

Originally listed as:
Mississippi Gopher Frog
(Rana capito sevosa)

Formally now recognized by the USFWS (2012) as:
Dusky Gopher Frog
(Rana sevosa)

**5-Year Review:
Summary and Evaluation**



(Photograph by John Tupy, Western Carolina University, used with permission)

**U.S. Fish and Wildlife Service
Southeast Region
Mississippi Ecological Services Field Office
Jackson, Mississippi**

5-YEAR REVIEW

Dusky gopher frog (*Rana sevosa*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and current distributions, life history, threats to, and habitats of this species. Our sources included the final rule listing this species under the Endangered Species Act (Act); peer reviewed scientific publications; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period on July 6, 2009 (74 FR 31972). The completed draft review was sent to affected Service Field Offices and peer reviewers for their review. Comments were evaluated and incorporated where appropriate into this final document (see Appendix A). We received one public comment during the open comment period. No part of this review was contracted to an outside party. This review was completed by the Service's lead Recovery biologist in the Mississippi Ecological Services Field Office, Jackson, Mississippi.

B. Reviewers

Lead Region – Southeast Region: Kelly Bibb, 404-679-7132

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C. Background

- 1. Federal Register Notice citation announcing initiation of this review:** July 6, 2009 (74 FR 31972)
- 2. Species status:** Improving - overall (2015)
Between the 2000/2001 breeding season and the current 2014/2015 breeding season, drought conditions have impacted the population. Rainfall has been insufficient to fill ponds and induce breeding in 2 years, and insufficient to maintain water in the ponds until metamorphosis was possible in 6 additional years. During the 2002/2003 breeding season a disease caused mass mortality of tadpoles in the main breeding pond (Glen's Pond); only 3 metamorphic frogs were recorded exiting the pond. However, subsequent to the disease

outbreak, natural recruitment of greater than 50 frogs has been observed during 6 of the 15 (40 percent) years when breeding occurred (2007/2008, 2009/2010, 2011/2012, 2012/2013, 2013/2014, and 2014/2015). When the dusky gopher frog was listed as an endangered species in 2001, only one breeding pond (Glen's Pond) was known. Naturally-occurring dusky gopher frogs have now been documented at three additional ponds: Pony Ranch Pond, Mike's Pond, and McCoy's Pond. An additional pond, TNC Pond 1, has been established as a breeding site through the translocation of Glen's Pond frogs. Nevertheless, the Glen's Pond population, supported by the Glen's Pond and Pony Ranch Pond breeding sites, is the only population that is considered stable at this time. Unfortunately, the disease that caused the mass die-off in 2003 is still being observed in the population, most recently at Pony Ranch Pond. We continue to improve upland and breeding habitat within the range of the species. Twelve additional ponds on the DeSoto National Forest (DNF), Ward Bayou Wildlife Management Area (WBWMA) (owned by the U.S. Army Corps of Engineers (COE)), and a site owned by The Nature Conservancy (TNC), and a pond on the Mississippi Sandhill Crane National Wildlife Refuge (MSCNWR) have been altered to create potential relocation sites. Two other ponds have been created; one on DNF and one on WBWMA. Although currently the status of the species can be considered to be improving due to four consecutive years of increasing recruitment, the future of the dusky gopher frog remains uncertain. When rainfall variability is combined with other threats such as disease, population isolation, small population size, low genetic variability, and low reproductive potential, it is clear that the dusky gopher frog remains critically endangered.

- 3. Recovery achieved:** (1 = 0-25% recovery objectives achieved)
Recovery achieved is based on lack of permanent protection of populations from present and foreseeable threats and the low number of extant populations.

4. Listing history

Original Listing

FR notice: 66 FR 62993

Date listed: December 4, 2001

Entity listed: DPS

Classification: Endangered

Critical Habitat

FR notice: 77 FR 35118

Date: June 12, 2012

- 5. Associated rulemakings:** n/a

- 6. Review History:**
Recovery Data Call: 2014, 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, and 2002.
Recovery Plan: A final recovery plan was signed July 23, 2015, and a Notice of Availability will publish in the *Federal Register* on September 9, 2015.
- 7. Species' Recovery Priority Number at start of review (48 FR 43098): 5**
Degree of Threat: High
Recovery Potential: Low
Taxonomy: Species
- 8. Recovery Plan:** A final recovery plan was signed July 23, 2015, and a Notice of Availability will publish on September 9, 2015.

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

- 1. Is the species under review listed as a DPS?** When the dusky gopher frog was originally listed in 2001 (66 FR 62993), it was listed as a DPS. In our final rule designating critical habitat (77 FR 35118), we described taxonomic changes that warrant the dusky gopher frog's acceptance as a full species. Therefore, at that time we concluded that listing as a DPS is no longer appropriate.
- 2. Is there relevant new information that would lead you to re-consider the classification of this species with regard to designation of DPSs?** No

B. Recovery Criteria

- 1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes. The dusky gopher frog has an approved recovery plan with objective measurable criteria.
- 2. Adequacy of recovery criteria.**
 - a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?** Yes.
 - b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?** Yes.
- 3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.**

The stated Recovery Objective is to prevent the extinction of the dusky gopher frog. The long-term recovery objective is to downlist the dusky gopher frog from endangered to threatened. Delisting is not currently foreseeable due to the extreme curtailment of range; current low number of individuals and populations; and magnitude of threats. This species can be considered for reclassifying to threatened when:

a. Six viable metapopulations* are documented within blocks of recovery focus areas and are widely distributed across the range of the species. The six metapopulations would include a minimum of 12 breeding ponds and would be distributed as follows within the species historic range:

- **One metapopulation in Block #1 (Louisiana. Portions of St. Tammany, Tangipahoa, and Washington Parishes, west to the Tangipahoa River);**
- **Two metapopulations each in Block #2 (South-Central Mississippi. North of State Hwy. 26, between the Pearl and Pascagoula Rivers; Forrest County and portions of George, Greene, Jones, Lamar, Marion, Pearl River, Perry, Stone, and Wayne Counties) and Block #3 (South Mississippi. South of Hwy. 26, between the Pearl and Pascagoula Rivers; Hancock and Harrison Counties, and portions of Jackson, George, Pearl River, and Stone Counties); and**
- **One metapopulation in either Block #4 (Eastern Mississippi. East of Pascagoula/Leaf Rivers; portions of George, Greene, Jackson, Perry, and Wayne Counties) or Block #5 (Alabama. West of the Mobile River Delta; Mobile and Washington Counties, and a small portion of Choctaw County).**

*** A viable population is one that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat and environmental changes, and exhibits parameters consistent with a stable or increasing reproductive rate, without the addition of frogs raised in artificial environments or introduced from other populations. Viable populations generally consist of multiple age classes of individuals, including newly recruited juveniles. In addition, a dusky gopher frog population should be supported by habitat containing breeding ponds and their surrounding uplands. To be a viable population, a dusky gopher frog population must be a metapopulation. Two or more breeding ponds within dispersal distance of one another function as a metapopulation; if breeding conditions for the species are not met by certain ponds in one or more years, the species may persist by breeding at other nearby ponds. For the purposes of this recovery plan, a dusky gopher frog metapopulation will be defined as two or more occupied breeding ponds, individually separated from each other by a mile (1.6 kilometer) or less, within a contiguous area of suitable habitat with no**

major barriers to dispersal (e.g., major highways, rivers, developed areas, etc.) between ponds.

This criterion has not been met. Recovery efforts have focused on the South Mississippi, Block #3 where the primary breeding pond (Glen's Pond) for the dusky gopher frog occurs on the DNF. An additional breeding pond (Pony Ranch Pond) has been documented within the dispersal range of Glen's Pond; therefore, the first metapopulation for the species has been established in Block #3. In addition, small cohorts of head-started tadpoles have been released at New Pond (a pond created on DNF) over three years; if breeding frogs become established there, it would provide a third breeding pond within the Glen's Pond metapopulation. The Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) has coordinated with the U.S. Fish and Wildlife Service (USFWS) and TNC to successfully establish a breeding site on TNC's Old Fort Bayou Mitigation Bank (OFBMB). We have completed the first year of a translocation onto the MSCNWR which represents the initial effort to establish a dusky gopher frog breeding pond on the refuge. An active breeding pond on OFBMB and MSCNWR would represent a second metapopulation in Block #3. Over the last several years, habitat assessments have been conducted in Alabama to identify potential translocation sites and areas to be further examined in our search for new populations. These assessments contribute to efforts to ultimately establish a metapopulation in Alabama, Block #5. In addition, our partners within the Association of Zoos and Aquariums, led by the Memphis Zoo, have developed a successful technique to breed dusky gopher frogs through in vitro fertilization. Their success has provided another source of frogs for future translocations.

- b. Long-term monitoring (at least 10 years) of each metapopulation documents population viability. The 10-year timeframe will allow monitoring recruitment events and other population attributes in a species that has been characterized by highly variable reproductive and survival rates. In each of at least two annual breeding events within a three-year period, a total of 30 egg masses per metapopulation must be documented and natural recruitment must be verified.**

This criterion has not been met. In Block #3, monitoring at Glen's Pond has occurred for 10+ years; over the last three years, there have been greater than 30 egg masses laid within this metapopulation. Breeding has been very low (five or less egg masses laid) at all other breeding sites.

- c. Breeding and adjacent upland habitats within the six metapopulations are protected long-term through management agreements, public ownership, or other means, in sufficient quantity and quality to support growing populations.**

This criterion has not been met. The Glen's Pond metapopulation (Block #3) occurs on DNF. Biologists on DNF work in close partnership with USFWS to ensure the protection of this dusky gopher frog habitat, as well as habitat for future translocations in South-Central Mississippi, Block #2. The wetlands and uplands on the OFBMB, as well as dusky gopher frog habitat surrounding the Mike's Pond breeding pond, are being restored and will be protected in perpetuity by TNC. OFBMB and the adjacent MSCNWR habitat protected and managed by USFWS represent a potential second metapopulation in Block #3. The WBWMA, owned by COE and managed in conjunction with MDWFP, is also being restored and will be protected in perpetuity. This property contains two ponds which have been selected as future translocation sites (Block #3). Efforts to identify and protect breeding and adjacent upland habitats in Louisiana, Block #1; Eastern Mississippi, Block #4; and Alabama, Block #5 are on-going.

d. Studies of the dusky gopher frog's biological and ecological requirements have been completed and measures necessary for recovery discovered during these studies are being implemented and are showing progress.

This criterion has not been met. Studies of the dusky gopher frog's biological and ecological requirements are on-going. Implementation of some measures discovered during these studies has shown progress. For example, studies of the use of cattle watering tanks to artificially raise tadpoles to metamorphosis have been essential to the survival of the species and have provided a source of froglets to be used in efforts to establish new populations. Current studies to determine whether particular tadpole developmental stages, or metamorphic frogs, provide the best source of frogs for future population establishment will provide important information as we increase the number of translocation sites.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends, demographic features, or demographic trends:

Allen (1932) found gopher frogs to be common in the coastal counties of Mississippi early in the 20th century; however, between this time and the early 1980s, very little information is available on the status of the species. In 1987 and 1988, Crawford (1988) surveyed 42 ponds in six Mississippi counties for the dusky gopher frog. During his attempts to relocate all of the State's historical localities for the gopher frog, he found that habitat in the vicinity of most localities had been altered by conversion of natural forest to agriculture, pine plantations, and urban areas. In addition, the character of remaining

historical breeding ponds had been changed from open-canopy, temporary ponds with clear water and hard bottoms to muddy, more permanent closed canopy ponds (G. Johnson, U.S. Forest Service, pers. comm. 1999). No appropriate habitat for the dusky gopher frog could be found near any of the historical localities (G. Johnson, pers. comm. 1999). Nevertheless, during his study Crawford discovered a new breeding pond on the DNF, Harrison County, Mississippi. In the period between this discovery in 1988 and 2004, this site, named Glen's Pond, supported the only known population of dusky gopher frogs. Glen's Pond has been monitored continuously since its discovery.

Annual recruitment of dusky gopher frogs is limited by rainfall that is inadequate to completely fill ponds or to maintain them long enough for tadpoles to metamorphose. Since 1996, natural recruitment at Glen's Pond occurred in 1997, 1998, 2003 (only three metamorphs), 2008, 2010, and 2012 through 2015. Human intervention was necessary for significant recruitment to occur during the 9-year period between 1998 and 2007, and has also been used to supplement natural recruitment at Glen's Pond in other years (Sisson 2003, 2005; Pechmann *et al.* 2012; Pechmann and Tupy 2013, 2014, 2015). In 2001 and 2005, water from an onsite well was added to Glen's Pond to prevent it from drying (Seigel *et al.* 2006). Starting in 2002, a portion of the available egg masses have been collected and the hatchlings reared to metamorphosis in outdoor tanks for release at Glen's Pond (Tupy *et al.* 2010). Prior to their release into the wild, metamorphic frogs raised in cattle tanks received dye marks for several years, but currently receive visible implanted alphanumeric (VIA) tags. The predominance of adult frogs with dye marks entering Glen's Pond to breed in 2007, at the end of the "drought period", indicated that raising frogs in tanks is a successful technique (Baxley and Qualls 2007). Mark-recapture and demographic analyses suggest that human recruitment assistance rescued the population from likely extinction and helped maintain the population size (Pechmann *et al.* 2012). Most gopher frogs breed each year that the pond fills to a sufficient depth; therefore we are using the most current breeding event to provide an estimate of 135 adult frogs as the current size of the Glen's Pond population (Pechmann and Tupy 2015). In 2013, dusky gopher frogs dispersed 0.8 mi (1.3 km) from Glen's Pond to a restored pond named Pony Ranch Pond where they had never been observed previously; three egg masses were deposited and seven adult frogs and 18 metamorphosed juveniles were captured using a temporary drift fence (Pechmann and Tupy 2014). In 2014, three dusky gopher frog egg masses were deposited in Pony Ranch Pond and 16 adult dusky gopher frogs were captured (Pechmann and Tupy 2015). Unfortunately, tadpole mortality was high and preliminary reports indicate that most of this mortality was caused by the undescribed disease that caused a tadpole mortality event at Glen's Pond in 2003 (Pechmann and Tupy 2015).

In 2004, dusky gopher frogs were found at two additional sites, Mike's Pond and McCoy's Pond, in Jackson County, Mississippi. Mike's Pond is approximately 20 miles (mi) (32 kilometers (km)) east of Glen's Pond and separated from it by the Tchoutacabouffa River drainage. Mike's Pond supports a very small breeding population. Breeding at Mike's Pond has been verified in only four years (2004, 2005, 2010, 2012) since it was discovered, although several male dusky gopher frogs have been heard calling in other years and as recently as 2013 (Lee 2013). The breeding in 2010 was the result of two Glen's Pond females being introduced into Mike's Pond to breed with two males heard calling there; two egg masses resulted from this event. McCoy's Pond is east of Mike's Pond by approximately 16 mi (25 km) and separated from it by the Pascagoula River drainage. No dusky gopher frogs have been observed at this site since a frog was heard calling there in 2004; the pond has not held water long enough in most years to support population recruitment.

Presently, we estimate that a minimum of 160 adult dusky gopher frogs survive in the wild, the vast majority of which occur within the original Glen's Pond population known at the time of listing.

Efforts to locate new dusky gopher frog populations continue within the historical distribution of the frog in Alabama, Louisiana, and Mississippi. Field surveys conducted in Alabama and Louisiana have been unsuccessful in documenting the continued existence of dusky gopher frogs in these states (Seigel and Doody 1992, Bailey 1994, Leonard *et al.* 2003, Hart 2004, Pechmann *et al.* 2006, Bailey 2009, Landry 2011). Due to the paucity of available suitable habitat for the dusky gopher frog, we have worked with our State, Federal, and nongovernmental partners to identify and restore additional upland and wetland habitats to create appropriate translocation sites for the species, in close proximity to each other when possible. Thus far, we have focused our efforts on areas in the state of Mississippi because of the proximity of the primary breeding site to nearby restorable habitat and the availability of willing partners. We have identified more than 15 ponds and associated forested uplands, which we considered to have restoration potential, and have worked to improve these sites as potential translocation areas. After restoration efforts were completed, suitable sites were included in the designation of critical habitat for the dusky gopher frog. After completing habitat assessments of available restored habitat, a site on TNC property, managed as Old Fort Bayou Mitigation Bank, was considered to be in the best condition to support an initial translocation attempt (Sisson 2008). Tadpoles and metamorphic frogs were released at the site and three breeding events have been verified there (Lee 2014). This site is currently considered to have an extant population. Additionally, in 2012, 2013, and 2014 we released Glen's Pond tadpoles that had been head-started in cattle tanks into New Pond (Pechmann and Tupy 2013, 2014, 2015). New Pond is a pond created on DNF in an area east of Pony Ranch Pond; no breeding activity has yet been

observed at this pond. The potential for population establishment using translocation is limited because only the Glen's Pond population is large enough to have a sufficient number of egg masses to supply the frogs needed.

b. Genetics, genetic variation, or trends in genetic variation:

Initial work on the genetics of the dusky gopher frog was conducted by Young and Crother (2001). In an allozyme (any one of a number of different structural forms of the same enzyme used as a genetic marker) study comparing crayfish frogs (*Rana areolata*) and gopher frogs (*R. capito*), the population of gopher frogs in Mississippi (Glen's Pond; at that time considered to be subspecies, *R. c. sevosa*) displayed a single fixed difference in relation to other gopher frog populations (Young and Crother 2001). This difference indicates that the Glen's Pond population is on a unique evolutionary trajectory.

When breeding has occurred at Glen's Pond and/or Mike's Pond, eggs have been collected from individual clutches for genetic sampling. Five eggs from each clutch are collected and stored in separate vials of 95 percent non-denatured ethanol. These samples have been sent to Dr. Stephen Richter at Eastern Kentucky University for genetic analysis. Richter and Broughton (2005) and Richter *et al.* (2009) found evidence of past population bottlenecks and overall low population genetic variation. Richter and Nunziata (2014) discovered inbreeding depression in the Glen's Pond population; however, individuals with greater genetic variability had higher survival to metamorphosis, which should help prolong population persistence.

Dr. Richter and the Memphis Zoo have collaborated on genetic analysis of the captive dusky gopher frog population. Initial results indicate that the genetics of the captive population reflect the wild population, and many captive individuals are unrelated based on relatedness measures (Richter 2012).

In summary, the genetic and population ecology data available for the dusky gopher frog illustrate the consequences of geographic range collapse and geographic isolation of populations: reduced overall population sizes, increased negative effects of variation in reproductive success, low genetic diversity, and elevated probability of extinction.

c. Taxonomic classification or changes in nomenclature:

Gopher frogs (*R. capito* and *R. sevosa*) are members of the large family, Ranidae ("true frogs"), which has a worldwide distribution. The genus *Rana* is the only North American representative of this family. The range of the dusky gopher frog includes those parts of the lower coastal plain extending from southeastern Louisiana across the southern Mississippi coastal counties, to the Mobile River delta in Alabama. Goin and Netting (1940) originally

described frogs from this geographic range as a distinct species of gopher frog (*R. sevosa*). The taxonomic history of gopher frogs is complex (summary in Altig and Lohoefer 1983). Subsequent to the original description by Goin and Netting (1940), frogs of this population segment were considered subspecies of the gopher frog, *R. capito*, (*R. c. sevosa*, common name dusky gopher frog) (Wright and Wright 1942), a distinct species (*R. sevosa*) (Wright and Wright 1949), and later, subspecies of the crawfish frog (*R. a. sevosa*) (Viosca 1949, Neill 1957). Collins (1991) challenged the taxonomic arrangement that lumped crawfish frogs and gopher frogs together as one species and recommended their separation based on biogeographical grounds. This arrangement was followed by Conant and Collins (1991), who again recognized the name *R. c. sevosa*.

Shortly after the USFWS listed the frog, Young and Crother's (2001) paper was published describing the first comprehensive biochemical analysis of the relationships between gopher frogs and crawfish frogs and among subspecies of gopher frogs. They found strong support for the species designations *R. areolata* (crawfish frogs) and *R. capito* (gopher frogs). In addition, they found that the population of gopher frogs from Harrison County, Mississippi, showed a fixed difference at a single locus (site for a specific gene on a chromosome) from all other gopher frogs east of the Mobile River drainage in Alabama. This difference is considered by many taxonomists that support the phylogenetic (evolutionary) species concept (PSC) to be significant enough to warrant elevation of the frog to its own species (Young and Crother 2001). No other specific taxonomic divisions were determined among the remaining populations of gopher frogs sampled. Since Harrison County is within the range of the original specimens used to describe *R. sevosa*, Young and Crother (2001) recommended the resurrection of *R. sevosa* as a distinct species. The Standard English common name for *R. sevosa* is dusky gopher frog (Crother 2012).

Frost *et al.* (2006) proposed removing the genus name *Rana* from a group of North American frogs (one of which is the dusky gopher frog) and replacing it with the genus *Lithobates*. There is still reluctance by some in the scientific community to accept this change (Hillis 2007, Pauly *et al.* 2009, Wiens *et al.* 2009, Crother 2012). Until there is a clear consensus within the scientific community, we will continue to use the scientific name *Rana sevosa* for the dusky gopher frog as we formally recognized it in 2012 (USFWS 2012).

d. Spatial distribution, trends in spatial distribution, or historic range:

The dusky gopher frog has a very limited historical range in Alabama, Mississippi, and Louisiana. At the time of listing in 2001, this species occurred at only one site, Glen's Pond, on the DNF in Harrison County, Mississippi (USFWS 2001).

To summarize, since the dusky gopher frog was listed as an endangered species in 2001, three naturally-occurring populations supported by four breeding ponds have been documented. The four ponds are Glen's Pond, Pony Ranch Pond, Mike's Pond, and McCoy's Pond. A fourth population, breeding at TNC Pond 1, has been established through translocation of Glen's Pond frogs. The Glen's Pond population, supported by the Glen's Pond and Pony Ranch Pond breeding sites, is the only population that is considered stable at this time. We have restored an additional 12 ponds on the DNF, WBWMA (owned by the U.S. Army Corps of Engineers), TNC property, and the MSCNWR. Two additional ponds have been created; one on DNF and one on WBWMA. We hope these 14 ponds (all designated as critical habitat, except for one on the MSCNWR) may all eventually be used as translocation sites. As of fall 2015, Glen's Pond tadpoles, head-started in tanks, have been released at three of these ponds (Upper Mars Hill Pond and New Pond on DNF; Sawdust Pond on MSCNWR). In addition, we designated critical habitat at a site in Louisiana which contains two historical dusky gopher frog breeding ponds. The frog does not currently exist at this privately-owned site. We continue to survey areas within the historical range of the frog and hope to discover currently unknown populations or at least habitat that could be restored and used to establish populations.

e. Habitat:

The dusky gopher frog is an endemic of the longleaf pine ecosystem. Optimal habitat is created when management includes the use of seasonally-appropriate prescribed fire to support a diverse ground cover of herbaceous plants, both in the uplands and in the breeding ponds (Hedman *et al.* 2000, Kirkman *et al.* 2000, Roznik *et al.* 2009). The use of prescribed fire as a management tool has been reduced as longleaf pine dominated uplands have been converted to pine plantations (often loblolly (*P. taeda*) or slash pine (*P. elliottii*)). Outside of occupied habitat and those areas managed as potential translocation sites, many remaining parts of the longleaf pine ecosystem within the historical range of the frog continue to decline through fragmentation and destruction, primarily as a result of urbanization from residential and commercial development (Wear and Greis 2013).

Dusky gopher frog habitat includes both upland sandy and sandy loam habitats—historically forest dominated by longleaf pine—and wetland breeding sites embedded within the forested landscape. Breeding sites are ephemeral (seasonally flooded) ponds not connected to other water bodies (isolated) (Kirkman *et al.* 2007) with an open canopy (Thurgate and Pechmann 2007). Prescribed fire is being used at those sites occupied by the dusky gopher frog to create optimal habitat, and at sites being managed as potential translocation sites, to maintain the open canopy and groundcover vegetation of the frog's aquatic and terrestrial habitats (Roznik *et al.* 2009). Prescribed fire can result in burning of downed logs and stumps which creates

temporary and permanent subterranean refuges for the frog, and improving habitat for other species that make burrows used by the frog such as gopher tortoises and small mammals. Additional active management to improve habitat quality is occurring at both occupied and potential translocation sites including tree thinning, planting longleaf pine, controlling invasive vegetation, hydroperiod improvements, and creation of new ponds.

Adult and subadult dusky gopher frogs spend the majority of their lives underground, generally in stump holes or small mammal burrows within forested habitat (Richter *et al.* 2001, Tupy 2012). Historically, they were frequently found in active and abandoned gopher tortoise (*Gopherus polyphemus*) burrows (Allen 1932) on sandy soil sites. On less sandy, more marginal sites for gopher tortoises, stump holes and small mammal burrows have likely always been important refuges for gopher frogs. Thurgate (2006) conducted a choice experiment with two different sets of artificial burrows, those containing chemical cues of gopher tortoises or cotton mice (*Peromyscus gossypinus*) and those without. She found that dusky gopher frogs spent significantly more time in the treatment burrows than control burrows. This suggests that the species has an innate response to the chemical cues of these species, and that this response may help them locate burrows in the environment. The gopher tortoise is listed as a threatened species under the Act within the range of the dusky gopher frog and is in decline. Thus, the specialized microhabitat which they create is rare in occupied dusky gopher frog habitat. Because fossorial (underground) habitat represents the primary upland habitat for the dusky gopher frog, their survival is dependent on the quality and quantity of appropriate underground refugia (Roznik and Johnson 2009). High winds, generated during Hurricane Katrina in August of 2005, pushed over many pine trees in the vicinity of Glen's Pond and created a large number of belowground habitats for the dusky gopher frog.

Connectivity of dusky gopher frog breeding and nonbreeding habitat within the geographic area occupied by the species must be maintained to support the species' survival (Semlitsch 2002, Rothermel 2004, Harper *et al.* 2008, Richter *et al.* 2009, Richter and Nunziata 2014). This connectivity allows for gene flow among local populations within a metapopulation, which enhances the likelihood of metapopulation persistence and allows for recolonization of sites that are lost due to drought, disease, or other factors (Hanski and Gilpin 1991).

Published studies of population dynamics in gopher frogs (*R. capito*) indicate that their populations are naturally (but often only historically) distributed across the landscape among multiple breeding ponds interconnected by suitable upland habitat; they may have small local/pond subpopulation sizes, which cumulatively can form large populations (Semlitsch *et al.* 1995, Greenberg 2001, Richter *et al.* 2009). When multiple breeding ponds were present in the landscape, there was greater potential for recruitment in a given

year. It is likely that, historically, dusky gopher frogs were similarly distributed. As subpopulations of dusky gopher frogs became fragmented and isolated, overall population sizes and genetic variation rapidly diminished (Richter *et al.* 2009). The result is that only three small, isolated, naturally-occurring populations have been documented since 2001 and their distribution is limited from what was once likely a larger, connected complex of subpopulations and breeding ponds.

2. Five-Factor Analysis

a. Present or threatened destruction, modification or curtailment of its habitat or range:

The dusky gopher frog is an endemic of the longleaf pine ecosystem. Outside of occupied habitat and those areas managed as potential translocation sites, the remaining parts of this ecosystem within the historical range of the frog continue to decline through fragmentation and destruction, primarily as a result of urbanization from residential and commercial development. In addition, management of remaining natural areas of the longleaf pine ecosystem is inadequate (e.g., limited use of prescribed fire as a management tool; site prep which removes stumps and destroys belowground habitat). Plant community changes as a result of invasive species such as cogongrass (*Imperata cylindrica*) and tallow tree (*Triadica sebifera*) represent an additional threat to the frog's habitat. Terrestrial microhabitat within burrows of the threatened gopher tortoise continues to decline as gopher tortoise populations are diminished (Conservation Southeast, Inc. 2009; Hinderliter 2015). Historically, the dusky gopher frog was found in the coastal counties of Mississippi as well as in the Florida parishes of Louisiana and in Alabama west of Mobile Bay (Allen 1932, Dickerson 1969, Neill 1957, Dundee and Rossman 1989). Populations in Alabama and Louisiana appear to be extirpated (Pechmann *et al.* 2006, Bailey 2009). Searches for potentially suitable gopher frog habitat in Alabama are on-going in 2015 and some likely candidate ponds will be studied further (TNC 2015). Recent visits to localities historically occupied by the frog in Louisiana have verified the continued presence there of suitable breeding sites. In Mississippi, only three naturally-occurring dusky gopher frog populations have been documented since 2001; an additional population has been established through translocation.

Connectivity of dusky gopher frog breeding and nonbreeding habitat within the geographic area occupied by the species, and gene flow among local populations within a metapopulation, are important for the species' survival. Additionally, connectivity of these sites with other areas outside the geographic area occupied currently by the dusky gopher frog is essential for the conservation of the species (Semlitsch 2002, Harper *et al.* 2008).

Metapopulation dynamics is also important for the dusky gopher frog because ponds with slightly different drainage basins and hydrologies will respond differently to variations in local rainfall and provide different breeding opportunities. This variability can make the difference between whether or not tadpoles survive to metamorphosis in a population. Until recently, there were no dusky gopher frog metapopulations. However, longleaf pine restoration efforts and work conducted by the U.S. Forest Service (FS) to improve the hydrology of a pond (Pony Ranch Pond) near Glen's Pond, the primary breeding pond for dusky gopher frogs, has resulted in a new breeding site and creation of a metapopulation for the species on the DNF.

A site slated for residential development is located immediately north of the Glen's Pond breeding site on the DNF. After the frog's listing under the Act, the USFWS began working with the developers of the site to restore and protect habitat immediately adjacent to the DNF property boundary. In 2015, a Mississippi environmental nonprofit organization bought 170 acres of this property to protect it for the dusky gopher frog. Nevertheless, large scale development in the vicinity of this habitat, including ongoing highway expansion, will fragment the remaining longleaf pine habitat in the area. Urbanization will expand along these highway corridors and further reduce potential habitat for the frog.

The Mike's Pond dusky gopher frog breeding population is located primarily on a site owned by TNC. Unfortunately, part of the Mike's Pond drainage basin occupies private property outside of TNC ownership. A semi-truck repair shop was developed on this area after the owner's original shop was destroyed during Hurricane Katrina. Efforts have been made to work with the shop owner and encourage him to eliminate possible sources of toxic chemical inflow into Mike's Pond. Runoff of oils, gasoline, or other toxic substances from this shop represents a very real threat to the future of the Mike's Pond population.

Historic dusky gopher frog wetland breeding sites have been degraded and destroyed. The number and diversity of these small wetlands have been reduced by alterations in hydrology, agricultural and urban development, incompatible silvicultural practices, shrub encroachment, dumping into or filling ponds, conversion of wetlands to fish ponds or farm ponds for domestic animal grazing, soil disturbance, and highway construction (Richter and Jensen 2005). Fire suppression and hydrological alterations represent the most serious threats to dusky gopher frog breeding sites. Fire suppression at some sites has led to tree and shrub encroachment into ponds and destruction of the herbaceous groundcover needed for egg attachment. Lowered water levels and shortened hydroperiods, even at sites with herbaceous groundcover, limit opportunities for successful dusky gopher frog reproduction.

Several studies (National Council on Air and Stream Improvement, Inc. (NCASI) 1999, Baughman 2000, Russell 2000) have demonstrated that management of industrial forest lands can be compatible with maintaining a diverse amphibian community. However, rare amphibians which are endemic to the longleaf pine ecosystem, such as gopher frogs (LaClaire 1997), are not a typical component of this amphibian community on industrial forest lands. For example, a survey of ephemeral ponds on intensively managed forest lands resulted in documentation of gopher frogs in only 17 of 444 (4 percent) ponds surveyed in Alabama, Florida, and Georgia (NCASI 1999). The loss of essential upland and wetland habitat features is most likely responsible for the absence of these species. Habitat alterations resulting from historical land use practices, including fire suppression, removal of downed logs and other coarse woody debris, and short rotation times, may offer a partial explanation for the loss of these habitat features (Baughman 2000, Russell 2000).

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Direct take of dusky gopher frogs for commercial, recreational, scientific, or educational purposes was not considered a threat at the time of listing and is not currently known to be a threat to the species.

c. Disease or predation:

A lethal disease killed most gopher frog tadpoles at the Glen's Pond site in 2003 (Overstreet and Lotz 2004). Recent monitoring indicates this disease, an unnamed protist (*Dermomycooides* sp., also known as "*Perkinsus*-like" disease (Green *et al.* 2003, Cook 2008) is still present at the site, but mortality is sporadic and a mass die-off of tadpoles has not been observed since the first outbreak. Nevertheless, this disease has been implicated in the apparent low juvenile recruitment at newly-occupied Pony Ranch Pond on DNF. The disease does not appear to negatively affect adult dusky gopher frogs and multiple years of high juvenile recruitment have occurred subsequently at Glen's Pond since the initial disease outbreak (Pechmann and Tupy 2012, 2013, 2014, 2015). Portions of egg masses are collected at each breeding event, the eggs are hatched in the lab, and tadpoles are raised in cattle tanks adjacent to the pond. Metamorphic frogs from the cattle tanks are then released back at the breeding site. This strategy helps to ameliorate any threat from disease. In addition to the above disease, a disease caused by the pathogen *Batrachochytrium dendrobatidis*, commonly referred to as chytrid fungus, has been found in two other species of amphibians at Glen's Pond (Sisson 2003), although not yet in dusky gopher frogs. Dusky gopher frogs may not be susceptible to the disease due to their basking behavior. Thermal environment has been shown to affect the progress of this disease. Experimentally housing frogs at 98.6 degrees Fahrenheit (F) (37 degrees Celsius (C)) for less than 16 hours can clear them of the pathogen (Woodhams *et al.* 2003).

Ranaviruses in the family Iridoviridae may be potential threats. Ranaviruses have been responsible for die-offs in eight different species of frogs, especially those with an aquatic larval stage. Studies of the susceptibility of the dusky gopher frog to infection by ranaviruses have been conducted at the University of Tennessee. Initial results indicate that dusky gopher frogs are highly susceptible to ranavirus and when infected in laboratory experiments, have high mortality rates approaching 100 percent (Gray 2013; frogs for this experiment were individuals that resulted from an earlier captive breeding experiment and were excess to those needed to maintain genetic diversity in captivity). For the most part, diseases of amphibians in the southeastern United States have not been well studied, and they may represent a bigger threat to the dusky gopher frog than is currently understood.

Predation may be a threat to the dusky gopher frog. Predation is expected to be high since survivorship from the egg stage to adulthood is typically low for ranid frogs (reviewed in Richter *et al.* 2003). No published records of predation on adults or juvenile dusky gopher frogs exist, but predators would be similar to those of other gopher frog and ranid species (e.g., snakes, birds, and mammals; Jensen and Richter 2005, Pechmann and Tupy 2010). Richter (2000) reported an undetermined amount of the egg mortality due to predation by caddisfly larvae (Order Trichoptera, Family Phryganeidae) on the egg masses. Caddisfly infestations of dusky gopher frog egg masses have been variable since the time of listing (Baxley and Qualls 2007); however, they do not currently pose a threat to the species. No other direct documentation of egg or larval predation on dusky gopher frogs exists, but potential predators include those observed feeding on southern leopard frog eggs (*Rana sphenocephala*) and larvae in Glen's Pond and those of other gopher frog species. These potential predators include dragonfly naiads (Odonata), backswimmers (Hemiptera), giant water bugs (Hemiptera), predaceous diving beetles (Coleoptera), fish, salamanders, snakes, turtles, and birds (Jensen and Richter 2005, Richter pers. comm. 2013).

Predation from fishes likely contributed to the loss of historic populations. Studies of other amphibians, which breed in temporary wetlands, have demonstrated a decline in larval survival in the presence of predatory fish (Semlitsch 1987, 1988). Gregoire and Gunzburger (2008) studied the effects of predatory fish on survival and behavior of larval gopher frogs (*R. capito*) and southern leopard frogs (*Rana sphenocephala*) in Florida. Their results suggested that the presence of fish predators had a greater effect on survival and behavior of gopher frog tadpoles than those of the southern leopard frogs which are habitat generalists. Thurgate (2006) conducted experiments with dusky gopher frogs in which she recorded their lack of a behavioral response to the presence of the green sunfish (*Lepomis cyanellus*). This lack of a response suggests that the species may lack inducible defenses against fish predation and may be more vulnerable to fish introductions than other species (Thurgate 2006). Exposure to increased predation by fish may be a threat to

current dusky gopher frog populations when isolated, seasonally-ponded wetland breeding sites are changed to, or connected with, more permanent wetlands inhabited by fishes. In addition, ponds may be modified specifically to serve as fish ponds, sites may be altered due to the construction of drainage ditches or firebreaks which allow fish to enter the wetlands, or fisherman may purposefully stock fish at sites.

Predation on amphibians by the red imported fire ant (*Solenopsis invicta*) has been reported in the literature (Allen *et al.* 2004) and these ants have been observed at Glen's Pond and caused the death of at least one gopher frog (Pechmann and Thurgate 2001). Although this invasive species appears to be tied to disturbance and does not invade undisturbed forest habitats of native ants (King and Tschinkel 2008), increases in habitat alterations near occupied habitat is a concern (Todd *et al.* 2008). At Glen's Pond, control of this species is necessary in the disturbed area of the drift fence surrounding the pond. The threat of predation by red imported fire ants is likely tied to the increase in urbanization occurring through-out the longleaf pine ecosystem. Habitat degradation may also amplify predation on dusky gopher frogs by their natural predators due to a reduction in the amount of suitable terrestrial fossorial habitat for newly metamorphosed and adult frogs.

Although the magnitude of the threat from disease and predation is unknown, a significant increase in mortality resulting from these factors is a concern due to the extremely small size, low levels of natural recruitment, and isolation of dusky gopher frog populations.

d. Inadequacy of existing regulatory mechanisms:

At the State and local levels, regulatory mechanisms are limited to restrictions on direct take of dusky gopher frogs and do not protect the habitat required for their survival. Although not listed as threatened or endangered in Alabama, the dusky gopher frog is listed among those non-game species for which it is "unlawful to take, capture, kill, or attempt to take, capture or kill; possess, sell, trade for anything of monetary value, or offer to sell or trade for anything of monetary value" (Alabama Department of Conservation and Natural Resources 2015). In January 2013, the Louisiana Wildlife and Fish Commission voted to add the Mississippi (dusky) gopher frog to the Louisiana list of endangered species that cannot be killed or removed from the wild without a permit and this change was formalized in 2014 (Louisiana Administrative Code 2014). In Mississippi, the dusky gopher frog is listed as endangered and is protected under the Nongame and Endangered Species Conservation Act of 1974 which prohibits taking, possessing, transporting, exporting, offering to sell, or offering to ship endangered species (Mississippi Museum of Natural Science 2001). There are no Alabama, Louisiana, or Mississippi state regulations that protect dusky gopher frog habitat.

There are a group of Federal rules and regulations that provide measures to protect habitat of listed species, including the dusky gopher frog. For example, on June 12, 2012, critical habitat, as defined under the Act, was designated for the dusky gopher frog (77 FR 35118; USFWS 2012). This designation includes 1,196 ac (484 ha) of habitat occupied by the frog, as well as 5,281 ac (2,137 ha) of unoccupied habitat. The protections afforded under the Act to unoccupied critical habitat will help secure essential habitat features for the frog. However, critical habitat protection would only apply in cases where a Federal action, such as Federal funding or a Federal permit, is associated with the potential destruction of dusky gopher frog critical habitat.

The dusky gopher frog's habitat is afforded some protection under the National Forest Management Act (NFMA) when it occurs on lands managed by the FS. Rules and guidelines implementing NFMA require land management plans include provisions supporting recovery of endangered and threatened species. Land management plans must contain components to maintain or restore ecosystem integrity, ecosystem diversity, and provide additional components where needed to contribute to the recovery of listed species and conservation of proposed and candidate species. In addition, Section 7(a)(1) of the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species. Land managers on the DNF, where the primary population of the dusky gopher frog occurs, have conducted management actions in both occupied and unoccupied habitat to benefit the dusky gopher frog. These actions have included prescribed burning, pond restoration, and upland habitat improvements. Improvements at one particular site (Pony Ranch Pond) have resulted in dusky gopher frog breeding at a pond near the primary breeding site, Glen's Pond.

Section 404 of the Federal Clean Water Act (CWA) has the potential to provide some protection for the wetland breeding sites of the dusky gopher frog. As a result of recent case law (*Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* (SWANCC) 2001, *Rapanos v. United States* (Rapanos) 2006), isolated wetlands, such as dusky gopher frog breeding sites, have not been considered to be under Federal jurisdiction. In 2015, a Final Rule defining the "Waters of the United States" was published (U.S. Army Corps of Engineers, Department of the Army, Department of Defense and Environmental Protection Agency 2015). It is unclear what affect this rule may have on the status of dusky gopher frog breeding sites. On August 10, 2015, 13 states filed a Motion for Preliminary Injunction to prevent the revised definition from going into effect on August 28, 2015, pending resolution of the states' challenges. Nevertheless, in the case of large development sites where dusky gopher habitat occurs and jurisdictional wetlands would be affected, CWA may come into play when a section 404 permit is required.

e. Other natural or manmade factors affecting its continued existence:

Fire is the preferred habitat management tool used to maintain the natural longleaf pine community. Fire suppression of naturally-occurring fire, and low fire frequencies, have the potential of reducing the quantity and quality of terrestrial (including fossorial habitat) and aquatic habitat for the dusky gopher frog. Urban areas are being developed around dusky gopher frog habitat and, as a result, it is becoming more challenging to conduct prescribed burns. Drought has also contributed to a reduction in the number of days available to conduct prescribed burns. Although prescribed burning is an important management tool, timing of introducing fire into dusky gopher frog habitat should be carefully assessed in order to prevent mortality to the species during its migrations to and from breeding sites (Humphries and Sisson 2012).

Pesticides and herbicides commonly used in habitat management pose a threat to amphibians such as the dusky gopher frog, because their permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb 1986). Negative effects of commonly used pesticides and herbicides on amphibian larvae include delayed metamorphosis, paralysis, reduced growth rates, and mortality (Bishop 1992, Berrill *et al.* 1997, Bridges 1999). Sublethal levels of chemical contamination can alter juvenile recruitment in amphibian populations (Bridges and Semlitsch 2000, Rohr *et al.* 2013). Herbicides may alter the density and species composition of vegetation surrounding a breeding site and reduce the number of potential sites for egg deposition, larval development, or shelter for migrating frogs. For the reasons described above, the USFWS and our private and Federal partners who own property occupied by the dusky gopher frog are vigilant in the approval and use of any pesticides and/or herbicides on these sites. Through cooperation, we are working to keep this threat extremely low.

Habitat fragmentation of the longleaf pine ecosystem, resulting from habitat conversion, threatens the survival of the remaining dusky gopher frog populations. Even large tracts of intact longleaf pine habitat are fragmented by roads and pine plantations. Roads contribute to habitat fragmentation by isolating blocks of remaining contiguous habitat. This fragmentation may disrupt migration routes and dispersal of individuals to and from breeding sites and result in the death of dusky gopher frogs when they are attempting to cross roads. Extant dusky gopher frog populations are widely separated from each other by unsuitable habitat. Studies have shown that the loss of small, fragmented populations is common, and recolonization is critical for their regional survival (Fahrig and Merriam 1994, Burkey 1995, Marsh and Trenham 2001). As patches of available habitat become separated beyond the dispersal range of a species or become inaccessible, disruption of metapopulation dynamics occurs and populations become more sensitive to genetic, demographic, and environmental variability and may be unable to sustain themselves (Gilpin 1987, Sjogren 1991, Blaustein *et al.* 1994). Populations may be unable to recolonize areas after local extinctions due to their physiological constraints, relatively low mobility, and site fidelity.

(Blaustein *et al.* 1994). The isolation of dusky gopher frog populations eliminates the possibility of reestablishment occurring naturally and brings into question the long-term viability of the species. The genetic and population ecology data available for the dusky gopher frog illustrate the consequences of geographic range collapse and geographic isolation of populations: reduced overall population sizes, increased negative effects of variation in reproductive success, inbreeding-related mortality, low genetic diversity, and elevated probability of extinction (Richter *et al.* 2009, Richter and Nunziata 2014). Small populations are at increased threat from natural processes and random events (genetic isolation, inbreeding, and drought) as well as the threats listed above. Inbreeding depression and loss of genetic diversity may also occur in small populations and reduce the fitness of individuals and the ability of the population to adapt to change (Frankel and Soule 1981), as well as increase their vulnerability to environmental stressors (Weyrauch and Grubb 2006).

Low reproductive potential may also present a threat to the dusky gopher frog's continued existence. Studies of the Glen's Pond population suggest that female dusky gopher frogs do not breed until at least 2 to 3 years of age and only average one to two lifetime breeding events (Richter and Seigel 2002, Pechmann *et al.* 2012). In addition, larval survival to metamorphosis is extremely low (Richter *et al.* 2003, Pechmann *et al.* 2012).

Annual variability in rainfall influences how frequently, and how long, a pond remains appropriate breeding habitat for the dusky gopher frog. The amount of rainfall has been shown to have a positive effect on the number of egg masses produced in closely related *R. capito* (Jensen *et al.* 2003). Breeding events can be unpredictable (and may become more so with climate change), and the likelihood that recruitment will occur in a given year cannot be predicted. Higher temperatures that may result from climate change could reduce the hydroperiod of breeding ponds. A pond must hold water long enough for metamorphosis of dusky gopher frog tadpoles to occur, typically in late May or early June (Richter *et al.* 2003, Sisson *et al.* 2008, Pechmann and Tupy 2010, 2013, 2014, 2015). Between the 2000/2001 breeding season when the dusky gopher frog was listed, and the current 2014/2015 breeding season, natural recruitment in excess of 50 individuals has occurred at Glen's Pond in only 6 of 15 (40 percent) seasons due either to inadequate rainfall to fill the breeding pond or a sufficient amount to keep it filled until metamorphosis was possible (Sisson *et al.* 2008, Pechmann 2014, Pechmann and Tupy 2010, 2012, 2013, 2014, 2015). In 2 of 15 (13 percent) breeding seasons, Glen's Pond remained dry and the frogs did not breed; in 6 of the 15 (40 percent) breeding seasons the frogs bred but the ponds dried before their tadpoles could complete development (Pechmann *et al.* 2012). Although rainfall variability is a result of natural processes, extreme weather events such as drought may increase as a result of global climate change. When rainfall variability is combined with other threats such as population isolation,

small population size, and low reproductive potential, dusky gopher frog populations may be threatened to the point that they cannot recover.

D. Synthesis

The status of the dusky gopher frog has generally improved since its listing in 2001. To summarize, since the dusky gopher frog was listed as an endangered species in 2001, three naturally-occurring populations supported by four breeding ponds have been documented. The four ponds are Glen's Pond, Pony Ranch Pond, Mike's Pond, and McCoy's Pond. A fourth population, breeding at TNC Pond 1, has been established through translocation of Glen's Pond frogs. The Glen's Pond population, supported by the Glen's Pond and Pony Ranch Pond breeding sites, is the only population that is considered stable at this time. We have restored an additional 12 ponds on the DNF, WBWMA (owned by the U.S. Army Corps of Engineers), TNC property, and the MSCNWR. Two additional ponds have been created; one on DNF and one on WBWMA. We hope these 14 ponds (all designated as critical habitat, except the one on MSCNWR) may eventually be used as translocation sites. We continue to survey areas within the historical range of the frog and hope to discover currently unknown populations or at least habitat that could be restored and used to establish populations.

Considerable time and effort by the Service and our State, Federal, and private partners has made dusky gopher frog population and habitat improvements possible. Habitat management by the FS has enhanced existing and potential habitat on DNF. The Nature Conservancy owns the property where Mike's Pond is located and the site where the new population was established. The Natural Resources Conservation Service has provided funds through the Healthy Forests Restoration Act for habitat management at Mike's Pond. The state of Mississippi has partnered with the Service, through section 6 funding, on research and monitoring of the species.

The number of individuals in amphibian populations fluctuates widely because of their susceptibility to biological constraints, especially their dependence on seasonal aquatic habitat. Dusky gopher frogs are no different (Richter *et al.* 2003, Pechmann *et al.* 2012). The stability of populations may depend in part on the species' ability to colonize new sites and maintain connections among extant populations. If natural re-colonization is insufficient, reintroductions may be necessary to maintain natural populations and may require the use of captive-bred stock due to the lack of a large primary population. Suitable habitat for maintenance of existing populations and establishment of new ones must contain certain characteristics if the dusky gopher frog is to survive. Water-filled breeding sites must be available in sufficient quality and quantity long enough (greater than 3 months) for metamorphosis to occur. These ponds must be shallow, open, and contain emergent vegetation for egg attachment. Ponds must also dry periodically in order to prevent establishment of aquatic predators and prevent regeneration of hardwood plant species. Upland pine habitat (including habitat necessary to disperse between ponds in a metapopulation) must be adjacent to the breeding ponds. Below-ground habitat such as stumpholes or gopher tortoise burrows must be present for long-term survival of adult dusky gopher frogs. Prescribed fire is an important management tool to ensure long-term optimal habitat quality for both terrestrial and aquatic habitats.

In summary, threats continue for the dusky gopher frog in spite of our best efforts. Habitat destruction outside of protected areas continues, disease issues and drought are still a concern, and gopher frog population numbers are still very low. We believe the dusky gopher frog continues to meet the definition of an endangered species due to its limited known range; small population size; habitat destruction, modification, and fragmentation; and susceptibility to drought events and disease outbreaks.

III. RESULTS

- A. Recommended Classification:** No change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- A.** Protect existing wild dusky gopher frog populations through habitat restoration, management and other conservation techniques.
- B.** Monitor dusky gopher frog populations and their habitat.
- C.** Head-start dusky gopher frog tadpoles in cattle tanks as a hedge against breeding pond drying and as a source of frogs for translocation projects.
- D.** Continue searches for additional dusky gopher frog populations.
- E.** Continue translocation projects to establish additional dusky gopher frog breeding populations consisting of multiple breeding ponds within dispersal distance of each other (metapopulations).
- F.** Conduct a population and habitat viability analysis (PHVA) and develop the necessary supporting research.
- G.** Revise and implement a controlled propagation and reintroduction plan to facilitate use of captive dusky gopher frogs in translocation efforts.
- H.** Continue to conduct research on the ecological needs and natural history of the dusky gopher frog.
- I.** Study the “*Perkinsus*-like” disease which was the causative agent in the 2003 massive dusky gopher frog tadpole die-off in Glen’s Pond.
- J.** Continue to work with Federal, state, and non-governmental agency partners on recovery efforts for the dusky gopher frog.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the
Mississippi Gopher Frog (now recognized as the Dusky Gopher Frog)**

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change is needed

Review Conducted By: Linda LaClaire, Mississippi Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve: Stephen Rich Date: 15 Aug 2015

REGIONAL OFFICE APPROVAL:

Lead Regional Director, U.S. Fish and Wildlife Service

Approve: Franklin J. Smith Date: 9/9/15

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Appendix A: Summary of peer review for the 5-year review of the dusky gopher frog (*Rana sevosa*)

A. Peer Review Method:

This document was peer-reviewed internally by Cary Norquist, Jackson, Mississippi Field Office. Once her comments were incorporated into the document, it was emailed to three outside reviewers (see below) with known expertise and interest in the dusky gopher frog, along with a request for peer review.

Peer Reviewers:

Dr. Joseph Pechmann
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B. Peer Review Charge: The below guidance was provided to the reviewers.

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data that appears not to have been used by the Service.
3. Do not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.
4. Provide written comments on:
 - Validity of any models, data, or analyses used or relied on in the review.
 - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
 - Oversights, omissions, and inconsistencies.
 - Reasonableness of judgments made from the scientific evidence.

- Scientific uncertainties by ensuring that they are clearly identified and characterized and those potential implications of uncertainties for the technical conclusions drawn are clear.
 - Strengths and limitation of the overall product.
5. All peer reviews and comments will be public documents, and portions may be incorporated verbatim into our final document with appropriate credit given to the author of the review.

C. Summary of Peer Review Comments/Report:

1. Summary of Dr. Pechmann's comments.
Dr. Pechmann provided specific factual comments and corrections of data that added clarification to the review when they were incorporated into the document. He emphasized the importance of stump holes as adult habitat for gopher frogs and stressed that protection and creation of them may as important for the frogs as gopher tortoise burrows, especially in areas with marginal gopher tortoise soils.
2. Summary of Dr. Richter's comments.
Dr. Richter pointed out that the reduced genetic variability resulting from a severe population size reduction due to geographic range collapse and geographic isolation is a serious threat that elevates the probability of the species' extinction. He emphasized the importance of the captive populations of dusky gopher frogs, and that they should be managed to reflect natural population biology and genetic diversity. He also recommended continuing translocation projects to establish additional breeding ponds that would form multiple breeding populations at multiple ponds separated by a distance in the landscape that would allow for dispersal among them.
3. Summary of Mr. Tupy's comments.
Mr. Tupy provided additional data and comments that improved the accuracy of the document. He pointed out that fire management of terrestrial habitat is the primary driver of the creation of new underground refugia for dusky gopher frogs.

D. Response to Peer Review: Peer reviewers' comments were evaluated and incorporated into the document, as appropriate.