

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

2013 STATUS REPORT



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TABLE OF CONTENTS

LIST OF FIGURES	3
LIST OF TABLES	5
LIST OF APPENDICES	6
INTRODUCTION	7
AREA DESCRIPTION.....	11
Overview	11
Historical Land Use	12
Restoration Efforts	13
GOPHER TORTOISE SURVEY METHODOLOGY	15
RESULTS AND DISCUSSION	21
Activity Status.....	21
Cluster Use.....	25
Burrow Size Classes	28
Soil Types	32
MANAGEMENT RECOMMENDATIONS	34
Overview.....	34
Cluster 1	36
Cluster 2	36
Cluster 3	38
Cluster 4	39
Cluster 5A	40
Cluster 5B	40
AREAS OF CONCERN	42
FUTURE PLANS AND EXPECTATIONS	43
RELOCATION CONSIDERATIONS	43
LITERATURE CITED	45

LIST OF FIGURES

Figure 1. Vertebrate species are often observed utilizing gopher tortoise burrows on the Carter Tract, including the Gulf Coast box turtle (<i>Terrapene carolina major</i>).....	8
Figure 2. Virginia opossums (<i>Didelphis virginiana</i>) 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.....	11
Figure 3. Prescribed burning occurred on 643 acres from 2012 to 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.....	14
Figure 4. Photos from Photo Plot #61 in gopher tortoise cluster 2 show changes resulting from restoration efforts occurring from 2012 to 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.....	14
Figure 5. 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 2013.	16
Figure 6. Land cover types within surveyed gopher tortoise clusters on the Carter Tract of Econfina Creek WMA, Washington County, Florida.....	17
Figure 7. Example of each burrow status category from top left clockwise: active, possibly active, old/abandoned, and inactive.....	18
Figure 8. 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).....	19
Figure 9. Active gopher tortoise burrow showing marker tag (A), burrow entrance (B), and burrow apron (C).	20
Figure 10. Each burrow was marked with a numbered stake (a); location was geo-referenced with a handheld GPS (b); directional orientation was measured with a compass (c); and burrow width was measured with constructed calipers (d).	21
Figure 11. Activity status of gopher tortoise burrows (n=512) located during 2013 surveys on the Carter Tract of Econfina Creek WMA, Washington County, Florida..	22
Figure 12. Annual change in activity status of gopher tortoise burrows from 2005-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida. ..	23
Figure 13. 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.	25

Figure 14. Distribution of gopher tortoise burrows by cluster on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013..... 26

Figure 15. Activity status by cluster of burrows on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013. 26

Figure 16. Size class distribution of active and possibly active burrows surveyed from 2007 – 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida. 29

Figure 17. 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 2013. 31

Figure 18. Soil type distribution of gopher tortoise burrows surveyed on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013..... 32

Figure 19. Map of soil types found on the Carter Tract of Econfina Creek WMA; also shown are locations of gopher tortoise clusters, burrows, and 2013 burrow status. 33

Figure 20. Land management activities implemented by NFWFMD from 2012-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida. ... 35

LIST OF TABLES

Table 1. Summary of recent literature detailing vertebrate commensals captured or observed in gopher tortoise burrows in Florida.	9
Table 2. Size class distribution of active (n=85) and possibly active (n=38) gopher tortoise burrows surveyed May 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.	29

LIST OF APPENDICES

Appendix I. Datasheet used to complete gopher tortoise surveys on the Carter Tract of Econfina Creek WMA, Washington County, Florida 51

Appendix II. Activity status of gopher tortoise burrows by cluster from 2005-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida 52

INTRODUCTION

The Fitzhugh Carter Tract (hereafter referred to as the Carter Tract) was purchased by the Northwest Florida Water Management District (NFWFMD) 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 NFWFMD in August 2005 to manage the property. Management objectives identified by the NFWFMD 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 NFWFMD to develop and implement a comprehensive fish and wildlife management program for the Carter Tract. Following six years of successful partnership, this agreement was renewed in April 2011 for an additional three years through 2014. As part of this agreement, a monitoring program for the gopher tortoise (*Gopherus polyphemus*) commenced in 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 NFWFMD utilizing results from monitoring efforts for gopher tortoises on the Carter Tract. Changes in gopher tortoise population status can be a factor in determining 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 is important not only because it is a protected imperiled species but because it is a keystone species for sandhill communities of the southeastern coastal plain. 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) Table 1 summarizes the findings in current literature on use of burrows by commensals.



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.

Table 1. Summary of recent literature detailing vertebrate commensals captured or observed in gopher tortoise burrows in Florida.

Study	Number of Burrows Examined	Method			Burrow Status			Vertebrate Commensals Captured or Observed	
		Backhoe excavation	Funnel trap in entrance	Camera at entrance	Active	Inactive	Abandoned	Total	Number of Species
Witz et al. 1991	1019	X			X	X	X	99	19
Kent and Snell 1994	155	X			X	X		33	8
Lips 1991	80		X		X	X		319	16
Alexy et al. 2003	6			X	X			55	12
Pike and Grosse 2006	8			X	X			unk	6

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). This means 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

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*; Figure 2), 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 (*Dasybus novemcinctus*), 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 exotic 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 exotic 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. Virginia opossums (*Didelphis virginiana*) are known to prey on gopher tortoise hatchlings and have been documented using gopher tortoise burrows on the Carter Tract of Econfinia 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 1990). 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, the composition of which are mostly sand. Swamp soils, which are strongly acidic mineral soils containing large amounts of organic matter, are the most common soil type. Two additional soil types that occur are Lakeland and Blanton soils. Lakeland soils are deep, well-drained, strongly acidic sandy and loamy soils. Blanton soils are also sandy and acidic in nature. These soil types occur across the range of slopes found on the Carter Tract.

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 NFWMD 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

In 2007, the pine plantations were logged, and many of the upland hardwood forests were thinned of encroaching mid-story scrub oaks. 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 (Figure 3) and mechanical removal/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 4). 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. Prescribed burning occurred on 643 acres from 2012 to 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.



Figure 4. Photos from Photo Plot #61 in gopher tortoise Cluster 2 show changes resulting from restoration efforts occurring from 2012 to 2013 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 during May 2013, corresponding to one 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 5). These boundaries do not necessarily coincide with forest stand boundaries, but often include multiple stands. Clusters were primarily delineated for devising management options. 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.

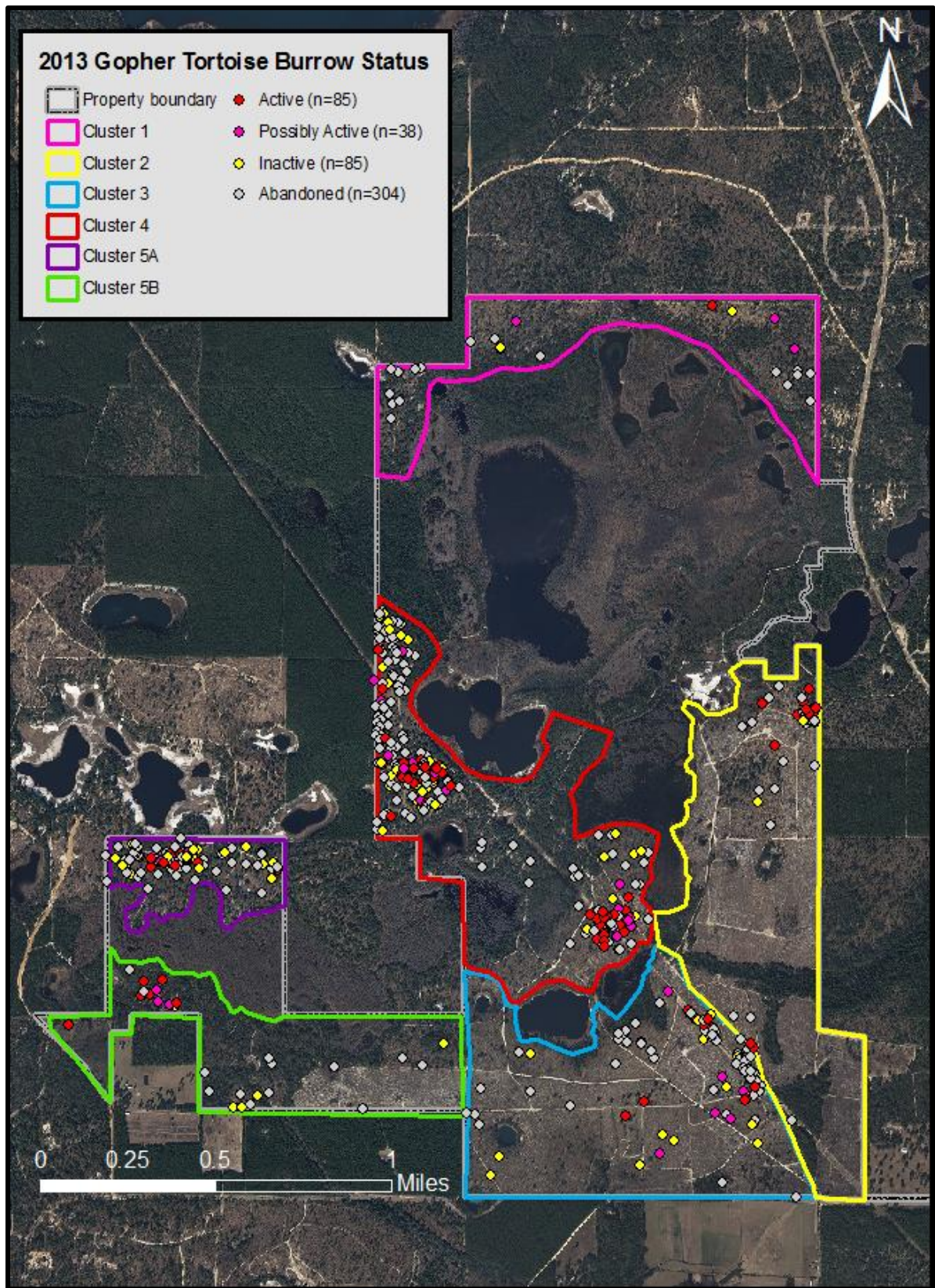


Figure 5. Distribution of gopher tortoise survey Clusters 1 – 5B and burrows with activity status located via visual searches using systematic transects across suitable habitat on the Carter Tract of Econfina Creek WMA, Washington County, Florida, May 2013.

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 is sandhill or upland tree plantations with the remaining 15% consisting primarily of other high pine, wet flatwoods, utilities (i.e. powerline ROW), etc. (Figure 6). 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). It has been assumed that comprehensive surveys are 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).

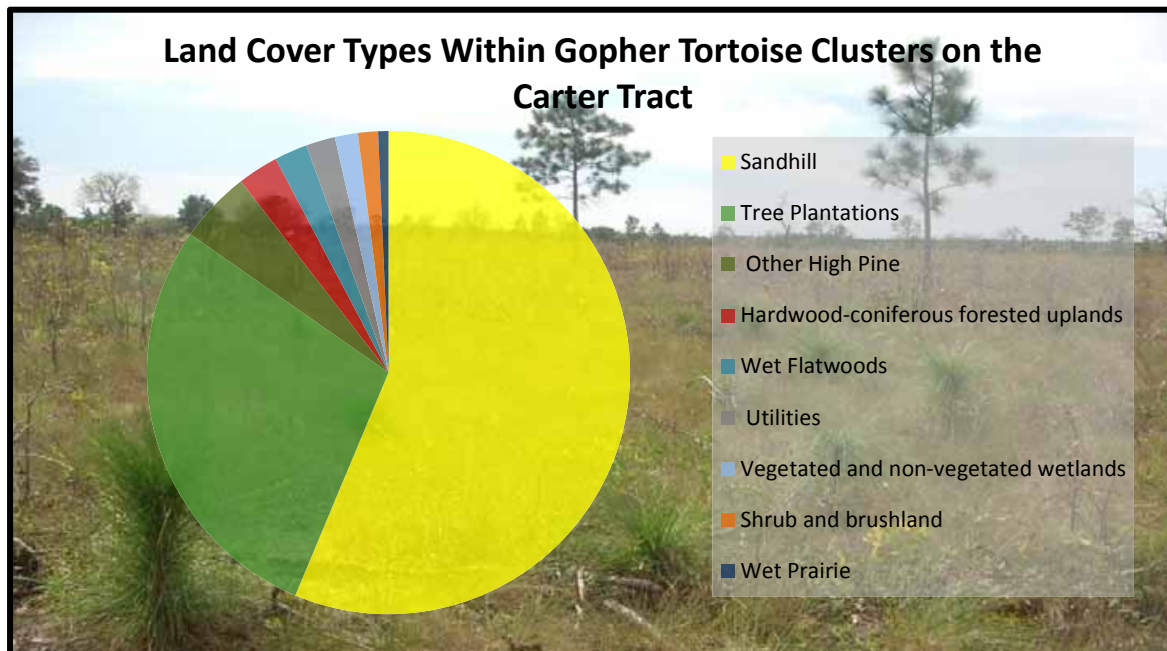


Figure 6. Land cover types within surveyed gopher tortoise clusters on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Distinguishing activity status followed Breininger et al. (1986) and Diemer (1992a). Activity status attributes are described below and illustrated in Figure 7:

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 7. Example of each 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/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 (i.e. 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 8). 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.

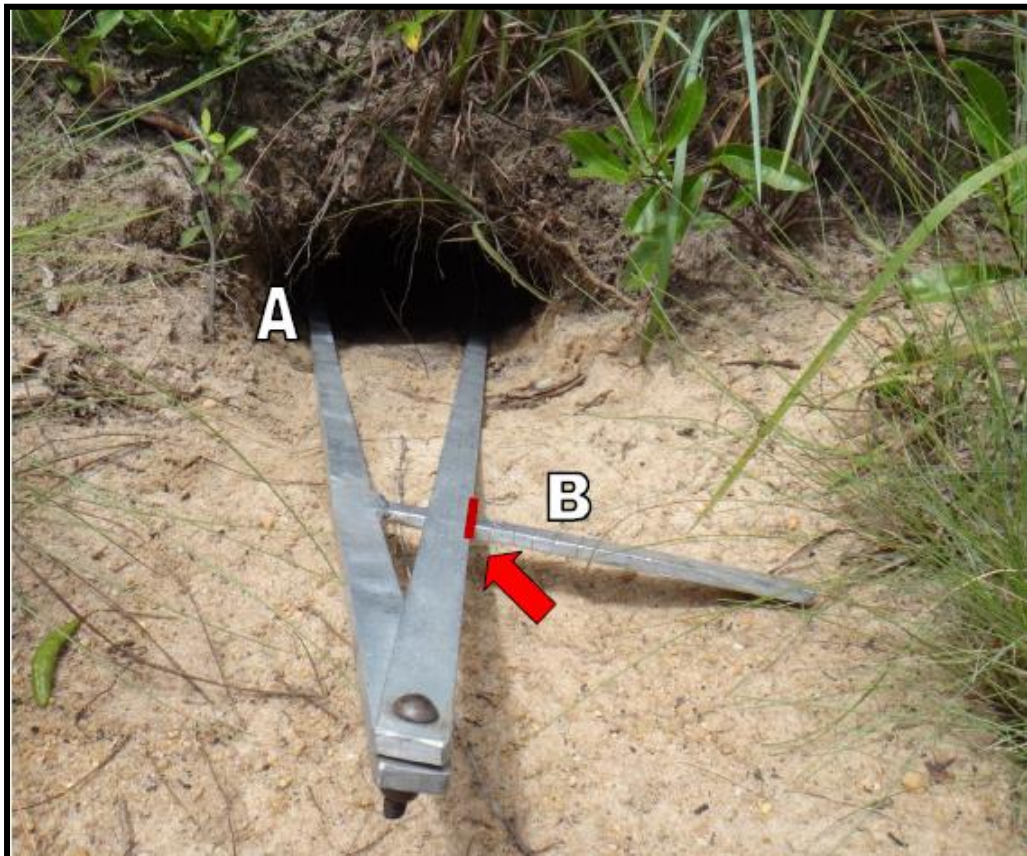


Figure 8. Constructed calipers are inserted 50 cm into gopher tortoise burrow (A), caliper arms are spread open to touch both sides of burrow, and burrow width is measured where red line meets attached ruler (B).

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 9). 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 old/abandoned and some inactive burrows were often too obscured to determine direction (Figure 10). Standardized data sheets were completed for each burrow found (Appendix I).



Figure 9. Active gopher tortoise burrow showing marker tag (A), burrow entrance (B), and burrow apron (C).



Figure 10. Each burrow was marked with a numbered stake (a); location was geo-referenced with a handheld GPS (b); directional orientation was measured with a compass (c); and burrow width was measured with constructed calipers (d).

RESULTS AND DISCUSSION

Activity Status

A total of 512 burrows were located across the Carter Tract during the 2013 sampling season. Seventeen percent ($n=85$) of burrows were found to be active, 7% ($n=38$) were possibly active, 17% ($n=85$) were inactive, and 59% ($n=304$) were old/abandoned (Figure 11). Appendix II outlines detailed burrow counts by cluster and activity status across the Carter Tract from 2005-2013.

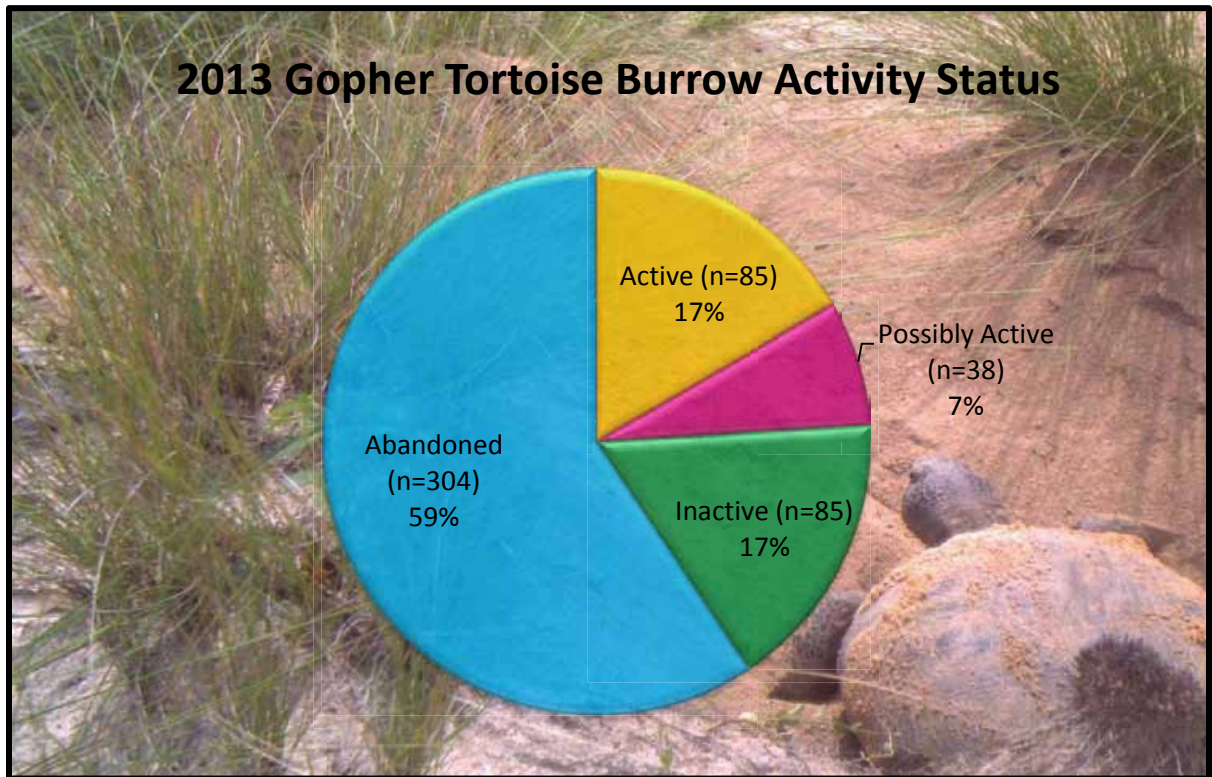


Figure 11. Activity status of gopher tortoise burrows (n=512) located during 2013 surveys on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

The total number of burrows, as well as the number of active and possibly active burrows, reached their highest numbers to date since surveys began in 2005. Figure 12 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 12) 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.

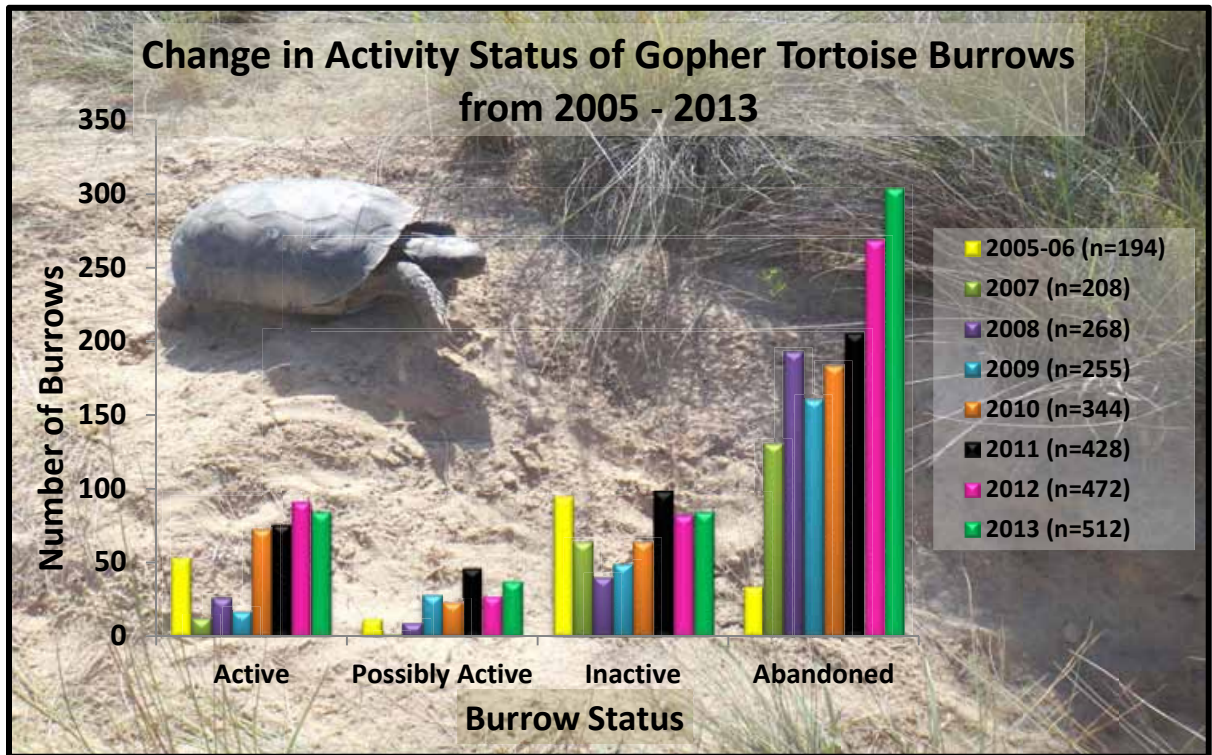


Figure 12. Annual change in activity status of gopher tortoise burrows from 2005-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

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 five 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 (i.e. “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 13).



Figure 13. 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 2013 found the majority (47%) of all burrows continued to be located in Cluster 4 (Figure 14). The greatest number of active and possibly active burrows were also located in Cluster 4 (n=65; Figure 15). 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). Further, recent habitat restoration efforts have opened the canopy considerably and successfully promoted herbaceous groundcover. It is therefore not surprising to see a greater concentration of burrows within this cluster.

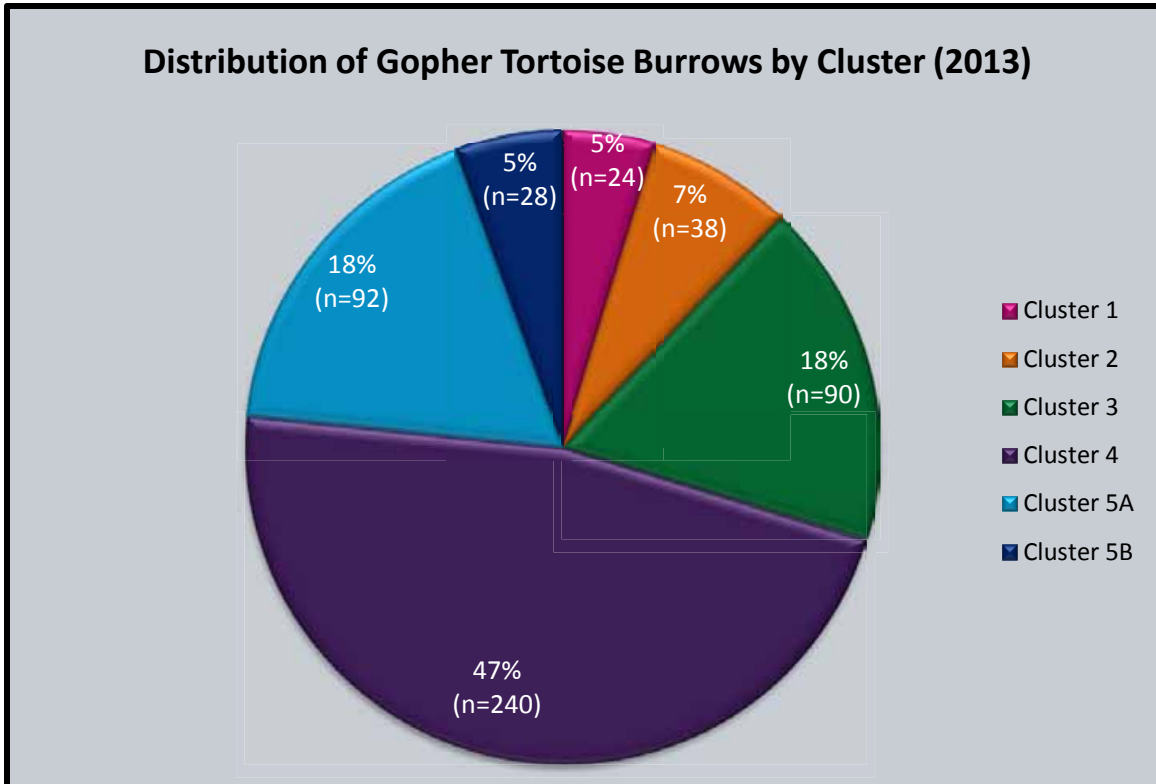


Figure 14. Distribution of gopher tortoise burrows by cluster on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013.

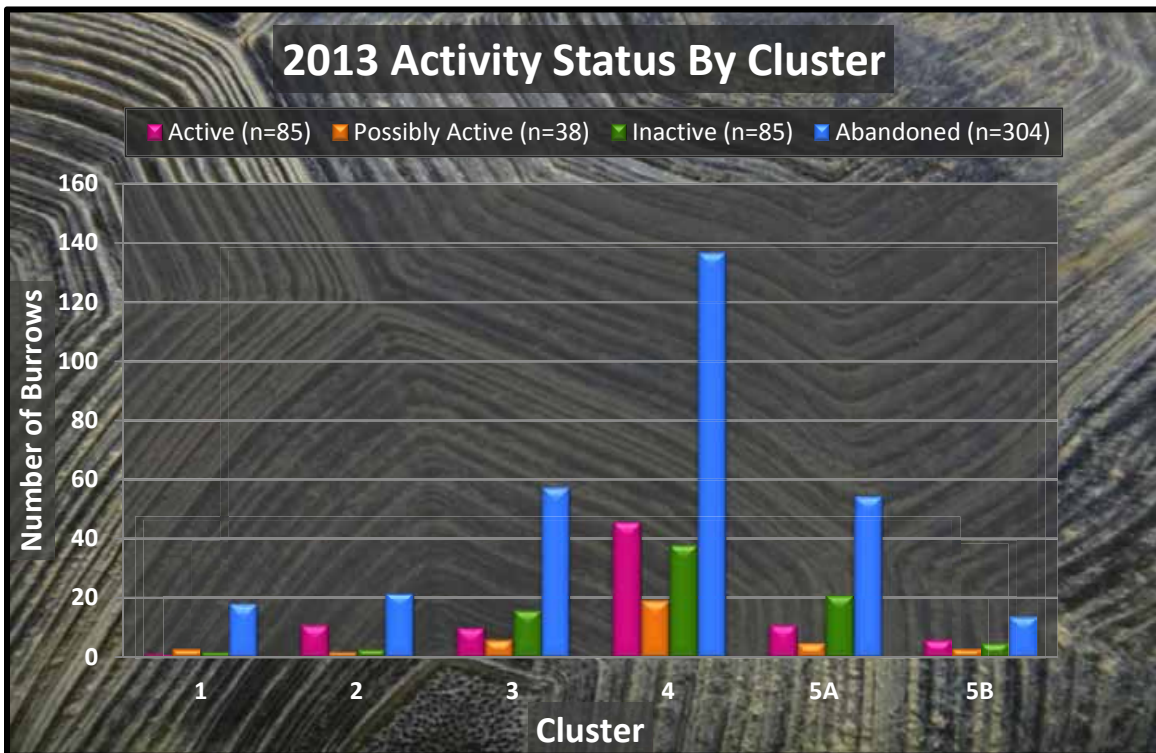


Figure 15. Activity status by cluster of burrows on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013.

Xeric oak sandhills also comprise nearly the entire habitat within Cluster 5A; however, there have been no habitat restoration efforts in this area since 2010. Since surveys began in 2005, Cluster 5A was the second most productive gopher tortoise cluster on the Carter Tract, supporting the second highest number of total burrows and the second largest percentage of active and possibly active burrows. Cluster 5A now contains just 13% (n=16) of active or possibly active burrows, compared to 23% (n=28) in 2012 and 15% (n=19) in 2011. It is expected that burrow activity within this cluster will 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 supported 18% (n=90) of tortoise burrows with 16 active or possibly active burrows in 2013. This area is a combination of xeric oak habitat and previous slash and sand pine plantations. Past habitat restoration efforts have restored this cluster to include an open canopy and thriving herbaceous groundcover. Recent mechanical reduction/herbicide of regenerated sand pine and hardwoods during summer 2013 and continuation of a two year prescribed burn regime should help to maintain an open canopy and promote native groundcover expansion.

Seven percent (n=38) of tortoise burrows were found in Cluster 2. This area 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 planting of wiregrass tublings and longleaf pine seedlings. Active burrows are concentrated in the northeastern-most portion of Cluster 2, but recent prescribed burns in the central part of this cluster may encourage tortoises to expand south into the improved habitat. 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.

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 2013 survey results were consistent with this trend, finding just 5% (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/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=85) and possibly active (n=38) burrows found during 2013 surveys (Table 2). Figure 16 shows how the number of tortoises per size class has changed from 2007-13.

Table 2. Size class distribution of active (n=85) and possibly active (n=38) gopher tortoise burrows surveyed May 2013 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	6	5%
10	10.67	16	13%
15	15.23	21	17%
20	19.62	35	28%
25	23.87	21	17%
30	28.01	17	14%
35	32.08	6	5%
40	36.08	1	1%

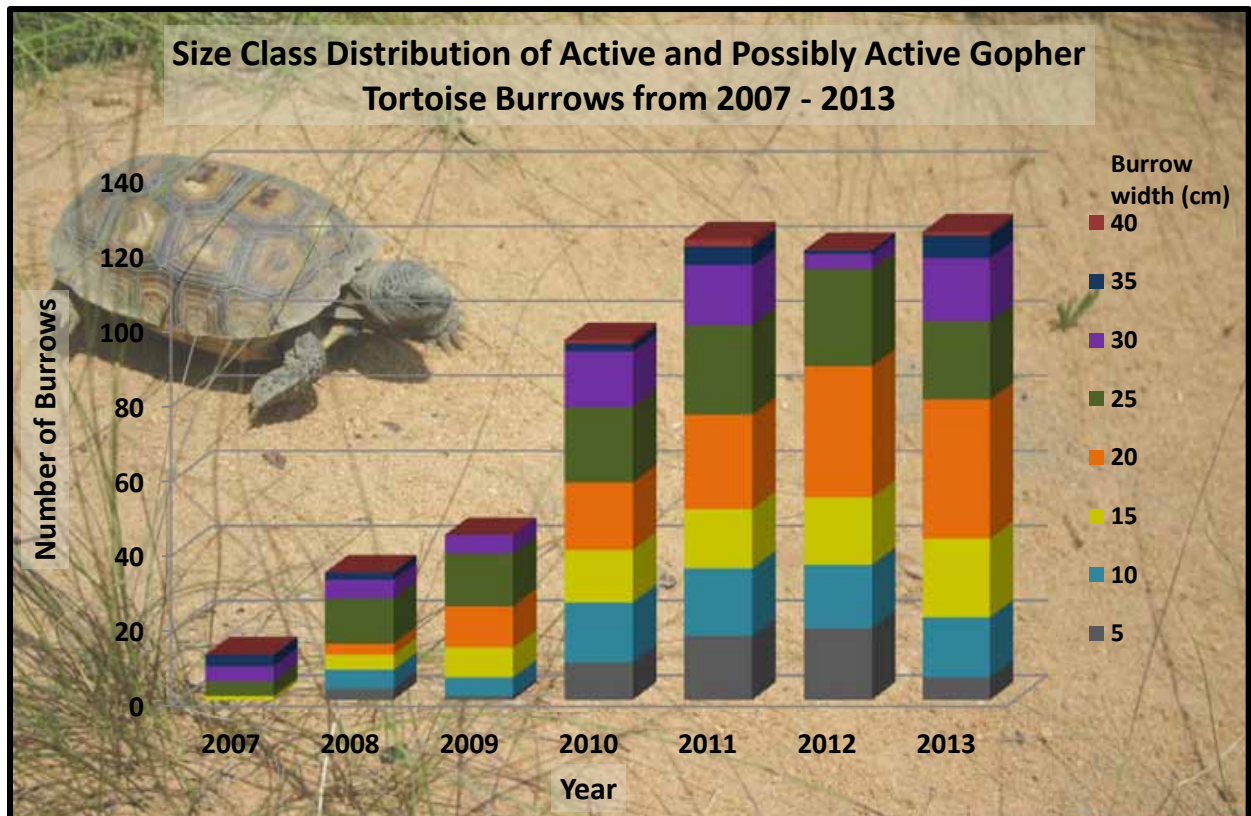


Figure 16. Size class distribution of active and possibly active burrows surveyed from 2007 – 2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

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, 37% (n=45) resulted in a CL corresponding to sexual maturity (CL > 19.62 cm) and 63% (n=78) 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 17). 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).

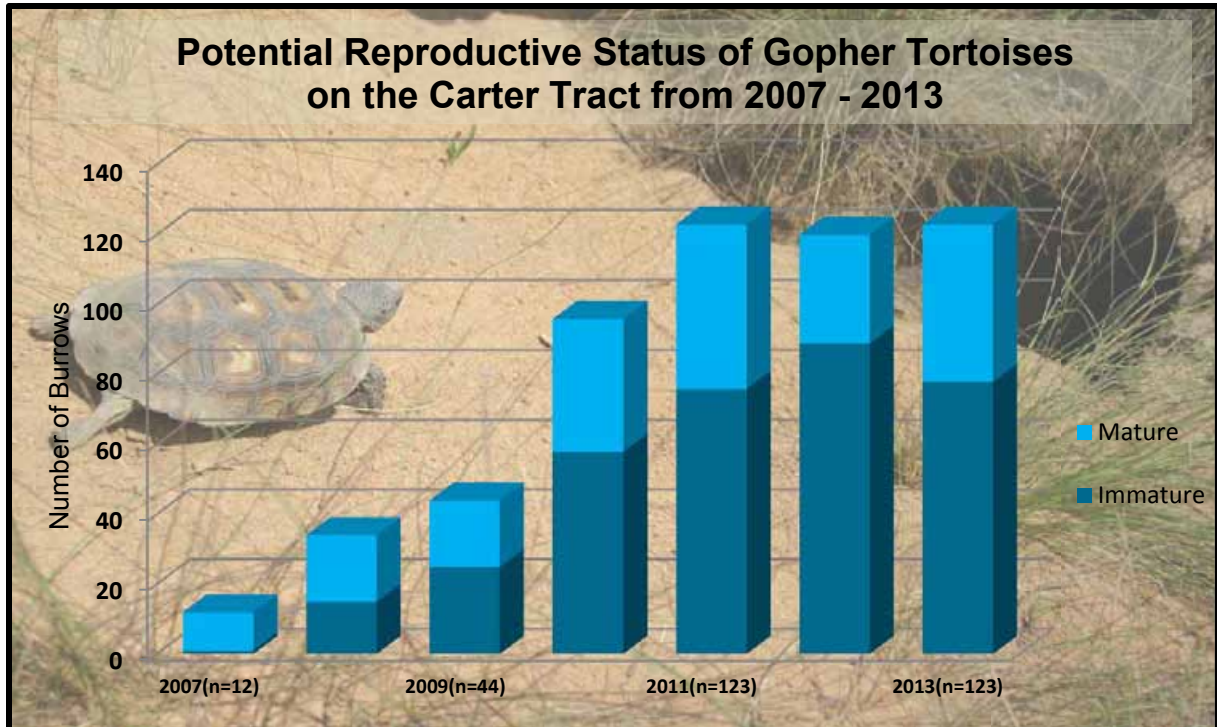


Figure 17. Potential reproductive status of gopher tortoises determined by burrow width of active and possibly active burrows found on the Carter Tract of Econfina Creek WMA, Washington County, Florida, from 2007 to 2013.

Beginning in 2009 the trend shifted, revealing more burrows belonging to sexually immature tortoises than mature tortoises (Figure 17). 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 ≤ 20 cm) likely signifies a greater survival of younger tortoises.

It is difficult to make definitive statements about the specific demographics of the gopher tortoise population on the Carter Tract. 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 (i.e. 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 improvement/restoration activities.

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. Eighty-eight percent (n=443) of all gopher tortoise burrows on the Carter Tract were located in Lakeland Coarse Sands (Figure 18), the most common soil type found on the Carter Tract (Figure 19). Lakeland Coarse Sands occupy large acreages in southern Washington County (Huckle and Weeks 1962), and is one of the soil types recognized for supporting gopher tortoises in northern Florida (J. Diemer Berish, pers. comm.). The remaining 12% of burrows were found in Eustis Coarse Sand (n=50), Blanton Sand (n=6), Klej Sand (n=4), and Rutlege Loamy Fine Sand (n=1) types.

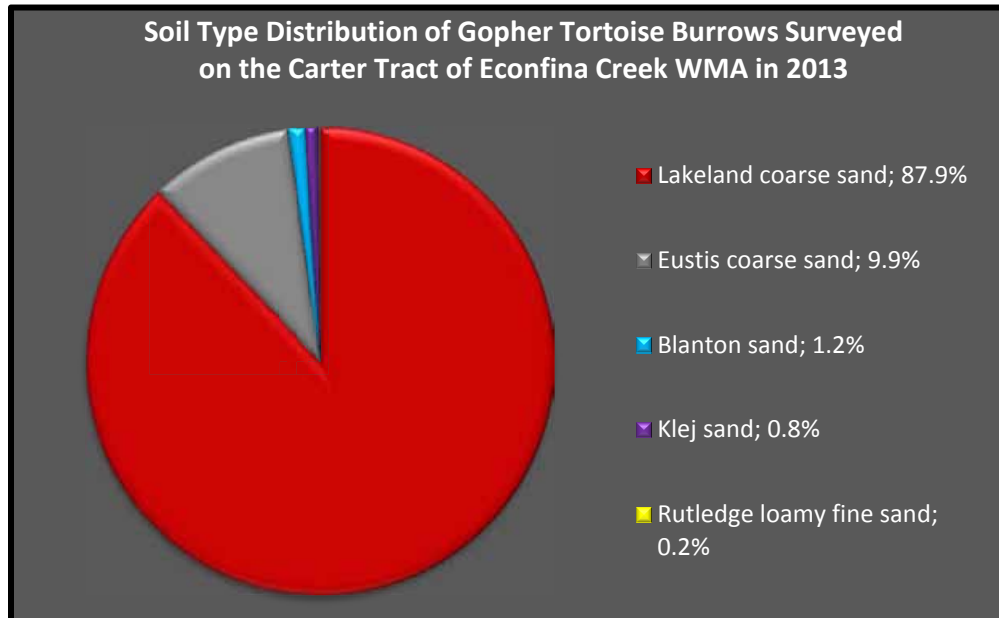


Figure 18. Soil type distribution of gopher tortoise burrows surveyed on the Carter Tract of Econfina Creek WMA, Washington County, Florida, 2013.

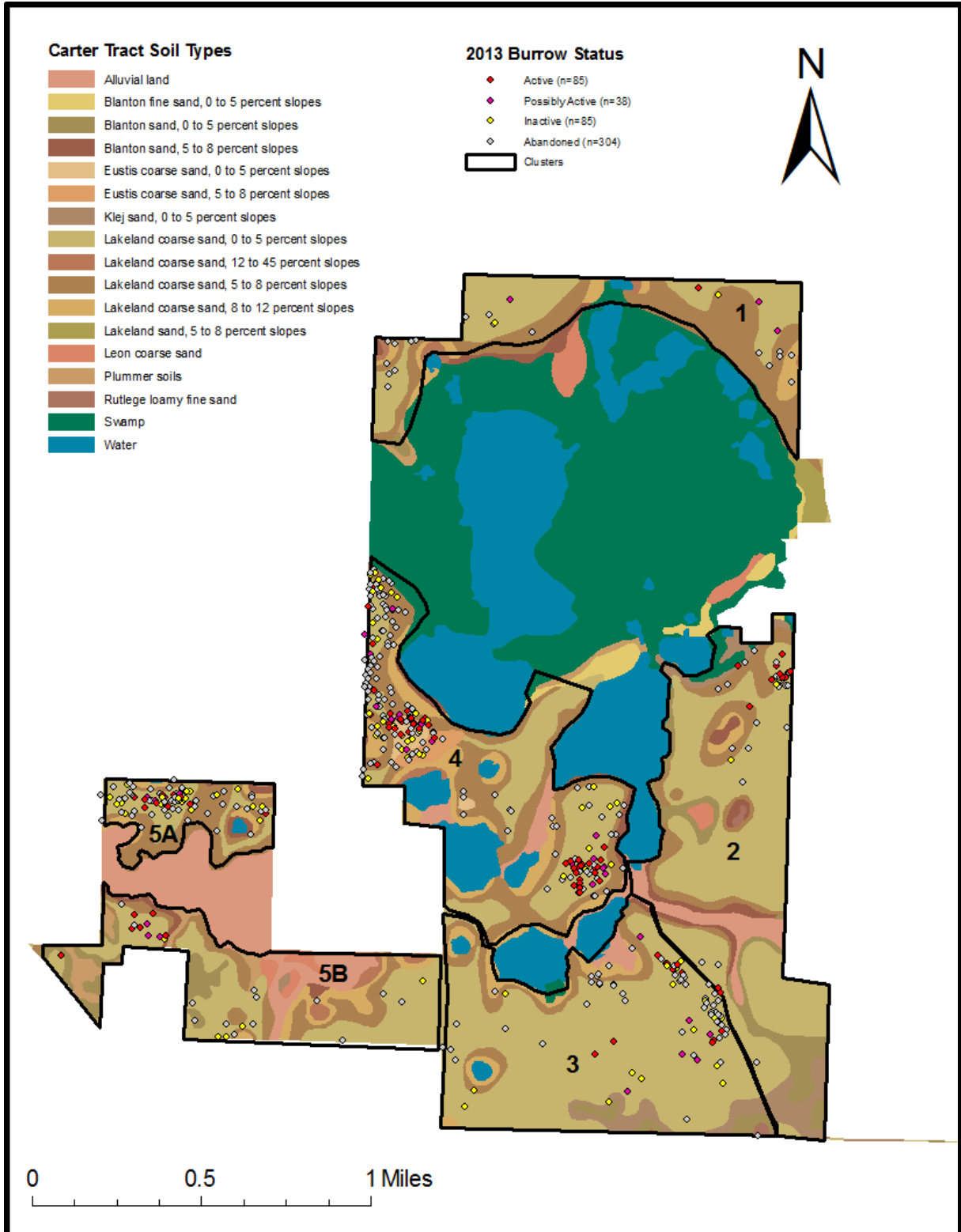


Figure 19. Map of soil types found on the Carter Tract of Econfina Creek WMA; also shown are locations of gopher tortoise clusters, burrows, and 2013 burrow status.

MANAGEMENT RECOMMENDATIONS

Overview

Improvements have been made over the last five years 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 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. Studies have found summer burns to 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 permissible weather conditions, adequate staff/equipment availability, funding, etc.) influence the frequency with which prescribed fire can be utilized. Therefore supplemental management activities may need to be implemented to help accomplish restoration goals. These might include the mechanical cutting of regenerating hardwoods and sand pine, herbicide application, etc.

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 2012). Our methods address such management considerations as midstory/hardwood management, regeneration, and implementation of a regular prescribed burning regime (Figure 20). This management approach will improve habitat and tortoise cluster size on a site-specific basis.

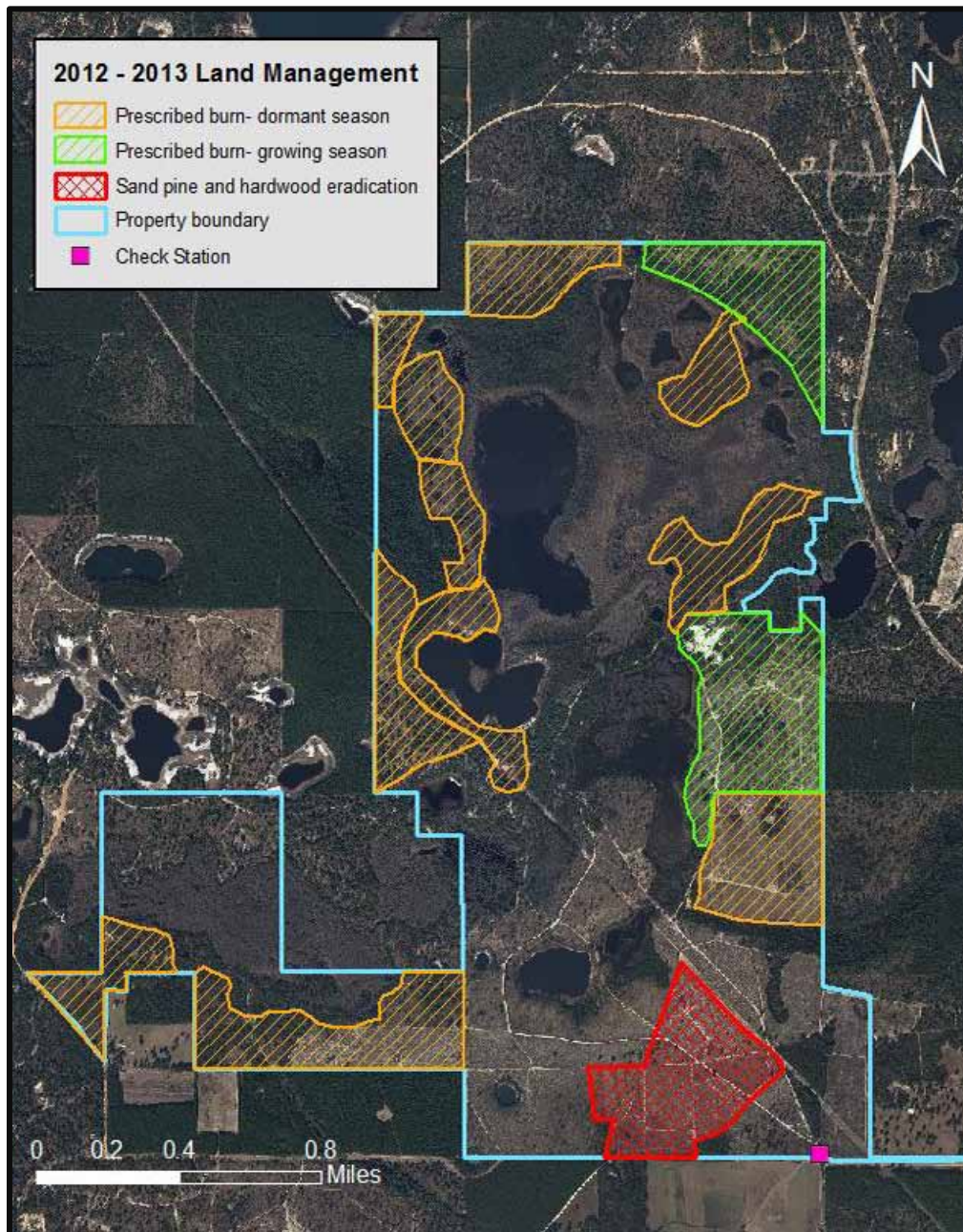


Figure 20. Land management activities implemented by NFWMD from 2012-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

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. We suggest continuation and improvement of growing season burns in an effort to maintain hardwood suppression 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				
*2014	X					


* Denotes *suggested* management activities for 2014

Cluster 2

Cluster 2 is the second least active cluster on the Carter Tract. 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/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 was eradicated from forty eight acres in the southern portion. Finally, 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.

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	

* Denotes *suggested* management activities for 2014

Cluster 3 – 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/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 persimmon and hardwoods were treated with herbicide, resulting in reduced competition for planted wiregrass tublings and a more open understory for native forbes.

In summer 2013, 101 acres of sand pine and hardwoods in the eastern portion of Cluster 3 were cut and treated with herbicide. 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				

* Denotes *suggested* management activities for 2014

Cluster 4 – 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. However, given ideal conditions, growing season burns are desirable for promoting flowering of wiregrass and would be more beneficial in topkilling any remaining hardwood regeneration. 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				

* Denotes *suggested* management activities for 2014

Cluster 5A – 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 burn was in 2010, and hardwoods have since started to encroach on the entire cluster. 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 establishment, 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						
*2014	X		X	X		

* Denotes *suggested* management activities for 2014

Cluster 5B

Cluster 5B supports 5% (n=28) of all burrows on the Carter Tract. While the majority of burrows are currently abandoned, six active and three potentially active burrows were identified in the extreme western portion of this cluster, south of Pine Log Creek (Figure 6). This portion of Cluster 5B was burned in spring 2010 and winter 2013 resulting in good wiregrass regeneration and transforming it into the best gopher tortoise habitat within the cluster. It is therefore 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; therefore, this habitat component 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 to promote 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 6). In 2007 the sand pine was harvested, followed by a site preparation prescribed burn and subsequent planting of longleaf pine/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	X		X	X		

* Denotes *suggested* management activities for 2014

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. It may be that 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; Lohoefer 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. Further, during 2013, as in previous years, multiple burrows appear to have been dug up, most likely by canids. 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.

FUTURE PLANS AND EXPECTATIONS

Comprehensive gopher tortoise burrow surveys will continue from May through September in subsequent years. Specific habitat and management recommendations will continue to be made for each cluster and will be adjusted as demographic analyses dictate. Clusters will be prioritized based on existing gopher tortoise activity, restoration/habitat improvement efforts, and potential tortoise expansion. The maintenance of a current and complete GIS database of burrow and cluster information/data will be essential. Plans are to incorporate general observations related to habitat structure, as well as habitat improvement/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, however, 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).

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Appendix II. Activity status of gopher tortoise burrows by cluster from 2005-2013 on the Carter Tract of Econfina Creek WMA, Washington County, Florida.

Cluster 1	Year							
	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