Gopher Frog Biological Status Review Report

March 31, 2011

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
620 South Meridian Street
Tallahassee, Florida 32399-1600

Biological Status Review
for the
Gopher Frog
(*Lithobates capito*)
March 31, 2011

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of November 8, 2010 that had not undergone a status review in the past decade. Public information on the status of the gopher frog was sought from September 17 through November 1, 2010, but no information was received. The 5-member Biological Review Group (BRG) met on November 18, 2010. Group members were Kevin Enge (FWC lead), Steve Johnson (University of Florida), Thomas Ostertag (FWC), Rick Owen (Florida Department of Environmental Protection), and David Printiss (The Nature Conservancy) (Appendix 1). In accordance with rule 68A-27.0012, Florida Administrative Code (F.A.C.), the BRG was charged with evaluating the biological status of the gopher frog using criteria included in definitions in 68A-27.001, F.A.C,. and following protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. Please visit http://myfwc.com/wildlifehabitats/imperiled/listing-action-petitions/ to view the listing process rule and the criteria found in the definitions.

In late 2010, staff developed the initial draft of this report that included BRG findings and a preliminary listing recommendation from staff. The draft was sent out for peer review, and the reviewers' input has been incorporated to create this final report. The draft report, peer reviews, and information received from the public are available as supplemental materials at http://myfwc.com/WILDLIFEHABITATS/imperiledSpp_biological-status.htm.

The BRG concluded from the biological assessment that the gopher frog did not meet any of the listing criteria. FWC staff recommends that the gopher frog not be listed as a Threatened species and that it be removed from the Species of Special Concern list.

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BIOLOGICAL INFORMATION

Taxonomic Classification – Two subspecies of gopher frog were formerly recognized in Florida, the Florida gopher frog (*Rana capito aesopus*) and the dusky gopher frog (*R. c. sevosa*). The latter subspecies was thought to occur west of the Apalachicola River (Conant and Collins 1991). However, Young and Crother (2001) analyzed allozyme data that showed no genetic divisions among populations of *Rana capito* (Le Conte, 1855), except for the population in southern Mississippi, which they recommended elevating to specific status by resurrecting *Rana* *sevosa* (Goin and Netting, 1940), the dusky gopher frog. Frost et al. (2006) removed New World frogs from the genus *Rana* and placed them in *Lithobates*, so the current name for the species occurring in Florida is the gopher frog (*Lithobates capito*).

Life History and Habitat Requirements – Information on the species has been summarized by Jensen and Richter (2005). The gopher frog primarily inhabits areas with well-drained sandy soils that support gopher tortoise (*Gopherus polyphemus*) populations (Wright 1932, Franz 1986, Blihovde 2006, Roznik 2007). During the non-breeding season, the gopher frog is generally associated with longleaf pine (*Pinus palustris*)–xeric oak (*Quercus* spp.) sandhills but also occurs in upland pine forest, scrub, xeric hammock, mesic and scrubby flatwoods, dry prairie, mixed hardwood-pine communities, and a variety of disturbed habitats (Enge 1997). Gopher frogs extensively use gopher tortoise burrows for underground retreats (Wright 1932, Carr 1940, Franz 1986) but also use southeastern pocket gopher (*Geomys pinetis*) burrows, mouse burrows, crayfish burrows, hollow logs, stump holes, root mounds, broken limbs, crevices, dead vegetation, and clumps of grass (Wright and Wright 1949, Gentry and Smith 1968, Lee 1968, Godley 1992, Richter et al. 2001, Nickerson and Celino 2003, Blihovde 2006, Roznik et al. 2009; K. Enge, FWC, pers. commun. 2010). Underground retreats in uplands are important for avoiding predation and desiccation, and frogs would be unlikely to survive droughts without them (Blihovde 2006). Furthermore, underground retreats are essential for the survival of newly metamorphosed gopher frogs, which experience high predation rates when they are above ground, and are more vulnerable to desiccation than adults (Roznik and Johnson 2009a). Gopher frogs breed in temporary or semipermanent, shallow, fishless ponds with an open canopy and emergent vegetation, including depression marshes, basin marshes, wet prairies, dome swamps, upland sandhill lakes, sinkhole ponds, borrow pits, and ditches (Godley 1992; Jensen and LaClaire 1995; Enge 1997; K. Enge, FWC, pers. commun. 2010).

Gopher frogs will travel up to 2 km to a breeding pond (Franz 1986), typically during heavy winter and spring rains. The breeding season is usually September–April (Palis 1998; Branch and Hokit 2000; Blihovde 2006; S. Morrison, The Nature Conservancy, pers. commun. 2010), but frogs potentially can breed during any month of the year during heavy rains; summer breeding is probably more common in southern Florida because winter frontal systems are weaker (Godley 1992, Jackson 2004). A female apparently deposits only a single egg mass containing a mean of 1,200–2,200 eggs (*see* Jensen and Richter 2005). Egg masses are attached to vegetation, and tadpoles transform in 3–7 months (Godley 1992, Palis 1998). Newly metamorphosed frogs leave their natal pond and spend most of their life in the surrounding uplands (Roznik and Johnson 2009b). Males apparently become reproductively mature at 1.5 years and females at 2 years (*see* Jensen and Richter 2005).

Population Status and Trend – There is no quantitative information, but the population is assumed to have declined as the human population in Florida has increased and converted suitable habitat to urban, agricultural, and other land uses. Based on the lack of recent activity at many historic breeding sites, Franz and Smith (1999) concluded that gopher frog populations had declined east of the Apalachicola River in the last 20 years (1975–95), particularly in coastal counties and in South Florida where most of the human population is concentrated. However, Franz and Smith (1999) considered the species to still be common on protected lands along the central spine of the Peninsula north of Lake Okeechobee. Franz and Smith (1999) compiled records from 258 localities in 45 counties in the peninsula. During surveys in 1990–95, they found gopher frogs at only 3 of 63 historical sites visited but found 83 new sites in 19 counties, including 4 new county records. Of the 12 counties for which Franz and Smith (1999) found no records, there have been recent records for 2 counties, Gilchrist and Hamilton (Tucker and Handrick 2006; K. Enge, FWC, unpubl. data). In the past 13 years (since 1998), gopher frogs have been recorded in 27 counties: Alachua, Baker, Citrus, Clay, Columbia, Gilchrist, Glades, Hernando, Highlands, Indian River, Lake, Leon, Levy, Manatee, Marion, Martin, Orange, Osceola, Pasco, Polk, Putnam, Sarasota, Seminole, St. Lucie, Sumter, Taylor, and Volusia (museum and Florida Natural Areas Inventory [FNAI] records; K. Enge, FWC, unpubl. data). None of these counties is west of the Apalachicola River, because there have not been recent surveys in those counties; however, records in the 1990s exist for Calhoun, Okaloosa, Santa Rosa, Walton, and Washington counties (museum and FNAI records). Surveys in 2006-11 recorded gopher frogs in 121 ponds on 21 public conservation lands, and additional ponds are found on private lands (K. Enge, FWC, unpubl. data). Of the 63 ponds where gopher frogs were found from July 2009 through June 2010, 50 represented new ponds (K. Enge, FWC, unpubl. data). Many public lands were not surveyed, such as Avon Park Air Force Range, where Franz et al. (1998) found 11 gopher frog breeding ponds. Surveys for gopher frogs on public lands typically document multiple breeding ponds, such as 20 ponds on Eglin Air Force Base (Palis and Jensen 1995) and 21 ponds on Camp Blanding Military Reservation (Hipes and Jackson 1996). At the Ordway–Swisher Biological Station in Putnam County, Franz (1986) marked 100 gopher frogs at tortoise burrows over a 16-month period. On Mosaic Phosphates (IMC) land in Polk, Hillsborough, Manatee, and Hardee counties, 12,266 tortoise burrows were excavated in 1989−2003, and 286 gopher frogs were found at 45% of the sites and on 33.7% of the 12,648 ha (31,254 acres) sampled (S. Godley, Cardno ENTRIX, pers. commun. 2010).

Geographic Range and Distribution – The gopher frog occurs in the southeastern Coastal Plain from southeastern Alabama to North Carolina, with disjunct populations in central Alabama and the Cumberland Plateau in Tennessee (*see* Jensen and Richter 2005). The gopher frog historically occurred throughout Florida except for the Everglades region (Fig. 1), and Florida represents the largest portion of the total global range of the species (Jensen and Richter 2005).

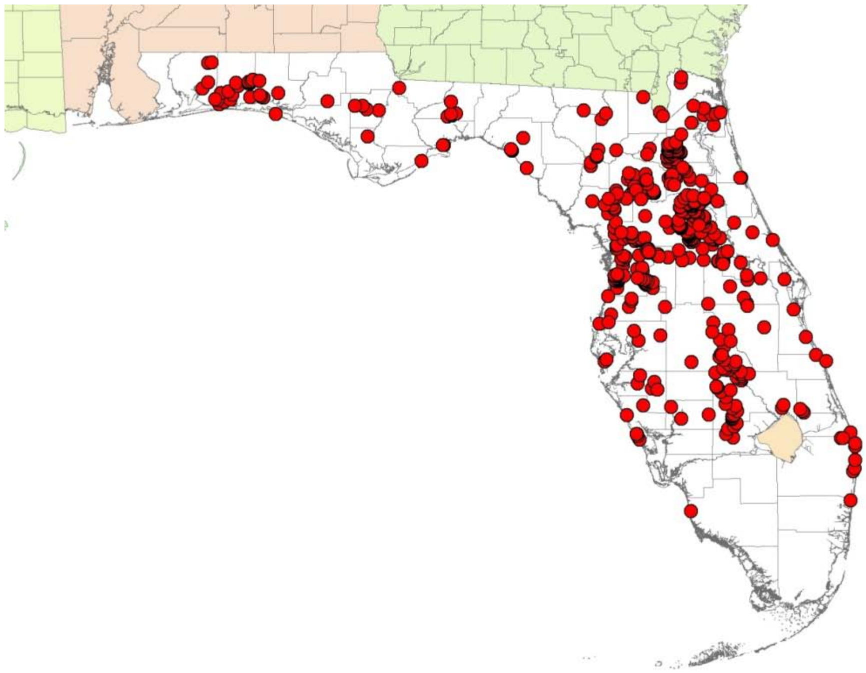

Fig. 1. Locality records from museums, FNAI, and the literature for the gopher frog.

Quantitative Analyses – We are not aware of a population viability analysis for the gopher frog. However, we believe that it is unlikely that the species will become extinct within the next 100 years based upon the large acreage of suitable habitat contained in conservation lands throughout Florida, its adaptability to some habitat alteration, and the increased security of gopher tortoise populations because of its new Threatened status (*see* Enge et al. 2006) and concomitant Gopher Tortoise Management Plan (FWC 2007). The only factor that might change this scenario would be catastrophic die-offs from disease, but the isolated nature of many populations should keep them protected from disease vectors.

BIOLOGICAL STATUS ASSESSMENT

Threats – The greatest threat to gopher frogs is loss and alteration of xeric upland habitats resulting from commercial and residential development, silviculture, agriculture, and mining (Jensen and Richter 2005). Intact xerophytic upland ecosystems inhabited by gopher frogs have suffered severe losses in Florida, including longleaf pine-dominated sandhill as well as scrub habitat on the ridges of central and coastal Florida (Means and Grow 1985, Myers 1990, Kautz 1998, Enge et al. 2006). Losses have been especially severe along the highly developed coastal ridges of both southeastern and southwestern Florida, as well as the central ridges that have been mined, converted to agriculture, and more recently developed (Jackson 2004). Because of their vagility, gopher frog populations can persist in fragmented landscapes, even when breeding ponds occur in unsuitable upland habitat, provided that suitable habitats are not too far apart and are not separated by busy highways or habitats lacking temporary refugia (needed during migrations). Gopher frogs do not require intact native ground cover, and dense populations can occur in pastures containing gopher tortoise burrows. For example, 97 gopher frogs were observed using 261 tortoise burrows in an abandoned pasture in Green Swamp West, Pasco County (M. Barnwell, Southwest Florida Water Management District, pers. comm. 2010). The most cited management concerns for gopher frogs are altered fire regimes, resulting in the encroachment of hardwoods and shrubs in the upland habitat, and the loss of gopher tortoise or pocket gopher populations that provide the primary source of upland shelters (Godley 1992, Greenberg et al. 2003, Jensen and Richter 2005, Blihovde 2006, Roznik 2007, Roznik et al. 2009). In Ocala National Forest, adult use of breeding ponds in regularly burned, savanna-like sandhill habitat versus hardwood-encroached sandhill habitat was similar, but juvenile recruitment was higher in savanna-like sandhills (Greenberg and Tanner 2008). Newly metamorphosed gopher frogs emigrating from ponds in Ocala National Forest selected fire-maintained habitat that was associated with an open canopy, few hardwood trees, small amounts of leaf litter, and large amounts of wiregrass (*Aristida stricta*); this habitat contained higher densities of gopher tortoise and small mammal burrows used as refuges (Roznik and Johnson 2009b). Adults emigrating from breeding ponds also preferentially selected fire-maintained habitat (Roznik et al. 2009). Altered fire regimes have resulted in canopy closure and unnatural shading of the grassy ground cover, which provides food for gopher tortoises and the frog's invertebrate prey base. Silvicultural practices can degrade upland habitat and impact gopher frog populations. Gopher frog larvae were found in <7% of 444 ponds sampled on forest industry lands (Wigley et al. 1999). On commercial forest lands in the Panhandle, dense stands of sand pine *(Pinus clausa*) are often planted in sandhill habitat. Gopher frog larvae were found in only 1 of 85 ponds sampled in a sand pine plantation on private land, whereas they were found significantly more often in ponds in an adjacent longleaf pine forest on Apalachicola National Forest (Means and Means 2005).

Degradation and destruction of wetlands also affect gopher frogs that rely on these ponds for breeding. Exclusion and suppression of fire from wetlands often leads to degradation of breeding ponds through shrub encroachment, peat buildup, and increased evapotranspiration shortening hydroperiods (LaClaire 2001). Coverage of grassy emergent vegetation decreases, and peat buildup may acidify the water past tolerance levels (Smith and Braswell 1994). Land managers often use fire lines to exclude prescribed fire from dry wetlands to prevent problems with smoke management or muck fires, particularly if the wetlands are associated with wildland urban interface (Bishop and Haas 2005). Erosion from adjacent unpaved roads can lead to siltation and sedimentation of ponds, and runoff from paved roads can pollute ponds with petrochemicals and other toxic substances to frogs (LaClaire 2001). Pond degradation also results from garbage dumping and off-road vehicle (ORV) use (Means and Means 1998, LaClaire 2001). Use of ORVs in pond basins can cause direct mortality of tadpoles and adults, and it can affect habitat quality by altering pond contours, herbaceous vegetation, and hydrology (LaClaire 2001). Loss of herbaceous vegetation decreases cover for tadpoles from predators and can discourage reproduction, because egg masses are attached to stems of herbaceous vegetation (*see* LaClaire 2001). Large tires of ORVs may break the organic hardpan beneath a pond, causing water to drain out and shortening the hydroperiod (LaClaire and Franz 1990). The hydrology of many of Florida's depression marsh wetlands may already have been significantly influenced by anthropogenic-caused impacts related to groundwater withdrawals (R. Owen, Florida Department of Environmental Protection, pers. commun. 2010). North Florida has already undergone extreme shifts in groundwater potentiometric levels (i.e., "groundwater contours") (Grubs and Crandall 2007). The hydrologic impact has been documented for the first time across regional hydrologic divides between the Suwannee River and St. Johns River water management districts, and there are numerous examples across the entire state where groundwater withdrawals are significantly shifting the historic directional flow of localized groundwater supplies (R. Owen, Florida Department of Environmental Protection, pers. commun. 2010). State regulators and governing water management districts have been forced to plan for future losses of ground water and even develop written recovery strategies, as mandated by legislative law, because of significant damaging groundwater losses (http://www.swfwmd.state.fl.us/waterman/swuca/). Some ephemeral wetlands are independent of ground water or surface aquifer water, but other wetlands are being impacted by hydrological alterations related to groundwater withdrawal (Guzy et al. 2006). Groundwater withdrawal can shorten hydroperiods or even eliminate ephemeral wetlands. Climate change may be affecting the amount of winter precipitation in peninsular Florida (K. Enge, FWC, pers. commun. 2010) and could potentially affect breeding pond hydrology (hydroperiod, timing, and water temperature) and upland habitat conditions (fire return and intensity) (C. Greenberg, U.S. Forest Service, pers. commun. 2011). Long-term droughts may already have caused some populations to disappear because of insufficient population recruitment.

The introduction of fish may play a role in population declines of certain anurans breeding in normally fish-free wetlands. Eastern mosquitofish (*Gambusia holbrooki*) are often introduced into isolated wetlands for mosquito control purposes, and even these small fish may have significant negative effects on gopher frog tadpoles (Gregoire and Gunzburger 2008). A far more serious threat, however, is the stocking of game fish (*Lepomis* spp. and *Micropterus* spp.) into ponds used by gopher frogs, or the introduction of predaceous fish into formerly fish-free wetlands during natural flooding events. Invertebrates can significantly impact population recruitment by feeding on eggs and tadpoles (Richter 2000), and a variety of vertebrates, such as wading birds and snakes, potentially prey upon tadpoles. Seventy-five percent of 32 metamorphs leaving a natal pond were killed by North American racers (*Coluber constrictor*), common garter snakes (*Thamnophis sirtalis*), or mammals (Roznik and Johnson 2009a). The long distances sometimes traveled by gopher frogs to breed, or following metamorphosis, can make them susceptible to highway mortality. A metamorph leaving a natal pond moved 691 m before being killed, and 3 of 32 metamorphs were killed by vehicles on lightly traveled dirt roads (Roznik and Johnson 2009a) that they apparently used as migration corridors (Roznik and Johnson 2009b).

A chytridiomycete fungus (*Batrachochytrium dendrobatidis*), or *Bd*, has been implicated as a primary or suspected cause of disease epidemics and subsequent population declines of amphibians in many parts of the world, although chytrid fungus is not known to be responsible for any amphibian die-offs in the southeastern United States. None of 18 gopher frog tadpoles examined from Florida and Georgia tested positive for *Bd* (Rothermel et al. 2008). Ranaviruses are likely a greater threat to amphibians, particularly tadpoles, than *Bd* in North America (Gray et al. 2009a, b). A die-off of hundreds of ranid tadpoles, including gopher frogs, in 2 ponds in Withlacoochee State Forest, Hernando County, was apparently caused by an unnamed *Perkinsus*-like (or alveolate) microorganism (Davis et al. 2007, Rothermel et al. 2008). A newly identified mesomycetozoan pathogen, *Anuraperkinsus emelandra*, has been the cause of massive ranid tadpole mortalities in 10 states, including a 2003 die-off of almost all tadpoles at the only known breeding pond of the federally endangered dusky gopher frog (http://www.nwhc.usgs.gov/disease_information/amphibian_malformation_and_decline/index.jsp).

Population Assessment – Findings from the BRG are included in Biological Status Review Information Findings tables. The BRG found the gopher frog did not meet any listing criteria.

LISTING RECOMMENDATION

Staff recommends that the gopher frog not be listed as a Threatened species and that it be removed from the Species of Special Concern list.

SUMMARY OF THE INDEPENDENT REVIEW

Comments were received from 6 reviewers: Mr. John G. Palis (independent consultant), Mr. Boyd Blihovde (U.S. Fish and Wildlife Service), Dr. Cathryn H. Greenberg (U.S. Forest Service), Dr. D. Bruce Means (Coastal Plains Institute and Land Conservancy), Mr. J. Steve Godley (Cardno ENTRIX), and Ms. Elizabeth A. Roznik (James Cook University). Appropriate editorial changes recommended by the reviewers were made to the report. No changes were recommended that would affect the findings or staff recommendations. Five reviewers concurred with the BRG findings, but 4 reviewers expressed concern for the future of the species and wanted some level of protection. The sixth reviewer thought the species should be listed as threatened. One of the concurring reviewers was concerned about the effects of climate change and whether FWC would be monitoring populations to detect declines. FWC has already developed gopher frog monitoring protocol for wildlife management areas and is trying to predict the effects of climate change on wildlife species. A management plan will be developed and approved before the species is delisted, and strategies for alleviating threats to this species will be part of this plan.

One of the concurring reviewers who wanted some level of protection for the species questioned whether the GIS analysis of potential habitat, which was used to determine area of occupancy, only included suitable upland habitat that was in proximity to suitable wetland (i.e., breeding) habitat. In response, the BRG provided more details on the habitat model in Additional Notes under Sub-criterion B2. Although the GIS analysis only included suitable upland habitat near potentially suitable wetland landcover types, there is no guarantee that the wetlands lack predatory fish and possess other characteristics important for use by breeding gopher frogs. This reviewer suggested an alternative means of calculating area of occupancy that multiplied the number of breeding ponds by the circular area around each pond, using 2 km (the maximum distance gopher frogs are known to migrate) as the radius. He suggested that 300 breeding ponds in Florida is a fair assumption and calculated the area around each pond as 6.28 km^2, yielding an area of occupancy estimate of 1,884 km^2, which is less than the 2,000 km^2 threshold for Sub-criterion B2. Staff considers this an acceptable means of calculating area of occupancy, but the actual area of potentially occupied upland habitat around each breeding pond would be 12.56 km^2, which is 3.14 (π) multiplied by 4 (the square of the radius). The area of occupancy would then be 3,768 km^2, almost twice the necessary threshold. However, as the reviewer pointed out, not all ponds are completely surrounded by suitable habitat, and ponds are often clustered on the landscape, resulting in overlapping of the circular areas of potentially occupied upland habitat. If the uneven distribution of ponds and unsuitable upland habitat were accounted for by using the figure of 6.28 km^2 of occupied upland habitat around each pond, only 319 ponds would be required to exceed the threshold for Sub-criterion B2. At least 200 breeding ponds have been identified on 7 public lands, and recent surveys have documented gopher frogs on 14 other public lands and various private lands. Based on these surveys, which are not completed, staff believes that Florida has more than 319 breeding ponds and Sub-criterion B2 is not met.

Two other reviewers thought the area of occupancy estimate was too high. One of the concurring reviewers pointed out that the area of occupancy estimate was approximately two-thirds that of the gopher tortoise (*see* Enge et al. 2006), but gopher frogs are seemingly absent or rare at most sites with gopher tortoises, often because of a lack of suitable breeding ponds. For example, no gopher frogs were found in 1,109 tortoise burrows excavated in a Hernando County sandhill because breeding ponds were absent (Witz et al. 1991). Staff recognizes this problem, and the GIS analysis only includes suitable upland gopher tortoise habitat within 2 km of potential breeding habitat; however, there is no guarantee that gopher frogs and gopher tortoises inhabit these uplands. This same reviewer thought the potential breeding habitat estimate of 283.7 km^2 (open water combined with freshwater marsh and wet prairie) was over estimated because gopher frogs typically breed in small, isolated, fishless wetlands. Staff agrees that this is an overestimate, because the lakes dataset that was used had an upper size limit of 33.3 ha, whereas breeding ponds are seldom >10 ha in size. In addition, many wetlands (especially the larger ones with open water) would be unsuitable because of the presence of predatory fish. However, even if the potential breeding habitat figure was only $1/100^{th}$ or $1/1{,}000^{th}$ as large, the area of occupancy threshold would be far exceeded. The reviewer who thought the species should be listed as threatened disagreed with the assumption that the area of potential habitat is equal to the area of occupancy. Her personal experience was that GIS analyses vastly over predict areas of habitat suitability and actual occupancy, and she suggested that this may be particularly true for the gopher frog because it requires both high-quality sandhill habitat that is actively managed with fire and high burrow densities of the gopher tortoise, a threatened species. Staff realizes that the actual area of occupancy cannot be accurately determined at this time, but it feels confident that the threshold is met because the estimated potential habitat is 4.5 times greater than required.

Two reviewers questioned how the gopher tortoise can be listed as threatened and the gopher frog does not meet any listing criteria, despite its dependence upon the tortoise as an upland host and its more restricted distribution because of its need for both suitable upland and wetland habitats. The long-lived gopher tortoise was listed because of population declines over 3 generations, which is equivalent to 60–93 years (*see* Enge et al. 2006); 3 generations for the gopher frog is only about 12 years. The reviews are available at MyFWC.com.

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Biological Status Review Information
Findings

Species/taxon: Gopher Frog
Date: 11/18/10
Assessors: Enge, Johnson, Ostertag, Owen, Printiss

Generation length: 4 years

Criterion/Listing Measure	Data/Information	Data Type*	Sub-Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Sub-Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Causes of reduction have not ceased (c)	S	N	
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	<30% population size reduction because only 16.0% increase in human population since 2000 and acquisition of conservation lands. Loss of suitable habitat in the past 12 years is <30%.	S	N	Kautz et al. (2007), U.S. Census Bureau
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	<30% population size reduction because human population projected to increase by 16.5% in next 10 years, 47.6% of potential habitat is on conservation lands, and species can survive in some altered habitats	S	N	Zwick and Carr (2006), GIS analysis of potential habitat by B. Stys (FWC)
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	<30% population size reduction (see A2 and A3)	S	N	Zwick and Carr (2006)
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	ca. 80,440 km^2 (37 counties)	E	N	
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	8,992 km^2	E	N	GIS analysis of potential habitat by B. Stys (FWC)
AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations		S	N	
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or		P	Y	See Sub-criterion A3

subpopulations; (v) number of mature individuals				
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals		S	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	>10,000 mature individuals	S	N	Palis and Jensen (1995); Hipes and Jackson (1996); Franz et al. (1998); Palis (1998); Franz and Smith (1999); FNAI and museum records; K. Enge, unpubl. data
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	Uncertain if there will be a 10% decline in the next 12 years	S	N	See Sub-criterion A3
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:		P	Y	See Sub-criterion A3
a. Population structure in the form of EITHER		S	N	
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation		I	N	
b. Extreme fluctuations in number of mature individuals		S	N	
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	>10,000 mature individuals	S	N	See Criterion C
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	8,992 km^2	E	N	See Sub-criterion B2
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	No PVA		N	

Initial Finding (Meets at least one of the criteria/sub-criteria OR Does not meet any of the criteria/sub-criteria)	Reason (which criteria/sub-criteria are met)
Not Threatened	
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria/sub-criteria OR Does not meet any of the criteria/sub-criteria)	Reason (which criteria/sub-criteria are met)
Not Threatened	

1	Species/taxon:	Gopher Frog
2	**Biological Status Review Information** Date:	11/18/10
3	Regional Assessment Assessors:	Enge, Johnson, Ostertag, Owen, Printiss
4		
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	No
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	No
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	Not Threatened

Additional notes – Generation length is defined as the average age of parents of the current cohort (estimated at 5 years), which is greater than the age at first breeding and less than the age of the oldest breeding individual. Franz (1986) estimated that it took gopher frogs 3.8 years to attain the maximum size observed at the Ordway–Swisher Biological Station. In a mark-recapture study of the closely related dusky gopher frog in Mississippi, the minimum age of sexual maturity was 4–6 months for males and 24–36 months for females, and annual population turnover was apparently high (Richter and Seigel 2002). Only 13.6% of 301 marked frogs were captured in more than 1 breeding season; the average number of breeding seasons for a frog was 1.2, although 1 frog bred 5 times (Richter and Seigel 2002). Richter et al. (2003) estimated maximum longevity of the dusky gopher frog to be 6–10 years but thought most adults did not live longer than 4–5 years. Based upon this information, we will infer a mean generation length of 4 years.

Sub-criterion A2. **–** We assume that the gopher frog population has declined as the human population in Florida has increased and converted suitable habitat to urban, agricultural, and other land uses. Florida's human population increased by 23.5% from 1990 through 2000 and by 16.0% from 2000 through 2009. Florida loses 182 ha (450 acres) of forest and 166 ha (410 acres) of farmland to development every day (Bouvier and McCloe Stein n.d.). Actual estimates of gopher frog populations do not exist, but we suspect that loss and degradation of habitat would not have resulted in a $\geq$ 30% population decline within the past 12 years, particularly considering Florida's programs for purchasing public conservation lands (e.g., Preservation 2000 and Florida Forever). See Population Status and Trend section for past and present occurrence information. On most public lands, suitable upland habitat for the gopher frog is managed by controlled burning, and these public lands probably have extant populations. However, gopher frogs were documented in the Panacea Unit of St. Marks National Wildlife Refuge in 1978 but apparently no longer occur there, despite suitable upland habitat and wetlands (Dodd et al. 2007). Inexplicable population declines or extinctions are a cause for concern and indicate that such events could occur elsewhere. Apparent population declines or extirpations may be related to several years of unsuitable weather for breeding or population recruitment (or to unknown factors), but populations may reappear. For example, calling gopher frogs have been monitored from 1 station (choruses from 2 breeding ponds can be heard) on the Lake Wales Ridge in Polk County since 1993, and the number of nights frogs were heard calling ranged from 4 to 35 annually. However, no gopher frogs were heard calling from 2006 through 2009, but frogs were again heard in 2010 (S. Morrison, The Nature Conservancy, pers. commun. 2010). The gopher frog is currently not hunted for food or pets (Enge 2005). Massive die-offs of gopher frog adults and tadpoles from pathogens could contribute to future population declines (see Threats section).

Sub-criterion A3. **–** Three generations from 2010 as the present would be 2022. Florida's population is projected to increase by 16.5% by 2020 and by 24.4% by 2025 (Zwick and Carr 2006). The exact relationship between human population increase and habitat loss is unknown. Much of the population increase could occur in urban areas, and residential development in suburban and rural areas may not eliminate frog populations. Both public and private lands will continue to experience habitat degradation from altered fire regimes (timing, intensity, fire-return interval, and season) (D. Printiss, The Nature Conservancy, pers. commun. 2010), leading to future population declines. Increased groundwater withdrawal shortening the hydroperiod of ephemeral wetlands used as breeding ponds may also impact frog populations. Of the potential habitat identified using GIS analysis, 47.6% is in conservation lands (B. Stys, FWC, pers. commun. 2010), and presumably gopher frog populations will continue to persist on most of these lands, particularly the larger parcels. However, just because land is protected does not mean that it is properly managed. There are ca. 900,000 ha (2.2 million acres) of fire-dominated natural communities on all publicly managed state lands, and ca. 336,000 ha (830,000) acres were reported to have been prescribe burned in fiscal year 2009–10 within the fire interval necessary to maintain optimal habitat conditions (State of Florida Land Management Uniform Accounting Council 2010). This means that 61% of fire-dominated communities are being fire suppressed. This trend of backlogged, fire-suppressed communities has occurred each year all the way back to the mid-1970's when state agencies in Florida first began using fire as a management tool, and these backlogged acres, on average, are not decreasing (R. Owen, Florida Department of Environmental Protection, pers. commun. 2010). Because of this downward trend, the available optimal habitat for upland species is projected to continue to decrease on the very lands that were meant to conserve them. The ability of gopher frog populations to continue to persist on fire-suppressed public and private lands is unknown. Efforts are being made to restore degraded sandhill habitat. For example, a 3-year multi-state sandhill ecological restoration project will enhance restoration on public and private lands by providing additional resources to meet sandhill restoration goals, significantly increasing the quality and quantity of habitat for wildlife species on 6,740 ha (16,655) acres of sandhill habitat in Florida by 2012 (http://myfwc.com/wildlifelegacy/fundedprojects/GrantDetails.aspx?ID=215). Another project will completely or partially restore 539 ha (1,333 acres) of sandhill and scrub habitats to benefit wildlife on Apalachee Wildlife Management Area (WMA), Big Bend WMA, Guana River WMA, and Lake Wales Ridge Wildlife and Environmental Area by 2012 (http://myfwc.com/wildlifelegacy/fundedprojects/GrantDetails.aspx?ID=229).

Sub-criterion B1. – The extent of occurrence was calculated by adding up the land area of the 37 counties in which gopher frogs have been reported since 1990 (museum and FNAI records; K. Enge, FWC, unpubl. data). The extent of occurrence is 80,440 km^2 (31,058 mi^2).

Sub-criterion B2. – A GIS analysis of potential habitat for the species identified 8,992 km^2 (3,462 mi^2) of potential habitat (B. Stys, FWC, pers. commun. 2010), which we will assume is equivalent to the area of occupancy. The major FWC 2003 landcover classes that comprised the potential habitat were pinelands (3,428 km^2; 1,323.6 mi^2), sandhill (1,903 km^2; 734.6 mi^2), dry prairie (1,254 km^2; 484.0 mi2), mixed pine-hardwood forest (874 km^2; 337.6 mi^2), shrub and brushland (627.0 km^2; 242.1 mi^2), xeric oak scrub (159.8 km^2; 61.7 mi^2), sand pine scrub (145.8 km^2; 56.3 mi^2), open water (143.7 km^2; 55.5 mi^2), and freshwater marsh and wet prairie (140.0 km^2; 54.0 mi^2), and unimproved pasture (139.6 km^2; 53.9 mi^2). The potential habitat model for this species includes breeding and upland habitats in proximity to each other and within range of appropriate gopher tortoise habitat. Potential breeding habitats were selected from the National Hydrography Dataset Hydrography Waterbodies data (intermittent ponds and lakes) and the Florida Department of Environmental Protection's data (lakes 0.12−33.3 ha in size). These 2 shapefiles were exported and buffered at 100 m. Natural landcover classes from the 2003 Florida vegetation and landcover image were subset using the 2 buffered layers as masks. The resulting potential breeding areas were used to select contiguous blocks (>10 ha) of upland gopher tortoise habitat (*see* Enge et al. 2006 for details of the potential habitat model) within 2 km of breeding habitat, and this upland habitat was then used to retain breeding areas within 2 km of upland/gopher tortoise areas. The breeding and upland areas were merged to produce the final model of potential gopher frog habitat (B. Stys, FWC, pers. commun. 2011). The amount of potential habitat just on conservation lands, which is 4,280 km^2 (1,653 mi^2) (B. Stys, FWC, pers. commun. 2010), is over twice the threshold for listing. Well-managed sandhill habitat is considered the most favorable natural habitat for both gopher tortoises and commensal gopher frogs. Potential habitat just in the sandhill landcover class (1,903 km^2; 734.6 mi^2) almost meets the threshold for area of occupancy.

Criterion C. **–** Because females lay only a single egg mass, counts of egg masses are a good index of the number of breeding females in the population. At 2 ponds in Conecuh National Forest, Alabama, a maximum of 160–180 egg masses were counted in each pond during 1 year (Jensen et al. 2003). Gopher frog populations apparently have an equal sex ratio (Palis 1998); thus, over 300 adult frogs used each of these ponds. At a 1.2-ha pond on Eglin Air Force Base, Florida, 301 unmarked adult frogs were captured during 1 breeding season (Palis 1998). We suspect that most ponds are not used by this many frogs, and the number of adult frogs in a population will vary annually depending upon the number of frogs recruited into the population and mortality rates. In some years, there is no population recruitment from some ponds (Greenberg 2001, Richter and Seigel 2002). Since 1990, at least 200 breeding ponds have been found during surveys on 7 public lands: Apalachicola National Forest, Avon Park Air Force Range, Camp Blanding Military Reservation, Chassahowitzka WMA, Eglin Air Force Base, Ocala National Forest, and Rock Springs Run State Reserve. If an average of 50 frogs bred in these ponds, these 7 public lands would contain 10,000 adult gopher frogs. There are far more than 200 breeding ponds in Florida. During a survey in northern Florida in 2006–11, gopher frogs were found using 121 ponds (K. Enge, FWC, unpubl. data).

Sub-criterion C2. **–** Ocala National Forest has at least 70 gopher frog breeding ponds, and this subpopulation probably contains >1,000 adults. Prolonged droughts could result in extreme population fluctuations of adults, but we think it is unlikely that the fluctuations would be the scale of on an order of magnitude.

APPENDIX 1. Brief biographies of the Gopher frog Biological Review Group members.

Kevin M. Enge received his M.S. in Wildlife Ecology and Conservation from the University of Florida and B.S. degrees in Wildlife and Biology from the University of Wisconsin–Stevens Point. He is currently an Associate Research Scientist in the Reptile and Amphibian Subsection of the Wildlife Research Section, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission (FWC). He has worked for FWC since 1989, serving as a nongame survey and monitoring biologist and the Herp Taxa Coordinator. He has conducted numerous surveys of both native and exotic amphibians and reptiles, and he has published >60 scientific papers and 25 reports.

Steve A. Johnson received his Ph.D. from the University of Florida and M.S. and B.S. degrees from the University of Central Florida. He is an Assistant Professor of Urban Wildlife Ecology at the University of Florida, and he holds a teaching and extension position in the Department of Wildlife Ecology and Conservation, Gulf Coast Research and Education Center. His area of expertise is natural history and conservation of amphibians and reptiles, especially those using isolated wetlands, and he has >60 publications.

Richard D. Owen received his M.S. and B.S. in Biology from the University of Central Florida. He is currently a District 2 Environmental Specialist for the Department of Environmental Protection, Florida Park Service, specializing in aquatic systems and prescribed fire management at 40 north Florida state parks. He has over 22 years of vertebrate survey and monitoring experience in the southeastern United States. His area of expertise is natural history and distribution of Florida's amphibians and reptiles. He has been involved with over 30 publications on amphibians and reptiles.

Thomas E. Ostertag received his M.S. in Biological Sciences from the University of West Florida and B.S. degrees in Anthropology and Biological Sciences from Florida State University. He is currently the Listed Species Conservation Ecologist in the Species Conservation Planning Section of the Division of Habitat and Species Conservation, FWC. His areas of expertise are the ecology of ephemeral ponds and fire ecology. He has published several papers on the effects of fire in upland pine ecosystems.

David Printiss received B.S. in Biological Sciences from Florida State University. He is currently the Northwest Florida Program Director for The Nature Conservancy and is responsible for management and restoration of over 30,000 acres across 12 preserves. As a Conservancy Field Zoologist, he has surveyed nearly all conservation lands in northern Florida in order to provide rare species and natural community inventories and management plans. Although much of his current work is related to natural community restoration, his early training was in herpetology, and he co-authored many survey and management recommendation reports when he worked for the Florida Natural Areas Inventory.

APPENDIX 2. Summary of letters and emails received during the solicitation of information from the public period of September 17, 2010 through November 1, 2010.

No comments were received during the public solicitation for information period.