Oak Savanna and Hardwood Oak units at Key Cave NWR, reduce basal area, retain oak species, and increase herbaceous ground cover (as described below and referenced from: Nelson 2002; USDA 2005, CHJV pers. comm.) using forested thinning, prescribed fire, and other chemical and mechanical methods. Continue to provide a forested buffer in the Hardwood units around the cave and Tennessee River utilizing passive management;	No change

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
	however, control invasive species in all units. 2.D.1. In all forest units survey selected plants, fish, and wildlife in forested areas pre- and post-management to monitor the effectiveness of forest management and change. 2.D.2 In units OS-S, OS-N, OS- SE, OS-W, HW-1, HW-2, HW-3, HW-4, Woodlot, and Woodlot 2 convert existing oak woodlots at Key Cave NWR to oak savanna habitat by reducing average basal area to 60 square-feet per acre, favoring white oak and other more fire-tolerant species with canopy cover ranging from 30-80%. Consider reducing to 40 square-feet basal area. 2.D.3 In above oak savanna units, increase native grass and forb cover and diversity in open areas to aid in savanna establishment. 2.D.4 Maintain shagbark hickory and other loose bark trees. 2.D.5 Provide passive forest management on 300 acres in units OA1, OA2, OA3, CS-1, and Main.	
Objective 2.6. Invasive/Exotic Plant Species Management. Within five years of plan implementation, eliminate at a minimum 25 percent of the non-native invasive or exotic	No change	No change

Existing Wheeler NWR Complex CCP Goals and Existing Objectives for Key Cave NWR	Refined/Updated/New Objectives and New Sub-Goal for Key Cave NWR	Remaining Objectives for the other Refuges in the Wheeler NWR Complex
plant species from Complex lands.		
Goal 3. Provide Resource Conservation and Protection. Provide coordination and cooperation among organizations to enhance effective management and protection of natural and cultural resources within northern Alabama.	No change	No change
Objective 3.8. Water Quality and Quantity Management. Within five years of plan (CCP) implementation, develop and implement a water quantity and water quality monitoring program to ensure that the Wheeler Complex maintains adequate and environmentally safe water supplies to meet the needs of plants, fish, and wildlife, including the natural processes that support these resources (e.g., water levels in ground and surface that support hydric soils).	No change	No change