PETITION TO LIST THE SPRING PYGMY SUNFISH AS ENDANGERED UNDER THE ENDANGERED SPECIES ACT

CENTER FOR BIOLOGICAL DIVERSITY

PETITIONER

NOVEMBER 2009

NOTICE OF PETITION

Mr. Ken Salazar
Secretary of the Interior
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

Dear Mr. Salazar:

Petitioners Center for Biological Diversity (CBD), Michael Sandel, and Noah Greenwald formally request that the United States Fish and Wildlife Service (USFWS) list the Spring Pygmy Sunfish (*Elassoma alabamae*) as an endangered species under the federal Endangered Species Act, 16 U.S.C. § 1531 (ESA).

This petition is filed under the Endangered Species Act, 16 U.S.C. sections 1531-1543 (1982) and 5 U.S.C. section 553(e), and 50 C.F.R. part 424.14 (1990), which grants interested parties the right to petition for issuance of a rule from the Assistant Secretary of the Interior. The petitioners request that Critical Habitat be designated as required by 16 U.S.C. 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553). Petitioners realize this petition sets in motion a specific process placing definite response requirements on the FWS and very specific time constraints upon those responses.

The USFWS has the authority to promulgate an emergency listing rule for any species when an emergency exists that poses a significant risk to the species. 16 U.S.C. §1533(b)(7). The petitioner believes that the Spring Pygmy Sunfish warrants immediate emergency listing and emergency critical habitat pursuant to section 4(b)7 of the E.S.A and 50 C.F.R. § 424.20, 50 C.F.R § 424.12, and the Administrative Procedures Act (5 U.S.C. §553), in order to sustain the species in the very immediate future. The fish faces several threats of imminent peril: 1) the fish's distribution is geographically restricted to less than 5 miles of Beaverdam Creek in Limestone County; 2) groundwater withdrawals have increased from irrigation, agricultural, and municipal purposes lowering the water table and amount of spring recharge that is necessary for the survival of the species; 3) riparian zones have been removed from multiple localities intensifying water quality degradation; 4) recent housing developments, planned industrial facilities, and associated infrastructure will soon claim over 2,000 acres within the spring recharge zone, increasing demand upon an already stressed groundwater supply, intensifying water quality degradation and destroying critical habitat and; 5) a reintroduced population in nearby Pryor Branch has recently been extirpated via excessive groundwater harvest and herbicide runoff.

I. PETITIONERS

The Center for Biological Diversity is a nonprofit conservation organization with more than 220,000 members and online activists dedicated to the protection of endangered species and wild places. The Center for Biological Diversity submits this petition on its own behalf and on behalf of its members and staff with an interest in protecting the Spring Pygmy Sunfish and its habitat.

Michael Sandel is a doctoral candidate of biological sciences at the University of Alabama, whose research focus involves the conservation, evolution, and ecology of pygmy sunfishes, especially the Spring Pygmy Sunfish (*Elassoma alabamae*). He has independently monitored the relative abundance and reproductive health of *Elassoma alabamae* since 2004, and has received Section 6 funds to examine the genetic variation within and among subpopulations (Sandel 2008).

Noah Greenwald is the endangered species program director for the Center for Biological Diversity. In this capacity, he directs the Center's efforts to protect species, such as the spring pygmy sunfish, under the Endangered Species Act.

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II. EXECUTVE SUMMARY

The spring pygmy sunfish (*Elassoma alabamae*) is considered an endangered species by the American Fisheries Society (Williams et al 1998); considered critically imperiled by NatureServe; listed by the Alabama Department of Conservation and Natural Resources (ADCNR) as "highest conservation priority" (P1); and its status is under evaluation by the International Union for the Conservation of Nature (IUCN) Red List of threatened species. Additionally, the spring pygmy sunfish is considered among the twelve regional freshwater fishes under greatest risk of extinction (the "Desperate Dozen") by the Southeastern Fishes Council (Sandel 2008). Of the twelve species listed in this publication, *Elassoma alabamae* is one of two species which are not yet protected, or under consideration for protection, by the Endangered Species Act.

In addition to a host of previous anthropogenic threats (pesticide and herbicide contamination, unsustainable irrigation practices, removal of riparian zones) new construction and expansion of the Huntsville metropolis into the Beaverdam Creek watershed will lead to rapid and widespread habitat disturbance, and an imminent threat of extinction to this sensitive species. 1,813 acres within the watershed are being promoted for development by the Limestone County Economic Development Association (LCEDA). Construction of associated infrastructure has begun, without consult of the USFWS or ALDWFF. Moss Spring, the type locality for the spring pygmy sunfish, is contained within a development site which is set for sale at the price of $25,000 per acre. Other agents of landuse change include construction of a new limestone quarry upstream of Pryor Branch, an automotive manufacturing megasite that has been solicited to Toyota and Volkswagen, and conversion of the local cotton gin to a land development firm, located 0.5 miles from Beaverdam Creek.

These claims are not speculation, but are based on the personal observations of Mr. Sandel and other experts in the field, who have witnessed the extirpation of four of the nine existing subpopulations within the last five years.

III. INTRODUCTION

Since its discovery in 1937, conservation of the spring pygmy sunfish has been a major concern among informed biologists. In fact, the species was twice presumed extinct during the 70 years it has been known to science. Its highly localized distribution in the eastern Highland Rim makes this fish one of North America’s most geographically restricted vertebrate species. Within the Tennessee River Drainage, the Highland Rim is unique in having an abundance of swamps and spring complexes, which support a distinctly diverse “lowland” aquatic community, isolated within an otherwise upland geography. The spring pygmy sunfish is known to have occupied three small disjunct spring complexes (Cave, Pryor, and Beaverdam Springs), separated by up to 65 miles. Two of the three native populations have been extirpated by anthropogenic disturbance. The Cave Spring (Lauderdale Co.) population was extirpated in 1938 due to habitat inundation, incurred via formation of Pickwick Reservoir. The Pryor Springs (Limestone Co.) population disappeared by the late 1960s, most likely due to compounding influences of dredging and chemical contamination (Jandebeur, 1997). Reintroduced populations in Pryor

Spring were sustained for approximately 20 years, but have since been extirpated, due to agricultural runoff, repeated contamination events, and natural drought. The single remaining native population occupies *ca*. 5 river miles of Beaverdam Creek, its tributaries, and surrounding wetlands within the Beaverdam Spring Complex (Limestone Co.) (Figure 2).[1]

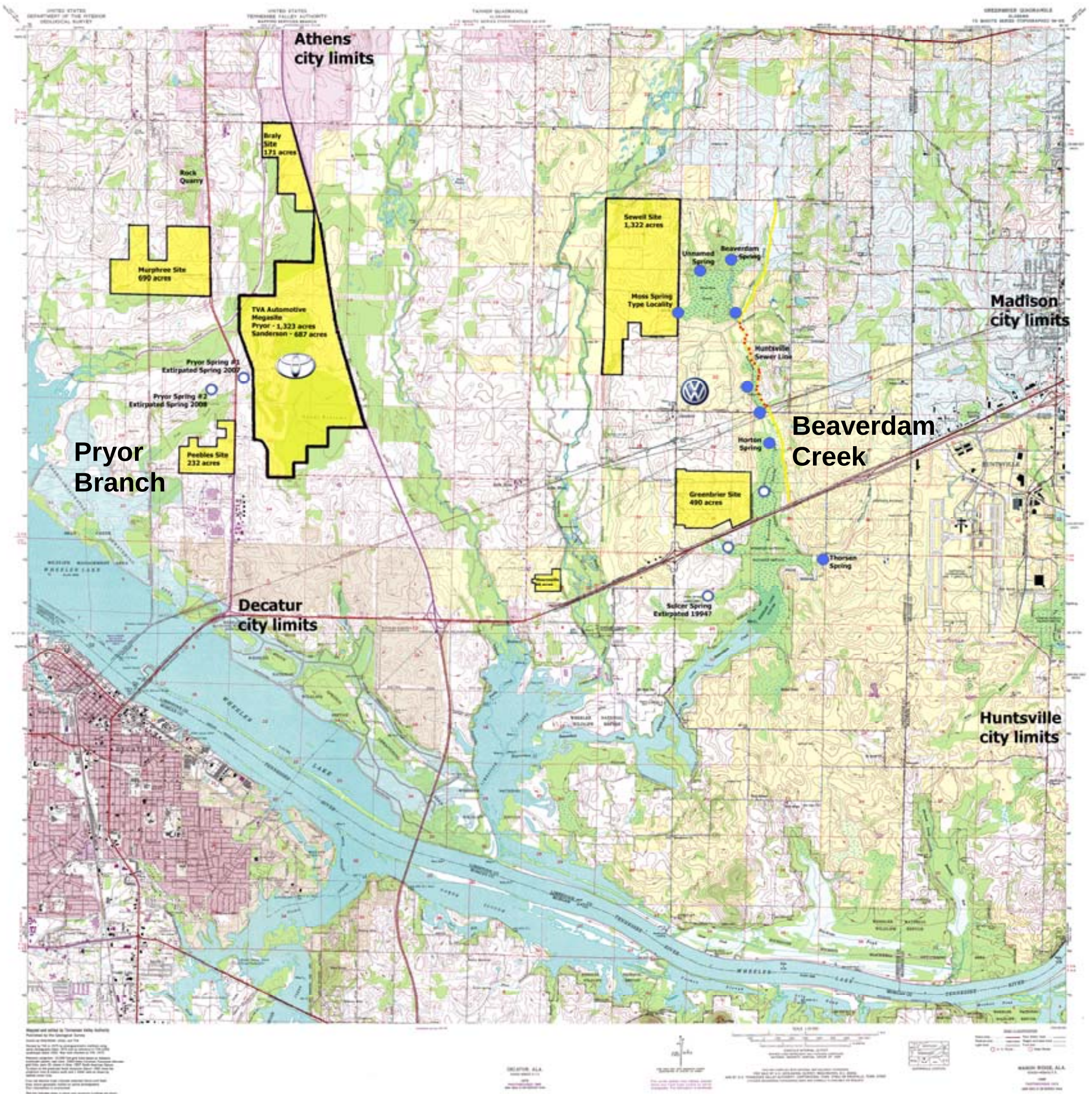

Figure 2. Topographical map of southeastern Limestone County, Alabama. Solid blue circles signify known collection localities, while hollow blue circles signify extirpated localities. Proposed development sites in yellow. City limits shown in opaque polygons.

[1] There has been considerable confusion regarding the paratype locality of this species, mainly due to name changes published on the 1975 USGS topographic map. Historical "Mossy Spring" (34.7029°N, 86.8294°W) is now referred to as "Beaverdam Spring". Present-day "Moss Spring" is located one mile Southwest of this locality, just West of Greenbrier Road (34.6918°N, 86.8433°W). Hereafter, all references to Moss Spring imply the latter locality, while all references to Beaverdam Spring imply the former.

IV. NATURAL HISTORY AND STATUS OF THE SPRING PYGMY SUNFISH (*Elassoma alabamae*)

A. NATURAL HISTORY

1. Description

The spring pygmy sunfish, *Elassoma alabamae* (Mayden 1993) is a small (less than 2 inches TL) spring associated perciform fish endemic to the Tennessee River Drainage in the Eastern Highland Rim province of northern Alabama (Figure 1).

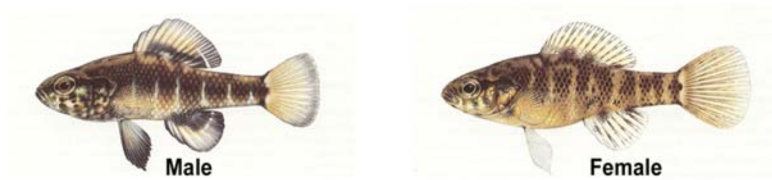

Figure 1. Illustrations courtesy of Joseph Tomelleri

2. Taxonomy

The spring pygmy sunfish was discovered in 1937, but due to repeated conservation threats and a lack of scientific research, remained undescribed until 1993 (Mayden 1993). The genus *Elassoma* was described by David Starr Jordan in 1877, and it now contains seven species (Snelson et al. 2009). Until recently, very little scientific information has been available for this group, evidenced by the fact that over half of all pygmy sunfish species have been described within the last 25 years. The family Elassomatidae is contained within Acanthopterygii, also known as the spiny ray-finned fishes. The systematic position and taxonomy of pygmy sunfishes within Acanthopterygii is the subject of long-standing debate, due to their unique combination of morphological characteristics (Johnson and Patterson 1993). Taxonomic resolution of the group's closest relatives is pending molecular phylogenetic analysis (Sandel pers. comm.).

3. Reproduction and Growth

The life history of *Elassoma alabamae* in natural systems is poorly understood. In 1974, Maurice Mettee completed a doctoral dissertation on captive specimens, which compared captive rates of reproduction and development among four *Elassoma* species. In captivity and in nature, male courtship behaviors consisted of a complex ritual involving fin undulation, weaving, vertical bobbing, and dashing. In fact, the courtship of pygmy sunfishes is among the most complex behaviors described for teleost fishes (Echelle and Echelle 2006). Immediately following courtship, eggs are deposited in dense submergent vegetation and protected by a clear gelatinous mass. Compared to other pygmy sunfishes, Mettee (1974) found the spring pygmy sunfish to have the highest average number of eggs per spawn, but the lowest percentage of egg survival. This result suggests that egg survival is relatively sensitive to variation of specific environmental conditions, and could represent a critical factor limiting the species to spring borne habitats. Additionally, relatively high fecundity suggests that this species may be able to

repopulate and reach carrying capacity within a short time period within optimal habitat. Such speculation is concordant with observations made at Moss Spring, whereby reproduction occurs for an extended duration, and is likely continuous throughout the year. The spring pygmy sunfish exhibits greatest relative abundance nearest the spring emergence, and protolarvae have been observed from April to
September (Sandel pers. obs.).

As with most fish species, initial growth in pygmy sunfishes is relatively slow, attributed to the energetic demand of metamorphosis from larval stage to juvenile morphology. Following this transition, growth rate increases rapidly between 5 and 19 mm. Beyond this point, growth slows again, reaching an asymptote of around 33mm (1.3") TL. Maximum observed body size among specimens collected was 31mm TL. Maximum mean body size for an adult cohort at any subpopulation was 27.94mm TL (Table 2).

As noted by other researchers, *Elassoma alabamae* appears to be an opportunistic breeder, as spawning may occur any time water quality (pH 6-7.5) and temperature (14-20° C) is within a suitable range. It is not surprising, therefore, that reproductively active adults were observed throughout much of the year, from March to late August at most localities, and perhaps January to October at Moss and Beaverdam Springs.

4. Movement

Rubenstein (1981) documented territorial behavior within the closely related everglades pygmy sunfish (*Elassoma evergladei*). Fishes were observed defending territories centered around food sources and spawning sites for months at a time. It is inferred from this publication and personal observations in the field that pygmy sunfishes are generally sedentary, and seasonally territorial, with semi-regular dispersal across less favorable habitat. This dispersal in inferred from infrequent but regular collection of individuals within unvegetated portions of Beaverdam Creek. Such movements are critical to the maintenance of genetic variation within any particular spring pool, which serve as source habitats for the overall population. Without continuous riparian and submerged aquatic vegetation along Beaverdam Creek, gene flow between spring pools is highly unlikely. Inbreeding in this species has already been shown to reduce population viability and tolerance to disturbed habitat (Sandel 2008). Before extirpation in 2008, extensive inbreeding within Pryor Spring #2 was associated with pronounced bottleneck effects, including 10% occurrence of spinal deformity in multiple monthly samples (Figure 3).

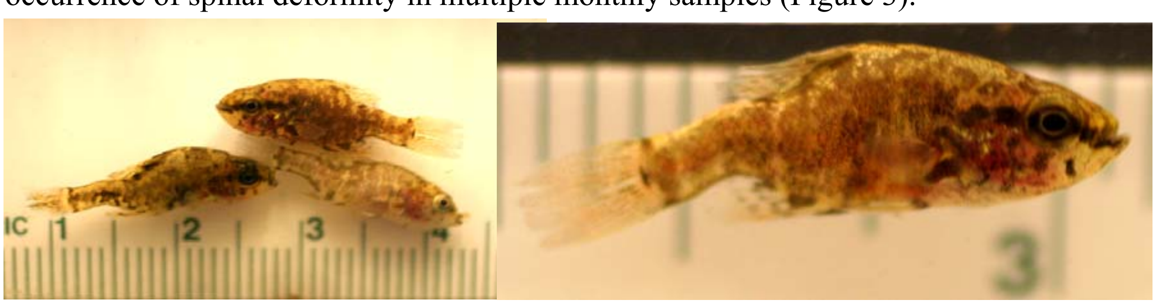

Figure 3. Up to 10% of the inbred population at Pryor Spring #2 exhibited spinal lordosis

5. Feeding

All pygmy sunfish species are stalking invertivores, using the dense submergent vegetation to conceal their foraging activity. *Elassoma* species are not cannibalistic, nor do they regularly consume larvae of other fishes. Plant consumption is negligible, and considered accidental on most accounts. Macroinvertebrates most often associated with pygmy sunfishes include cladocerans, copepods, amphipods, isopods, and snails. In 1993, an examination of planktonic fauna by Doug Darr and Marsha Slate proposed Daphnia as "the only plausible constituent food for the fish", leading to the suspicion that this prey item is the major component of the spring pygmy sunfish diet (Slate, 1993). In fact, Daphnia and other Cladocera are recorded in the diets of all pygmy sunfishes, but they usually comprise 25-30% of the volumetric consumption. Equally important prey items include amphipods, copepods, and dipteran larvae, and less important items include juvenile snails and ostracods (Barney and Anson, 1920; Walsh and Burr, 1984). Preliminary observations of *E. alabamae* gut contents at Moss Spring included amphipods, chironomid larvae, cladocerans, and small snails; in descending order of frequency. A thorough gut-content analysis is needed to determine seasonal variation of prey species.

6. Species Interactions

The spring pygmy sunfish has few natural competitors. Among fishes, only juvenile Tuscumbia darters (*Etheostoma tuscumbia*) could be considered to occupy an overlapping ecological niche. In disturbed systems, however, juvenile centrarchids and *Gambusia affinis* rapidly displace pygmy sunfishes, either through resource competition or aggressive behavioral interaction. A more likely competitor in natural systems is the neotenic salamander (*Eurycea sp. cf. aquatica*). The systematic validity of this potentially distinct amphibian species is currently being examined by Dr. Ronald Bonnett at the University of Tulsa. Observations in the field suggest that the spring pygmy sunfish is more sensitive to agricultural habitat disturbance than other species found in the area, as it is among the last to recover from such events.

Predators of *E. alabamae* are also rare in these systems. Among the potential predators listed in Appendix II, gut content dissections have not recovered the spring pygmy sunfish as a prey item (Sandel 2008). Although Jandebeur (1979) did recover a single individual from the stomach of a chain pickerel in a similar study. Comparable results were reported in a life-history study of the banded pygmy sunfish, whereby monthly examination of predator gut contents yielded only a single *E. zonatum*, which was consumed by a warmouth (Walsh and Burr, 1984). It is thought that the habitat preference of *Elassoma* species serves as protection from most large predators. However, perhaps the strongest predation threat comes from large predaceous invertebrates. Water scorpions, predaceous water beetles, and dragonfly larvae are abundant at localities inhabited by spring pygmy sunfish, and are suspected to be the primary predators of juvenile and sub-adult fishes in natural systems.

7. Population Genetics

Recent status surveys have been combined with a genetic analysis of population dynamics within the Beaverdam Creek system (Sandel 2008). Mitochondrial DNA sequence data and microsatellite DNA variation were used to assess standing levels of variation within spring pool habitats, and estimate gene flow parameters between such habitats (Sandel 2008). Within the Beaverdam Creek watershed, the spring pygmy sunfish exhibits a metapopulation structure, with source habitats centered upon spring pools. Microsatellite DNA variation is highest within the northern pools, including Beaverdam Spring, Moss Spring, and Lowe's ditch. To the south, Horton Spring and Thorsen Spring pools are each characterized by distinct mitochondrial DNA haplotypes, thereby indicating a moderate degree of recent genetic isolation. Preliminary evidence suggests that microsatellite variation at these sites is lower than in northern spring pools, but additional data is needed to confirm this result (Sandel pers. comm.). Individuals are infrequently collected within the main channel of Beaverdam Creek, and are interpreted as evidence of occasional gene flow between spring pools. This gene flow is critical to the health and adaptive potential of each subpopulation. Therefore riparian buffer zones should be protected along Beaverdam Creek and its tributaries in order to sustain gene flow among subpopulations and prevent the negative effects of inbreeding, previously documented for this species (Sandel 2008).

8. Habitat Requirements

Elassoma alabamae is largely restricted to patches of dense, filamentous submergent vegetation, which provides the fish with foraging habitat, refuge from predators, and sites for reproduction. Without stable aquatic environments offered by springpools and springruns, submergent plants are easily replaced by more tolerant emergents, such as *Juncus* species, parrotfeather, and water hyacinth. Such species do not support productive macroinvertebrate populations, making them unsuitable foraging habitats for pygmy sunfishes. Among plant species, *E. alabamae* is most strongly associated with the spineless hornwort (*Ceratophyllum echinatum*) and the two-leaf watermilfoil (*Myriophyllum heterophyllum*).

Loss of filamentous submergent vegetation has historically led to extirpation of a spring pygmy sunfish population. In 1971, the aquatic vegetation of Pryor Springs #1 was described as "Watercress abundant in spring with eelgrass and *Myriophyllum* in spring run" (Armstrong and Williams, 1971). Since at least 2004, watercress, native *Myriophyllum* and eelgrass have been extirpated at this locality. As of January 2008, the substrate is covered with a thick continuous mat of filamentous algae, and the water's edge is dominated by invasive Brazilian parrotfeather (*Myriophyllum braziliense*). Just downstream, invasive Amazon water hyacinth (*Eichhornia crassipes*) covers the surface of a shallow wetland. The aquatic invertebrate community once consisting of at least a dozen species of snails, bivalves, amphipods, isopods, and crayfishes, is now dominated by a single species of backswimmer (*Notonecta* sp.). The spring pygmy sunfish has been extirpated from both spring pools of the Pryor Branch system, and replaced by stocked juvenile centrarchids and the ever present *Gambusia affinis*.

Unfortunately, early signs of this pattern of habitat change and species replacement are also observed at other localities, including Moss Spring, Thorsen Spring, and Horton Spring.

B. POPULATION STATUS

1. Historic Distribution

Since its discovery in 1937, conservation of this species has been a major concern among informed biologists. In fact, the species was twice presumed extinct during the 70 years it has been known to science. Its highly localized distribution in the eastern Highland Rim makes this fish one of North America's most geographically restricted vertebrate species. Within the Tennessee River Drainage, the Highland Rim is unique in having an abundance of swamps and spring complexes, which support a distinctly diverse "lowland" aquatic community. The spring pygmy sunfish is known to have occupied three small disjunct spring complexes (Cave, Pryor, and Beaverdam Springs), separated by up to 65 miles. Two of the three native populations have been extirpated by anthropogenic disturbance. The Cave Spring (Lauderdale Co.) population was extirpated in 1938 due to habitat inundation, incurred via the formation of Pickwick Reservoir. The Pryor Springs (Limestone Co.) population disappeared by the late 1960s, most likely due to compounding influences of dredging and chemical contamination (Jandebeur, 1997). Reintroduced populations at Pryor Springs persisted for just over 20 years, but were again extirpated by the end of 2008. The single remaining population occupies ca. 5 river miles within the Beaverdam Spring Complex (Limestone Co.) (Figure 2).

2. Current Distribution

Elassoma alabamae ranks among North America's most geographically restricted freshwater fishes (Conway and Mayden 2006). A single native metapopulation occupies less than five linear miles of Beaverdam Creek, its tributaries, and associated wetlands in Limestone County, Alabama. The Beaverdam Creek watershed (USGS HUC 060300020703) drains 17,438 acres (27.25 sq. mi.) into Wheeler Reservoir. Boschung and Mayden (1993) mistakenly report that part of the species' range is protected by Wheeler NWR. In the mid 1990's a few *E. alabamae* were collected and released within Wheeler National Wildlife Refuge (Schute pers. comm.), but subsequent surveys to the area were yielded no fish in 2007 (Sandel and Gates pers. obs.). There is no evidence for a sustained population within the refuge boundaries. All known populations occur North or East of the refuge boundary within the Beaverdam Creek watershed.

Within the Beaverdam Creek watershed, a network of sinks and springs connect the aquifer with the surficial streams. The habitats provided by the spring complex is critical to survival of *E. alabamae* and other spring-adapted species. The spring emergences are centers of optimal habitat for foraging and reproduction of the spring pygmy sunfish. A continuous supply of clear, cool water from these springs promotes growth of a diverse aquatic plant community, which provide habitat for nearly all of the spring adapted animals in this system. Three spring emergences in the northern portion of the range are geographically proximate, and exhibit substantial gene flow between subpopulations. Beaverdam Spring is the northern-most locality, which is confluent with an unnamed spring at the western terminus of Lowe's ditch, as well as Moss spring, which is just west of Greenbriar Road. These three subpopulations are located upstream of a beaverdam which forms Beaverdam Lake. The lake is not considered optimal habitat for spring pygmy sunfish. Downstream of the lake, individuals have been collected at the Sewell farm road crossing, near the Norfolk Southern Railroad bridge, and at Old Hwy 20. Just downstream of Old

Hwy 20, Horton Spring is another important reproductive source habitat. Very few collection records exist between Horton Spring and I-565, as abundance declines rapidly along the reclaimed cattail swamp, which replaced a native Tupelo Gum stand. Before the timber was cleared from this wetland, spring pygmy sunfish abundance was likely much greater, and gene flow was likely more frequent between northern and southern spring pools. South of I-565, a single source population is found in Thorsen Spring, just East of the Wheeler NWR boundary. Microsatellite DNA variation identify three subpopulations within the system. The first subpopulation consists of all individuals upstream of Beaverdam Lake. The second contains individuals between Beaverdam Lake and I-565, and the third contains individuals from Thorsen Spring. A reintroduced population in Pryor Branch was extirpated in 2008, but was genetically indistinguishable from its source population (Moss Spring).

3. Abundance and Viability

In unaltered optimal habitat, density may exceed 1 fish per square meter. Optimal habitat is limited to shallow vegetated areas of the springpools and spring runs confluent with Beaverdam Creek. Abundance decreases with distance from springpools, but intermediate stretches of Beaverdam Creek are regularly occupied at low density.

In February, 1984, a group of spring pygmy sunfishes were reintroduced to subspring #2 of the Pryor Spring Complex (Figure 2). This precautionary measure was taken to ensure persistence of the species, should extinction risk increase in the Beaverdam Spring Complex (Mettee and Pulliam 1986). The founding group was comprised of 11 males and 25 females, all collected from Moss Spring at Greenbrier Road. In mid-September, 1985, it was determined that the reintroduction effort was successful, as evidenced by numerous young-of-the-year individuals observed at Pryor Spring #2. Therefore, a second reintroduction took place, consisting of 37 males and 83 females. This group was again collected from Moss Spring, but released into Pryor Spring #1, which is approximately 400 yards Northwest of Pryor Spring #2 (Mettee personal communication). Both subpopulations in the Pryor Complex persisted at least 20 years. During this period, the habitat occupied by the respective groups was never contiguous, and the subpopulations are suspected to have persisted in genetic isolation. Another translocation was attempted in the early 1990's into nearby Byrd Spring, but repeated attempts to document its persistence have been unsuccessful (Sandel and Rider pers. obs.).

Among subpopulations sampled between October, 2006, and October, 2007, Moss Spring and Beaverdam Spring exhibited the highest and most consistent relative abundance. Pryor Spring #1 exhibited the lowest density during all months, and a declining trend in relative abundance was directly correlated with habitat disturbance, with the last individuals collected nearest the springhead. Just west of the spring emergence, a small riparian zone shaded a shallow area and permitted growth of *Ceratophyllum*. During the last two successful collections at this locality, fishes were strictly limited to the vegetated riparian habitat. Following destruction and removal of the riparian buffer by the landowner, water temperatures increased, and *Ceratophyllum* was replaced by *Myriophyllum aquatica*. Shortly thereafter, irrigation pumps were used to lower the water level in the springpool by 4 feet, water temperatures increased to 27° C, and an algal bloom occurred. No spring pygmy sunfishes were collected from this locality during monthly visits after May of 2007. *See Exhibits 4-10.* Pryor Spring #2 was also extirpated following a similar pattern, with individuals last collected in spring of 2008.

Evidence for metapopulation dynamics within the Beaverdam Spring Complex is presented by the demographic structure of samples. Larval and small juvenile pygmy sunfishes were consistently collected near spring emergences in Moss and Beaverdam Springs. Alternatively, at Pryor Springs #2 and Thorsen Spring, larvae and juveniles were only collected among clumps of Ceratophyllum in Spring pools. This suggests that reproduction is restricted to localized conditions at spring emergences and spawning activity is triggered by temperature change , vegetation growth, food supply, or unknown factors.

Moving away from spring emergences, samples include fewer larvae and juveniles. In Horton Spring, for example, juveniles have not been collected over 150 meters north or south of the spring emergence. At Moss Spring near Greenbriar road, most individuals are less than 18 mm TL. Just 100 feet east of the road (into the swamp) individuals were recorded up to 31 mm. This indicates that (1) at some distance from the spring emergence offspring are produced at a lower frequency, or that (2) offspring move nearer the spring emergence shortly after hatching. Either explanation demonstrates the importance of undisturbed springs and spring pools as a reproductive habitat for this species.

The strongest evidence for metapopulation dynamics in the Beaverdam Spring Complex comes from long term collection records at particular localities. Generally speaking, the metapopulation model describes a dynamic equilibrium, whereby individual subpopulations may become locally extirpated due to natural causes, and new habitats may be colonized over long periods of time. Given sufficient recovery time, this pattern of extirpation and colonization occurs at a rate that maintains genetic diversity within the metapopulation, which is periodically exchanged through geneflow from one source to another.

In the case of the spring pygmy sunfish, one natural extirpation and one colonization event have been documented within the last 15 years. For example, in the early 1990's, a subpopulation of spring pygmy sunfish was documented from the Sulcer Spring, and Sulcer run (P.Schute and S. Weber pers. comm.). This subpopulation, the only record within Wheeler National Wildlife Refuge, was assumed to represent the downstream boundary of the species. However, during a more recent survey (Sandel 2008), it was found that Sulcer Spring had been recently inundated by a beaver pond, and that the subpopulation had been extirpated at this locality, probably during the late 1990's or early 2000's. Beaverdams do not appear to benefit the spring pygmy sunfish, as relative abundance is lower in beaverdam pools at Beaverdam Lake, and Pryor Spring #1 prior to its extirpation. It is unclear whether the formation of the beaver pond caused the extirpation of the Sulcer subpopulation, but no anthropogenic events are known which could have caused this loss.

Within this metapopulation, colonization must occur at a rate which is fast enough to compensate for loss through local extirpation, and slow enough to allow genetic adaption to local conditions, but only if habitat is not persistently disturbed by anthropogenic alterations. In the mid 1990's, a number of regional spring surveys were conducted within the Beaver Springs Complex, either in search of *Elassoma alabamae*, *Etheostoma tuscumbia*, or similarly distributed species. Among the springs sampled, Thorsen Spring, located south of I-565, and ESE of Sulcer Spring, represented the southernmost locality within the complex. During these surveys, *E. alabamae* was not collected at Thorsen Spring, although habitat descriptions suggest that it would have been an optimal locality for the species. However, in July, 2007, an exploratory visit to Thorsen Spring yielded large numbers of adult and juvemile spring pygmy sunfishes. The spring was nearly covered with Ceratophyllum echinatum, and all of the typical spring associated species were abundant throughout the spring pool. The discovery of *E. alabamae* at Thorsen Spring represents a small extension of the downstream boundary of the species, and indicates that the species is capable of natural colonization of habitats in the absence of anthropogenic disturbance. However, this range extension does not suggest that the species is adapting to conditions within Wheeler Reservoir, as hoped by many conservationists. Rather, *E. alabamae* has simply colonized (probably recolonized) a springborn habitat in accordance with the metapopulation dynamics shared by all *Elassoma* species. In 2007, natural and anthropogenic reduction of the aquifer at this locality resulted in catastrophic loss of habitat for all spring adapted species, including *Elassoma alabamae, Etheostoma tuscumbia*, *Eurycea* sp. Cf. *aquatica*, numerous isopods and amphipods, and the federally endangered snail, *Campeloma decampi*. A brief visit in February, 2008 yielded only four pygmy sunfish specimens, all collected within an isolated patch of *Ceratophyllum* near the spring emergence.

These observations suggest that the metapopulation structure of *Elassoma alabamae* is finely adapted to a natural frequency of disturbance within this system. Under natural conditions, spring pools would persist relatively unchanged for thousands of years before drought, karstic diversion, or other natural disturbance would cause local extirpation. All available evidence suggests that anthropogenic disturbance, including intensive agriculture, residential and industrial development, and aquifer contamination, are increasing the rate at which spring pool subpopulations are extirpated. This increased frequency of extirpation exceeds the rate at which spring pool habitats can recover, and the rate at which *Elassoma alabamae* can recolonize. Thus, with each additional spring pool extirpation event, the genetic variation and long term viability of the species as a whole is reduced. With an impending threat of increased human development in this watershed, the rate of local subpopulation extirpation could easily exceed the species' ability to persist in this unique system.

V. THE SPRING PYGMY SUNFISH WARRANTS LISTING UNDER THE ESA

The pygmy sunfish indisputably merits immediate listing under the ESA, and the listing decision must be made solely on the basis of the best scientific and commercial data available. 16 U.S.C. § 1533(b)(1)(A). The legislative history of this provision clearly states the intent of Congress to "ensure" that listing decisions are "based solely on biological criteria and to prevent non-biological criteria from affecting such decisions." H.R. Rep. No. 97-835, 97th Cong. 2d Sess. 19 (1982). As further stated in the legislative history, "economic considerations have no relevance to determinations regarding the status of species." Therefore, political and economic arguments may not be considered by the USFWS in its determination of whether to list this species. The numerous factors threatening the continued survival of the pygmy sunfish are detailed below.

A. PRESENT OR THREATENED MODIFICATIONS OR DESTRUCTION OF ITS HABITAT

The Spring Pygmy Sunfish is an imperiled species and continues to be threatened by its extremely small and confined range, the destruction or modification of its habitat including degradation of water quality, reduction of water quantity, and geomorphic, hydrologic and vegetative changes of the spring systems (Warren *et al.* 2000, Warren 2004, Boschung and Mayden 2004). *See Exhibits 4-10.*

The Pryor Spring/ Branch native population was likely extirpated in the 1940's by herbicide treatments to control spring vegetation, channelization, other agricultural pollution, or a combination of factors (Jandebeur 1979, Mayden 1993). In 2007 and 2008, the system was impacted by similar activity, and the reintroduced populations were again extirpated. At site-specific and regional scale, this species has been shown to be very sensitive to anthropogenic disturbance.

Between 1997 and 2001, the United States Geological Survey (USGS) National Water Quality Assessment (NAWQA) program conducted a study on the lower Tennessee River catchment, which contains the Highland Rim province. In this study, the eastern Highland Rim subunit, which contains the entire Beaverdam Creek watershed and aquifer, was found to have daily human water withdraw volumes (40 million gal./day) of at least three times the comparable volumes from eight surrounding subunits (≥12 million gal./day)(Figure 4). Much of this demand stems from the Huntsville public water supply, but even local groundwater withdraw along Beaverdam Creek is relatively high. In summer of 2007, Mr. Sandel observed five diesel irrigation pumps in simultaneous operation, which each have a capacity to withdraw approximately 8,000 gallons of groundwater per minute. This occurred during one of the worst regional drought conditions on record, and water levels in spring pools lowered dramatically (Figures 6 & 7). Among the nine subunits compared in the NAWQA study, the subunit containing the Beaverdam Creek watershed and aquifer was found to have the highest rate of daily surface water withdraw (12 million gal./day), the greatest annual crop harvest (140

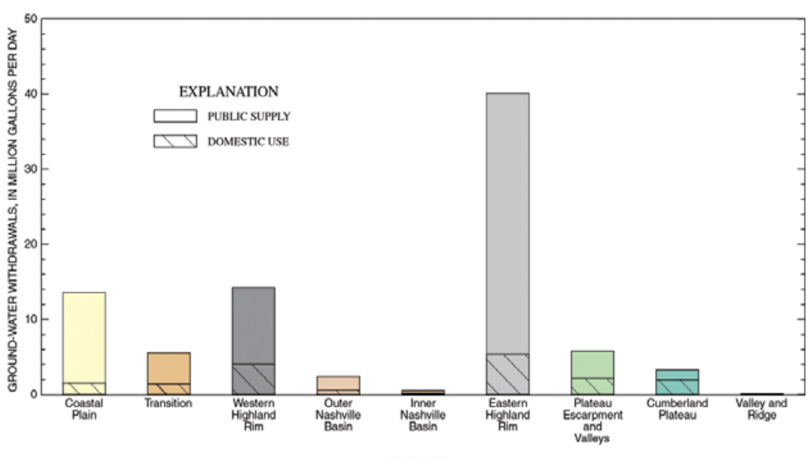

Figure 4. Daily groundwater withdraw per geologic subunit. Beaverdam Spring Complex is entirely contained within Eastern Highland Rim subunit (NAWQA 2009).

harvested acres/sq.mi.), the highest rate of wastewater discharge (>25 million gal./day), the highest annual nitrogen input from fertilizer (7.1 tons/sq.mi.), the highest total nitrogen input (>15.2 tons/sq.mi.), the highest annual phosphorus input from fertilizer (1.37 tons/sq.mi.), and second highest total phosphorus input per square mile (2.8 tons/sq.mi.)(NAWQA 2001, U.S. Dept. Commerce 1994) (Figure 5). With new development, will come additional demand for clean freshwater, and ecological stress from storm water runoff, chemical and wastewater contamination, and reduced aquifer recharge. Sandel (pers. obs. 2004-2007) has documented increased groundwater withdrawal by private landowners from springheads of the Beaverdam Creek/Spring system (Thorsen Spring, Horton Spring, Lowe's Ditch, and Pryor Branch/Spring systems), dredging (Horton Spring and Pryor Spring #1), herbicide contamination & algal blooms (Pryor Spring 1 and 2, Thorsen Spring), and the removal of riparian and aquatic vegetation (Thorsen Spring, Horton Spring, Pryor Spring #1).

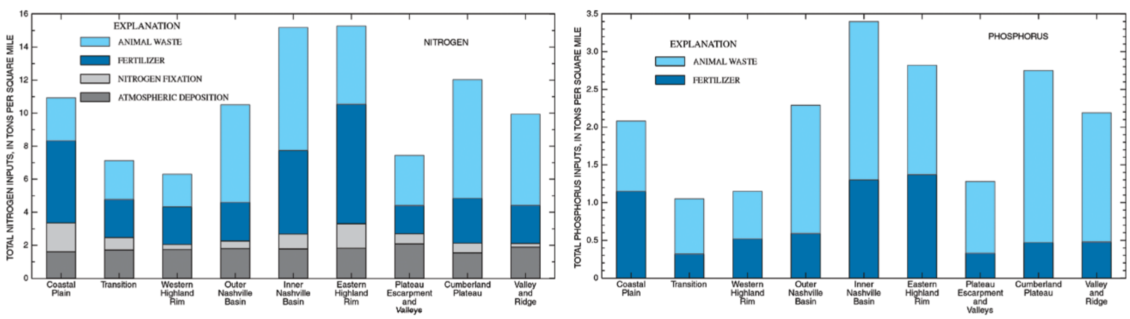

Figure 5. Total Nitrogen and Phosphorus input in 1992 (NAWQA 2009). Note the substantial contribution from fertilizer runoff in the Eastern Highland Rim.

The proposed 1,322-acre industrial site on Moss Spring has the potential to disrupt adjacent wetlands, increase the amount of impervious surface and the resulting stormwater runoff into the spring head, spring run, and recharge areas. The size of the site suggests a significant reduction of the recharge area for the spring habitat of the Spring Pygmy Sunfish. Similar effects are to be expected from the 490 acre Greenbrier site to the south (Figure 2). Although the proposed Volkswagen plant was relocated to Chattanooga, TN, the Limestone County Economic Development Association (LCEDA) and Huntsville chamber of commerce continue to advertise this and similar sites for construction of industrial facilities, stating:

> With approximately half of the area's economy tied to federal defense and space spending, the chamber works to strengthen the scope of defense and space-related opportunities and to complement and add diversity to the regional economic base by attracting non-government dependent employers.

Figure 6. Pryor Spring #1(Aug 2007) showing cause and effect of groundwater overharvest during extreme regional drought. Extirpation at this locality was directly tied to the same activity in preceding months.

Figure 7. Huntsville sewer line construction, within 50 feet of Beaverdam Creek channel (left) resulting silt load emptying into spring fed ecosystem and *E. alabamae* habitat (right)

Figure 8. Moss spring (type locality) at normal water level Sept 2006 (left), and following groundwater overharvest and regional drought Sept 2007 (right).

Figure 9. Roadside pollution and runoff at Moss Spring (type locality) June 2006

Figure 10. Algae bloom at Pryor Spring #2 2007 (left) and defunct silt fence along new Huntsville sewer line installation Oct 2009 (right)

B. OTHER NATURAL EVENTS OR HUMAN-RELATED ACTIVITIES

According to Sandel (pers. comm. 2007), Spring Pygmy Sunfish exhibits metapopulation structure by occupying all suitable spring borne habitats including sites under bridges and in pastures where there is flowing spring water. This suggests that the population is a single semi-continuous group of subpopulations; where individuals from each spring pool are identifiable with genetic markers, creating a structured population, with limited but regular gene flow among demes or subpopulations. In the Spring Pygmy Sunfish metapopulation, the genetic viability of subpopulations (e.g. Moss Spring or Beaverdam Spring) is interdependent. Thus, migration between springheads is very important in maintaining genetic diversity within these small areas. Even though subpopulations may be naturally extirpated at times, due to drought or other ecological issues, the simultaneous loss of many subpopulations may cause the metapopulation (species) to become extinct. The Beaverdam Creek metapopulation is therefore considered a single population, not a number of small populations.

Protecting only the springheads and small portions of spring runs may inadvertently cutoff the dispersal routes of the species by allowing these areas to be modified by land or water use practices. This may result in a genetically extinct subpopulation because it is no longer contributing to the genetic viability of the metapopulation.

With the inundation of Wheeler Reservoir, a host of palustrine species have gained potential access to the wetland habitats of Beaverdam Creek. Where the Tennessee River was once a rather swift and shallow system with few associated wetlands, the impoundments now create continuous habitat for many predators and potential competitors from the Mississippi and Ohio River basins. Of specific concern are the predator species; pirate perch (*Aphredoderus sayanus*), grass pickerel (*Esox americanus*), and the potential competitors; the flier (*Centrarchus macropterus*) and bantam sunfish (*Lepomis symmetricus*). The Asian silver and bighead carps (*Hypopthalmichthys* species) threaten to disturb the Beaverdam Creek ecosystem from the bottom up, by rapidly consuming significant proportions of phytoplankton and zooplankton. Although these species has not been observed in the Beaverdam Creek system, they are present in lower portions of the Tennessee River, and the Wheeler Reservoir represents an ideal habitat for this invasive fish. The only observed invasive fish species within the watershed is the grass carp (*Ctenopharyngodon idella*). This species was stocked in Pryor Spring #1 and Thorsen Spring to eradicate native vegetation (which clogs irrigation pumps). The status of the grass carp in this system is unknown at this time.

Apart from fishes, other invasive species also threaten to disturb the Beaverdam Creek ecosystem, and the spring-adapted species therein. Specifically, floating emergent aquatic vegetation (EAV), such as Amazonian parrot feather (*Myriophyllum aquaticum*) and water Hyacinth (*Eichhornia* species). These species grow rapidly and effectively outcompete the native submerged aquatic vegetation (SAV), including *Myriophyllum verticillatum* and the imperiled *Ceratophyllum echinatum*. In contrast with the native SAV, the invasive floating species store nutrients in the aerial stems and leaves, leaving little nutrition or protective cover for spring adapted crustaceans or other invertebrates. As these animals serve as the food base for *E. alabamae*, a transition to EAV is soon followed by eradication of spring pool invertebrates, and then eradication of the spring pygmy sunfish and other specialist predators.

C. THE INADEQUACY OF CURRENT REGULATORY MECHANISMS

Although the State of Alabama lists the Spring Pygmy Sunfish as a Priority 1 species, there are no State or Federal laws protecting *Elassoma alabamae* or its habitat (Mayden 1993, Warren 2004). Current State and Federal laws and regulations involving alteration of wetlands, channelization, water withdrawal, pesticide use and other agriculture best management practices and buffer zones to protect water quality and quantity within spring systems are available but these do not prohibit destroying the fish or its habitat.

Enforcement of current laws and regulations are essential to the species survival. Five private landowners own the Spring Pygmy Sunfish habitat. Among these landowners, three have demonstrated a propensity to conduct activities that damage *E. alabamae* habitat and eradicate subpopulations. Mr. Richard Pryor Jr. has repeatedly applied herbicides, and dredged Pryor Spring #1 in order to eliminate submerged vegetation, (which may clog the intake of irrigation pumps). Previous attempts to eliminate vegetation including manual removal by Mr. Pryor's employees, and introduction of the invasive grass carp (*Ctenopharyngodon idella*) at Thorsen Spring. At both localities (Thorsen Spring and Pryor Spring #1), Mr. Pryor has withdrawn water from the spring pool at rates up to 16,000 gallons per minute (Sandel pers. obs.). In 2007, both sites were pumped to a level which ultimately destroyed the existing vegetation, and either extirpated (Pryor Spring #1) or severely decreased (99% abundance reduction at Thorsen Spring) the local spring pygmy sunfish subpopulation. In the summer of 2008, Mr. Pryor was presented with a restraining order which prevented him from accessing Thorsen Spring, which is owned by Ms. Susan Towe. He was granted temporary authorization from a local judge to continue irrigation later in the summer, which continued even during extended periods of rainfall. Under this temporary authorization, Thorsen Spring was pumped at an unsustainable rate, which caused the spring to flow backward for a number of days. This occurred even after Mr. Pryor had been consulted regarding the sensitivity of the species living in the spring pools (Sandel pers. comm.).

The Macdonald and Horton properties surround most of the Beaverdam Creek channel between Beaverdam Lake and I-565. Horton Spring has been impacted by intensive beef agriculture (Macedon Farms), with direct livestock access to the spring pool. Riparian vegetation has been cleared for over 100 yards upstream of Horton Spring. Additionally, Horton Spring has been dredged in the form of a cattle pond, in order to provide easier accessibility for the livestock. Historically, cattle access was detrimental to spring pygmy sunfish abundance at Moss Spring (Sandel 2008). Local abundance at Horton Spring has decreased by 80% since pre-2007. At some point between 1970 and 2004, a large portion of Mr. Horton's Tupelo Gum swamp surrounding Beaverdam Creek was cleared for forestry purposes. What once was a large area of suitable habitat for the spring pygmy sunfish has been replaced by a dense stand of cattail, which is relatively poor habitat, and supports no viable populations.

The Macdonald family owns land which has recently seen the installation of a Huntsville sewer line, which runs parallel to the Beaverdam Creek channel for over three miles (Sandel pers. obs. September 2009). At the Macdonald/Sewell property boundary, the sewer line is within 44 feet of Beaverdam Creek. At other points, the sewer is within 32 feet of the forested wetlands inhabited by the spring pygmy sunfish. This presents an obvious and imminent threat to the Beaverdam Creek ecosystem. Plans for completion of this sewer line and associated development should be reconsidered in light of the legal status of the spring pygmy sunfish and cohabiting species.

Dr. Sewell owns all spring pygmy sunfish habitat north of Beaverdam Lake. Dr. Sewell is currently in negotiation to establish a conservation easement for Beaverdam Spring, the northernmost subpopulation of the species. However, just across Greenbriar Road to the west, Dr. Sewell is selling 1,322 acres, advertised as an industrial development site on the LCEDA website (exhibit). This site includes Moss Spring, the type locality of *E. alabamae*. Any industrial or residential development on this property would severely threaten the viability of the subpopulations inhabiting Moss Spring, Lowe's Ditch, and Beaverdam Spring. As these are the three most isolated and productive populations in existence, the survival of these subpopulations should be viewed as critical to the long term persistence of the species.

Clearly, the spring pygmy sunfish is in need of regulatory protection from the activities of one or more of these landowners.

D. OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Over utilization has not been implicated in the decline of this species. Monthly surveys for life history study are nonlethal, and previous lethal sampling for genetic work never constituted more than 10 % of the total individuals collected per site (Sandel pers. comm.).

E. DISEASE AND PREDATION

Disease is not known to be a factor in the status of this species. However, Jandebeur (1997) did find the remains of a Spring Pygmy Sunfish in the stomach of a chain pickerel, *Esox niger*, collected from Pryor Spring #2, suggesting that the species is eaten by larger, piscivorous fishes. Walsh and Burr (1984) found a closely related species (*Elassoma zonatum*) in the gut contents of warmouth sunfish (*Lepomis gulosus*). Sandel (2008) found that Spring Pygmy Sunfish abundance is negatively correlated with warmouth abundance in Beaverdam Creek. See section V.B. for comments on the threat of non-native predators in this system.

Inbreeding has been documented and suggested as a potential cofactor in the decline in Pryor Spring #2, which was a reintroduction attempt that was founded from 36 individuals. Genetic analysis indicate that only eight females were likely to have contributed to the F1 generation at Pryor Spring #2 in 1985 (Mettee and Pullium 1986). Morphological indication of inbreeding was manifested in the form of thoracic lordosis (bent spine), exhibited by up to 10% of a monthly population sample (Sandel 2008).

VI. CRITICAL HABITAT

Petitioners request the designation of critical habitat for the Spring Pygmy Sunfish concurrent with its final listing. Critical habitat should include the primary channel of Beaverdam Creek, all of its tributary streams, associated wetlands, and riparian vegetation, including a 300 foot buffer zone surrounding all saturated ground within the watershed (USGS HUC 060300020703), and the recharge basin for these streams, as recommended by Sandel (2008). The specific latitudinal and longitudinal extent of critical habitat will be provided in electronic (GIS shapefile) and printed format upon request.

Prohibited activities within the buffer zone would include, deforestation, land clearing, industrial and residential development, structural installation, aquaculture, stocked farm ponds, pesticide and herbicide use, and impervious surface installation (excepting public road construction), and any other activity which would degrade spring pygmy sunfish habitat. Additionally, to prevent contamination of the aquifer and reduction of seasonal spring recharge, impervious surfaces (pavement, concrete, parking lots, industrial development, etc.) should be limited to less than 15% of the watershed surface area exclusive of the buffer zone. Therefore, total impervious surface area within the Beaverdam Creek watershed (USGS HUC 060300020703) should not exceed 2,616 acres.

Critical habitat is defined by Section 3 of the ESA as:

(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species. 16 U.S.C. §1532(5). The designation and protection of critical habitat is one of the primary ways in which the fundamental purpose of the ESA, "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved," (16 U.S.C. §1531(b) (emphasis added)) is achieved.

Critical habitat receives additional protection through Section 7 of the ESA. The Section 7 consultation requirements provide that no action authorized, funded, or carried out by any federal agency will "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical habitat]." 16 U.S.C. §1536(a)(2) (emphasis added). "Destruction or adverse modification" is further defined in the implementing regulations as an "alteration [of habitat] that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species." (50 C.F.R. §402.02). This prohibition is separate and distinct from, and in addition to the prohibition against actions which "jeopardize the continued existence of" a species. "Jeopardize the continued existence of" is defined as "to reduce appreciably the likelihood of both the survival and recovery of a species by reducing the reproduction, numbers, or distribution of that species." (Id.)

Critical habitat designation offers an added layer of protection to ensure that a listed species' habitat - the loss of which is widely recognized to be the primary reason for most species' decline - will not be harmed. Without critical habitat designation, a listed species' protection under Section 7 of the ESA is effectively limited to avoiding "jeopardy" to the species in its occupied habitat, without separate consideration of the potential for "destruction or adverse modification" of habitat or suitable unoccupied habitat which may be essential to the species' recovery. This distinction was nicely summarized by the U.S. Fish and Wildlife Service in the Final Rule designating critical habitat for the northern spotted owl:

> The Act's definition of critical habitat indicates that the purpose of critical habitat is to contribute to a species' conservation, which definition equates to recovery. Section 7 prohibitions against the destruction or adverse modification of critical habitat apply to actions that would impair survival and recovery of the listed species, thus providing a regulatory means of ensuring that Federal actions within critical habitat are considered in relation to the goals and recommendations of a recovery plan. As a result of the link between critical habitat and recovery, the prohibition against destruction or adverse modification of the critical habitat would provide for the protection of the critical habitat's ability to contribute fully

> to a species' recovery. ***Thus, the adverse modification standard may be reached closer to the recovery end of the survival continuum, whereas, the jeopardy standard traditionally has been applied nearer to the extinction end of the continuum.*** (57 Fed. Reg. 1796 at 1822) (emphasis added)).

This added protection will be implemented through the issuance of a biological opinion under 16 U.S.C. §1536(b)(3)(A), which must suggest reasonable and prudent alternatives by which a finding of jeopardy or adverse modification may be avoided. Critical habitat designation also protects species by helping to define the meaning of "harm" under Section 9 of the ESA, which prohibits unlawful "take" of listed species, including harming the species through habitat degradation. Although "take" through habitat degradation is not expressly limited to harm to "critical habitat," it is practically much easier to demonstrate that the significance of the impact to a species' habitat where that habitat has already been deemed "essential," or "critical," to the species' continued survival. (*See* Palila v. Hawaii Department of Land and Natural Resources, 852 F. 2d 1106 (9th Circ. 1988)).

Critical habitat also helps species by providing for agency accountability through the citizen suit provision of the ESA. The citizen suit provision permits members of the public to seek judicial review of the agency's compliance with its mandatory statutory duty to consider the habitat needs of imperiled species. Also, the designation of critical habitat provides valuable information for the development of recovery plans that identify actions, including habitat protection, necessary for the recovery of the species.

The Spring Pygmy Sunfish will benefit from the designation of critical habitat in all of the ways described above. To give this type of protection to a species through the protection of its habitat was the clearly articulated intent of Congress in the 1978 and 1982 amendments to the ESA. Due to the small number of remaining populations, the Spring Pygmy Sunfish is potentially vulnerable to unrestricted collection, vandalism, or other disturbance.

However, it is not expected that the identification of critical habitat will increase the degree of threat to this species of taking or other human activity. In the absence of a finding that critical habitat would increase threats to a species, if there are any benefits to critical habitat designation, then a prudent finding is warranted. The biological needs of Spring Pygmy Sunfish are well understood to identify an area appropriate to designate as critical habitat. Therefore, critical habitat is both prudent and determinable for Spring Pygmy Sunfish.

VII. SIGNATURE PAGE

Submitted this 24th day of November 2009

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