POPULATION STATUS AND MANAGEMENT OF THE GOPHER TORTOISE ON THE FITZHUGH CARTER TRACT OF ECONFINA CREEK WILDLIFE MANAGEMENT AREA

2014 STATUS REPORT

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INTRODUCTION

The Fitzhugh Carter Tract (hereafter referred to as the Carter Tract) was purchased by the Northwest Florida Water Management District (NWFWMD) in October 2003 and established as a tract of Econfina Creek Wildlife Management Area (WMA). A mitigation bank permit from the Florida Department of Environmental Protection (DEP) was issued to the NWFWMD in August 2005 to manage the property. Management objectives identified by the NWFWMD include wetlands restoration, preservation and management, aquatic habitat preservation, erosion control, and uplands restoration and management. In June 2005, the Florida Fish and Wildlife Conservation Commission (FWC) entered into a cost-share agreement with NWFWMD to develop and implement a comprehensive fish and wildlife management program for the Carter Tract. Following eight years of successful partnership, this agreement was renewed in April 2014 for an additional five years through 2019. As part of this agreement, an annual survey and monitoring program for the gopher tortoise (*Gopherus polyphemus*) has continued since 2005.

The goal of this project is the continuation of surveying, monitoring, and assessing the status of the gopher tortoise population on the Carter Tract. Equally important is our commitment to providing management recommendations to the NWFWMD for gopher tortoises on the Carter Tract. Changes in gopher tortoise population status can be an indicator of the health of xeric plant communities in this region. Therefore, monitoring the status of such populations can aid land managers in gauging the efficacy of management and restoration efforts.

Monitoring for the gopher tortoise, a protected imperiled species, is important because it is a keystone species for sandhill communities of the southeastern coastal plain. Gopher tortoise are commonly found in the sandhills (upland areas with well-drained, sandy soils) and are commonly associated with longleaf pine (*Pinus palustrus*) and xeric oak (*Quercus spp*.) communities. Ideal gopher tortoise foraging habitat are areas of open canopy where plants have ample access to sunlight, promoting the growth of grasses and herbaceous groundcover (Ashton and Ashton 2008). These habitat types are found on the Carter Tract and are actively managed through the use of prescribed fire, and mechanical and chemical plant control methods (Enge et al 2006).

Tortoise burrows have been known to support hundreds of obligate and non-obligate species (Jackson and Milstrey 1989; Cox et al. 1987). Sixty vertebrate and 302 invertebrate species are known to utilize gopher tortoise burrows in Florida to varying degrees (Jackson and Milstrey 1989; Figure 1). Witz et al. (1991) found a vertebrate associate in 10% of the 1,019 active, inactive, and abandoned burrows they excavated, while Kent and Snell (1994) found a vertebrate associate in 20% of active and inactive burrows excavated. Alexy et al. (2003) and Pike and Grosse (2006) studied active burrows and observed a vertebrate associate in every burrow (n=6 and n=8, respectively)

Figure 1. Vertebrate species are often observed utilizing gopher tortoise burrows on the Carter Tract, including the Gulf Coast box turtle (*Terrapene carolina major*).

Moreover, gopher tortoise burrows provide a refuge for state and federally listed species (Speake 1981). Four noteworthy burrow commensals include the Federally Threatened eastern indigo snake (*Drymarchon couperi*), the State Species of Special Concern (SSC) gopher frog (*Lithobates capito*), the State SSC Florida pine snake (*Pituophis melanoleucus mugitus*) (Witz et al. 1992; Moler 1992; Ashton and Ashton 2008), and, the eastern diamondback rattlesnake (*Crotalus adamanteus*), which is currently under review for federal listing (US Fish and Wildlife Service

2012). The Florida pine snake and eastern diamondback rattlesnake have both been documented on the Carter Tract.

Legal status of the gopher tortoise across the southeastern coastal plain varies by region. It was listed as a Florida SSC in 1979, but it was not until 1988 that the harvest of tortoises was prohibited statewide. In November 2007, the gopher tortoise in Florida was uplisted from a SSC to Threatened status and is now protected by state law, Chapter 68A–27, Florida Administrative Code (F.A.C.). Regionally, populations west of Mobile Bay are federally protected as threatened. On 27 July 2011, the US Fish and Wildlife Service (USFWS) added gopher tortoise populations east of Mobile Bay to the list of candidate species eligible for protection under the Endangered Species Act. The USFWS issued a finding of "warranted but precluded" for the species in the eastern portion of its range, including Florida, Georgia, and South Carolina (US Fish and Wildlife Service 2011). The USFWS concluded that listing of the gopher tortoise was warranted but that higher priority listing actions currently take precedence over the gopher tortoise.

The primary threat to the gopher tortoise population in Florida is habitat loss due to development of sandhill communities and habitat degradation due predominantly to fire suppression and incompatible forestry practices (Auffenberg and Franz 1982; McCoy and Mushinsky 2002). Over the past 25 years, selective timber harvests have largely been replaced by pulpwood production; this usage demands dense, deeply shaded stands of sand (*Pinus clausa*) and slash pine (*Pinus elliotti*), where tortoises are not found. It is difficult to estimate how much tortoise habitat has been destroyed during this land conversion process, but the amount is likely large. The total area of suitable gopher tortoise habitat in Florida is estimated to have declined by more than 60% since 1910 (Enge et al. 2006), with just 44,000 hectares (ha) of original gopher tortoise habitat remaining in Washington County, Florida (Auffenberg and Franz 1982).

It has been estimated that only 1-3% of gopher tortoise eggs eventually produce breeding adults (Landers et al. 1980; Enge et al. 2006). The majority of predation occurs on gopher tortoise eggs and hatchlings with 80-90% of nests being depredated and less than 10% of hatchlings surviving past their first year (Landers et al. 1980, Witz et al. 1992, Butler and Sowell 1996, Epperson and Heise 2003) . Native and non-native predators alike can have detrimental impacts on vulnerable tortoise populations. Native predators of gopher tortoises include the raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), gray fox (*Urocyon cinereoargenteus*), and Florida cottonmouth (*Agkistrodon piscivorus conanti*; Ernst et al. 1994, Butler and Sowell 1996). Non-native predators include the coyote (*Canis latrans*), nine-banded armadillo (*Dasypus novemcinctus;* Figure 2), domestic dog (*Canis lupus familiaris*), and red imported fire ant (*Solenopsis invicta*)(Epperson and Heise 2003, Enge et al 2006, Moore et al. 2006, Smith et al. 2013). The additive pressure from non-native predators may further reduce gopher tortoise survival rates.

Exotic plants can also present a threat to gopher tortoises. For example, cogon grass (*Imperata cylindrica*), an aggressive exotic, can negatively impact gopher tortoises by increasing fire intensity (Brooks et al. 2004) and replacing native groundcover plants with lower-quality forage (Basiotis 2007). Given a general depletion of panhandle tortoise populations due to habitat loss and fragmentation (Diemer and Moler 1992; Landers and Speake 1980), human exploitation (Diemer 1987), and the introduction of non-native species, it has been postulated that by the year 2025 only scattered tortoise populations on fully protected lands will remain (Auffenberg and Franz 1982). This stresses the importance of maintaining viable tortoise populations on protected land like the Carter Tract.

Figure 2. Nine-banded armadillo (*Dasypus novemcinctus*) are known to prey on gopher tortoise hatchlings and have been documented using gopher tortoise burrows on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

AREA DESCRIPTION

Overview

The Carter Tract is a 2,175 acre parcel located in south-central Washington County, approximately five miles north of State Road 20 and one mile west of State Road 77. The physiographic region in which the Carter Tract is located is classified by the Florida Natural Areas Inventory (FNAI) as xeric upland sandhill (FNAI 2010). It is characterized by relatively high, rolling topography with sandy soils overlaying limestone and containing numerous small solution ponds. Much of the area's sandhill community, historically dominated by longleaf pine (*Pinus palustris*), has been harvested and converted to sand or slash pine plantation or developed for home sites and small farms. The surrounding land uses are primarily pine plantation, undeveloped open lands, sod farms, small residential developments, and a nearby Department of Corrections facility. There is increasing residential development in the vicinity, and there are plans to widen State Road 77.

The Carter Tract lies within the Choctawhatchee River Basin, near the watershed divide to the St. Andrews Bay Basin. Most surface water flows through area ponds and Pine Log Creek to the Choctawhatchee River, but much of the groundwater flow is toward the east into the Econfina Creek watershed of the St. Andrews Bay Basin. Interspersed within the 1,150 acres of uplands are approximately 875 acres of mesic and hydric habitats comprised of Swamp Lakes, Basin Swamps and Marshes, Seepage Streams, isolated Depression Marshes, Mesic Flatwoods, Baygalls, Wet Prairie, and Seepage Slopes. The remaining 150 acres are natural Sinkholes and Sinkhole Lakes (isolated, steep-sided karst ponds and shallow, gently-sloping lakes). These land cover types occur across several soil types Swamp soilsare strongly acidic mineral soils containing large amounts of organic matter. Lakeland and Blanton soil types dominate the upland habitat fo the Carter Tract. Lakeland soils are deep, well-drained, strongly acidic sandy and loamy soils while Blanton soils are sandy and acidic in nature (Huckle 1962).

Hot, humid summer months and mild winters characterize the regional climate. The area's proximity to the Gulf of Mexico influences its precipitation and temperature. The annual average daily temperature reaches the upper 60s (°F), with mean summer (June–August) temperatures in the low 80s (°F) and mean winter temperatures (December–February) in the low 50s (°F). Generally, the last spring freeze occurs no later than the first week in March, while the first autumn freeze occurs at November's end. Mean annual precipitation totals approach 152.4 cm (60"). Two peak rainfall periods occur: a primary peak during the summer and a secondary peak throughout late winter and early spring.

Historical Land Use

The Carter Tract represents several distinct ecological communities. A significant portion of the property (1,150 acres) is upland sandhill habitat which was historically logged for longleaf pine and replanted in sand or slash pine plantations or left to regenerate with pine (*Pinus* spp.), live oak (*Quercus virginiana*), and scrub oaks (*Quercus* spp.). Prior to NWFWMD acquisition of the property, the essential element of maintaining this community, periodic prescribed fire, had been absent for many years. Therefore few of the vegetative communities which constitute historic sandhills, including the longleaf pine/wiregrass (*Aristida spp*.) community, remained. As a result, wiregrass was replaced with shrubs and taller understory species, and longleaf pine was outcompeted by hardwoods and other pine species. Prior to 2007, the uplands contained 750 acres of upland hardwood forest (xeric oak and live oak) and 400 acres of sand and slash pine plantation.

Restoration Efforts

NWFWMD began habitat restoration on the Carter Tract in 2007 with the logging of the pine plantations, and thinning of the upland hardwood forests. Prescribed burning followed logging and thinning operations, and subsequent planting of longleaf pine seedlings and wiregrass tublings followed site preparation burns. Planted upland areas were then broadcast treated via helicopter using Velpar®, a broad spectrum herbicide, to control scrub oaks. Restoration efforts on the Carter Tract continue to be aggressive in nature with continued prescribed fire, mechanical removal and herbicide of encroaching shrubs and regenerating sandpine. Such restoration efforts are documented annually via photo plots and provide a snapshot of habitat improvement over time (Figure 3). When managing for gopher tortoises it is essential to manage for the integrity of the forest system that supports the tortoise population, specifically the sandhills longleaf-turkey oak-wiregrass association. These restoration efforts are a necessary first step.

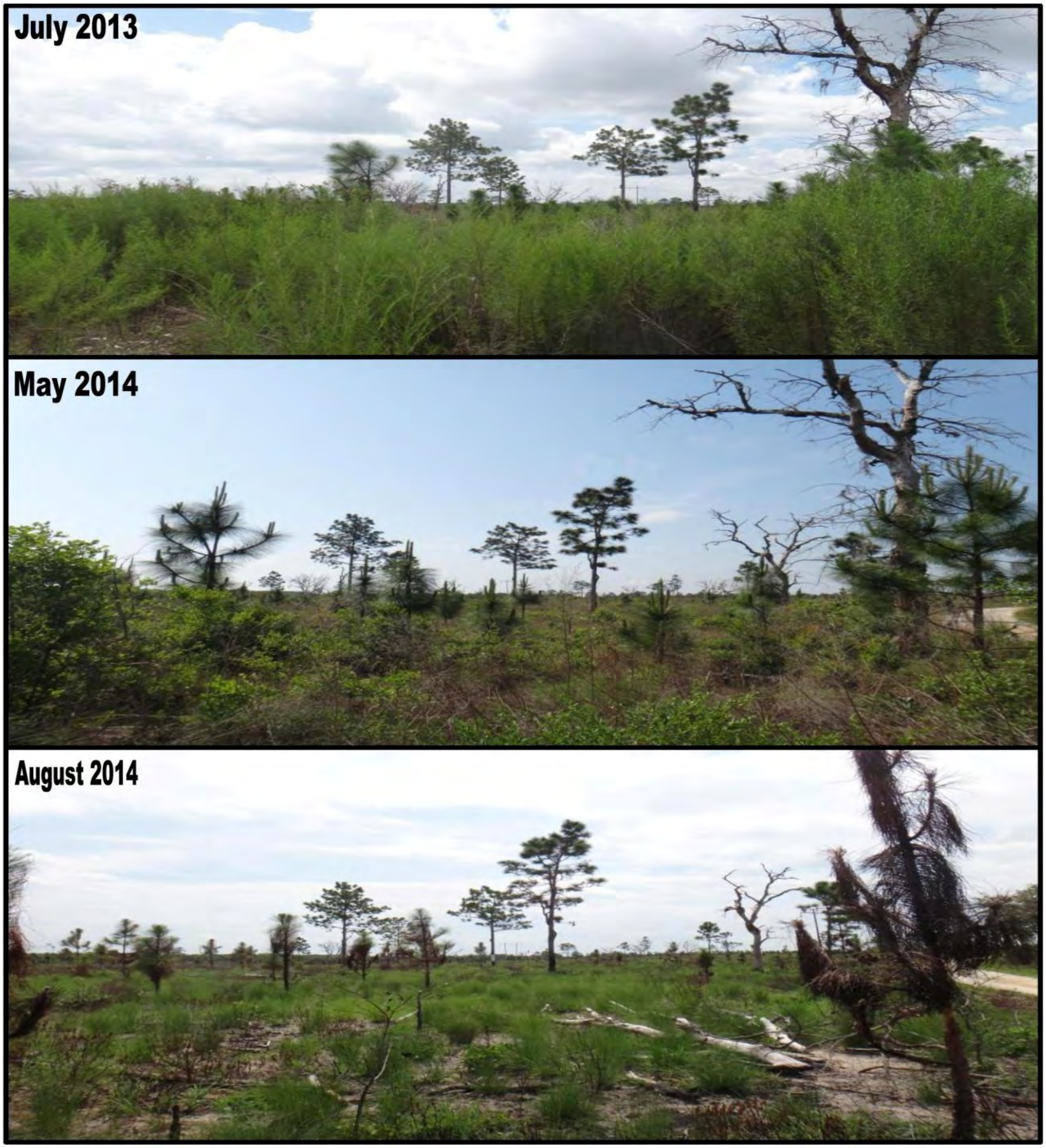


Figure 3. Photos from Photo Plot #35 in gopher tortoise Cluster 4 show changes resulting from restoration efforts occurring from 2013 to 2014 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

GOPHER TORTOISE SURVEY METHODOLOGY

Comprehensive burrow counts were used to determine the relative abundance of tortoise populations. Surveys were conducted between May and July 2014, corresponding to several of the warmer months of the year when tortoises are prone to leave their burrows more frequently, leaving tracks and freshly disturbed sand as indicators of activity. Soil maps and aerial photographs facilitated the prioritization of survey efforts, with areas classified as having excessively drained soils being surveyed first.

Burrow clusters were defined by boundaries around mapped concentrations of tortoises (Figure 4). These boundaries do not necessarily coincide with forest stand boundariesand often include multiple stands. Clusters were primarily delineated for devising management options and no attempt to group burrows using stringent behavioral or spatial criteria was made. Cluster numbers simply denote location and are used for accounting and management purposes.

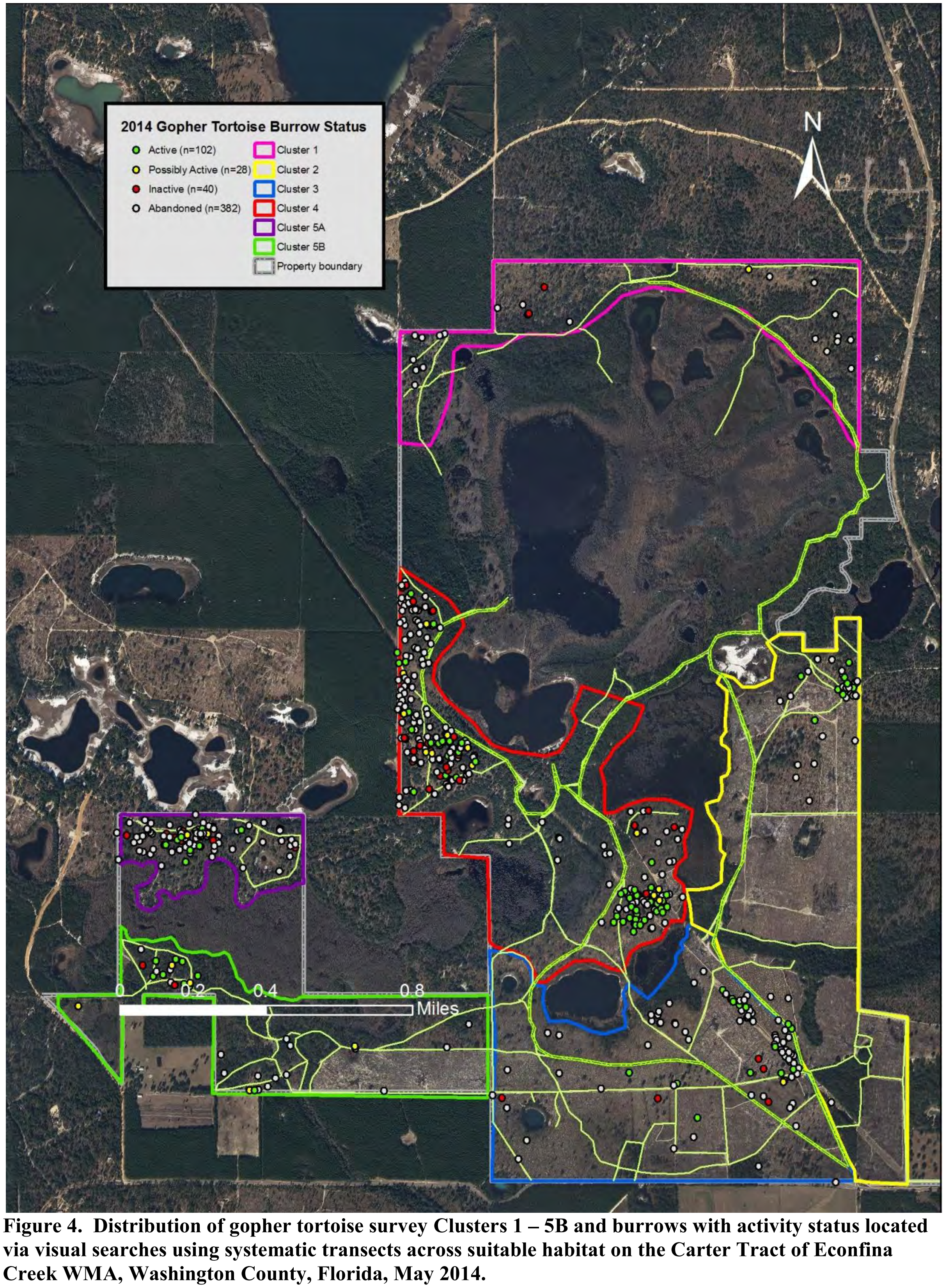


Figure 4. Distribution of gopher tortoise survey Clusters 1 – 5B and burrows with activity status located via visual searches using systematic transects across suitable habitat on the Carter Tract of Econfina Creek WMA, Washington County, Florida, May 2014.

Burrows were located by a thorough visual search of potential habitat. Surveys were conducted by walking systematic transects to ensure nearly complete coverage of potential habitat. Transects served only as a guide, with distance between transects varying based on vegetative cover within the survey areas. Survey intensity reflected the vegetative structure of a specific site (i.e. scrub habitat versus pinelands habitat). Eighty-five percent (963 acres) of habitat surveyed was sandhill or upland tree plantations with the remaining 15% consisting primarily of other high pine, wet flatwoods, utilities (i.e. powerline ROW), etc. (Figure 5). Vegetative communities within clusters were identified using 2012 FNAI data and mapped via ArcMap (ArcGIS® 9.3). Transects should not be confused with strict line-transect sampling methods for estimating population density of gopher tortoises as described in Cox et al. (1987). Comprehensive surveys are assumed to be more accurate than line-transect estimates, which are vulnerable to distortions resulting from the scarcity and patchiness of tortoise burrows on many sites (Mann 1993), including other WMAs surveyed across the Florida panhandle (C. F. Robinette, pers. comm.). Further, researchers have suggested a tendency for line-transects to overestimate abundance when compared to total counts or comprehensive surveys (Doonan 1986; Doonan and Epperson 2001). However, in more open habitat, Nomani et al. (2008) found simple line-transect methodology reliable and used them in conjunction with burrow cameras to detect occupancy rates (i.e. patch occupancy modeling approach).

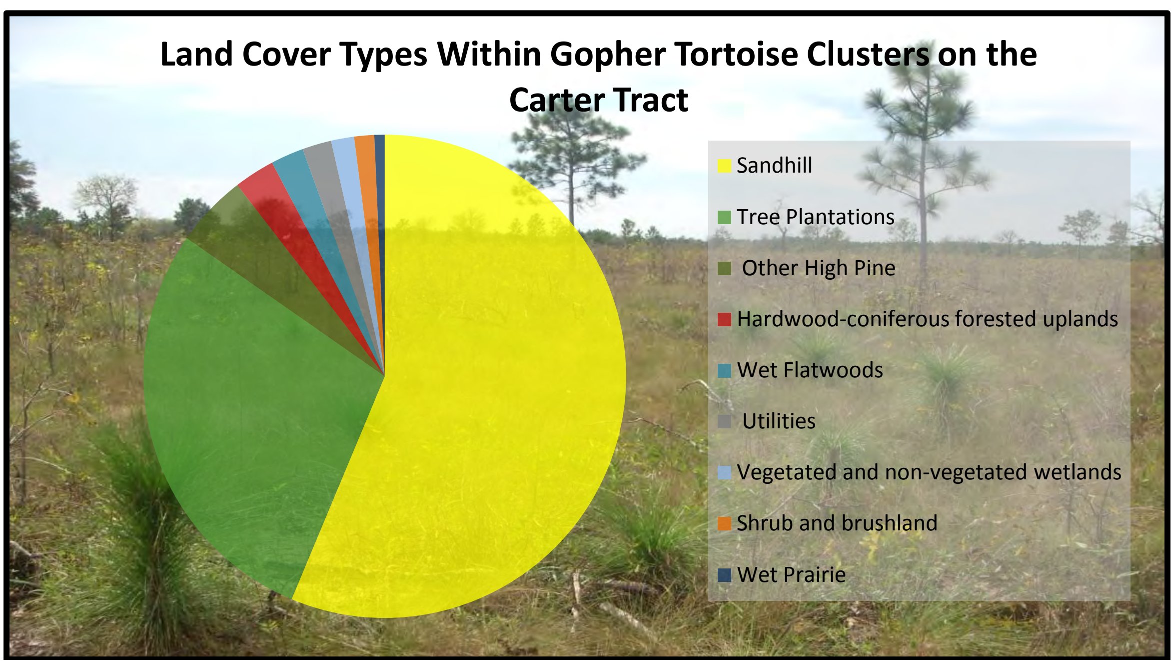


Figure 5. Land cover types within surveyed gopher tortoise clusters on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Distinguishing activity status followed Breininger et al. (1986) and Diemer (1992a). Activity status attributes are described below and illustrated in Figure 6:

1. **Active-** recent slide marks and footprints; soil at entrance has recently been disturbed by tortoises.
2. **Possibly Active-** difficult to determine whether activity was recent or caused by a tortoise.
3. **Inactive-** Soil undisturbed; lacks fresh sign of tortoise use but appears to be maintained.
4. **Old/abandoned-** partly or completely filled with litter, caved in, or dilapidated.

Figure 6. Example of each gopher tortoise burrow status category from top left clockwise: active, possibly active, old/abandoned, and inactive.

Given the relationship between gopher tortoise body size and burrow width (Wilson 1991), burrow size class distribution data obtained during comprehensive surveys were examined as an indirect estimate of the demographic structure of the tortoise population. Burrow widths correlate strongly with age and carapace lengths of tortoises inhabiting them (Alford 1980; Martin and Layne 1987). Therefore, the size distribution of burrow widths may accurately reflect the size distribution of carapace lengths of resident gopher tortoises. Subsequently, carapace length can be used as a characterization of reproductive potential in individual tortoises. However, resulting biases must be considered such as small tortoises occurring in large burrows and obscurity of hatchlings. The width of each identified burrow was measured to the nearest five centimeters at a depth of 50 cm with the aid of specially fabricated calipers (Martin and Layne 1987; Wilson, 1991) (Figure 7). Abandoned burrows with collapsed tunnels were not measured. Calipers were constructed using two narrow pieces of flat aluminum on a hinge to form a connected pair of calipers and calibrated in five-centimeter increments via an attached ruler/gauge.

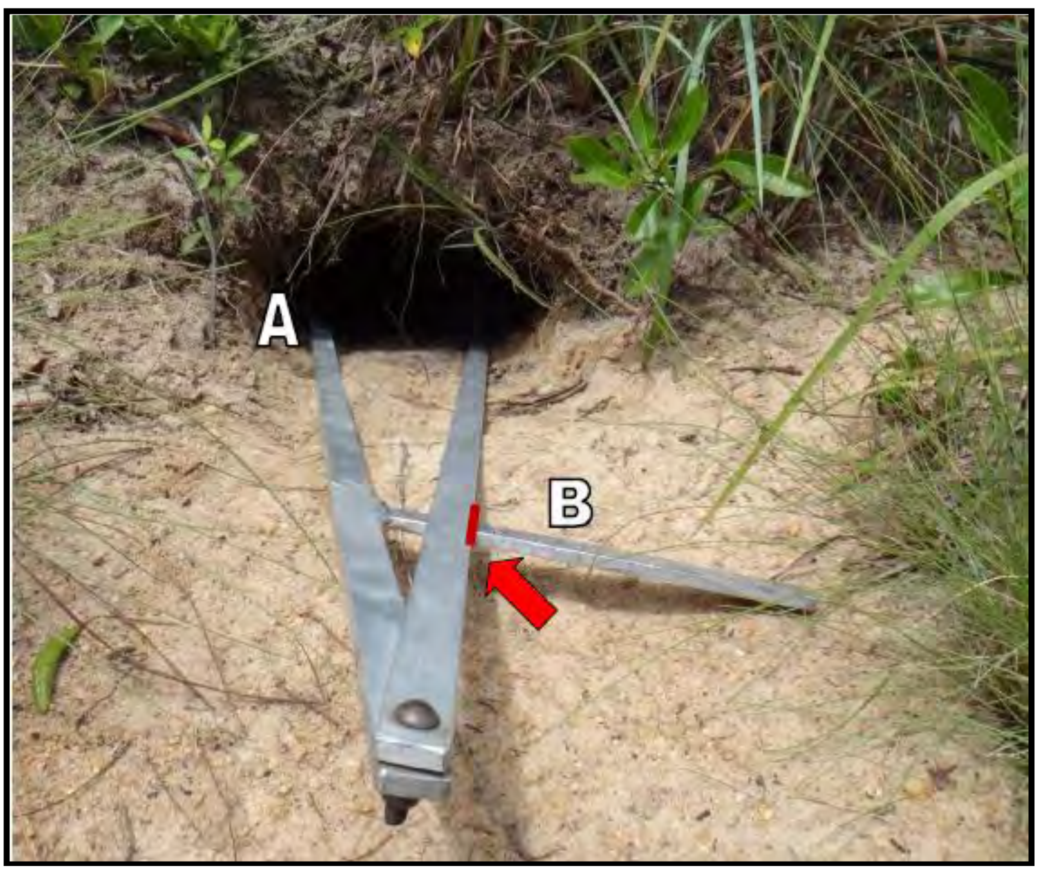


Figure 7. Constructed calipers are inserted 50 cm into gopher tortoise burrow (A), caliper arms are spread open to touch both sides of burrow, and burrow width is measured where red line meets attached ruler (B).

When located, burrows were marked with aluminum numbered tags (1.5″ diameter), wired to steel or aluminum stakes and placed approximately one meter in front and two meters to the left of the burrow entrance (Figure 8). Burrow locations were geo-referenced using handheld Garmin® 76CSx GPS units, with data points downloaded into ArcGIS® 9.3. Directional orientation (azimuth bearing) of burrow entrances was also recorded when possible; entrances for oldor abandoned and some inactive burrows were often too obscured to determine direction (Figure 9). Standardized data sheets were completed for each burrow found (Appendix I).

Figure 8. Active gopher tortoise burrow showing marker tag (A), burrow entrance (B), and burrow apron (C).

Figure 9. Each burrow was marked with a numbered stake (a); location was geo-referenced with a handheld GPS (b); directional orientation was measuredwith a compass (c); and burrow width was measured with comstructed calipers (d).

RESULTS AND DISCUSSION

Activity Status

A total of 552 burrows were located across the Carter Tract during the 2014 sampling season. Nineteen percent (n=102) of burrows were found to be active, 5% (n=28) were possibly active, 7% (n=40) were inactive, and 69% (n=382) were old or abandoned (Figure 10). Appendix II outlines detailed burrow counts by cluster and activity status across the Carter Tract from 2005-2014.

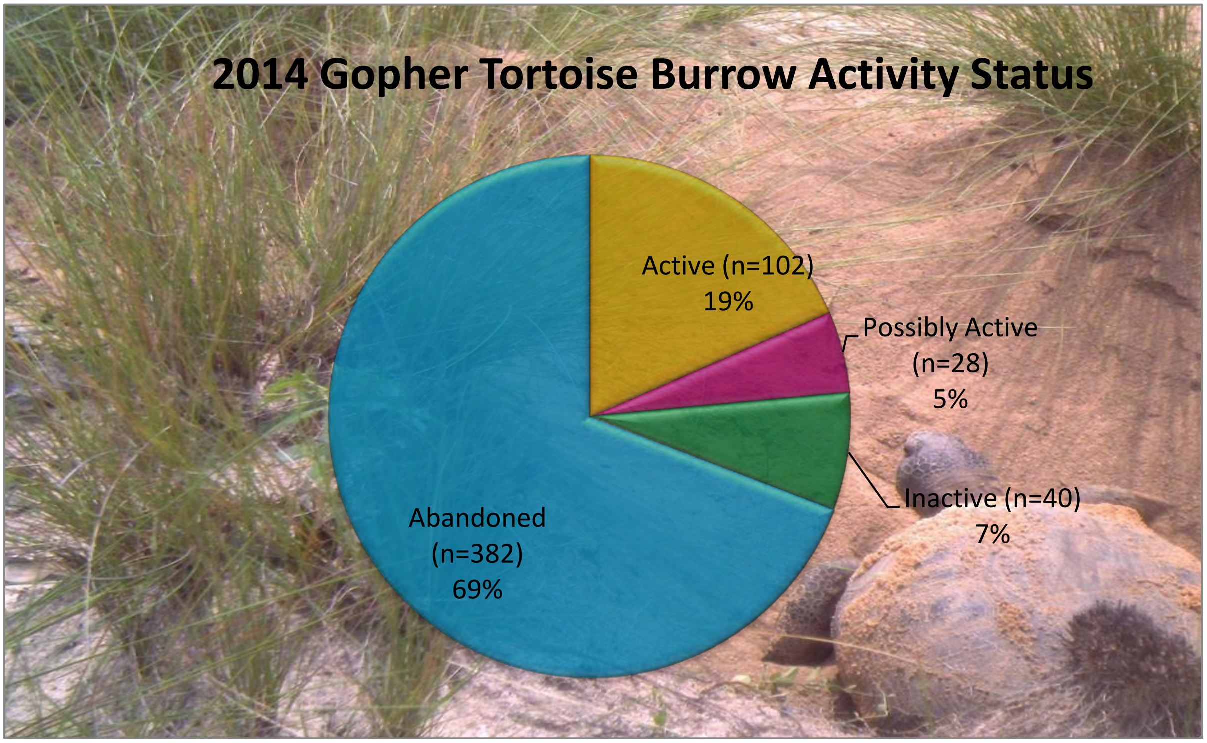


Figure 10. Activity status of gopher tortoise burrows (n=512) located during 2014 surveys on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

The total number of active and possibly active burrows increased by 7 in 2014. Figure 11 illustrates how activity status of burrows has changed annually since the inception of the monitoring program. Due to the complexity of gopher tortoise behavior, frequent burrow status changes (such as those demonstrated in Figure 11) are natural and expected (Mushinsky and Esman 1994). Burrow occupancy rates vary over time and space (Nomani et al. 2008) and burrow creation and abandonment is highly dynamic. Therefore it is not uncommon to see steady and sometimes increasing numbers of abandoned burrows, even following habitat improvement activities. During a five-year study, Aresco and Guyer (1999) found that gopher tortoises in southern Alabama abandoned their burrows at a rate of 22% per year. Because FWC staff return to all burrows marked during previous years without regard for past activity status, a subsequent increase in these numbers is anticipated.

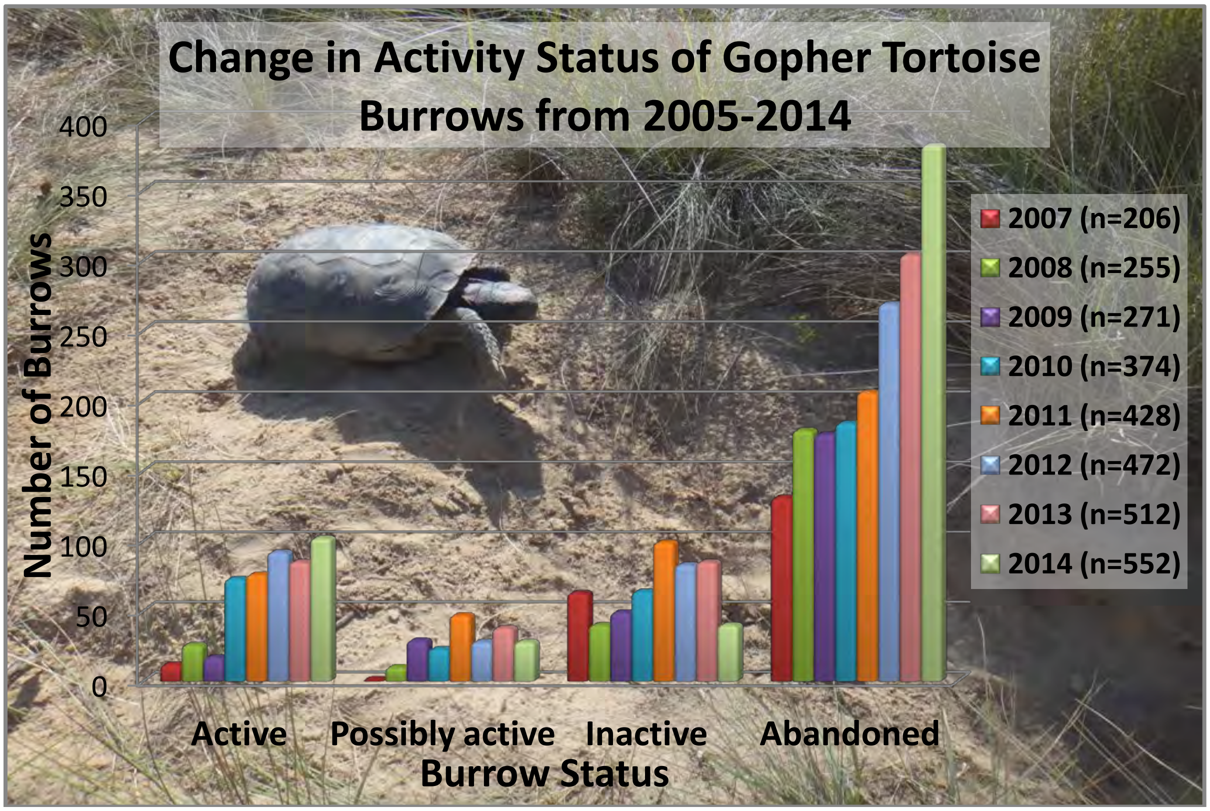


Figure 11. Annual change in activity status of gopher tortoise burrows from 2005-2014 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Although burrow counts are a useful tool for monitoring relative population changes, estimating actual tortoise populations from burrow counts is challenging. The number of burrows may increase or decrease without a corresponding change in actual population (Carthy et al. 2005). Gopher tortoise burrow surveys on the Carter Tract have revealed a continuous cycle of burrow creation and abandonment over time. For example, some burrows fill with debris, cave in, and effectively disappear, while new ones are excavated. Further, tortoises use more burrows including those that were previously unoccupied and are more likely to excavate new ones during the summer months (May – September) when surveys are conducted (Ott Eubanks et al. 2003). The number of burrows in use per tortoise does not remain constant with burrow occupancy rates influenced by region, season, and population density as well as habitat quality (Carthy et al. 2005; Nomani et al. 2008). Depending on habitat quality, male gopher tortoises may use as many as 10 burrows and females as many as 5 burrows per year (Ott Eubanks et al. 2003). In northern Florida, Diemer (1992b) found that on average adult male tortoises use 5.5 burrows, and adult female tortoises use 2.7 burrows during the active season (April-December). In Georgia, male and female tortoises were reported to use 7 and 4 burrows respectively (McRae et al. 1981). Mean annual burrow use by juvenile tortoises ranged from 1.1 by 0- to 1-year olds, 2.2 by 2-year olds, and 1.7 by 4- to 5-year olds in a southern Georgia population (McRae et al. 1981). Whereas, in a central Florida population, by 1- to 4-years of age, juvenile tortoises used an average of 4.4 burrows annually (Wilson et al. 1994). Suggested reasons for differences in burrow use among populations include differences in ground cover composition and structure, soil composition, temperature extremes at different latitudes, and number of disturbances to burrows. Although younger tortoises use several burrows, they spend most of their time in one primary burrow. Annual use of the primary burrow for younger tortoises in a central Florida population was 75% of all burrow use (Wilson et al. 1994).

Over the past few years on the Carter Tract there has been an accelerated program of upland habitat restoration and enhancement including “off-site” slash pine harvests, herbicide application, mechanical removal of hardwoods and sand pine, longleaf and native groundcover plantings, and frequent prescribed fire. These restoration efforts directly benefit the gopher tortoise and thus have the potential to positively affect future burrow occupancy rates (Figure 12).

Figure 12. A gopher tortoise entering a burrow (bottom right of photo) following a prescribed burn on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Cluster Use

Survey results from 2014 found the majority of burrows were located in Cluster 4 (47% of total burrows; Figure 12), which is consistent with previous years findings. The greatest number of active and possibly active burrows were also located in Cluster 4 (n=73; Figure 13). This is a slight increase in active and possibly active burrows than what was seen in 2013 (n=65) for this cluster. The primary habitat type characterizing this cluster is xeric oak sandhills, which is one of the preferred habitats for the gopher tortoise (Auffenberg and Franz 1982; Diemer, 1992a). Thus, we would expect greater concentrations of burrows in this area. Recent habitat restoration efforts have opened the canopy considerably and successfully promoted herbaceous groundcover.

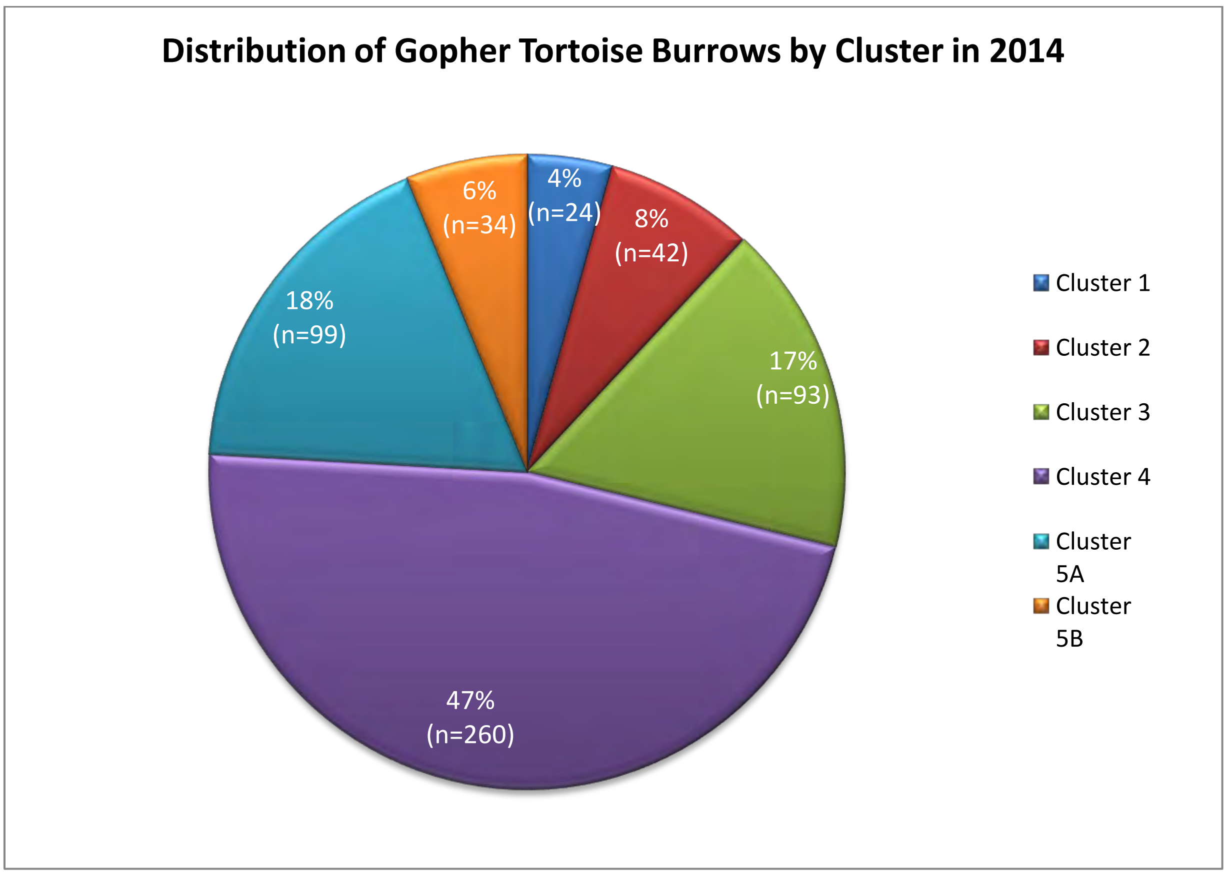


Figure 13. Distribution of gopher tortoise burrows by cluster on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2014.

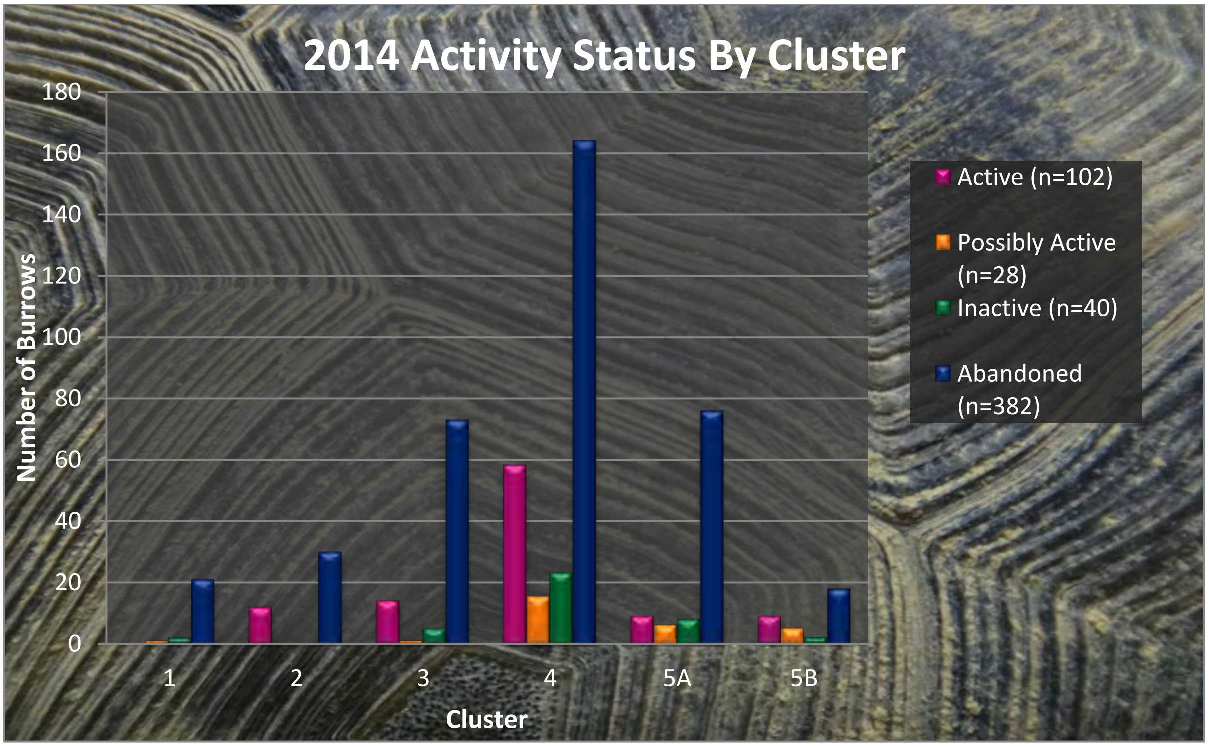


Figure 14. Activity status by cluster of burrows on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2014.

Xeric oak sandhills also comprise nearly the entire habitat of Cluster 5A; however, other than a 53 acre prescribed burn in November 2013 there have been no habitat restoration efforts in this area since 2010. Historically, Cluster 5A is a reasonably productive gopher tortoise cluster on the Carter Tract. However, the number of active and possibly active burrows has decreased over the last three years. Burrow activity within this cluster will likely improve with the application of growing season fires. Burning during the growing season not only topkills undesired hardwoods but also stimulates flowering of wiregrass and native ground cover. This helps to maintain the grass-like savannah preferred by tortoises and provides substantial herbaceous forage.

Cluster 3 might be considered another reasonably productive site, supporting 17% (n=93) of tortoise burrows with 15 active or possibly active burrows in 2014. This area is a combination of xeric oak habitat and previous slash and sand pine plantations. Habitat restoration efforts have restored this cluster to a system that contains an open canopy and thriving herbaceous groundcover. A two year prescribed burn regime will reduce any encroaching hardwoods, keep the canopy open, and promote native groundcover expansion.

Cluster 2 is an area which previously consisted of large stands of sand pine plantation with two small patches of xeric oak sandhill. Habitat restoration efforts in this area since 2007 followed those implemented in Cluster 3, with selective timbering, prescribed fire, hand-cutting of regenerating sand pine and hardwoods, herbicide application, and replanting of wiregrass tublings and longleaf seedlings. The southern portion of Cluster 2 will require additional treatment efforts and an aggressive growing season prescribed burn regime before native groundcover will re-establish successfully and increase suitability of this area for gopher tortoises in the future. Still, this year, eight percent (n=42) of total tortoise burrows on Carter were found in Cluster 2.

Since surveys began in 2005, Cluster 1 has continually proven to be the least robust area for gopher tortoise burrows on the Carter Tract. Our 2014 survey results were consistent with this trend, finding just 4% (n=24) of all burrows in this area. The northeast and northwest corners of Cluster 1, along with the western edge, contain suitable xeric oak habitat. A narrow travel corridor connecting Cluster 1 to Cluster 4 (along the western boundary) has opened in recent years as a response to land management activities. Habitat restoration, including mechanical reduction of hardwoods and prescribed burning, in the northwest portion of Cluster 1 has begun to reduce scrub oak densities and encouraged establishment of wiregrass. While there are currently few active or possibly active burrows, maintenance of a 1-2 year burn regime could encourage expansion of the gopher tortoise population from Cluster 4 into this area over time.

Observations of active and possibly active gopher tortoise burrows on the Carter Tract tend to be along the powerline right-of-way bisecting Clusters 2, 3, and 4, or the edges of dirt roads. Because these areas typically contain fewer trees and a more open canopy, a higher percentage of bare ground and more herbaceous species are common. Structural changes in ground cover due to recent mechanical removal of sand pine and hardwoods, herbicide application, and prescribed burning, in conjunction with past timber harvests, have begun to provide the sparse overstory and savannah-like grassy understory that gopher tortoises prefer. Recent plantings and eventual regeneration of native food sources, aided by the maintenance of a regular prescribed fire regime, should help to sustain our local population and expedite the restoration process.

Burrow Size Classes

Given the relationship between gopher tortoise age, body size, and burrow width, size class distribution data obtained during our comprehensive survey were examined as an indirect estimate of the demographic structure of the tortoise population. Burrow widths correlate strongly with the carapace lengths (CL) of tortoises inhabiting them (Alford 1980; Martin and Layne 1987). Therefore, the size distribution of burrow widths may accurately reflect the size distribution of CL of resident gopher tortoises. However, smaller tortoises have been known to utilize burrows abandoned by larger individuals. Thus, burrow size may not always accurately reflect the CL of the current resident tortoise if a smaller tortoise is utilizing a previously established burrow (Ashton and Ashton 2008).

Alford (1980) established that tortoise burrow width and CL are highly correlated according to the following equation: $\log_{10}y=0.879 \log_{10}x + 0.149$, where y is CL in centimeters and x is burrow width in centimeters. We used this formula to calculate size classes from measured burrow widths for all active (n=102) and possibly active (n=28) burrows found during 2014 surveys (Table 2). Figure 15 shows how the number of tortoises per size class has changed from 2007-14.

Table 1. Size class distribution of active (n=102) and possibly active (n=28) gopher tortoise burrows surveyed May 2014 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Burrow Width (cm)	Predicted Carapace Length (cm)	Number of Burrows	% of Active and Possibly Active Burrows
<5	< 5.80	8	6%
5	5.80	16	12%
10	10.67	29	22%
15	15.23	29	22%
20	19.62	18	14%
25	23.87	17	13%
30	28.01	9	7%
35	32.08	4	3%
40	36.08	0	0%

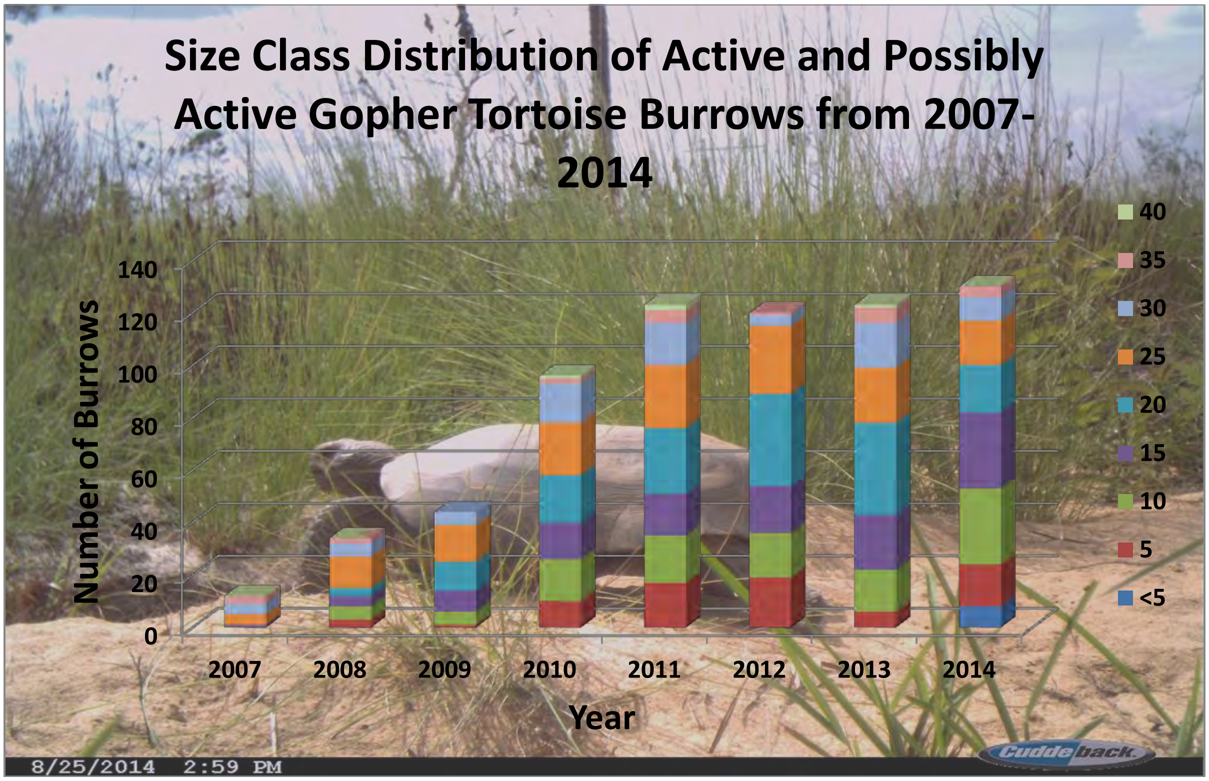


Figure 15. Size class distribution of active and possibly active burrows surveyed from 2007 – 2014 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Sexual maturity in gopher tortoises appears to be gauged by CL rather than age (Mushinsky et al. 1994). Depending upon latitude and location, adult gopher tortoises reach sexual maturity between 18-24 cm CL for males and 21-28 cm CL for females (Diemer and Moore 1994). Using Alford's (1980) approximation method (1.8 cm/yr), these CL correspond to ages 10-15 years. This method was not used as a precise aging tool but as a general index of tortoise age demographics on the Carter Tract by estimating the number of sexually mature tortoises. The age categories used are arbitrary, and the division between juvenile and adult classes may not reflect actual reproductive status. Gopher tortoises may reach sexual maturity at considerably different ages in different geographical regions. For example, Mushinsky et al. (1994) discovered that female tortoises in south Florida became sexually mature 6-10 years before females in the northern part of their range. Consequently, wildlife managers should not assume that small female gopher tortoises are unable to reproduce; gravid females with 18.7 cm, 19.9 cm, and 20.2 cm CL have been reported in a population of remnant-resident tortoises occupying a disturbed sandhill in central Florida (Small and Macdonald 2001). Therefore, we refrained from analyzing strict size classes in the form of juvenile, subadult, and adult because differences in numbers between size classes may actually reflect differences in growth rates rather than actual age structure (Averill-Murray 2000).

Among active and possibly active burrows measured on the Carter Tract, 23% (n=30) resulted in a CL corresponding to sexual maturity (CL > 19.62 cm) and 77% (n=100) were determined as sexually immature (CL ≤ 19.62). This is a conservative estimate because we did not directly determine gender or sexual maturity during burrow surveys. On select federal lands in Florida, McCoy and Mushinsky (1992) found that burrow percentages in size classes smaller than 20 cm ranged from 15-22%. O'Meara and Abbott (1987) found only 6.84% of burrows in size classes smaller than 20 cm. From 2005 until 2008, sexually mature tortoises consistently outnumbered immature tortoises on the Carter Tract (Figure 16). Subadult and adult tortoises can excavate more burrows than juveniles, which induces biases in the relative frequency data toward the larger size classes (Diemer 1992a).

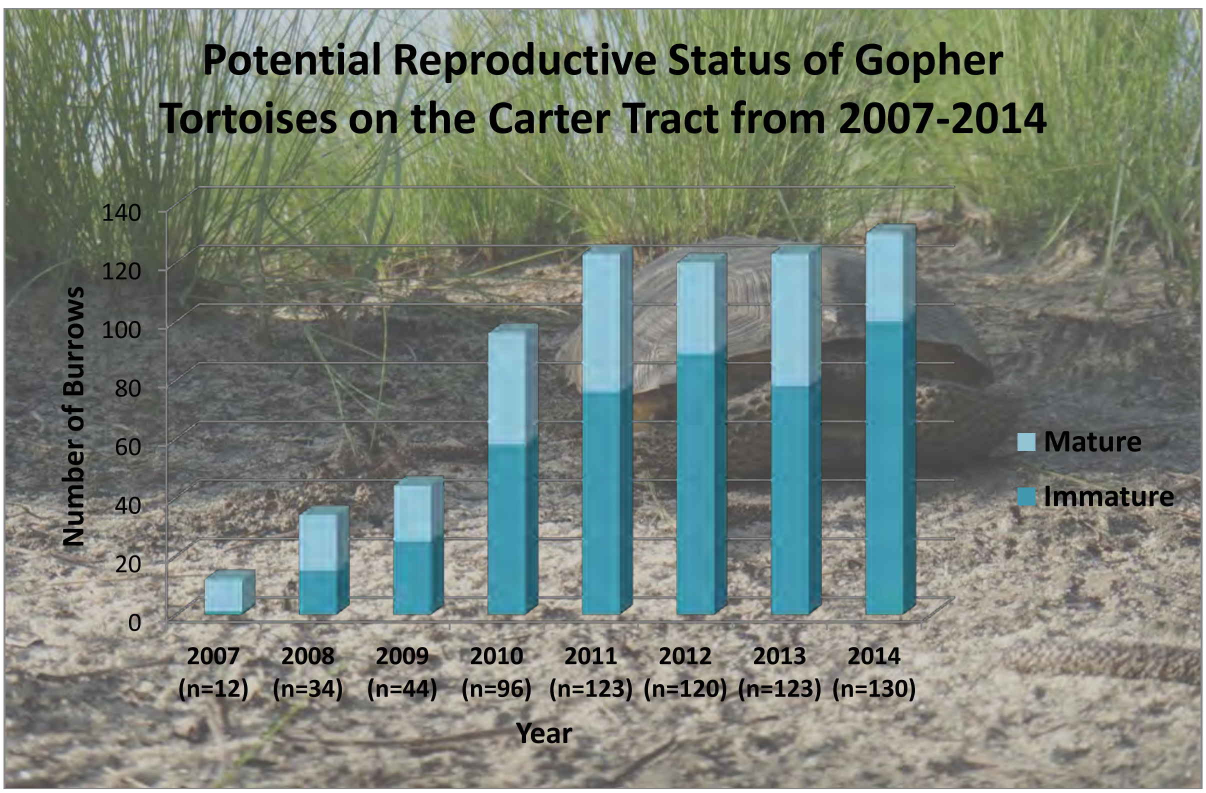


Figure 16. Potential reproductive status of gopher tortoises determined by burrow width of active and possibly active burrows found on the Carter Tract of Econfina Creek WMA, Washington County, Florida, from 2007 to 2014.

Beginning in 2009 the trend shifted, revealing more burrows belonging to sexually immature tortoises than mature tortoises (Figure 16). The effective rate of reproduction of gopher tortoises results in 5.8 hatchlings per mature female every ten years, varying with available habitat, groundwater levels, predation intensity, and competition for limited habitat (Ashton and Ashton 2008; Ernst et al. 1994). Ashton and Ashton (2008) have found subadults and juveniles utilizing what were thought to be inactive burrows, and the tendency of younger tortoises (up to 10-12 cm CL) to share burrows with adults or conceal themselves under leaf litter rather than digging individual burrows is well documented (Auffenberg and Weaver 1969; Douglass 1978; Alford 1980; Landers et al. 1982; Pike 2006). Therefore, the number of juvenile tortoises based on burrow size alone could be an underestimate. Regardless, a rise in number of immature tortoise burrows (burrow width $\leq$ 20cm) likely signifies a greater survival of younger tortoises. In addition, Guyer et al 2012 suggests an importance in the density of gopher tortoise burrows, with higher chances of population viability being tied to adult burrow proximity. While gopher tortoises will expand or contract their homerange based on burrow density, less dense areas can result in high energy costs due to individuals needing to cover greater distances to find suitable mates. This could lead to decreased mating opportunities, further limiting overall breeding success.

Making definitive statements about the specific demographics of the gopher tortoise population on the Carter Tract is tenuous at best . This is due to biases in detection frequency of large (subadult and adult) versus small (juvenile) tortoises, as well as a relatively poor understanding of juvenile gopher tortoise behavior such as how and where to look for juveniles specifically. Variations in hatchling survival and possible adult predation also make age structure and recruitment analysis difficult. However, continued monitoring and annual comparative data assessments should aid in future demographic mapping as well as demonstrate the effects of habitat restoration.

Soil Types

Soil type is an important limiting factor for gopher tortoises. The soil must be friable enough to allow excavation, yet firm enough to prevent burrows from collapsing. In the panhandle of Florida, some commonly preferred soil types for gopher tortoises cited by Cox et al. (1987) included Lakeland, Troup, Kureb, and St. Lucies soils Lakeland Coarse Sands occupy large acreages in southern Washington County (Huckle and Weeks 1962). The Lakeland and Eustis soil series are classified as “priority” soils for supporting gopher tortoises and together account for 98.2% (n=493) of the soil types found on the Carter Tract

(Figures 17 and 18). Topsoils of deep sand, which are thoroughly drained and do not have well-developed loam or clay horizons are classified as "priority soils" by the USFWS. (USFWS 2005, 2009). The remaining Blanton Sand (n=7), and Klej Sand (n=4).

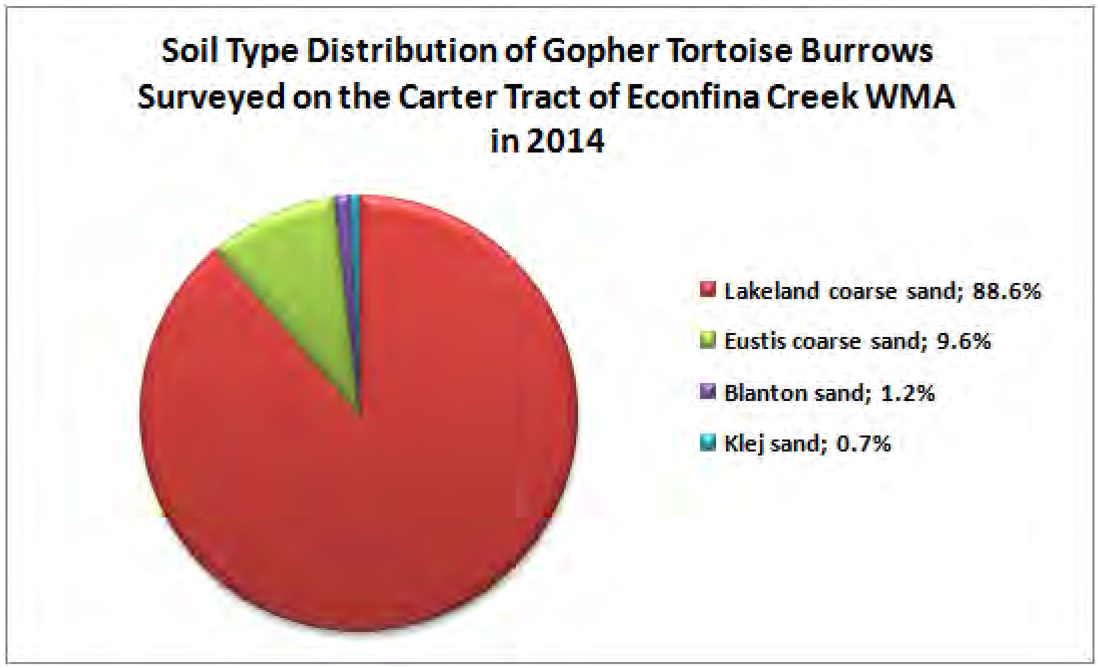


Figure 17. Soil type distribution of gopher tortoise burrows surveyed on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2014.

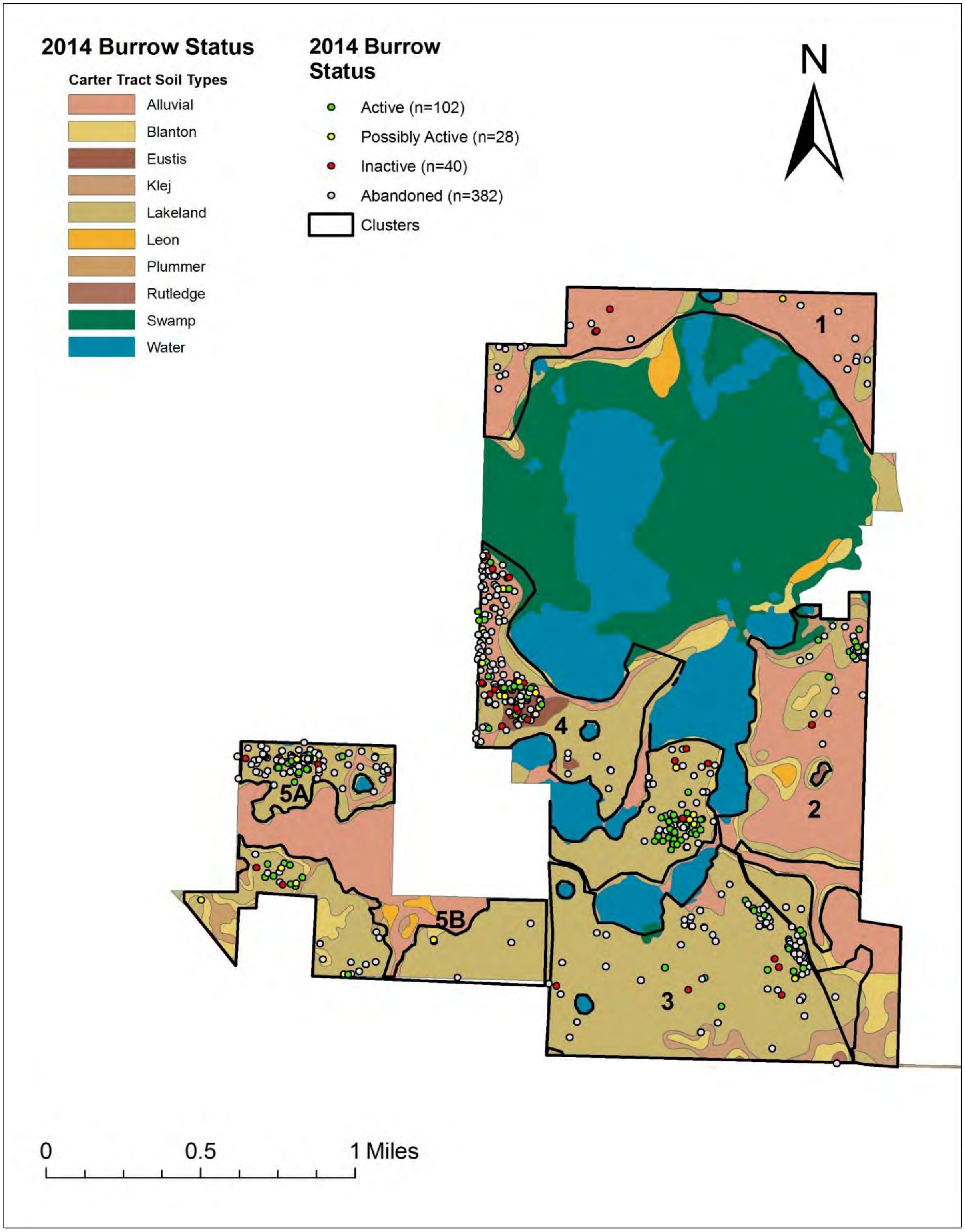


Figure 18. Map of soil types found on the Carter Tract of Econfina Creek WMA; also shown are locations of gopher tortoise clusters, burrows, and 2014 burrow status.

MANAGEMENT RECOMMENDATIONS

Overview

Improvements have been made over the last eight eyears within the 1,144 acres of potential gopher tortoise habitat and travel corridors on the Carter Tract. Stands of slash and sand pine have been logged and scrub oak encroachment and sand pine regeneration have been mitigated using herbicide and mechanical thinning. Moreover, native herbaceous groundcover species have been planted, and much of the area has been reintroduced to a frequent burning regime. All of these activities were identified as beneficial to gopher tortoises in our previous management recommendations. Future work will continue to provide comparative data on tortoise population trends on the Carter Tract, which will enable FWC staff to make informed management decisions.

Continuation of management activities is imperative to the restoration and health of the Carter Tract landscape. Prescribed burning is the most important habitat enhancing element in sandhill communities, improving and increasing the herbaceous food supply and decreasing woody species. Being in the early stages of restoration, an ardent approach to habitat management must be maintained. Continued suppression of scrub oak and sand pine regeneration is most important at this stage in the restoration process. This can be accomplished most effectively by burning during the growing season. Last year's contract prescribed fire plan included 719 acres of growing season burns, which encompassed the entirety of Clusters 2 and 3 and part of Cluster 4. This growing season burn regime is critical to continuing improvements within gopher tortoise clusters of the Carter Tract (Figure 19). Summer burns can be more detrimental to oak recruitment compared to other seasons, while significantly increasing the composition of herbaceous cover (Glitzenstein et al. 1995; Lewis and Harshbarger 1976). Topkill and complete kill of oaks was found to be greatest when burned biannually in April and May, providing the best combination of oak control and dense herbaceous growth (Glitzenstein et al. 1995; Mushinsky 1985; Berish 2001). Multiple factors including permitable weather conditions, adequate staff/equipment availability, and funding influence the frequency with which prescribed fire can be utilized. Therefore supplemental management activities, such as chopping, mowing, and herbiciding undesirable species, may need to be continued to help accomplish restoration goals.

Following the completion of primary management activities, the focus can shift to evaluation and management of habitat within individual clusters. Viewing the landscape as a whole is important for maintaining connectivity for dispersal and immigration routes, but focusing on habitat characteristics for individual clusters will allow us to better observe isolated changes in habitat structure. Our guidelines continue to closely follow recommendations by Landers and Speake (1980), Diemer (1987), and the 2012 Gopher Tortoise Management Plan (Florida Fish and Wildlife Conservation Commission 20122). Our methods address such management considerations as midstory hardwood management, regeneration, and implementation of a regular prescribed burning regime (Figure 19). This management approach will improve habitat and tortoise cluster size on a site-specific basis.

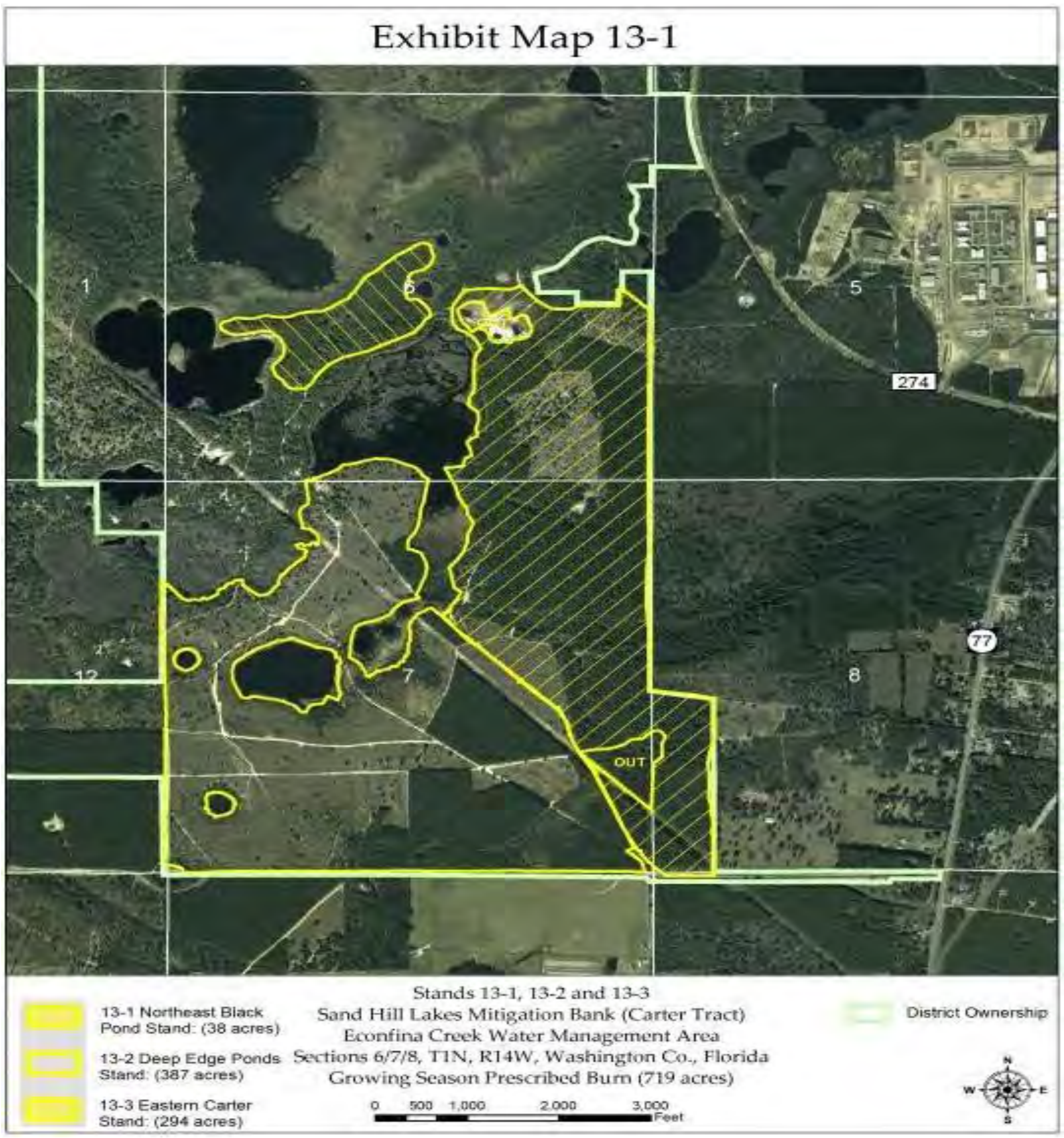
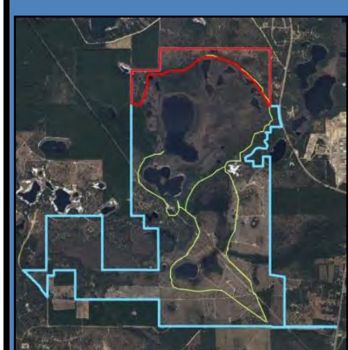


Figure 19. Growing season prescribed burn implemented by NWFWMD conducted in late June and early July 2014 across multiple gopher tortoise clusters on the Carter Tract of Econfina Creek WMA, Washington County, FL.

Cluster 1

Cluster 1 is the northernmost cluster and the least active on the Carter Tract. The northwest and northeast corners of Cluster 1 currently contain the better tortoise habitat within this cluster. Wiregrass establishment to the northeast of Green Pond Road has improved. Annual prescribed dormant season burns since 2010, in combination with intensive mechanical and herbicide treatments during summer and fall 2011, have reduced the woody understory and should encourage existing groundcover to spread and longleaf pines to advance out of the grass stage. Prescribed growing season burns in 2012 and 2013 were patchy and did little to suppress hardwood regrowth. It appears that the hardwoods are beginning to vigorously encroach back within this Cluster and needs to be addressed soon. We suggest continuation and improvement of growing season burns as well as mechanical reduction and herbicide treatments in an effort to maintain hardwood supression and promote the spread of native groundcover. This strategy may help to promote immigration of offsite tortoises north of the Carter Tract into this cluster. Tortoise dispersal to this cluster from within the property is difficult given its separation from other clusters by a mix of wet hardwoods and hydric pine flatwoods.

CLUSTER 1—Past and Suggested Future Management Activities



Year	*Prescribed growing season burn*	*Prescribed dormant season burn*	*Herbicide*	*Mechanical reduction*	*Planting*	*Timber removal*
2007						
2008						
2009						
2010		X		X	X	
2011		X	X	X		
2012	X	X				
2013	X	X				
2014						
***2015**	X		X	X		

* Denotes *suggested* management activities for 2015

Cluster 2

Little gopher tortoise activity has been documented in Cluster 2 presently. However, multiple habitat restoration efforts have been made to date to improve suitability for gopher tortoises. In 2007 the sand pine plantation was harvested, followed by a site preparation prescribed burn and subsequent planting of longleaf pine and wiregrass in 2008. The northern half of Cluster 2 was burned again in spring 2010, resulting in excellent wiregrass regeneration. As mentioned, due to poor initial recruitment, the central part of Cluster 2 was replanted with wiregrass tublings in February 2010. This area experienced herbicide and mechanical removal of scrub hardwoods in fall 2010 to reduce competition with newly planted wiregrass. A cluster-wide prescribed burn in August 2011 discouraged hardwood regeneration and promoted wiregrass seeding in addition to controlling the establishment of blackberry (*Rubus sp.*), gallberry (*Ilex glabra*), and other woody shrubs in the southernmost portion. The fire did not burn evenly as a result of low fuel loads and lack of native groundcover. Eight acres in the central part of Cluster 2 were planted with wiregrass tublings in fall 2011, and Bahia grass (*Paspalum notatum Flugge*) was eradicated from 48 acres in the southern portion. During summer 2012, mechanical cutting and stump herbicide application of regenerating sand pine and hardwoods took place across the northern two-thirds of this cluster. Prescribed growing season and dormant season burns in 2012 and 2013 consumed cut sand pine and hardwood debris and allowed previously-planted longleaf pine and wiregrass to mature. In March of 2014, thirty-seven acres of the southeastern portion of Cluster 2 underwent treatment to eradicate Bahia grass and hardwoods (Figure 20). The initial treatment was successful in eradicating hardwoods, however a second treatment in April was required to eliminate Bahia grass from the site. A cluster-wide prescribed burn across approximately 294 acres occurred in summer 2014 suppressed hardwood regeneration and promoted the establishment of native groundcover. The 2014 growing season burn was successful in stimulating wiregrass growth, promoting ideal gopher tortoise habitat that will hopefully result in gopher tortoise expansion in the future.

Although most of Cluster 2 was a former slash pine plantation, timber removal, longleaf pine/wiregrass plantings, and prescribed burns have encouraged native groundcover to return in the northern two thirds of the cluster. However, there is currently little to no native groundcover in the southernmost portion. Therefore, this portion of Cluster 2 will require additional site preparation and direct seeding before native plants will propagate successfully. We recommend establishment of a two year burn regime throughout this cluster until sufficient herbaceous groundcover is established throughout, at which time extending intervals between burns could be entertained. These efforts should greatly enhance this area, increasing suitability as future gopher tortoise habitat and potentially encouraging immigration from nearby Cluster 3.

CLUSTER 2—Past and Suggested Future Management Activities

Year	*Prescribed growing season burn*	*Prescribed dormant season burn*	*Herbicide*	*Mechanical reduction*	*Planting*	*Timber removal*
2007						X
2008		X			X	
2009						
2010	X		X	X	X	
2011	X		X	X	X	
2012	X		X	X		
2013		X				
2014	X		X	X		
***2015**					X	

* Denotes *suggested* management activities for 2015

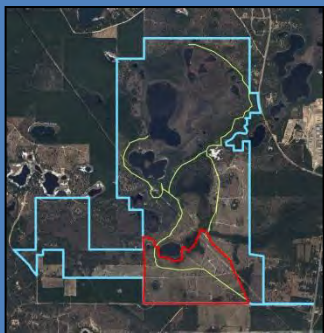
Figure 20. Thirty seven acres of Cluster 2 underwent treatment to eradicate hardwoods and Bahia grass in March 2014 on the Carter Tract of Econfina Creek WMA, Washington County, FL.

<u>Cluster 3</u> – PRIORITY AREA

Cluster 3 is a priority management area due to high gopher tortoise activity along the power line right-of-way. Historically, this cluster was divided between xeric oak and slash and sand pine plantations, which were logged in 2007, then burned and planted with longleaf pine and wiregrass in 2008. Aerial herbicide application in June 2009 successfully eradicated a large portion of the scrub oak component. The northern half of this cluster was burned in May 2010, resulting in good wiregrass regeneration and establishment. The southern half of this cluster was treated with herbicide and mechanical removal of scrub oaks and shrubby hardwoods was performed in fall 2010. During fall 2011, a prescribed burn was conducted throughout the entire cluster, and 94 acres of common persimmon (*Diospyros virginiana*) and hardwoods were treated with herbicide, resulting in reduced competition for planted wiregrass tublings and a more open understory for native forbes. One hundred one acres of sand pine and hardwoods in the eastern portion of Cluster 3 were cut and treated with herbicide in summer 2013.

Extensive land management practices took place across Cluster 3 throughout early to current 2014. In January 2014, approximately 24,200 wiregrass plugs were established across 20 acres of the northeast corner (Figure 21). One hundred one acres of the eastern half of the cluster underwent sand pine and hardwood eradication in an effort to restore the area to a sandhill community (Figure 22). A growing season prescribed burn took place in summer 2014 across the entirety of Cluster 3. Given the success of herbicide applications in 2009 and 2013, both dormant and growing season burns can be used to maintain suitable habitat within this cluster. However, in the event of excessive hardwood regeneration, growing season burns should be re-established to topkill scrub oaks and reduce shrub competition. Growing season burns promote wiregrass flowering, which increases herbaceous groundcover and potentially encourages expansion of tortoises into areas outside the power line right-of-way. Due to the amount of tortoise activity along the power line right-of-way, all mechanized equipment (mowers, bush-hogs, etc.) should be prohibited during breeding season months (March-August) and hatchling season (September and October; Ashton and Ashton 2008), and operators should take care to avoid collapsing established burrows if using equipment outside of the breeding season in these areas.

CLUSTER 3—Past and Suggested Future Management Activities



Year	*Prescribed growing season burn*	*Prescribed dormant season burn*	*Herbicide*	*Mechanical reduction*	*Planting*	*Timber removal*
2007						X
2008		X			X	
2009			X			
2010	X	X	X	X		
2011		X	X	X	X	
2012						
2013			X	X		
2014	X		X	X	X	
***2015**	X					

* Denotes *suggested* management activities for 2015

Figure 21. In January 2014, approximately 24,200 wiregrass plugs were established across 20 acres of the northeast corner of Cluster 3 on the Carter Tract of Econfina Creek WMA, Washington County, FL.

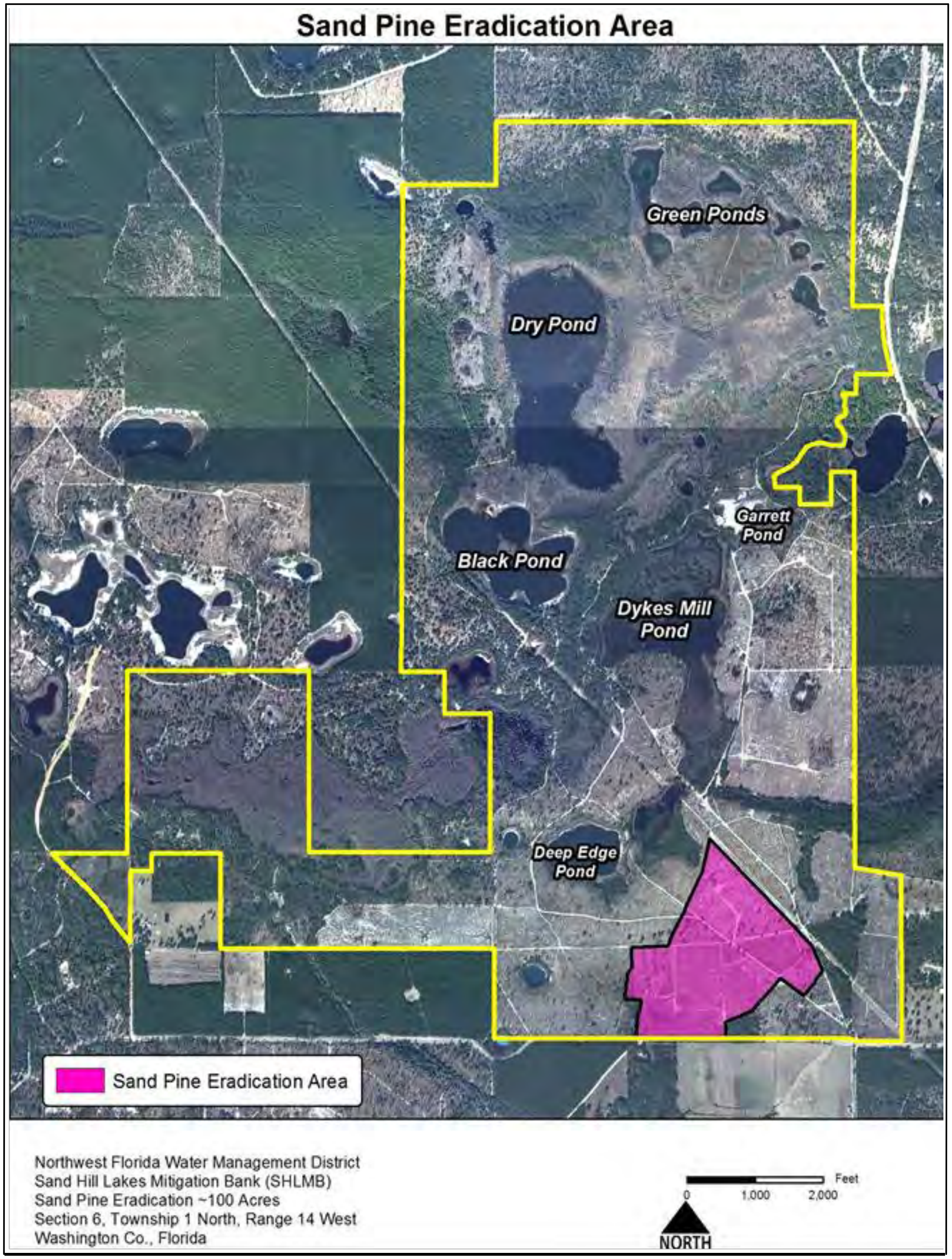
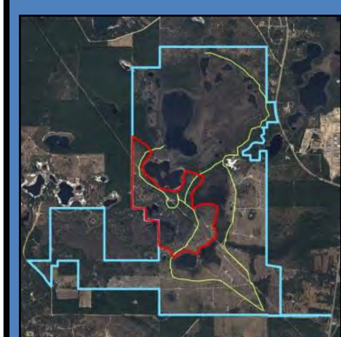


Figure 22. Sand pine and hardwoods were eradicated from 100 acres of Cluster 3 on the Carter Tract of Econfina Creek WMA, Washington County, FL.

<u>Cluster 4</u> – **PRIORITY AREA**

Habitat improvement activities to date within Cluster 4 have successfully transformed this area into quality gopher tortoise habitat. Cluster 4 has been burned annually in the dormant season since 2010, resulting in excellent current herbaceous groundcover, with wiregrass becoming well established. Because groundcover is well established, dormant or growing season burning within Cluster 4 is acceptable. In summer 2014, a prescribed burn was conducted on the eastern portion of Cluster 4 successfully topkilling most of the remaining hardwood regeneration. Burning during the growing season promoted wiregrass flowering , increasing the amount of herbaceous groundcover in this location, and may encourage tortoises to continue expanding away from the powerline right of way. . We recommend a two- year burn regime to maintain groundcover levels and consume residual brush reduction debris. Cluster 4 supports the largest number of total burrows on the Carter Tract, as well as the most active and potentially active burrows; we therefore consider it a high priority management area. The power line right-of-way is an important feature within this cluster as an area of high burrow density. Therefore, as was suggested for Cluster 3, mechanized cutting equipment should not be used during breeding season months and operators should be aware of existing burrows and prevent collapsing them.

CLUSTER 4—Past and Suggested Future Management Activities



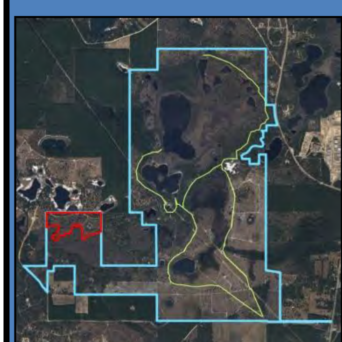
Year	*Prescribed growing season burn*	*Prescribed dormant season burn*	*Herbicide*	*Mechanical reduction*	*Planting*	*Timber removal*
2007						
2008						
2009			X			
2010	X	X				
2011		X	X	X		
2012		X				
2013		X				
2014	X	X				
***2015**	X					

* Denotes *suggested* management activities for 2015

<u>Cluster 5A</u> – PRIORITY AREA

Although Cluster 5A is spatially separated from other clusters on the area, it is an important, active cluster. Given that Cluster 5A harbors 19% (n=92) of all burrows on the area, we consider it a high priority management area. In 2012, Cluster 5A supported 23% (n=28) of all active and possibly active burrows, while in 2013 we found only 13% (n=16) of all active and possibly active burrows in this cluster. The most recent prescribed growing season burn was conducted in 2010, allowinghardwoods to encroach on the entire cluster. In November 2013, 53 acres of cluster 5A were burned as part of a training exercise. While some habitat improvement occurred as a result of the burn further management will be required to eliminate hardwood regeneration caused over a three year burn lapse. We suggest a combination of mechanical reduction and herbicide application to reduce competing hardwoods in addition to maintaining this cluster on a two-year burn rotation, utilizing growing season burns. Growing season burns will help control the hardwood component and further consume residual downed woody debris throughout the cluster and promote the flowering and spread of wiregrass. Following additional wiregrass estasblishment, the burn regime could be adjusted to once every 2-3 years, as habitat quality dictates. These efforts should facilitate movement of dispersing tortoises from adjacent offsite sandhills habitat into this cluster.

CLUSTER 5A—Past and Suggested Future Management Activities



Year	Prescribed growing season burn	Prescribed dormant season burn	Herbicide	Mechanical reduction	Planting	Timber removal
2007						
2008						
2009						
2010	X					
2011						
2012						
2013		X				
2014						
***2015**	X		X	X		

* Denotes *suggested* management activities for 2015

Cluster 5B

Cluster 5B supports 6% (n=34) of all burrows on the Carter Tract. While the majority of burrows are currently abandoned, nine active and five potentially active burrows were identified in the extreme western portion of this cluster, south of Pine Log Creek (Figure 5). This portion of Cluster 5B was burned in spring 2010 and winter 2013, resulting in good wiregrass regeneration and transforming the area into the best gopher tortoise habitat within the cluster. Therefore, it is not surprising that all active and possibly active burrows were found there. While this area contains pockets of oak hammocks, the overstory is not excessively dense and is not detrimental to current tortoise populations or future recruitment in this area. We suggest maintaining this area on a two-year growing season burn regime to continue the promotion of wiregrass recruitment and control establishment of a shrubby hardwood midstory.

In contrast to the western section of cluster 5B, the eastern section is an old clearcut that currently contains only abandoned and inactive burrows (Figure 5). In 2007 the sand pine was harvested, followed by a site preparation prescribed burn and subsequent planting of longleaf pine and wiregrass in 2008. This area was burned in October 2011 to consume residual logging debris and encourage the spread of wiregrass and native groundcover. In 2012, additional wiregrass tublings were planted on 22 acres of this old clearcut. The area was burned again in winter 2012. This eastern portion of cluster 5B has the potential to become excellent gopher tortoise habitat, as well as provide room for expansion from nearby Cluster 3. We suggest mechanical reduction and herbicide application for encroaching scrub oaks and regenerating sand pine to open the understory for wiregrass and longleaf pine development. We also suggest maintaining a two-year growing season burn regime to further consume logging debris and promote the flowering and spread of planted wiregrass and other native groundcover species.

CLUSTER 5B—Past and Suggested Future Management Activities

Year	Prescribed growing season burn	Prescribed dormant season burn	Herbicide	Mechanical reduction	Planting	Timber removal
2007						X
2008		X				
2009						
2010	X					
2011		X				
2012					X	
2013		X				
2014						
*2015	X		X	X		

* Denotes *suggested* management activities for 2015

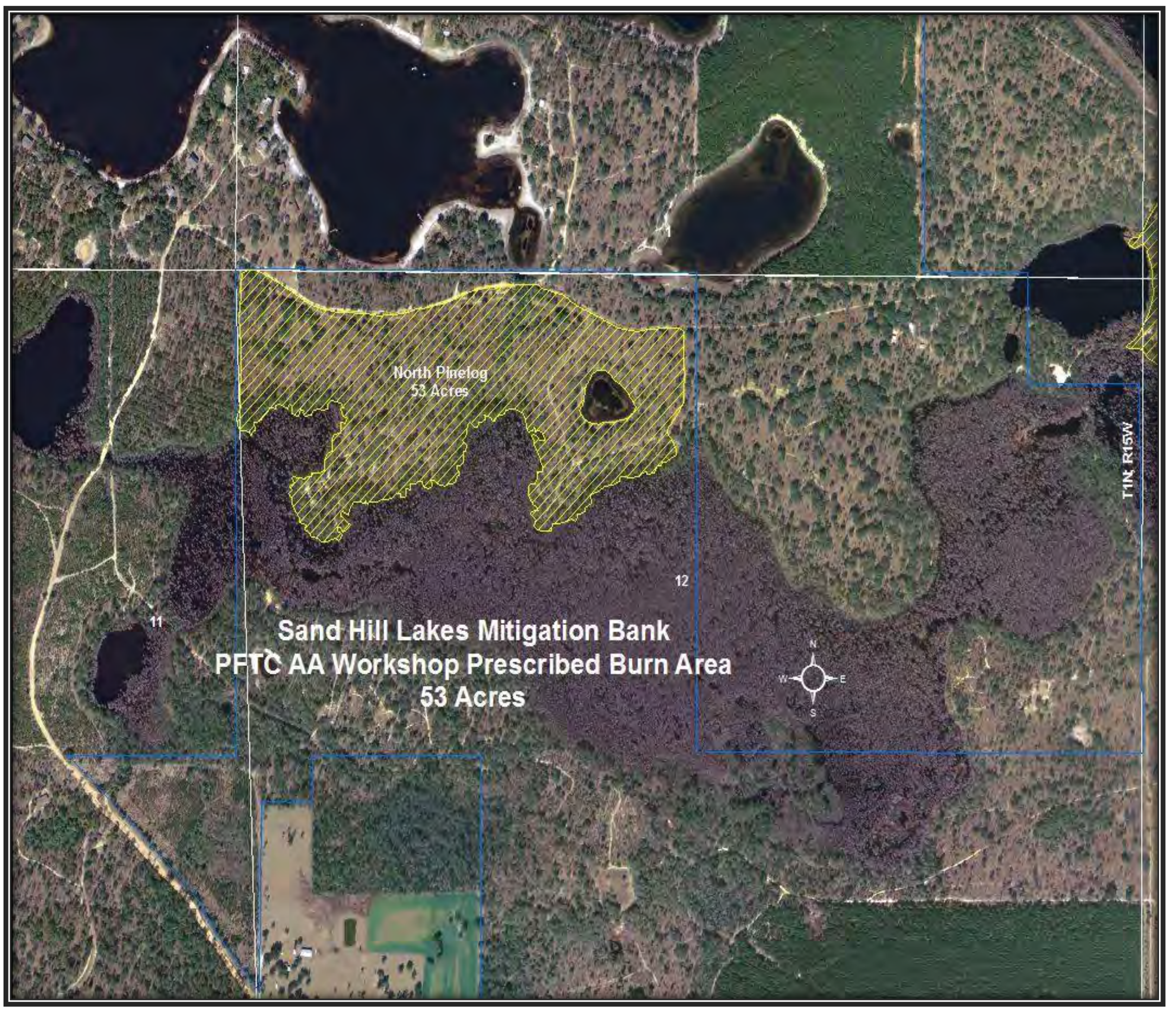


Figure 23. Dormant season prescribed burn across 55 acres of Cluster 5B implemented by NWFWMD as part of training exercise in November 2013 on the Carter Tract of Econfina Creek WMA, Washington County, FL.

AREAS OF CONCERN

Several significant factors threaten the long-term maintenance of gopher tortoise populations on the Carter Tract. Our primary concern is the poor suitability of the habitat comprising the connective areas between and among current suitable tortoise habitat. Without habitat improvement in these 'connective corridors', the likelihood of tortoises dispersing from one subpopulation to another is low and increases susceptibility of subpopulations to disease outbreaks and low genetic variability. As urban and residential areas expand, the suitability of dispersal habitat may decline to the point that successful dispersal is restricted within the confines of the Carter Tract. In this event, the Carter Tract population must then survive demographically on its own or otherwise decline. Therefore, the importance of quality habitat within the Carter Tract cannot be over-emphasized. While the 41,424-acre Econfina Creek Wildlife Management Area is located just to the east, plans to continue the widening of State Road 77 through Washington County will increase hazards for individuals dispersing from this area.

The second level of concern is at the scale of the individual cluster. The greatest threat to the persistence of the gopher tortoise population is a subtle but continual decline in habitat quality on a site-by-site basis. Therefore, management recommendations for each cluster should continue to be reviewed closely and revised annually following comprehensive burrow surveys and habitat assessment.

Although habitat restoration on the Carter Tract is an influential factor on gopher tortoise behavior, predation can be a rising concern to their welfare. High levels of predation are expected among eggs and juveniles because their small size and thin shells increase their vulnerability to many predators. For example, Landers et al. (1980) found that 87% of nests were depredated within a few weeks after laying, and estimated that a female gopher tortoise would produce a successful hatch only once every ten years. Additionally, Alford (1980) reported a mortality rate of 94.2% within one year of hatching and Wilson (1991) documented considerable predation of tortoises less than five years old. Therefore, predation of eggs and hatchlings may result in a shortage of young tortoises in some years (Witz et al. 1992).

Due to body size and structure, adult tortoise predation rates are low compared to those of hatchlings (Wilson 1991). However, coyotes and feral/free-ranging domestic dogs are known to be effective predators of adult tortoises (Mann 1993; Lohoefener and Lohmeier 1984). In the past, packs of wild dogs have been observed on the area by both recreationalists and FWC staff, and coyote tracks are not uncommon, indicating this adaptable predator frequents the property. Compounding juvenile mortality with increased adult mortality could greatly impact survival of the gopher tortoise population on the Carter Tract, as well as commensals that are highly dependent on burrows (Speake 1981). In an effort to reduce the potentially negative impact of free-ranging dogs on the gopher tortoise population at the Carter Tract, large (60 x 20 x 26in) Tomohawk® cage-style live traps are opportunistically set based on visual confirmation of the pack and other sign (i.e. tracks, digging, etc.). Trapping efforts are adjusted accordingly as behavior patterns and areas of use change. Since 2009 nine dogs have been captured and removed from the property. All dogs captured were handled by Washington County Animal Control upon immediate notification. Though in recent years the “wild dog issue” on Carter has seemed to subside.

FUTURE PLANS AND EXPECTATIONS

Comprehensive gopher tortoise burrow surveys will continue annually during the summer months. Specific habitat and management recommendations will continue to be developed per cluster and adjusted as surveying and monitoring results dictate. Clusters will be prioritized based on existing gopher tortoise activity, habitat restoration improvement efforts, and potential tortoise expansion. The maintenance of a current and complete GIS database of burrow and cluster information will be essential. Plans are to incorporate general observations related to habitat structure, as well as habitat restoration activities, upon completion of summer burrow surveys. This will allow us to make appropriate management recommendations at the cluster level.

RELOCATION CONSIDERATIONS

In concert with recent re-evaluation of gopher tortoise relocations statewide, we will explore the benefits and feasibility of tortoise relocation onto the Carter Tract as a mechanism for future population recovery and expansion across the forest as habitat improvements make available more suitable tortoise habitat. Relocation as an avenue of gopher tortoise management should proceed cautiously. Historically, relocations as an effective management tool have been controversial (Dodd and Seigel 1991; Burke 1991; Reinert 1991). Due to a shortage of long term studies, little conclusive work has investigated the persistence of translocated gopher tortoises. However, one long term study by Ashton and Burke (2007) found an initial retention rate of 42% for the first year of the study and 92-100% retention rate for years 2-17. As research on the conservation of this species advances, tortoise relocation methods and retention rates continue to improve.

One issue of concern when dealing with habitat fragmentation and the potential relocation of tortoises is the increased risk of disease introduction and outbreak within subpopulations. Risk can be high for the spread of disease between gopher tortoise colonies and therefore should not be underestimated (Florida Fish and Wildlife Conservation Commission 2008). Recent studies have focused on the prevalence and distribution of Upper Respiratory Tract Disease (URTD) within gopher tortoise colonies. Clinical symptoms of URTD include intermittent serous, mucoid, or purulent nasal discharge, ocular discharge, palpebral edema, conjunctivitis, eyes recessed into the orbits, and dullness of the skin and scutes (Jacobson et al. 1991; Schumacher et al. 1993; Brown et al. 1994; McLaughlin 1997). Declines in both relocated and non-relocated tortoise populations have been associated with URTD (Brown et al. 2002; Gates et al. 2002; Diemer Berish et al. 2000). Wendland et al. (2010) found URTD may be transmitted more like a sexually transmitted infection rather than like a respiratory disease (transmitted via close proximity), and therefore is 11 times more prevalent in surveyed adult tortoises than in juveniles. In 2000, Diemer Berish et al. documented the distribution of URTD in Florida gopher tortoises, finding the nearest seropositive tortoises in Santa Rosa County to the west and Suwannee County to the east of the Carter Tract. This suggests that tortoises within the Carter Tract may not presently be exposed to the disease. However, in light of the still tenuous facts and abiding concern for disease in tortoises, it is recommended that any potential tortoise relocations to the Carter Tract in the future only be done following thorough physiological screening, with an emphasis on URTD testing and following closely the recommendations of Wendland et al. (2009).

LITERATURE CITED

Alexy, K.J., K.J. Brunjes, J.W. Gassett, and K.V. Miller. 2003. Continuous remote monitoring of gopher tortoise burrow use. Wildlife Society Bulletin 31(4): 1240-1243.

Alford, R.A. 1980. Population structure of *Gopherus polyphemus* in northern Florida. Journal of Herpetology 14:177-182.

Aresco, M.J. and C. Guyer. 1999. Growth of the tortoise *Gopherus polyphemus* in slash pine plantations of southcentral Alabama. Herpetologica 55:499-506.

Ashton, P.S. and R.E. Ashton. 2008. The Natural History and Management of the Gopher Tortoise (*Gopherus polyphemus* Daudin). Krieger Publishing Company, Malabar, FL.

Ashton, K.G. and R.L. Burke. 2007. Long term retention of a relocated population of gopher tortoises. Journal of Wildlife Management 71(3): 783-787.

Auffenberg, W. and R. Franz. 1982. The status and distribution of the gopher tortoise (*Gopherus polyphemus*). Pp. 95-126 *In* R.B. Bury, ed. North American tortoises: conservation and ecology. USDI Fish and Wildlife Serv. Res. Rep. 12.

Auffenberg, W. and W.G. Weaver, Jr. 1969. *Gopherus berlandieri* in southeastern Texas. Bulletin of Florida State Museum, Biological Sciences. 13:141-203.

Averill-Murray, R. C. 2000. Survey protocol for Sonoran Desert tortoise monitoring plots. Arizona Game and Fish Department.

Basiotis, K. A. 2007. The effects of invasive cogongrass (*Imperata cylindrica*) on the threatened gopher tortoise (*Gopherus polyphemus*). Thesis, University of South Florida, Tampa, Florida, USA.

Berish, J.E. 2001. Management considerations for the gopher tortoise in Florida. Florida Fish and Wildlife Conservation Commission. Final Report.

Brooks, M. L., C. M. D'Antonio, D. M. Richardson, J. B. Grace, J. E. Keeley, J. M. DiTomaso, R. J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. BioScience 54:677.

Breininger, D.R., P.A. Schmalzer, D.A. Rydene and C.R. Hinkle. 1986. Burrow and habitat study of the gopher tortoise in scrub and flatwoods habitat types. Final Project Report, Project No. GFC-84-016. Florida Game and Fresh Water Fish Comm., Nongame Wildlife Program.

Brown, M.B., I. M. Schumacher, P. A., Klein, K. Harris, T. Corrella, and E. R. Jacobson. 1994. *Mycoplasma agassizii* causes upper respiratory tract disease in the desert tortoise. Infect. Immun. 62:4580-4586.

Brown, D. R., I. M. Schumacher, G. S. McLaughlin, L. D. Wendland, M.B. Brown, P. A. Klein, and E. R. Jacobson. 2002. Application of diagnostic tests for Mycoplasmal infections of desert and gopher tortoises, with management recommendations. Chelonian Conservation and Biology 4:497–507.

Burke, R.L. 1991. Relocations, repatriations, and translocations of amphibians and reptiles: Taking a broader view. Herpetologica 47(3): 350-357.

Butler, J.A., and S. Sowell. 1996. Survivorship and predation of hatchling and yearling gopher tortoises, gopherus polyphemus. Journal of Herpetology 30(3): 455-458.

Carthy, R. R., M. K. Oli, J. B. Wooding, J. E. Berish, and W. D. Meyer. 2005. Analysis of gopher tortoise population estimation techniques. US Army Corps of Engineers, Washington, D.C., USA.

Cox, J., D. Inkley and R. Kautz. 1987. Ecology and Habitat protection needs of gopher tortoise (*Gopherus polyphemus*) populations found on land slated for large scale development in Florida. Nongame Wildlife Program Technical Report No. 4. Florida Game and Fresh Water Fish Comm., Tallahassee, FL.

Diemer, J.E. 1987. Gopher tortoise status and harvest impact determination: Final Report. Florida Game and Fresh Water Fish Comm., Nongame Wildlife Program. Tallahassee, FL.

Diemer, J.E. 1992a. Demography of the tortoise *Gopherus polyphemus* in Northern Florida. Journal of Herpetology26:281-289.

Diemer, J.E. 1992b. Home range and movements of the tortoise *Gopherus polyphemus* in Northern Florida. Journal of Herpetology 26:158-165.

Diemer, J.E. and P.E. Moler. 1992. Gopher tortoise response to site preparation in northern Florida. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 36: 634-637.

Diemer, J.E. and C.T. Moore. 1994. Reproduction of Gopher Tortoises in North-central Florida. Pp. 129-137 *In* Bury, R.B. and D.J. Germano, Eds. Biology of North American Tortoises. Fish and Wildlife Research 13. USDI, National Biological Survey, Washington, D.C.

Diemer Berish, J.E., Lori D. Wendland, and Cyndi A. Gates. 2000. Distribution and prevalence of upper respiratory tract disease in gopher tortoises in Florida. Journal of Herpetology 34(1): 5-12.

Dodd, C.K. Jr. and R.A. Seigel. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: Are they conservation strategies that work? Herpetologica 47(3): 336-350.

Doonan, T.J. 1986. A Demographic Study of an Isolated Population of the Gopher Tortoise, *Gopherus polyphemus*: and an Assessment of a Relocation Procedure for Tortoises. Thesis. University of Central Florida. Orlando, FL.

Doonan, T.J. and D.M. Epperson. 2001. Gopher Tortoise (*Gopherus polyphemus*) Populations of Naval Air Station, Cecil Field, Florida: Structure, Prevalence of upper Respiratory Tract Disease, and Activity Patterns. Final Performance Report. Florida Fish and Wildlife Conservation Commission. Tallahassee, FL

Douglass, J.F. 1978. Refugia of juvenile gopher tortoises, *Gopherus polyphemus* (Reptilia, Testudines, Testudinidae). Journal of Herpetology 12(3):412-413.

Enge, K. M., J. E. Berish, R. Bolt, A. Dziergowski, and H. R. Mushinsky. 2006. Biological status report: gopher tortoise. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida, USA.

Epperson, D.M. and C.D. Heise. 2003. Nesting and hatchling ecology of gopher tortoises (Gopherus polyphemus) in Southern Mississippi. Journal of Herpetology 37(2):315-324.

Ernst, C.H., Lovich, J.E., and Barbour, R.W. 1994. Turtles of the United States and Canada. Smithsonian Institution. Washington, DC. 466-478.

Florida Fish and Wildlife Conservation Commission. 2008 (as revised). Gopher Tortoise Permitting Guidelines: Appendix 6. Health Considerations for Gopher Tortoises during Relocations. Tallahassee, Florida, USA.

Florida Fish and Wildlife Conservation Commission. 2012. Gopher Tortoise Management Plan. Tallahassee, Florida, USA.

Florida Natural Areas Inventory and Florida Department of Natural Resources. 2010. Guide to the Natural Communities of Florida.

Gates, C. A., M. J. Allen, J. E. Diemer Berish, D. M. Stillwaugh, Jr., and S.R. Shattler. 2002. Characterization of a gopher tortoise mortality event in west-central Florida. Florida Scientist 65:185–197.

Glitzenstein, J.S., W.J. Platt, and D.R. Streng. 1995. Effects of fire regime and habitat on tree dynamics in northern Florida longleaf pine savannas. Ecological Monographs 65(4):441-476.

Guyer, C., V.M. Johnson, and S.M. Hermann. 2012. Effects of population density on patterns of movement and behavior of gopher tortoises (Gopherus polyphemus). Herpetological Monographs 26(1):122-134.

Huckle, H.F. and H.H. Weeks. 1962. Soil survey of Washington County, Florida. U.S. Department of Agriculture Soil Conservation Service, in cooperation with the University of Florida Agricultural Experiment Stations. 2:1-119.

Jackson, D.R. and E.G. Milstrey. 1989. The fauna of gopher tortoise burrows. Pp. 86-89 *In* Gopher tortoise relocation symposium proceedings (Diemer, J.E., D. R. Jackson, J.L. Landers, J.N. Layne and D.A. Wood, eds.). Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 5, Tallhassee.

Jacobson, E.R., J. M. Gaskin, M.B. Brown, R.K. Harris, C. H. Gardiner, J.L. LaPointe , H.P. Adams, and C. Reggiardo. 1991. Chronic upper respiratory tract disease of free-ranging desert tortoises (*Xerobates agassizii*). J. Wildl. Dis. 27:296-316.

Kent, D.M., and E. Snell. 1994. Vertebrates associated with gopher tortoise burrows in Orange county, Florida. Florida Field Naturalist 22(1): 8-10.

Landers, J.L. and D.W. Speake. 1980. Management needs of sandhill reptiles in southern Georgia. Proceed. of Annual Conf. Southeastern Assoc. Fish Wildlife Agencies. 34:515-529.

Landers, J.L., J.A. Garner, and W.A. MacRae. 1980. Reproduction of gopher tortoises (*Gopherus polyphemus*) in southwestern Georgia. Herpetologica 36: 353-361.

Landers, J.L., W.A. MacRae, and J.A. Garner. 1982. Growth and maturity of the gopher tortoise in southwestern Georgia. Bull. Florida State Mus. Biol. Sci. 27(2):81-110.

Lewis, C.E. and T.J. Harshbarger. 1976. Shrub and herbaceous vegetation after twenty years of prescribed burning in the South Carolina coastal plain. Journal of Range Management 29(1):13-18.

Lips, K.R. 1991. Vertebrates associated with tortoise (*Gopherus polyphemus*) burrows in four habitats in south-central Florida. Journal of Herpetology 25(4): 477-481.

Lohoefener, R. and L. Lohmeier. 1984. The status of *Gopherus polyphemus* (Testudines, Testudinidae) west of the Tombigbee and Mobile rivers. A report on research presented in conjunction with a petition to list the gopher tortoise west of the Tombigbee and Mobile rivers without critical habitat.

Mann, T. 1993. Gopher tortoise densities and burrow occupancy rates on selected sites in Mississippi. Mississippi Museum of Natural Science. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson.

Martin, P.L. and J.N. Layne. 1987. Relationship of gopher tortoise body size to burrow size in a southcentral Florida population. Florida Scientist 50:264-267.

McCoy, E.D. and H.R. Mushinsky. 1992. Studying a species in decline: gopher tortoises and the dilemma of "correction factors". Herpetologica 48(4):402-407.

McCoy, E. D. and H. R. Mushinsky. 2002. Measuring the Success of Wildlife Community Restoration. Ecological Applications 12:1861-1871.

McLaughlin, S. 1997. Upper respiratory tract disease in gopher tortoises. *Gopherus polyphemus*: pathology, immune responses, transmission, and implications for conservation and management. Unpubl. Ph.D. Diss., Univ. Florida, Gainesville.

McRae, W. A., J. L. Landers, and J. A. Garner. 1981. Movement patterns and home range of the gopher tortoise. American Midland Naturalist 106:165-179.

Moler, P.E. 1992. Eastern indigo snake *Drymarchon corais couperi*. pp. 181-186. In P.E. Moler (ed.). *Rare and Endangered Biota of Florida, Volume III, Amphibians and Reptiles.* University Press Florida, Gainesville.

Moore, J. A., H. T. Smith, R. M. Engeman, and J. Woolard. 2006. *Gopherus polyphemus* (gopher tortoise) coyote predation. Herpetological Review 37:78-79.

Mushinsky, H. R. 1985. Fire and the Florida sandhill herpetofauna community: with special attention to responses of *Cnemidophorus sexlineatus*. Herpetologica 41(3):333-342.

Mushinsky, H.R. and L.A. Esman. 1994. Perceptions of gopher tortoise burrows over time. Florida Field Naturalist 22(1):1-7.

Mushinsky, H.R., D.S. Wilson and E.D. McCoy. 1994. Growth and sexual dimorphism of *Gopherus polyphemus* in central Florida. Herpetologica 50(2):119-128.

Nomani, S. Z., R.R. Carthy and M.K. Oli. 2008. Comparison of Methods for Estimating Abundance of Gopher Tortoises. Applied Herpetology 5:13-31

O'Meara, T.E. and M.J. Abbott. 1987. Gopher Tortoise Response to Summer Burning in Longleaf Pine/Turkey Oak Sandhills. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Section Annual Performance Report, Tallahassee.

Ott Eubanks, J., W.K. Michener, and C. Guyer. 2003. Patterns of movement and burrow use in a population of gopher tortoises (*Gopherus polyphemus*). Herpetologica 59 (3):311-321.

Pike, D.A., 2006. Movement patterns, habitat use, and growth of hatchling tortoises *Gopherus polyphemus*. Copeia 1: 68-76.

Pike, D.A. and A. Grosse. 2006. Daily activity of immature gopher tortoises (*Gopherus polyphemus*) with notes on commensal species. Florida Scientist 69(2): 92-98.

Reinert, H.K. 1991. Translocation as a conservation strategy for amphibians and reptiles: Some comments, concerns, and observations. Herpetologica. 47(3): 357-363.

Schumacher, I. M., M.B. Brown, E.R. Jacobson, B.R. Collins, and P. A. Klein. 1993. Detection of antibodies to a pathogenic mycoplasma in desert tortoises (*Gopherus agassizii*) with upper respiratory tract disease. J. Clin. Microbiol. 31:1454-1460.

Small, C. R., and L. A. Macdonald. 2001. Reproduction and growth in relocated and resident gopher tortoises (*Gopherus polyphemus*) on reclaimed phosphate-mined lands. Florida Institute of Phosphate Research, Bartow, Florida, USA.

Smith, L.L., D.A. Steen, L.M. Conner, and J.C. Rutledge. 2013. Effects of predator exclusion on nestand hatchling survival in the gopher tortoise. Journal of Wildlife Management 77(2): 352-358.

Speake, D.W. 1981. The gopher tortoise burrow community. Pp. 44-47 *In* Lohoefener, R., L. Lohmeier, and G. Johnston, eds., The future of gopher tortoise habitats. Proc. 2nd Annu. Mtg. Gopher Tortoise Council. Florida State Museum, Gainesville, FL.

U.S. Fish and Wildlife Service Service. 2005. Gopher tortoise (*Gopherus polyphemus*) soil classification for the federally listed range. US Fish and Wildlife Service, Jackson, MS, 15 pp.

U.S. Fish and Wildlife Service Service. 2009. Guidelines for the Establishment, Management, and Operation of Gopher Tortoise Conservation Banks. U.S. Fish and Wildlife Service, Jackson, Mississippi. 22pp.

US Fish and Wildlife Service. 2011. 12-Month finding on a petition to list the gopher tortoise as threatened in the eastern portion of its range. Federal Register 76:45130-45162.

US Fish and Wildlife Service. 2012. 90-Day Finding on a Petition To List the Eastern Diamondback Rattlesnake as Threatened. Federal Register 77:27403-27411

Wendland, L., H.Balbach, M. Brown, J. Berish, R. Littell and M. Clark. 2009. Handbook on Gopher Tortoise (*Gopherus polyphemus*): Health Evaluation Procedures for Use by Land Managers and Researchers. ERDC/CERL TR-09-1. U.S. Army Corps of Engineers. Washington, D.C.

Wendland, L. , J. Wooding, C.L. White, D. Demcovitz, R. Littell, J.D. Berish, A. Ozgul, M.K. Oli, P.A. Klein, M.C. Christman, and M.B. Brown. 2010. Social behavior drives the dynamics of respiratory disease in threatened tortoises. Ecology 91(5): 1257-1262.

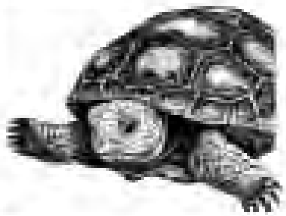
Wilson, D.S. 1991. Estimates of survival for juvenile gopher tortoises, *Gopherus polyphemus*. Journal of Herpetology 25(3):376-379.

Wilson, D. S., H. R. Mushinsky, and E. D. McCoy. 1994. Home range, activity, and use of burrows of juvenile gopher tortoises in central Florida. Pages 147-160 *In* R. B. Bury and D. J. Germano (eds.). Biology of North American tortoises. National Biological Survey, Fish and Wildlife Research 13.

Witz, B.W., D.S. Wilson and M.D. Palmer. 1991. Distribution of *Gopherus polyphemus* and its vertebrate symbionts in three burrow categories. American Midland Naturalist 126 (1):152-158.

Witz, B.W., D.S. Wilson and M.D. Palmer. 1992. Estimating population size and hatching mortality of *Gopherus polyphemus*. Florida Scientist 55:14-19.

Appendix I. Datasheet used to complete gopher tortoise surveys on the Carter Tract of Econfina Creek WMA, Washington County, Florida.



GOPHER TORTOISE SURVEY

Page ____ of ____

Fitzhugh Carter Tract of Econfina Creek Wildlife Management Area

Year 2013 Observers ______________________________

Cluster number _____

DATE	BURROW NUMBER	BURROW STATUS	BURROW DEPTH	BURROW WIDTH	HABITAT TYPE	LAT	LONG	COMMENTS

BURROW STATUS

1 = ACTIVE: Recent slide marks & footprints; soil at entrance has recently been disturbed by tortoise.
2 = INACTIVE: Soil undisturbed, lacks fresh sign of tortoise use but appears to be maintained.
3 = POSSIBLY ACTIVE: Difficult to determine whether activity was recent or due to tortoise.
4 = OLD (Abandoned): Partly or completely filled with litter or partially caved in, dilapidated.

HABITAT TYPES

1 = SANDHILL (Longleaf-turkey oak)
2 = PINELANDS (Flatwoods, plantations, etc.)
3 = SAND PINE SCRUB
4=XERIC OAK SCRUB
5 = HARDWOOD HAMMOCKS
6 = RUDERAL: a = grassland, b = shrub & brushland
7 = COASTAL STRAND
8 = OTHER (specify in comments section)

NOTES

1. Collect all snake skins found at or near burrow entrance. Place skin in zip-loc bag and label..
2. Facing burrow entrance, place numbered stake one meter in front and two meters to the left.
3. Read burrow caliper from inside measurements.
4. Burrow orientation is compass direction burrow entrance is facing.

Appendix II. Activity status of gopher tortoise burrows by cluster from 2005-2014 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

	Year							
Cluster 1	**2005/2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Active	3	0	0	0	3	1	1	1
Possibly Active	0	0	0	0	0	2	1	3
Inactive	1	0	1	1	11	3	4	2
Abandoned	0	4	0	3	4	13	17	18
Total	**4**	**4**	**1**	**4**	**18**	**19**	**23**	**24**
Cluster 2								
Active	5	2	1	0	9	6	7	11
Possibly Active	0	0	1	6	3	8	4	2
Inactive	2	6	3	5	2	8	5	3
Abandoned	2	3	12	11	14	12	20	22
Total	**9**	**11**	**17**	**22**	**28**	**34**	**36**	**38**
Cluster 3								
Active	3	1	4	4	14	13	16	10
Possibly Active	1	0	2	4	8	9	3	6
Inactive	5	4	10	11	3	14	16	16
Abandoned	3	13	25	25	30	36	53	58
Total	**12**	**18**	**41**	**44**	**55**	**72**	**88**	**90**
Cluster 4								
Active	35	6	15	8	30	40	42	46
Possibly Active	2	0	4	14	8	17	10	19
Inactive	35	25	9	13	15	38	37	38
Abandoned	22	54	97	78	103	98	119	137
Total	**94**	**85**	**125**	**113**	**156**	**193**	**208**	**240**
Clusters 5A and 5B								
Active	7	3	6	5	17	16	26	17
Possibly Active	9	0	3	5	4	11	10	8
Inactive	52	28	17	19	33	36	21	26
Abandoned	7	57	45	59	63	47	60	69
Total	**75**	**88**	**71**	**88**	**117**	**110**	**117**	**120**
All Clusters Combined	**194**	**206**	**255**	**271**	**374**	**428**	**472**	**512**