Range-Wide Conservation Strategy for the Gopher Tortoise (*Gopherus polyphemus*)

December 2012

Common Name Gopher Tortoise
Scientific Name *Gopherus polyphemus*

Listing Status and Date **Threatened** (populations west of the Mobile & Tombigbee Rivers in AL, MS, & LA); July 7, 1987 (USFWS 1987)

Candidate (populations east of the Mobile & Tombigbee Rivers in AL, GA, FL, & SC); July 27, 2011 (USFWS 2011)

Purpose of the Conservation Strategy: This document lays out a preliminary course of action for the conservation of the gopher tortoise. It is meant to serve as a "roadmap" for all partners to determine the highest priority conservation efforts for the tortoise, and identify those agencies and organizations best suited to effectively undertake those efforts. It is our hope that partner implementation of this plan, with progress evaluated annually, will provide the information needed to address the threats to the species and improve its conservation status range-wide. This is intended to be an adaptive document that will be revised as new information is received from the public and partners, and should be used as a guide for helping to develop conservation and habitat plans between land managers and partners.

OVERVIEW

The gopher tortoise is one of the most heavily studied non-game vertebrate species in the southeastern United States. This is due to a variety of factors, including: 1) its value as a keystone species, since its presence and abundance dramatically affect many other organisms as well as the dynamics of the ecosystem; and 2) the high level of detectability because of the distinctive burrows they create. The current federal status of the gopher tortoise is "Threatened" for populations west of the Mobile & Tombigbee Rivers in AL, MS, & LA, and it is a "Candidate" (determined to qualify for listing) for populations east of the Mobile & Tombigbee Rivers in AL, GA, FL, & SC. Throughout this document, the term "eastern range" corresponds to the geographic area where the tortoise is considered a Candidate species for listing, while "western range" corresponds to the area where it is currently listed as Threatened. The status of the tortoise in all six states can be found in Table 1.

Table 1. State listing status of the gopher tortoise throughout its range.

State	Status
Alabama	Protected non-game species
Florida	Threatened
Georgia	Threatened
Louisiana	Threatened
Mississippi	Endangered
South Carolina	Endangered

There have been many peer-reviewed manuscripts since the late 1970's which have provided details of adult gopher tortoise home range, social interactions, habitat use, movement patterns, forage requirements, predation, nesting, translocation, and disease across the full geographic range. In the last 10 years there have been great advances in research on genetics, population viability analyses, patch size requirements, and predictive GIS modeling. However, questions remain; specifically, what is the demography and density of tortoises that make up a viable population, how large an area of appropriately-managed habitat is necessary to maintain that population, and what distribution of viable populations across the landscape is sufficient to reflect long-term stability. Ongoing deficiencies in research are the life history traits, threats, and habitat needs of juvenile tortoises; long-term effects of invasive, nuisance, and exotic species; reliable range-wide survey trends; and the status of tortoise populations on public as well as private lands. Information on gopher tortoise life history, range, and habitat descriptions can be found in Appendix 2.

The range of the gopher tortoise is generally associated with the longleaf pine ecosystem (Auffenber and Franz 1982), which is estimated to have once covered 90 million acres, but which now covers approximately 3.4 million acres (America's Longleaf 2009). Fifty-five percent of the remaining longleaf pine habitat is in private ownership, 34 percent is in Federal ownership, and 11 percent is in State or local ownership (Gaines 2010). Since there has been no

range wide survey of gopher tortoises, and the number of comprehensive surveys only cover a relatively small percentage of the total range, modeling efforts have been used to identify potential habitat where tortoises may be present. Although there is some debate about the total acreage of potential habitat within the eastern range, it is generally estimated that over 80 percent of the potential tortoise habitat is in private ownership, and the remainder is controlled by local, State, Federal, or conservation entities (Hoctor and Beyeler 2010; FWC 2011).

Population Estimates/Status

A wide variety of information is available on the number and density of gopher tortoises and their burrows from many areas throughout their range. These data resulted from numerous surveys/censuses using a variety of methodologies ranging from one-time censuses to repeated surveys over several decades. The diversity of data poses a challenge when trying to evaluate the status of a species from a landscape perspective. For example, in areas where we have more data, we have higher confidence in drawing conclusions about status of those populations. In other areas, where there is little or no data, our confidence in assessing the status of tortoises is lower. Because of disparities in the type of data collected, methodologies in collecting data, and differences in the scope of studies, it is not possible to simply combine datasets to evaluate the status of the gopher tortoise throughout its range. Instead, we consider each individual dataset in the context of all other best available science to form general conclusions about the status of the gopher tortoise.

The gopher tortoise is more widespread and abundant in parts of the eastern portion of its range, particularly southern Georgia and central and northern Florida. Estimates of adult tortoise abundance include approximately 785,000 in Florida (FWC 2012); 30,000 to 130,000 in Alabama (Guyer et al. 2011); 11,000 in Mississippi (Lohoefener and Lohmeier 1984); and 300 in Louisiana (B. Gregory [LA DWF] – pers. comm). State-wide population estimates are currently being calculated for Georgia and South Carolina. Long-term monitoring data indicate that many populations have declined and are relatively small and fragmented (McCoy et al. 2006). Similarly, smaller-scale, short-term or one-time surveys indicate that tortoise populations typically occur in fragmented and degraded habitat, are small, and densities of individuals are low within populations; however, there are also many populations of tortoises in the eastern portion of the range that appear to be sufficiently large to persist long-term (Service 2011). From population modeling efforts (Miller et al. 2001; Tuberville et al. 2009), we can draw two very general conclusions: first, gopher tortoise populations are likely to decline in the future under a wide array of demographic and environmental conditions that exist today. Second, gopher tortoise populations, although declining, and in some cases functionally extinct, will persist for 100 to 200 years. The effect of these may be that tortoises will be seen for long periods of time throughout their range, not because their populations are stable or increasing, but because they are long-lived.

Recently, segmented regression models were developed to evaluate the relationship between area of habitat occupied by gopher tortoises and abundance of tortoises to define how many

individuals constitute a viable population and how much area is required for such a population. Data synthesized from 21 study sites in Alabama, Georgia, and Mississippi with varying tortoise population numbers indicated that an average gopher tortoise population consists of 444 burrows, covers 1,865 acres, and contains 240 tortoises (Styrsky et al. 2010). The proximity of adult tortoises to one another can be quite influential; Guyer et al. (2012) determined that when density falls below ~ 1 tortoise every 6 acres, social interactions decrease dramatically because it takes too much energy to search for mates; thus potentially having a negative effect on population reproductive fitness.

McCoy and Mushinsky (2007) evaluated minimum patch size for the gopher tortoise, and determined that where populations were spatially constrained (e.g., not able to disperse) tortoises were estimated to require about 247 acres, and unconstrained populations inhabited 353–618 acres. Recent modeling efforts recognized the need to evaluate the viability of individual populations, rank populations most appropriate for in-situ protection, and determine if nonviable populations are more likely to contribute to conservation through augmentation or translocation (Tuberville et al. 2009). All baseline model scenarios resulted in a population decline of one to three percent per year, which varied as a function of habitat quality and location within the range. Only modeled populations with at least 250 tortoises were able to persist for 200 years, which was the maximum duration possible in the modeling software (Tuberville et al. 2009).

ESA LISTING FACTORS/PRIMARY THREATS TO THE SPECIES

The goal of the Endangered Species Act (ESA) is to conserve endangered or threatened species. When a species is able to survive on its own in the wild and the factors that previously threatened that species have been ameliorated, the species is considered to be "recovered," and protection of the ESA is no longer necessary. To delist (remove it from endangered or threatened status), reclassify (from endangered to threatened, or vice versa), or remove a species from candidate status, the FWS will consider similar information used to decide whether to list a species. The FWS will assess populations and achievements in eliminating or reducing threats, and we seek peer-review. In assessing threats, the FWS uses the "5-factor analysis" as outlined in Section 4 of the ESA.

The following is an outline of the existing threats to the gopher tortoise, summarized primarily from the warranted but precluded *12-Month Finding on a Petition to List the Gopher Tortoise as Threatened in the Eastern Portion of its Range*. The information is outlined according to each of the 5 ESA listing factors.

Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range

This is by far the biggest threat facing the continued existence of the gopher tortoise. There are many direct and indirect factors contributing to this threat, including (but not limited to): 1)

habitat fragmentation by roads (potentially causing road mortality, reproductive isolation, small and discontinuous populations, and edge effects that may increase predation); 2) habitat destruction from activities such as urbanization and sand extraction (potentially causing direct mortality and/or displacement of tortoises to undesirable habitats); and 3) habitat modification (either deliberately or from inattention), including conversion of open pine (e.g. longleaf pine) forests to other silvicultural or agricultural habitats, phosphate mining, shrub/hardwood/sand pine encroachment (mainly from fire exclusion or insufficient fire management), and establishment and spread of invasive species (potentially causing the aforementioned indirect effects due to canopy closure and decline of available forage/groundcover).

Gopher tortoise habitat in the eastern portion of its range has been destroyed or modified in the past due to conversion of natural pine forests to intensely managed planted pine plantations or naturally regenerated stands (Hermann et. al. 2002; Siry 2002; Conner and Hartsell 2002). Additionally, loss of natural pine forests has resulted from urban development and industrialization (Kautz 1998; FWC 2006), and degradation of natural pine forest due to lack, or insufficient use, of prescribed fire (FWC 2006; Bailey and Smith 2007; Yager et al. 2007). Several of these same factors are cited in the gopher tortoise recovery plan as historical processes that resulted in habitat destruction and modification in the western portion of the tortoise's range (USFWS 1990). The conversion of native southern pine forests to intensively managed pine forests (planted pine plantations or regenerated forests) is anticipated to continue in the future (Bailey and Smith 2007), although the rates of projected conversion vary. The future rate of conversion to pine plantations may be lower than in the past because rates of conversion seem to have declined over the past decade compared to the rates of conversion documented in the 1980s and 1990s. Additionally, there are ongoing developments with how to effectively balance planted pine plantations with a mixture of more open conditions compatible with good gopher tortoise habitat (Wigley et al. 2012).

In Florida, future urban development may result in the loss of about 700,000 acres or 20 percent of the remaining gopher tortoise habitat (not defined in publication) in Florida by 2060 (FWC 2008). Some have predicted a loss of up to 50 percent of forest lands in central Florida and up to 25 percent in north Florida and southeast Alabama (Prestemon and Abt 2002). In 10 coastal Georgia counties, the human population is expected to increase 51 percent by 2030 (Center for Quality Growth and Regional Development 2006), but no estimate of impact on native habitats was provided. Florida law provides more protection for tortoises than elsewhere in the eastern portion of the range, and there is more protected habitat in Florida than in the rest of the range combined. Florida is also the only state with a comprehensive management plan and permitting program for the species. Significant development/habitat conversion has occurred in the past which has lead to the species' imperilment, and future pressures from development are likely.

In addition to habitat loss, gopher tortoise habitat will continue to be degraded due to fragmentation, conversion to intensively managed pine forests, impacts to habitat resulting from conversion of agricultural lands, and lack, or ineffective use of prescribed fire. The spatial

and temporal scale of fragmentation from silvicultural activities will vary depending on location, size, and timing of these activities. Frequent alterations of intensely managed pine forests are unlikely to support stable tortoise populations (Diemer 1992); however, there are indications that tortoise populations can persist on sites with a history of intensive silvicultural activities (Diemer Berish et al. 2012). Gopher tortoises are known to abandon areas that had been recently converted to pine plantations (FWC 2001).Typically, gopher tortoises move from intensively managed pine forests when canopies begin to close to roadsides and then to adjacent clearcuts or other peripheral habitats, if they are available (Auffenberg and Franz 1982; Diemer 1992). These peripheral areas are often road shoulders, which may give the impression that population numbers are high, even though the adjacent pine plantation is largely unoccupied (FWC 2001).

Gopher tortoise habitat is fire-dependent, and naturally ignited fires and prescribed burning maintains an open canopy and reduces forest floor litter that combine to allow penetration of sunlight necessary for ground cover growth and gopher tortoise nest thermoregulation. In natural and planted pine stands, frequent burning is the most important management tool in sustaining gopher tortoise habitat (Landers and Buckner 1981; Breininger et al. 1994). In suitable habitats, periodic burning or shrub removal can increase gopher tortoise carrying capacity (Stewart et al. 1993). Landers (1980) found that mixed stands of longleaf pine, turkey oak, and other scrub oaks that were burned every 2 to 4 years produced the densest tortoise colonies. In south-central Florida, tortoises moved into areas that were frequently burned and abandoned areas that were unburned or burned less frequently (Ashton et al. 2008). However, recently burned potential (but unoccupied) habitat may not be colonized by tortoises if fire has been suppressed in surrounding habitat making it unsuitable for tortoises. These areas, if properly restored, could potentially be utilized as a re-stocking site if long-term management plans have been established, it is thought to historically have been occupied by tortoises, and the reason(s) why the site was originally abandoned have been addressed.

Even though management efforts may restore habitat, previous fire suppression can result in abandonment of adjacent habitat and create dispersal barriers (Ashton et al. 2008). Breininger et al. (1994) determined that burned habitats had more herbaceous ground cover and gopher tortoises than unburned oak-palmetto. Landers and Buckner (1981) determined that burned plantations and longleaf pine scrub oak ridges had nest densities four times higher than in unburned plantations and ridges. Landers and Speake (1980) recorded that herbaceous ground cover was 2.3 times higher and gopher tortoise density was 3.1 times higher in a frequently burned slash pine plantation as in an adjacent unburned natural sandhill area. We also know that not all potential habitats on public lands are currently suitable gopher tortoise habitat. Few lands have been acquired expressly for gopher tortoise conservation. Thus, tortoise habitat suitability is often a byproduct of other management treatments. Public lands, while less vulnerable to development, are still subject to economic pressures and constraints. Currently, public agency budgets are strained, and most are probably not adequate to provide for large-scale, intensive management specifically targeting gopher tortoise habitat. We know that periodic burning of gopher tortoise habitat is crucial to the conservation of the species. We also

know that pressures to control wildfires for public safety and the adverse effects of smoke make burning more and more difficult.

Loss and alteration of gopher tortoise habitat from fire exclusion or fire suppression has a significant effect on survival of the gopher tortoise (Boglioli et al. 2000). Although burning has been accepted as a management tool, increased urbanization has limited its use in many locations (Ashton and Ashton 2008). Many southeastern pine forests have dense canopies, more mid-canopy shrubs, and herbaceous ground cover decline due to fire suppression (Yager et al. 2007). Tortoise population life expectancy was shorter than normal in fire-suppressed savanna communities (Auffenberg and Iverson 1979). Population reduction was directly correlated with the degree and rate of successional habitat modification (Auffenberg and Iverson 1979). Fire exclusion may reduce tortoise numbers by 60 to 80 percent in 8 years (Diemer 1989) or 100 percent in 16 years (Auffenberg and Franz 1982). In south-central Florida, sandhill and scrubby flatwoods were abandoned by gopher tortoise after about 20 years of fire exclusion (Ashton et al. 2008).

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

The primary threat associated with this factor is the harassment and mortality of gopher tortoises associated with the unregulated harvest of rattlesnakes, specifically the eastern diamondback rattlesnake (*Crotalus adamanteus*). The technique of blowing fumes of noxious liquids (otherwise known as "gassing") down tortoise burrows in order to capture the exiting snakes undoubtedly harms or harasses the resident tortoise, and is thought to be used primarily to collect the snakes for rattlesnake "round-ups" (Means 2009). Illegal collection for human consumption is also thought to still be occurring, although this type of harvest is thought to be localized and sporadic (FWC 2012), and the magnitude of this threat is currently unknown.

Before 2012 there were only three rattlesnake round-ups remaining (events offering prizes for the largest rattlesnakes, followed by the killing of the snakes for skins and meat); however, this year the Claxton, GA round-up was converted to a wildlife festival, where snakes will no longer be harvested from the wild. This threat has abated over the past several decades but still occurs in some rural areas. However, public pressure to convert the two remaining rattlesnake round-ups (one in Alabama, the other in Georgia) to wildlife festivals, in addition to regulations prohibiting the gassing of tortoise burrows (Florida, Georgia, and Alabama) should continue to help diminish this threat to the tortoise. Florida law specifically prohibits the use of gasoline or other chemical or gaseous substances to drive wildlife from their retreats (Florida Administrative Code 68 A.4-001(2). Georgia codes § 27-1-130 and 27-3-130 prohibit gassing of burrows, but excludes protection of venomous snakes. Alabama recently adopted regulation 220-2-.11 prohibiting the use of gas, noxious chemicals or gaseous substances into wildlife burrows, dens, or retreats. We believe these regulatory measures will reduce incidental mortality of gopher tortoises during rattlesnake collections.

Factor C: Disease or predation

A number of diseases have been documented in the gopher tortoise, including fungal keratitis (Myers *et al.* 2009, p. 582), iridovirus, herpesvirus, bacterial diseases related to *Salmonella*, *Mycoplasma,* and *Dermatophilus*, and numerous internal and external parasites (Ashton and Ashton 2008). Upper Respiratory Tract Disease (URTD) resulting from *Mycoplasma* infection has received the most attention recently and has been implicated in mortality of gopher tortoises on State and Federal lands in Mississippi and Florida where URTD was documented (Berish *et al*. 2010). It is considered an infectious disease which may threaten populations of free-ranging tortoises (Seigel *et al.* 2003). However, correlations between exposure to *Mycoplasma* spp. and population declines appear to be variable among geographic locations and often transient when viewed over a 10-year timeframe (McCoy *et al.* 2007).

Currently, all tortoises in the listed range are tested for the presence of *Mycoplasma* antibodies prior to relocation. Additionally, as part of the guidelines for the establishment of conservation banks in the listed range (USFWS 2009), all resident tortoises at the bank are tested as well, and the FWS reserves the right to further evaluate and determine whether a prospective property with seropositive tortoises can accept relocated seronegative tortoises, or vice versa. However, consensus on the significance of a seropositive result is still unresolved. According to the Florida Gopher Tortoise Management Plan (FWC 2012), previous attempts to control the spread of URTD by requiring serological testing of a sample of tortoises prior to relocation were recognized as insufficient, with detrimental consequences to tortoise populations. The degree to which exposure to the pathogen correlates to clinical signs of URTD or death is still unclear, as are the degree of transfer between animals, and the potential for decreased resistance to the disease based on stresses from habitat modification or relocation. The threat of disease across the range is an ongoing challenge while we learn more about the potential pathogens in the environment and how populations respond to them.

Nest depredation by vertebrates typically has been considered substantial; from studies in southern Georgia, Landers et al. (1980) estimated about 90 percent of nests were destroyed by predators; a study in Alabama documented about 46 percent of nests (n = 11) were destroyed (Marshall 1986). Documented predators of nests, hatchlings, and juvenile gopher tortoises include raccoons (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), striped skunks (*Mephitis mephitis*), opossum (*Didelphis virginiana*), nine-banded armadillos (*Dasypus novemcinctus*), red-tailed hawks (*Buteo jamaicensis*), cottonmouths (*Agkistrodon piscivorous*), coachwhips (*Coluber flagellum*), eastern indigo snakes (*Drymarchon couperi*), and red imported fire ants (RIFA - *Solenopsis invicta;* see Epperson and Heise 2003 and references therein). Dogs and coyotes have been documented as predators of adult tortoises (Causey and Cude 1978; Hinderliter 2008). As is the case with most turtle species, predation pressures are highest for gopher tortoises in the first year post-hatching, and diminish gradually over the next several years. In a current head-starting study in the listed range (Camp Shelby, MS), documented predation by mammals was fairly constant on tortoises across all age groups (hatchling through 5-year-olds); however, 91% of the documented predation by RIFA was on hatchling tortoises

(M. Hinderliter, unpubl. data). The gopher tortoise has evolved to persist with the pressures of native predators, although the range expansions of armadillos and coyotes, combined with the introduction and invasion of other species (RIFA, constrictor snakes, and tegus) has re-defined predation as a serious threat that needs to be addressed.

Factor D: The inadequacy of existing regulatory mechanisms

Current Federal, State, and local regulations establish adequate regulatory protection of individual tortoises from take, but implementation of these regulations varies. All do not adequately protect gopher tortoise habitat in private ownership and most do not address the management needs of the tortoise. This is problematic because of the total forested landscape in the southeastern United States, about 3.4 million acres are longleaf pine forests, of which about 55% (2.0 million acres) are privately owned (America's Longleaf 2009). Within the gopher tortoise's range about 88% of the pine forests are privately owned (National Council for Air and Stream Improvement, Inc. 2010).

In the eastern portion of the tortoise's range, only Florida implements a regulatory program designed to mitigate the effects of habitat loss on non-agricultural private lands. The amount of habitat on protected lands might increase substantially if other States considered developing and implementing similar tortoise management plans, especially if those plans included best management practices within various types of tortoise habitat. While mechanisms are in place to protect individual tortoises, in terms of minimizing take, those processes ultimately resulting in the relocation of tortoises are not strict enough at the level where project alternatives are sufficiently examined. Additional conservation "weight" needs to be placed on the high quality tortoise habitats, since it is those areas that have the greatest potential for persistence of the species. Replacement of one acre of pristine sandhill habitat with one acre of sub-optimal (but "suitable") habitat as a relocation site results in a net conservation loss for the tortoise, and this needs to be addressed in any project's planning phase and state management plans.

There are several issues involving regulatory inconsistencies throughout the range, which need to be addressed to analyze which have the greatest conservation benefit on individual tortoises, their populations, and their habitat. The practice of maintaining a buffer area around known tortoise burrows while utilizing heavy machinery for habitat management is currently utilized in the listed range, but not everywhere in the candidate range. Additionally, the mechanisms of relocation/translocation of tortoise populations are not consistent throughout the states, specifically the methods of placing relocated tortoises in temporary enclosures and the use of "starter" burrows into which to release animals. In order to effectively assess the success of relocation, more consistency is needed in establishing long-term monitoring studies to investigate site fidelity, reproductive fitness, and population health post-relocation. The recipient site needs to be evaluated periodically as well to ensure that the habitat management plan is still effective, and that the site is still viable to maintain a tortoise population. It is imperative that these measures are evaluated for greatest benefit to the population and/or ecosystem, and incorporated range-wide.

Factor E: Other potential natural or manmade factors affecting its continued existence

Additional factors potentially threatening the continued existence of gopher tortoises include herbicide application, road mortality, and climate change; however, the status of these potential threats is unknown. The application of herbicide, for invasive species control, brush management, and site preparation, is an important component of habitat management, and a valuable tool for land managers. Although where herbicide is applied there is the potential for short-term loss of forage, the primary concern is that the possible effects of long-term or chronic exposure of herbicide on adults, juveniles, and eggs are unknown and need further investigation.

We know that road mortality occurs, but the extent to which it affects populations and the species as a whole is not well documented. Increases in observed road mortality, whether episodic or consistent, may be a by-product of new construction, road expansion, or relocation (legal or illegal); however, there is no information directly linking road mortality to population declines so the magnitude of this factor is not currently known. Climate change is not an imminent threat because we have not detected climate change-related impacts on gopher tortoise populations. There is the potential for a loss of coastal dune habitat from sea level rise, and a skewed sex ratio in some populations since tortoises have temperature-dependent sex determination. However, we are uncertain about the magnitude of this threat because we do not currently understand all potential impacts of climate change on the gopher tortoise or human responses to mitigate those effects.

Current Conservation Efforts

One of the major conservation steps taken thus far in the non-listed range is the Florida Gopher Tortoise Management Plan (FWC 2012), which has recently undergone a 5-year revision. The ultimate goal of this plan is to:

> "restore and maintain secure, viable populations of gopher tortoises throughout Florida so the species no longer warrants state listing. For this 10-year plan, the overarching objective of no net loss of gopher tortoises will be accomplished by meeting all of the following objectives:
>
> 1. Minimize the loss of gopher tortoises.
> 2. Increase and improve gopher tortoise habitat.
> 3. Enhance and restore gopher tortoise populations
> 4. Maintain the gopher tortoise's function as a keystone species.
>
> To achieve these objectives, a cooperative program partnering with state, local, and private entities has been established across the state" (FWC 2012).

Another tool that has been implemented to document existing population levels, management plans, and reporting/survey methods is the Candidate Conservation Agreement (CCA) for the Gopher Tortoise – Eastern Population, which was completed in 2008 and whose signatories

(Parties) represent the four States' fish and wildlife agencies, branches of the Department of Defense, U.S. Forest Service, FWS, and various NGOs. These types of agreements can be between the FWS and any other public or private entity (including another Federal agency), and are a formal partnership created to identify and share specific conservation measures. However, if the species covered in a CCA ultimately is listed under the ESA, the FWS provides no assurances or waivers regarding regulations that may be required as a result.

The goal of the Gopher Tortoise CCA is to organize a cooperative range-wide approach to tortoise conservation and management in the eastern portion of the range. The CCA uses a common conservation approach and framework and allows the Parties to leverage knowledge and funding within it. The CCA is flexible and voluntary, so that different conservation and management actions can be adopted and implemented at varying levels by the Parties. In their report there is information on: acres included by protection level; acres managed and restored; invasive exotics treated; population trends/survey results; population manipulation; research; land conservation; education and outreach; and legal protection measures (Southeast Regional Partnership for Planning and Sustainability 2010). Additionally, the report contains conservation-related research on gopher tortoises that is ongoing or recently completed by the Parties: 1) rare plant & animal inventories/surveys; 2) disease prevalence and impacts; 3) population responses to management actions; 4) effectiveness of re-stocking tortoises; 5) habitat assessments; and 6) population dynamics assessments. Within the CCA it states, "It is the intent and expectation of the Parties that the execution and implementation of this Agreement will lead to the conservation of the gopher tortoise in its natural eastern range…It is also the expectation of the Parties that the conservation and management commitments made in this document will be considered in the event of a listing under the ESA".

The CCA is a valuable tool connecting federal, state, and other entities, although additional data collection on existing populations, habitat, and effective management are still needed to demonstrate success. It should continue to be utilized as a working document, and should include more information on habitat management and population goals and how to reach those goals. In terms of research needs, any studies which actively focus on the major threats to the species need to be supported. Specific areas for research are population responses to habitat management, status and surveys of populations on private lands, habitat modeling to identify previously-unknown tortoise habitat, and long-term effects of current habitat management or population manipulations.

There are many other collaborative efforts and agency/NGO-led actions currently ongoing which are either targeting species-specific conservation for the gopher tortoise (e.g. NRCS Working Lands for Wildlife) or ecosystem based conservation programs (e.g. America's Longleaf Restoration Initiative) which could benefit the tortoise. There are also many programs in place that are contributing to on-the-ground gopher tortoise conservation on private lands, illustrating the power and potential of public/private partnerships (e.g. Wildlife Habitat Incentive Program, Environmental Quality Incentives Program). Additionally, military installations across the southeast complement the state and Federal laws by maintaining

regulations on training restrictions in areas where rare species are found, as part of their Integrated Natural Resource Management Plans. These organizations and initiatives are important in addressing the preservation and management needs across state lines and land ownership categories, specifically when they offer landowner incentives and cost-share programs.

Other tools for conservation include Safe Harbor Agreements (SHA) in the listed western range, and Candidate Conservation Agreement with Assurances (CCAA) in the candidate eastern range. An SHA is a voluntary agreement involving private or other non-Federal property owners whose actions contribute to the recovery of species listed as threatened or endangered under the ESA. In exchange for actions that contribute to the recovery of listed species on non-Federal lands, participating property owners receive formal assurances from the Service that if they fulfill the conditions of the SHA, the Service will not require any additional or different management activities by the participants without their consent. In addition, at the end of the agreement period, participants may return the enrolled property to the baseline conditions that existed at the beginning of the SHA. There is currently one active SHA in Mississippi for gopher tortoises. The CCAA is similar to a CCA, but they also provide incentives, in the form of a permit, to non-Federal property owners who engage in voluntary conservation activities for a particular species. If the species has to be listed under the ESA, participants are assured of regulatory certainty and receive what is called an Enhancement of Survival Permit to cover their ongoing land and/or water use. That means no additional conservation actions would be required of the non-Federal participant beyond what was agreed upon in the CCAA, and the Service would not impose additional limitations on the land, water or resource.

Current Conservation Needs

There is a strong conservation community already established for the gopher tortoise throughout its range; one with innovative research studies, creative management plans, and a vast library of ecological, biological, and ethological data dating back several decades. The threats to continued survival, habitat management tools, and habitat needs have been well documented, and must be coalesced into a singular conservation plan. A top priority is that wherever possible, prescribed fire must be returned to the landscape where it has been excluded, and given the proper burn interval, severity, and seasonality that most closely reflects ancestral conditions of the longleaf pine ecosystem. Proper site-specific planning with professionals is crucial to determine at what point fire can safely be returned to an overgrown landscape, and at what point the fire return interval switches from a restoration phase to a management phase. The issues of smoke management, liability, and resource limitations have been obstacles in recent fire programs at a time when these programs should be more aggressive. Additionally, although invasive, nuisance, and exotic species control programs have been integral parts of management plans for years, they must continue to be given high priority since we have yet to realize the long-term effects these species (plant and animal) are having on tortoise populations.

We must take full advantage of the local knowledge in each state (through partnerships with federal, state, NGO, & local sources) to identify the best remaining tortoise habitat and establish protection of those lands in perpetuity. Since many recent surveys comparing long-term tortoise burrow activity data reveal moderate to drastic population declines (McCoy et al. 2006; Conservation Southeast, Inc. 2009), we can no longer assume that our actions are not impacting the future persistence of the species. Funding sources must remain available to the research community and to land managers, specifically where potential priority areas are in drastic need of restoration, and where tortoise population responses to management actions are studied and can be expanded across a broader landscape.

CONSERVATION OBJECTIVES AND ACTION PLANS

For this section, action items described under Objective 1 address some over-arching needs concerning how we define, enhance, and survey gopher tortoise populations; they do not specifically relate to any one of the 5 threats to the species described previously. The remaining 5 objectives (Objectives 2 – 6) are organized to correlate directly to Factors A – E, respectively (Objective 2 directly relates to Factor A, the present or threatened destruction, modification, or curtailment of its habitat or range, for example).

Objective 1: Determine population viability parameters

1) Establish consensus within the research community on what defines a viable gopher tortoise population across various states/habitats (e.g., age structure, number of individuals, acreage, recruitment rate, spatial distribution, etc.);

2) Establish consensus on the necessary number and distribution of viable gopher tortoise populations in suitable habitat such that the species in the eastern portion of its range would be considered secure, and in the western range would be considered recovered;

3) Investigate the potential use of captive-reared or head-started gopher tortoises to augment a population or re-populate a previously occupied area to increase viability of the general population;

4) Integrate the use of Line Transect Distance Sampling (LTDS) as a surveying/monitoring protocol (where applicable) into State, Federal, and local policy as the approved method to accurately assess gopher tortoise population levels, trends, and responses to management; determine appropriate time frames for surveying, and acceptable alternative survey protocols in small parcels and in scrub or flatwoods communities;

5) Investigate using Section 6 funding to conduct surveys and censuses of large, suitable public parcels that contain a substantial amount of potential gopher tortoise habitat, to estimate the number of tortoises present and evaluate those sites for potential tortoise population enhancement or re-establishment. Provide information and incentives to

private landowners to manage their land for tortoises, possibly working with partners to offer higher cost-sharing for more aggressive habitat management

Objective 2: Address the present and threatened destruction, modification, or curtailment of gopher tortoise habitat

1) Identify, prioritize, protect, and manage viable tortoise populations and best remaining tortoise habitat;

2) Increase the size and/or carrying capacity of those viable population areas (and areas with tortoise populations just below the "viable" threshold) through applied land management, land acquisition, or incentives to adjacent landowners to properly manage for tortoises; in order to allow for the potential expansion of those populations;

3) Working with partners/land managers, maximize the amount of acreage appropriately maintained by prescribed fire, with specific emphasis on developing implementation plans with recommendations for fire intensity, frequency, seasonality, and post-fire analyses. Part of this effort should be educational outreach with the public, emphasizing the benefits of prescribed fire for both habitat management and for decreasing the chances of catastrophic wildfire;

4) Create a draft document detailing Best Management Practices (BMPs) and Desired Future Conditions (DFCs) for various gopher tortoise habitat types (longleaf pine forests, sandhills, scrub, etc.) for range-wide distribution; encourage participation from the silvicultural industry and private lands foresters in the development of these recommendations. Also must include input from migratory birds and rare species biologists to ensure compatibility;

5) Evaluate whether each state in the candidate range for the tortoise should have a state Management/Conservation Plan;

6) Encourage the development and implementation of a model CCAA/HCP (preferably one that is state-wide and programmatic) that details effective, measurable conservation objectives and habitat management goals;

7) Locate areas of "secondary priority" where re-stocking and restoration can most effectively be accomplished by creating large, contiguous tracts or habitat corridors that may or may not be occupied by tortoises, specifically those directly adjacent to current managed lands.

Objective 3: Address issues related to overutilization for commercial, recreational, scientific, or educational purposes

1) Work with partners to convert the two remaining rattlesnake round-ups to wildlife festivals;

2) Work with Georgia state legislature to change the law that currently exempts venomous snakes from gassing;

Objective 4: Investigate and mitigate disease and predation effects

1) Working with a gopher tortoise health/disease working group, investigate: 1) if and when disease testing should be performed on gopher tortoises, and for what diseases; 2) the significance and ramifications of a positive result (i.e. presence of *Mycoplasma* antibodies); 3) what to do with suspect and positive tortoises; and 4) the degree to which disease can be linked to die-offs in tortoise populations (temporal and spatial scales);

2) Identify the predators having the largest impact on gopher tortoise populations, with special emphasis on documenting unnaturally high rates from nuisance, invasive, and introduced predators (e.g. red imported fire ants, coyotes, armadillos, feral hogs); this should include documenting predation on various tortoise age classes, and recommendations for predator control.

3) Work with local and state law enforcement to investigate the magnitude of illegal tortoise harvest for human consumption, evaluating current regulations and creating culturally-based outreach to educate the public on laws protecting gopher tortoises.

Objective 5: Investigate range-wide effective regulatory mechanisms

1) Adopt mitigation strategies across the range that address the ongoing need for relocation of tortoises, but do it in a way as to minimize loss of preferred habitat (sandy soils, open forest structure, herbaceous groundcover), maximize site fidelity, and provide protection of relocated tortoises and the recipient site;

2) Complete a study investigating gopher tortoise burrow collapse, specifically to determine the minimum distance from the entrance where the burrow integrity is still maintained when run over by heavy equipment (in different representative soil types). This value can then be used as a burrow buffer recommendation range-wide for conservation measures during habitat management practices;

3) Develop state regulatory processes to minimize and mitigate loss/degradation of tortoise habitat resulting from agricultural land conversion.

Objective 6: Investigate other natural or man-made factors affecting its continued existence

1) Initiate a risk assessment of the use of herbicides in gopher tortoise habitat, specifically where broad-spectrum herbicides are utilized as a common management tool, not for treating invasive species. The study should evaluate the potential short-term and long-term impacts on forage availability, and tortoise health and reproduction;

2) Create a database for documenting tortoise road mortality events, in order to document potential responses to road expansion, construction projects, etc. This data could then be used to identify areas with the high incidences of vehicle collisions, as well as potentially assist with project planning of road construction (e.g. minimizing curbs, utilizing excluder fences).

The majority of these objectives address, either directly or indirectly, the primary threat to the gopher tortoise, which is the destruction, modification, or curtailment of its habitat. Other major threats such as disease and predation will ultimately be addressed in the process of meeting these objectives as well. These objectives and action items, along with coordinating Federal and State partners assigned to take the lead in addressing them, have been categorized by the five-factor threat analysis and included in this document (Appendix 1).

This species will always require protection and management specific to its needs; however, successful conservation of the longleaf pine ecosystem and other suitable habitats will undoubtedly benefit tortoise populations, as it will for other native rare species such as the red-cockaded woodpecker and eastern indigo snake. Although these objectives put emphasis on the larger occupied tracts of high-quality habitat, the smaller isolated populations may play a pivotal role in the persistence of the species, and should be protected when possible. It is possible that in the future the conservation of the species will be placed solely on protecting sizable “refuges” of tortoises on large tracts of land; however, losing the smaller, isolated groups of tortoises may ultimately be detrimental to the species if, for instance, reduced genetic diversity causes tortoises to be more susceptible to disease outbreak.

One unifying action needed to reach many of these conservation objectives is to work with partners to participate in the development and implementation of conservation programs, and to take full advantage of private lands management-based initiatives that become available, maximizing their scope. By reaching out to private landowners with existing or potential tortoise habitat, we need to demonstrate that they can either create a matrix of habitats across their lands or perform management that benefits the tortoise while still maintaining economically viable use of their lands for silvicultural, recreational, or agricultural use.

Habitat protection has been and continues to be an important conservation strategy for this species. Many of the larger known populations of gopher tortoises occurring on state conservation lands, National Forests, and military installations are managed under site-specific

management plans. However, we believe that there may be many other large parcels of high-quality tortoise habitat under private ownership that have not been identified and opportunities to engage these private landowners regarding gopher tortoise conservation needs have not taken place to date. Past protection efforts have focused on securing high quality natural communities because of the values these habitats provide to tortoises, burrow commensals, and other wildlife species. However, most protected habitat contains a matrix of varying quality tortoise habitat. Management of quality native habitats through acquisition or conservation easements will continue to be priorities, but it may also be desirable to protect disturbed or altered habitats when they augment existing adjacent gopher tortoise habitat or otherwise contribute towards recovery of the tortoise.

CITATION

U.S. Fish and Wildlife Service (USFWS). 2012. Range-Wide Conservation Strategy for the Gopher Tortoise. Jackson, MS. 32 pp.

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APPENDIX 1.

Sample Matrix Addressing the Action Items Presented in the Range-Wide Gopher Tortoise Conservation Strategy

GOPHER TORTOISE STRATEGY ACTION ITEMS							
Listing factor	**Primary threats to the species**	**Actions needed to address the specific threat**	**Policy/regulatory partners**	**Implementation partners**	**Lead (FWS)**	**Lead (State)**	**Due date**
THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF ITS HABITAT OR RANGE (FACTOR A)					**M. Hinderliter (MS)**		
	No defined description of a viable tortoise population	Determine a target population size, demography, critical area, number, and locations of viable tortoise populations throughout the range.	State Wildlife Agencies	Gopher Tortoise Council, PARC, SERRPAS, LCC			
	Need data on viable population identification and management	Prioritize viable population areas and best remaining tortoise habitat; increase size through land management					
	Fire suppression	Work with land manager partners to develop a prescribed fire implementation plan, and develop a system for compiling data on prescribed burning	EPA, State Forestry Commissions	Fire teams (TNC, USFS, DoD)			
	Silvicultural & agricultural compatability	Develop Best Management Practices for forestry management to include tortoise conservation; and Desired Future Conditions, for all potential tortoise habitat types, utilizing experience of silvicultural industry and private lands foresters	Farm Bureau, State Dept. of Agriculture	NRCS, Forestry Commissions			

Listing factor	Primary threats to the species	Actions needed to address the specific threat	Policy/regulatory partners	Implementation partners	Lead (FWS)	Lead (State)	Due date
THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF ITS HABITAT OR RANGE (FACTOR A)					**M. Hinderliter (MS)**		
	Urbanization	Work with local development planning authorities to include gopher tortoise conservation; education on management, disease, prescribed fire	All states				
	Lack of consistent survey (population) data range-wide	Integrate LTDS as approved surveying protocol; establish other methods where LTDS not applicable. Establish baseline population estimates, monitoring population trends, and population response to habitat management	State Wildlife Agencies	Jones Center, State wildlife agencies, CCA signatories			

Listing factor	Primary threats to the species	Actions needed to address the specific threat	Policy/regulatory partners	Implementation partners	Lead (FWS)	Lead (State)	Due date
OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATION PURPOSES (FACTOR B)					**J. Doresky (GA)**	**J. Jensen (GA)**	
	Indirect mortality/harassment associated with rattlesnake roundups	Work with partners to convert the 2 remaining rattlesnake roundups to wildlife festivals; work with State legislature to change the law that exempts venomous snakes from gassing	States (GA & AL) DNR	Orianne Society, Local chambers of commerce, "converted" roundups	J. Doresky (GA)	J. Jensen (GA)	
DISEASE OR PREDATION (FACTOR C)					**M. Hinderliter (MS)**		
	Illegal harvest of tortoises for human consumption	Working with State and local law enforcement, evaluate current regulations; and develop outreach tools to educate the public on laws concerning tortoise protection					
	Disease impacts on populations	Investigate when to test tortoises, for which diseases, what to do with positive animals, how much outbreaks correlate to die-offs	NIH,	SCWDS, UF Vet Med, GTC, Jones Ctr.			
	Predation of eggs, hatchlings, juvenile, and adult tortoises	Research to determine impact to populations; investigation into magnitude of predation from nuisance, exotic, and invasive predators (including proposed predator control)	State Wildlife officials	GTC, DoD, Nokuse, MDWFP grant	M. Hinderliter (MS)		

Listing factor	Primary threats to the species	Actions needed to address the specific threat	Policy/regulatory partners	Implementation partners	Lead (FWS)	Lead (State)	Due date
THE INADEQUACY OF EXISTING REGULATORY MECHANISMS (FACTOR D)					**D. Imm (FL)**		
	Perpetual protection of relocated tortoises	Develop best model for effective relocation (methods minimizing disease transmission & maximizing site fidelity); utilize same language in all mgmt. plans, conference reports, biological opinions					
	Need for additional agreements/plans	Investigate whether each state should have a Management Plan; encourage the development of a programmatic CCAA					
	Degradation of tortoise habitat from agricultural land conversion	Work with State Agencies to promulgate policy and/or regulations regarding ag land conversion					
	Burrows/tortoises/eggs impacted during habitat management activities	After completion of burrow collapse study, ensure consistent language in land management plans, specifically heavy equipment use	DoD, USFS, FWS (Refuges)	DoD, USFS, FWS (Refuges), NRCS			
OTHER NATURAL OR MANMADE FACTORS AFFECTING ITS CONTINUED EXISTENCE (FACTOR E)					**B. Porter (AL)**		
	Short- and long-term exposure to herbicides	Risk assessment of effects of herbicide on tortoise populations	State Agencies	Land managers			
	Road mortality	Assess impact in high traffic areas, possible use of barriers to limit mortality		State DOTs, County roads managers, PARC			

Appendix 2.

Gopher Tortoise Species Description

Life History

The gopher tortoise is the only tortoise (family Testudinidae) east of the Mississippi River; one of five species in the genus *Gopherus* in North America. It has a domed, brown to grayish-black carapace typically ~ 10-14 inches long, and typically weighs ~ 9-13 lbs. The plastron is yellowish and hingeless. A fossorial species, its hind feet are elephantine or stumpy, and the forelimbs are shovel-like, with claws used for digging. In comparison to females, males are smaller; usually have a larger gland under the chin, a longer gular projection, and more concave plastron. Hatchlings are ~ 2 inches in length, with a softer, yellow-orange shell (Ernst and Lovich 2009).

The burrows of a gopher tortoise are the habitat and center of normal feeding, breeding, and sheltering activity. Gopher tortoises can excavate many burrows over their lifetime, and typically use several each year. Burrows may extend up to 67 feet (Ashton and Ashton 2008), can be up to 10-12 feet deep, and provide shelter from predators, winter cold and summer heat. Tortoises spend most of their time within burrows and emerge during the day to bask in sunlight, to feed, and reproduce. Tortoises typically breed from March through October (Landers et al. 1980; McRae et al. 1981; Wright 1982; USFWS 1987; Diemer 1992; Eubanks et al. 2003), but females do not reproduce every year (estimated at 80-85%; Smith et al. 1997). Females excavate a shallow nest to lay and bury eggs, typically between early May and late June, and usually in the apron of soil at the mouth of the burrow. Range-wide, average clutch size varies from about four to 10 eggs/clutch, and incubation lasts 85-100 days.

Home range size and movements increase with age and body size, and home range area tends to vary with habitat quality, becoming larger in areas of poor habitat (Auffenberg and Iverson 1979). Males typically have larger home ranges than females. Mean home ranges of individual tortoises in Alabama, Florida, and Georgia outside the federally listed area have varied from 1.3 - 5.2 acres (3.2 - 2.2 ha) for males and 0.2 - 2.5 acres (0.09 - 1.0 ha) for females (McRae et al. 1981; Auffenberg and Franz 1982; Diemer 1992; Tuma 1996; Eubanks et al. 2003; Guyer 2003).

Some of the challenges for the conservation of this species lie in its life history traits; specifically the late age of reproductive maturity (estimated to be between 12-20 years), low reproductive output, and long lifespan (generally estimated at 50-80 years). Growth rates and sizes at sexual maturity can also vary among populations and habitat types (Landers et al. 1982; Mushinsky et al. 1994; Aresco and Guyer 1998, 1999a). Because of these traits it is difficult to ascertain the short-term success of management efforts, especially in terms of whether the reproductive viability of a population has been enhanced. An effective monitoring effort must be a multi-year project to truly measure the results of any actions. A major obstacle is the perception that a population may appear to be stable because the number of burrows in an area remains

unchanged for years, when in fact this could simply reflect a handful of aging animals in a declining population.

Current Range/Distribution

The gopher tortoise occurs in the southeastern Atlantic Coastal Plain from southern South Carolina west through Georgia, Alabama, and Mississippi to eastern Louisiana, and south through peninsular Florida. The eastern portion of the gopher tortoise's range includes Alabama (east of the Tombigbee and Mobile Rivers), Florida, Georgia, and South Carolina (Figure 1). The core of the current distribution of the gopher tortoise in the eastern portion of its range includes central and north Florida and southern Georgia. Long-term monitoring data indicate that many populations have declined and most are relatively small and fragmented. Smaller-scale, short-term or one-time surveys throughout the range indicate that tortoise populations typically occur in fragmented and degraded habitat, are small, and densities of individuals are low within populations. However, unlike the western portion of the range, there are several known populations of tortoises in the eastern portion of the range that appear to be sufficiently large to persist long-term (Service 2011).

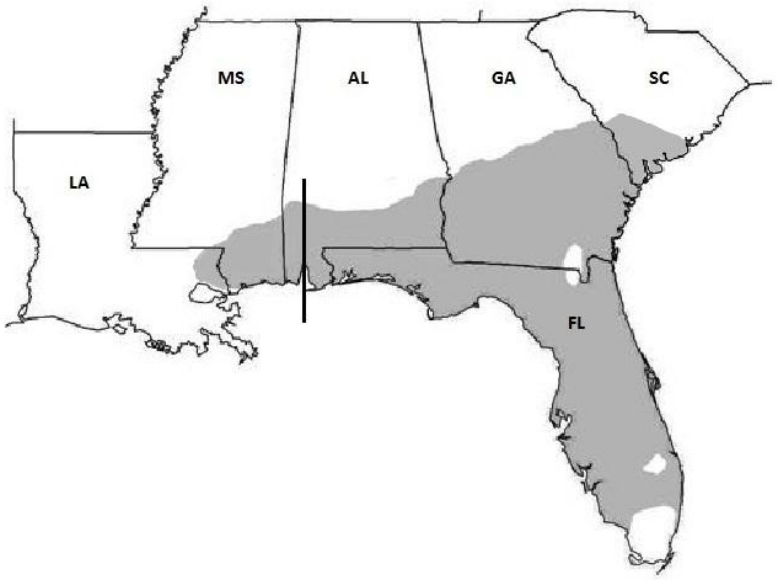

Figure 1. Distribution of the gopher tortoise (FWC 2012). The vertical line in western Alabama shows the approximate boundary between the western (federally listed) population and eastern (candidate) population.

Habitat Description

Gopher tortoises require relatively well-drained, sandy soils for burrowing and nest construction, an abundance of herbaceous ground cover for food, and a generally open canopy that allows sunlight to reach the forest floor (Landers 1980; Auffenberg and Franz 1982). Longleaf pine and oak uplands, xeric hammock, xeric Florida scrub, maritime scrub, and ruderal

(disturbed) habitat most often provide the conditions necessary to support gopher tortoises (Auffenberg and Franz 1982). Ruderal (i.e., disturbed or atypical) habitats include roadsides and utility rights-of-way, grove/forest edges, fencerows, and clearing edges. In the western range, soils contain more silt, and xeric (dry) conditions are less common west of the Florida panhandle (Craul et al. 2005). Ground cover in this Coastal Plains area can be separated into two general regions with the division in the central part of southern Alabama and northwest Florida. To the west, bluestem (*Andropogon* spp.) and panicum (*Panicum* spp.) grasses predominate; to the east, wiregrass (*Aristida stricta*) is most common (Boyer 1990). However, gopher tortoises do not necessarily respond to specific plants but rather the physical characteristics of habitat (Diemer 1986). Historic gopher tortoise habitats were open pine forests, savannahs, and xeric grasslands that covered the coastal plain from Mexico and Texas to Florida. Historic habitats might have had wetter soils at times and been somewhat cooler but were generally xeric, open, and diverse (Ashton and Ashton 2008).

Gopher tortoises have a well-defined activity range where all feeding and reproduction take place and that is limited by the amount of herbaceous ground cover (Auffenberg and Iverson 1979). Tortoises are herbivores, eating mainly grasses, plants, fallen flowers, fruits, and leaves. Gopher tortoises prefer grassy, open-canopy microhabitats (Boglioli et al. 2000), and their population density directly relates to the density of herbaceous biomass (Auffenberg and Iverson 1979; Landers and Speake 1980; Wright 1982; Stewart et al. 1993) and a lack of canopy (Breininger et al. 1994; Boglioli et al. 2000). Grasses and grass-like plants are important in gopher tortoise diets (Auffenberg and Iverson 1979; Landers 1980; Garner and Landers 1981; Wright 1982; Macdonald and Mushinsky 1988; Mushinsky et al. 2006; Birkhead et al. 2005). A lack of vegetative diversity may negatively impact the long-term sustainability of gopher tortoise populations (Ashton and Ashton 2008).

Gopher tortoises require a sparse canopy and open understory not only for feeding, but also for nesting (Landers and Speake 1980). In Florida, McCoy and Mushinsky (1995) found that the number of active burrows per tortoise was lower where canopy cover was high. Females require almost full sunlight for nesting (Landers and Buckner 1981) because eggs are often laid in the burrow apron or other sunny spot and require the warmth of the sun for appropriate incubation (Landers and Speake 1980). At one site in southwest Georgia, Boglioli (et al. 2000) found most tortoises in areas with 30 percent or less canopy cover. Diemer (1992) found that ecotones created by clearing were also favored by tortoises in north Florida. When canopies become too dense, usually due to fire suppression, tortoises tend to move into ruderal habitats such as roadsides with more herbaceous ground cover, lower tree cover, and significant sun exposure (Garner and Landers 1981; McCoy et al. 1993; Baskaran et al. 2006). In Georgia, Hermann et al. (2002) found that open pine areas (e.g., pine forests with canopies that allow light to penetrate to the forest floor) were more likely to have burrows, support higher burrow densities, and have more burrows used by large, adult tortoises than closed-canopy forests. Historically, open-canopied pine forests were maintained by frequent, lightning-generated fires.