

**Key Cave National Wildlife Refuge (NWR): Forest Habitat Objective for
Priority Resources of Concern: Northern Bobwhite (*Colinus virginianus*) and Gray bat (*Myotis grisescens*),
(CCP Objectives 1.5, 1.7, 1.8, 1.9, 1.11, 1.12,, 1.14, 1.15, 1.17, 1.19, 1.26, 2.5, 2.6)**

| Key Cave NWR HMP Forest Habitat Objective | Primary Habitat and Wildlife Response Variables and Probable Assessment Methods |
|--|--|
| <p>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, Central Hardwood Joint Venture (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. See Figure 1 and Table 1 for Forest Habitat Units information and Figure 2 for Habitat Coverage.</p> <p>D.2.1. 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.</p> <p>D.2.2 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-foot basal area.</p> <p>D.2.3 In above oak savanna units, increase native grass and forb cover and diversity in open areas to aid in savanna establishment.</p> <p>D.2.4 Maintain shagbark hickory and other loose bark trees.</p> <p>D.2.5 Provide passive forest management on 300 acres in Units OA1, OA2, OA3, CS-1, and Main.</p> | <ul style="list-style-type: none"> • Forest Stand composition, structure, and regeneration • Forest Stand habitat components (snags, coarse woody debris, cavities) • Forest System composition and structure • % herbaceous cover • Bird use, composition, and abundance • Forest breeding bird use (species composition, abundance, and type of use) • Bat species composition, abundance, and use of forests and cavities • Forest inventory sampling (traditional cruise parameter and habitat components) • GIS Stand mapping and harvest records • Regeneration plots • Breeding landbird surveys (point counts) • Cavity surveys, mobile acoustical bat surveys • Other wildlife surveys |

The following desired forest conditions are derived from CHJV (personal communication, D. Jones-Farrand, Science Coordinator); Nelson (2002); USDA, FS (2005):

- Oak savannas (listed as “barrens” by the CHJV) are defined as open-grown scattered trees with a ground layer of prairie grasses and forbs. They will typically occur on xeric, steep mid to upper south to southwest-facing slopes and narrow ridges over shallow, well-drained to droughty, often rocky soils. Canopy cover will range between 10-20 percent. The dominant canopy tree species will be chestnut oak, post oak, and scarlet oak.
- Open oak woodlands consist of patches of oaks at irregular intervals with an overall canopy coverage between 20-50 percent; with a sparse midstory and dense ground flora of forbs, grasses and sedges. The open oak woodlands will be interspersed with oak savannas on the southerly slopes and narrow ridges and dominate the well-drained broad ridges. The dominant canopy species will be post oak, chestnut oak, black oak, and pignut hickory.
- Closed oak woodlands will occupy the sites with moderate soil moisture that might include gentle sloping uplands, steep upper north slopes, and valleys that are not protected from sun exposure. The canopy cover will range between 50-80 percent and be dominated by white oak, black oak, mockernut hickory and shagbark hickory. The understorey will have a well-developed small tree and shrub layer, along with scattered forbs and grasses.
- Upland mesic forests will occur on the sites that are most protected from sun exposure and thus more mesic. These sites typically occur on slopes with a northerly aspect and valleys shielded from sun exposure by the adjacent ridges. With the lack of sun exposure these sites are more mesic and thus will rarely burn. Most of the forests on the refuge that fall within the “more mesic” locations are on the drier side of what might be classified as mesic. Nelson (2002) classified these forests as “dry-mesic forests”. The tree species that occupy the canopy within these sites are primarily white oak, yellow-poplar, shagbark hickory, and the occasional northern red oak. Canopy closure will range between 80-100 percent. The understorey will be dense to patchy (50-70% cover) and dominated by shade tolerant trees, shrubs, vines, and occasionally ferns.

Other benefitting species: Dickcissel (*Spiza americana*), Eastern Meadowlark (*Sturnella magna*), LeConte's Sparrow (*Ammodramus leconteii*), and Prairie Warbler (*Setophaga discolor*), tricolored bat (*Perimyotis subflavus*), Northern long-eared bat (*Myotis septentrionalis*), and Indiana bat (*Myotis sodalis*).

Forest Habitat Compartments on Key Cave National Wildlife Refuge

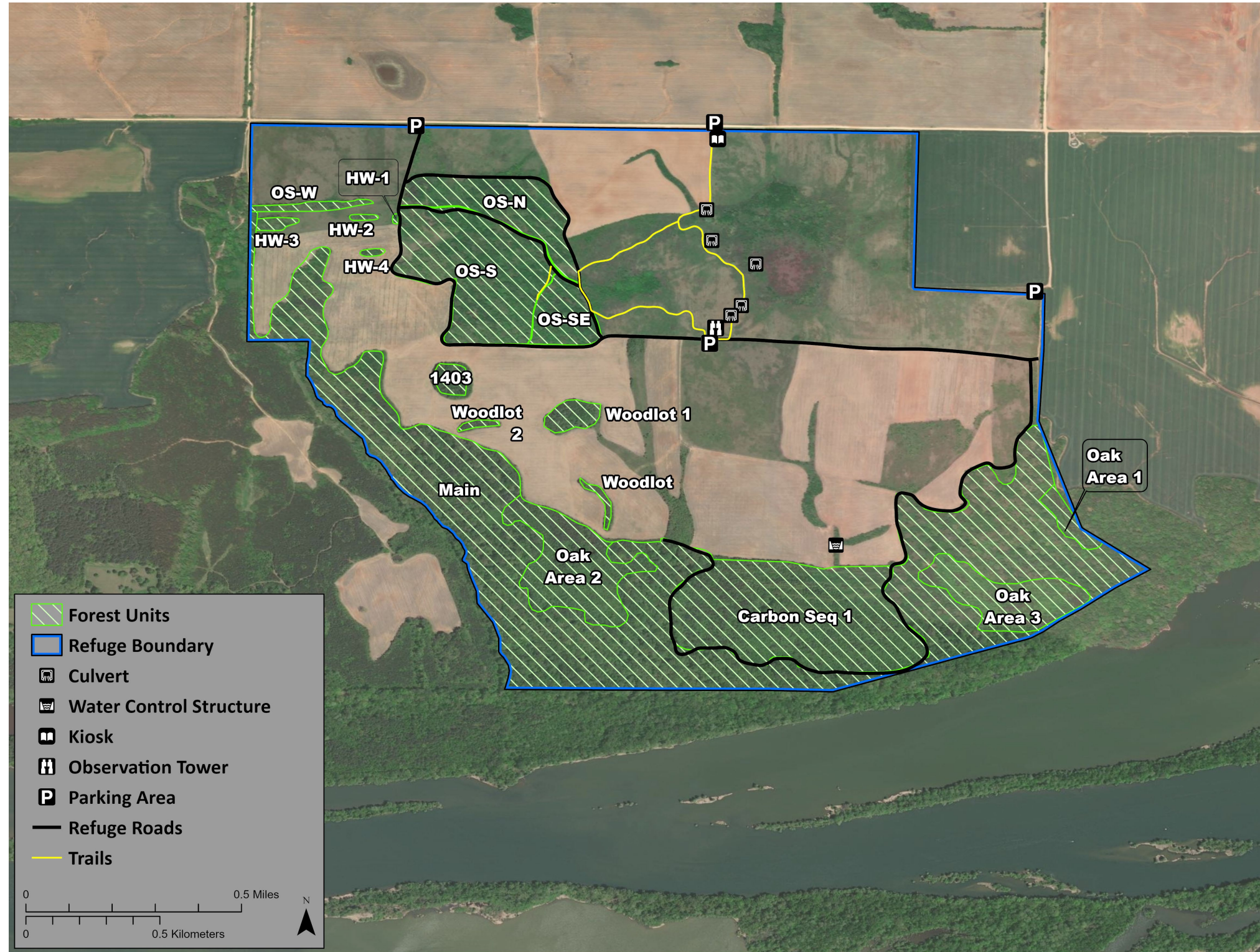


Figure 1. Forest Habitat Units on Key Cave National Wildlife Refuge (see Table 1).

| Unit | Acres | Type | Treatment |
|--------------|--------|--------------|-----------|
| OA1 | 3.67 | Hardwood Oak | Passive |
| OA2 | 25.98 | Hardwood Oak | Passive |
| OA3 | 18.68 | Hardwood Oak | Passive |
| OS-S | 42.23 | Oak Savannah | Thin/Fire |
| OS-N | 20.95 | Oak Savannah | Thin/Fire |
| OS-SE | 10.22 | Oak Savannah | Thin/Fire |
| OS-W | 2.47 | Oak Savannah | Thin/Fire |
| CS-1 | 63.69 | Hardwoods | Passive |
| Main | 208.43 | Hardwoods | Passive |
| HW-1 | 0.15 | Hardwoods | Thin/Fire |
| HW-2 | 0.43 | Hardwoods | Thin/Fire |
| HW-3 | 1.26 | Hardwoods | Thin/Fire |
| HW-4 | 0.43 | Hardwoods | Thin/Fire |
| Woodlot 1 | 3.79 | Hardwoods | Fire |
| Woodlot 2 | 0.72 | Hardwoods | Thin/Fire |
| Woodlot 1403 | 0.99 | Hardwoods | Thin/Fire |
| | 2.5 | Hardwoods | Fire |
| Total | 407 | | |

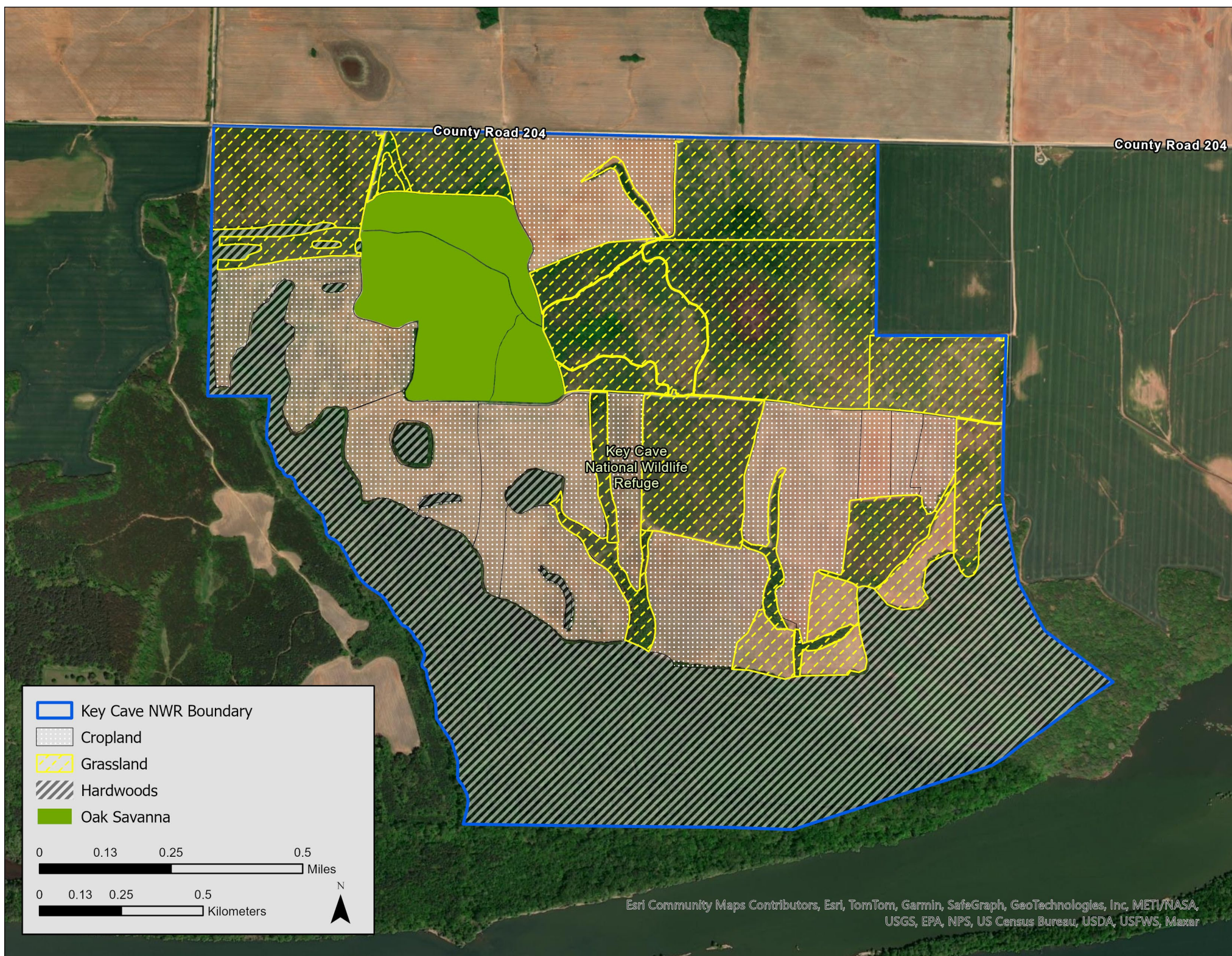


Figure 2. Habitat Coverage for Key Cave NWR.

Prescribed Fire Management

- Utilize prescribed fire (**Figure 3**) as a wildfire mitigation tool to manage forested habitats and/or reduce fuel loads to minimize wildfire risks.
- Explore opportunities to use partners, such as the Alabama Forestry Commission, to provide fire crews and equipment that is not available on the refuge.
- The prescribed fire program is to be designed to mimic natural fire regimes as much as possible. Fire frequency, intensity, burn season, and spatial pattern should be suited to the specific habitat objectives for each forest habitat classification within the oak savanna to upland mesic forest continuum (**Table 2** and **Figures 4 and 5**).
- Conduct a vigorous prescribed fire program consistent with the highest professional and technological standards.
- Continually evaluate the prescribed fire program to better meet program objectives by updating prescriptions and monitoring plans, and by integrating newly proven technical and scientific treatments.
- Ignition shall be in accordance with Service policy as detailed in [the Interagency Standards for Fire and Fire Aviation Operations](#) (NFES 2724).
- No ignition shall occur without an approved prescribed fire plan and concurrence of the Project Leader.
- Ignition methods shall be selected with due regard for safety and smoke management concerns.
- In addition to forested habitats, prescribed fire will be used to restore and maintain native warm season grass habitat.
- Prescribed fire within forest dwelling bat habitat will follow all recommendations set forth in referenced Programmatic Biological Opinion (USFWS 2024).

Table 2. Prescribed Fire Units on Key Cave NWR including acreages of each unit and prescribed burn cycle rotations.

| UNIT | NAME | CATEGORY | LANDUSE | ACRES | BURN YEAR CYCLE |
|-------------|------------------|--------------------|--------------------|-------|-----------------|
| 0201 | SHRUB THicket | THicket | WATERWAY | 2.6 | 1 |
| 0202 | NWGS | GRASSLAND | GRASSLAND | 14.5 | 1 |
| 0103 | NWGS | GRASSLAND | GRASSLAND | 47.3 | 1 |
| 0202 | NWGS | GRASSLAND | GRASSLAND | 1.5 | 1 |
| 0203 | SHRUB THicket | THicket | WATERWAY | 2.3 | 1 |
| 0203 | SHRUB THicket | THicket | SHRUB THicket | 0.5 | 1 |
| OS-N | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 20.9 | 1 |
| OS-S | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 42.3 | 1 |
| 0400 | NWGS | GRASSLAND | GRASSLAND | 8.2 | 1 |
| 1201 | NWGS | GRASSLAND | GRASSLAND | 88.4 | 1 |
| 1100 | NWGS | GRASSLAND | GRASSLAND | 27.6 | 1 |
| 1100 | NWGS | SHALLOW WATER AREA | SHALLOW WATER AREA | 3.9 | 1 |
| OS-SE | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 10.2 | 1 |
| 0800 | NWGS | GRASSLAND | GRASSLAND | 24.6 | 1 |
| 0500 | NWGS | GRASSLAND | GRASSLAND | 6.5 | 1 |
| 0202 | NWGS | GRASSLAND | GRASSLAND | 1.3 | 1 |
| 0300 | NWGS | GRASSLAND | GRASSLAND | 38.5 | 1 |
| OS-W | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 2.5 | 2 |
| 0300 | NWGS | GRASSLAND | GRASSLAND | 1.2 | 2 |
| HW-1 | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 0.1 | 2 |
| HW-2 | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 0.4 | 2 |
| HW-3 | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 1.3 | 2 |
| 0300 | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 0.4 | 2 |
| 1002 | NWGS | GRASSLAND | GRASSLAND | 5.0 | 2 |
| 0801 | NWGS | GRASSLAND | GRASSLAND | 35.3 | 2 |
| 0701 | NWGS | GRASSLAND | GRASSLAND | 13.3 | 2 |
| 1003 | UPLAND HARDWOODS | OS SAVANNA | OS SAVANNA | 2.5 | 2 |
| 0404 | NWGS | GRASSLAND | GRASSLAND | 4.1 | 2 |
| 1004 | SHRUB THicket | SHALLOW WATER AREA | SHALLOW WATER AREA | 3.8 | 2 |
| 0702 | NWGS | WATERWAY | WATERWAY | 0.4 | 2 |
| 0807 | NWGS | WATERWAY | WATERWAY | 5.8 | 2 |
| 1004 | SHRUB THicket | WATERWAY | WATERWAY | 0.7 | 2 |
| 0801 | NWGS | GRASSLAND | GRASSLAND | 14.1 | 2 |
| 0808 | SHRUB THicket | WATERWAY | WATERWAY | 0.9 | 2 |
| 1007 | SHRUB THicket | WATERWAY | WATERWAY | 2.2 | 2 |
| 0804 | SHRUB THicket | WATERWAY | WATERWAY | 2.2 | 2 |
| 0202 | NWGS | GRASSLAND | GRASSLAND | 7.9 | 2 |
| 0805 | NWGS | GRASSLAND | GRASSLAND | 6.0 | 2 |
| 0806 | NWGS | GRASSLAND | GRASSLAND | 6.5 | 2 |
| TOTAL ACRES | | | | 446.1 | |

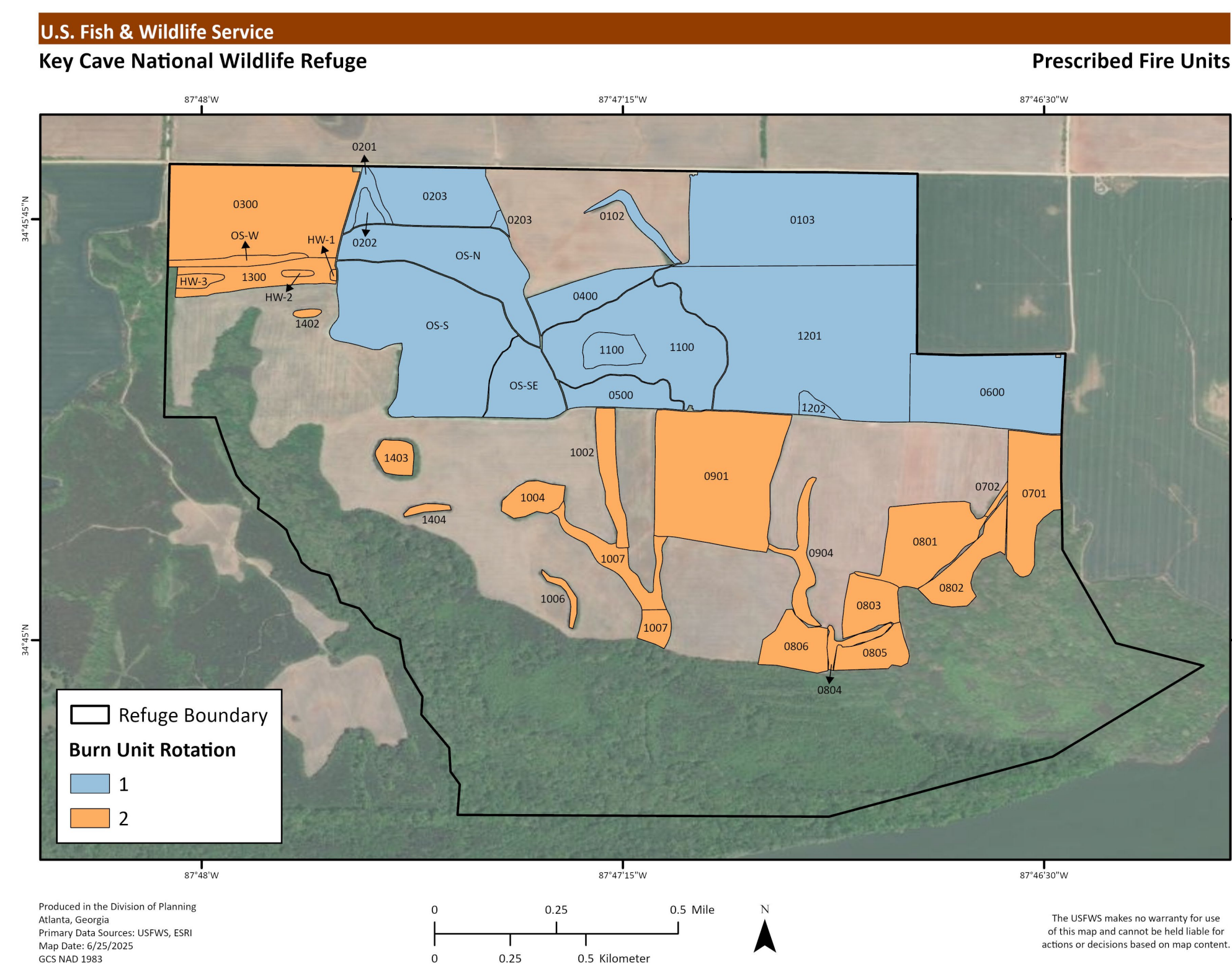


Figure 4. Current prescribed fire units and rotations for management on Key Cave National Wildlife Refuge (see Table 2).



Figure 3. Prescribed fire.

Forest Habitat Management Strategies

Inventory and Determine Stand Baseline Data

Intermediate Treatments

- Crown Thinning (thinning of dominants and co-dominants)
- Low Thinning (thinning of suppressed and intermediates)
- Free Thinning (combination of crown and low thinnings)
- Variable Density Thinning (varied target residual stocking)
- Thinning by Rules (Basal Area, diameter, species, spatial, etc.)
- Salvage/Sanitation Cutting

Regeneration Methods

- Individual Tree Selection (<0.1 acre)
- Group Selection (0.1 to 0.5 acre)
- Patch Selection (0.5 to 2.0 acre)
- Femelschlag (expanding gaps)
- Shelterwood
- Seed Tree

Potential and Selected Management Strategies and Tools

Non-commercial Forest Stand Improvement Strategies

- Mulching
- Pre-commercial Thinning
- Wildlife Stand Improvement
- Salvage/Sanitation Cutting
- Prescribed Fire
- Hydrological Restoration

Mechanical Management (Site Preparation for Plantations)

- Disking
- Mowing
- Ripping/Subsoiling
- Hydrological Restoration

Chemical Management (Site Preparation, Treatment of Impurities, and within Stand)

- Pre-emergent
- Hack and squirt
- Stem injection
- Cut stump
- Basal spray
- Streamline
- Foliar spray
- Fogging

Stand Regeneration/Plantation Establishment Strategies

- Site Preparation for Natural Regeneration
- Coppice
- Planting seedlings or cuttings
- Direct seeding
- Under-planting

Utilize State Best Management Practices when Conducting Forestry Operations

Monitor Future Vegetation
Community Trends

Forest management within forest dwelling bat habitat will follow all recommendations set forth in referenced Programmatic Biological Opinion (USFWS 2024).

Invasive Plant Control Strategies for All Objectives

The following strategies will be utilized in Forest Habitat Management to control invasive plant species:

- Prevent introduction of potential invaders.
- Prior to the initiation of invasive species control efforts, refuge staff must understand the biology of the species to be controlled.
- Employ early detection and rapid response actions.
- Prioritize invasive plant control efforts.
- Control or contain large established infestations; eradicate if possible.
- Eradicate new or small infestations.
- Monitor results and adjust strategies if warranted.
- Invasive species control within forest dwelling bat habitat will follow all recommendations set forth in referenced Programmatic Biological Opinion (USFWS 2024).
- Potential control methods:
 - a) Habitat manipulation/Mechanical Control
 - b) Chemical Control
 - c) Biological Control
 - d) Prescribed Fire

Nuisance Animal or Pest Control Strategies for All Objectives

- Employ integrated pest management techniques when a species is having a significant impact on an area resulting in major habitat replacement or damaging rare species.
- Determine the need for site-specific control, based on the potential to negatively affect wildlife and habitat management objectives on the refuge.
- Monitor results and adjust strategies if warranted.
- Potential control methods:
 - a) Trapping/shooting
 - b) Habitat Manipulation/Mechanical Control
 - c) Chemical Control
 - d) Biological Control



Figure 5. Key Cave NWR oak savanna.